The “Hot” topics: CPR and PoE

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BICSI Day Romania
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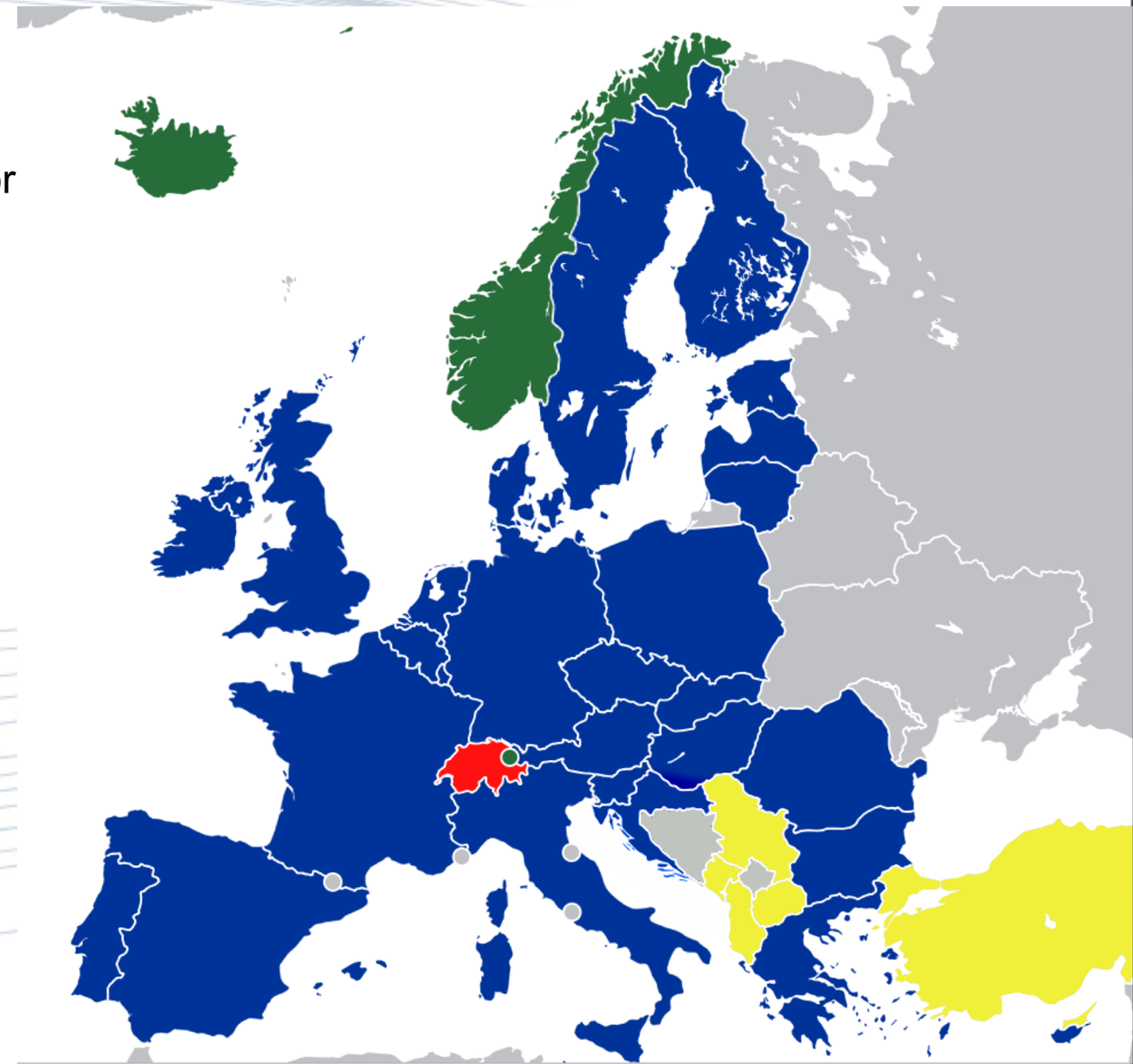
CPR

PVC Vs LSZH

IEC 60331-2

Construction Projects Regulation

- European Law No. 305/2011. mandatory compliance for CE mark.
- Regulation 2016/364 defines classification of communication cables.
- Publication in official journal of Europan Union C226 of 10th July 2015 (notice 2015/C226/0), identifying the EN 50575:2014 as applicable standard for the classification.
- All fixed communication cables must comply and DoP made available.
- Removable items do not need to comply. (patch cords)



- E.E.A. (european economic area)
- E.F.T.A (european free trade asociasion) Iceland, Liechtenstein and Norway
- Switzerland
- Ex-Yougoslavia, Turkey

7 Euroclasses

Type of control	A_{CA}	$B1_{CA}$	$B2_{CA}$	C_{CA}	D_{CA}	E_{CA}	F_{CA}
Standard for compliance: EN 50575							
System of Assessment and Verification of Constancy of Performance	1+				3		4
Initial Type Testing of the product by independent testing laboratory	yes	yes	yes	yes	yes	yes	Not Tested
Continuous surveillance, assessment and evaluation of factory production control from certification body	yes	yes	yes	yes	Not Tested	Not Tested	Not Tested

Test	Measurement	A_{CA}	$B1_{CA}$	$B2_{CA}$	C_{CA}	D_{CA}	E_{CA}	F_{CA}
Standard for Euro classification: EN 13501-6								
Calorific value	EN ISO 1716	Gross heat of combustion (max)	2,0 MJ/kg						
Vertical flame spread of single wire	EN 60332-1-2	Distance before self-extinguish (max)		425mm	425mm	425mm	425mm	425mm	Not Tested
Heat release	EN 50399	Flame source		30 kW	20.5 kW	20.5 kW	20.5 kW	Not Tested	Not Tested
		Total heat release after 1200s (max)		10 MJ	15 MJ	30 MJ	70 MJ	Not Tested	Not Tested
		Peak heat release (max)		≤ 20 kW	30 kW	60 kW	400 kW	Not Tested	Not Tested
		Fire growth rate (max)		120 Ws−1	150 Ws−1	300 Ws−1	1300 Ws−1	Not Tested	Not Tested
		Fire Propagation: Damaged length of sample (max)		1,75 m	1,5 m	2 m	Not Tested	Not Tested	Not Tested
Additional Criteria	Smoke production, smoke acidity, flaming droplets			Optional	Optional	Optional	Optional	Not Tested	Not Tested

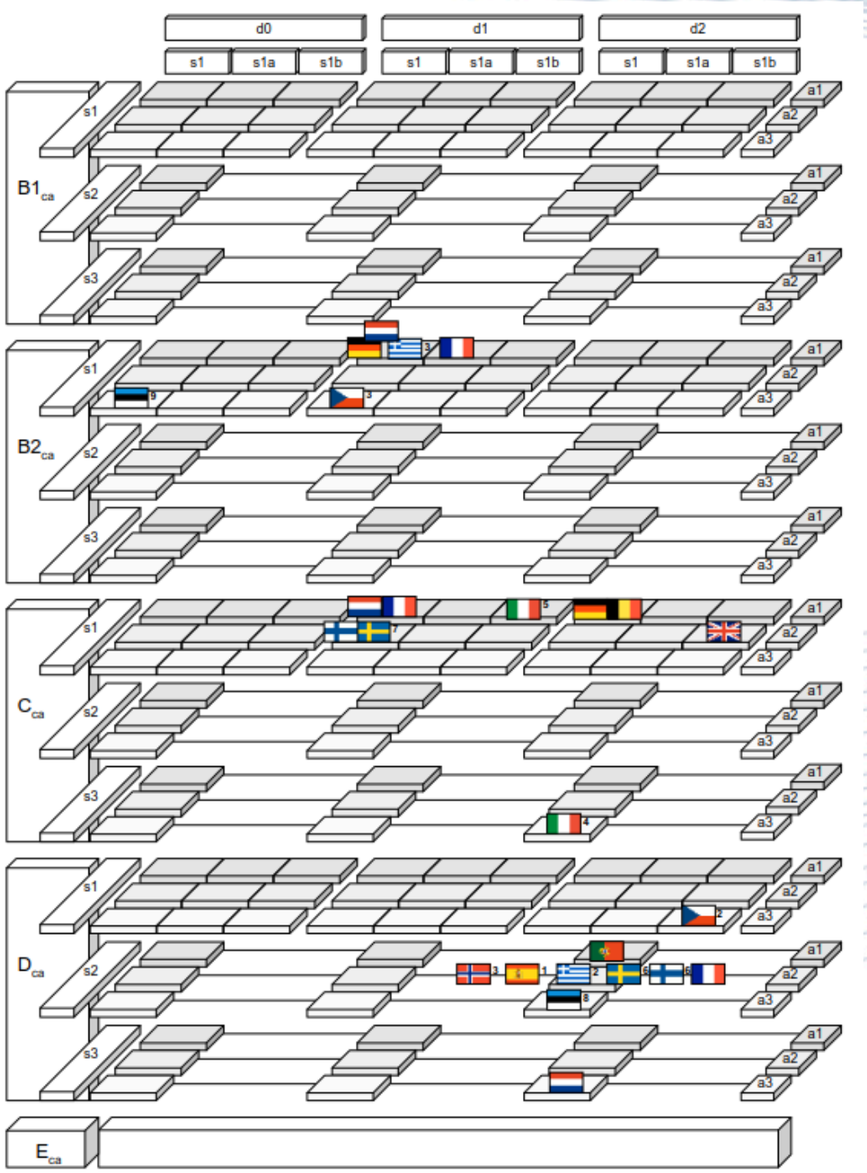
Additional Criteria

Smoke Production	EN 50399 with flame source 20.4kw*		Transmittance	EN 61034-2
Classification	Total (max.)	Peak (max.)	Minimum Transmittance	
s1	50m²	0.25m²/s	Not Applicable	
s1a			80%	
s1b			60%	
s2	400m²	1.5m²/s	Not Applicable	
s3	No Compliance	No Compliance	Not Applicable	
** Except for B1ca tested with 30kW flame source*				

Smoke acidity	EN 60654-2 (replacing EN 50267-2-3)	
Classification	Conductivity (max.)	pH (min.)
a1	2,5 µS/mm	4,3
a2	10 µS/mm	4,3
a3	No Compliance	No Compliance

Particles / Droplets	EN 50399 with flame source 20.4kw*
Classification	Persistence of droplets during test of 1200s (max.)
d0	No droplets
d1	10s
d2	No Compliance
** Except for B1ca tested with 30kW flame source*	

Countries Decide



What is really required?

Types of requirements

Mandatory

Regulations: Codes, Laws, Decrees

Example:
Greek GG 80A/07-05-2018

Voluntary

Standards

Example:
UK BS 6702

Market Demand

Specifications: End user or Consultant requirements

Example:
Healthcare association

What is really required?

Requirements are application specific !

Greek GG 80A/07-05-2018 specifies (regulation):

- Offices and residential, less then 20 floors: E_{ca}
- All other cases: D_{ca} s2, d2, a2
- Protected escape routes for all buildings: $B2_{ca}$ s1, d1, a1

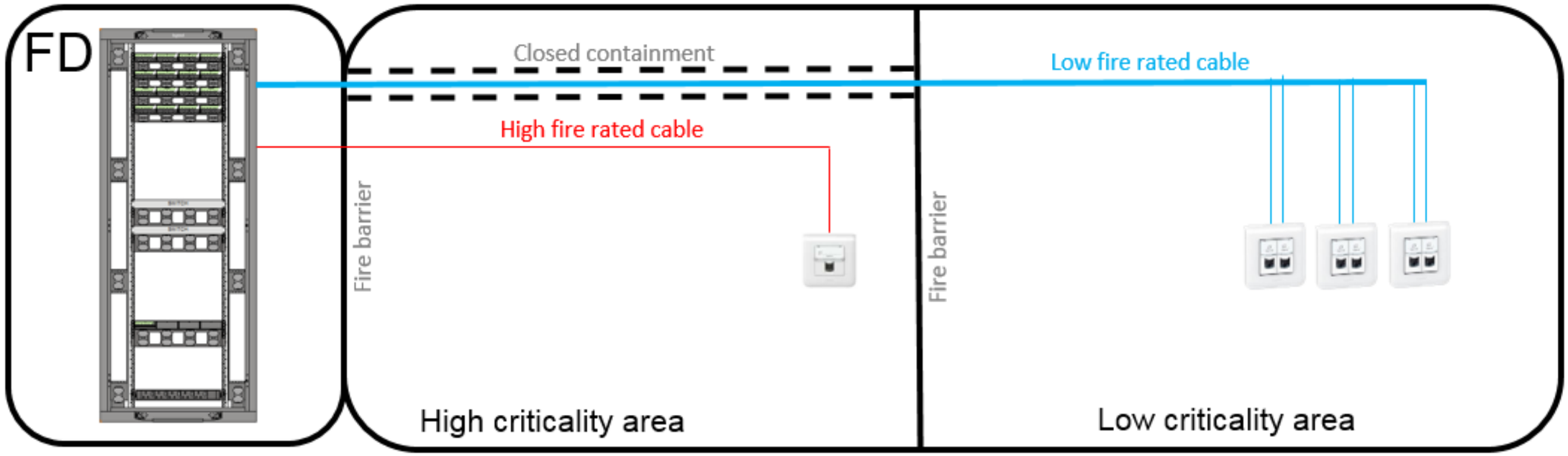
Italian Cei-UNEL recommends (standard):

- $B2_{ca}$ s1a, d1, a1 for high risk: airports, ports, underground, tunnels
- C_{ca} s1b, d1, a1 for medium risk: hospitals, sports halls, hotels, libraries...public buildings more than 24m
- C_{ca} s3, d1, a3 for low risk (cables in bundles): public buildings < 24m, waiting rooms, bars, restaurants, clinics
- E_{ca} for low risk: other buildings with low risk

Czech Republic, some projects require (Market demand):

- $B2_{ca}$ s1a, d1, a1 for all communications cables because of mis interpretation of the decree 23-2008, updated with 268-2011 specifying $B2_{ca}$ s1a, d1, a1 for cables for vital circuits in protected fire exits.
  - Vital circuits = electrical supply to emergency equipment (ie exit signs)
  - Protected fire routes = unique fire exit protected from fire, so with absolutely no flammable material.

Designers need to be smart



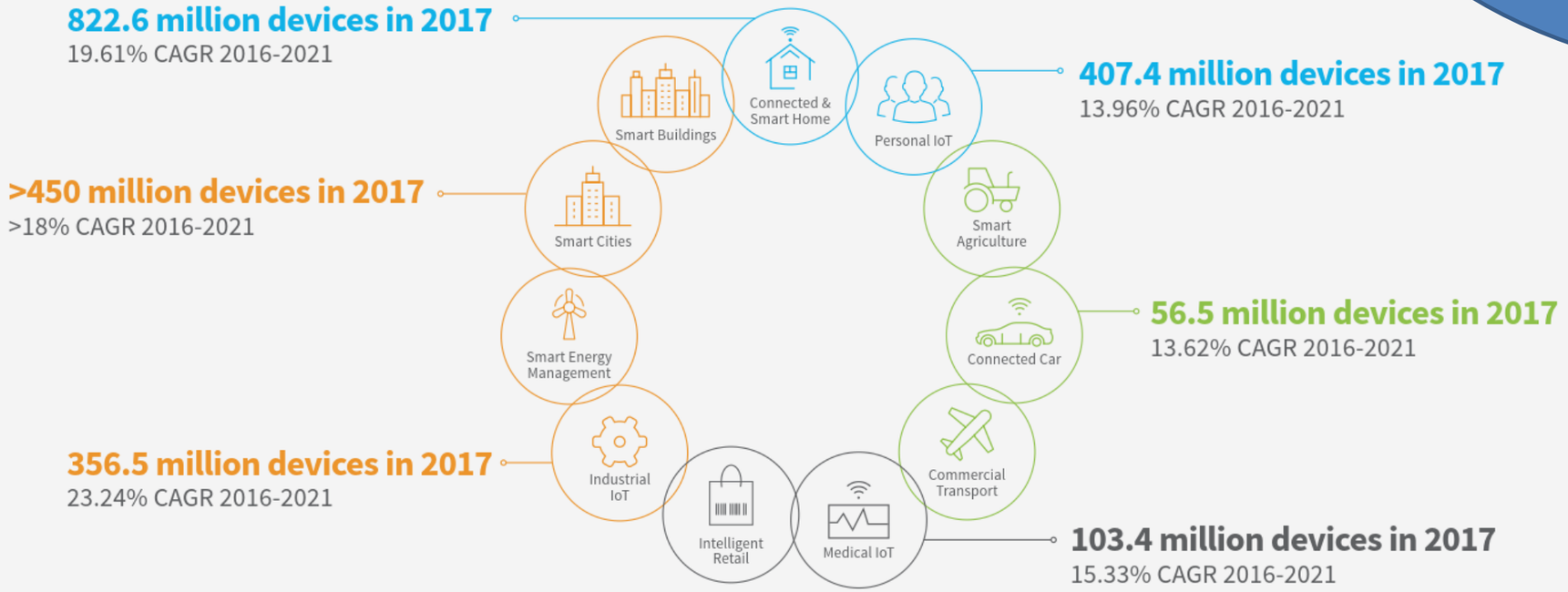
PoE

Market

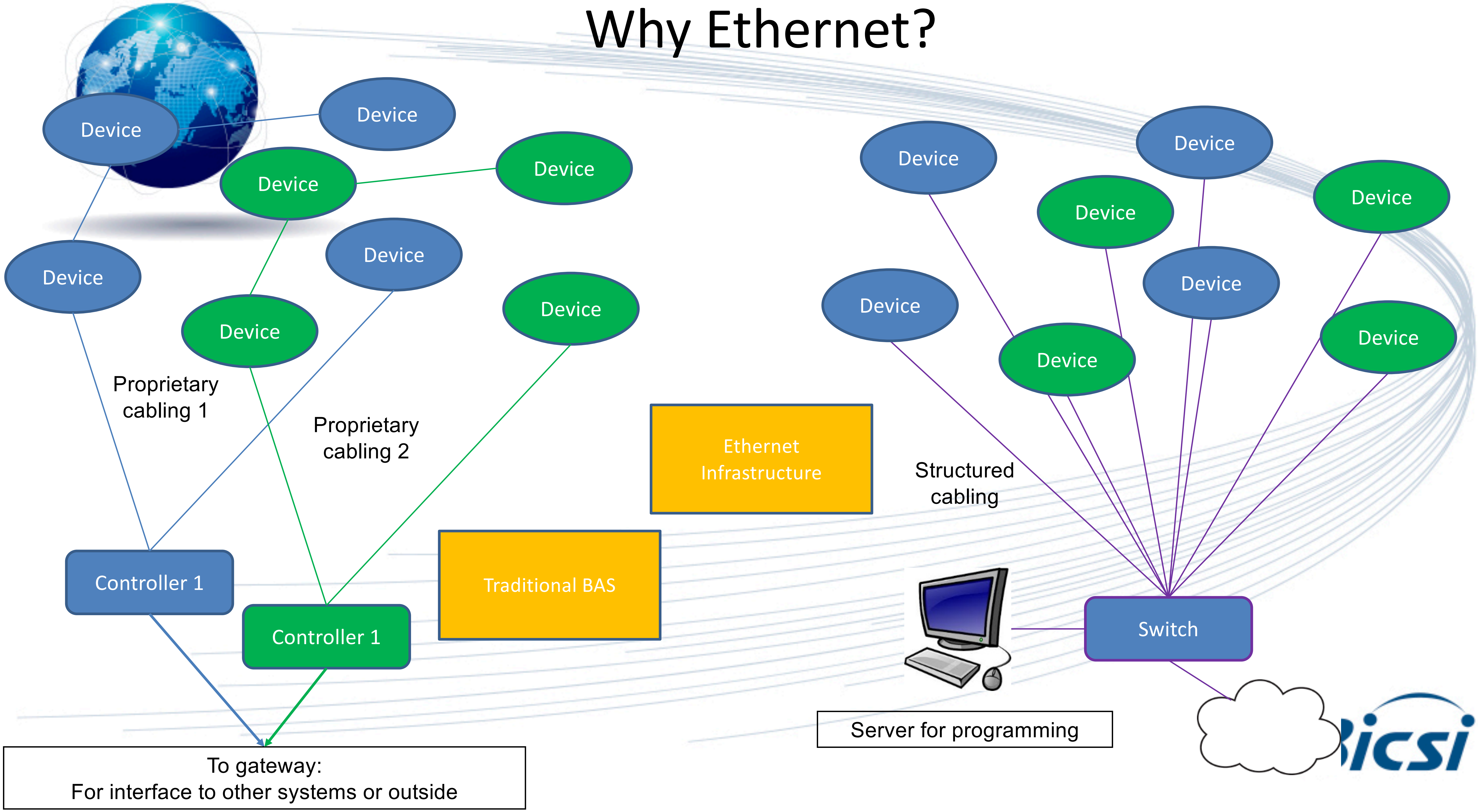
IoT

- From HIS Markit:

The number of connected IoT devices worldwide will jump from nearly 27 billion in 2017 to 125 billion in 2030.

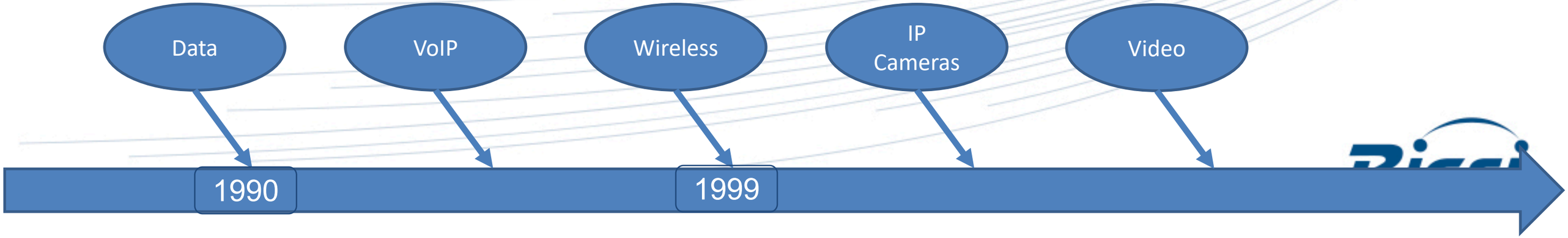


Why Ethernet?

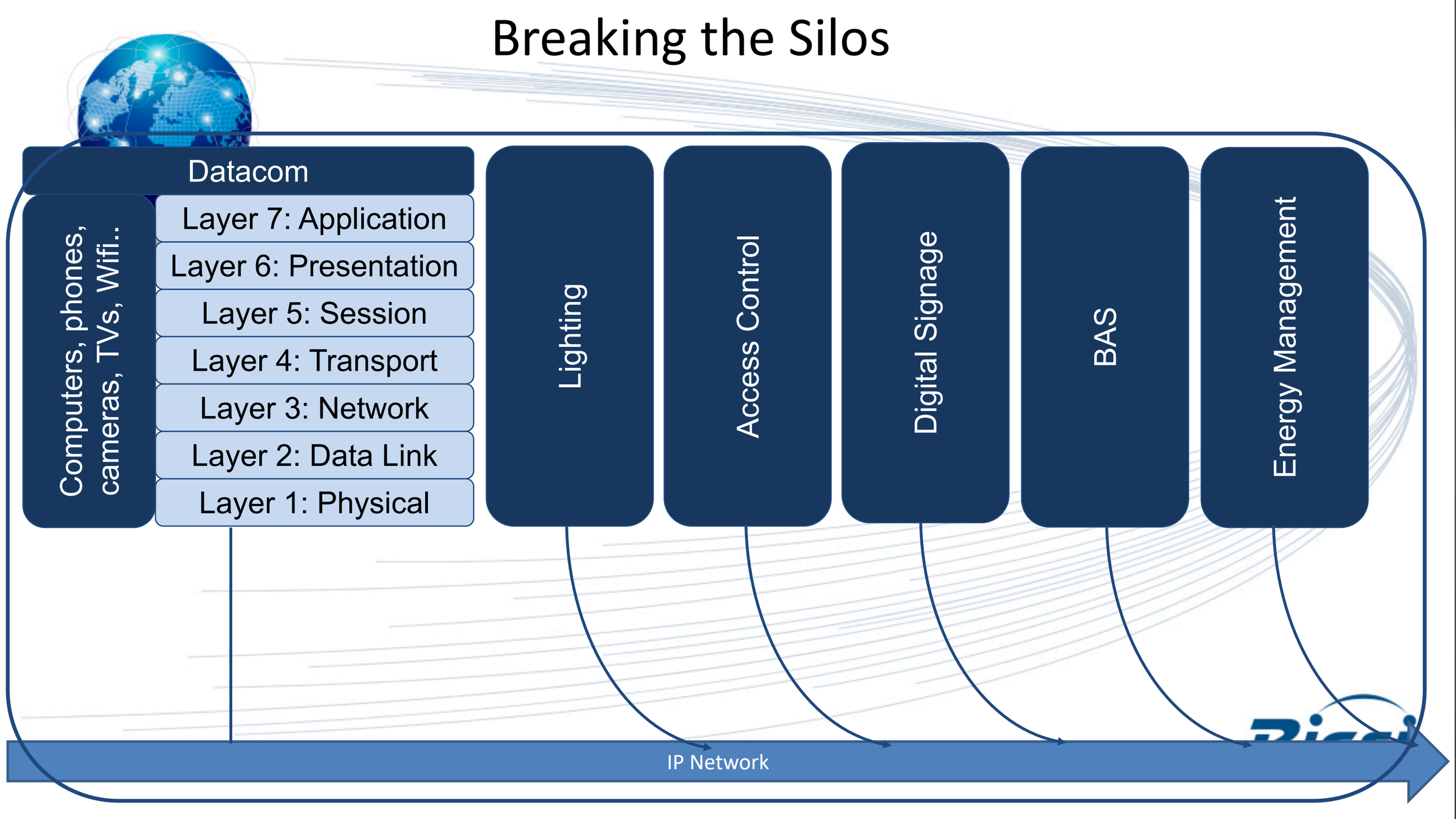


The OSI Model

- Layer 7: Application
- Layer 6: Presentation
- Layer 5: Session
- Layer 4: Transport
- Layer 3: Network
- Layer 2: Data Link
- Layer 1: Physical

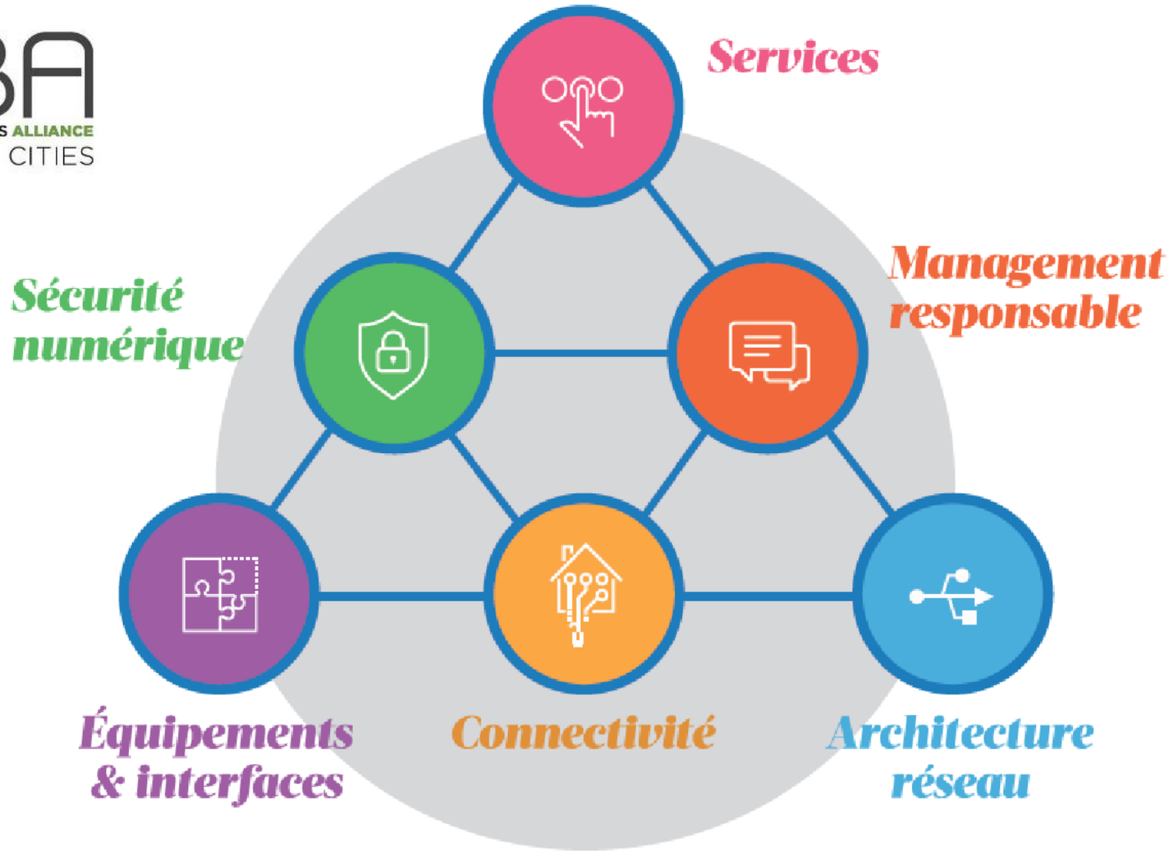


Breaking the Silos



Smart Buildings

- Certainties:
  - Smart buildings will be based around an Ethernet infrastructure.
  - They all have some form of PoE somewhere.



Services to building stakeholders

Governance

Technical Principles

Standards

IEEE for Ethernet

IEEE 802:
LAN / Man Standards

802.5: Token Ring (disbanded)

802.1: Higher LAN Protocols

802.15: WPAN (bluetooth, Zigbee,...)

IEEE 802: LAN / MAN standards	
802.3 Ethernet (CSMA / CD)	**802.11 Wireless (CSMA / CA)**
802.3j (1990) 10base-T, 10base-F	**802.11a (1999)** 54Mbps @ 5GHz
802.3u (1995) 100base-TX, 100base-T4, 100base-FX	**802.11b (1999** 11Mbps @ 2.4GHz
802.3z (1998) 1000base-X (Fiber optic)	**802.11g (2003** 54Mbps @ 2.4GHz
802.3ab (1999) 1000base-T	**802.11n (2012)** 150Mbps @ 2.4 and 5GHz, 600M w/MIMO 4
802.3ae (2003) 10G on fiber	**802.11ac (2012)** 867Mbps @ 5GHz , 6.77G w/ MIMO 8
802.3af (2003) Power over Ethernet, 15w	**802.11ad (2013)** 6.75Gbps @ 2.4, 5, and 60GHz
802.3an (2006) 10Gbase-T	**802.11ax (2019?)** improvement of 802.11ac for high density
802.3at "PoE+" 30W	
802.3ba (2010) 40G and 100G on fiber	
802.3bq (2016) 25Gbase-t and 40Gbase-T	
802.3bz (2016) 2.5Gbase-t and 5Gbase-T	
802.3bs (2018) 200G and 400G on fiber	
802.3bt (2018) "PoE++" 100W	

CENELEC, European

CENELEC
EUROPEAN COMMITTEE FOR ELECTROTECHNICAL STANDARDIZATION

CENELEC Information Technology Generic Cabling Systems

Components	Performance, Design	Implementation	Validation
IEC International Electrotechnical Commission	**CENELEC EN50173-1** General Requirements	**CENELEC EN50174-1** Specification and quality assurance	**CENELEC EN50346** Testing of installed cabling
	CENELEC EN50173-2 Office premises	**CENELEC EN50174-2** Installation planning and practices	
	CENELEC EN50173-3 Industrial premises	**CENELEC EN50174-3** Planning and Installation	
	CENELEC EN50173-4 Homes		
	CENELEC EN50173-5 Data centers		
	CENELEC EN50173-6 Distributed Building Services		

New, with PoE implementation

BICSI

ISO, International

Components

International Electrotechnical Commission

ISO Information Technology Generic Cabling Systems

Performance, Design

ISO/IEC 11801-1 (2017)
General requirements

ISO/IEC 11801-2 (2017)
Offices and commercial buildings

ISO/IEC 11801-3 (2017)
Industrial premises

ISO/IEC 11801-4 (2017)
Homes

ISO/IEC 11801-5 (2017)
Data centers

ISO/IEC 11801-6 (2017)
Distributed building services

Implementation

ISO/IEC 14763-2
Planning and Installation Implementation

ISO/IEC 30129
Bonding and Grounding

Revision 2 soon out with PoE implementation

Validation

ISO/IEC 61935-1
Testing of balanced twisted Pair Cabling

ISO/IEC 14763-3
Testing of Fiber Optic Cabling

ISO/IEC 14763-4 (Draft)
Measurement of E2E, MPT and DA links

Technical Reports

ISO/IEC TR 24704 (2004)
Cabling for wireless access points

ISO/IEC TR 24750 (2007)
Assessment and mitigation of installed balanced cabling channels in order to support 10GBASE-T

ISO/IEC TR 29125 (2010)
Requirements for RP of terminal equipment

ISO/IEC TS 29125 (2017)
Add. requirements for RP of terminal equipment

TIA, North American

ANSI/TIA: Telecommunications Cabling for Customer Premises

Components, Performance	Design	Implementation	Validation	Technical Reports
TIA - 568.2-D Balanced twisted-pair cabling	**TIA - 568.0-D** Generic cabling	**TIA - 569-D** Telecommunications pathways and spaces	**TIA - 526-7-A** Single-mode fibre testing	**TIA - TSB-155-A** Support of 10Gbase-T on existing Cat.6
TIA - 568.3-D Optical fibre cabling	**TIA - 568.1-D** Commercial building	**TIA - 607-C** Bonding and grounding telecommunications	**TIA - 536- 14-C** Multi-mode fibre testing	**TIA - TSB - 184A** Supporting PoE over twisted pair
TIA - 568.4-D Broadband coaxial cabling and components	**TIA - 758-B** Customer-owned outside plant	**TIA - 606-C** Administration		**TIA - TSB-5021** Guidelines for 2.5G and 5G on Cat5e and Cat6
TIA - 568.5 (Draft) Single pair cabling	**TIA - 942-B** Data centers	**TIA - 862-B** Intelligent building systems		
	TIA - 1005-A Industrial premises	**TIA - 5017** Physical network security		
	TIA - 1179-A Healthcare facilities			
	TIA - 570-C Residential			
	TIA - 4966 Educational facilities			
	TIA - 162-A Cabling for wireless access points			
	TIA - 5018			

New

PoE support

PoE Implementation

PoE Standards

Published 2018

	IEEE		HDBase-T Alliance	IEC	ISO / IEC	CENELEC	TIA	NEC
Applications	802.3af	15.4W	HDBase-T					
	802.3at	30W						
	802.3bt	60W and 100W						
Cable testing under load				61156-1-4 (draft)				LP Rating
Connector testing under load				60512-99-001				
				60512-99-002				
Cabling testing under load					TS-29125	TR 50174-99-1	TSB-184-A	
Conditions for new cabling					14763-2 (revision)	50174-2		

Existing

Just published

CDV, almost final

published 2018

End customer purchases compliant equipment

Manufacturer tests his components.

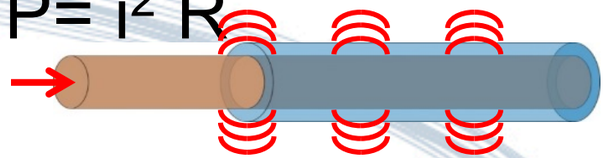
How to implement PoE on existing cabling

How to install new cabling PoE compliant

Bicsi

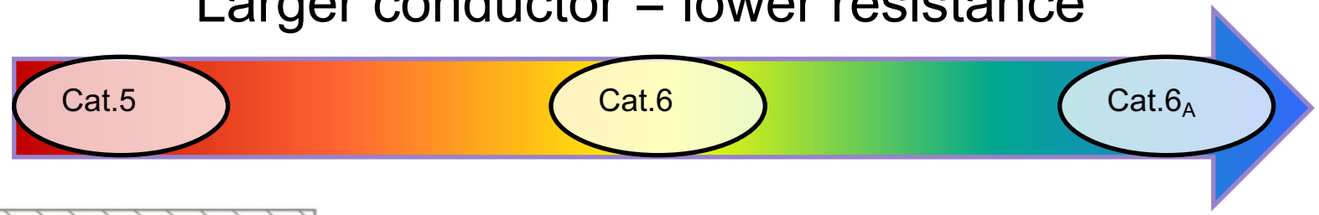
So what's so important about PoE in cabling?

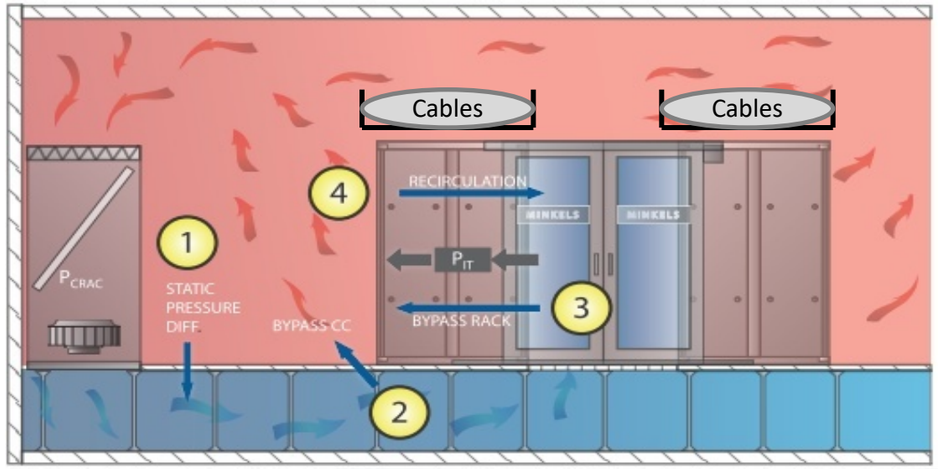
$P = i^2 R$

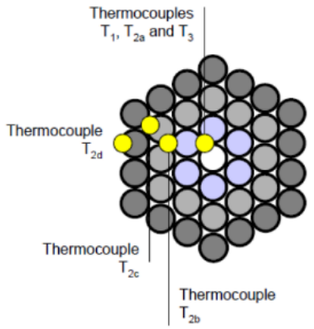


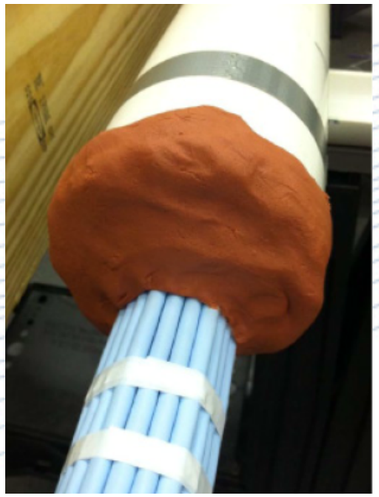
- Power through a cable, because of resistance, creates heat.
- Higher temperature = higher resistance = lower performance.

Larger conductor = lower resistance









Draft IEC 61156-1-4

ISO/IEC 11801-1, chapter 9.3.2.3: operating temperatures of the cables: -20°C to +60°C.

PoE compliance for new cabling

Draft. But the content on PoE is identical to EN 50174-2 which is already ratified.

- ISO /IEC 14673-2 (draft), information Technology - Implementation and operation of customer premises cabling – Part 2: Planning and installation.
  - For balanced cabling in accordance with ISO/IEC 11801-1
  - Remote Powering equipment to supply no more than 500mA per conductor.
  - Installation must be designated in one of the following categories:

Category	$i_{c\text{-}average}$	i_c	Controls required during	
			Attachment of remote powering equipment	Planning of subsequent cabling installation
RP1	≤ 212 mA	≤ 500 mA	Yes	Yes
RP2	> 212 mA < 500 mA	≤ 500 mA	Yes	Yes
RP3	-	≤ 500 mA	No	Yes

Mandatory to control before connecting a PoE device. Unless RP3.

-> Someone takes responsibility for the compliance during operation.

REMOTE POWERING INSTALLATION
CATEGORY RP1

NO UNAUTHORISED ATTACHMENT OF REMOTE POWERING EQUIPMENT

REMOTE POWERING INSTALLATION
CATEGORY RP2

NO UNAUTHORISED ATTACHMENT OF REMOTE POWERING EQUIPMENT

REMOTE POWERING INSTALLATION
CATEGORY RP3

Labeling required to identify the type

For installation of cabling in accordance with ISO/IEC 11801-2, ISO/IEC 11801-3, ISO/IEC 11801-4 and ISO/IEC 11801-6 the planning, installation and administration requirements of Category RP3 shall be applied.

Correspondence Between Current and Power

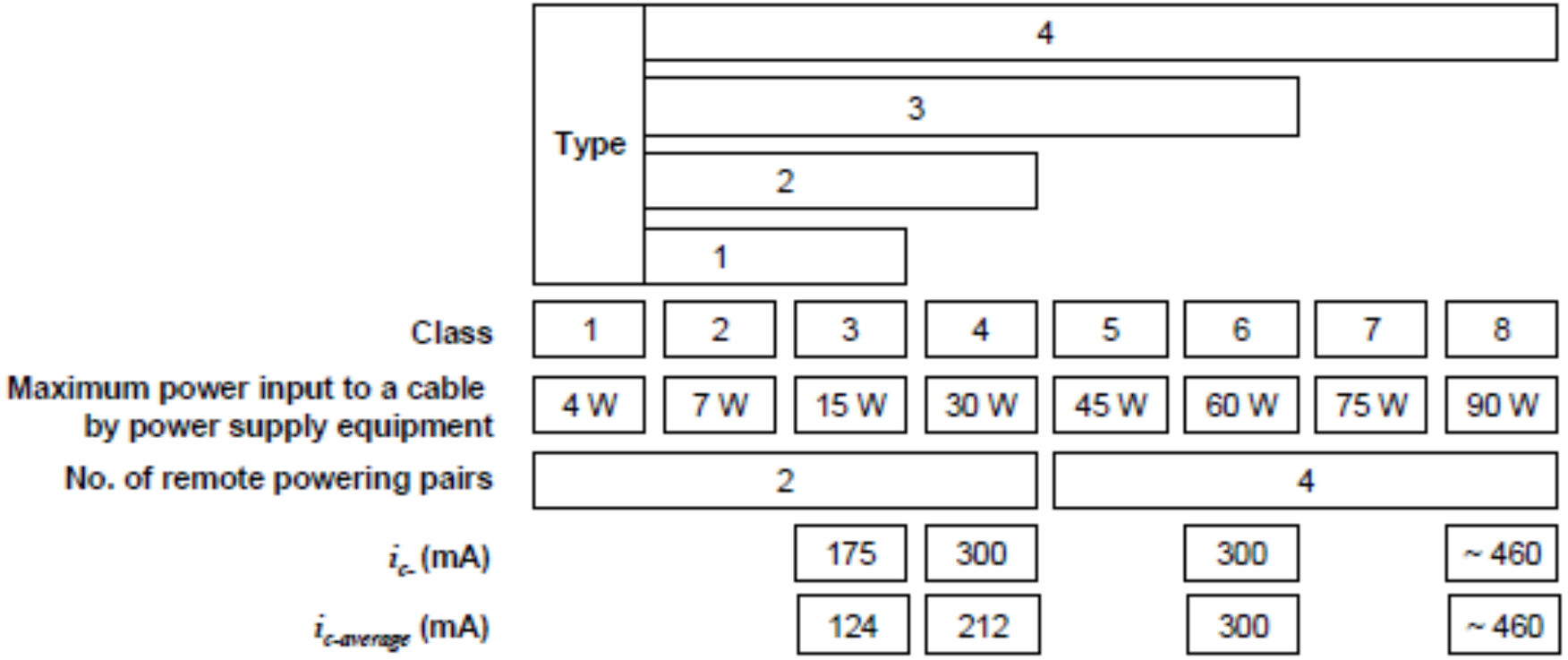
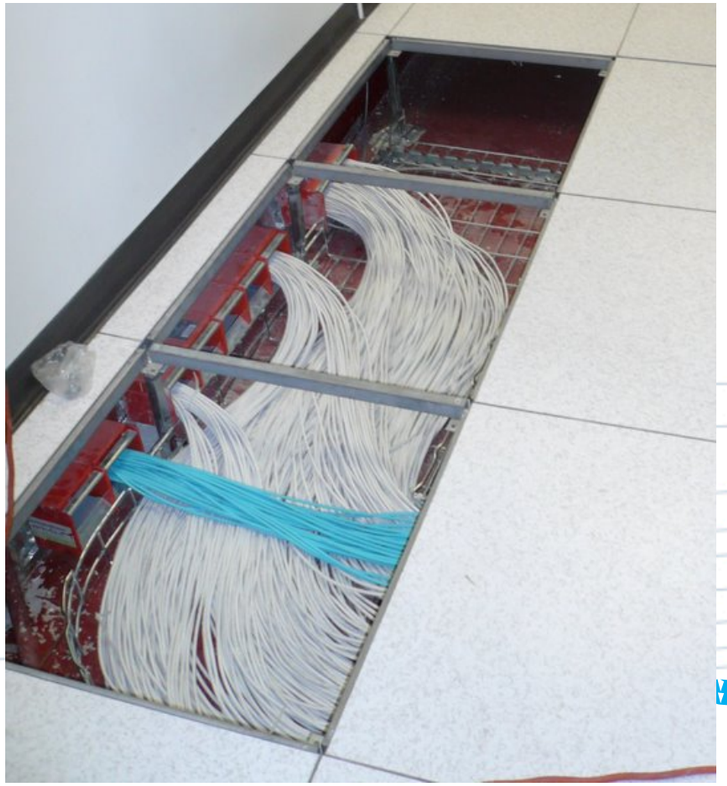


Figure A: Conductor currents for IEEE 802.3 remote powering applications

Calculate the heat increase

- Since you should comply to RP3, assume 500mA per conductor for 100% of the links (Type 4 100W everywhere).
- Irrelevant on PoE, the maximum number of cables in a bundle should be 24.
- However, bundles might join together in specific areas. For example through fire rated walls.



Calculate an average temperature

$$T_{\text{global}} = \frac{1}{L} \times \sum_{n=1}^{n} \left(T_{\text{ambient}-n} + \Delta T_n \right) \times L_n$$

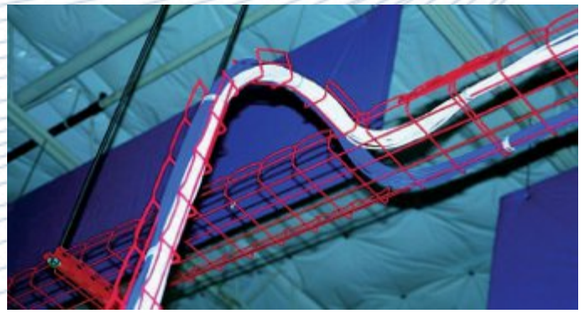
Suggestion: first only calculate worst case

Calculate the heat increase

- Calculate the temperature increase with the formula.

$$\Delta T\ °C = (0.8 \times N + \frac{K \times \sqrt{N}}{D}) \times R$$

N = number of cables
K = temperature coefficient of the cable management
D = diameter of the cables
R = resistance of the cables



ΔT Estimations

Table 19 - Temperature changes for various cable bundle sizes

Installation condition E/F - Ventilated								
No. of cables (N)	6	12	24	48	72	96	144	216
Cable R and D[a]	ΔT °C							
0,095 Ω/m 5,0 mm	3,0	5,0	7,0	11,0	15,0	18,0	24,0	32,5
0,075 Ω/m 7,0 mm	4,5	7,5	10,5	15,5	23,0	29,0	34,0	**
0,065 Ω/m 7,7 mm	6,0	8,5	12,5	18,5	23,0	27,5	35,0	**

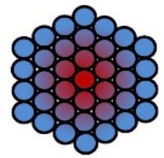
Installation condition C - Unperforated tray								
No. of cables (N)	6	12	24	48	72	96	144	216
Cable R and D[a]	ΔT °C							
0,095 Ω/m 5,0 mm	4,0	6,0	9,0	14,0	18,0	21,5	28,5	38,0
0,075 Ω/m 7,0 mm	5,5	9,5	13,0	19,0	25,0	31,0	38,0	**
0,065 Ω/m 7,7 mm	7,0	10,5	15,5	22,0	25,0	29,0	38,0	**

Installation condition A - Insulation								
No. of cables (N)	6	12	24	48	72	96	144	216
Cable R and D[a]	ΔT °C							
0,095 Ω/m 5,0 mm	$\approx \left(0{,}8\times N+\frac{0{,}27\times\sqrt{N}}{D}\right)\times R$	13,0	18,5	27,0	39,0	**	**	**	**
0,075 Ω/m 7,0 mm		7,5	10,5	15,5	23,0	29,0	34,0	**	**
0,065 Ω/m 7,7 mm		6,0	8,5	12,5	18,5	23,0	27,5	35,0	**

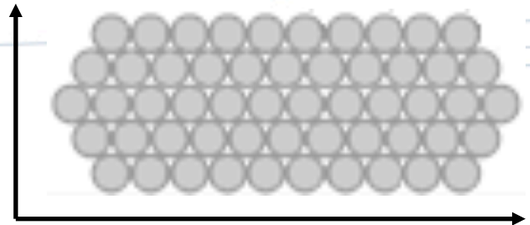
[a] Within the formula, D in metres e.g. for cable diameter 5 mm, D = 0,005

NOTE ** indicates a temperature in excess of 60 °C (assuming an ambient of 20 °C) which represent unacceptable localised heating

- You can estimate using the tables in the document.
- Or you could have a more precise using the annex I.
- Or most precise using the ISO/ IEC TS 29125
- Below is a simplification. (Caution: over – simplified. Add some extra margin)
- Adjust if the bundles are not round but rectangular



	Ventilated			Unperforated Tray			Trunking / Conduit			Insulation		
Typical Cat.	**24**	**72**	**216**	**24**	**72**	**216**	**24**	**72**	**216**	**24**	**72**	**216**
Cat.5	7.0	15.0	32.5	9.0	18.0	38.0	13.0	25.0	> 40	27.0	> 40	> 40
Cat.6	4.5	9.5	22.0	5.5	11.5	25.0	7.5	15.0	32.0	15.5	29.0	> 40
Cat.6A	4.0	8.0	18.5	4.5	9.5	21.0	6.0	12.5	26.0	12.5	23.0	> 40



Height to Width	1:1	1:2	1:3	1:4	1:5	1:6	1:7	1:8	1:9	1:10
ΔT multiplier	0.89	0.84	0.77	0.71	0.66	0.62	0.59	0.56	0.53	0.51

Verify the solution

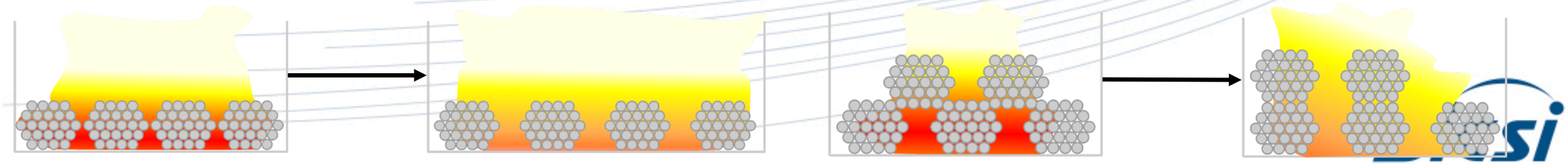
- Estimate the temperature of the environment and add the two together.
- In any case T + ΔT should be maximum 60 °C for standard compliant cabling.
- Calculate your maximum lengths for permanent links adjusted with the temperature. Here is a simplified table.

T (°C)	Permanent Link (m)
20	90
25	88
30	85
35	83
40	80
45	78
50	75
55	73
60	70
Assuming 10m of cords with 50% extra attenuation	

Risks:
Performance not guaranteed
Faster ageing of the cables

Mitigate

- At this point you might be trying to find solutions to reach a lower temperature.
- Calculate more precisely instead of using only absolute worst case.
- Then look into:
  - Bundle separation, geometry of bundles
  - Smaller bundles
  - Cables with lower resistance
  - Cables with larger diameter
  - Changes to the environment
  - Reduction of the ambient temperature
- If all fails, lower to RP2 and check again.
- In all cases, good practice is to arrange the bundles to improve airflow



PoE compliance for new cabling

For standard compliance:

- **Do not design or install new cabling without considering the PoE needs.**
- **Use worst case, then improve with more accurate calculations.**
- **Forget the 90m permanent link limit. You'll always be lower.**
- **Don't forget to record all the assumptions and conditions for use with future changes**

Thank You