Qualified Partner Program

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Nis, 27.11.2014

R&M

Convincing cabling solutions

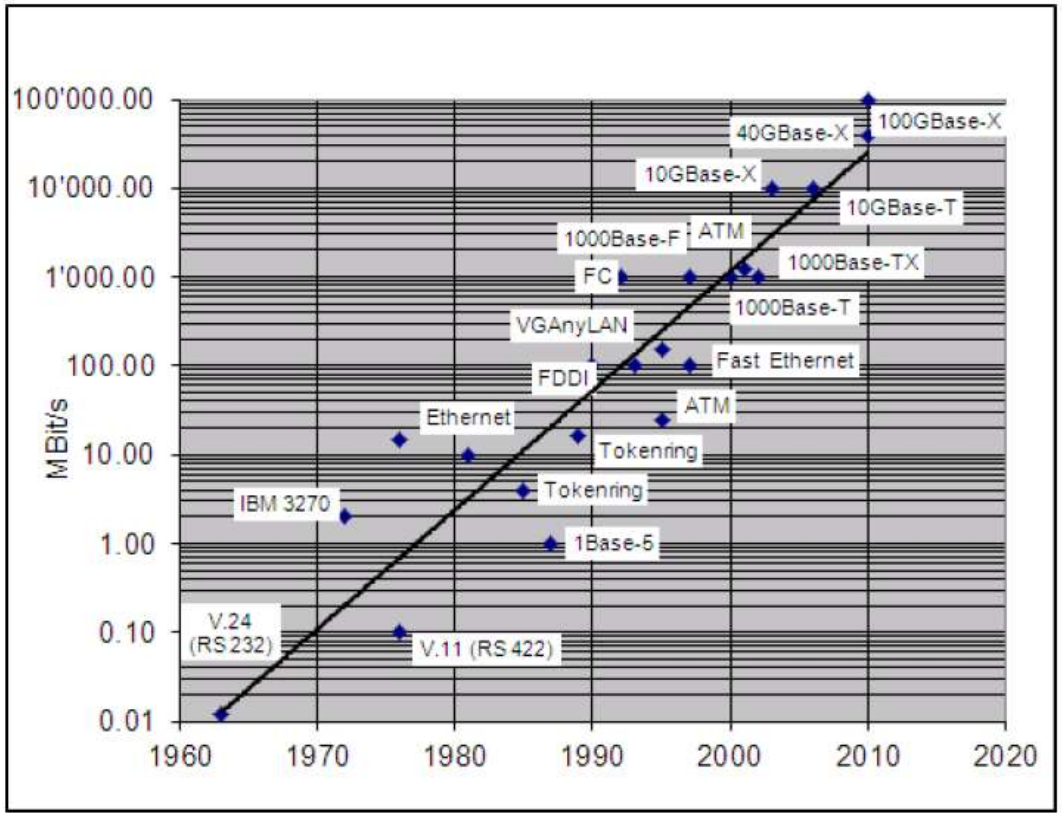
Agenda

- The Trends
- IEEE News
- EIA/TIA, CENELEC, ISO/IEC News
- Category 8.x Status
- R&M Solutions
- Telecommunication Infrastructure Project – Hands-on Exercise

The Trends

The Trends: Technology Driver 10GBASE-T

Data transmission technology over the past 50 years followed a slightly slowed down version of Moore's law (doubling every 26 months)

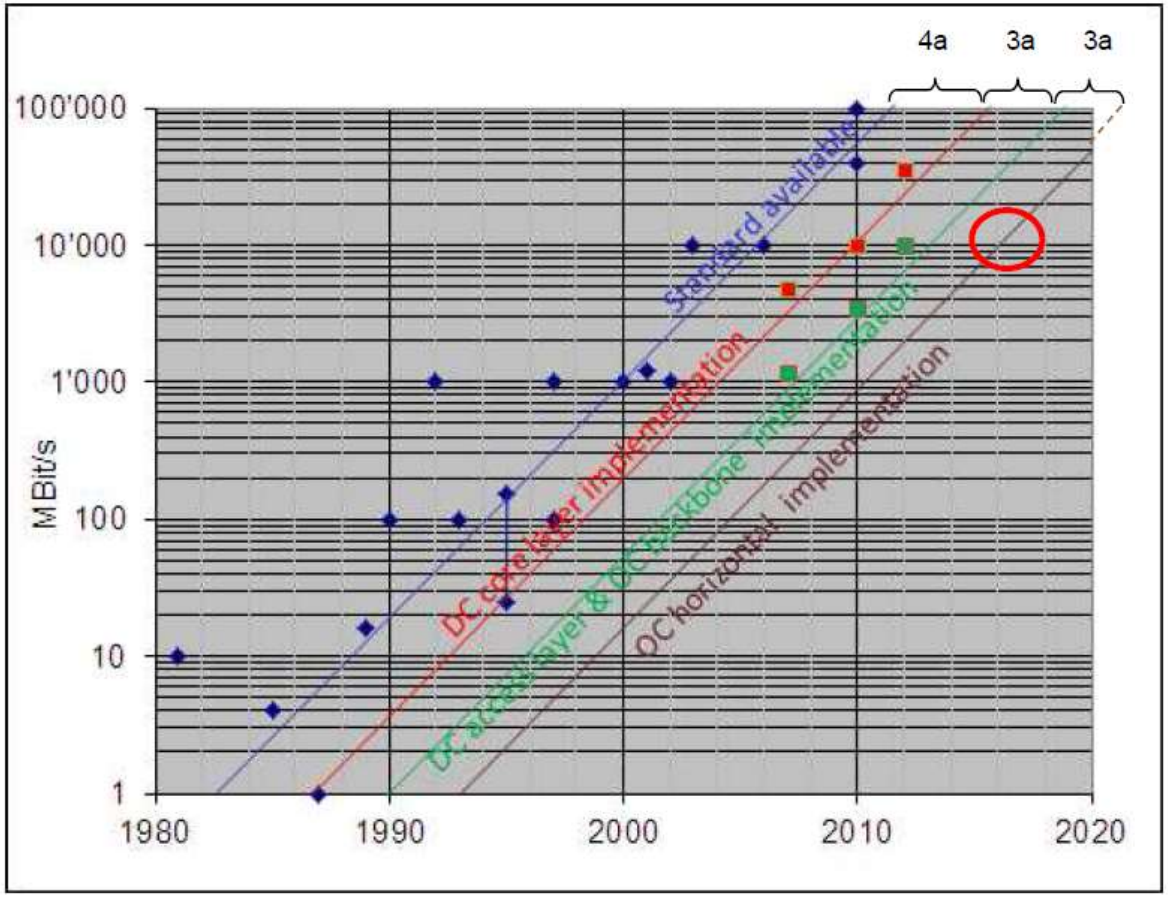


10GBASE-T in the Office Cabling

The increase of data transmission speed became faster the past 20 years (doubling every 21 months).

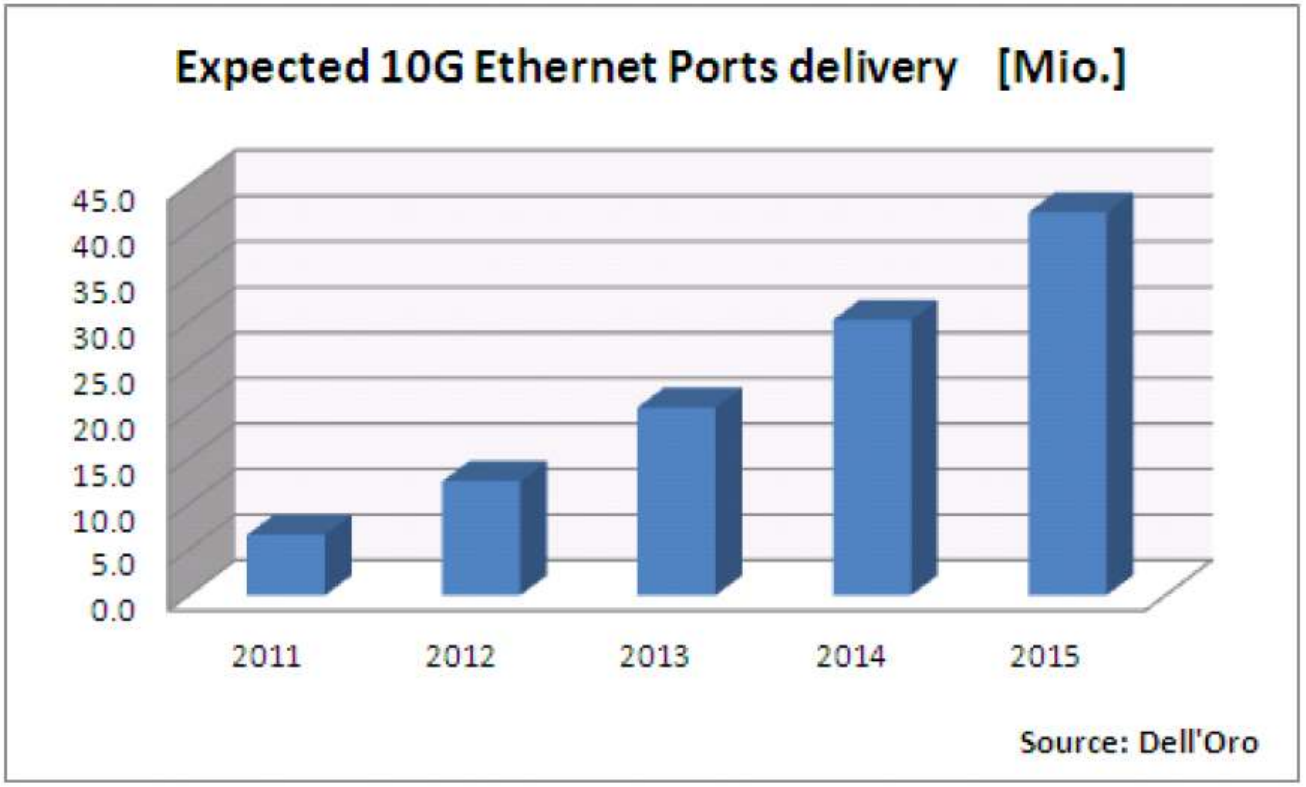
Adoption times for new technologies:
- 4 years in DC core layer
- 7 years in DC access layer
- 7 years in OC backbone
- 10 years in OC horizontal

In OC horizontal cabling 10GBase-T can be state of the art in 2016



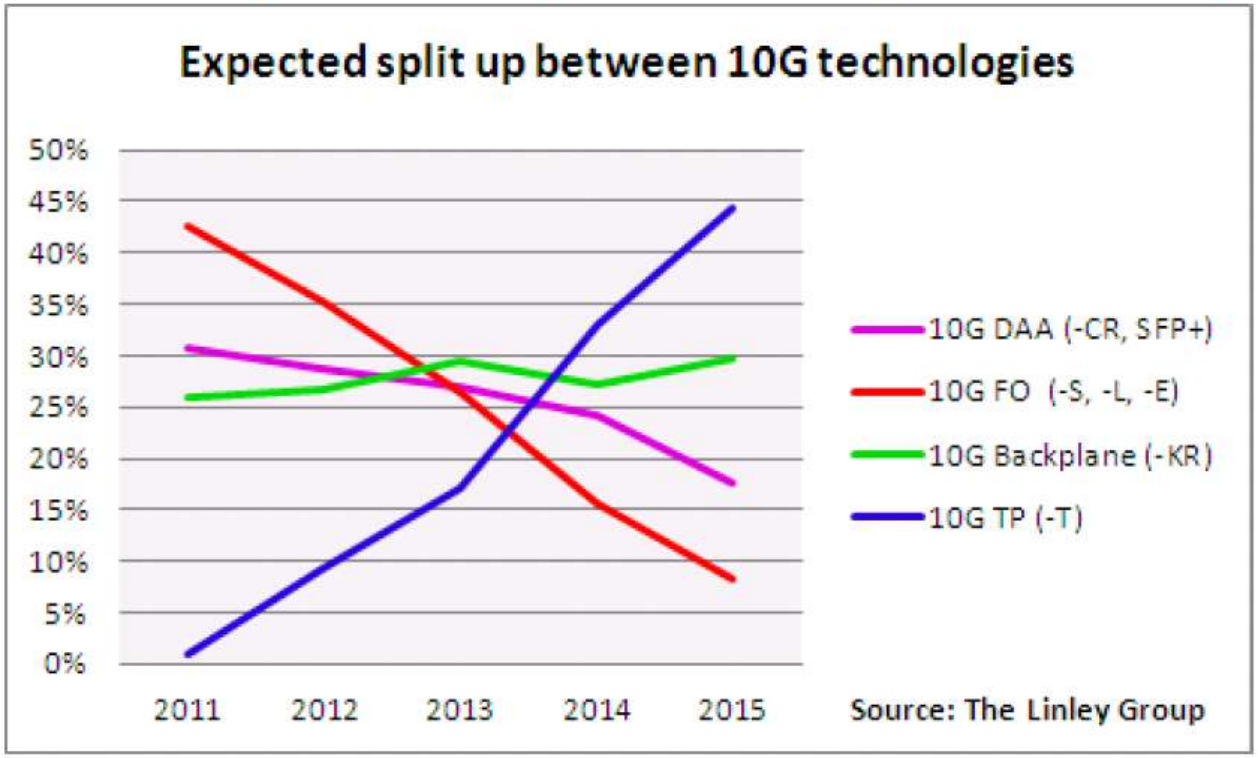
10G Ethernet

Shipped 10G Ethernet ports are expected to grow exponentially



10GBASE-T Technology Split

With new silicon chip technologies (40 / 28 nm lithography) 10GBase-T can overcome the problems of power consumption and port price



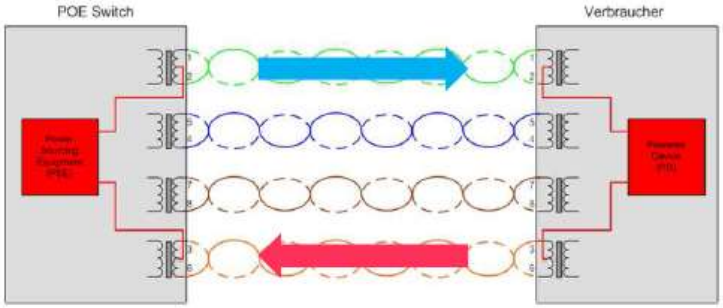
Forecasts indicate that by 2014 10GBase-T becomes the most used 10G protocol.

Summary - 10GBASE-T

- 10GBase-T breakthrough in office environment is imminent
- By 2016 10GBase-T could be the standard application in offices
- 10GBase-T is using all capabilities of CLASS EA cabling
- Only best quality CLASS EA cabling systemscan guarantee 100% 10GBase-T performance

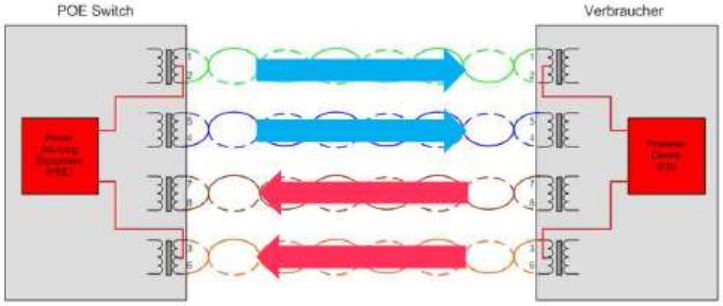
The Trends: PoE

Status today:
IEEE 802.3af:
Power over Ethernet **(POE)** = 15W
IEEE 802.3at:
Power over Ethernet **(PoE plus)** = 30W



Status tomorrow:
IEEE 802.3xx:
Power over Ethernet **(POE++)** = 60W

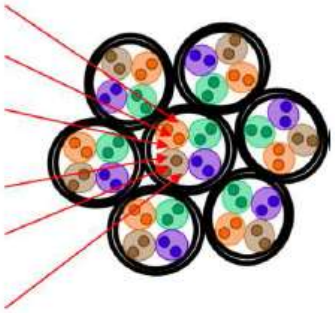
Future:
Power over Ethernet **(POE+++)** = 100W



Effects of PoE+: Cable heating

Values measured by IEEE working groups in cable bundles of 100.

Cat5e/u	AWG24	= 10 ºC
Cat5e/s	AWG24	= 8 ºC
Cat6/u	AWG24+	= 8 ºC
Cat6a/u	AWG23	= 6 ºC
Cat6a/s	AWG23	= 5 °C
Cat7	AWG22	= 4 ºC



At operating temperatures above 20°C, the maximum link length H must be reduced as follows:

Shielded cabling:	0,2% per °C
Unshielded cabling:	0,4% from > 20°C – 40°C
	0,6% from > 40°C – 60°C per degree

Cable type	Length-Factor Cat. 6, Cat. 7 Cables	Length of both Patch Cords	Patch cords incl. Insertion Loss Factor (1.5)		Ambient temperature °C	Temperature rise in Cable °C operating PoEplus	Total temperature °C		Max. Link-Length (Link-Length minus Temp.-Reduction Factor) Class D Formula *		Max. ambient Temperature °C (60 °C minus Cable Temp. Rise)
Cat. 5e / u (AWG 24)	109	1	10	15	94	20°C	10°C	30°C	0.4%/°C	90		50
						30°C	10°C	40°C	0.4%/°C	86		50
						40°C	10°C	50°C	0.4%/°C	83		50
						50°C	10°C	60°C	0.4-0.6%/°C	74		50
Cat. 5e / s (AWG 24)	109	1	10	15	94	20°C	8°C	28°C	0.2%/°C	90(92)		52
						30°C	8°C	38°C	0.2%/°C	90(91)		52
						40°C	8°C	48°C	0.2%/°C	89		52
						50°C	8°C	58°C	0.2%/°C	87		52
Cat. 6 (AWG	109	1.1	10	15								
								50°C	6°C	56°C	0.2%/°C	90(96)	83	54
Cat. 7 (AWG 22)	109	1.15	10	15	108	20°C	5°C	25°C	0.2%/°C	90(107)	89	55
						30°C	5°C	35°C	0.2%/°C	90(105)	87	55
						40°C	5°C	45°C	0.2%/°C	90(103)	85	55
						50°C	5°C	55°C	0.2%/°C	90(100)	84	55

Class D with a Cat 5e/s cable
H=109-FX = ***H=109- 15= 94m***

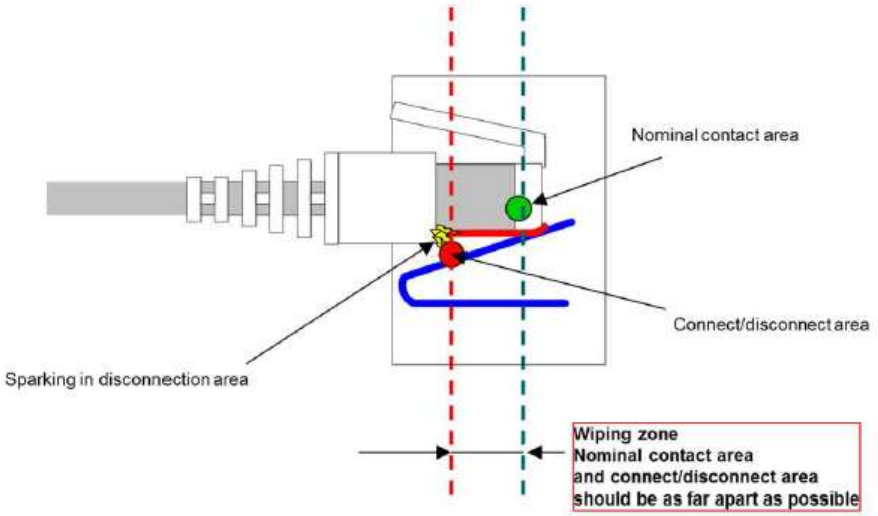
PoEplus at 30°C ambient temperature (30°C+8°C)

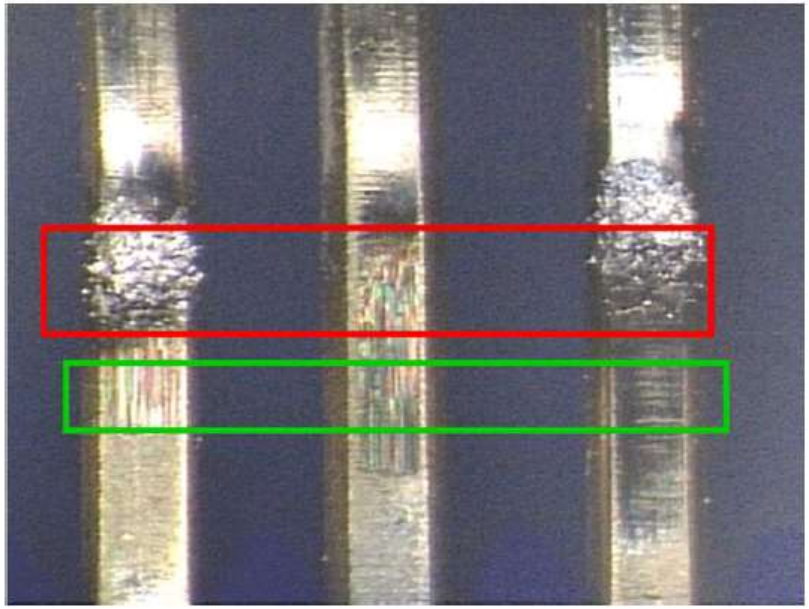
94- (18°C*0.2%)
94- 3.6%= 90.62m

Maximum ambient temperature: 60°C- cable temperature increase
60°C- 8°C= 52°C

- Current flow in cable generate heating of cable
- Higher temperature creates higher link attenuation
- Link length may have to be reduced to accommodate for attenuation increase

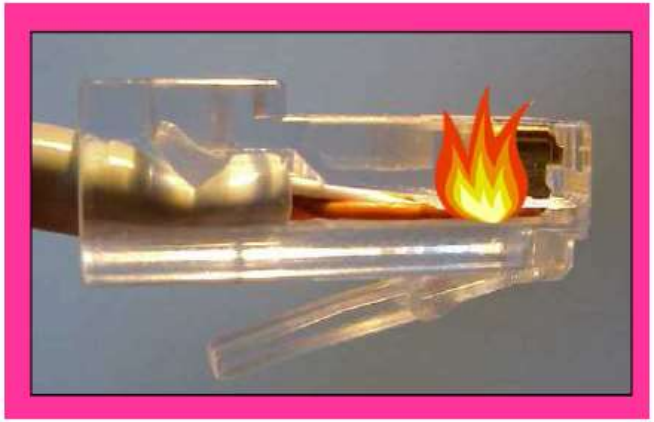
Effects of PoE+: Contact destruction

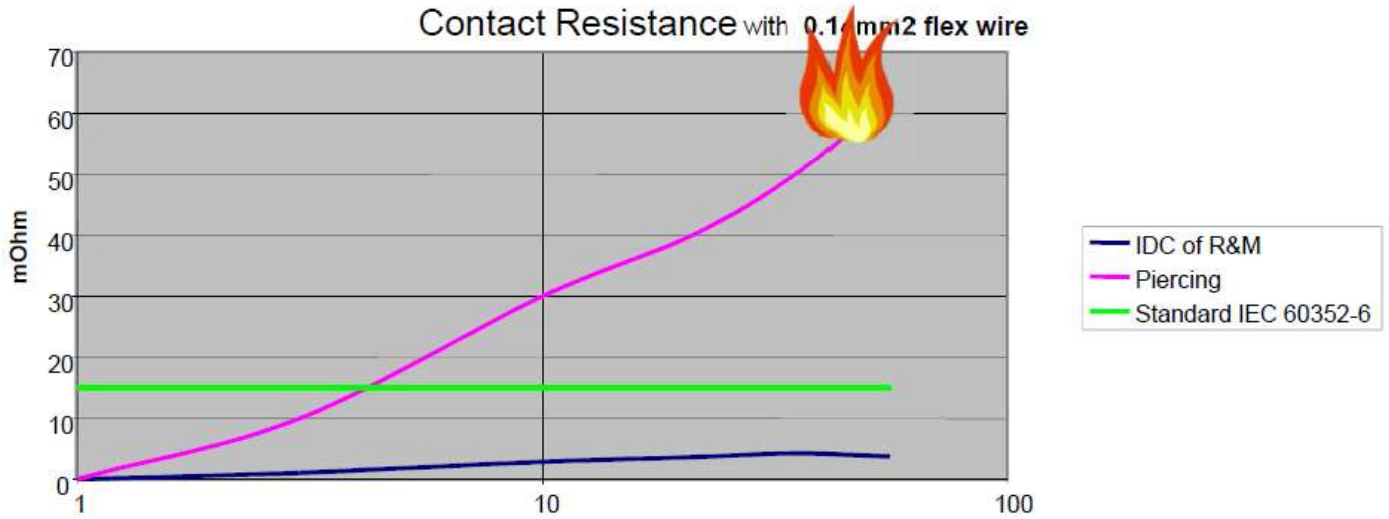




- Unplugging under load creates sparks that can destroy the contacts
- The higher the power the higher the destruction

Effects of PoE+: Plug destruction



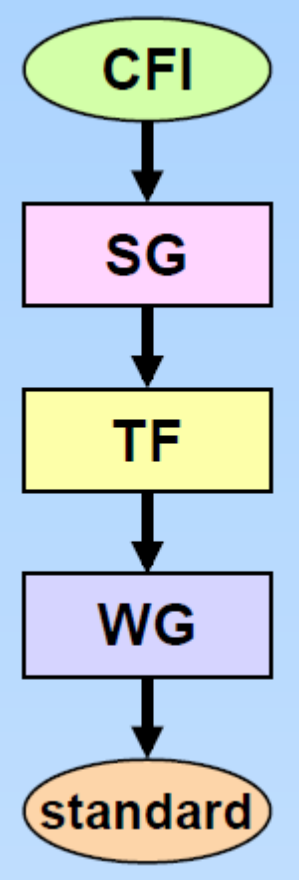


IEEE News

- 802.3bj 100G Cu backplane & twinax std published
- 802.3bm Next Gen 100G optical PHY sponsor ballot
- 802.3bp defining 1G via 1 pair for vehicle / industrial
- 802.3bq defining 40G over 30m of screened cabling
- 802.3bs definig 400G over MMF & SMF but not Cu
- 802.3bt defining 4-pair PoE with up to 100W at PD
- Study Group formed to investigate 1G over POF
- Study Group formed to investigate 25G / single lane

CFI = Call For Interest, SG = Study Group

TF = Task Force, WG = Working Group



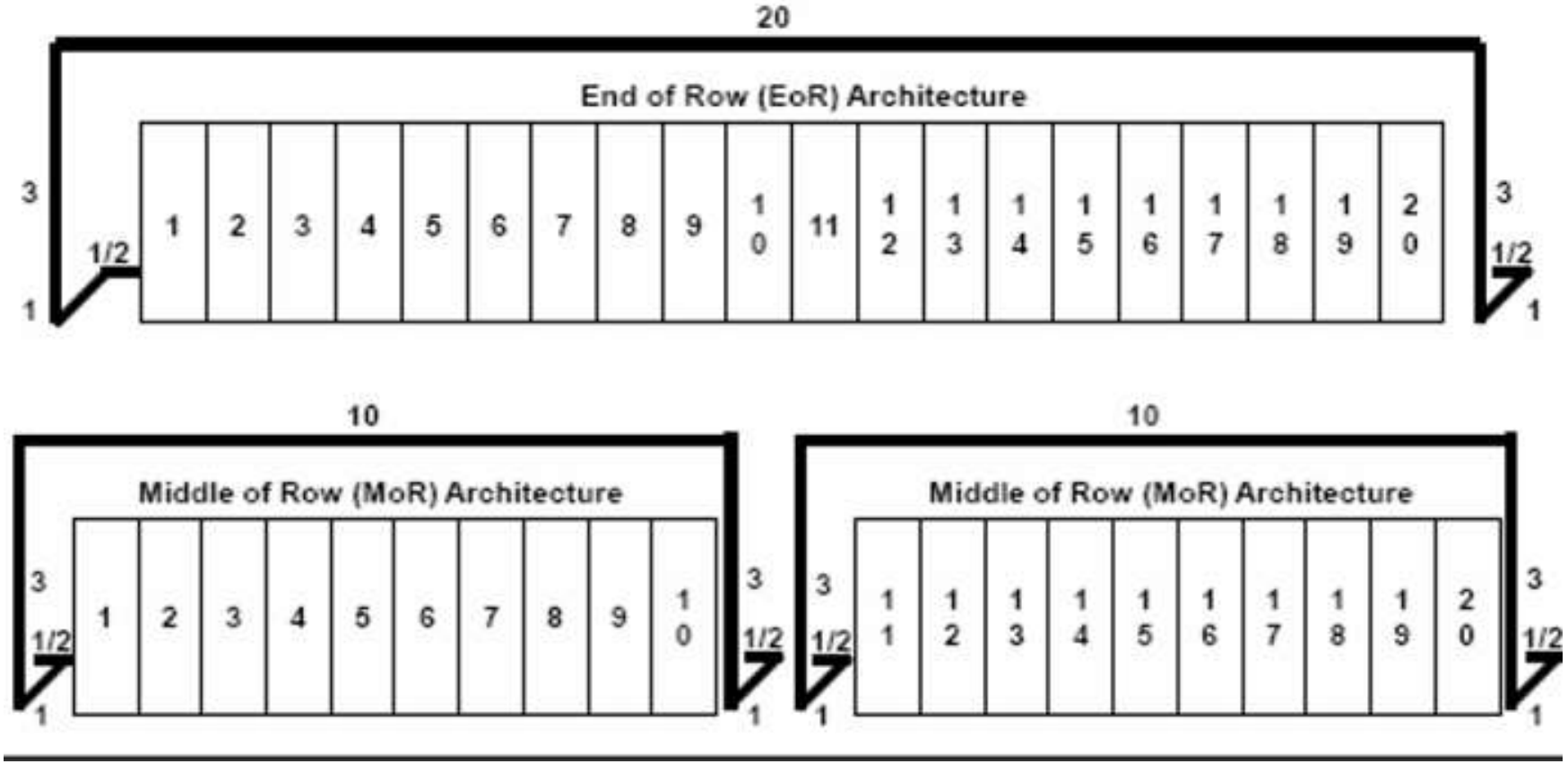
IEEE News: 802.3bm – Next Gen 100G Optical PHYs

- 100G via 4 lanes @ 25G instead of 10 lanes @ 10G
- 4x25G benefits high pack density, low cost & power
- 40G over 40km SMF link definition also included
- Support a BER of ≤ 10^{-12} at MAC/PLS interface
- Define 100G PHY for at least 100m of MMF
- Standard to be published end of Q1 2015

IEEE News: 802.3bp – Reduced TP Gigabit Ehernet

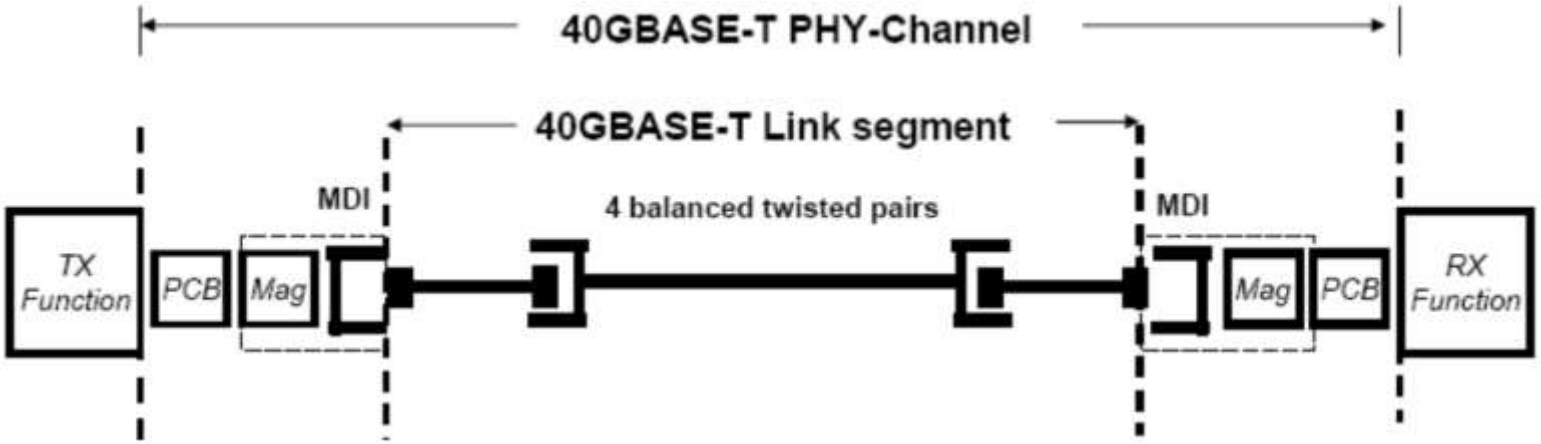
- Defining 1 pair 1000BASE-T for the automotive industry and industrial automation networks
- To be known as 1000BASE-T**1**
- Adopted 40m link for trucks, trains, planes, etc.
- 1-pair data line PoE being defined by 802.3bu
- 100m over single pair being defined by 802.3bw
- Standard to be published end of Q1 2016

IEEE News: 802.3bq – 40GBASE-T



IEEE News: 802.3bq – 40GBASE-T

- MDI-to MDI channels defined using s-parameters:
  - 4m channel with 0.5+3+0.5 configuration
  - 5m channel with 1+3+1 configuration
  - 30m channel with 3+24+3 configuration
  - 3m direct connect (i.e. cord)



IEEE News: 802.3bq – 40GBASE-T

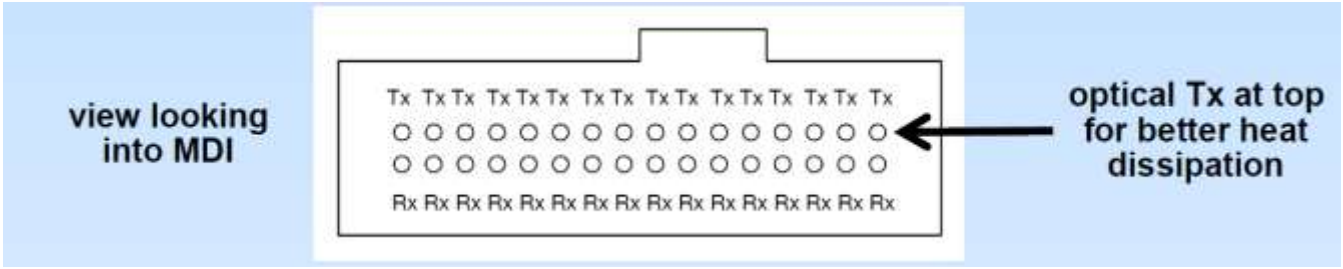
- Substantial re-use of 802.3an 10GBASE-T features
- Signaling rate of 3,200 Mbaud (4x10GBASE-T) adopted
- 1.6 Gbaud Nyquist + 25% = upper frequency of 2 GHz
- Supported cabling types = Class I, Class II and Cat.8
- Channel performance limits based on Class I / Cat. 8 (limits are inclusive)
- IEC 60603-7-51 / 81 adopted as an MDI connector *(Detail specification for 8-way, shielded, free and fixed connectors, for data transmissions with frequencies up to 500 MHz)*
- MDI = Medium Independent Interface (the equipment connector)

IEEE News: 802.3bq – 40GBASE-T Objectives

- Support full duplex operation only
- Support a BER of ≤ 10^{-12} at MAC/PLS interface
- Support a data rate of 40G at the MAC/PLS interface
- Support Energy Efficient Ethernet
- Support LAN using point-to-point links over structured cabling topologies with 2 mated connectors, including directly connected link segments
- Define a channel model based on copper media specified by ISO/IEC SC25 WG3 and TIA TR42.7, with the following:
  - 4-pair, balance twisted pair copper cabling
  - Up to 2-connectors
  - Up to 30m
- Standard to be published end of Q1 2016

IEEE News: 802.3bs – Next Generation Ethernet

- Defining 400G Ethernet over both MMF and SMF
- MMF approach likely to be parallel (e.g. 16x25G)
- SMF approach for 10km agreed to be duplex (2f)
- 400GBASE-SR16 Cabling:
  - 16x25G configuration parallel OM4 fibres each way
  - IEC 61754 will define 32f 2-row plugs with flat end-faces & adaptor (Type MPO)
  - Legacy 12f cables may support 32f interfaces via fan-out using 3x12f configuration



IEEE News: 802.3bs – Next Generation Ethernet

- Support full duplex operation only
- Support a BER of ≤ 10^{-13} at MAC/PLS interface
- Support a data rate of 400G at MAC
- Support Energy Efficient Ethernet
- Provide physical layer specifications which support link distances of:
  - At least 100m over MMF
  - At least 500m over SMF
  - At least 2km over SMF
  - At least 10km over SMF
- Standard to be published end of Q1 2017

IEEE News: 802.3bt – 4-Pair Power over Ethernet

- Defining 4-Pair PoE to deliver at least 49W at a PD
- Interest in achieving 100W power for LED lighting
- 4-Pair PoE system to be defined for 10GBASE-T
- Ad Hoc group studying cable and cord heating
- Support operation over the following channels with DC loop resistance of up to 25 ohms:
  - Class D or better 4-Pair copper medium from ISO/IEC 11801:2002, including Amendments 1 & 2
  - Class D or better media from ISO/IEC 11801:1995
  - Category 5e or better cable and components as specified in TIA-568-C.2
  - Category 5 cable and components as specified in TIA-568-A
- Standard to be published end of Q1 2017

IEEE News: 1G Ethernet over POF

- Study Group formed in March 2014
- 650nm LEDs over 50m of IEC 60793 type A4a.2 SI-POF
- 520nm lasers for longer reach of the same fibre type
- Key markets – residential, automotive & professional
- Support full-duplex operation only
- Support MAC data rate of 1G
- Support a BER of ≤ 10^{-12} at MAC/PLS interface
- Support 15m POF with 4 in-line connectors for automotive applications
- Support 40m POF with no in-line connectors for automotive applications
- Specify operations over at least 50m POF with 1 in-line connector for home & industrial applications

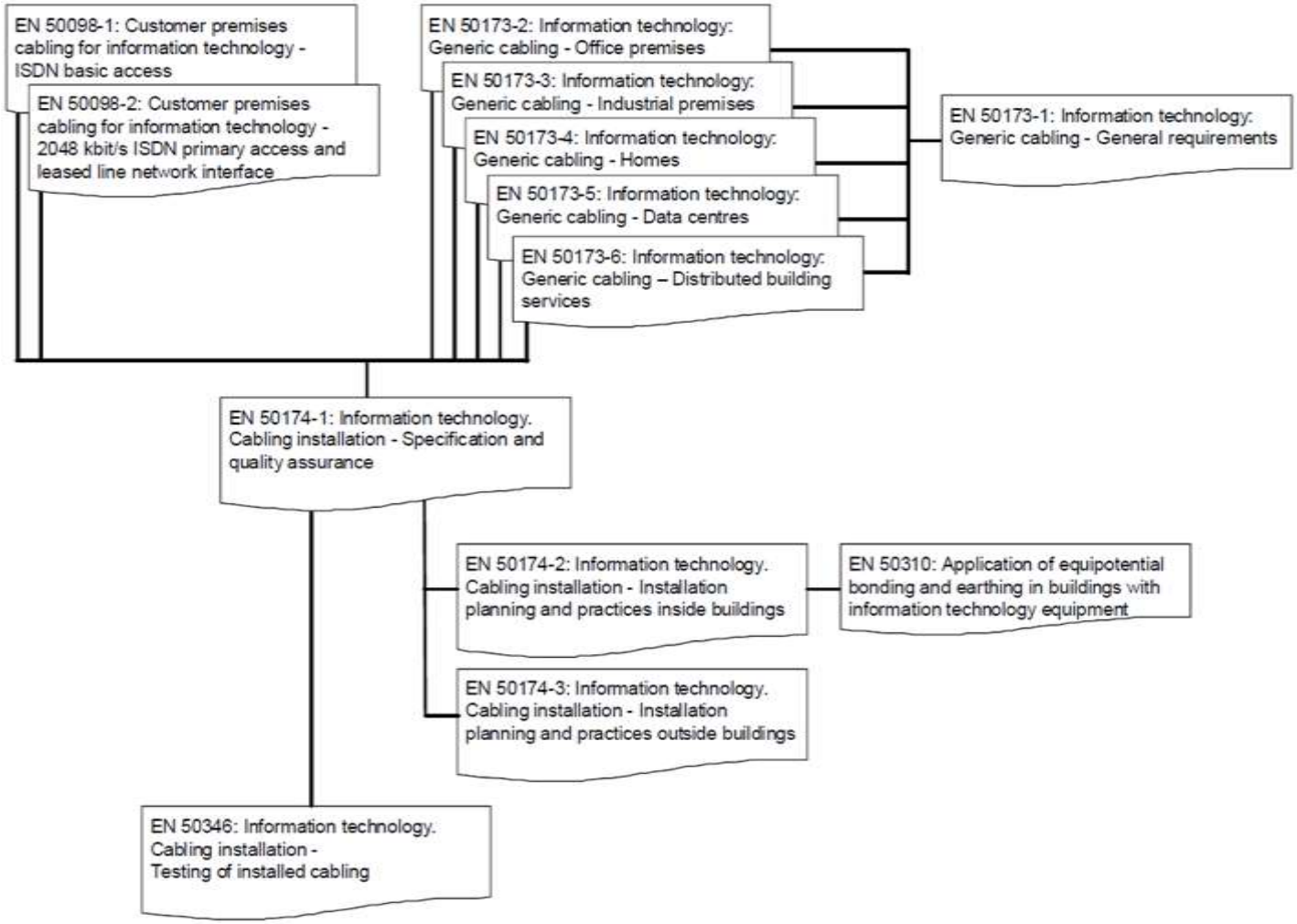
IEEE News: 25G Single Lane Ethernet

- Study Group investigating market need and feasibility for server interconnects, taking advantage of the existing PHY specs:
  - 802.3bj backplane & twinax links with 25G per lane
  - 802.3bm MMF links with 25G per lane

TIA News

- ANSI/TIA-568.0-D, Generic Cabling Standard
  - ANSI/TIA-568.1-D, Commercial Building Cabling Standard
- ANSI/TIA-862-B, Structured Cabling Infrastructure Standard for Intelligent Building Systems (Changed from Building Automation Systems BAS)
- ANSI/TIA-568-C.2-2009, Addendum 1, Next Generation, Category 8, Balanced Cabling Standard to support IEEE 802.3bq
- ANSI/TIA-1152A, Field Measurement for balanced cabling channels, revision for 2000MHz

CENELEC News



CENELEC News: EN 50173-6

Specifies generic cabling, that supports a wide range of communication services, which require Remote Powered Devices.

Remote Powered Devices Including:

- Telecommunications, e.g. wireless access points;
- Energy Management, e.g. Lighting, Power Distribution, Incoming Utility Metering;
- Environmental Control, e.g. Temperature, humidity;
- Personnel Management, e.g. Access Control, Camneras, Passive Infra-Red (PIR) detectors, Time and Attendance Monitoring, Electronic Signage, Audio-Visual (AV) Projectors;
- Personal Information and Alarms, e.g. Paging, Patient Monitoring, Nurse Call, Infant Security

CENELEC News: EN 50173-6

Structure

- In general, all functional elements, subsystems and interfaces from the CD to FD as described in EN 50173-1 are applicable.
- In addition to EN 50173-1, two implementations of generic cabling for distributed building services are specified:
  - Type A generic cabling to the SO
  - Type B generic cabling to the SCP, thereby providing the opportunity for:
    - Application-specific cabling to be installed between the SCP and terminal equipment
    - Application-specific equipment to be connected at the SCP

CENELEC News: EN 50173-6

Type A functional elements:

- Service Distributor (SD)
- Service Distribution Cable
- Service Concentration Point (SCP)
- Service Concentration Point Cable
- Service Outlet

Type A functional elements:

- Service Distributor (SD)
- Area Feeder Cable
- Service Concentration Point (SCP)

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TYPE A - Structure

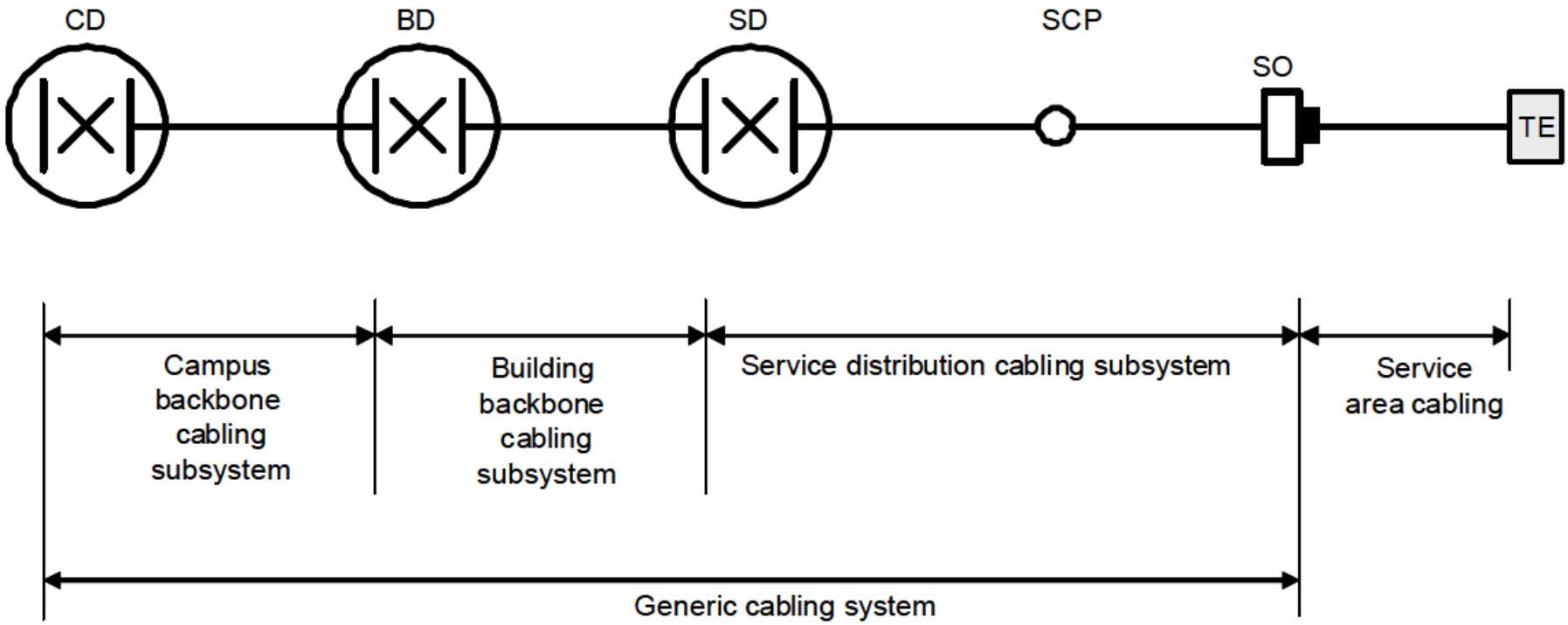

Figure 2 — Structure of Type A generic cabling

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TYPE B – Stand-alone Structure

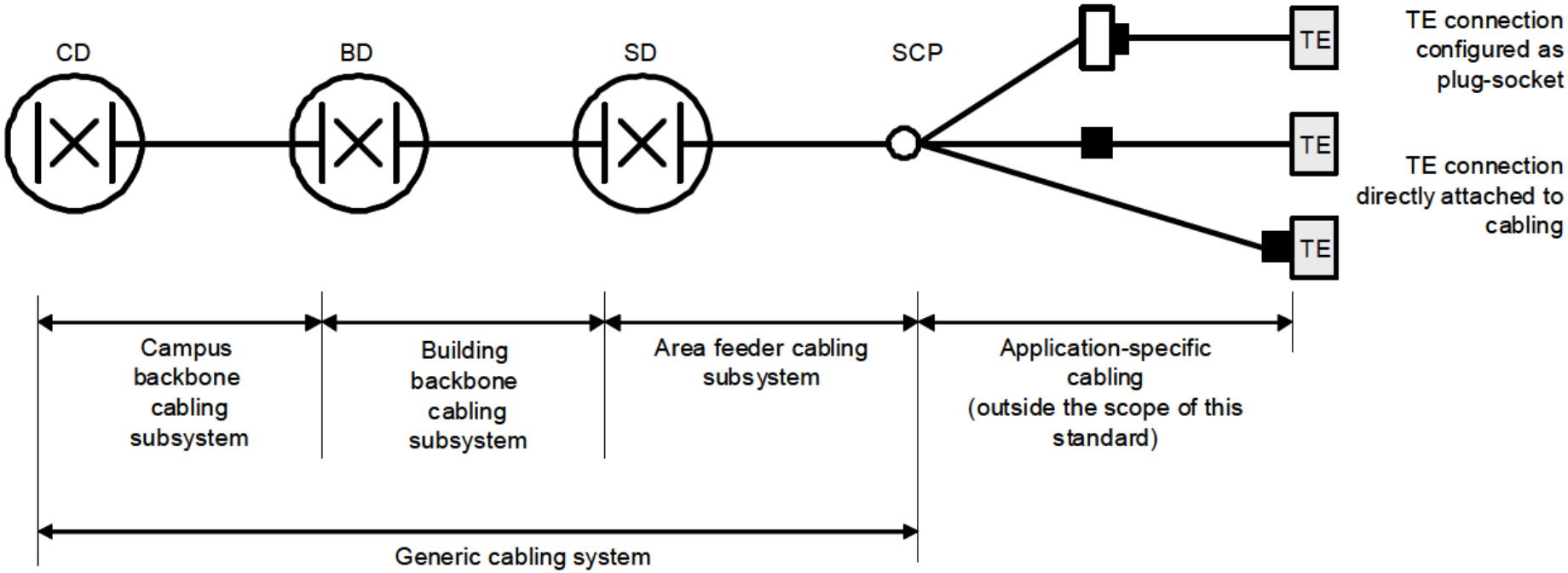

Figure 4 — Structure of Type B generic cabling

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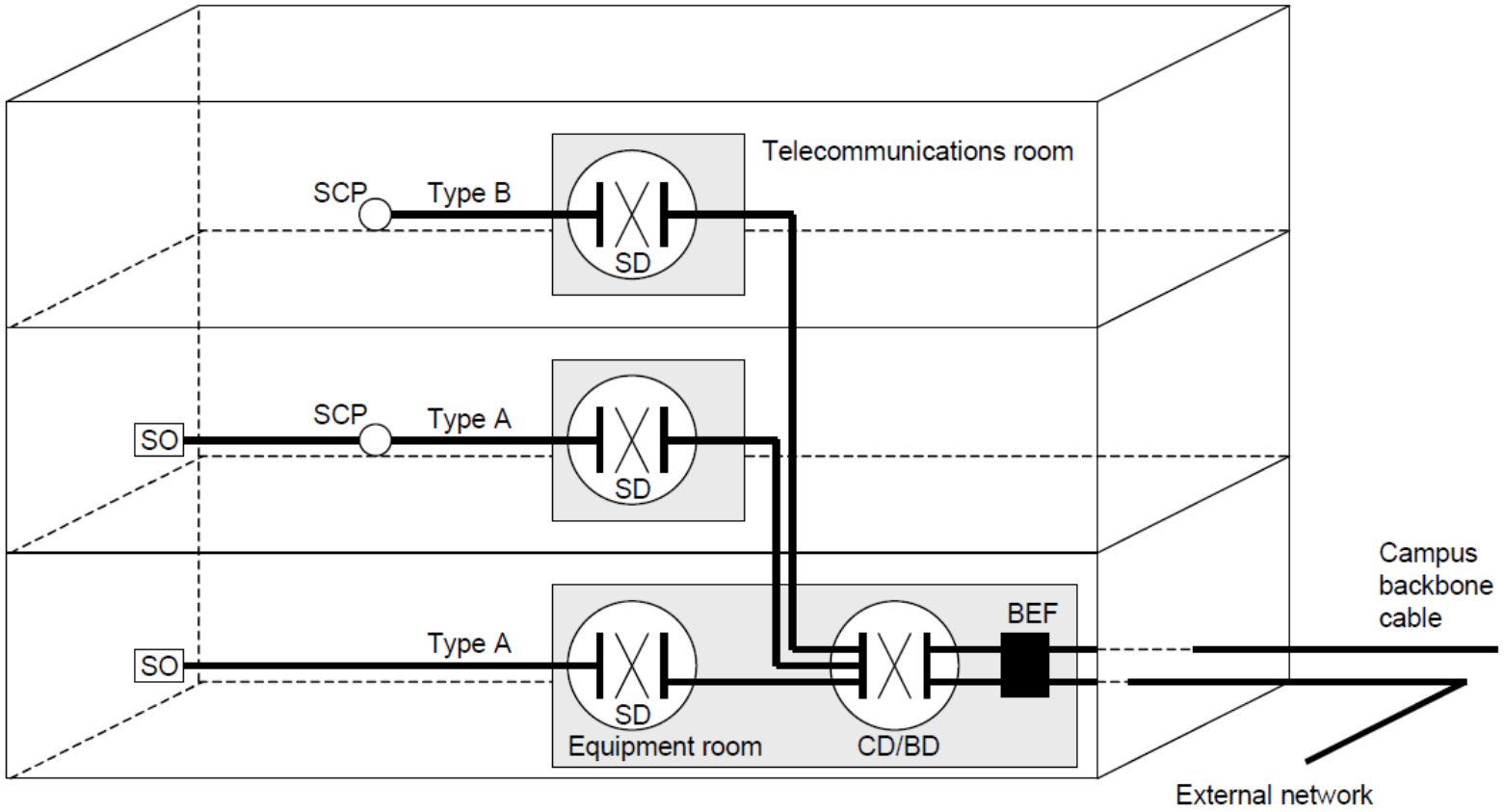
ACCOMODATION OF FUNCTIONAL ELEMENTS - GENERAL



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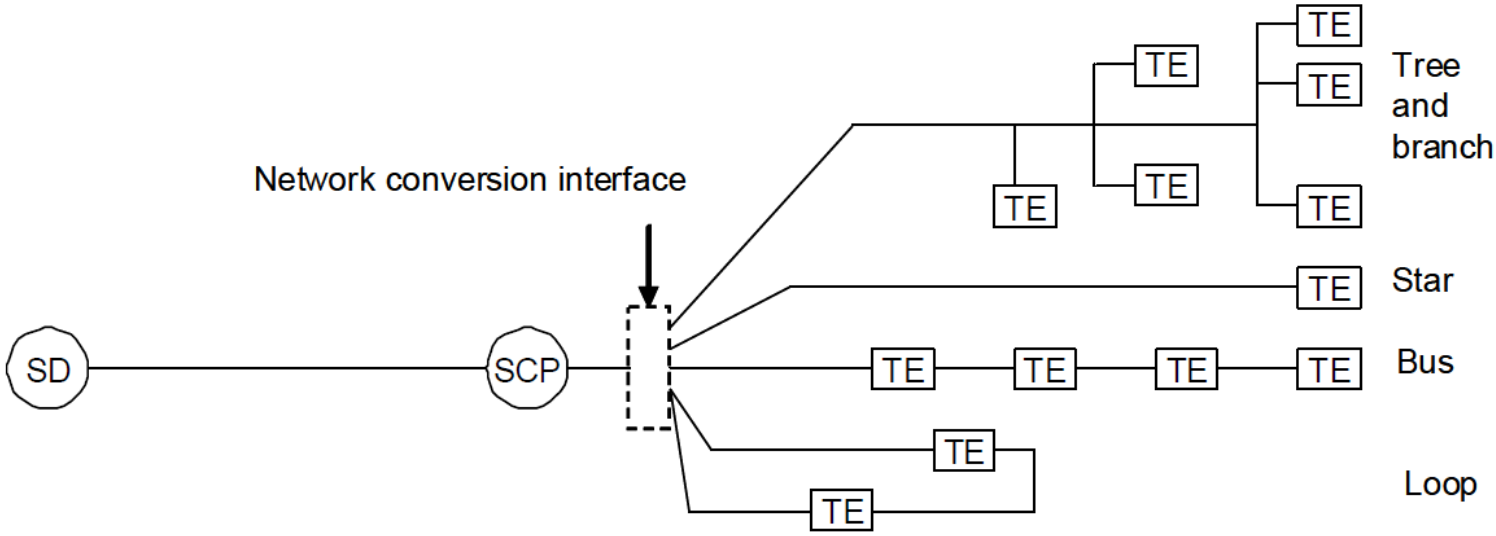
ACCOMMODATION OF SOs

- **Type A generic cabling:**
  - Located in the service area
  - Depending on the design of the building
- **Type B generic cabling:**



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INTERFACES – Equipment and Test Interfaces

- **Type A generic cabling**

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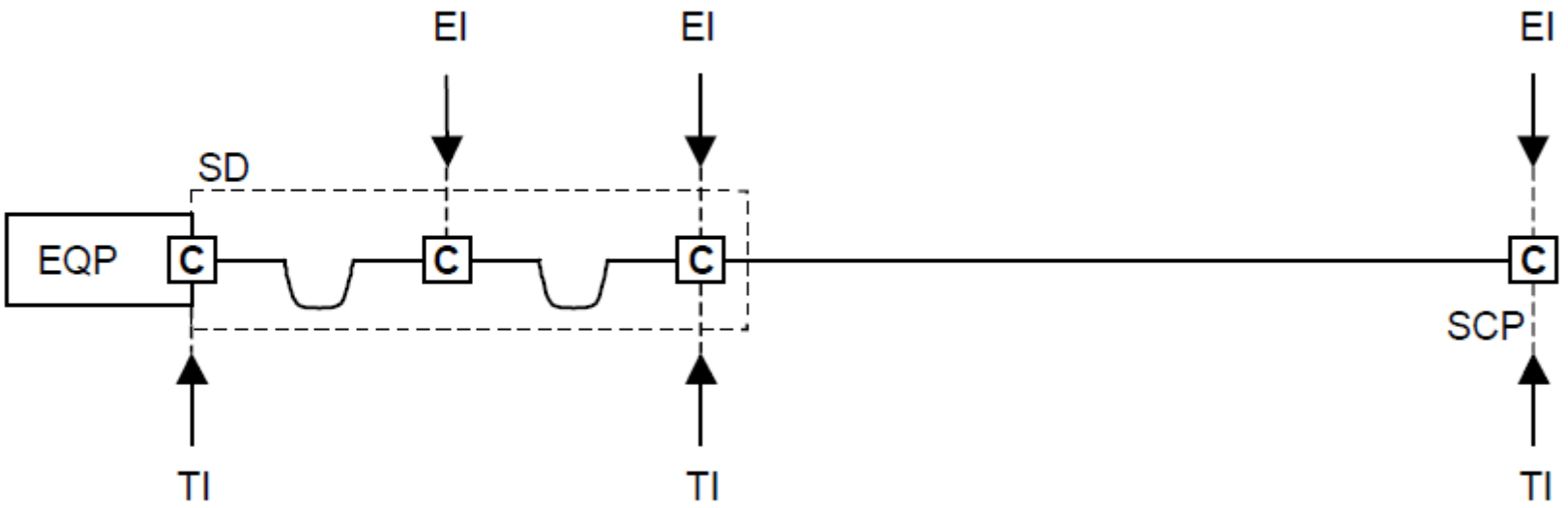
INTERFACES – Equipment and Test Interfaces

- **Type B generic cabling**



CENELEC News: EN 50173-6

DIMENSIONING AND CONFIGURING

- **Maximum Channel Lengths for Type A reference Implementations**

Channel	Length m
Service distribution	100
Service distribution + building backbone + campus backbone	10 000
NOTE In some implementations of the service distribution cabling subsystem in Clause 5, the SD may not support SOs up to the maximum distance shown.	

- **Maximum Channel Lengths for Type A reference Implementations**

Channel	Length m
Area feeder + distance to connected TE	100
Area feeder + distance to connected TE + building backbone + campus backbone	10 000

CENELEC News: EN 50173-6

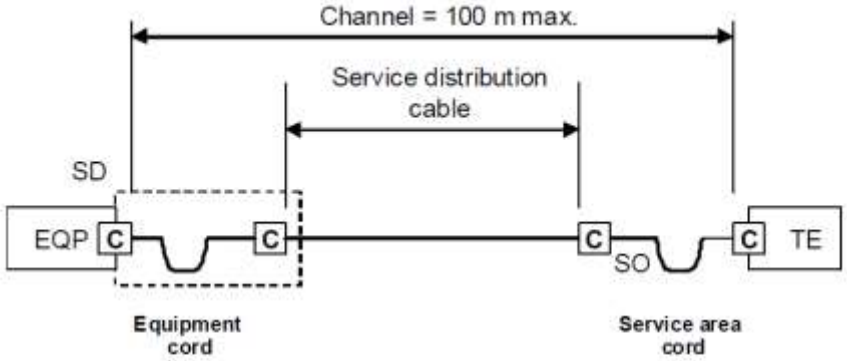
DIMENSIONING AND CONFIGURING

- **Service Outlet**
  - Shall terminate four pair balanced cable
  - Shall have permanent means of identification
  - Should prevent unauthorised access, disconnection, reconf.
  - Baluns and Impedance matching adapters shall be external
  - Cords performance contribution shall be taken into account
- **Service Concentration Point**
  - Shall be located so that each service area is served by min. one SCP
  - Should be limited in serving max. 36 service areas
  - Should be accessible
  - Should be part of the documentation and administration

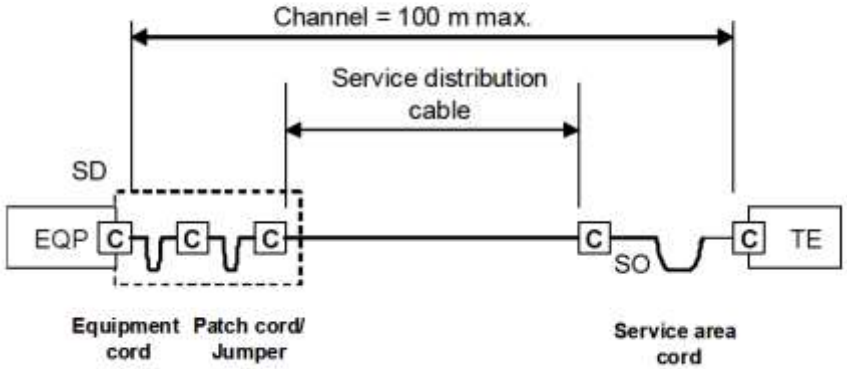
CENELEC News: EN 50173-6

DIMENSIONING AND CONFIGURING

- **Models:**



a) Interconnect – SO model



b) Crossconnect – SO model

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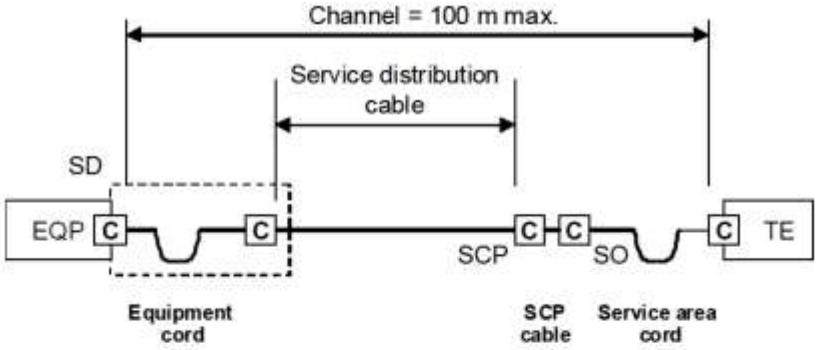
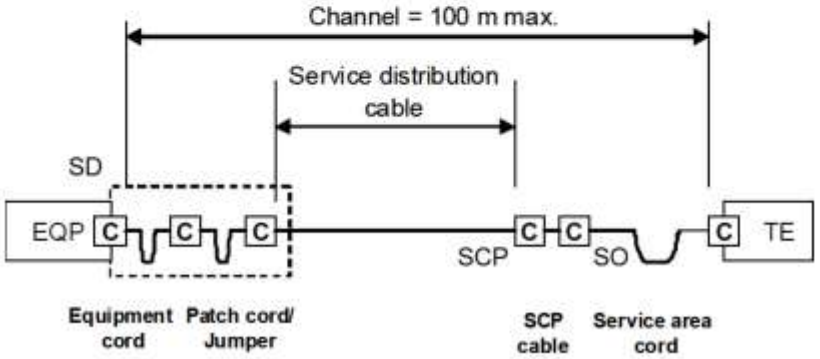
DIMENSIONING AND CONFIGURING

- **Models:**



c) Interconnect – SCP – SO model



d) Crossconnect – SCP – SO model

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DIMENSIONING AND CONFIGURING

- **General Restrictions:**

the physical length of the channel between the equipment located in the SD and the terminal equipment shall not exceed 100 m;

the physical length of the fixed area feeder cable:

1) shall not exceed 90 m;

2) should be at least 15 m in order to reduce the effect of multiple connections in close proximity on NEXT and return loss;

the length of individual patch cords or jumpers at the SD shall not exceed 5 m.

CENELEC News: EN 50173-6

WIRELESS NETWORKS - APPLICATIONS

Application	Standard Description	Typical indoor range (radius)
IEEE 802.11	Wireless Local Area Networks (2 Mbit/s at 2,4 GHz or infrared)	30 m
IEEE 802.11a	Wireless Local Area Networks (54 Mbit/s at 5 GHz)	12 m
IEEE 802.11b	Wireless Local Area Networks (11 Mbit/s at 2,4 GHz)	30 m
IEEE 802.11g	Wireless Local Area Networks (54 Mbit/s at 2,4 GHz)	12 m
DECT	Digital European Cordless Telephony (1 Mbit/s at 1,8 GHz)	30 m (ffs)
Bluetooth II	ISM Band 1 Mbit/s at 2,4 GHz	12 m (ffs)

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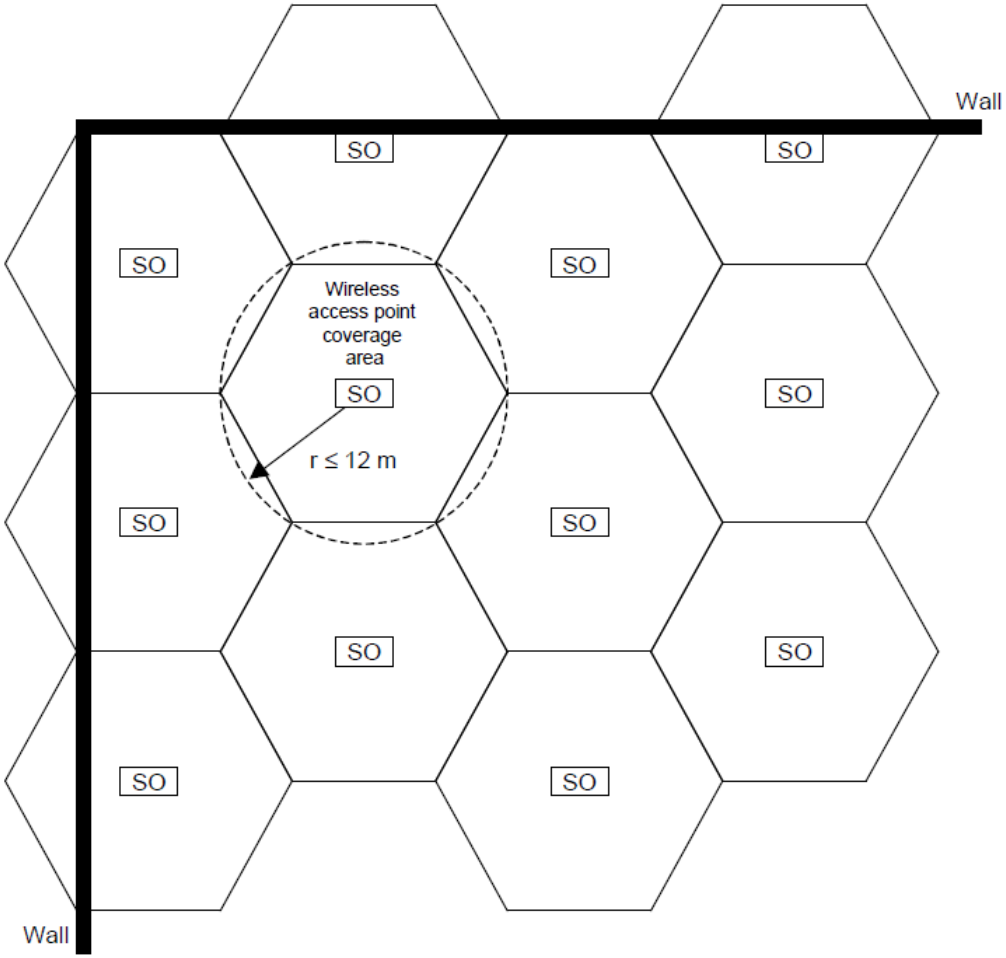
WIRELESS NETWORKS

- **AREA GRID**



CENELEC News: EN 50173-6

SERVICE CONCENTRATION POINT - AREAS

Premises/areas	Area served by SCP [a]	Notes
Plant room	5 m^2	Plant rooms contain air handlers, chillers, boilers, pumps, fans, compressors etc. Air handlers will typically require a higher density of SOs.
Dedicated office	25 m^2	The area served in open office areas may be greater than 25 m^2
Retail	25 m^2	Personnel management services may require reduction in the area served
Hotel	25 m^2	Area served may vary if service is centrally managed
Hospital	25 m^2	Average value only: each type of hospital environment should be specifically designed
Classroom	25 m^2	Average value only: each type of classroom environment should be specifically designed. Area served may vary if service is centrally managed.
Indoor parking	25 m^2	
Industrial (factory)	50 m^2	Area served may depend upon manufacturing process, environment and building design

[a] The area served by the SCP should comprise either a room with an area not greater than that specified or an area not greater than that specified within a larger room/space.

CENELEC News: EN 50173-6

COMPONENT REQUIREMENTS

- **Balanced Cables – EN 50173-1:2011 - Category 5, 6, 6_A, 7 or 7_A**
- **Optical Fibre Cables – EN 50173-1:2011**
- **Connecting Hardware: In addition to locations as per EN 50173-1**
  - **At SCP – Shall be fixed connector as per EN 50173-1:2011**
  - **At SO – Plug – Socket connection, fixed connector**
  - **At SO – Environmental protection to be considered**
  - **As per EN 50173-1**

CENELEC News: EN 50173-6

CHANNEL PERFORMANCE

- **Typical Environmental Classification**

$M_1I_1C_1E_1$ for office areas;

$M_2I_2C_2E_2$ for a light industrial environment;

$M_3I_3C_3E_3$ for a typical heavy industrial environment.

- **Service Distribution Cabling (Type A) – as specified in EN 50173-1**

- **Area Feeder Cabling (Type B) – Class D or higher**

CENELEC News: EN 50173-6

CHANNEL PERFORMANCE

Category 5 components provide Class D balanced cabling performance;

Category 6 components provide Class E balanced cabling performance;

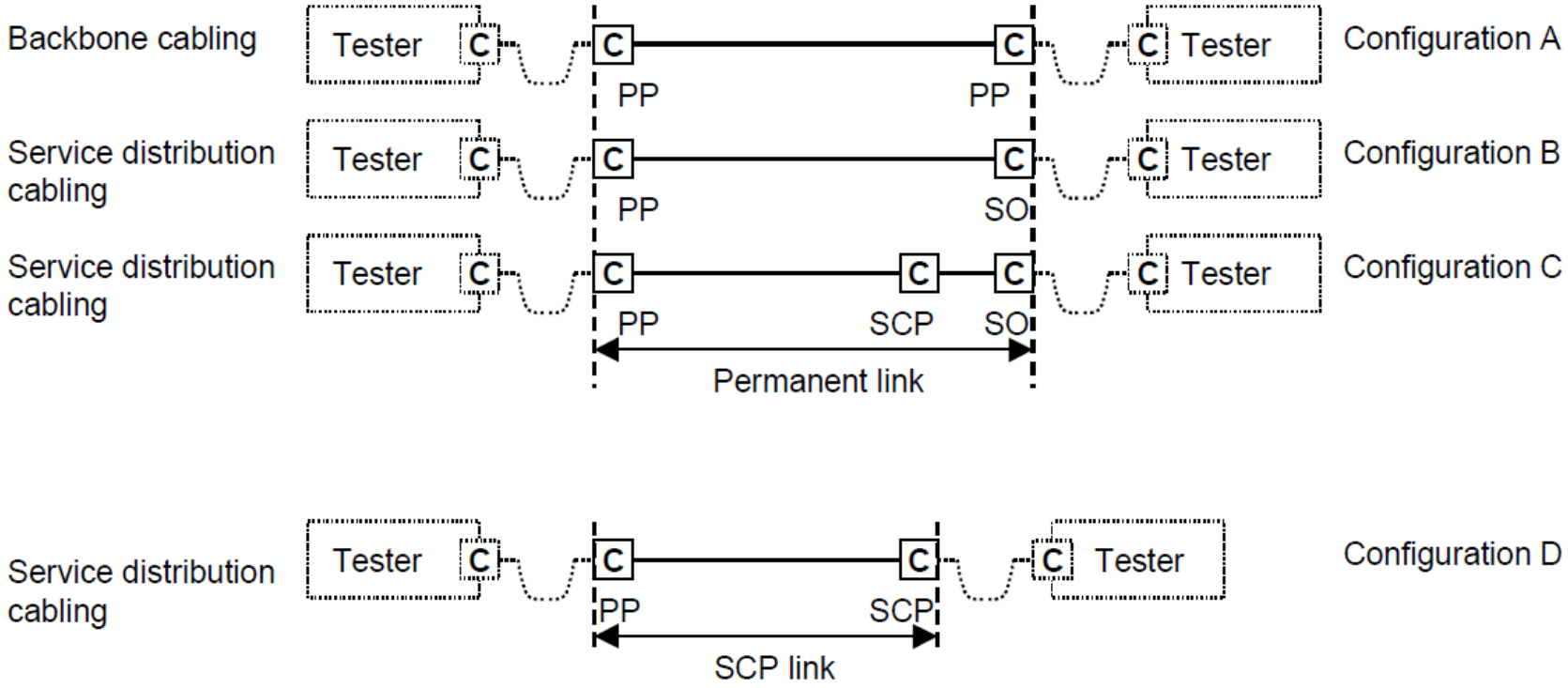
Category 6_A components provide Class E_A balanced cabling performance;

Category 7 components provide Class F balanced cabling performance;

Category 7_A components provide Class F_A balanced cabling performance.

CENELEC News: EN 50173-6

TESTING



ISO / IEC News: ISO 11801 Ed.3

Area of application	ISO/IEC	CENELEC	EIA/TIA
Premise Cabling – General requirements	ISO 11801-1	EN 50173-1	EIA/TIA 568-C.0
Premise Cabling	ISO 11801-2	EN 50173-2	EIA/TIA 568-C.1
Industrial Cabling	ISO 11801-3	EN 50173-3	TIA-1005
Home Cabling	ISO 11801-4	EN 50173-4	TIA-570
Data Centre Cabling	ISO 11801-5	EN 50173-5	TIA-942
Distributed Building	ISO 11801-6	EN 50173-6	

* **ISO/IEC 11801 Ed.3 (in development)**

Category 8.x Status

- 40GBASE-T functions with shielded cabling solutions only
- Data Center EoR: Server-Switch links up to a min. 30m with 2 connectors
- Data Center ToR: Port-to Port links using 5-10m of patch cable
- Technical Report 11801.99-1 released (Guidance for balanced cabling in support of at least 40 Gbit/s data transmission)
  - Specifications when using cabling pathways with contemporary components in the categories 6_A (500MHZ) to 7_A (1,00MHZ) for 30m lengths
  - Specifications for **CLASS I – CATEGORY 8.1** on the basis of future components in Category 6_A extrapolated to 2000MHZ and **CLASS II – CATEGORY 8.2** on the basis of Future components in Category 7_A extrapolated to 2000MHz for 30m lengths

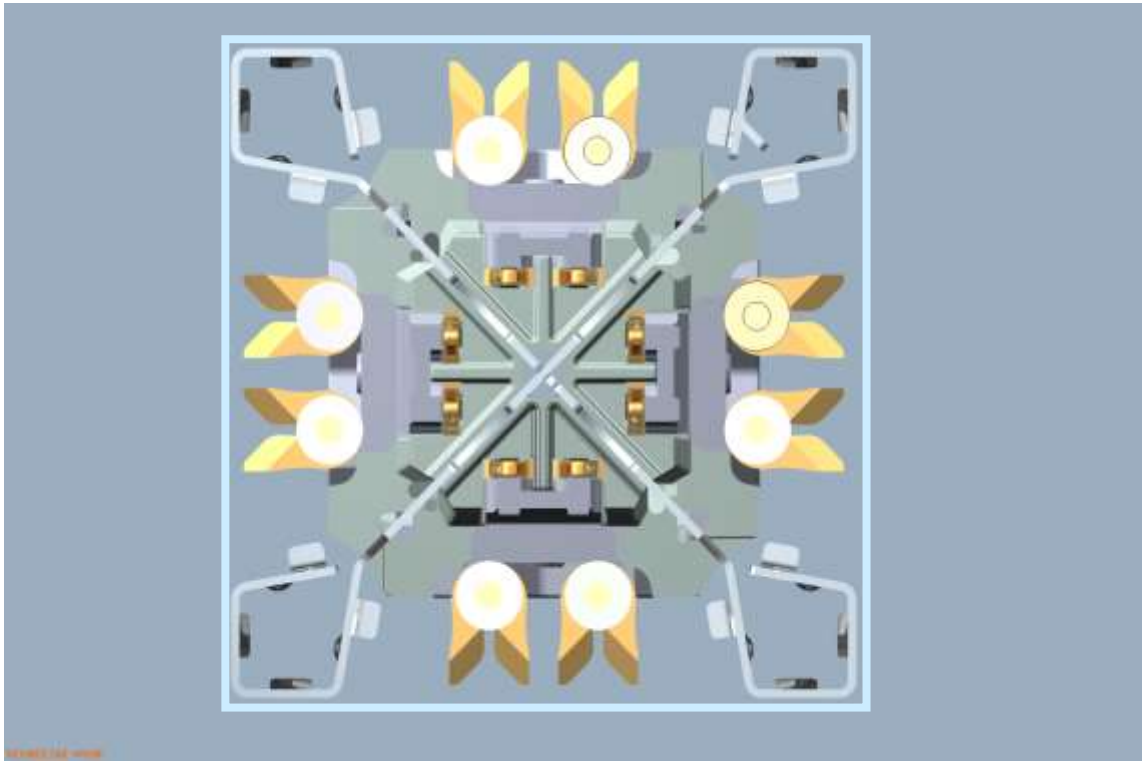
Category 8.x – R&M Status

	ISO/IEC	TIA	ISO/IEC more than TIA
Channel PS NEXT @ 500MHz [dB]	24.8[1)]	23.2	**1.6**
Permanent LINK PS NEXT @ 500MHz [dB]	26.4[2)]	23.8	**2.6**
Components Cat. 6A; Cat. 6_A NEXT @ 500MHz [dB]	37.0[2)]	34.0	**3.0**

[1)] Amendment 1
[2)] Amendment 2

Category 8.x – R&M Status

- Individual pair shielding in termination area
- X-Separator enables a complete separation of the pairs
- Effectively decouples individual pairs from each other



R&M Solutions

3

Floor distributor
CU & FO Patch Panels

3 6

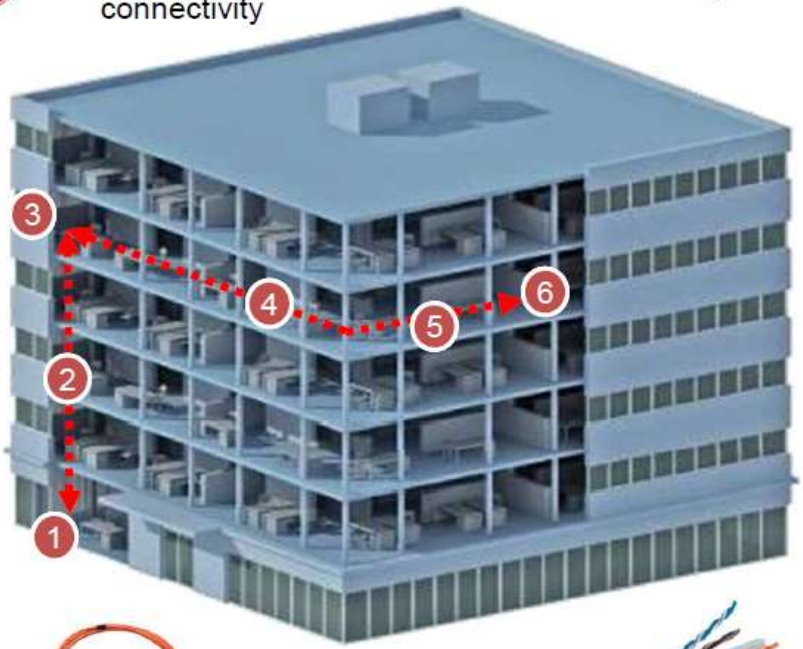
FO (Field-)
connectivity

CU Patch Cords

3 6

6

Outlets:
CU & FO faceplates



2 4

Backbone
cables FO

3 5 6

CU connectivity

1

Building distributor:
FO Patch Panels

1

Fiber Patch Cords

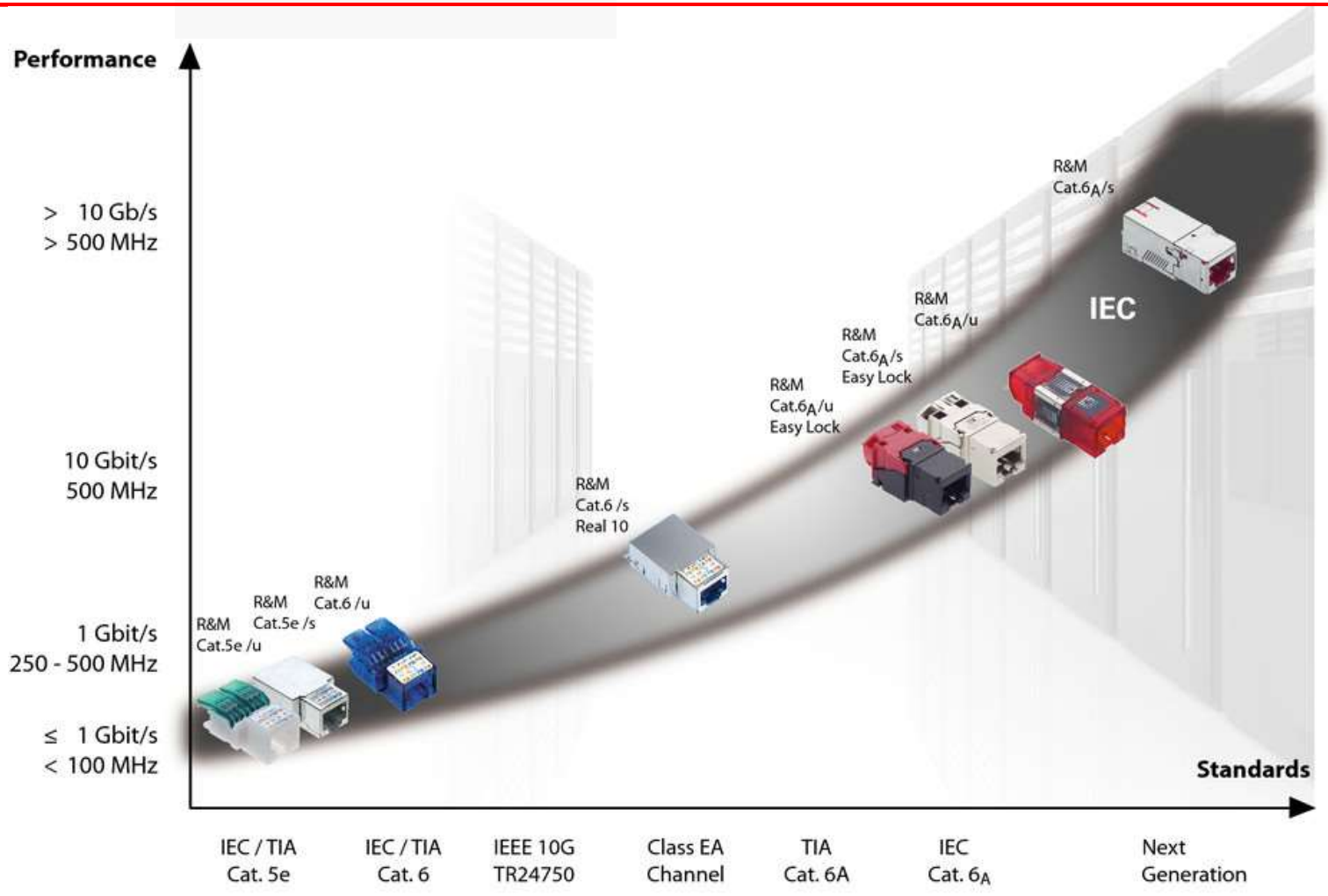
4

Installation cables

5

Consolidation points:
CU & FO boxes

R&M Solutions



Module Cat6$_A$ EL «EasyLock»

R&M

Convincing cabling solutions

R&M Solutions: Cat6$_A$ EL «EasyLock»

- Completely redesigned Cat6$_A$ module variant with a specially installation friendly termination concept
- The module consists of two handling parts only
  - RJ45 jack with contact set, compensation and integral IDC block
  - Wire guide for easy preparation of the wires
- Integrated termination function
- Integrated strain relief function
- Available in shielded (diecast) and unshieleded (AlienNEXT reducing plastic) version

Properties

- Meets Cat.6_A acc. Component standards IEC 60603-7-41 and IEC 60603-7-51
- Suitable for class E_A acc. ISO/IEC 11801 and EN 50173-1
- Fast and tool less termination (no special tools)
- Intuitive, easy handling → short break in phase
- Wide cable diameter range (4,5mm - 9mm)
- Integrated strain relief
- Suitable for all usual wire diameters:
  - Solid wire: AWG 26/1 - AWG 22/1
  - Stranded wire: AWG 26/7 – AWG 22/7
- Re-termination > 4x
- Suitable for POE and POEP
- Full traceability during production
- Made in EU

Reliable performance

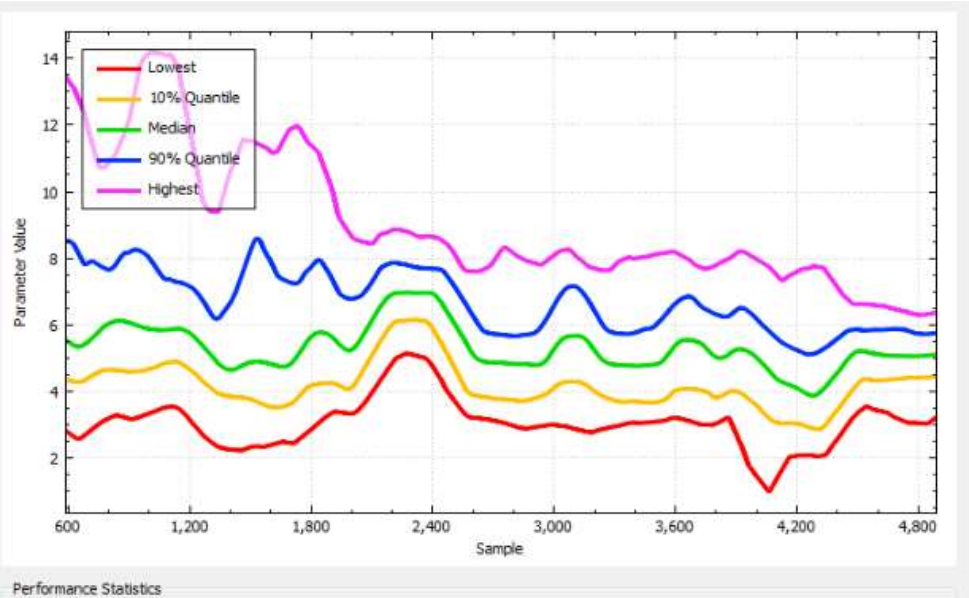
Certificates from independent laboratories:

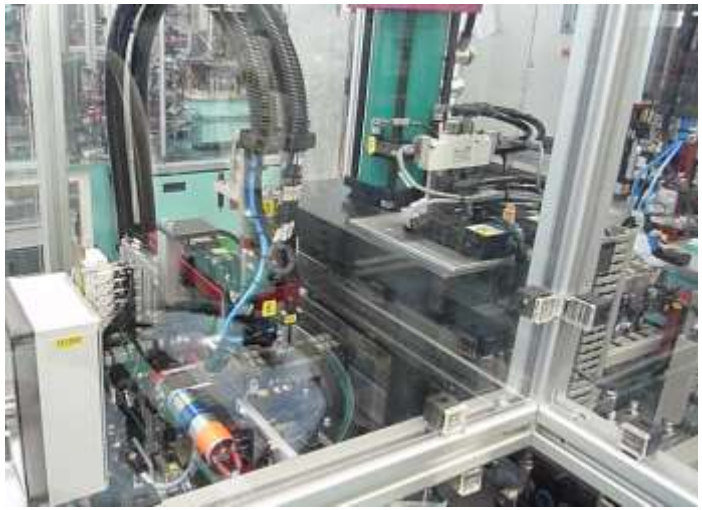
3P Third Party Testing, Denmark

- 4 connector channel
  (all common cable constructions)
- 3 connector Permanent Link
  (all common cable constructions)
- Component level Cat.6A
  according IEC 60603-7-41 / -51

100% quality

- Each module is marked with production date and serial number
- All modules are tested by automated test equipment (RL / Next / Voltage proof)
- All test results are stored and are traceable to individual modules
- Process control with statistical analytics (prediction and preventive activities)

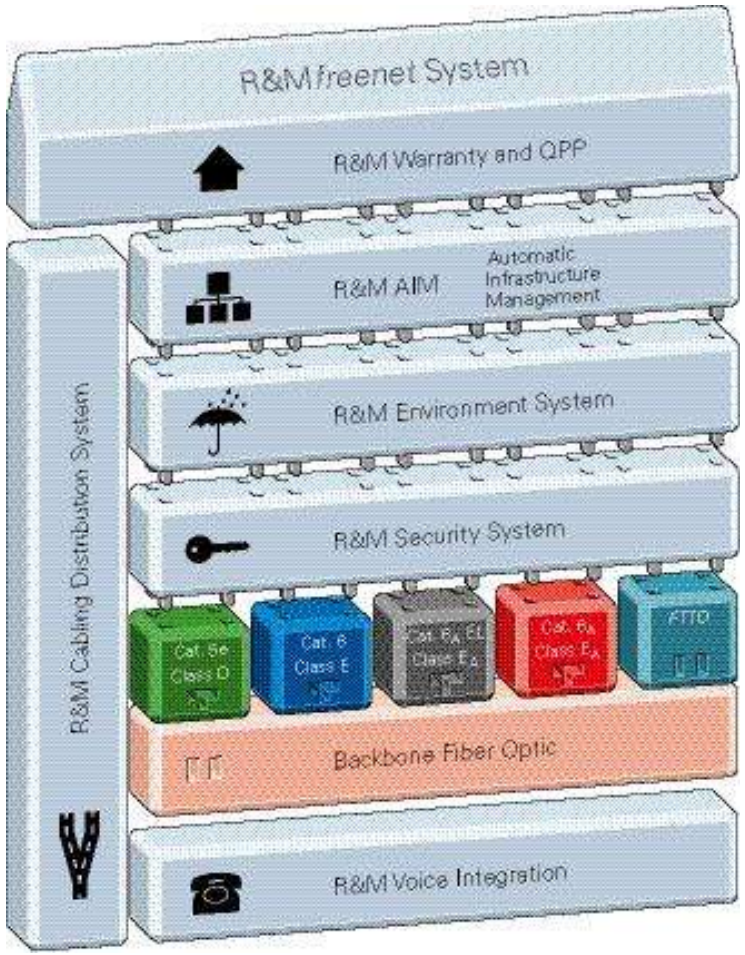




R&M*freenet* integration

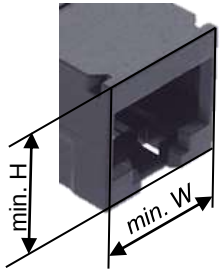
The Cat.6_A EL module fits seamlessly into the R&M*freenet* system.
It fits into the R&M*freenet* platforms and all accessories are compatible.

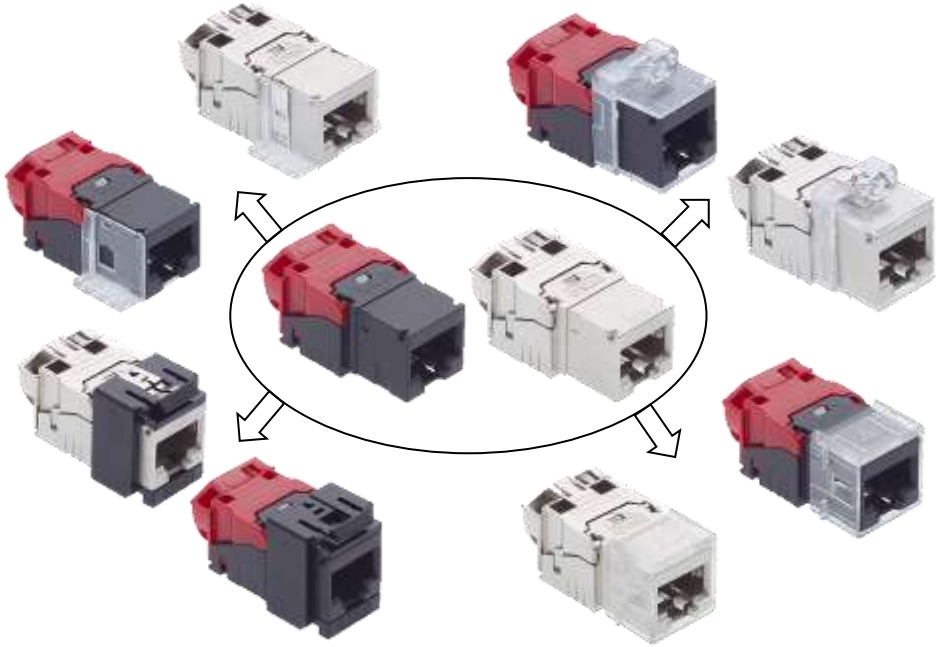
Specifically suitable to for the new R&M*inteliPhy*-ready 24-Port 1HE PC 19” panel



Fully Compatible

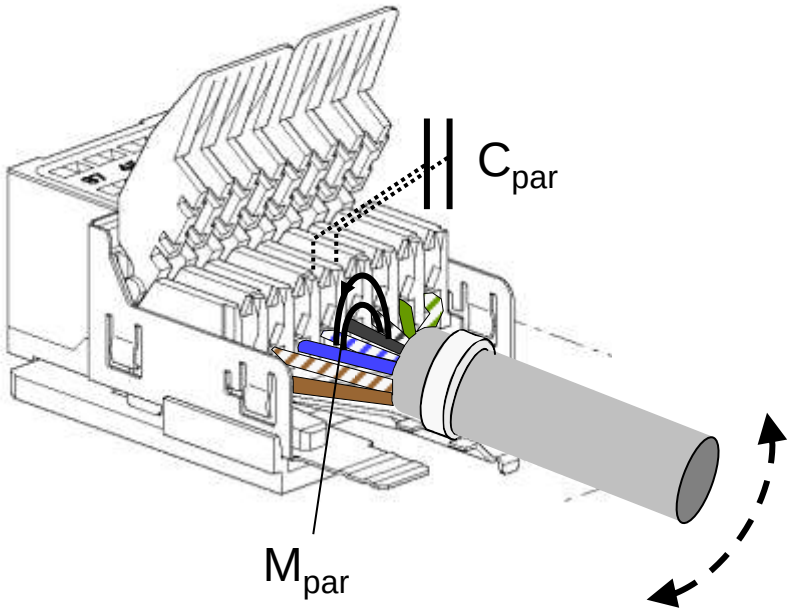
The extremely small form factor of the RJ45 jack in combination with different adaptors, allows the module to be also integrated into most faceplate programs of third party vendors.





Functional strain relief

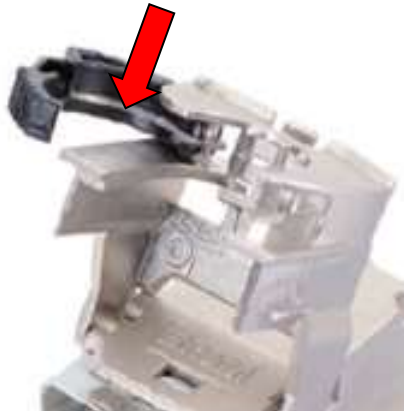
A safe, reliable strain relief prevents changes of the transmission parameters during operation → no re-testing needed



Sophisticated shield termination

Reliable shield termination → EMC protection over the whole lifetime of the system:

- 360° shield termination due to contact inlay in clamping ring
- Special, additional contact point for drain wire of foil only cables

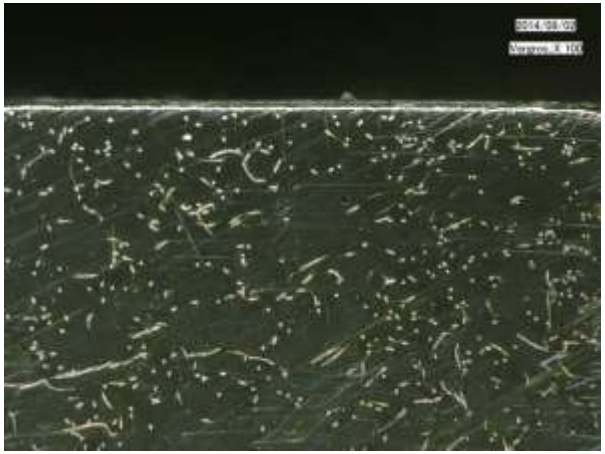


Built in Alien-NEXT protection

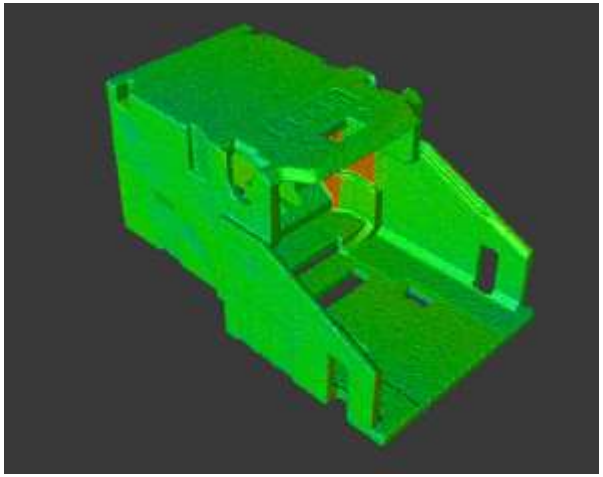
The housing of the UTP module is manufactured from a special plastic material that reduces crosstalk from one module to the next (Alien-NEXT).

This way can be mounted without required minimal distances and without any further special protection measures.

Microslice of housing



CT of housing (w/o plastic)



Module positioning

Cat.5e / 6

Cat.6_A EL

Cat.6_A

Reliability

- Up to 1GBit/s
- Unsurpassed reliability
- Extremely robust
- Residential, SOHO and Hotels

Easy handling

- Up to 10 Gbit/s
- Best in handling
- Fast, easy and efficient termination
- Safe standard compliance
- Normal office environment

High Performance

- 10Gbit/s +
- Highest reserves in performance
- 10GBit/s under tough conditions and next generation apps
- HD (48 ports / 1U)
- DC, HQ buildings

System positioning

Transmission performance

Module	Channel	Permanent Link	Short Link / Margin	Component standard
Cat.6A	Class E_A	Class E_A	Yes	Cat.6_A
Cat.6A EL	Class E_A	Class E_A	Yes*	Cat.6_A
Cat.6	Class E_A	Class E	No	Cat.6
Cat.5	Class D	Class D	No	Cat.5

Customer advantages

- Fast and easy termination → lower cost and lead time for installer and end customer
- 100% production tested → first time right on transmission testing → reduces re-termination time and re-testing expenses
- Wide range of allowable cable and wire diameters → one module for all applications (incl. CP-cable)
- Integrated, fully functional strain relief → reliable data transmission even after mechanical stress on the installation, no re-testing necessary
- Sophisticated shield termination → reliable EMC protection of the whole lifetime of the system, suitable for all cable construction types
- Short form installation guide printed on package → available all the time
- Extensive warranty (5 years product / 25 years system) → investment protection
- Keystone- /Adapter No1 for 3rd party faceplates → freedom of choice

Product portfolio

Module /s/u single packed in 10x / bulk packed in 100x units:

- With Freenet / Snap-In / Keystone / Adapter No1 or without adapter

Populated 19'' patch panel /s/u:

- 1HE 16P/ 1HE Angled 24P/ 1HR 24P PC (grey and black) / 2HE Global 48P / 3HE Global 48/60P

CP Cable /s:

- Configured

Trunk cable /s:

Configured

Accessory:

- Cable reduction ring

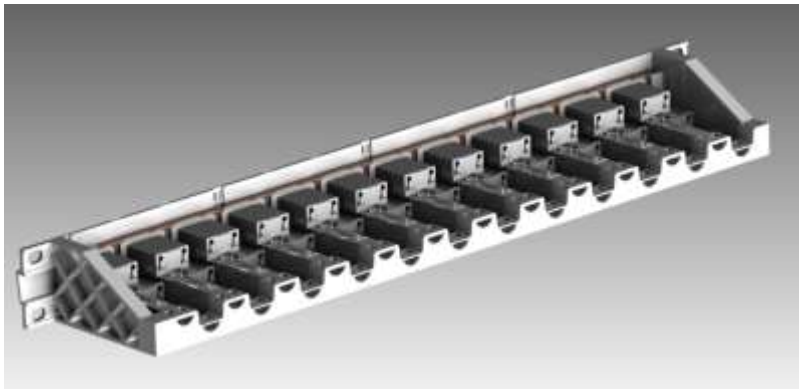
Optional opening tool:

1U 24Port Plastic Patch Panels Category 5e/6 & 6_A

R&M

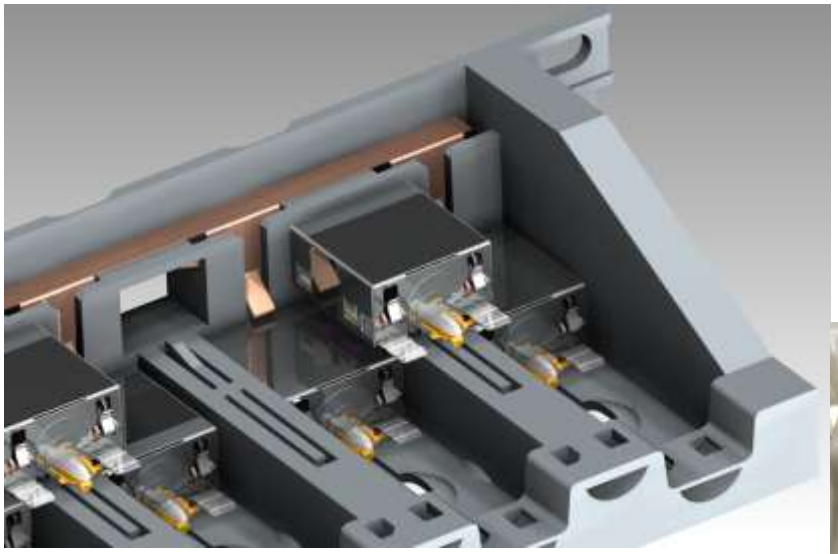
Convincing cabling solutions

Category 5e/6 - Features



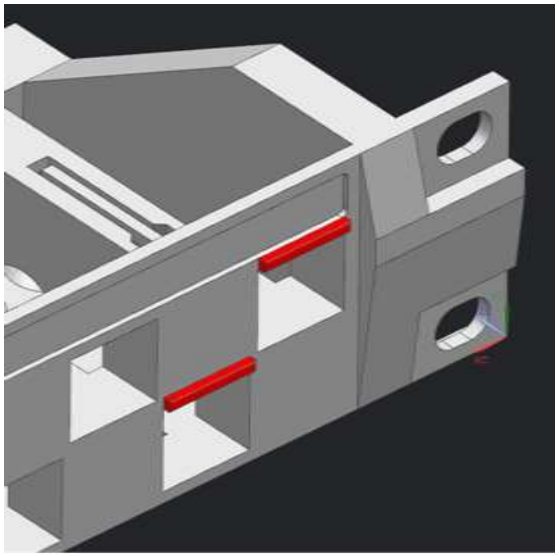
- Economical panel
- Only Copper C5-C6A/$C6_A$
- Colours grey and black
- Design module staggered
- Each port numbered
- Four labelling strips above
- Colour Clip
- Company Label
- UL-Listing planned

Category 5e/6 - Grounding

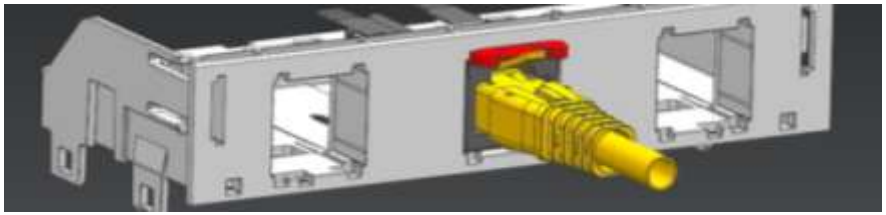


- Automatic grounding system for each module
- Supports method A-D

Category 5e/6 - Labelling



- Administration TIA-606-B
- Current labelling strip
- HD Colour coding
- Each port numbered comparing 1U 24 Port Panel

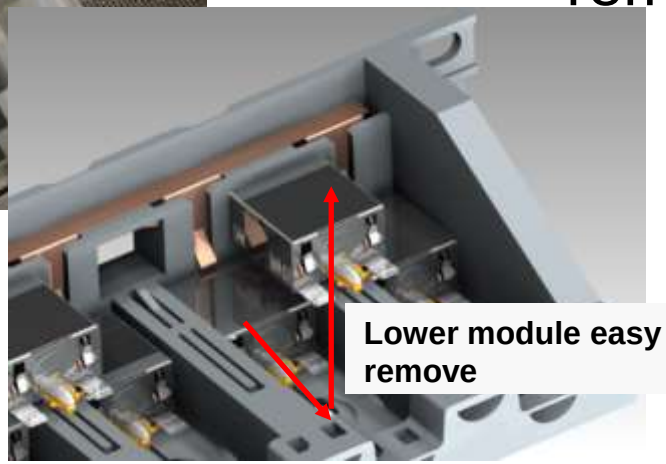


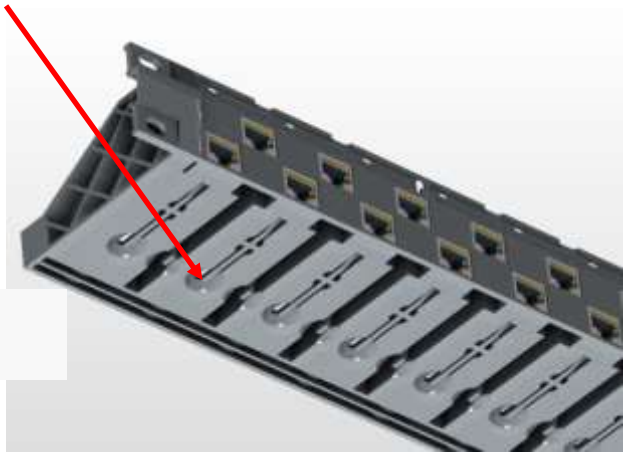
Category 5e/6 - Cable Management

- Integrated cable tie shelf
- Comparing 16 Port Panel
- Current cable manager

Category 5e/6 – Direct assembly technology

- Module will be clicked into panel directly, no adapter needed > cost reduction
- Easy handling
- Module tool less removable

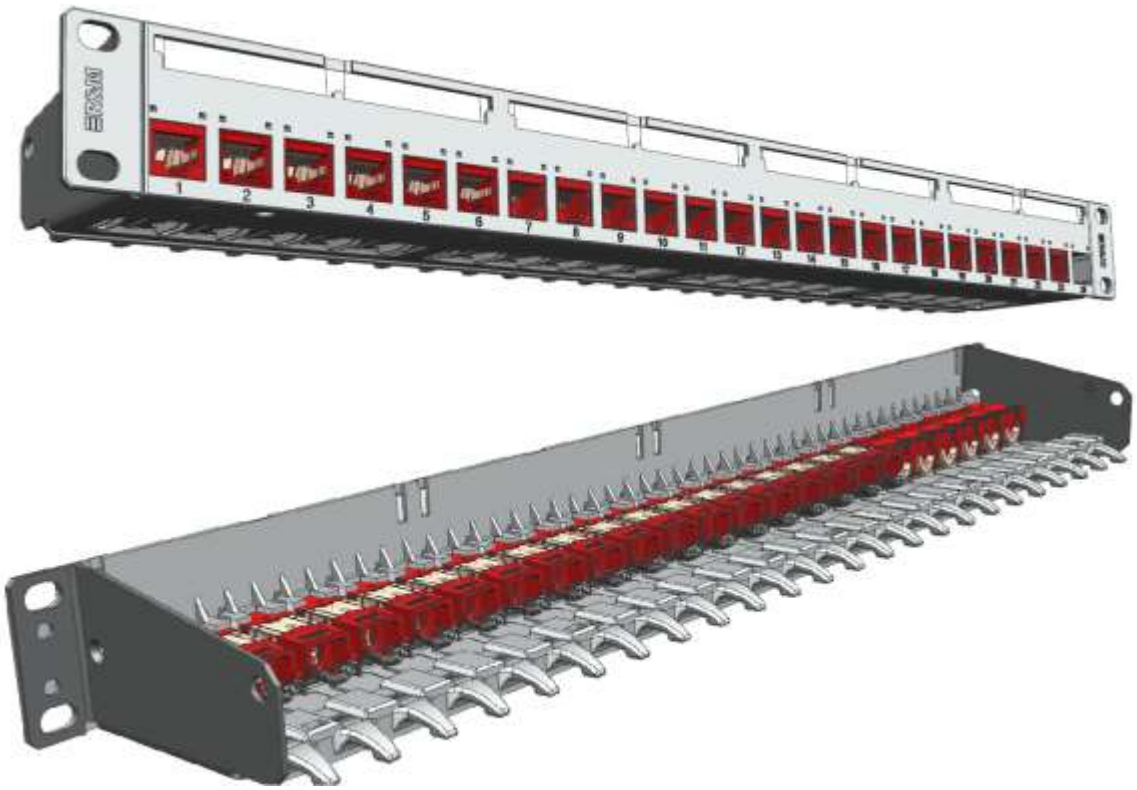




Advantage

- Economical Panel Price Saving installation time
- Design harmonizing (same as 16Port Panel)
- Tool less handling
- Colour coding / Labelling
- UL-Listing planned
- Standard module orientation

Category 6_A – Features



- The modules are in one row.
- Integrated Labeling and Numbering
- Direct Snap-In /without adapters/
- Grounding method A-D supported
- Compatibility with existing and new CAT6A modules
- InteliPhy system integrated

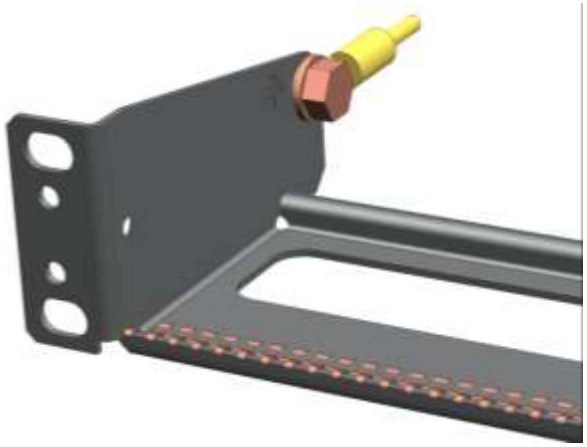
Category 6_A – Features

- **Plastic Panel** - a lot of functions
  - Direct Snap-In
  - Labeling and Numbering
  - Color Coding and Blind cover

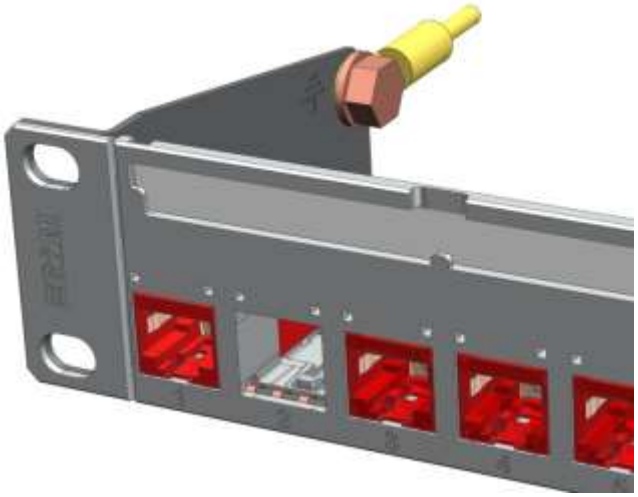
- **Easy Handling**
- **Grounding** Spring Strip
  - Reliable contact with the modules
- **Metal Frame**
  - Stability

Category 6_A – Grounding

- The direct grounding is via the metal frame.



- For grounding type “per panel” there is hole for grounding cable.



- The contact between the modules and the metal frame is performed with spring strip.

Category 6_A – InteliPhy

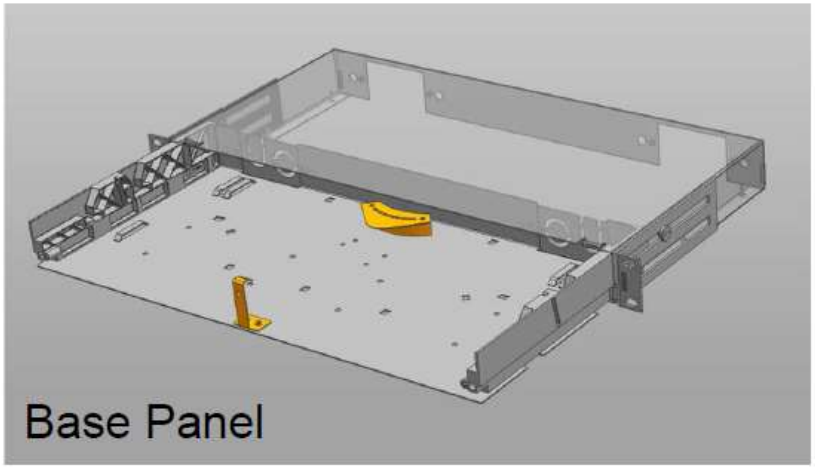
- The layout of the panel is compatible with the InteliPhy system.
  - A new Sensor Bar is necessary.

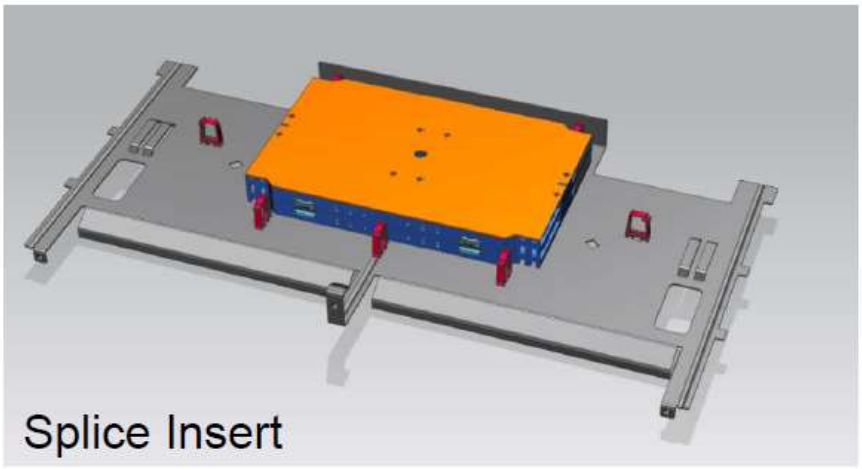
1U FO Patch Panel UniRack II

UniRack II - Features

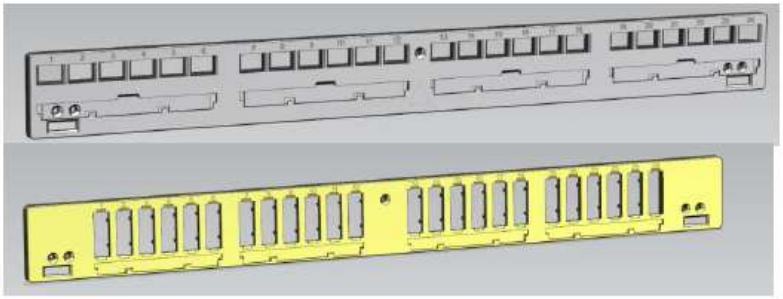
- Sliding technology for splicing and break-out cable
- No tool required for opening the box
- Pigtails and loos tube cable are supported in separate compartments
- Weight reduction of the complied body ~ 30%
- Modular concept improves logistics concept and opens up new options for shorter lead times
- Installation philosophy is self-explanatory and retained
- Customised assemblies (acc. Colour-code TIA-598-C)
- Network monitoring R&MinteliPhy for 24 LCD/LSH/SC

Modularity

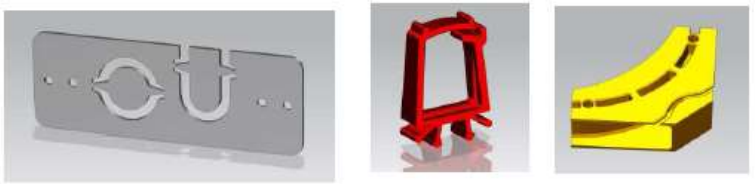




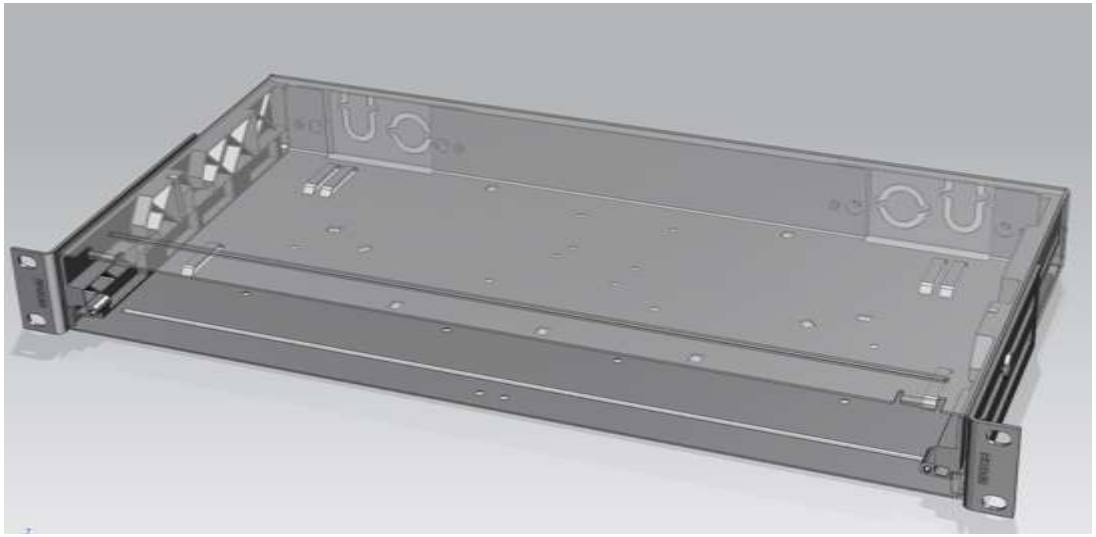
Front Plate



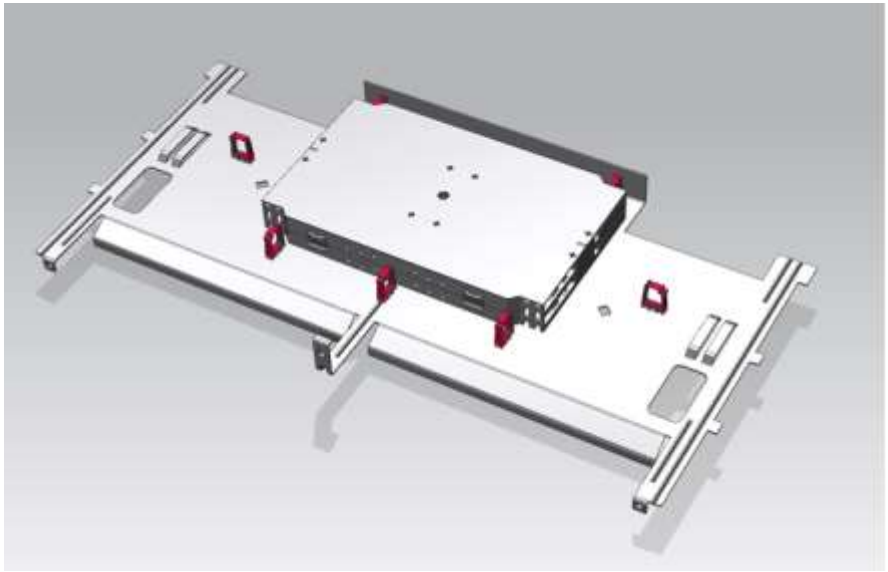
Acessories

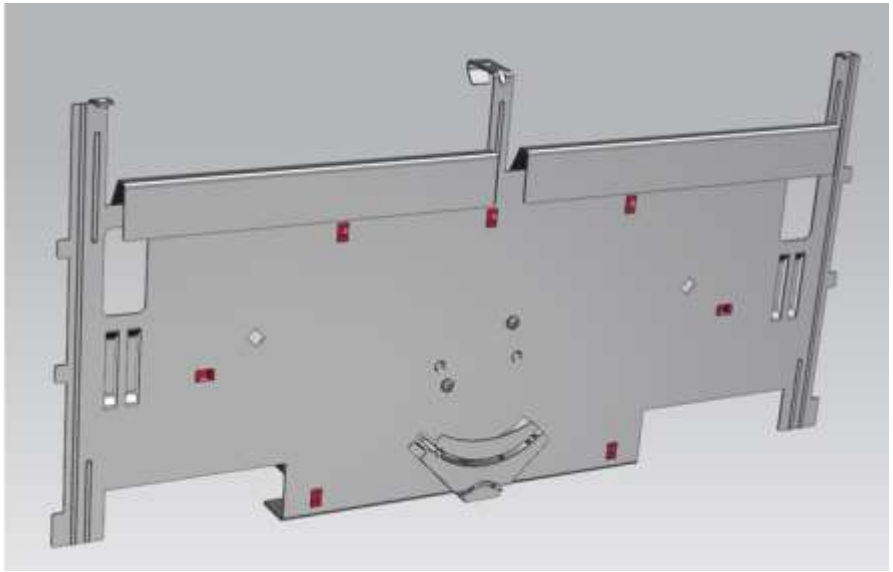


Splice Box

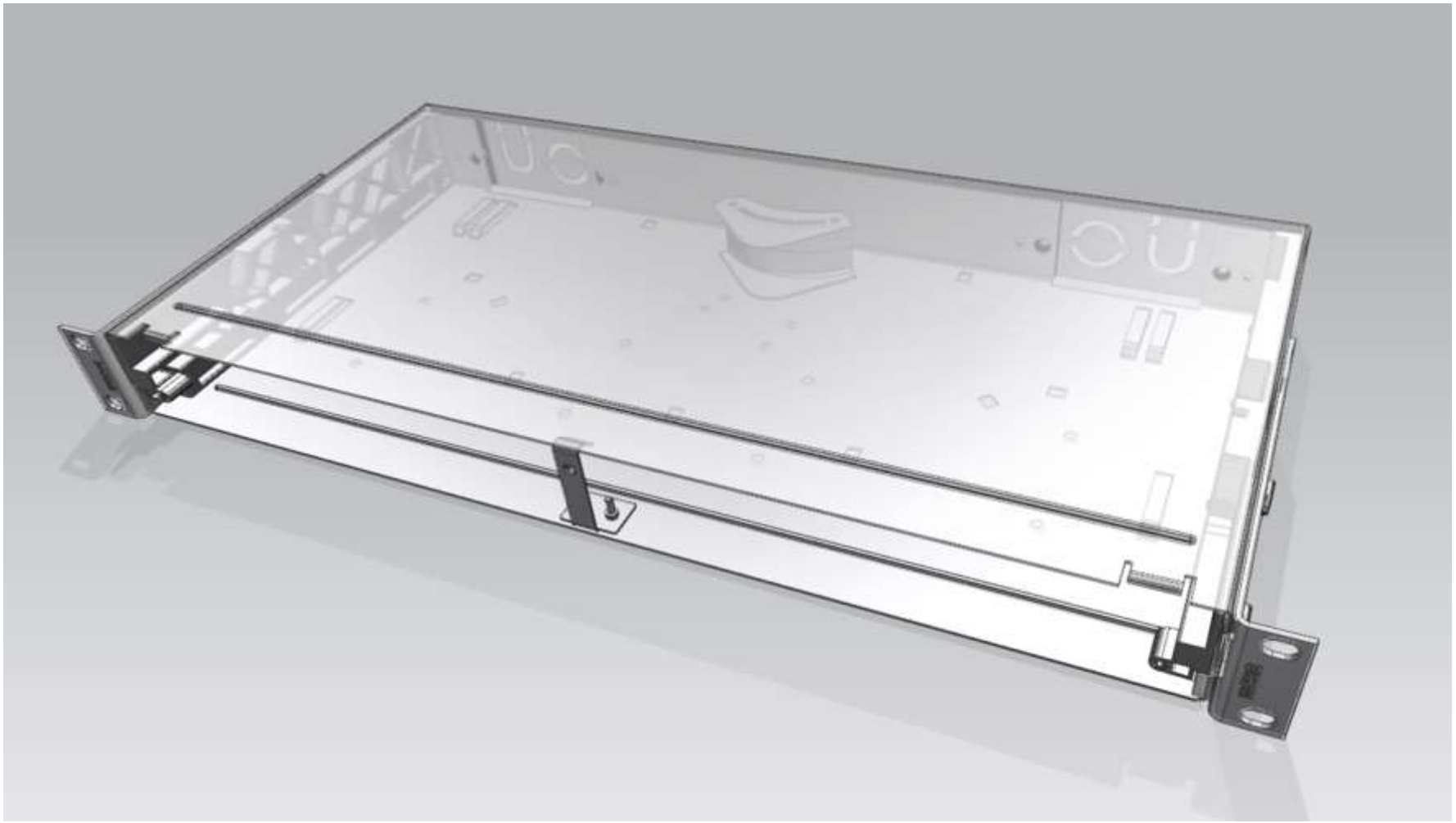


Splice Module

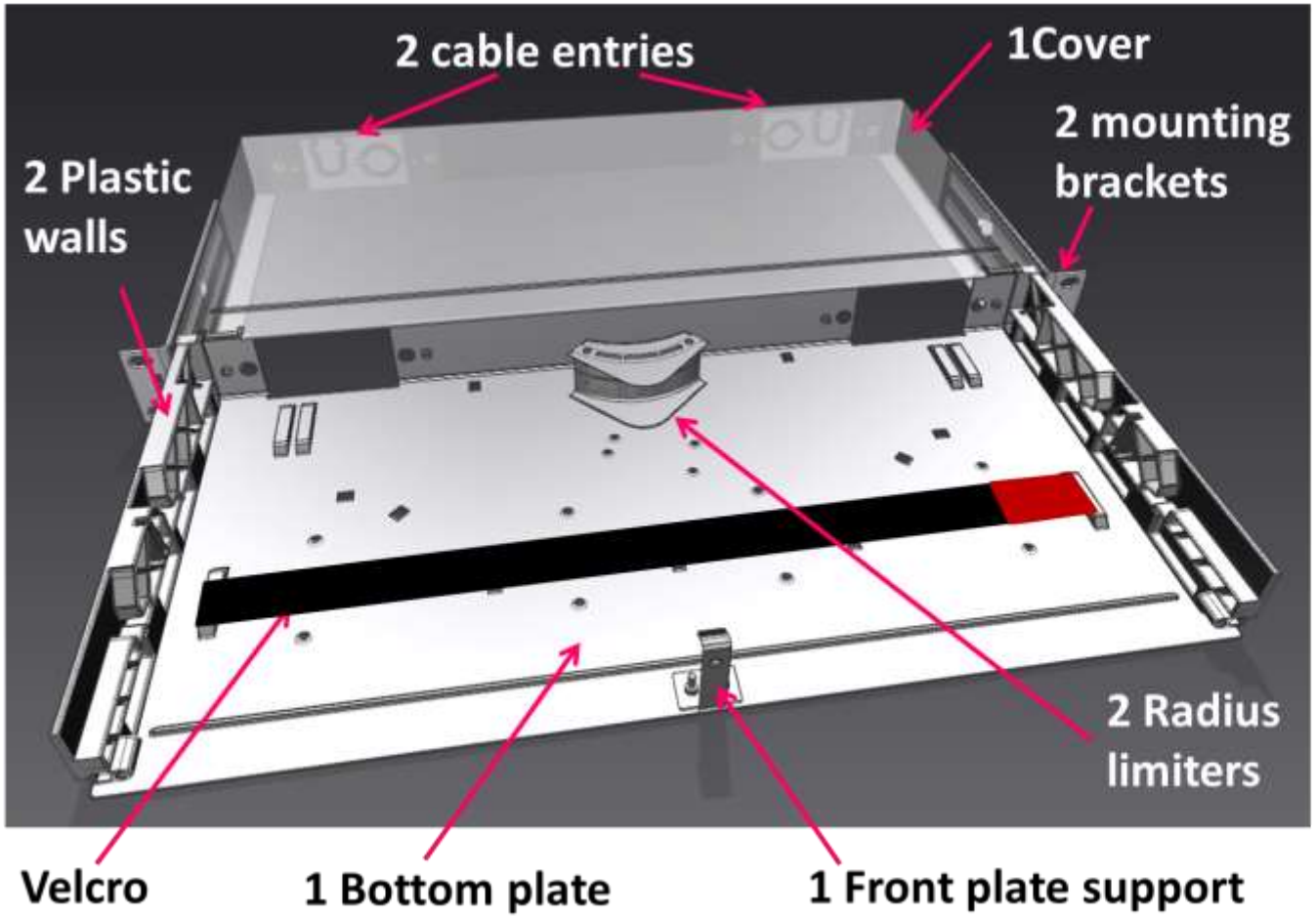




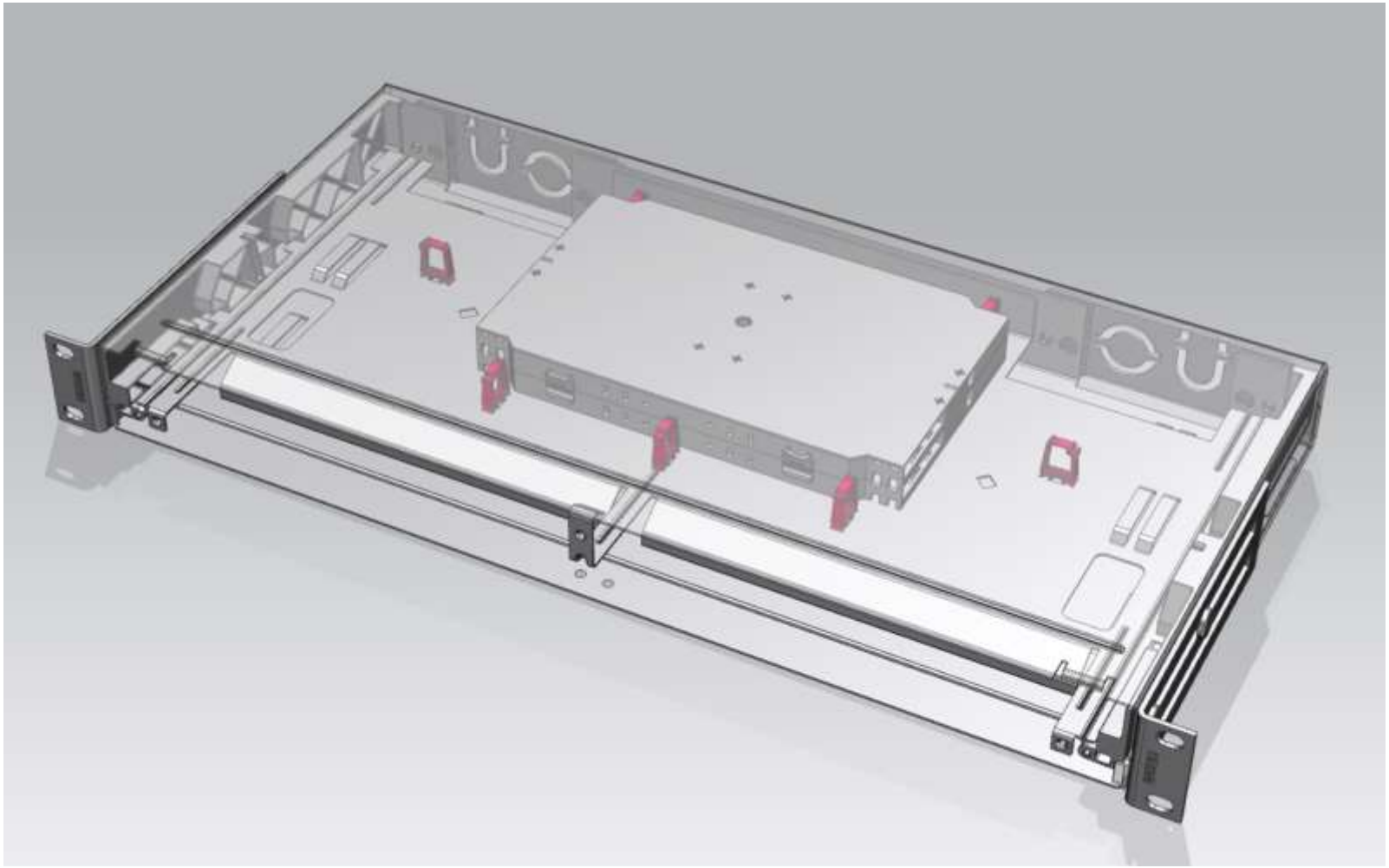
FiberEasy New



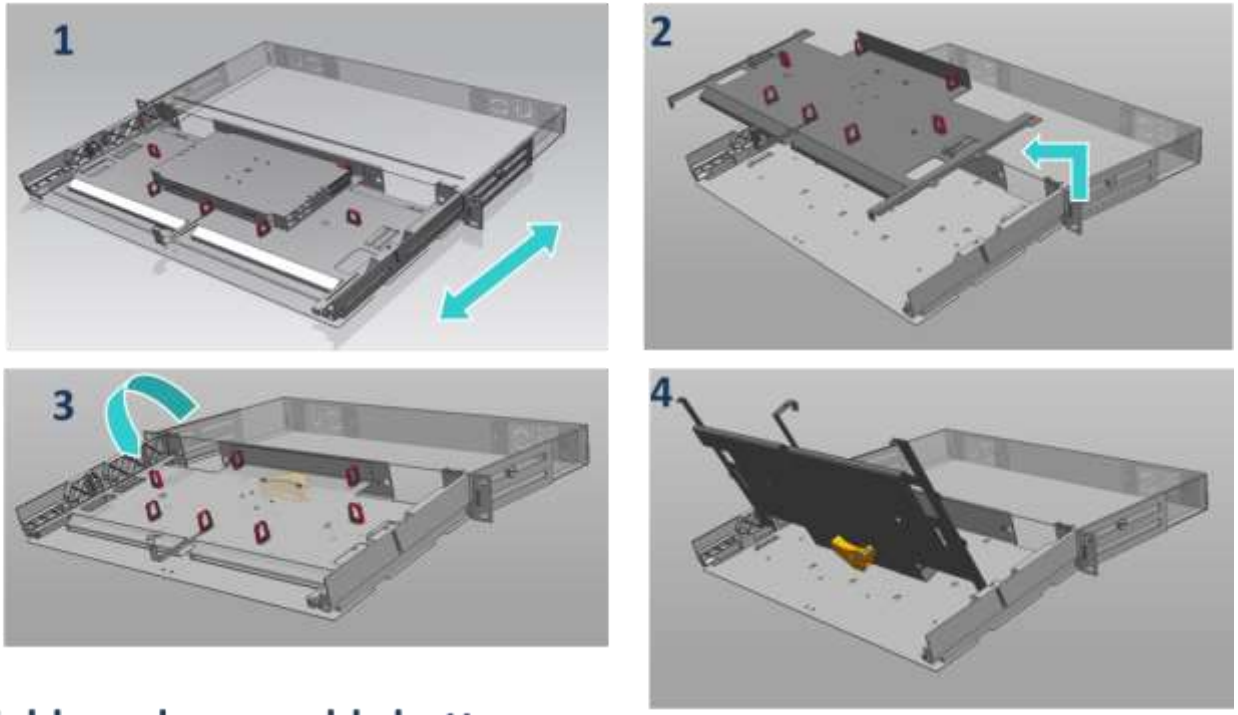
FiberEasy New



UniRack New



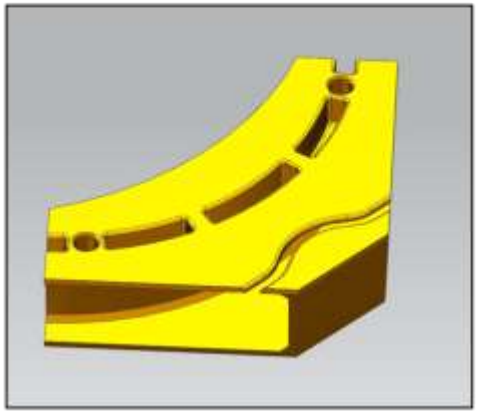
UniRack New

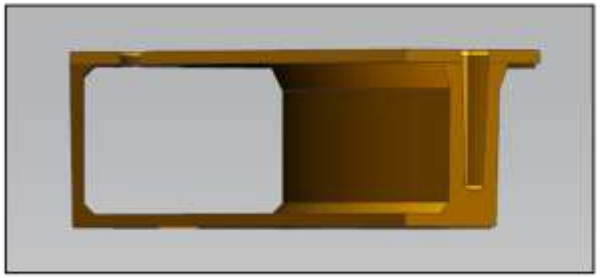


1.Slidable and removable bottom
2.Removable middle plate
3.Tiltable bottom plate
4.Tiltable middle plate
5.Loose tube reserve fixation with much simpler mechanism

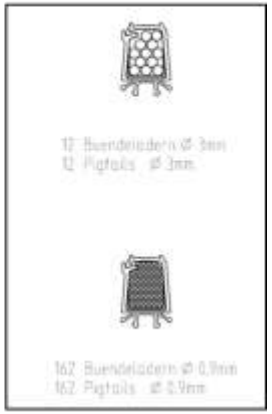
UniRack New

New Loose tube reserve fixation



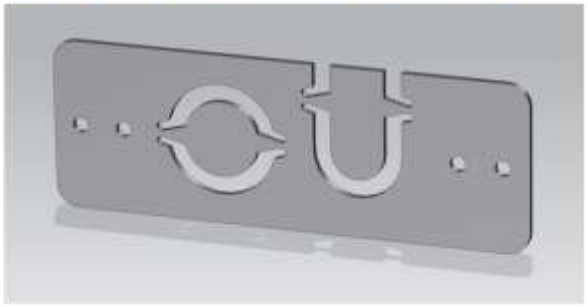


New Pigtail holder



UniRack New

New cable entry sheet

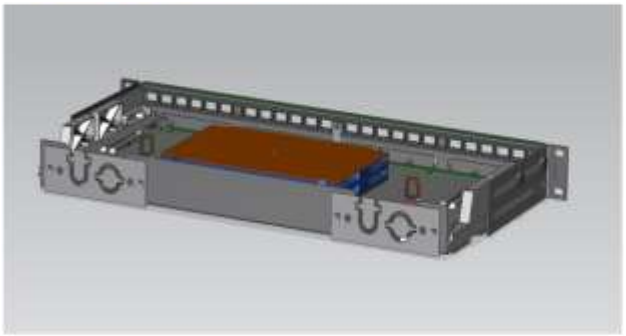


The cable entry has two cutouts (M20 and M25) suitable for cable glands and *Varioline*

Possibility to mount the cable entry :

1.On the cover

2.On the bottom

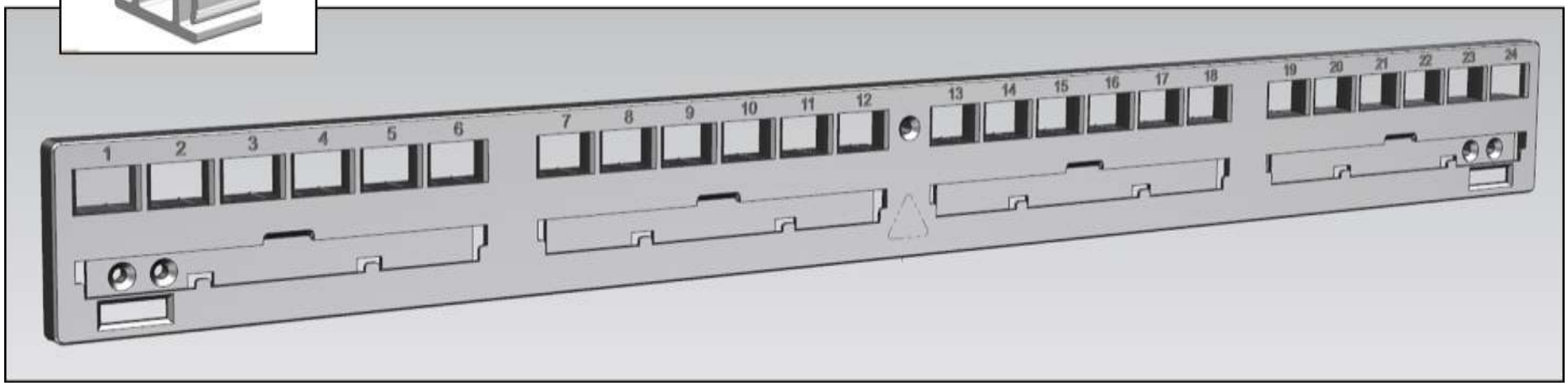


Possibility to use the existing cable entries

UniRack New

Plastic Front Plate-24-E-2000/SC/LC-D

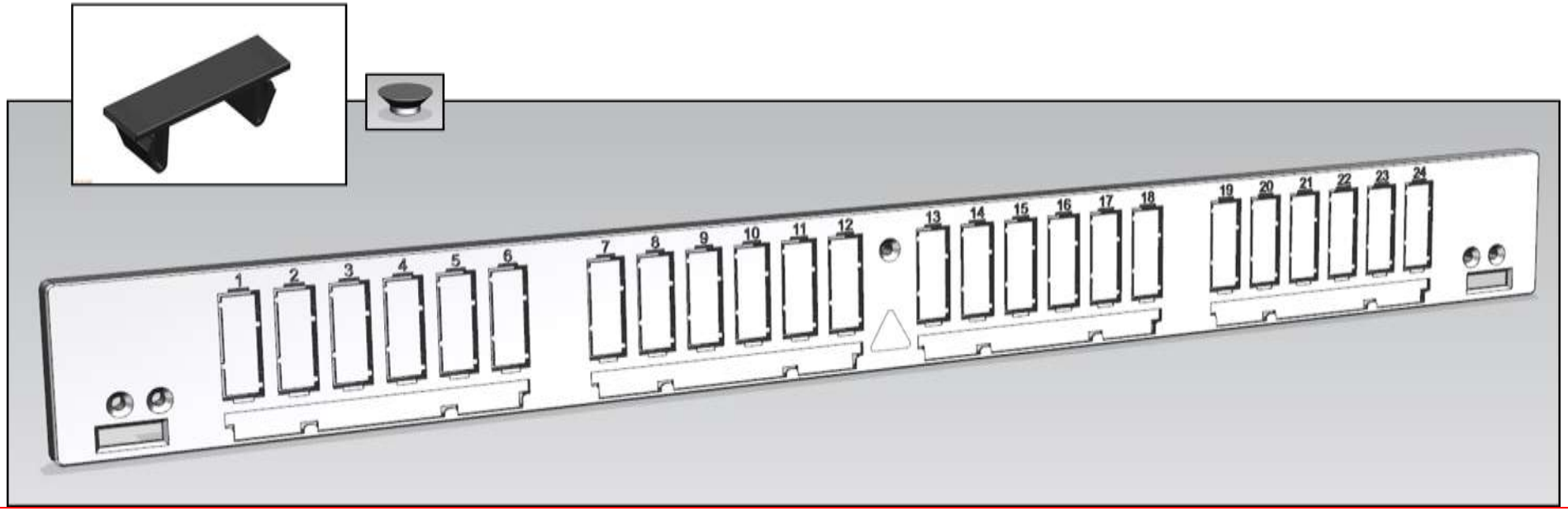
with integrated numbering and labeling and printed laser warning sign



UniRack New

Plastic Front Plate- 24 SC-D

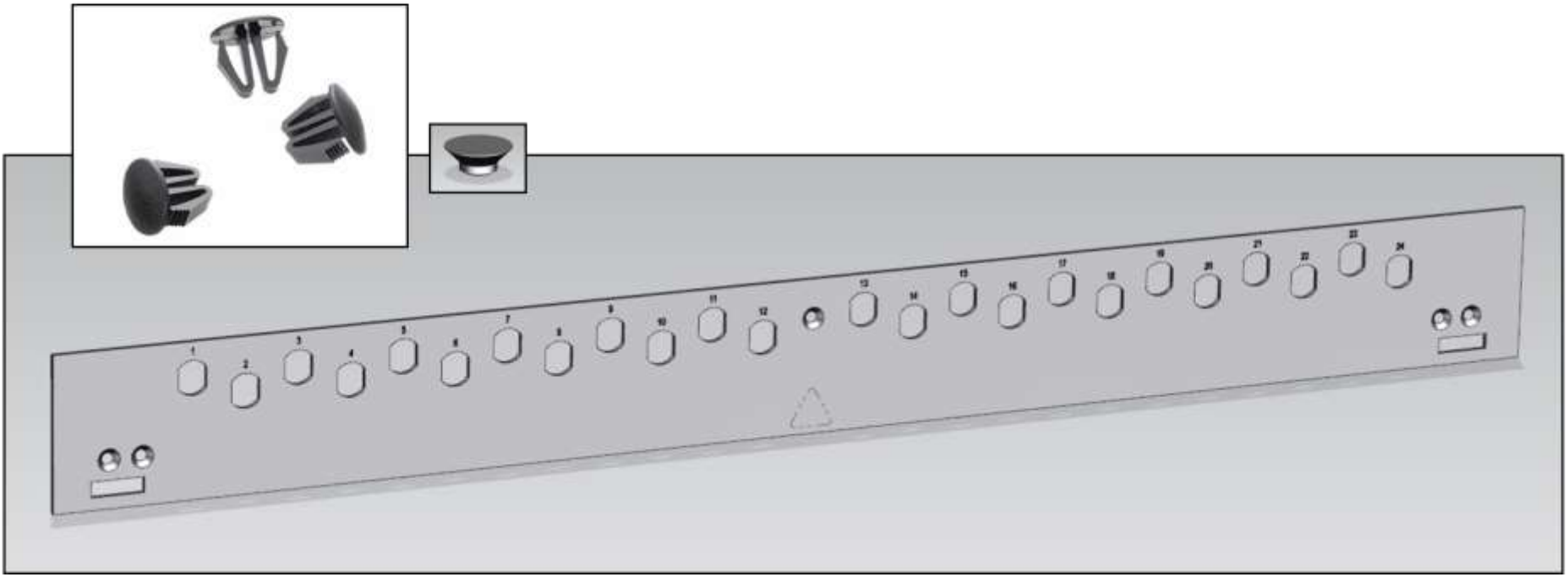
with integrated numbering and labeling and printed laser warning sign



UniRack New

Front Plate -24-ST-FC

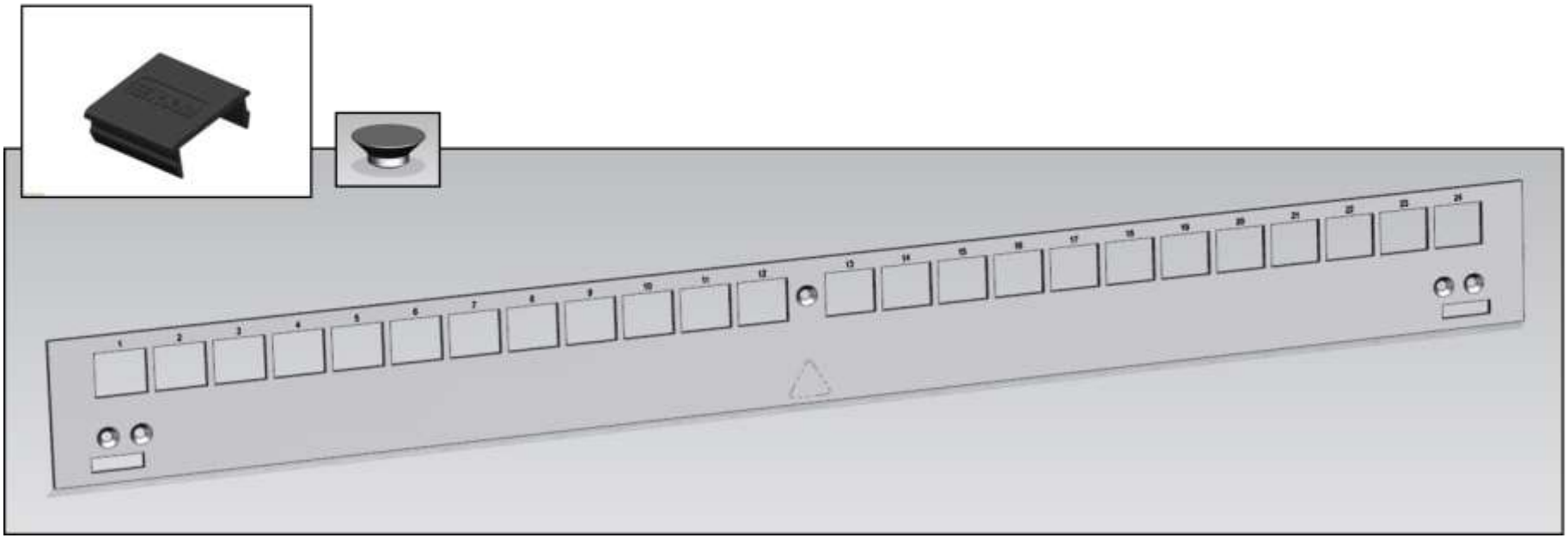
1.5mm powder coated with printed numbering and laser warning sign



UniRack New

Front Plate -24-LSHRJ

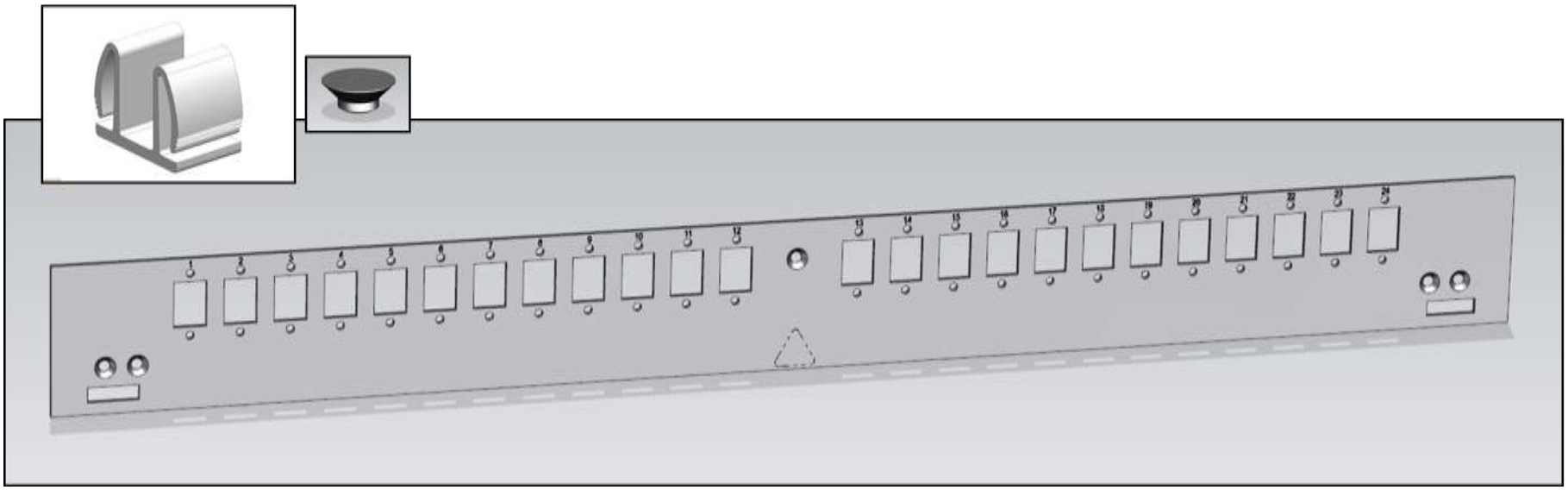
1.5mm powder coated with printed numbering and laser warning sign



UniRack New

Front Plate -24-E-2000

1.5mm powder coated with printed numbering and laser warning sign



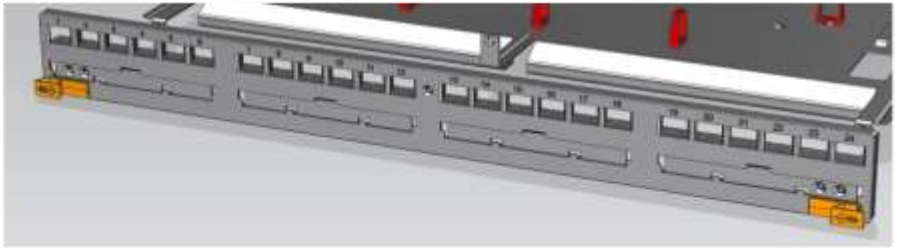
UniRack New

Locking System for the front plates

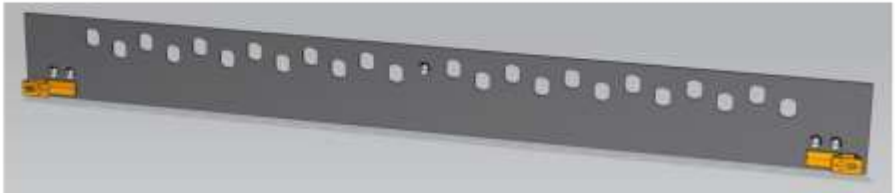
Locking System for all front plates, suitable for Unirack and Fibereasy

One part used for handle and also for locking

Plastic panels



Metal panels



UniRack New

Assembly brackets for *Inteliphy*

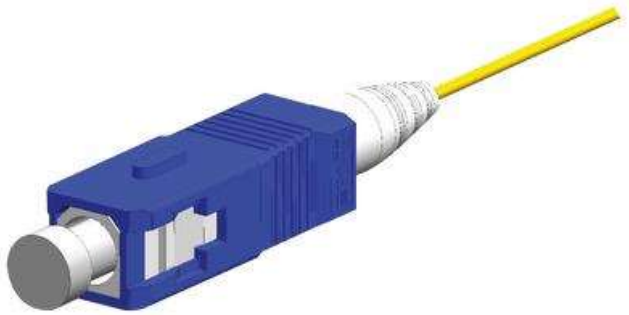
FO Field LC

R&M

Convincing cabling solutions

A Real Alternative to Splicing

The R&M field terminable connectors FO Field LC is the first real alternative to splicing and fulfills already coming standards.



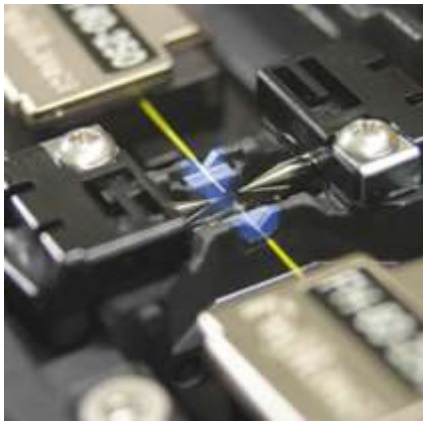
Benefits

- Tool less assembling (cleaver, cable stripper, scissor)
- Fast and secure assembling
- Easy logistic: all cable and tube types with one plug
- Real alternative to splicing
- Cost saving
- Time saving
- part of the R&M QPP program

	Pigtail splice	FO Field
Pigtail	1	
Splice holder	1	
Space	(Box)	
Connector		1
Time	5min	<1min
Tools	~10'000€	~2'000€
Skills	Expert	30min training

Cost calculation

Cost calculationn Pigtail splicing		
Pigtail	1 Stk	€ 3.00
Splice holder	1 Stk	€ 0.15
Installation time	45 min	€ 30.00
Hourly rate expert	40 €/h	
		€ 33.15
Splice equipment ~€ 7'000.-		
Cost calculation FO Field		
Connector	1 Stk	€ 7.00
Installation time	20 min	€ 8.33
Hourly rate worker	25 €/h	
		€ 15.33
Tool FO Field ~€1'100.-		



!!!Please adopt this calculation to your regional cost base!!!

Features

- MM Grade Bmf/3 (≤ 0.5dB each-to-each, >35dB RL plugged)
- SM Grade Cf/1 (≤ 0.5dB each-to-each, > 60dB RL plugged, >55dB unplugged) Cf/2 (≤ 0.5dB each-to-each, > 45dB RL)
- Fiber types: OM4 (covers OM3+OM2), G652.D and G657.A2
- 600µm / 900µm compact und tight tube with same connector
- Direct assembling on bare fiber 250µm (e.g. loose tube cable)
- Strain relieve 1.4mm- 3.0mm with additional set (one set for all connectors)
- Re-usable min 5x
- Existing (0°) Cleaver can be used

Fullfils coming standards

FprEN 50377-17-1 & FprTR 50510:2012

8° Cleave in the connector to reach >60dB for video overlay and future applications

CLC/FprTR 50510:2012 – 28 –

Table 3 – Typical proposed connection requirements for FTTx infrastructures

Connection type	Optical attenuation, typical dB	Optical attenuation, 97 % value dB	Return loss dB
Single-mode	≤ 0,25	≤ 0,5	≥ 45 ≥ 60 [a]

[a] Return loss ≥ 60 dB: For a video overlay network (with analog RF modulation) APC (angled polished connector) are recommended. Higher reflections may result in a distortion or a poor S/N ratio of the video signal.

Source: CLC/FprTR50510:2012

Recommended Field of Application

- Inside Optical Termination Outlet
- FTTDesk Installation
- As repair kit for defect connectors
- As solution for any required cable length (on site assembly)
- BEP / wall boxes (direct assembling on bare fiber possible)

Recommended Target Groups

Customer Groups:

- Telcos
- Utilities
- Colocation Center

Target Groups:

- Installers
- Technical Deciders
- Planer
- Distributors

Offering

Offering LC 01.07.2014

Item-Nr.	Description	Gross price	Gross price	Gross price	
810201	FO Field-LC C/1 G657.A-Pigtail	CHF 15.00	€ 11.25	$ 16.05	
810202	FO Field-LC C/1 G652.D-Pigtail	CHF 15.00	€ 11.25	$ 16.05	
810203	FO Field-LC C/2 G657.A-Pigtail	CHF 15.00	€ 11.25	$ 16.05	
810204	FO Field-LC C/2 G652.D-Pigtail	CHF 15.00	€ 11.25	$ 16.05	
810205	FO Field-LC Bm/3 OM4-Pigtail	CHF 12.00	€ 9.00	$ 12.84	

Offering SC 01.07.2014

Item-Nr.	Description	Gross price	Gross price	Gross price	
810213	FO Field-SC C/1 G657.A-Pigtail	CHF 15.00	€ 11.25	$ 16.05	
810214	FO Field-SC C/1 G652.D-Pigtail	CHF 15.00	€ 11.25	$ 16.05	
810215	FO Field-SC C/2 G657.A-Pigtail	CHF 15.00	€ 11.25	$ 16.05	
810216	FO Field-SC C/2 G652.D-Pigtail	CHF 15.00	€ 11.25	$ 16.05	
810217	FO Field-SC Bm/3 OM4-Pigtail	CHF 12.00	€ 9.00	$ 12.84	

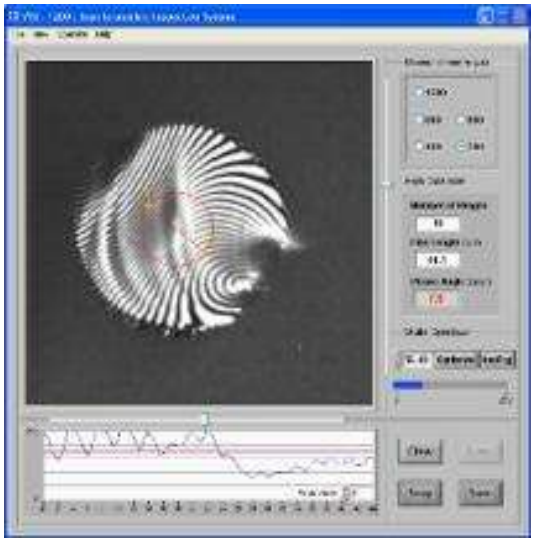
Tools

Tool case

- Protecting Hard-top case
- Stripping tools, fiber fixation tool
- Red light source, patch cords
- Cleaning tissues (alcohol not allowed for storage)
- Fiber container
- Manual
- Water-resistant marker
- Space for Cleaver
- Space for connector sets

Tools

Cleaver «RM-FAC-08 (R&M-Field Angled Cleaver-8°)



- 8° Cleaver
- Simple, intuitive handling
- Long endurance (10x1000 Cleaves), exchangeable «Blade's»
- 0.9mm, 2.1mm and 3.0mm insets

Tools

Pass-Fail-Tool (red light):

- Common red light source
- Jumper cable

Miscellaneous tools:

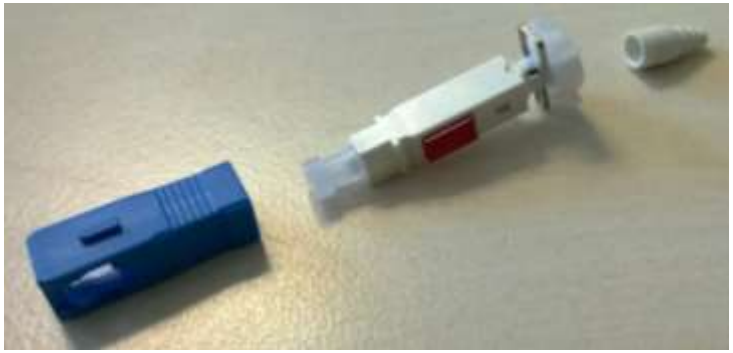
- Stripping tools
- Fiber fixation
- Cleaning tissues (alcohol not allowed for storage)
- Fiber container
- Water-resistant marker

FO Field Familie

FO Field LC

FO Field SC

- APC
  - G657.A
  - G652.D
- PC
  - G657.A
  - G652.D
  - OM4 (also for OM3, OM2)



Same tooling, handling and functionality

Product assortment cable

In general, all R&M cable with a 600µm or 900µm buffer can be assembled to a FO Field.

For loose tube cables with 250µm fiber the strain relive needs to be asured by a housing.

http://universe.rdm.com

Breakout

Mini-Breakout

Loose tube cable

FITH cable

Product assortment platforms

Thanks to its optical performance and easy assembling, the FO Field is a real alternative to splicing. It can generally be used in all platforms.

http://universe.rdm.com

Outlets

19” Racks

R&M*inteliPhy*

Intelligent Physical Network Management

Infrastructure Management: Key aspects

Highest availability

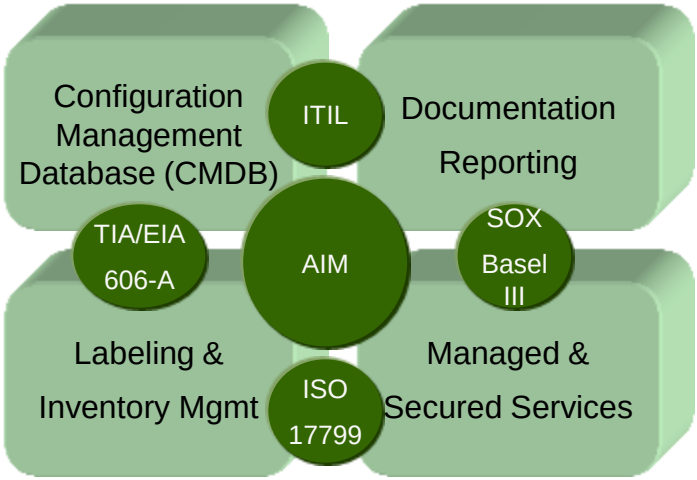
- Business processes are highly dependent on availability of a running network

Reduction of Downtime Cost

- One minute of downtime can cost up to USD 5'000

Economical aspects

- Efficient installation and move, add and change process (IMAC)
- Transparent and documented network

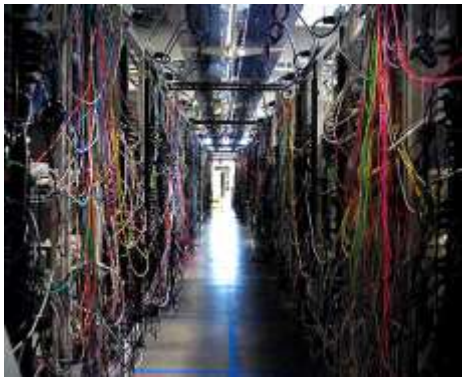


Disaster Recovery / Fault & Problem Management

- Risk Management, ITIL, BASEL III, SOX
- Up-to-date document is essential to ensure business continuity

Why Automated Infrastructure Management?

Gartner: 59% of network problems caused by physical layer issues



Documentation

- Accurate manual documentation requires high effort in creation and maintenance
- Impacts of human errors are significant

Patching

- High failure rate during MAC processes
- Insufficient work order management
- Patching mistakes cause of 28% of downtime in data centers (Gartner)

Stranded Switch Ports

- Due to an insufficient documentation up to 40% of all Switch Ports might be unused

(Source: Frost & Sullivan)

Automated Infrastructure Management: Benefits

Software Benefits

- Centralized database with entire physical infrastructure
- Controlled changes based on work order management
- Graphical illustration of network
- Powerful search and reporting features
- Multiple users with access and permission control
- Full compliance to ITIL processes
- Better use of installed capacity

With monitoring hardware

- Real-time physical connectivity monitoring
- Automatic update of database → 100% accurate documentation
- Automatically keep track of all move, adds and changes
- Alerts on unsolicited changes

Configuration Management Database (CMDB)

- The CMDB is a repository that stores and manages the 'configuration items' throughout their entire service lifecycle
- It represents the authorized configuration of all significant components of the IT environment.

Operate

- Localization of failures
- Event & alarm management
- Incident & problem management
- Security & risk management
- ITIL-, ISO 20000 processes

Provision

- Up-to-date view of process steps
- Change-control, review
- Quality control

Document

- Manual compilation
- Acquisition of IP & SNMP equipment
- Automatic data collection

Resources

- Bill of materials, part lists
- Load factors
- Inventory

Design

- Change planning
- Standardized Workflows
- Work orders

AIM Maturity Model

Source: Gartner

Manual	Reactive	Proactive	Service Oriented	Optimization
Little documentation	Fragmented, inaccurate documentation	Central documentation	Service-driven approach	Eliminate stranded capacity
No standard change process	High error rates (changes)	Change management process	Charge-back process	End-to-end analysis
Unrestricted access	Reliance on individual heroics	Limited access	Intelligent (business) capacity management	Agile infrastructure management
Outages commonplace	Incident firefighting	Reliable services	Infrastructure monitoring strategy	Predictive analysis
	Limited monitoring	Energy monitoring and measurement	Integrated change configuration (CMDB)	Dynamic infrastructure

Operations ← Focus → Business Processes

Standardization: ISO/IEC JTC1/SC25 14763-2 (EN 50174-2)

ISO/IEC 14763-2: Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation

Addendum to Tables 14 and 22

Table 22 – Recommendations of operational administration systems

	Administration system		
RECORDS (AND/OR DRAWINGS) that provide information about the item together with other items related to it			
Operational complexity Level	1	2	3
Cord connections (see Note 2)	None	Electronic	Automated
Service delivery (see Note 2)	None	None	Automated

NOTE

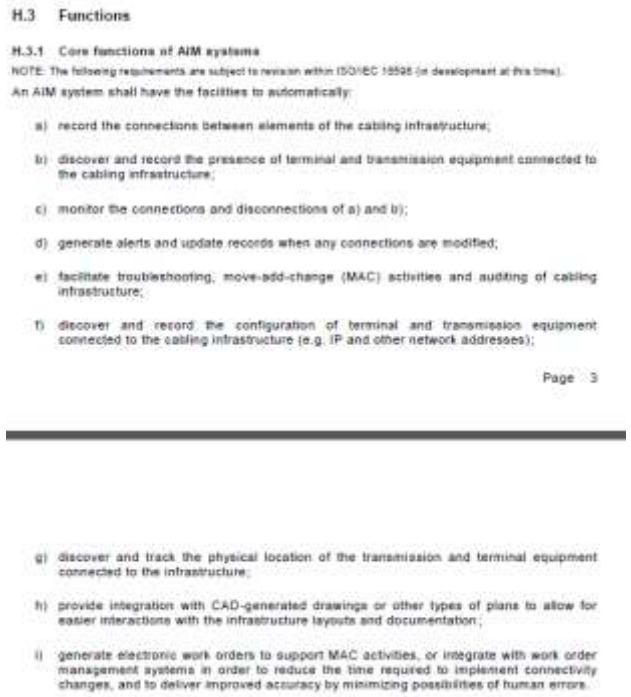
Table 14 – Minimum requirements of operational administration systems

	Administration system			
IDENTIFIERS				
Operational complexity Level	1	2	3	Enhanced
Cords/jumpers	-	-	Yes	Yes
LABELS (fixed to the item or are part of the item)				
Operational complexity Level	1	2	3	Enhanced
Cords/jumpers (see Note 1)	-	-	Yes	Yes
RECORDS (AND/OR DRAWINGS) that provide information about the item together with other items related to it				
Operational complexity Level	1	2	3	Enhanced
Cord connections (see Note 2)	None	Manual	Electronic	Automated
Service delivery (see Note 2)	None	None	None	Automated

ISO/IEC 14763-2: New Amendement H (Normative)

Core Functions

- Automatic documentation of infrastructure connectivity
- Automatic detection of connected devices
- Supervision of changes in connectivity
- Alarming and documentation of changes in connectivity
- Support in fault location, MAC, auditing
- Automatic detection and documentation of the configuration of connected devices
- Automatic detection of the physical location of connected devices
- Integration of CAD data
- Controlled changes (MAC) with work orders



H.3 Functions

H.3.1 Core functions of AIM systems

NOTE: The following requirements are subject to revision within ISO/IEC 18598 (in development at this time).

An AIM system shall have the facilities to automatically:

a) record the connections between elements of the cabling infrastructure;

b) discover and record the presence of terminal and transmission equipment connected to the cabling infrastructure;

c) monitor the connections and disconnections of a) and b);

d) generate alerts and update records when any connections are modified;

e) facilitate troubleshooting, move-add-change (MAC) activities and auditing of cabling infrastructure;

f) discover and record the configuration of terminal and transmission equipment connected to the cabling infrastructure (e.g. IP and other network addresses);

Page 3

g) discover and track the physical location of the transmission and terminal equipment connected to the infrastructure;

h) provide integration with CAD-generated drawings or other types of plans to allow for easier interactions with the infrastructure layouts and documentation;

i) generate electronic work orders to support MAC activities, or integrate with work order management systems in order to reduce the time required to implement connectivity changes, and to deliver improved accuracy by minimizing possibilities of human errors.

Status DAM (Draft Amendment)

ISO/IEC 18598: AIM System Requirements, Data Exchange, Applications

ISO/IEC JTC1/SC25

- Details to ISO/IEC 14763-2
- Functional Requirements
- Integration with other business information and network management systems
- Data exchange framework
  - Premises / Space
  - Telecommunications equipment and connectivity
  - Organizational elements
  - Work orders

- Status: Working Draft

18598/WD 2 © ISO/IEC – 3 –

CONTENTS

EN 50600-2-6: Data center: Management and operational information

Processes in data centers

- Operational Information and parameters
- Operational Processes
  - Operations
  - Incident Management
  - Change Management
  - Configuration Management
- Management Processes
  - Availability
  - Security
  - Energy
  - Capacity
  - Product Lifecycle
  - Cost
  - Service Level
  - Customer

Status: Draft

ANSI/TIA 606B Administration Standard for Telecoms Infrastructure

TR-42.6 Committee on Telecommunications Infrastructure and Equipment Administration

- Replace original Clause 13 "Automated Infrastructure Management Systems" to form a separate addendum
- Harmonized with ISO/IEC 14763-2 and ISO/IEC 18598

R&M*inteliPhy*

R&M*inteliPhy* Manage

R&M*inteliPhy* Monitor

R&M*inteliPhy* Key Features

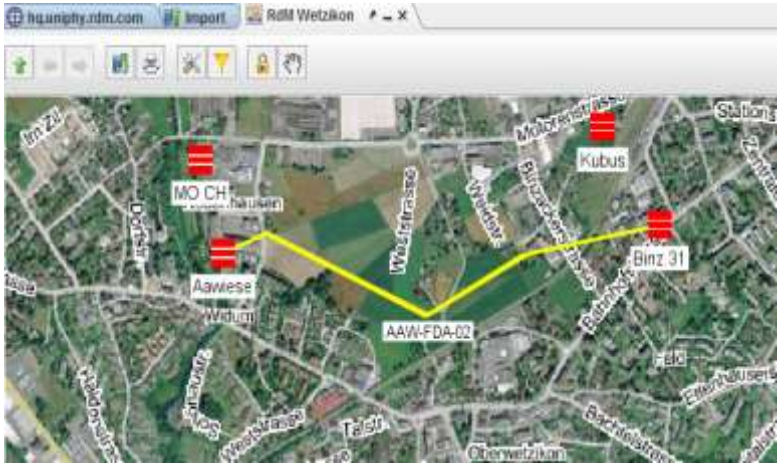
- Entire network configuration stored in central database
- Automatic update of physical layer documentation
- Easy set-up and execution of moves, adds and changes with guidance at patch panel
- Powerful search and reporting
- Alerts when unauthorized changes are made
- Retrofittable solution – implement where and when needed
- Uses R&M standard components (patch cords, panels)
- Fully customizable

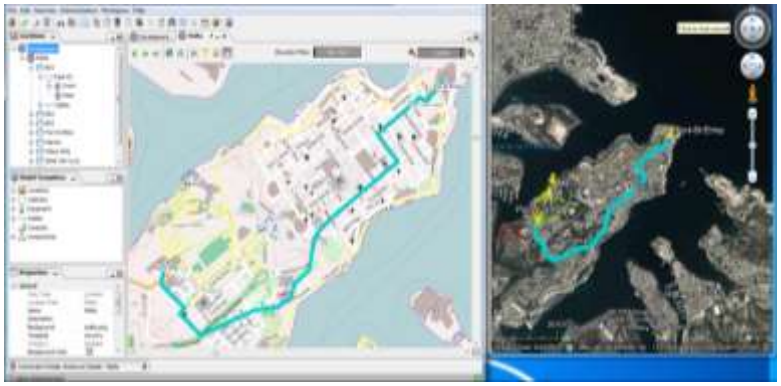
R&M*inteliPhy* Manage Overview

- Administration of physical layer infrastructure
- Management of multi-site networks
- Inside plant and outside plant networks
- Intuitive user interface
- Multiple Operating Systems
- Multiple Database Management Systems
- Available as "Software as a Service" (SaaS) solution
- Open architecture for easy integration with best of breed software

Network View

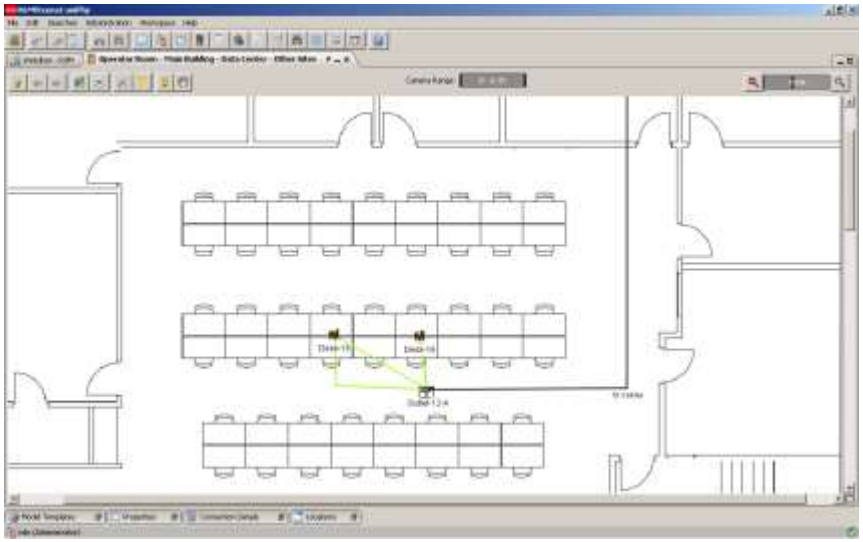
- Hierarchy Tree View
- Geographical View
- GIS Background (Geo-aware maps)
- Multi-Site capable
- Cable routing through locations or geographically
- System is dimension – aware
  → length calculations



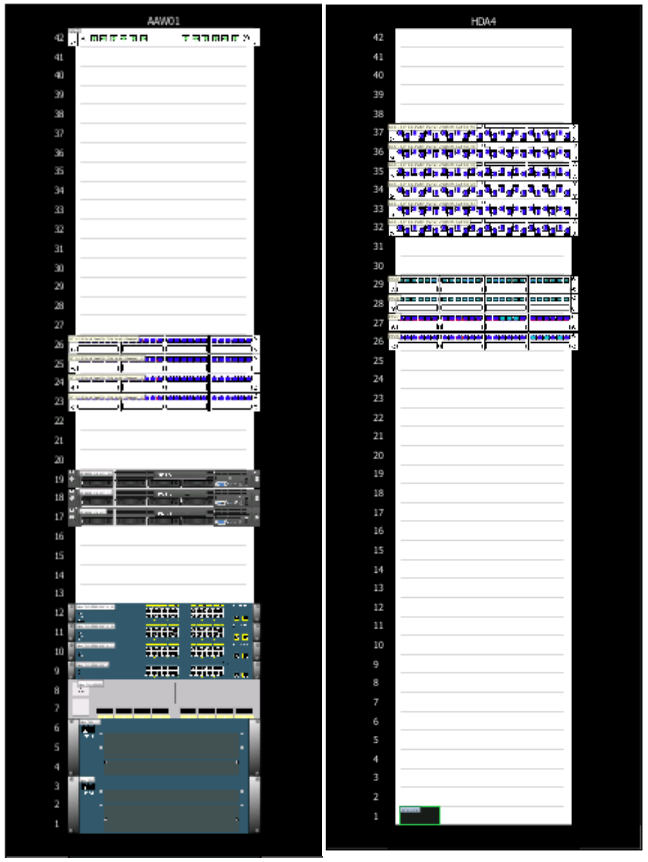


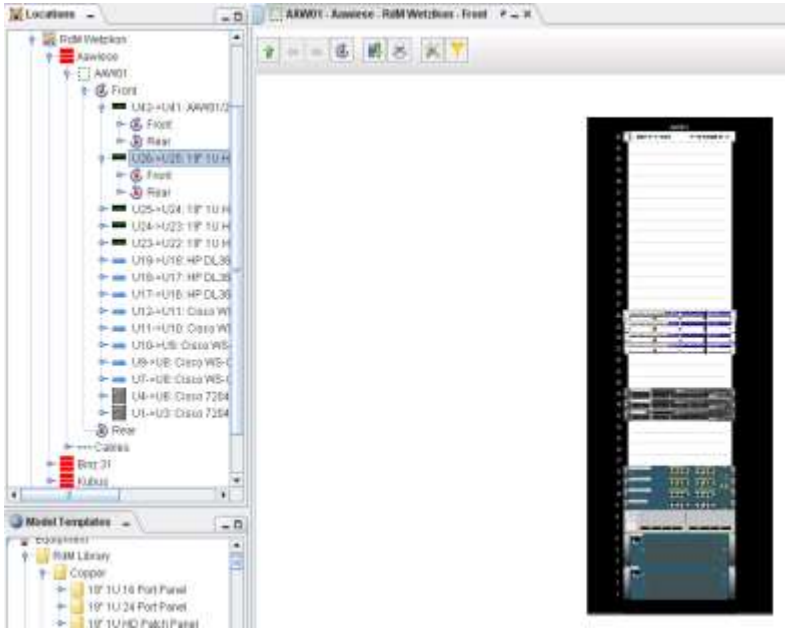
Equipment Room Layout View

- Architectural drawing can be added as background (Bitmap)
- Graphical representation of connectivity between objects
- Cable length calculation



Rack View

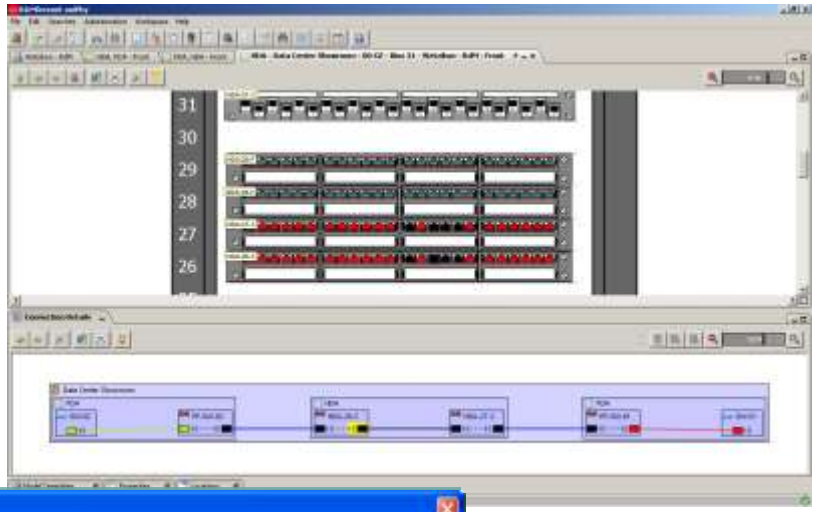


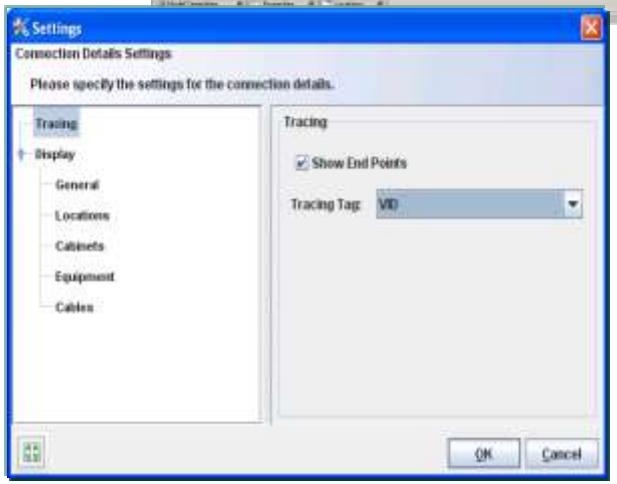


- Realistic visualization of cabinet layout
- Color-coding of ports for status indication

Connectivity View

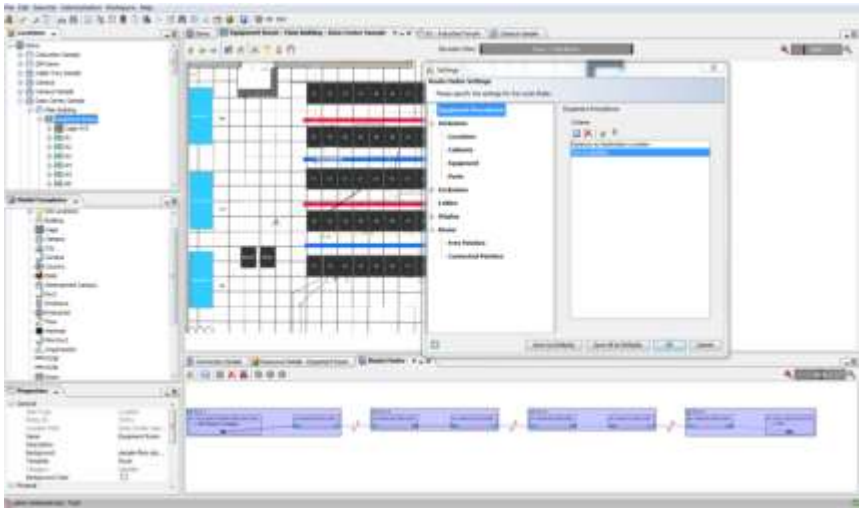
- End-to-End connectivity display
- Ports can be marked with service tags
- Restrict tracing to individual services





Route Finder

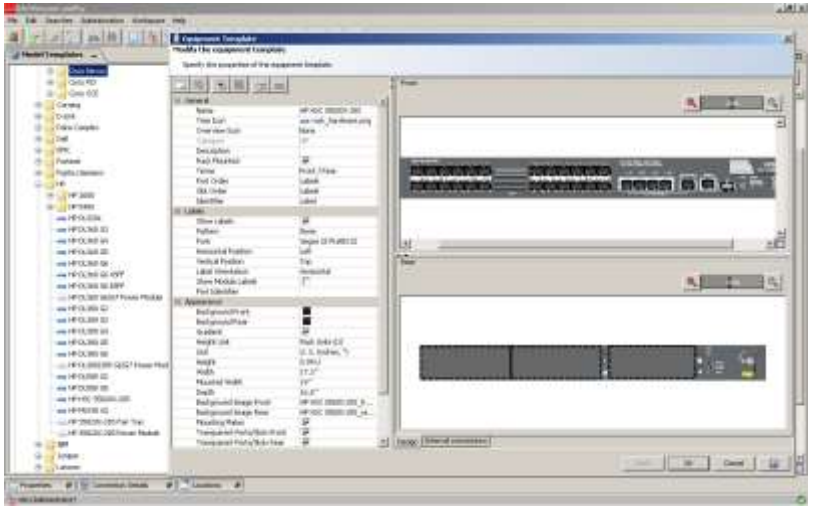
- Automatic creation of End-to-End Routes involving multiple patches
- Configurable search strategies
- Manual fine-tuning of route possible



Templates

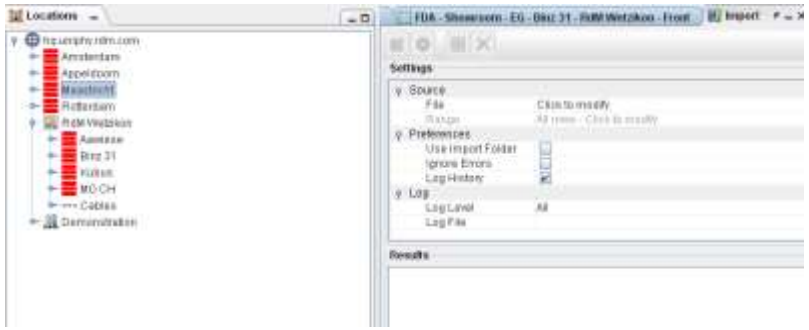
Large library of templates

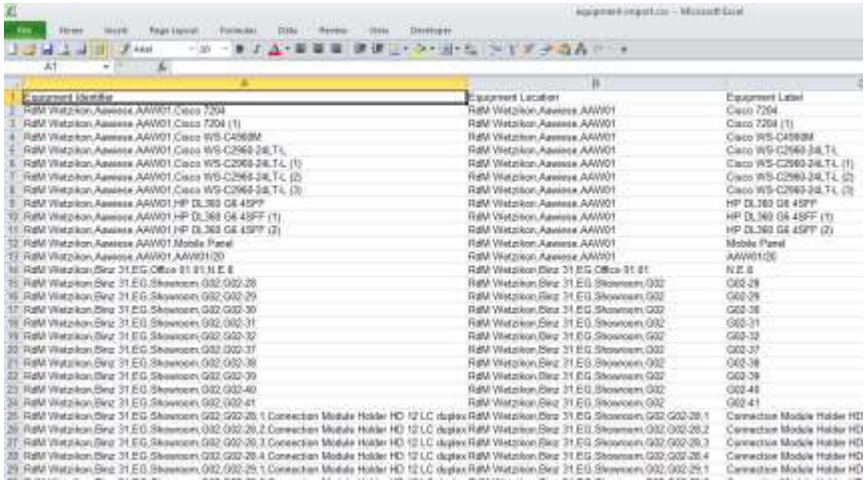
- R&M Library
  - Panels and modules
  - Racks and cabinets
  - Outlets
- Active Equipment (Switches, Servers, Peripherals)
- Built-in Template Editor
- "Request a Template" Service
- User-defined attributes (Asset Tag, IP Address, MAC Address, VLAN Tag …)



Infrastructure Import / Export

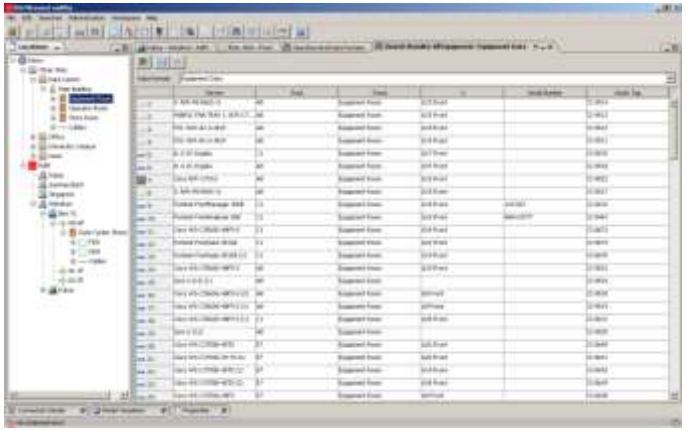
- Rapidly import existing infrastructure into model
- Import Filter based on CSV flat files
- Locations, Cabinets, Equipment, Cables





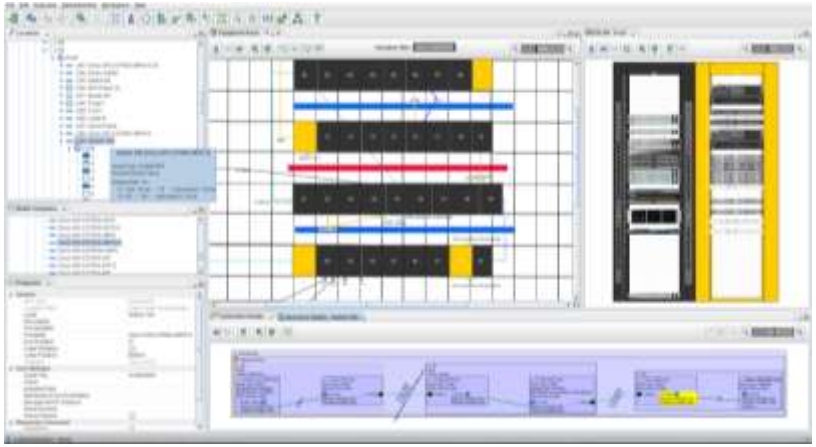
Customizable search and reporting

- Built-in Report Generator
- User-defined columns, data formats, totals
- Export reports as CSV, HTML, PDF
- Data fields include resources, labels, user attributes etc.
- Graphical reports and Dash-boards generated by third-party tools (e.g. CrystalReports, Excel)



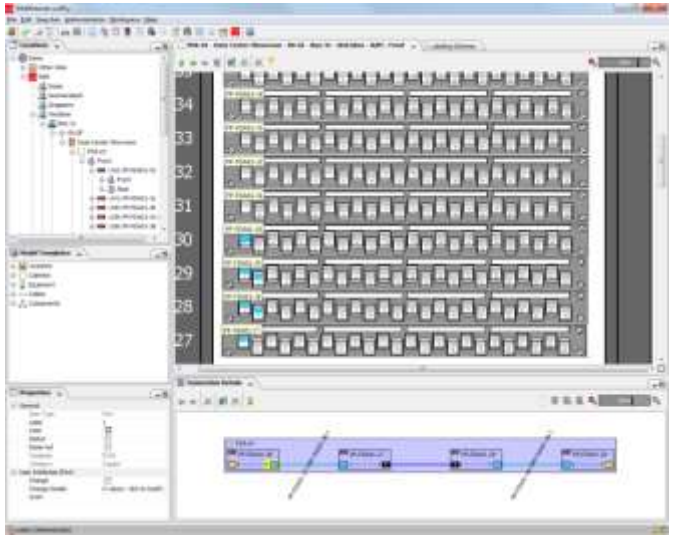
Resource Management

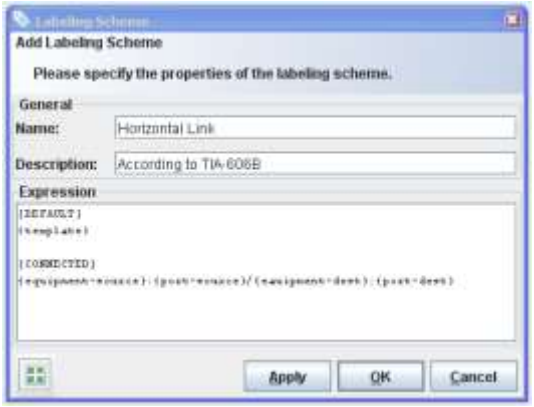
- Objects can provide or consume resources
- Space, Power, Cooling, …
- Reports on resource consumption
- Color-coding of objects depending on resource level



Labeling schemes

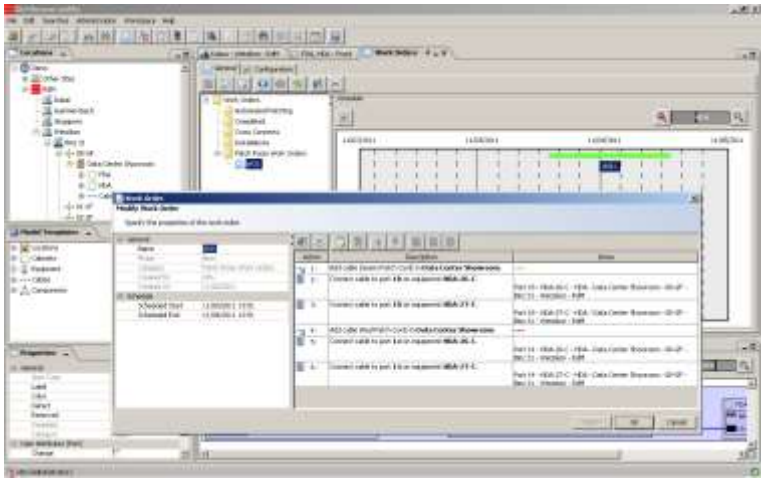
- Automatic generation of cable labels
- Consistent generation according to configurable labeling scheme
- Labels shown in connectivity diagram
- Export possibilities for labeling printer





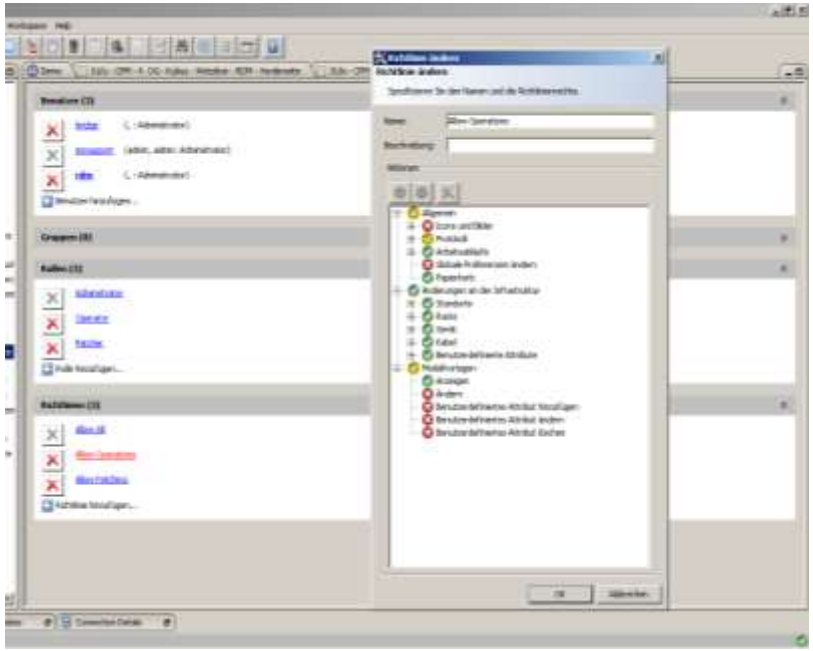
Work orders

- Managed Changes
- "Planning" Mode to generate Work Orders or Work Orders generated automatically from Route Finder
- Planning tool
- Dependency of work orders observed
- Time schedule
- Send work orders and bill of materials to email or mobile client
- Configurable workflow
- Work order log
- Outsourcing to external installation service providers



User management

- Many concurrent users
- Policy-based permission management
- Users, Groups, Roles and Policies
- Policies can restrict operations, access to objects, access to locations
- Interface to external directories (LDAP)



R&M*inteliPhy* Monitor - Components

Sensorbars

- Sensor bars are mounted onto patch panel
- Sense RFID tags and accurately locate position

RFID Clips

- RFID tags mounted onto plug (RJ45, LC, SC, E2000, MPO)
- Set of two clips with same unique identification number per cord

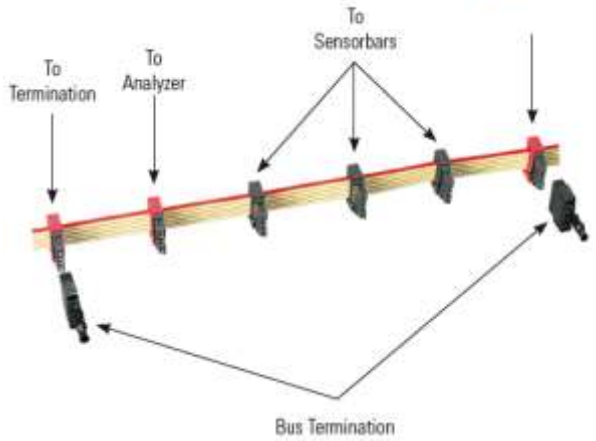
R&M*inteliPhy* Monitor - Components (2)

Analyzer

- Analyzer collects information from Sensorbars and forwards to inteliPhy Manage Server
- One analyzer can handle several cabinets
- 19" 1U rack mounted or 0 U DIN-Rail mounted

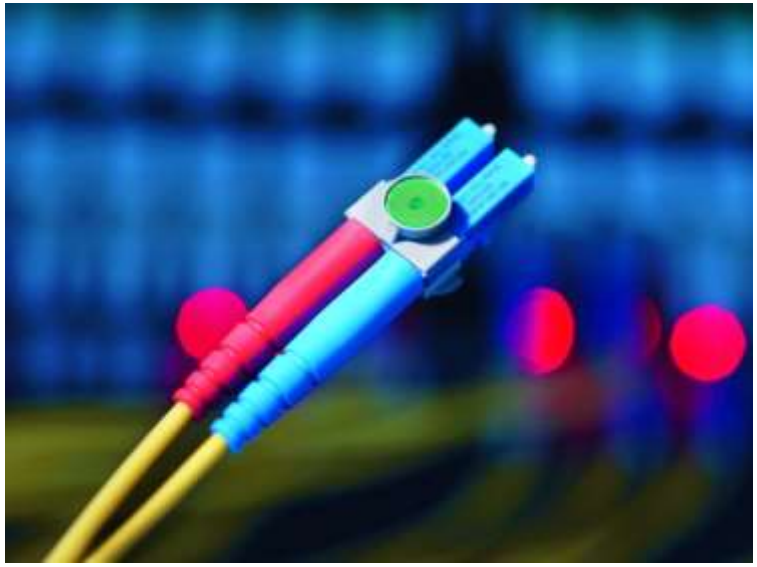
Bus Cabling

- Cabling system to connect Sensorbars to analyzer (Daisy Chain)



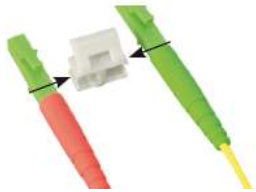
RFID Technology

- RFID sensors in sensor bar accurately identify RFID Tags on patch cords
- Tags carry unique identification number
- Tags can carry additional information ("DNA Profile")
- Contactless reading of Tags
- No influence on data transmission
- Tags are fully passive, no powering required



Retro-fitable

- Existing infrastructure can be easily upgraded to intelligent system
- Snap on Sensorbar to compatible R&M patch panels
- Snap-on RFID tag clips onto R&M patch cords
- Full flexibility to add intelligence when and where needed
- Common management of intelligent and conventional network zones



Technical System Structure

Patchpanels
with
Sensorbars

R&M*inteliPhy*
Manage
Server

Patch cords
with RFID-Tags

Cabling

Analyzer

Concentrator

Mobile
Clients

Operator
Workstations

Comparison of sensing technologies

	RFID	9th Wire	Time Based Sequence	Connection Point Identification
Special Panels	No	Yes	Yes	Yes
Special Patch cords	No	Yes	No	Yes
Connection to Analyzer	6-wire bus	1 wire/port	10-wire bus	1 x PoE/ Panel
Galvanic connection be-tween panels	No	Yes	No	No
Recognition reliability	++	+	-	++
Modular panels	Yes	No	No	No

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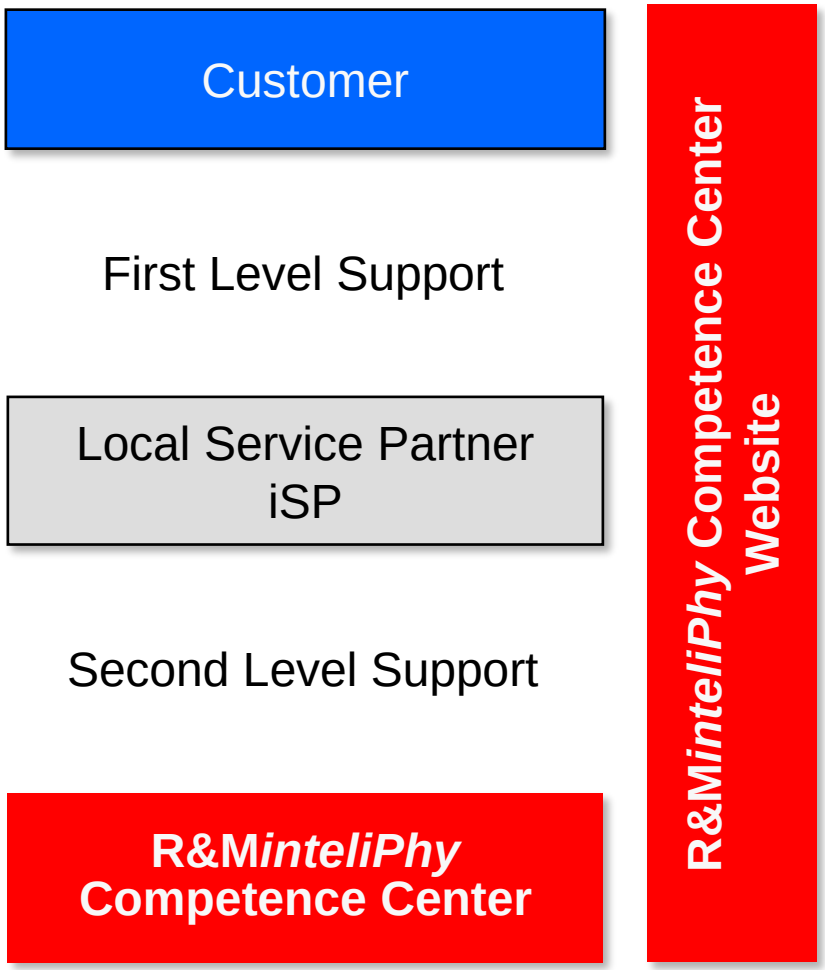
Service and Support Organization

- First Level Support → Local Service Partner
- Defined catalog of support services
- Second Level Support → R&M*inteliPhy* Competence Center (iCC) HQ Wetzikon



R&M*inteliPhy* Advantages

R&M*inteliPhy* Manage

- User – friendly, little training required
- Full feature set
- Complete Library of R&M Components
- All Configuration Tools included
- SaaS version
- Standard interfaces for third-party applications
- Multi-site, multi-user
- Inside and outside plant

R&M*inteliPhy* Monitor

- Retro-fit on R&M standard components
- Standard QPP warranty on cabling
- Modular patch panels, connector type identification
- Galvanic insulation
- Single-tiered Analyzer system, one Analyzer per 2'000 ports
- Simple, field-installable bus cabling
- Bus can cover several cabinets

Tirana Business Park:

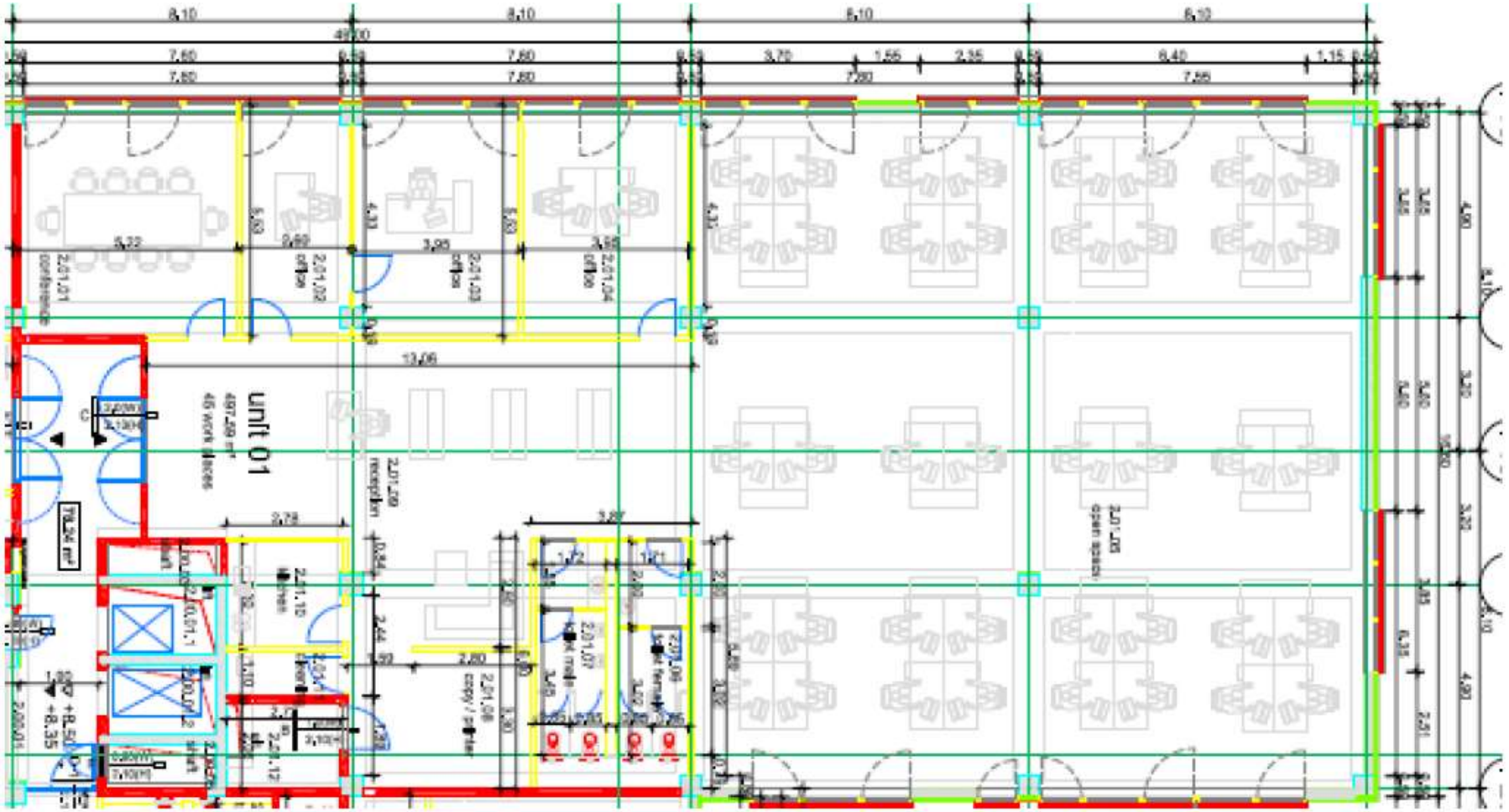
Investor: LINDNER Projektentwicklungs GmbH

Construction Company: LINDNER Bulgaria GmbH

R&M

Convincing cabling solutions

Typical Office Unit 01 - 497.59 m²
45 Working Places



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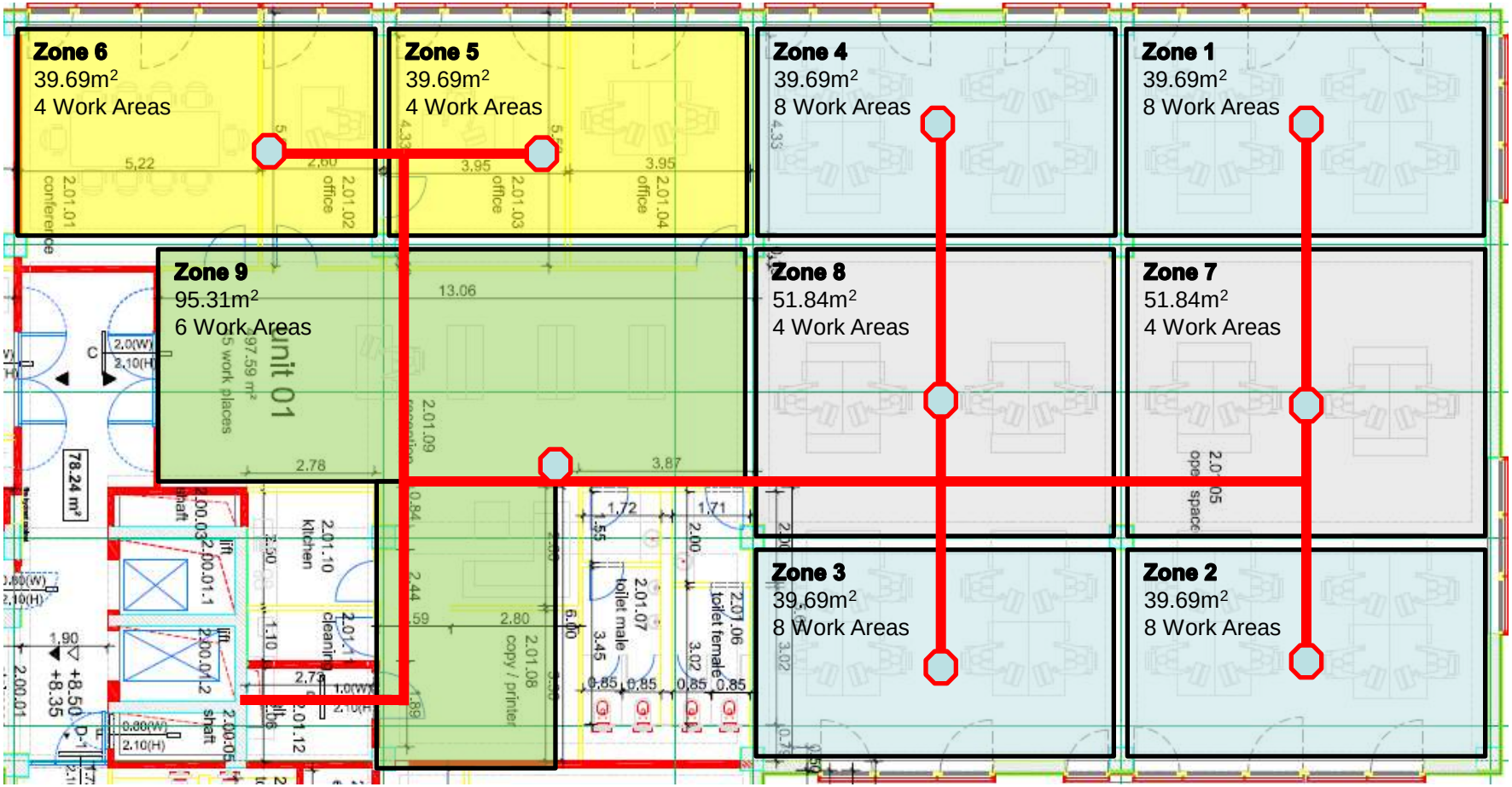
Convincing cabling solutions

Consolidation Point – Main Concept:



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Convincing cabling solutions

Copper Testing For Certification

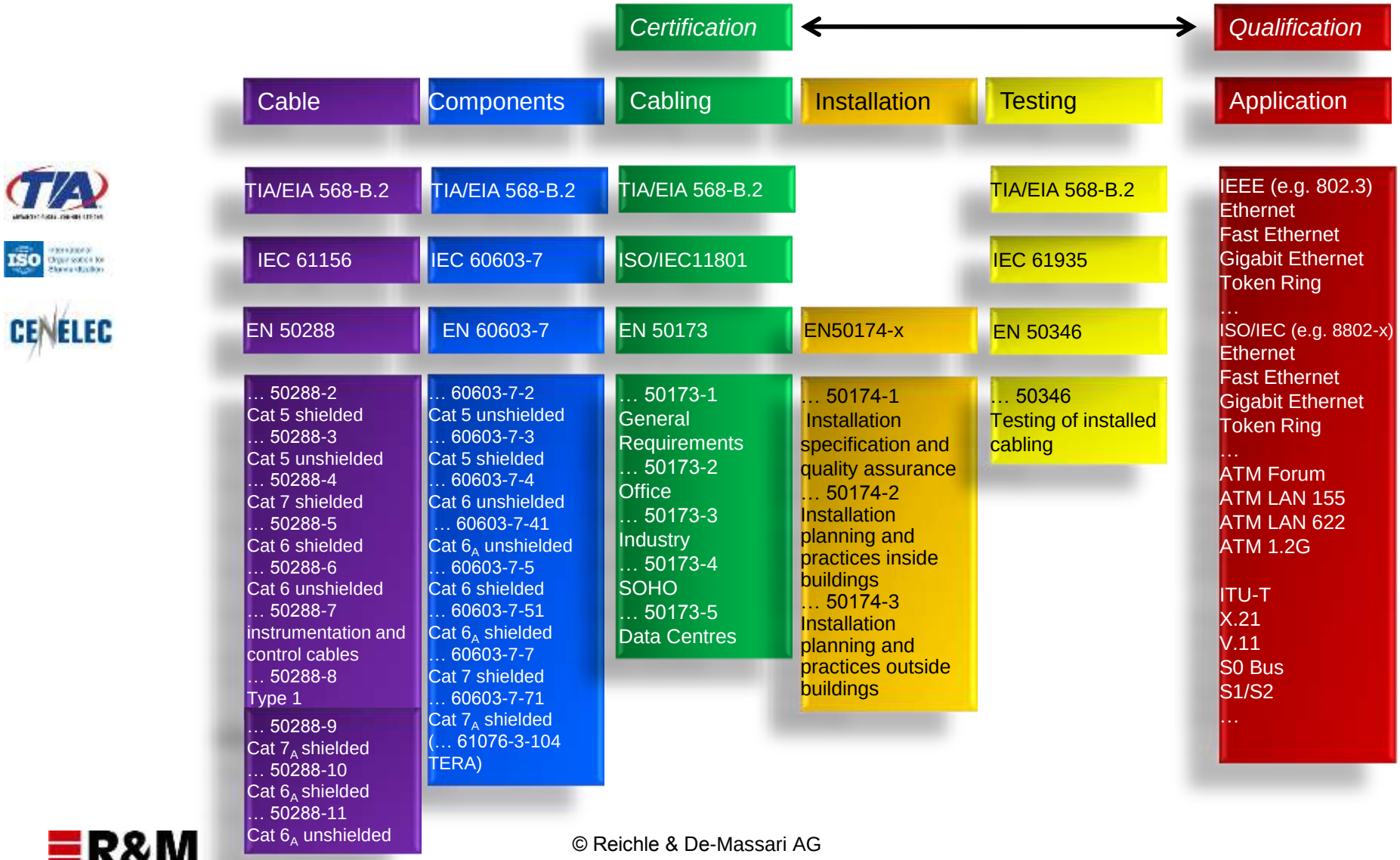
R&M

Convincing cabling solutions

Why is Certification of Structured Cabling Necessary?

- **Technical Reasons**
  - Assuring correct termination
  - Checking against required performance/bandwidth
  - Minimizing down-time caused by installation problems on the physical Layer
  - Manufacturer Warranty
  - Piece of mind for client on installation
- **Commercial Reasons**
  - Confidence and security for network carrier through certification
  - Confidence and security for installer through documentation
  - Defining responsibilities upon job completion

Standards



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Cabling Standards

	100 MHz	250 MHz	500 MHz	600 MHz	1000 MHz
TIA	TIA/EIA 568-B.1/2 Cat. 5e	TIA/EIA 568-B.2-1 Cat.6	TIA/EIA 568-B.2-10 Cat.6A		
ISO	ISO/IEC11801: 2nd Edition Class D	ISO/IEC11801 2nd Edition Class E	ISO/IEC11801 2nd Edition A1/2 Class E_A	ISO/IEC11801 2nd Edition Class F	ISO/IEC11801 2nd Edition A1/2 Class F_A
CENELEC	CENELEC EN50173-1 Class D	CENELEC EN50173-1 Class E	CENELEC EN50173-1 Class E_A	CENELEC EN 50173-1 Class F	CENELEC EN50173-1 Class F_A

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Convincing cabling solutions

Category vs. Classes (ISO/EN)

- Performance of individual components: **Categories**
  (Horizontal cables, patchcords, connecting hardware, patch panel, outlets)

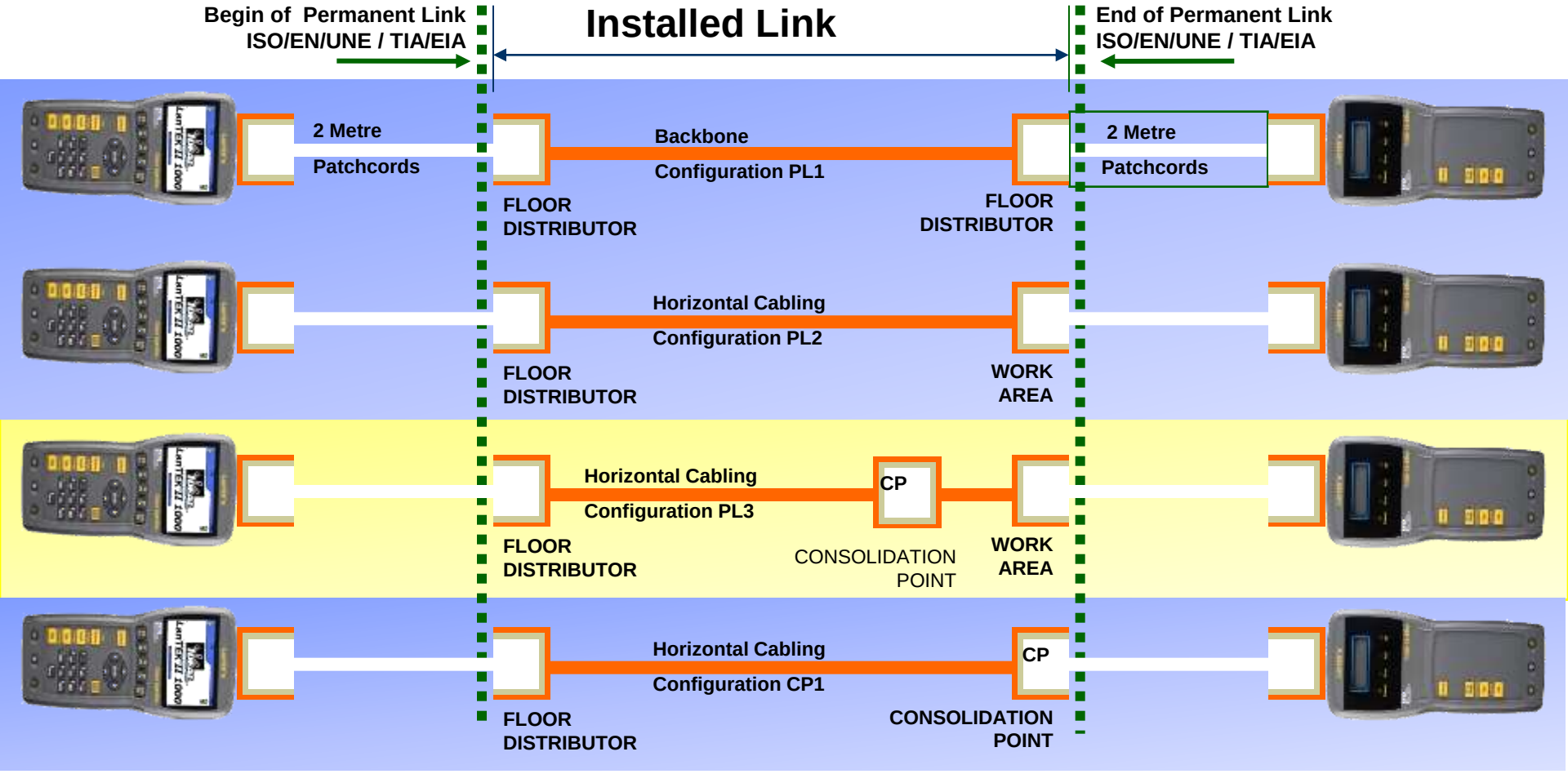
- Performance of Links: **Classes**
  (whole transmission link, built out of individual components)

- Only In **USA** are links classified as categories (In THEORY at least)

Frequency [MHz]	Category (components)	Class (links)	Application (typical/max.)
16	3	C	ISDN
100	5(e)	D	10/100/1000 Mbit (1Gbit)
250	6	E	100/1000 Mbit (1 Gbit)
500	6_A	E_A	10 Gbit
600	7	F	10 Gbit (- 40 Gbit)
1000	7_A	F_A	10 Gbit (-100 Gbit)

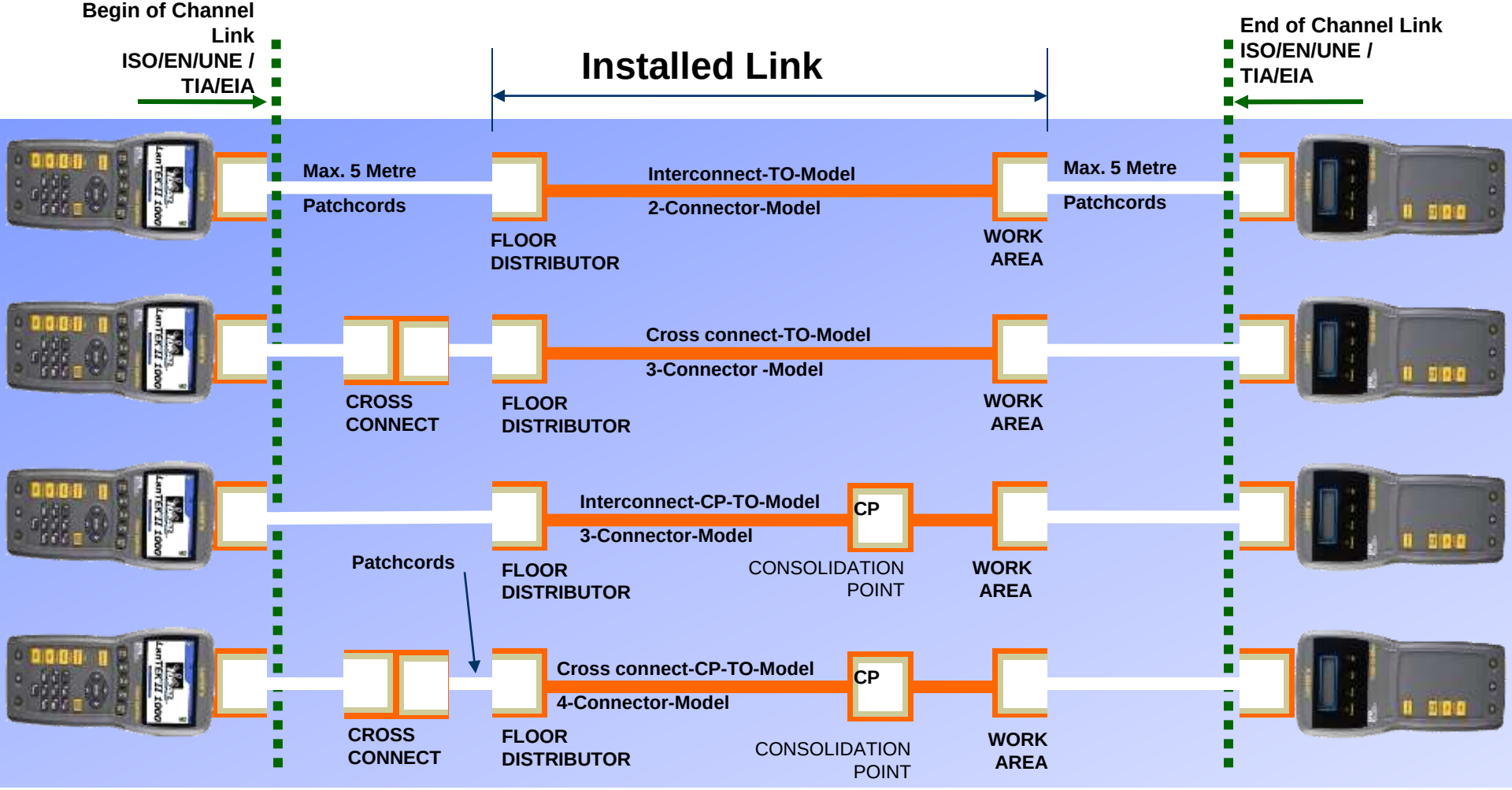
Link Definitions

Permanent Link



Link Definitions

Channel Link

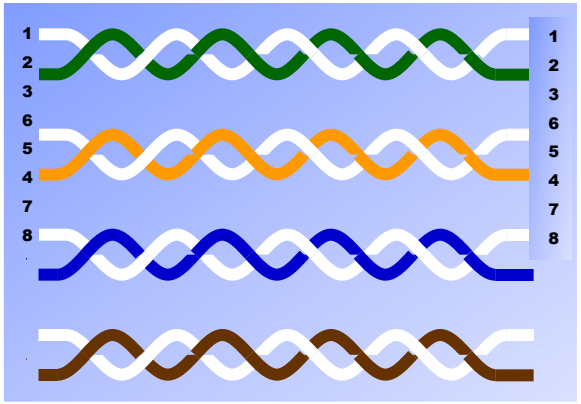


Auto Test – Test Parameters

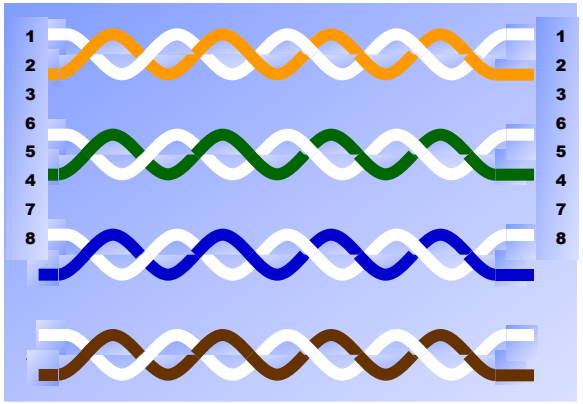
Quality of Installation	Components	Cable	Interaction between Components and Cabling	Disturbances between Links External Disturbances
Wiremap	NEXT	Insertion Loss (former: Attenuation)	Return Loss	PS-ANEXT
DC Resistance	PS-NEXT	Delay	ACR-N (former: ACR)	PS-AACR
		Delay Skew	PS-ACR-N (former: PS-ACR)	$PS\text{-}ANEXT_{AVR}$
		(Capacity)	ACR-F (former: ELFEXT)	$PS\text{-}AACR_{AVR}$
			PS-ACR-F (former: PS-ELFEXT)	
			(Impedance)	

Wiremap

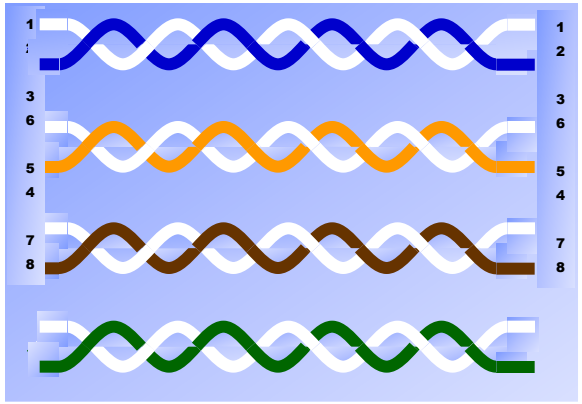
- The wires have to connect same pins on both sides
- The pairing system (1/2, 3/6, 5/4, 7/8) has to be retained
- Wire Map testing is used to locate shorts, opens, and miss-wires.
- Test results are displayed graphically for easy visual indication of any problems
- Three different Wiremap schemes are stored in the testers



Wiremap scheme “A”



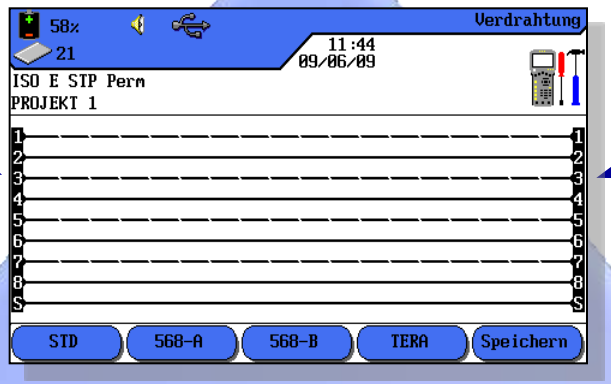
Wiremap scheme “B”



Wiremap scheme “TERA”

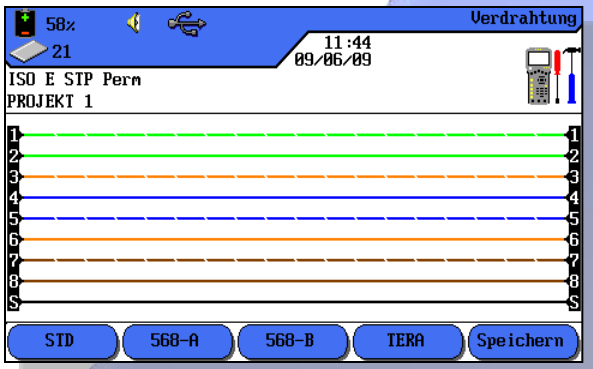
Correct Wiremap

NE:
Near End
DH:
Display Handset

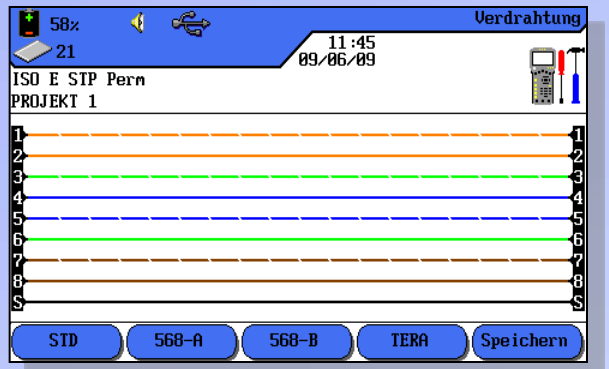


FE:
Far End
RH:
Remote Handset

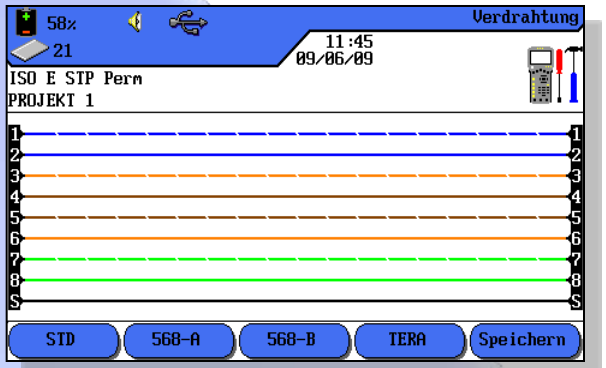
Wiremap scheme “STD”



Wiremap scheme “A”



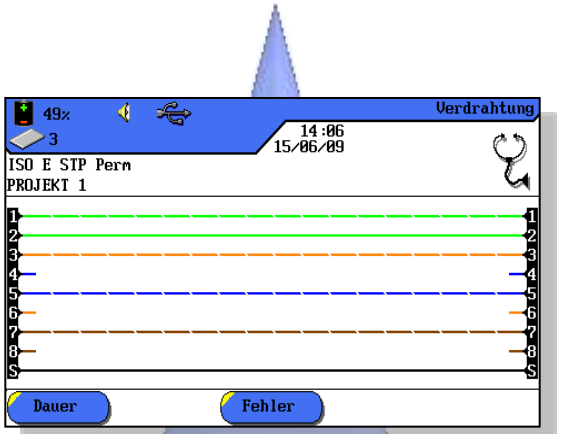
Wiremap scheme “B”

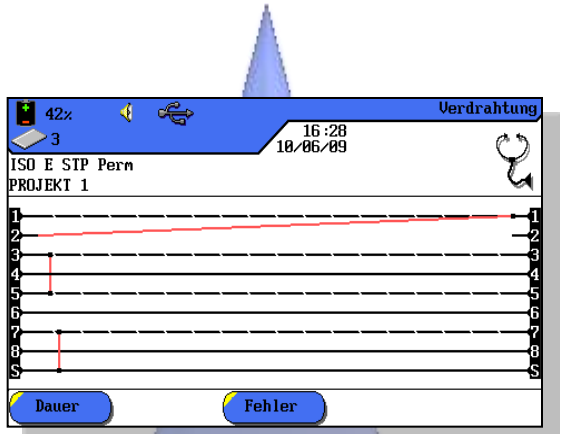


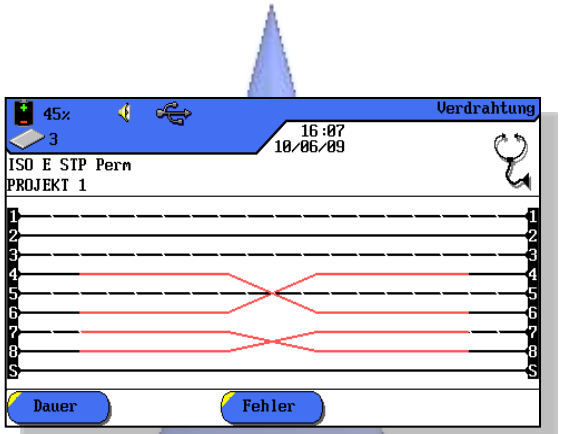
Wiremap scheme “TERA”

Faulty Wiremap

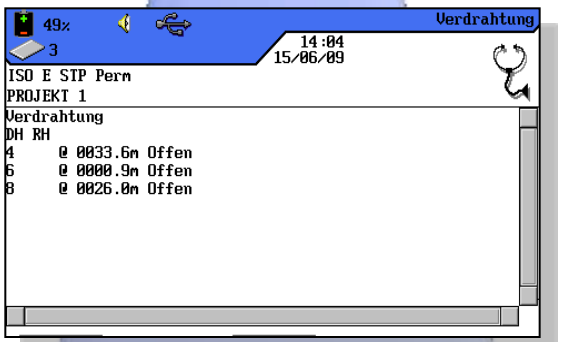
Graph

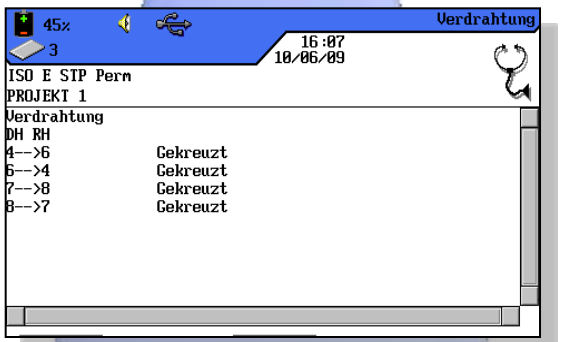






Analysis





Open wires

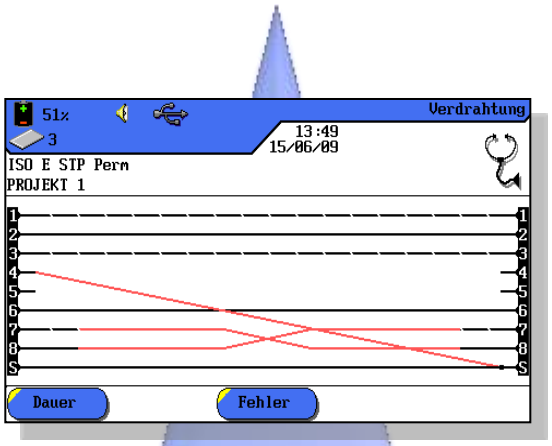
Shorted wires

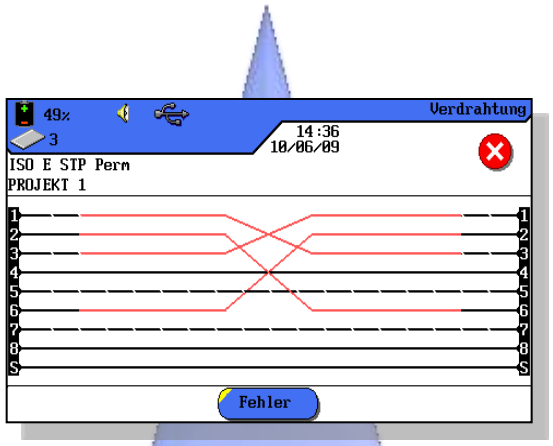
Miswires

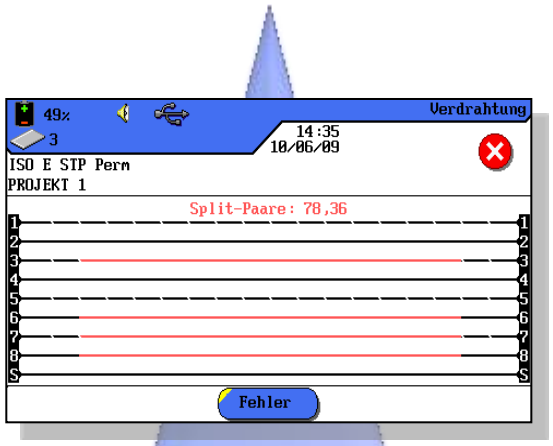
R&M
Convincing cabling solutions

Faulty Wiremap

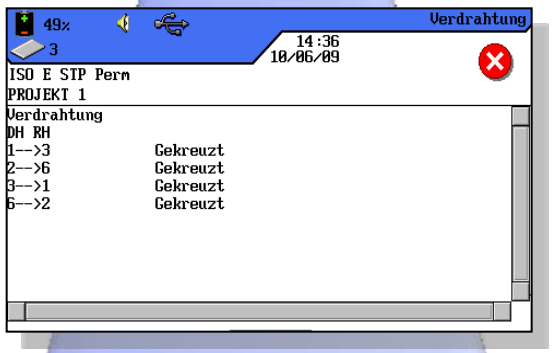
Graph

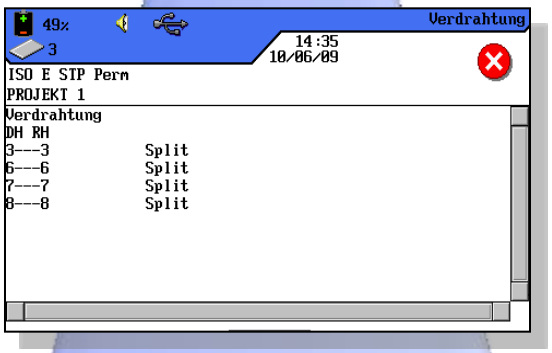






Analysis





“Complex Faults”

“A/B”-Mixture

“Split Pair”

R&M
Convincing cabling solutions

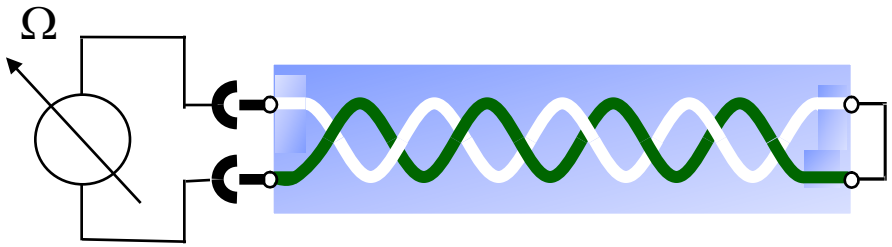
Troubleshooting Wiremap Faults

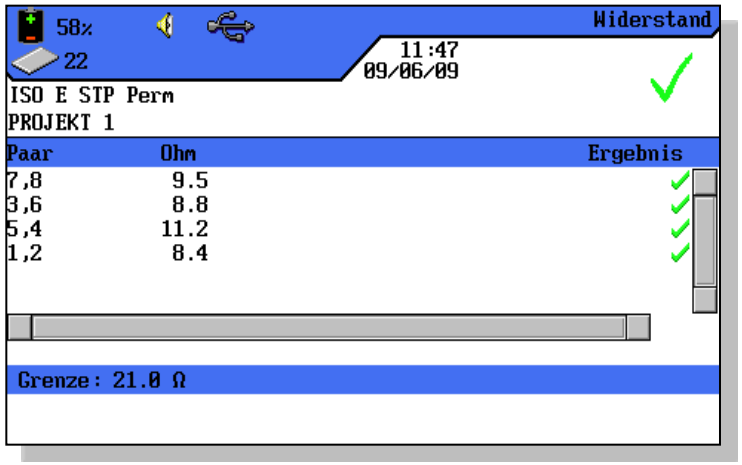
- Problem
  - One or more open pins
- Probable Causes
  - Connector-to-wire punch down not mated
  - Defective jack or plug.
  - Broken wire(s).
- Problem
  - Shorted pins
- Probable Causes
  - Conductors making contact at a connector.
  - Jack or plug has pin or circuit defect.
  - Cable damaged.
- Problem
  - Misswired pins
- Probable Causes
  - Conductors reversed at a connector.

- Common Hotline questions
  - Wiremap failing, Shield connection in red (solid or doted line)
    - *Reason:* UTP standard selected, therefore Shield connection flagged as fault on an STP system and vice versa
    - *Reason:* UTP patch cords used on STP standard and vice versa
  - Wiremap failing, “All connections failing”
    - *Reason:* STP system not properly grounded, measurements taken with power supplies, Ground loops generated

DC Resistance

- This parameter measures the DC loop resistance of each cable pair to ensure that resistance doesn't exceed the given limits.
- The results for each individual pair are reported in ohms together with their limit values based on the selected standard.
- Low resistance values enabling the use of PoE/PoE+ as a remote power supply system for e.g. ISDN telephones, relays, surveillance cameras, etc.
- DC Resistance values are an indicator for installation quality, for the consistency of the terminations
- All four pairs of a network link should have approximately the same resistance.





Troubleshooting DC Resistance Faults

- Problem
  - Excessive Resistance
- Probable Causes
  - Mismatched cable types.
  - Poor punch block connection.
  - Poor RJ-45 termination connections.
  - Wire pair has a tap (never done).
  - Cable damage.
  - Shorted cable.
  - Worn measurement patch cords.
- Problem
  - One wire pair has a very high DC loop resistance, others are normal.
- Probable Causes
  - Poor connection points.
  - Cable damage.
  - Connector blades not fully piercing wire insulation.
  - Worn Connector.

- Common Hotline questions
  - DC Resistance failing, All values too high
    - *Reason:* Link too long or bad quality of terminations
  - DC Resistance failing, One or two values too high
    - *Reason:* Patch cord wearing out, termination on specific pair of poor quality

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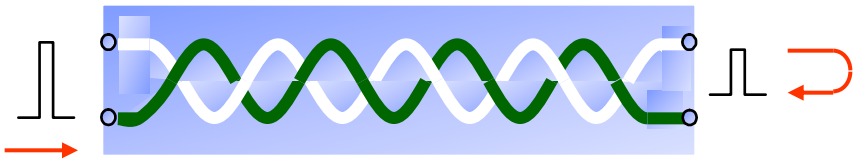
Length Measurements

- This test measures the length of each wire pair.
- The Wire Length Test is mainly used for informational purpose only.
- Depending on the units selected in the Setup menu, length is reported in either feet or meters (could be also changed later in software).
- Is often used to determine the overall length of the installed cables (always use the shortest pair!).
- Measuring the length of the cable requires that you know the Nominal Velocity of Propagation (NVP) of the cable
- Length measurements are based on reflection testing

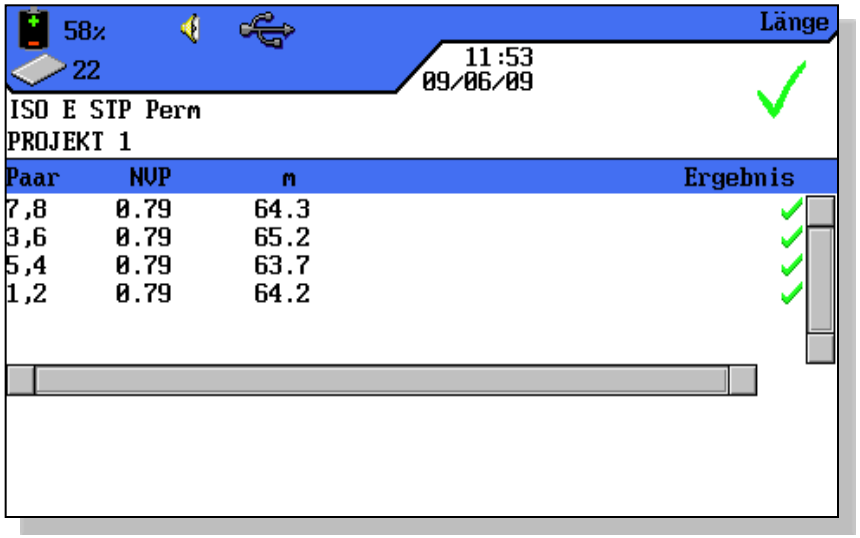


- Open cable end
- Signal sees ∞ Ohms
- Pulses will be completely reflected

NVP expresses the speed with which electrical signals travel in the cable relative to the speed of light in space or vacuum.

Length Measurements

- Wire Length Test is mainly used for informational purpose only, no Pass/Fail criteria!
- Lengths may differ slightly between pairs in the same cable, due to minor NVP differences between the pairs and physical length differences due to twisting patterns.
- The reported length values are directly proportional to the set NVP value
  - Selection via manufacturer‘s cable list
  - Taking from current datasheet of installed cable
  - Determining via reference link



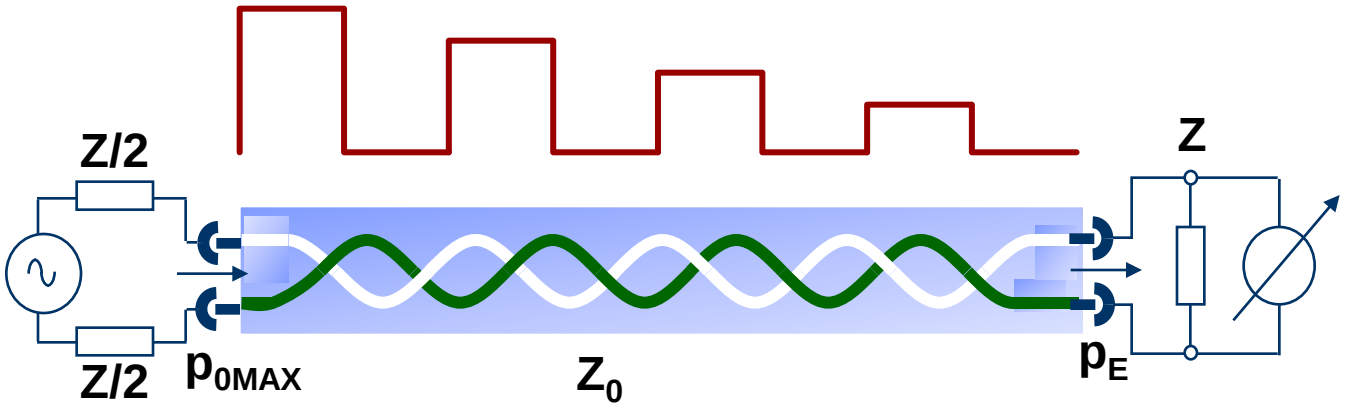
Troubleshooting Length Faults

- Problem:
  - Length between a pair of the same cables varies by more than 10%.
- Probable Causes
  - Incorrect NVP.
  - Excessive cable length.
  - Installed matched terminator not functioning correctly.
  - Cable insulation damage to longer pairs.
  - Break or short in a pair.
  - Elevated capacitance on a pair.

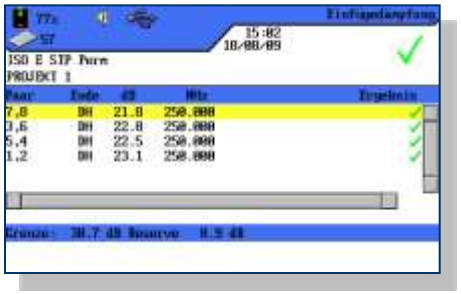
- Common Hotline questions
  - Length not failing on links >90m PL or >100m CL
    - *Reason:* Length measurement is mostly for information only, no Pass/Fail criteria. 90m and 100m are benchmarks for installation calculations only

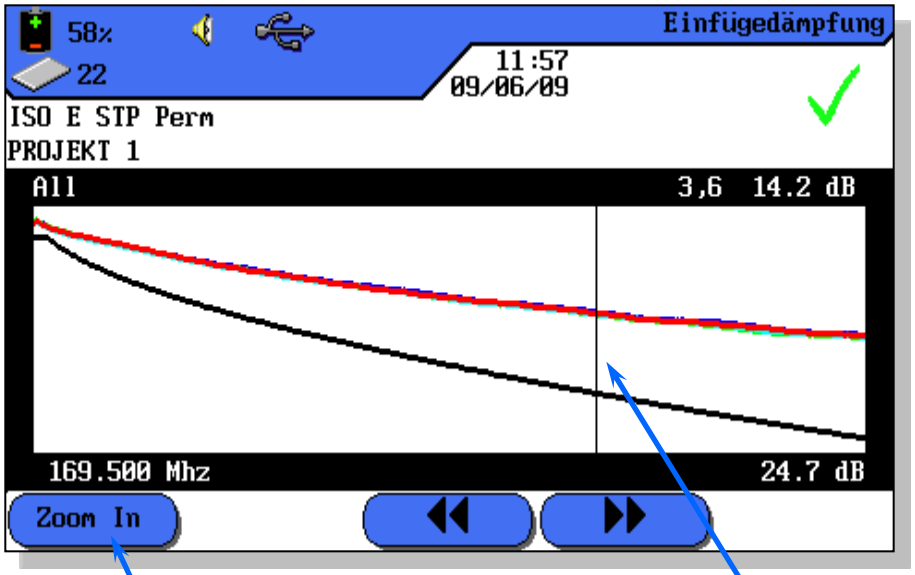
Insertion Loss (Formerly Attenuation)

- This test measures the overall signal strength loss in the cable and verifies that it is within acceptable limits. Low insertion loss is essential for error-free transmission.
- Insertion Loss is measured by injecting a signal of known amplitude at the Remote Handset and reading the amplitude at the Display Handset.
- Insertion Loss is depending on frequency and length of the link.



Insertion Loss (Formerly Attenuation)





Display:

- Tabular View
- View of individual pairs
- Summary View of all pairs

Zooming of points of interest at Cursor position

Moveable Cursor, initially at worst case (margin) point

- The Insertion Loss should be as much as possible identical for all pairs (very important with protocols like Gigabit Ethernet)

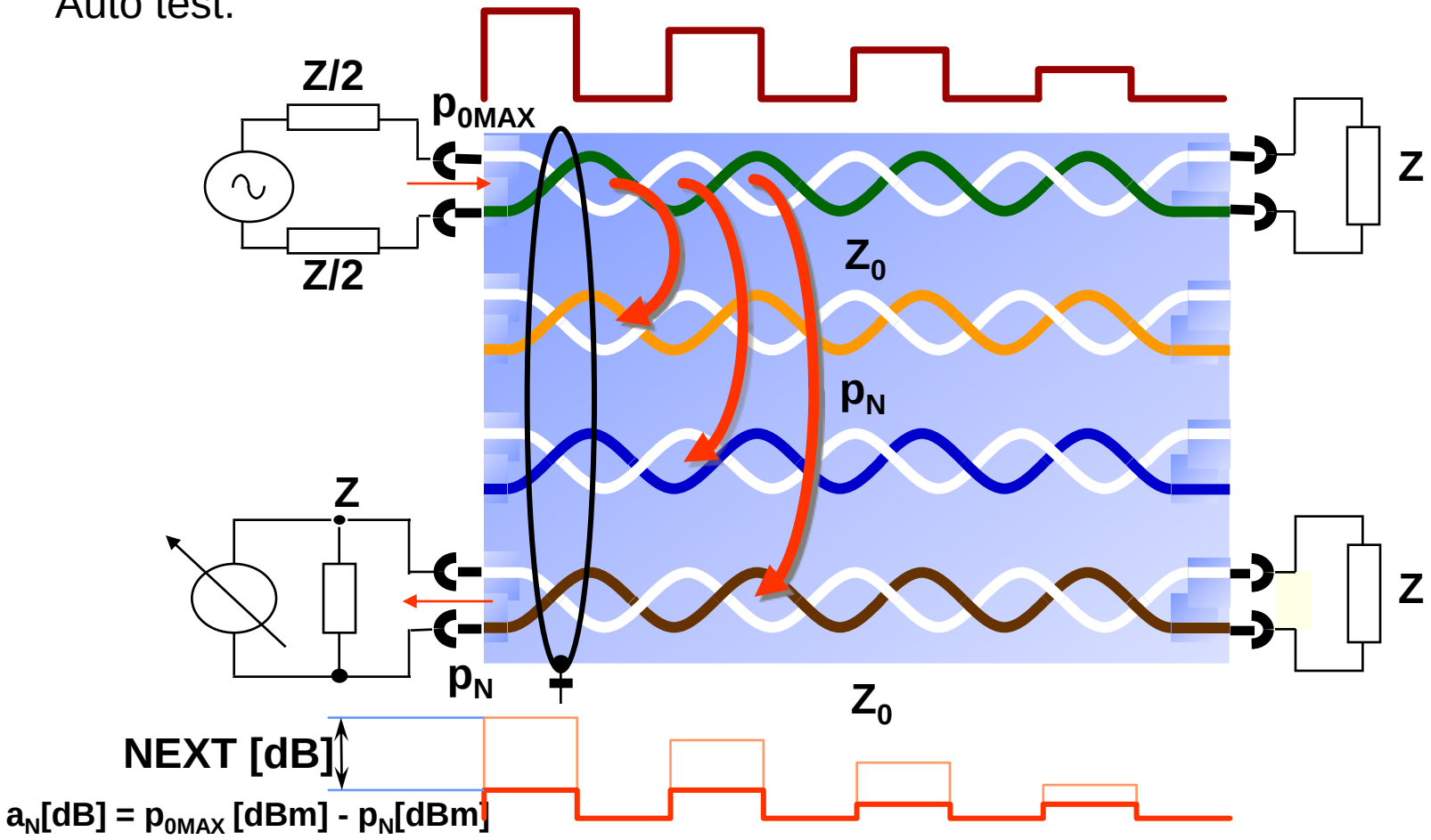
Troubleshooting Insertion Loss (Attenuation)

- Problem
  - High Insertion Loss Reading
- Probable Causes
  - Poor connector termination points.
  - Excessive cable length.
  - Incorrect or poor quality adapter cable.
  - Incorrect cable.

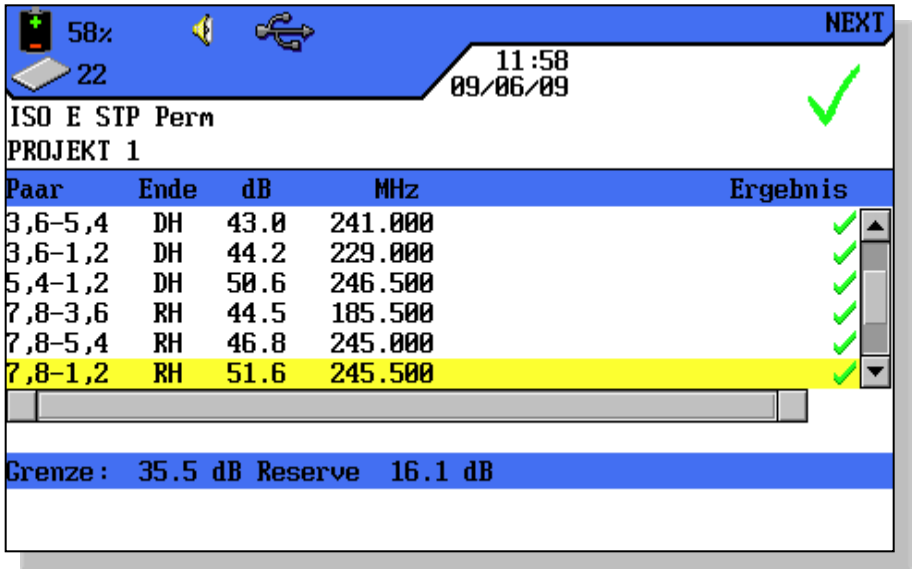
- Common Hotline questions
  - Insertion Loss failing on links <90m PL or <100m CL
    - *Reason:* Length reading wrong due to too little NVP value. In reality cable far longer

Dual (NEXT)

- The NEXT tests measure crosstalk at the near and far ends of the cable in one Auto test.



Dual (NEXT)

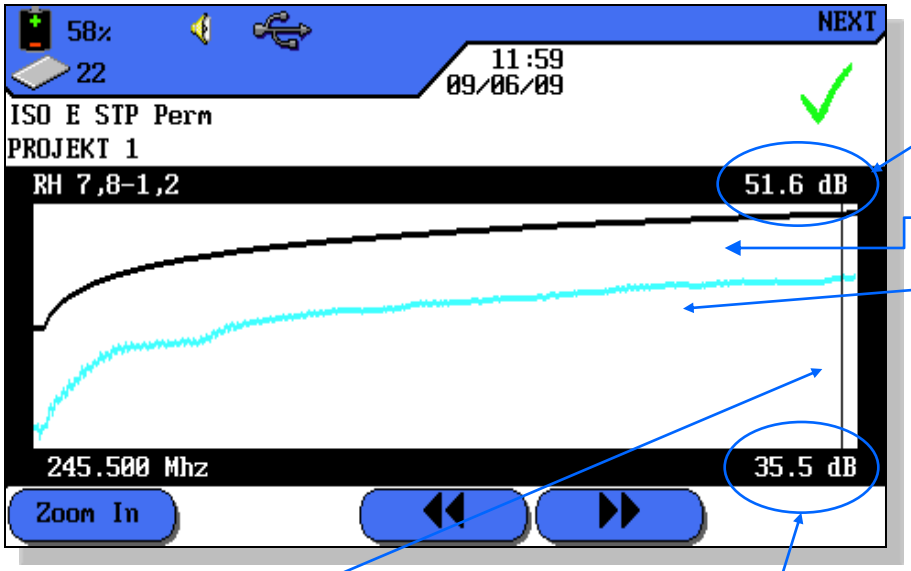


12 Measurements:

- 6 Measurements at Near End
- 6 Measurements at Far End

- Interpretation of Measurement
  - Pair 7,8 carries test signal
  - NEXT is determined at pair 1,2
  - The measurement is at the Remote Handset (RH)
  - The absolute measurement value at worst case margin is 51,6 dB
  - … at 245,500 MHz
  - The limit at that frequency is 35,5 dB
  - The headroom from measurement value minus limit value (51,6 dB - 35,5 dB = 16,1 dB)
  - The measurement value is within the limit

Dual (NEXT)



Graph View:

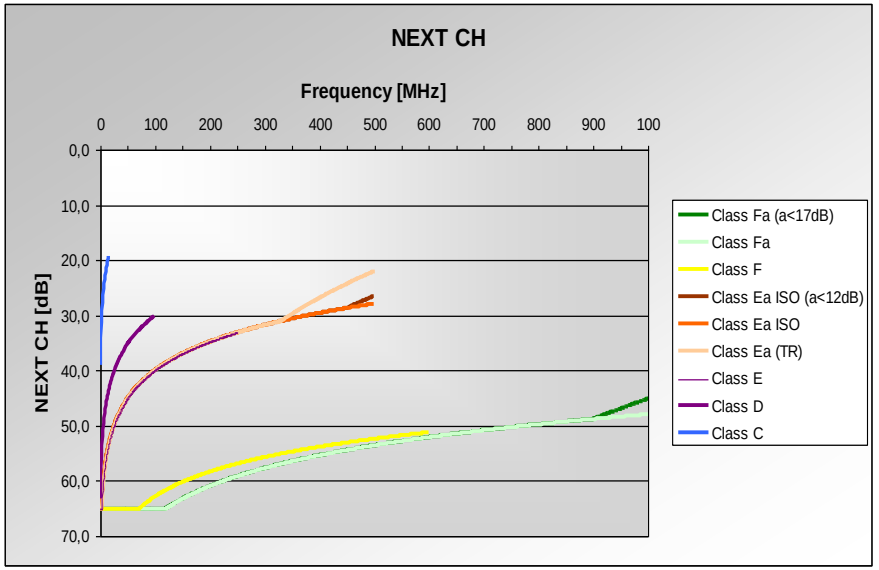
Absolut value at worst case margin

Limit line

Measurement graph

Cursor
(at worst case
margin frequency)

Limit value
(at Cursor)



Dual (NEXT)

- NEXT takes effect up to 20-30 m into the cable.
- DUAL NEXT provides measurements from both ends of the link
- Short link problems at link lengths <20m due to measuring both sides at once
  - Remedy:
    - Usage of only high quality components (e.g. Cat6 de-embedded or Cat6A re-embedded)
    - Standards (ISO & EN) are using correction formulas -> 4dB rule for NEXT

      “NEXT values at frequencies where the insertion loss (IL) is below 4,0 dB are for information only”
      (ISO 11801)

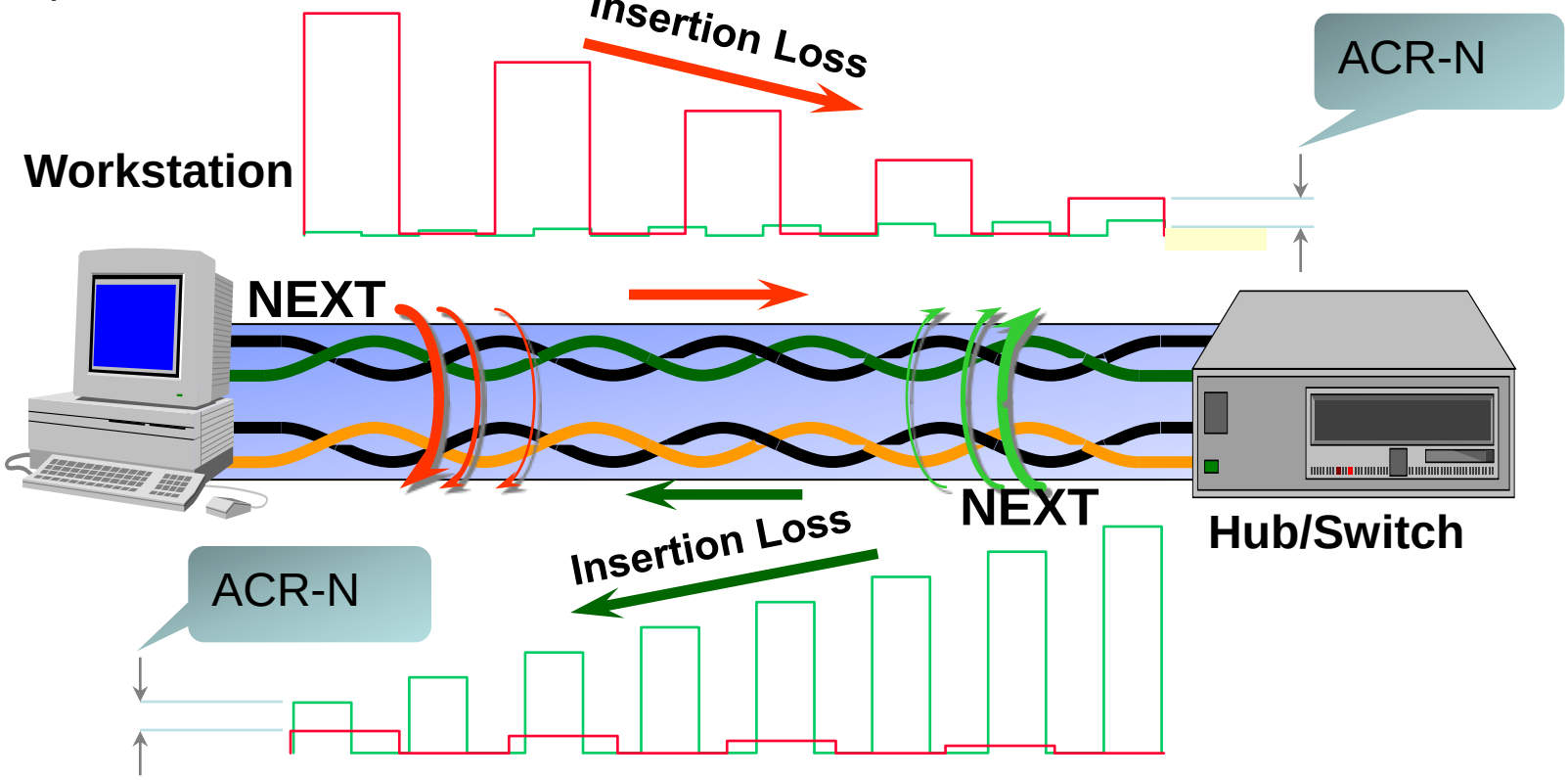
Troubleshooting NEXT Faults

- Problem
  - Low dB test readings
- Probable Causes
  - Installed cable or patch cable not correctly rated.
  - Defective, poor quality cable or too many connectors.
  - Poor quality installation at the connection points.
  - Too much insulation has been stripped from the wires at termination.
  - A pair of wires has been untwisted too much at termination.
  - Split-pairs.
  - Poor quality connectors or connectors not rated to desired category.
  - Measurement adapters/cables not correctly rated and/or worn out

- Common Hotline questions
  - NEXT is failing
    - First determine whether it is caused by installation or test system by swapping units/adapters/patch cords at ends.
    - Alternatively checking against reference link with reference patch cords
    - If Return Loss also fails -> Field Cal carried out wrong

ACR-N (former: ACR)
Attenuation Crosstalk Ratio @ Near End

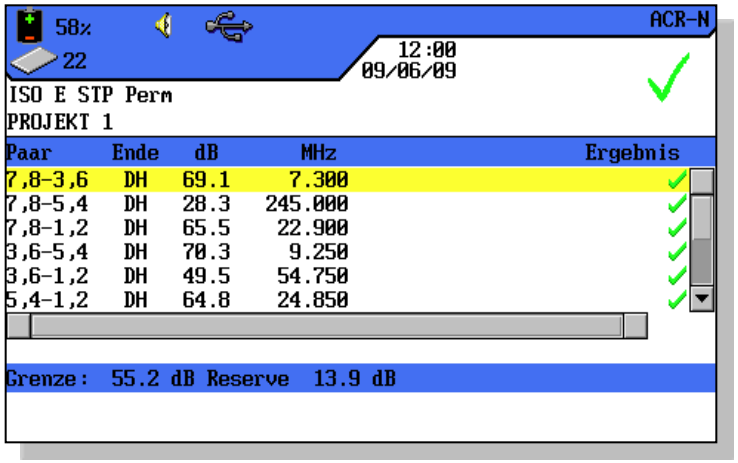
- The ACR (Attenuation-to-Crosstalk Ratio) test performs a mathematical comparison (difference) between the results of the Attenuation (now: Insertion Loss) and NEXT tests

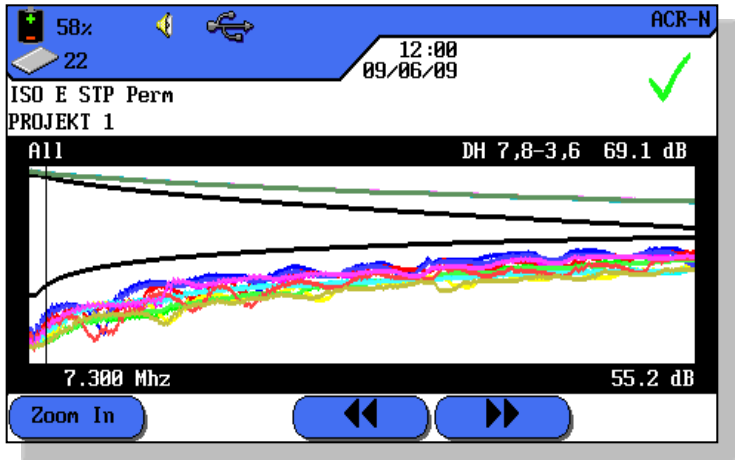


ACR-N (former: ACR)
Attenuation Crosstalk Ratio @ Near End

Views:

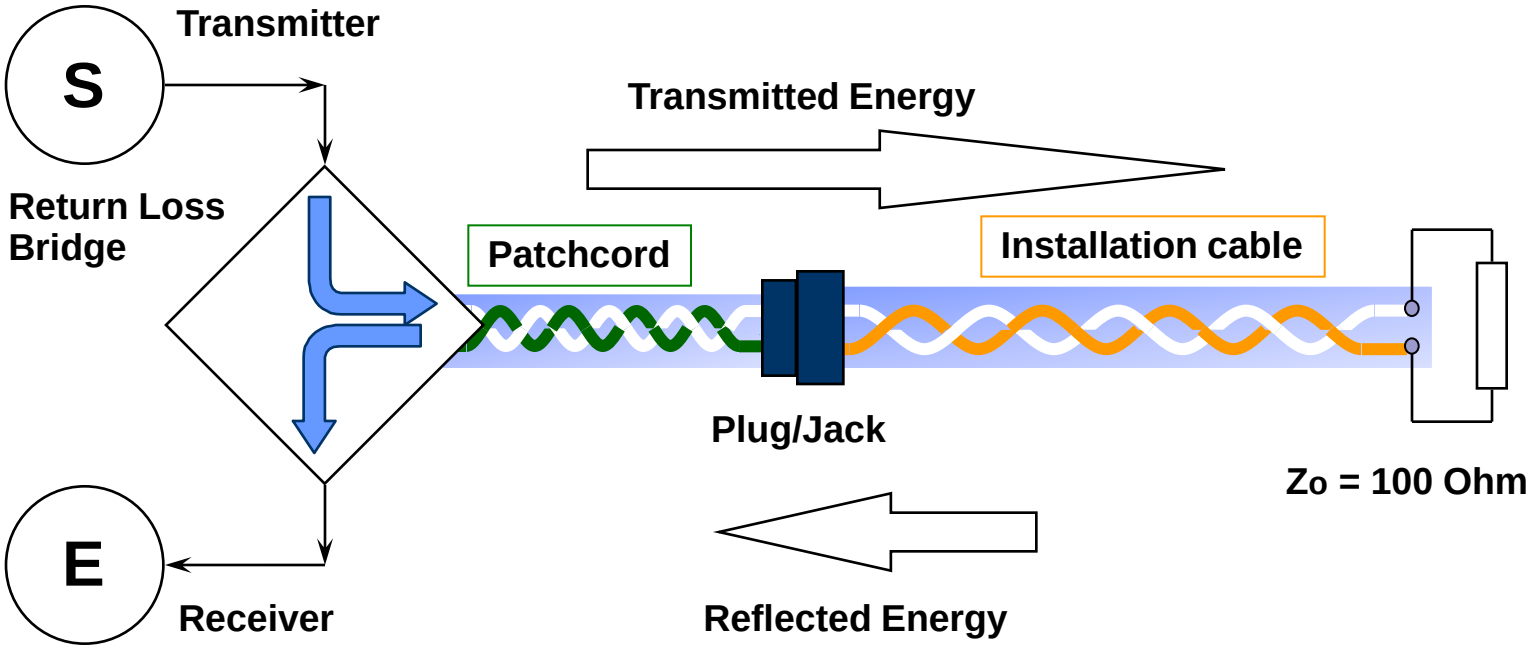
- Tabular values
- Combined NEXT and IL graphs to see cause of problem
- Individual and summary views
- Relation between Insertion Loss and NEXT



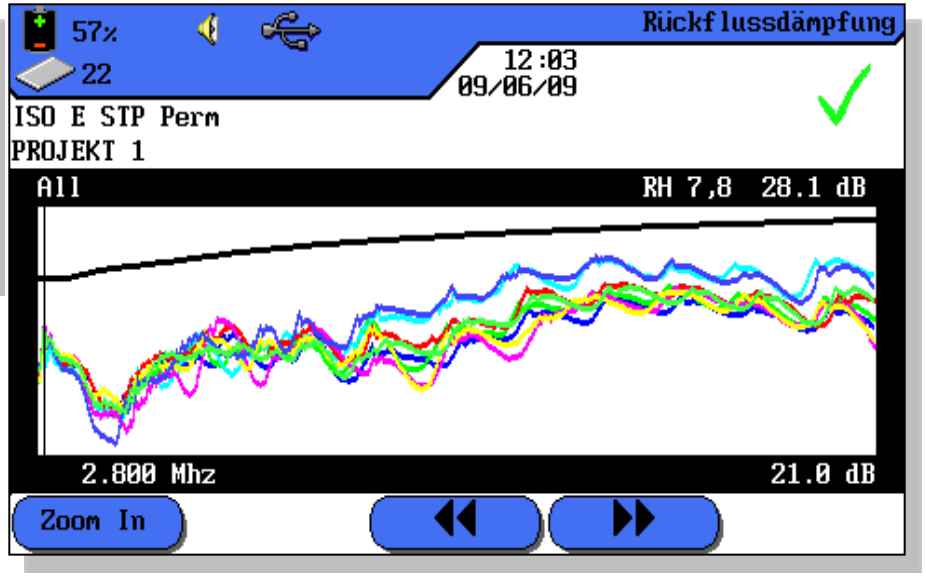


Return Loss

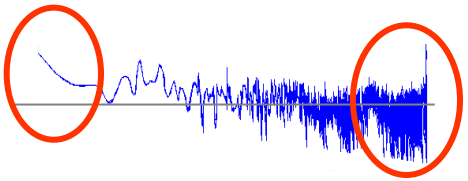
- This test measures the ratio of reflected to transmitted signal strength. Good quality cable runs will have little reflected signal, indicating good impedance matches in the run's various components.



Return Loss



With Return Loss typically the worst values will appear at very low or high frequencies



8 Measurements:

4 Measurements NE

4 Measurements FE

- Correction formula in Standards to cover problems of reflections at low frequencies -> 3dB rule for RL
  - “Return loss (RL) values at frequencies where the insertion loss (IL) is below 3,0 dB are for information only” (ISO 11801)

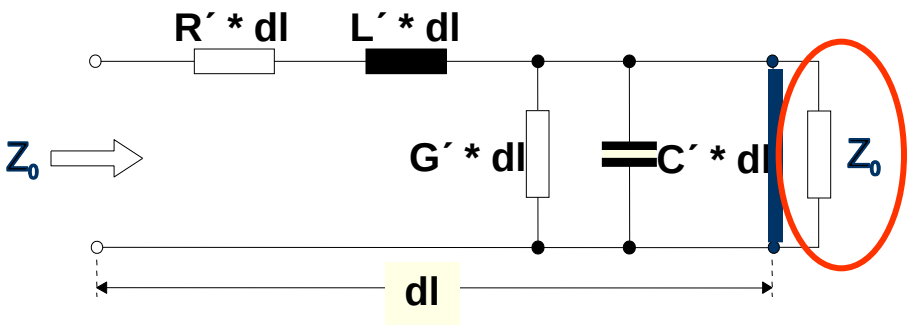
Troubleshooting Return Loss Faults

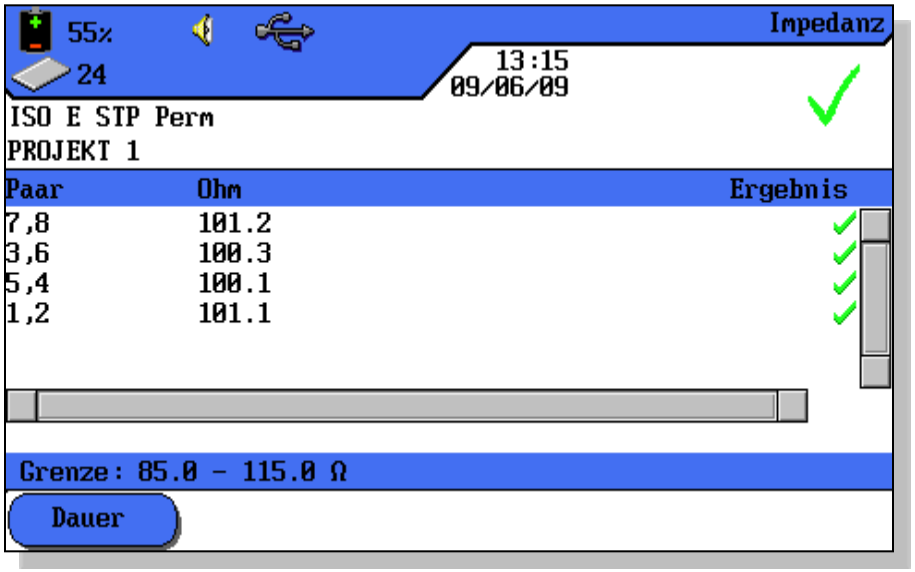
- Problem
  - Excessive Return Loss (Value of 10 dB or less)
- Probable Causes
  - Open, shorted, or damaged cable.
  - Installed cable, cable segments, or patch cord have improper characteristics.
  - Damaged or worn cable or connectors.
  - Poor punch-down.
  - Factory splice in cable.

- Common Hotline questions
  - RL is failing
    - If NEXT also fails -> Field Cal carried out wrong

Impedance Faults

Equivalent circuit diagram





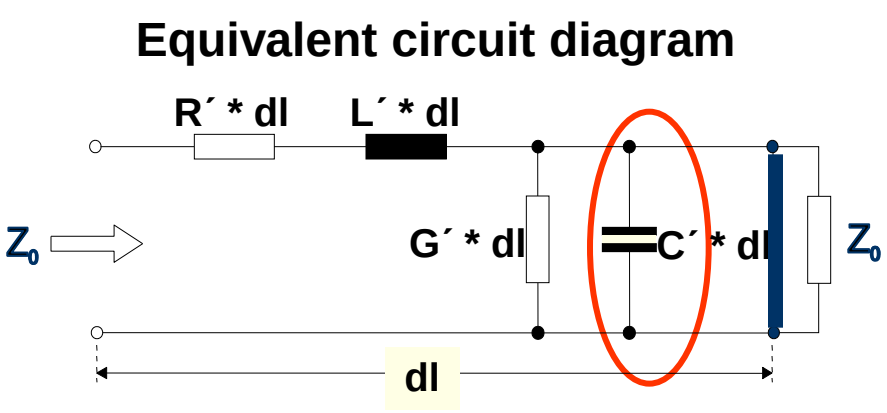
- Impedance is a calculated value:
  - t = delay time
  - C_g = total capacity
- Support function for troubleshooting in cable runs if Return Loss fails

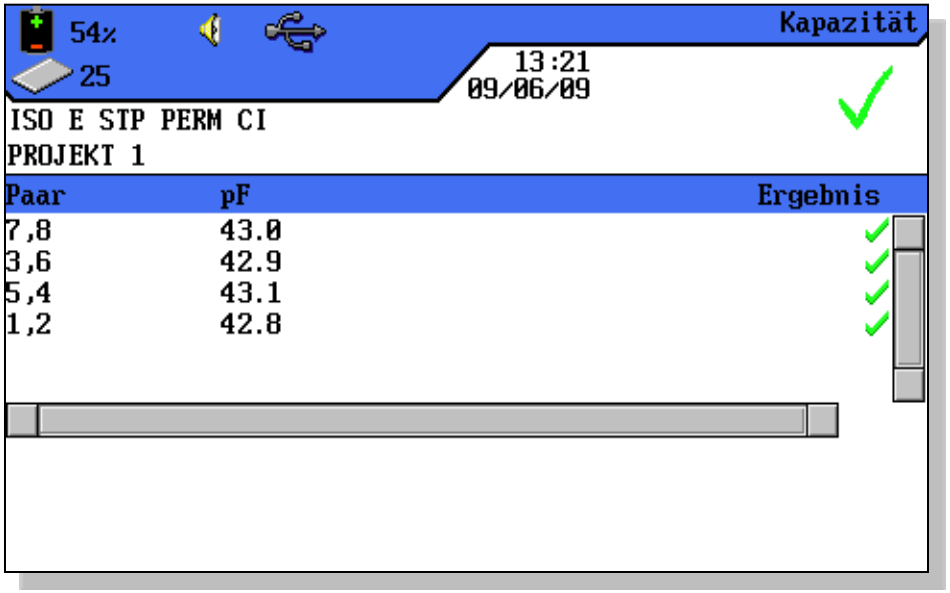
$$Z_0 = \frac{t}{Cg}$$

Troubleshooting Impedance Faults

- Problem
  - High Impedance Readings
- Probable Causes
  - Compression, stretching, or excessive bending damage to the cable.
  - Defective connectors.
  - Insulation damage at a connector.
  - Ground loops created between cable shielding (if used) and equipment grounding (via RS-232 cable to computer, or auxiliary power).
  - Improperly chosen cables or patch cords.
  - Moisture in the cable.

Capacity





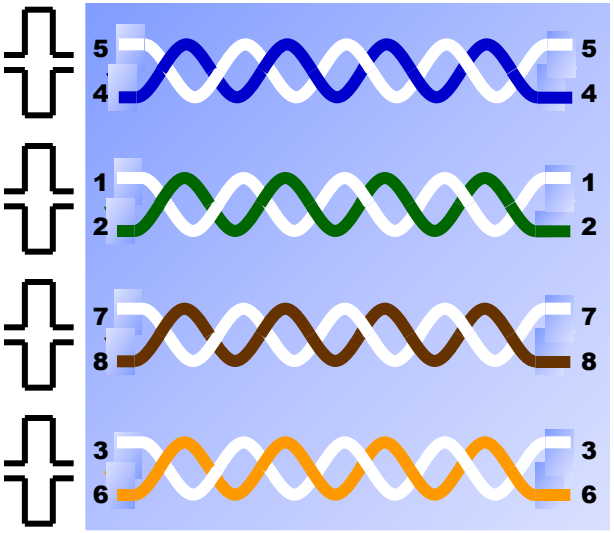
- Mutual capacity of cable twists
- Capacity per meter
- Support function for troubleshooting in installation cables
- Recognition feature for stressed cable

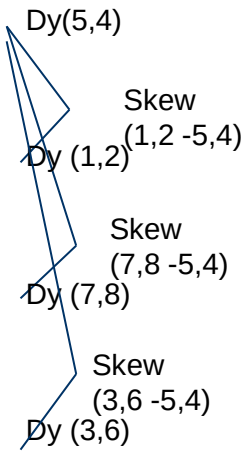
Troubleshooting Capacity Faults

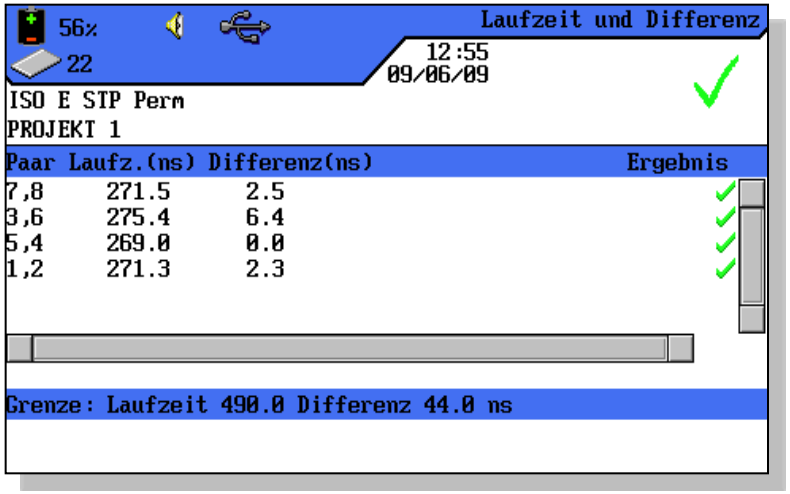
- Problem
  - Capacitance Exceeds the Maximum Limit
- Probable Causes
  - Compression, stretching, or excessive bending damage to the cable.
  - Defective connectors.
  - Insulation damage at a connector.
  - Ground loops created between cable shielding (if used) and equipment grounding (via RS-232 cable to computer, or auxiliary power).
  - Improperly chosen cables or patch cords.
  - Moisture in the cable.
  - Poor connections at punch downs and wall plates

Delay & Skew

- This test measures the period of time for a test signal applied to one end of a cable run to reach the other end.
- Skew indicates the difference between the measured time delay for that pair and the pair with the lowest value (displayed as 0.0 ns).
- Delay and Skew limits are set according to the currently selected Standard.







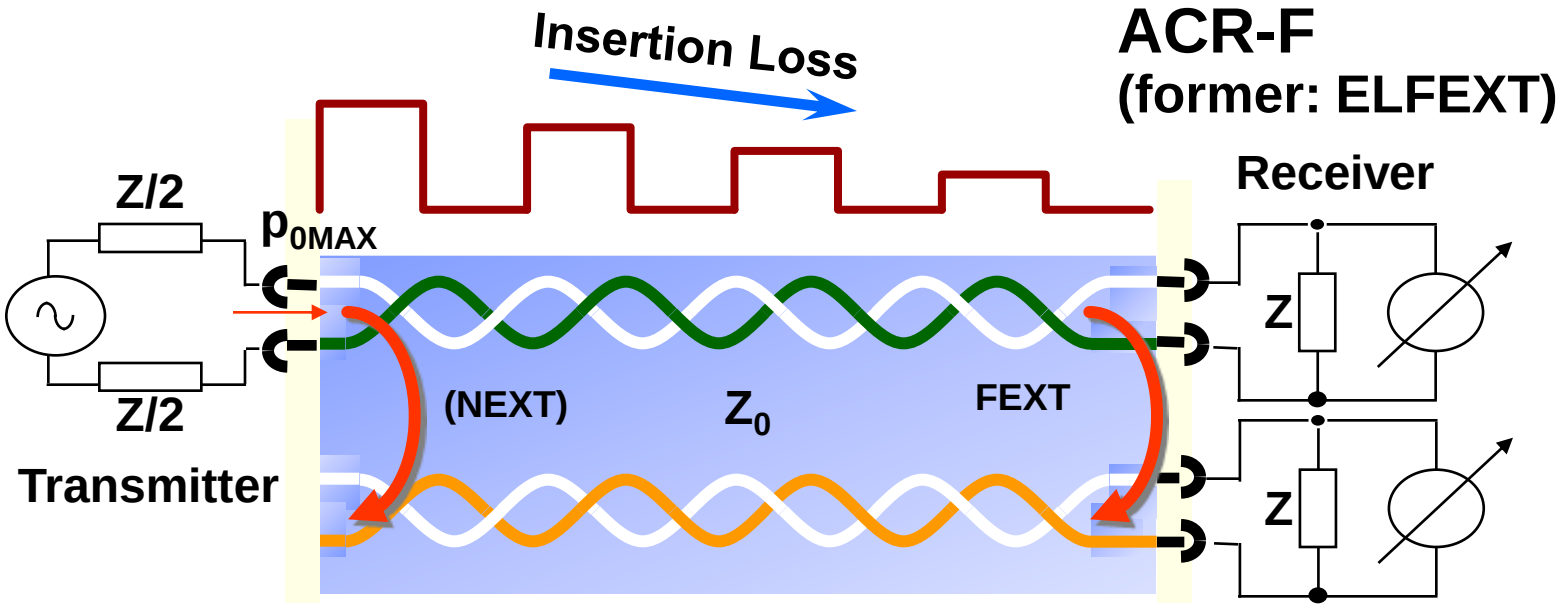
Troubleshooting Delay & Skew Faults

- Problem
  - Excessive Differences between Measurements
- Probable Causes
  - Cables which use different materials for insulating the four pairs of wires.
  - A break or short in the pair.
  - Excessive cable length.
  - Cable installation problems.

- Common Hotline questions
  - Delay and/or Skew are failing
    - *Reason:* Cables maybe too long, sometimes hidden by too low NVP value

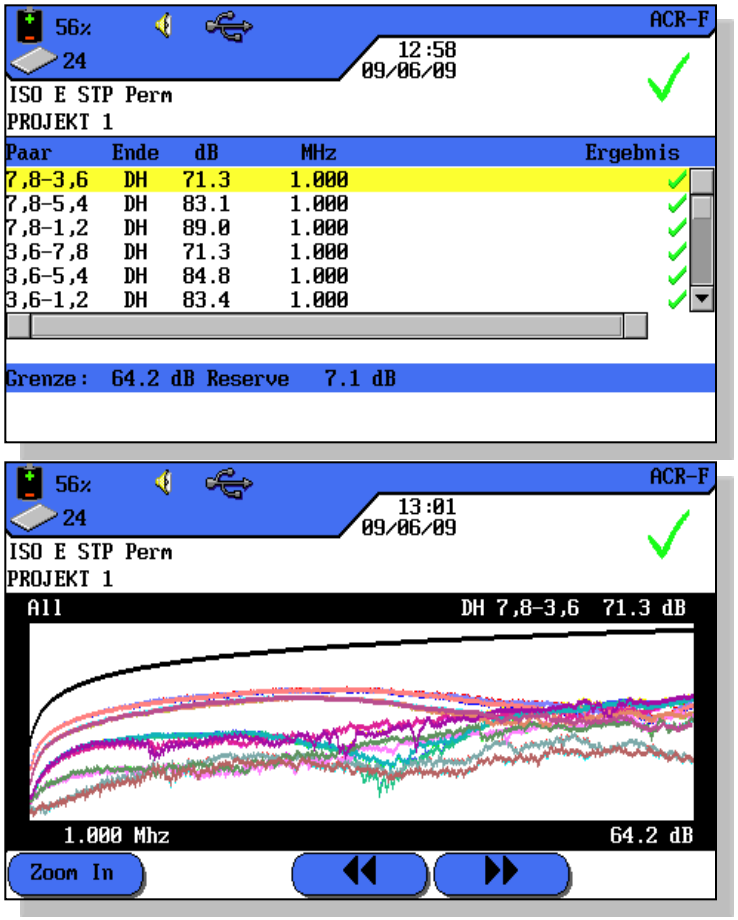
ACR-F (former: ELFEXT)
Attenuation to Crosstalk Ratio @ Far End

- The ACR-F tests measure crosstalk at the far ends of the cable minus insertion loss.
- Tests for mutual cancelling of signals at the end of the link



ACR-F (former: ELFEXT)
Attenuation to Crosstalk Ratio @ Far End

- Reports the worst value for each pair combination in each direction (e.g. Pair 12 <-> Pair 36)
- ACR-F is Far End NEXT minus Insertion Loss. So ACR-N and ACR-F are of comparable magnitudes
- Sometimes Fail criteria of older installations, where cables have too high differences in pair to pair insertion loss.



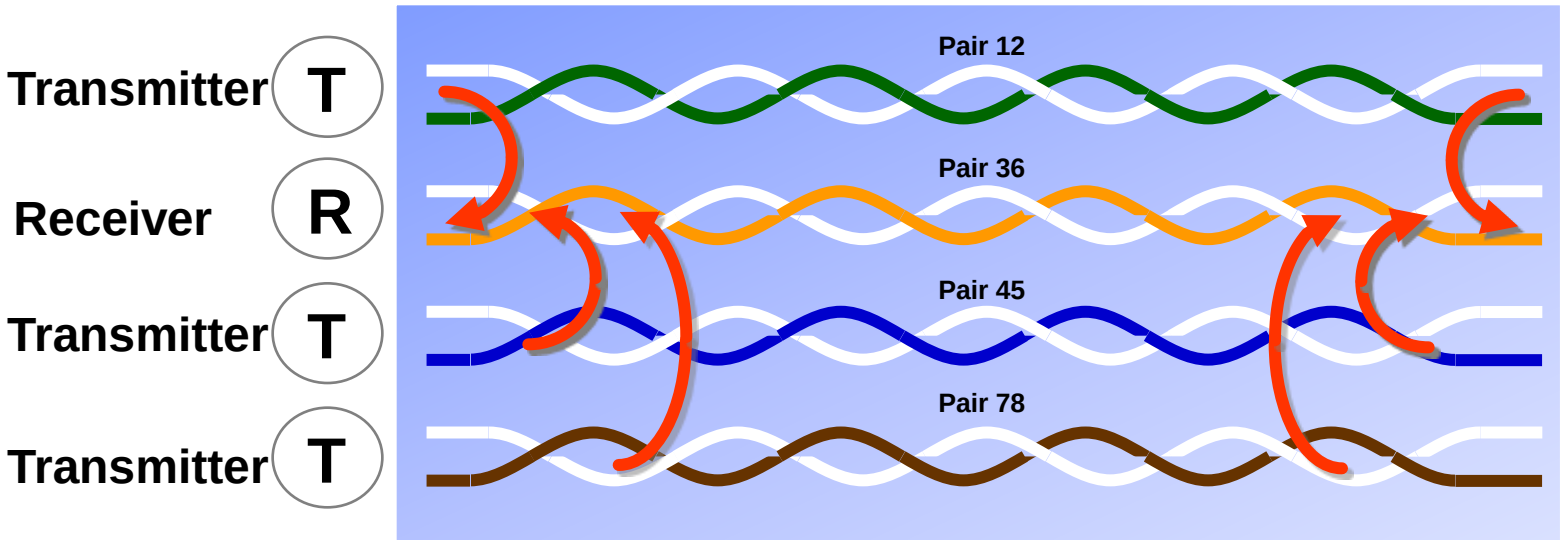
Troubleshooting ACR-F Faults

- Problem
  - Excessive Differences between Measurements
- Probable Causes
  - Cables which use different materials for insulating the four pairs of wires.
  - A break or short in the pair.
  - Excessive cable length.
  - Cable installation problems.

- Common Hotline questions
  - ACR-F is failing
    - *Reason:* Cables of too poor quality. Check pair-to-pair insertion loss characteristics

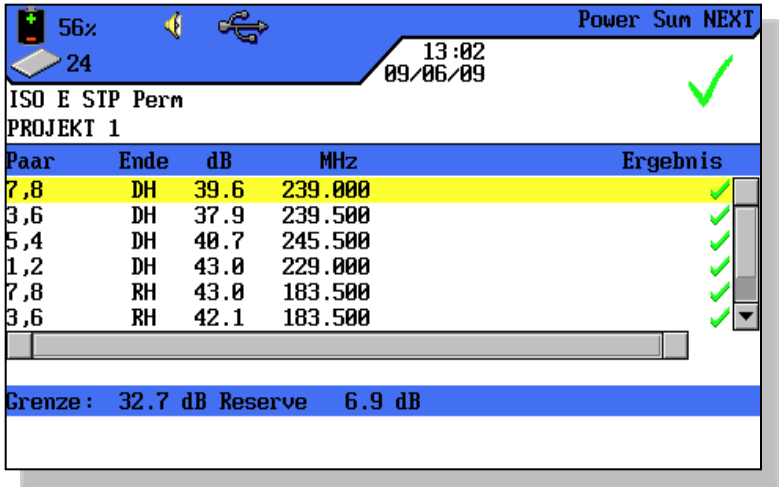
Power Sum NEXT
PS ACR-N (former: PS ACR) / PS ACR-F (former: PS-ELFEXT)

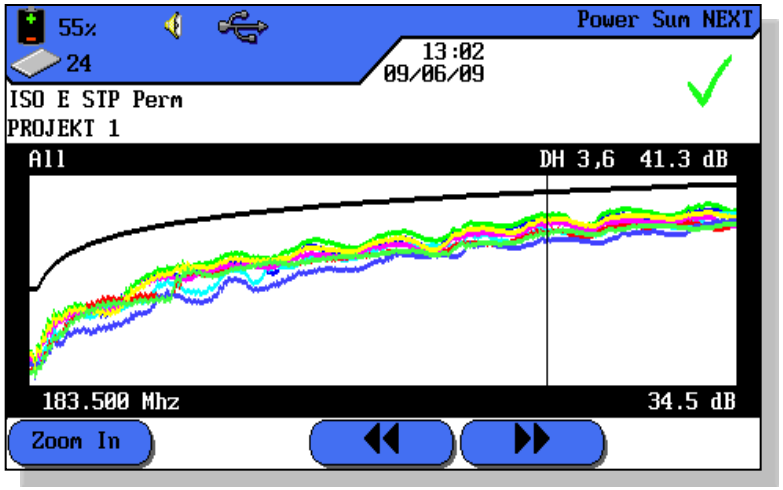
- Power Sum tests measure the crosstalk effects of three transmitting pairs on the fourth pair in the same cable sheath.



Power Sum NEXT
PS ACR-N (former: PS ACR) / PS ACR-F (former: PS ELFEXT)

- Critical for applications using all four pairs
  - 100Base-T4, Full Duplex, 622 MB/s ATM, 1/10/40 Gigabit Ethernet
- IDEAL uses the TIA algorithms to calculate Power Sum values
- Calculations are based on the NEXT measurements





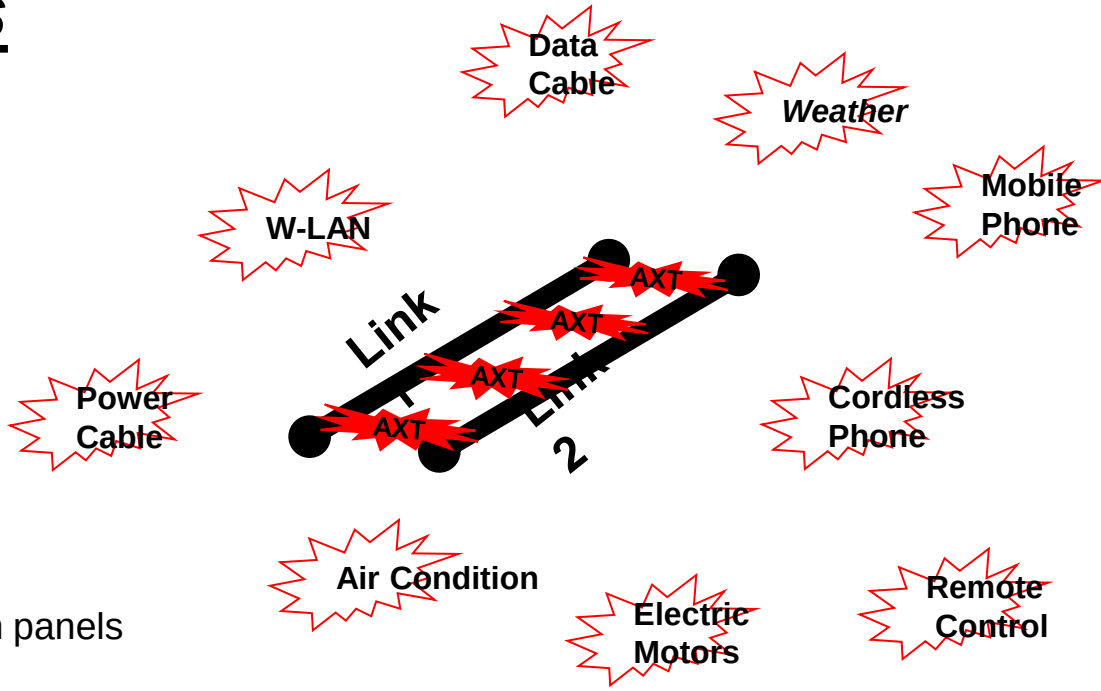
Troubleshooting Power Sum Faults

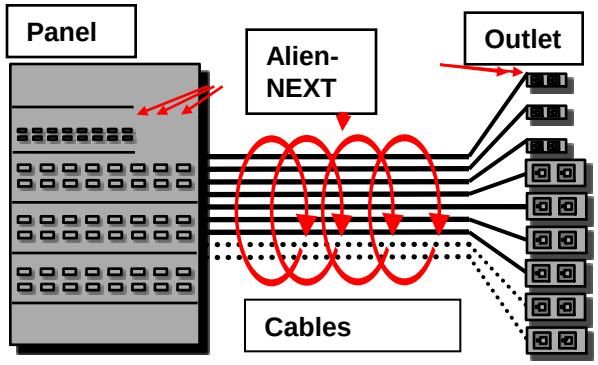
- Problem
  - Power Sum parameters are failing
- Probable Causes
  - Refer to the NEXT and Attenuation troubleshooting suggestions

- Common Hotline questions
  - Power Sum parameters are failing
    - *Reason:* Mostly a consecutive fault of NEXT or ACR-F

Extended Functions

- New measurement parameters required, caused by mutual interaction of adjacent data links and/or external interferences at frequencies >300 MHz
- Problem only exists at unshielded or poorly shielded systems!
- Potential sources of interference
  - Components
    - High packing density of ports in patch panels
  - Cables
    - Unshielded or poorly shielded cables
  - Arrangement of wiring
    - Parallel wiring in bunches of cables
  - Environment
    - High frequent external interferences (like: PMR: 446 MHz, Pager : 448 MHz, UHF-TV: > 470 MHz, ...)





Extended Functions

- New parameters – Alien-Crosstalk
  - Alien-NEXT (ANEXT)
  - Alien-FEXT (AFEXT)
  - Alien-“ELFEXT“ (AACR-F)
  - PS-Alien-NEXT (PS-ANEXT)
  - PS-Alien-NEXT, averaged (PS-ANEXT$_{avg}$)
  - PS-Alien-FEXT (PS-AFEXT)
  - PS-Alien-FEXT, normalized (PS-AFEXT$_{norm}$)
  - PS-Alien-ACR-N (PS-AACR-N)
  - PS-Alien-ACR-F (PS-ACR-F)
  - PS-Alien-“ELFEXT“ (PS-AACR-F)
  - PS-Alien-“ELFEXT“, averaged (PS-AACR-F$_{avg}$)