

# Copper Cabling from 10G to 400G, and back down to 10Mbps, but on 1 pair only

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# Agenda

- 1- Standards**
- 2- Copper Systems**
- 3- Fiber Systems**
- 4- IoT**

# IEEE for Ethernet

3



## 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)

**802.3j (1990)**

10base-T, 10base-F

#### 802.11 Wireless (CSMA / CA)

**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

Coming  
soon.



# ISO, International



## Components



**International  
Electrotechnical  
Commission**

### ISO Information Technology Generic Cabling Systems

#### Performance, Design

#### Implementation

#### Validation

**ISO/IEC 11801-1 (2017)**

General requirements

**ISO/IEC 14763-2**

Planning and Installation Implementation

**ISO/IEC 61935-1**

Testing of balanced twisted Pair Cabling

**ISO/IEC 11801-2 (2017)**

Offices and commercial buildings

**ISO/IEC 14763-3**

Testing of Fiber Optic Cabling

**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

**ISO/IEC TR 24750 (2007)**

Assessment and mitigation of installed balanced cabling channels in order to support of 10GBASE-T

**ISO/IEC TR 24704 (2004)**

Cabling for wireless access points

**ISO/IEC TS 29125 (2017)**

Requirements for remote powering of terminal equipment

Ongoing revision with  
RP1, RP2, RP3

New

# CENELEC



## Components



## CENELEC Information Technology Generic Cabling Systems

### Performance, Design

**CENELEC EN50173-1**

General Requirements

**CENELEC EN50173-2**

Office premises

**CENELEC EN50173-3**

Industrial premises

**CENELEC EN50173-4**

Homes

**CENELEC EN50173-5**

Data centers

**CENELEC EN50173-6**

Distributed Building Services

### Implementation

**CENELEC EN50174-1**

Specification and quality assurance

**CENELEC EN50174-2**

Installation planning and practices

**CENELEC EN50174-3**

Planning and Installation

Also...

**CENELEC EN50174-99-1**

Guide for remote powering

### Validation

**CENELEC EN50346**

Testing of installed cabling

Ongoing revision with  
RP1, RP2, RP3

PoE on existing cabling

# TIA, North American



## ANSI/TIA: Telecommunications Cabling for Customer Premises

### Components, Performance

#### TIA - 568.2-D

Balanced twisted-pair cabling

#### TIA - 568.3-D

Optical fibre cabling

#### TIA - 568.4-D

Broadband coaxial cabling and components

### Design

#### TIA - 568.0-D

Generic cabling

#### TIA - 568.1-D

Commercial building

#### TIA - 758-B

Customer-owned outside plant

#### TIA - 942-B

Data centers

#### TIA - 1005-A

Industrial premises

### Implementation

#### TIA - 569-D

Telecommunications pathways and spaces

#### TIA - 607-C

Bonding and grounding telecommunications

#### TIA - 606-C

Administration

#### TIA - 862-B

Intelligent building systems

#### TIA - 5017

Physical network security

### Validation

#### TIA - 526.7-A

Single-mode fibre testing

#### TIA - 536- 14-C

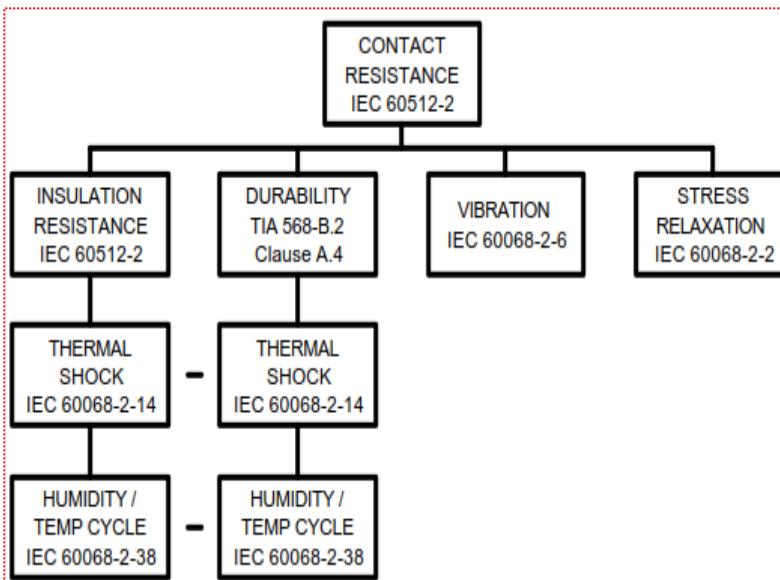
Multi-mode fibre testing

#### TIA - TSB-155-A

Support of 10Gbase-T on existing Cat.6

#### TIA - TSB-5021

Guidelines for 2.5G and 5G on Cat5e and Cat6



PoE on existing  
cabling

### Also...

#### TIA - 1183

Lab measurement methods and test fixtures

#### TIA - 1152-A

Twisted pair field testers

#### TIA - TSB - 184A

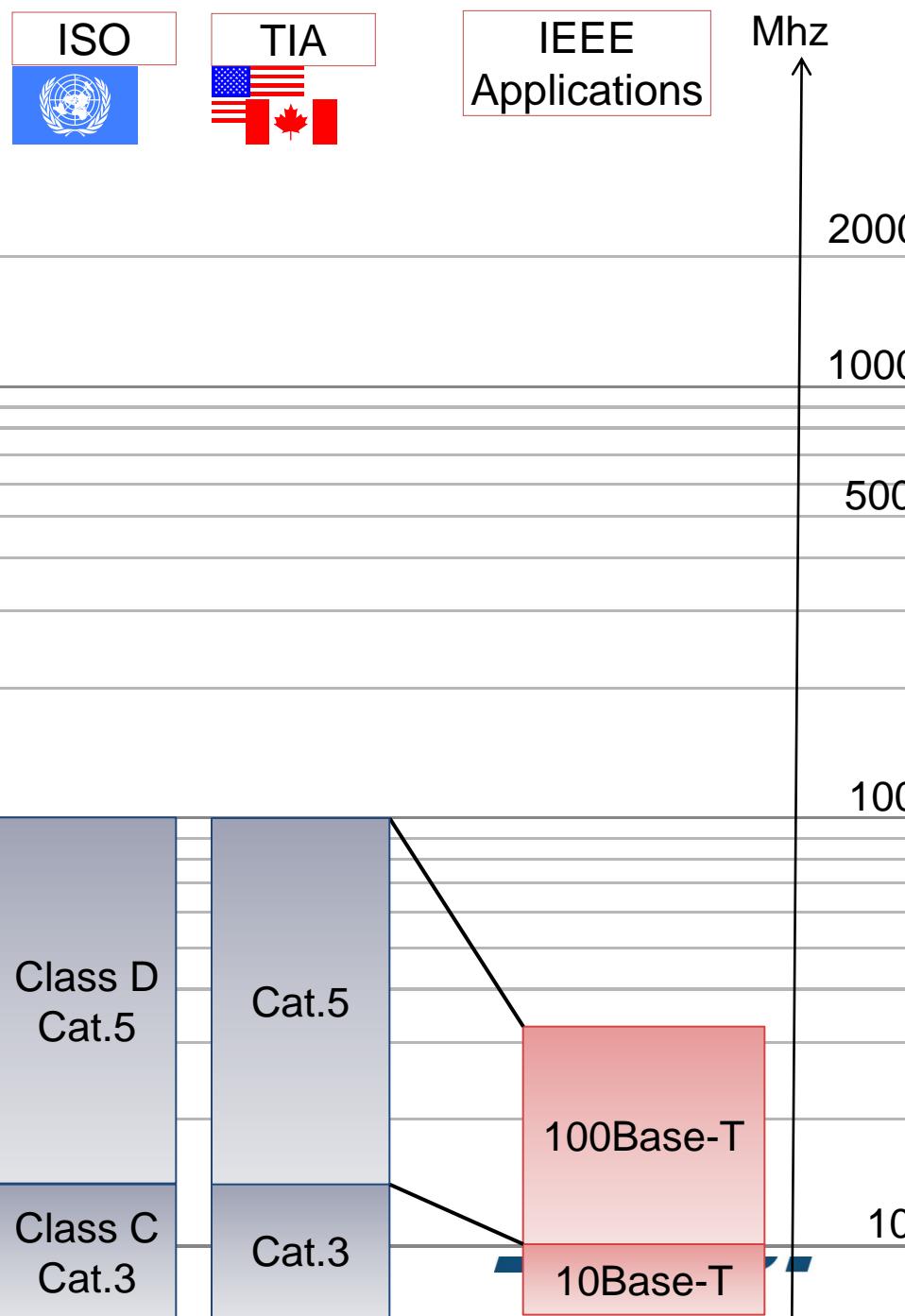
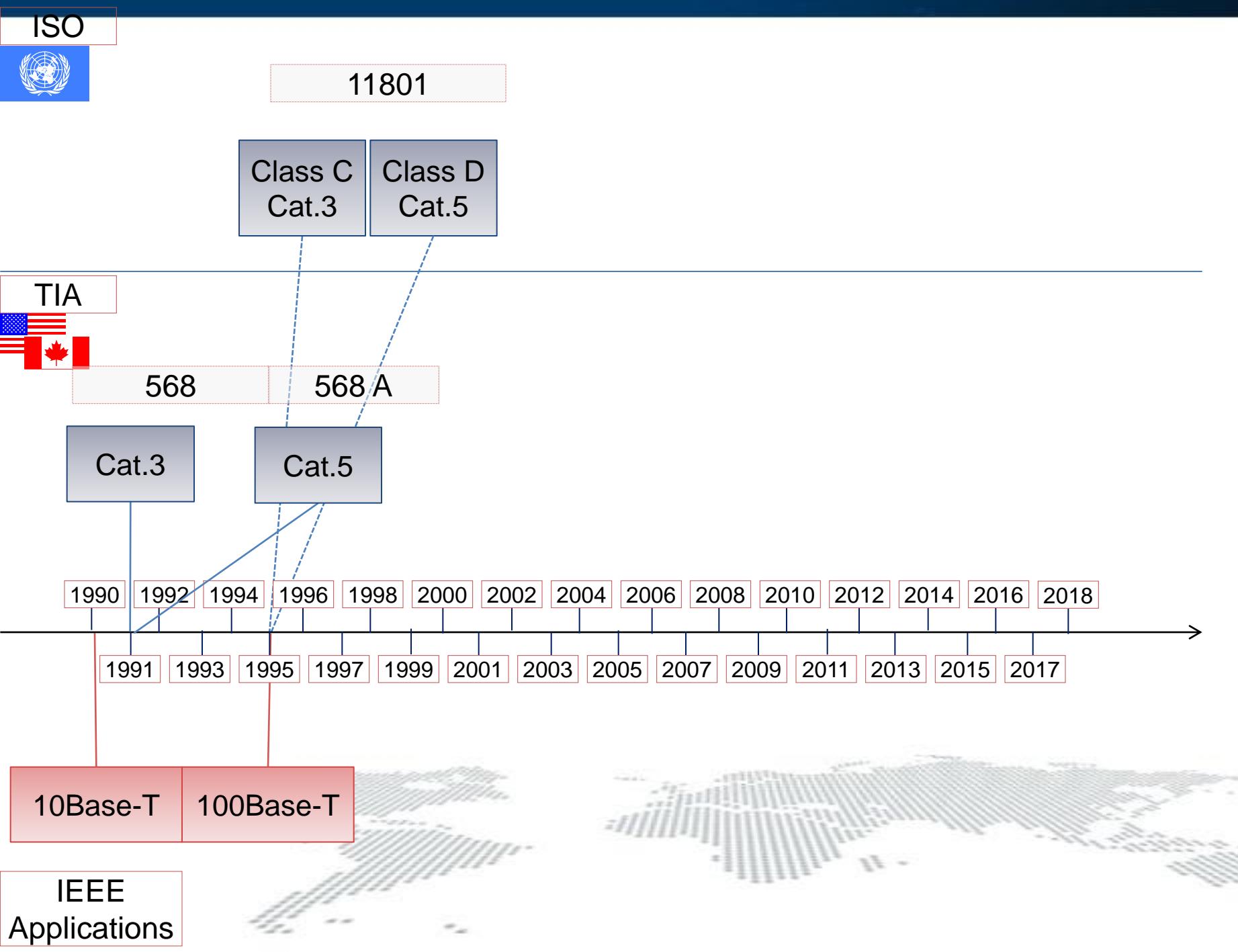
Supporting PoE over twisted pair



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# Copper Categories

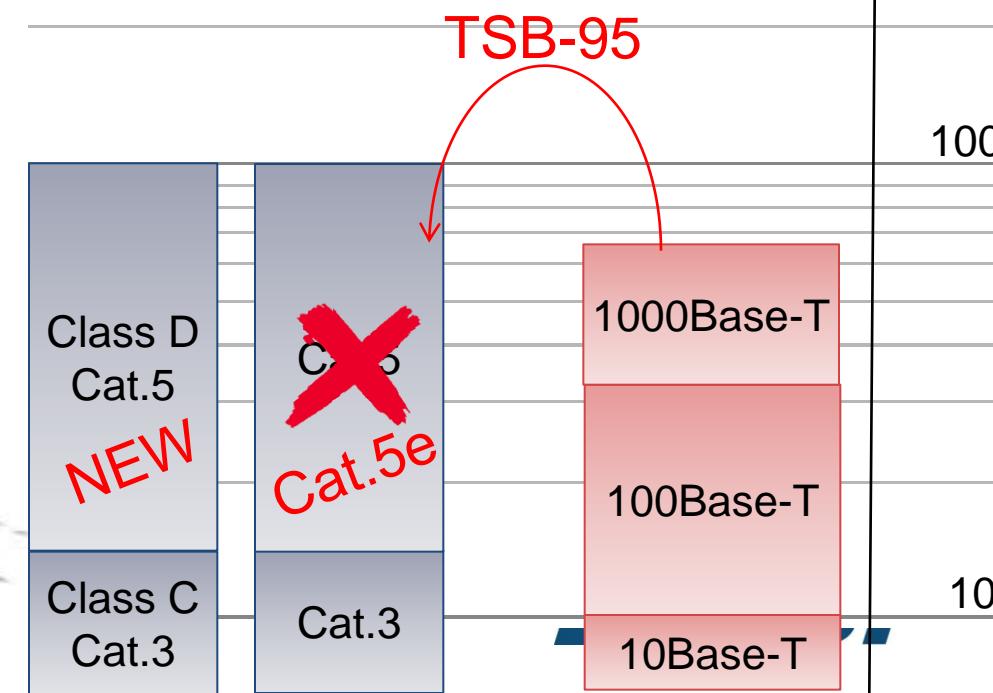


# IEEE 802.3ab, 1999: 1000Base-T

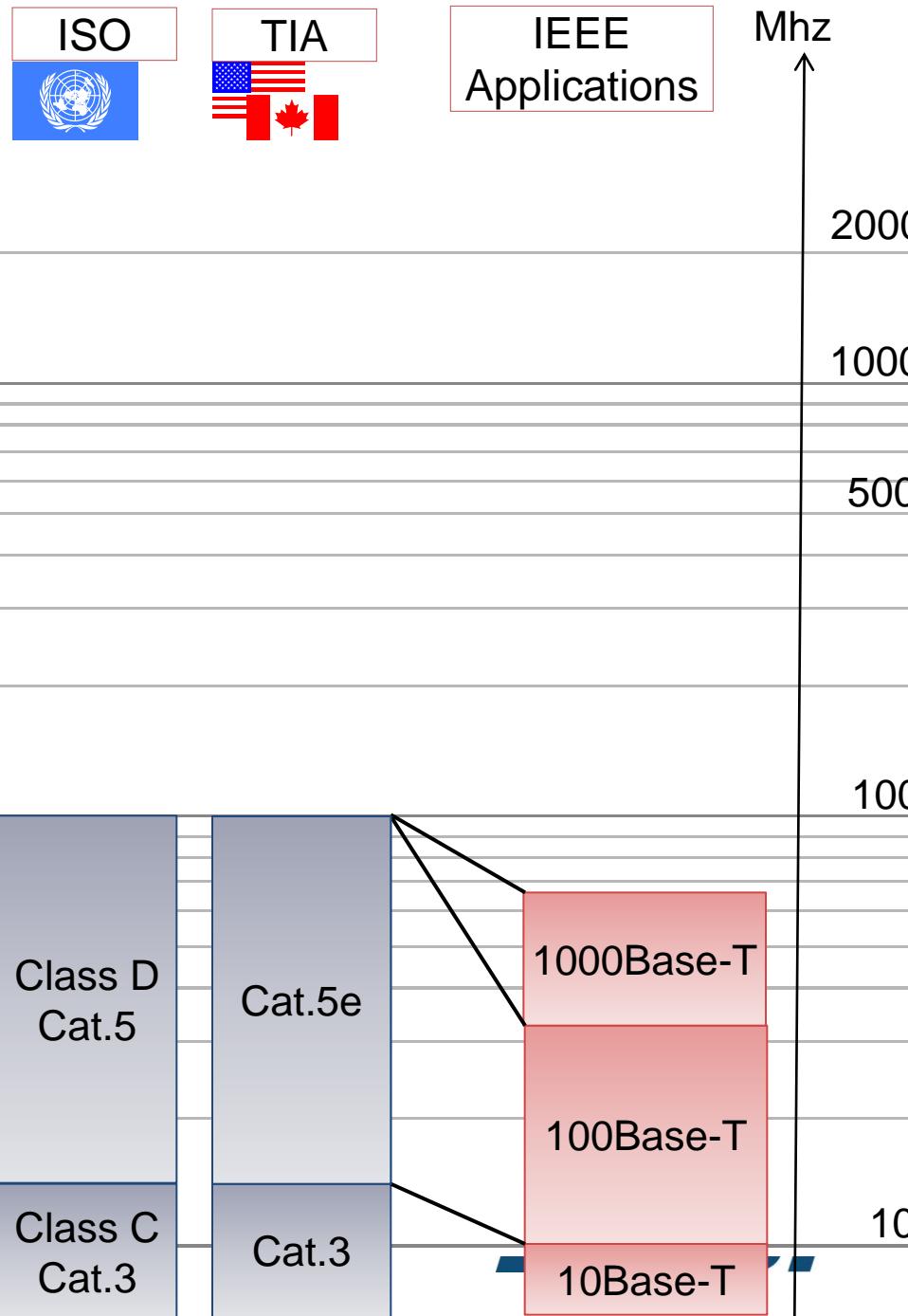
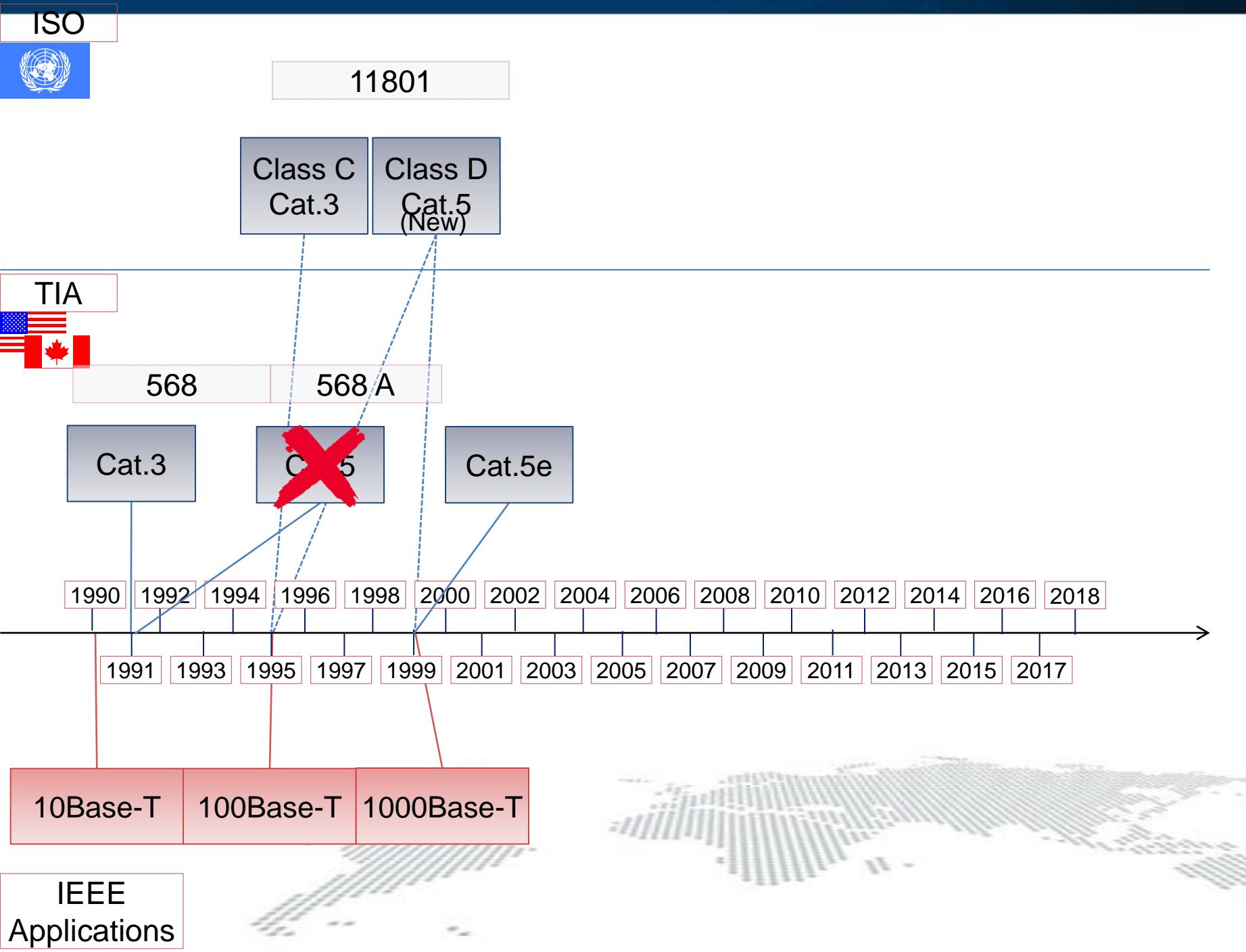
- So you could implement 1000Base-T on existing Cat5:
  - Test again with the new requirements in TIA TSB-95
- Or install new cabling guaranteed compliant to 1000Base-T:
  - Category 5e in TIA
  - “New” category 5 in ISO and CENELEC
- Of course, the “old” Cat5 became immediately obsolete.



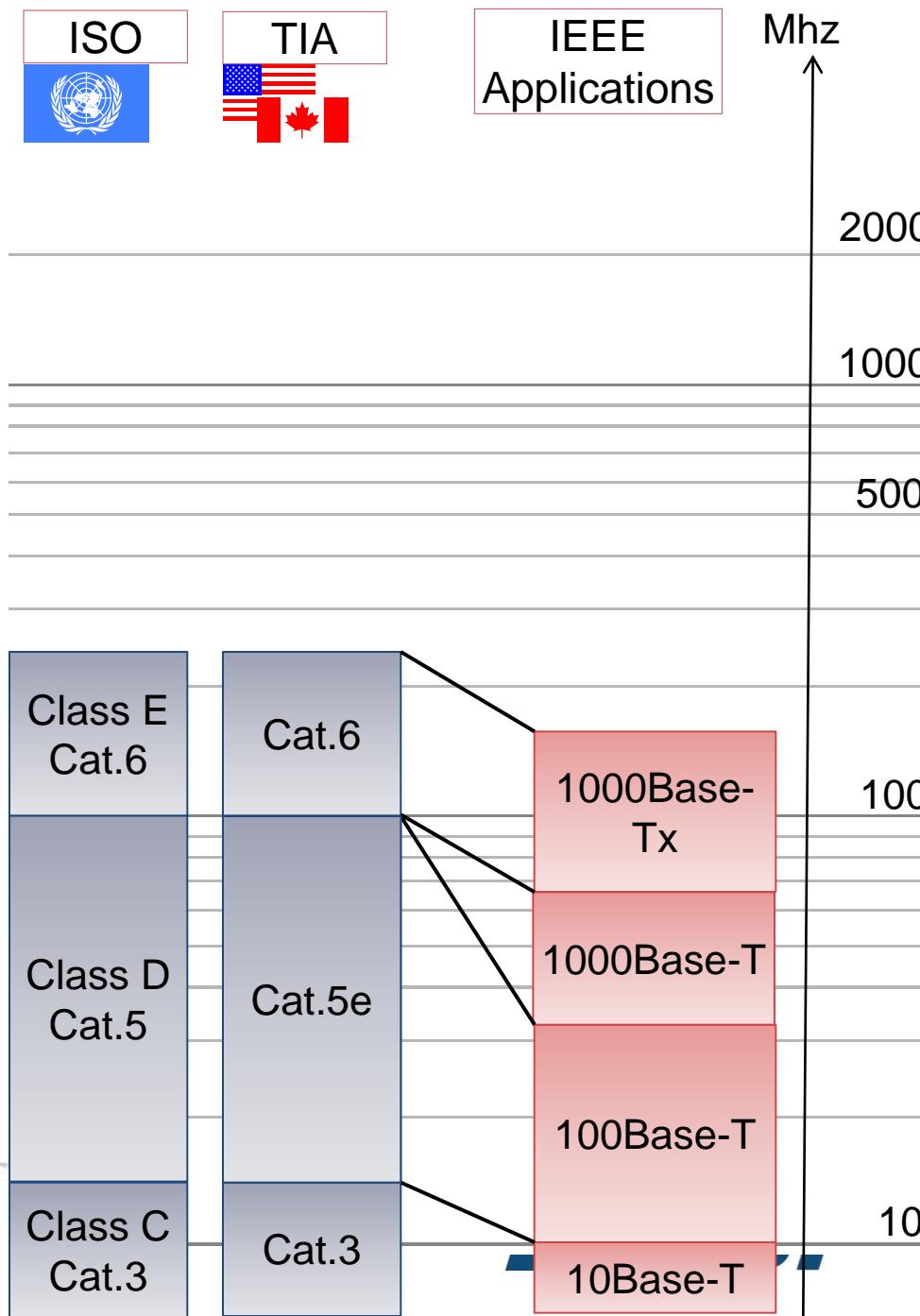
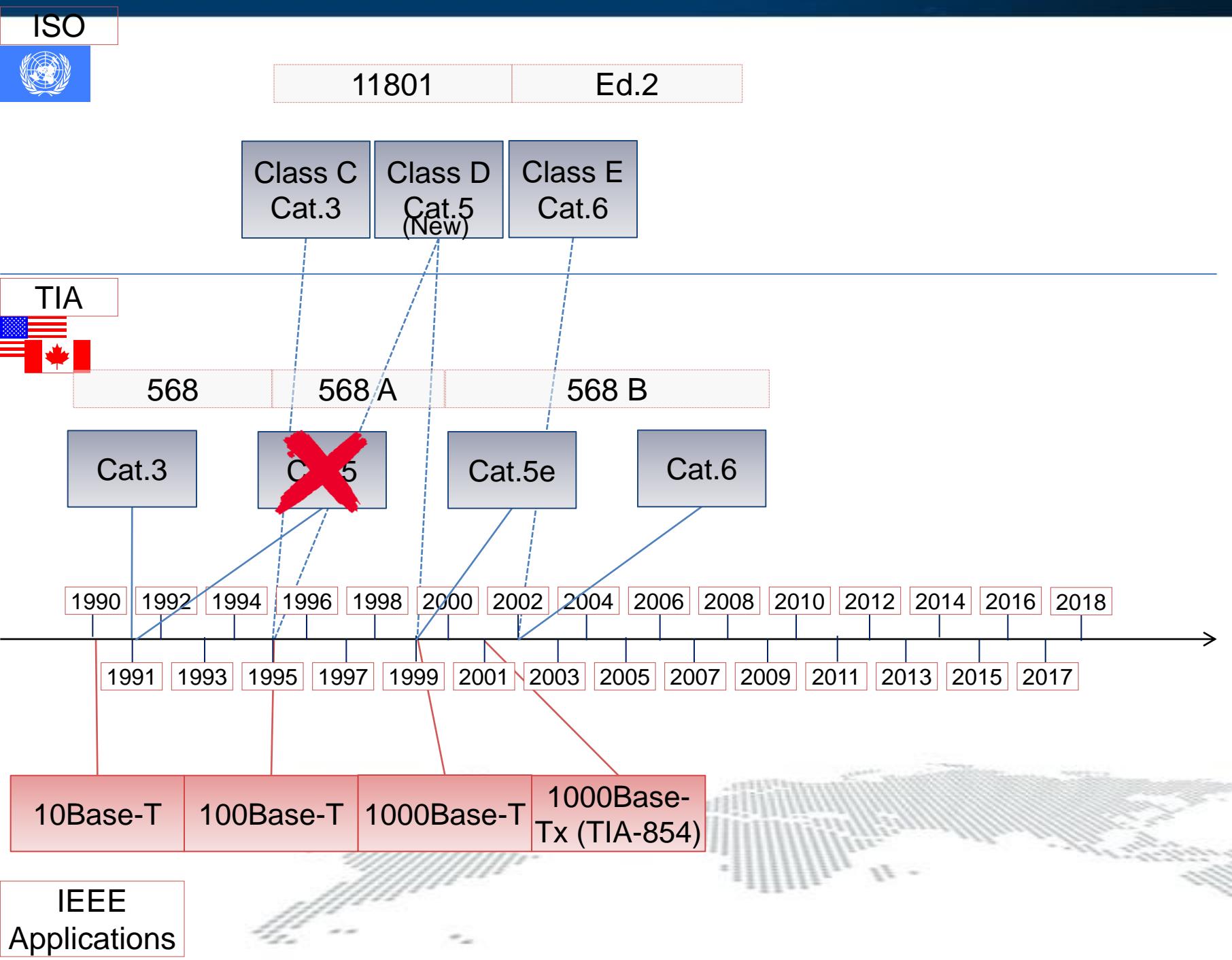
ISO Cat.5 = CENELEC Cat.5 = TIA Cat.5e



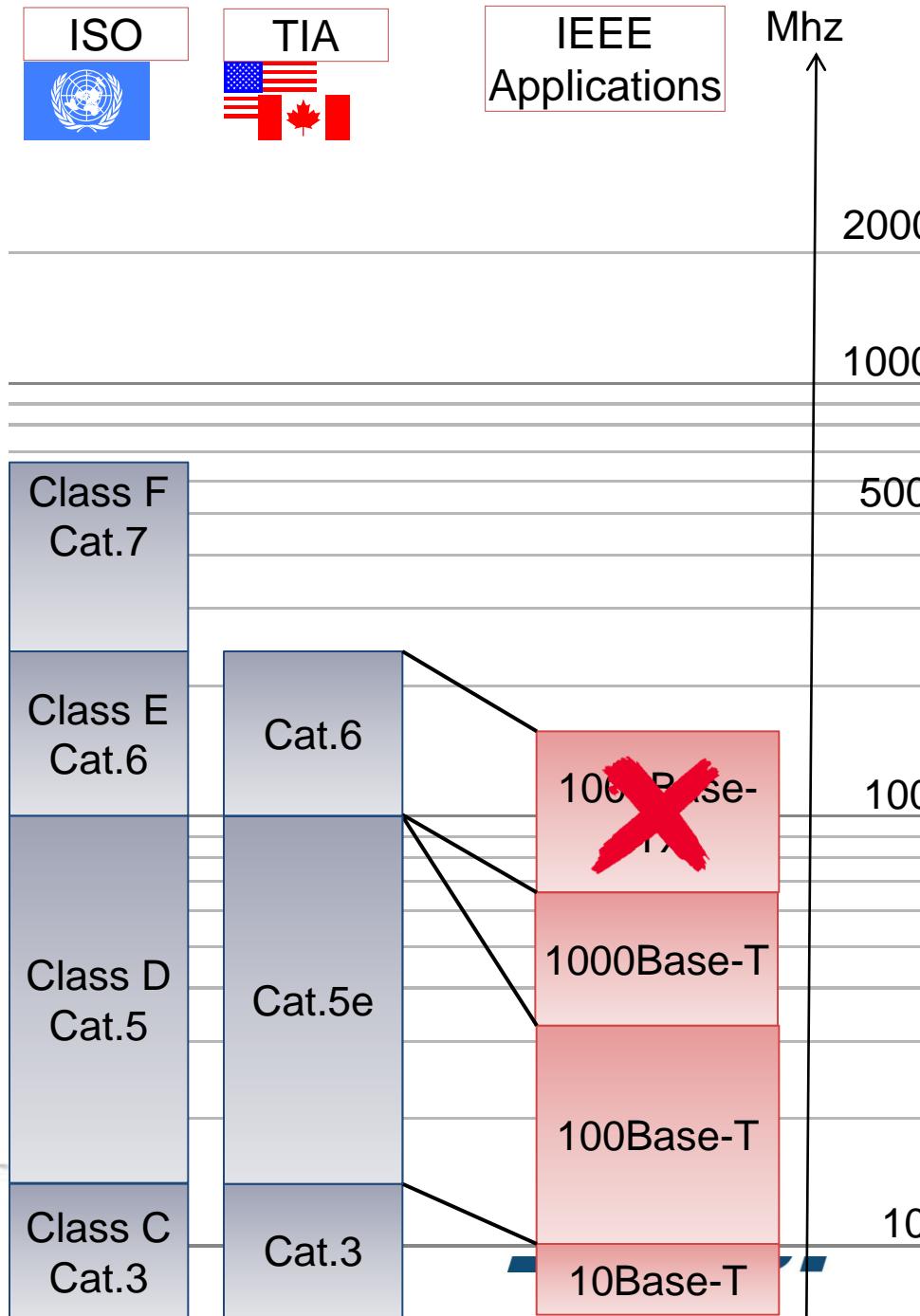
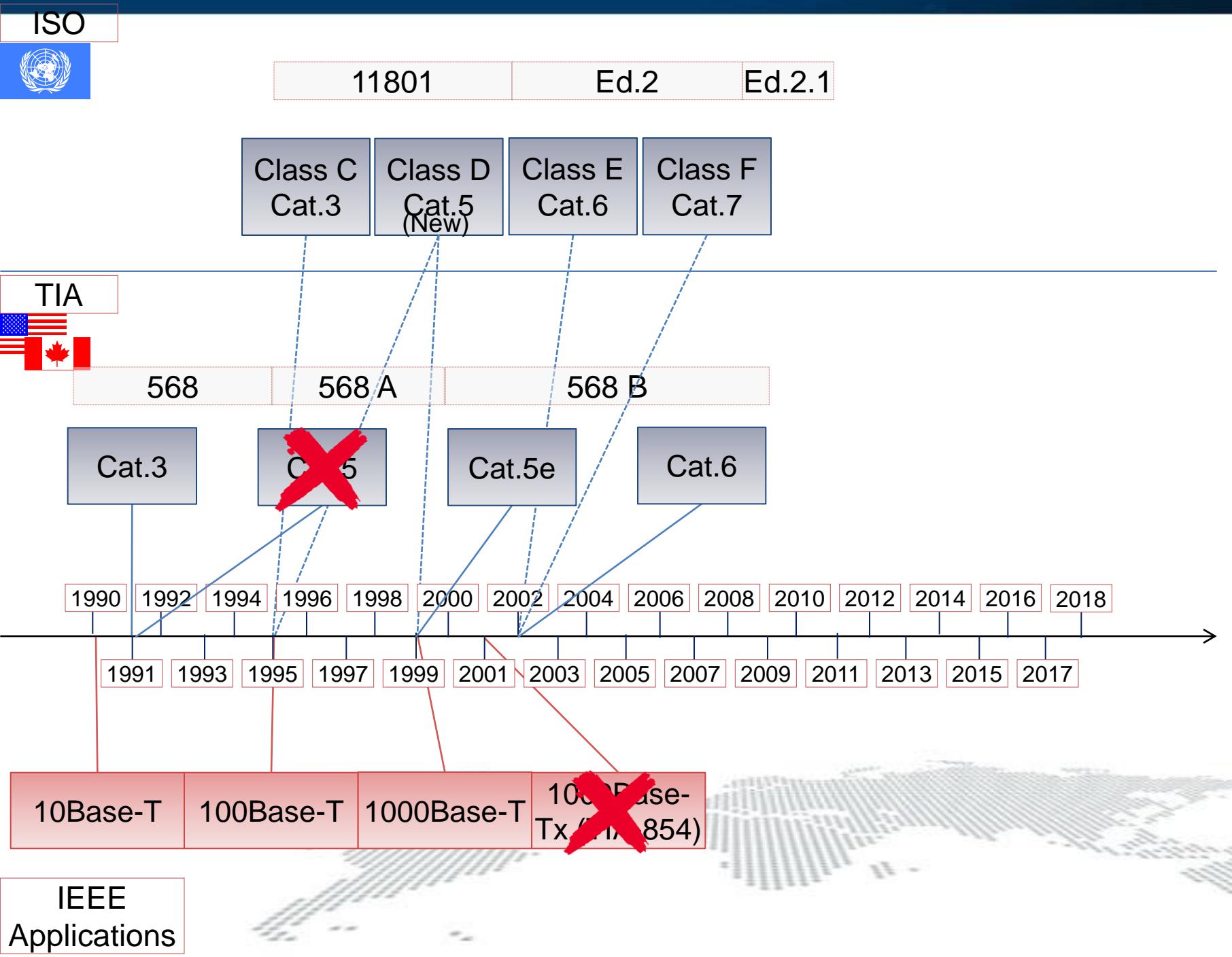
# Copper Categories



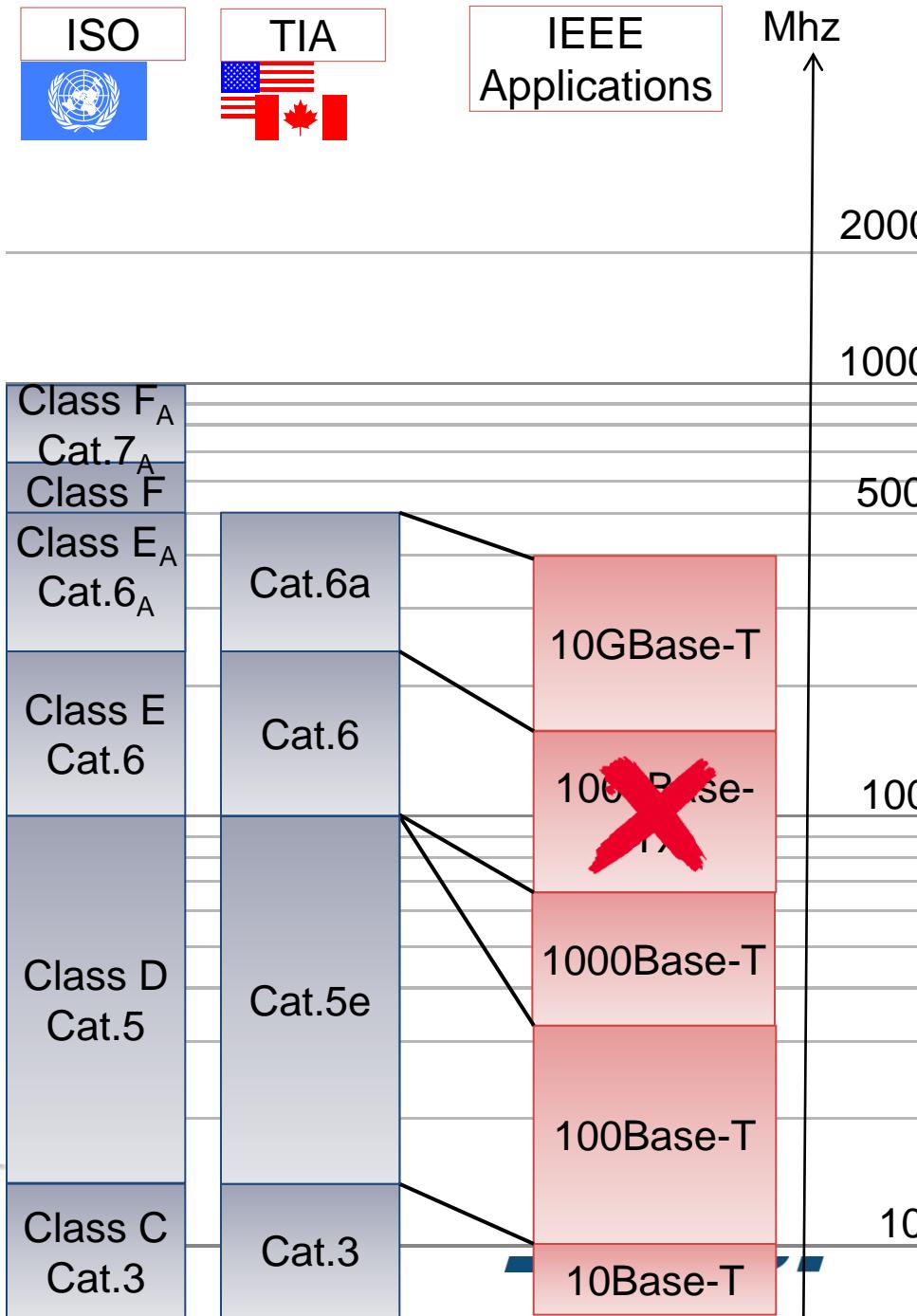
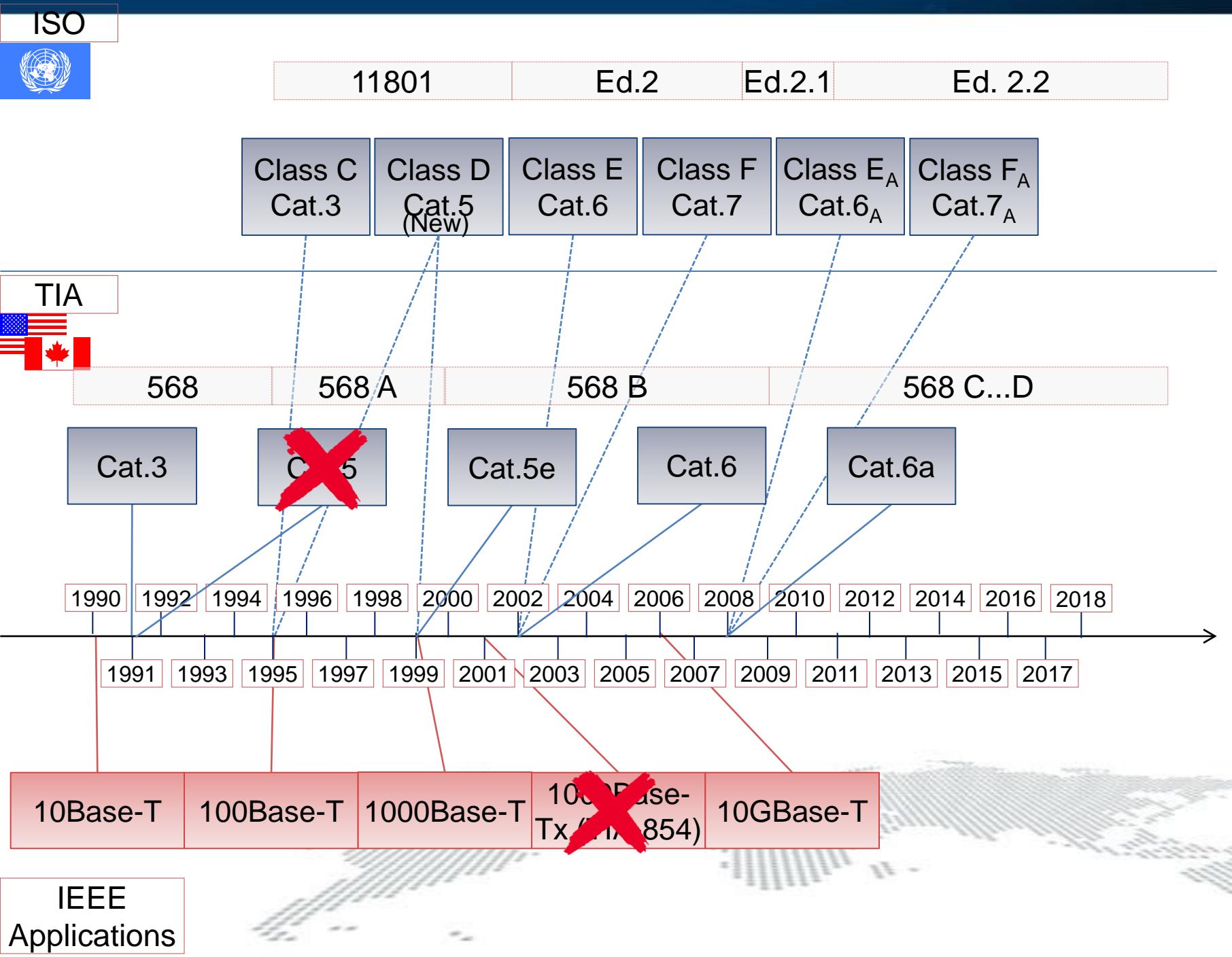
# Copper Categories



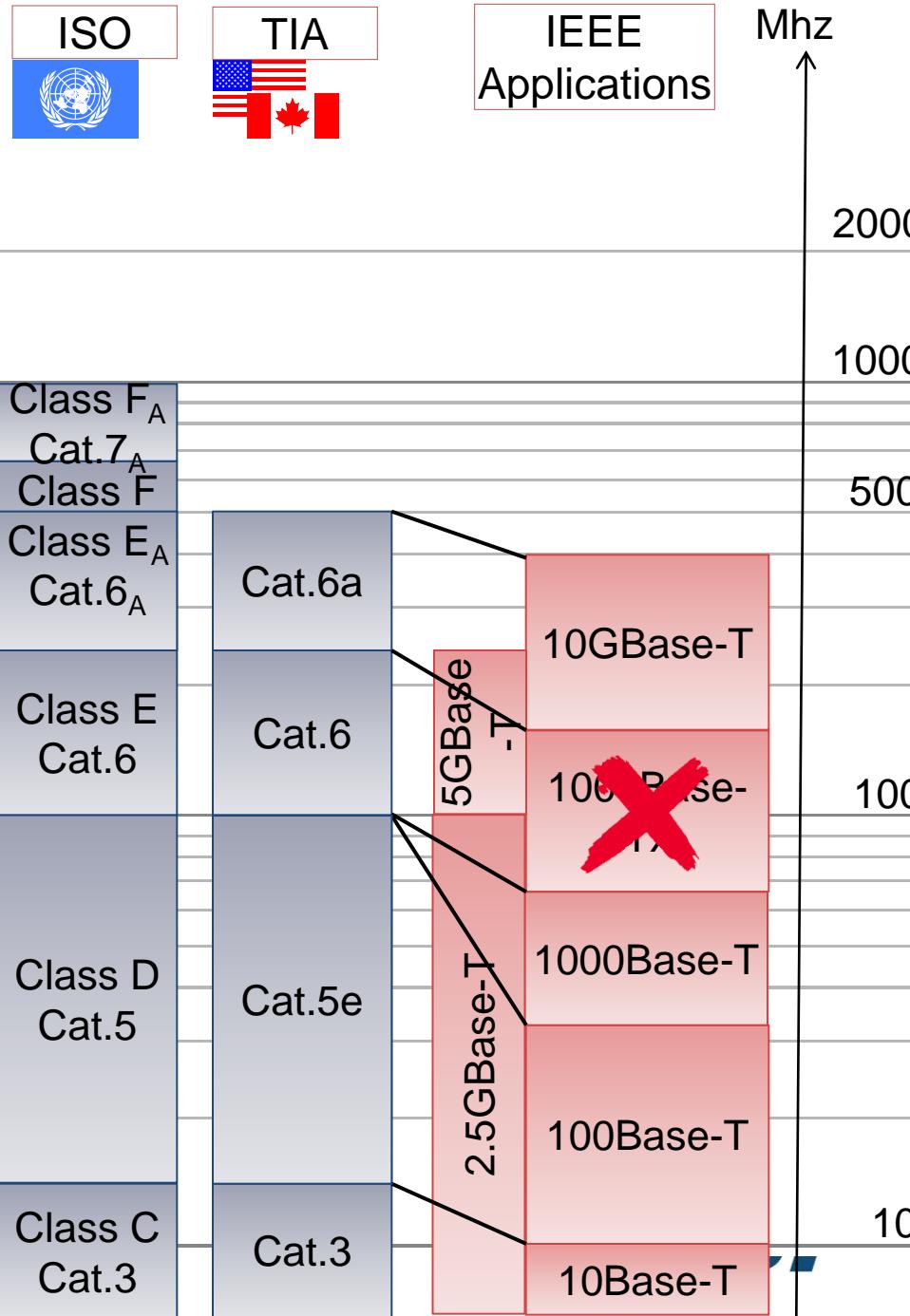
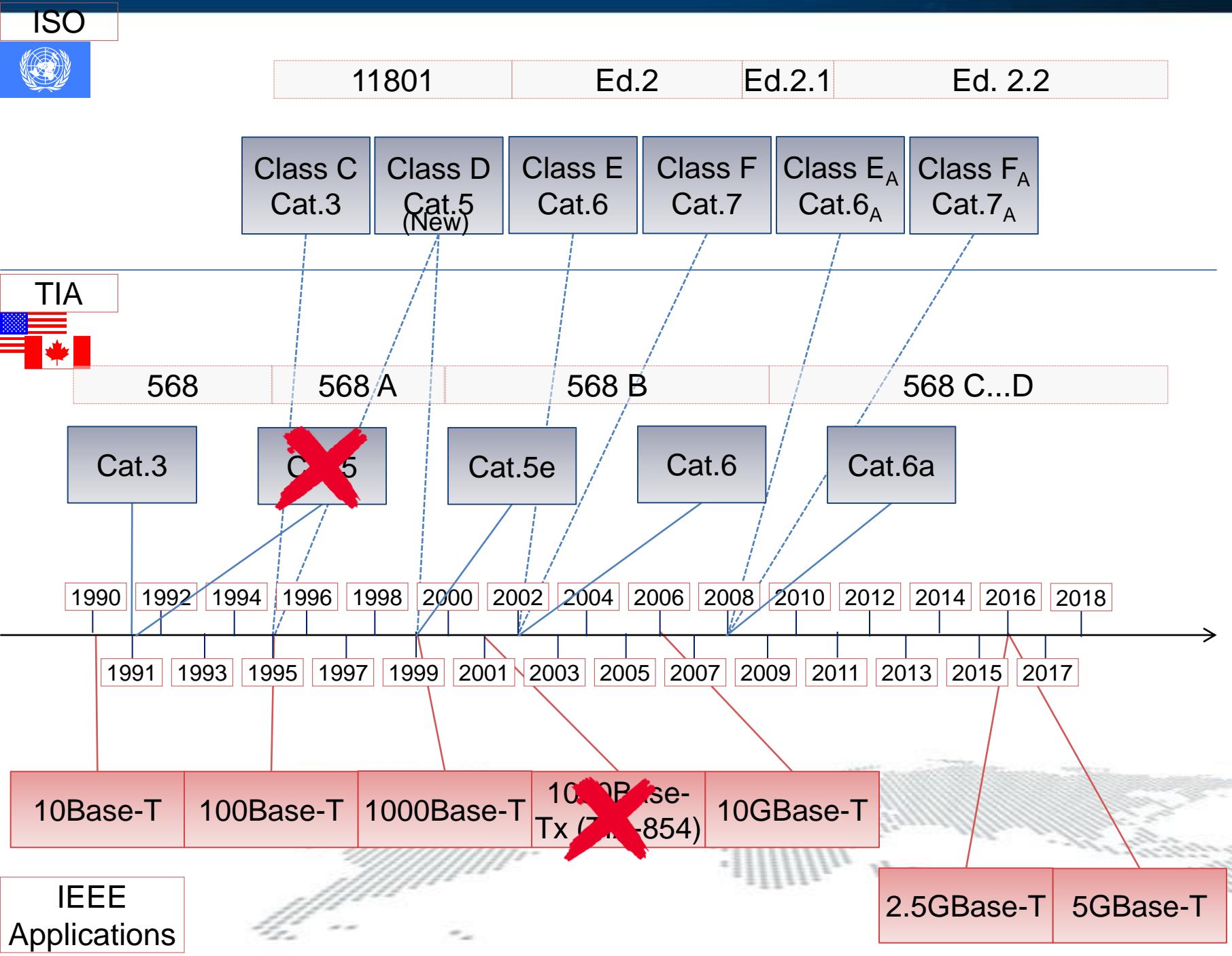
# Copper Categories



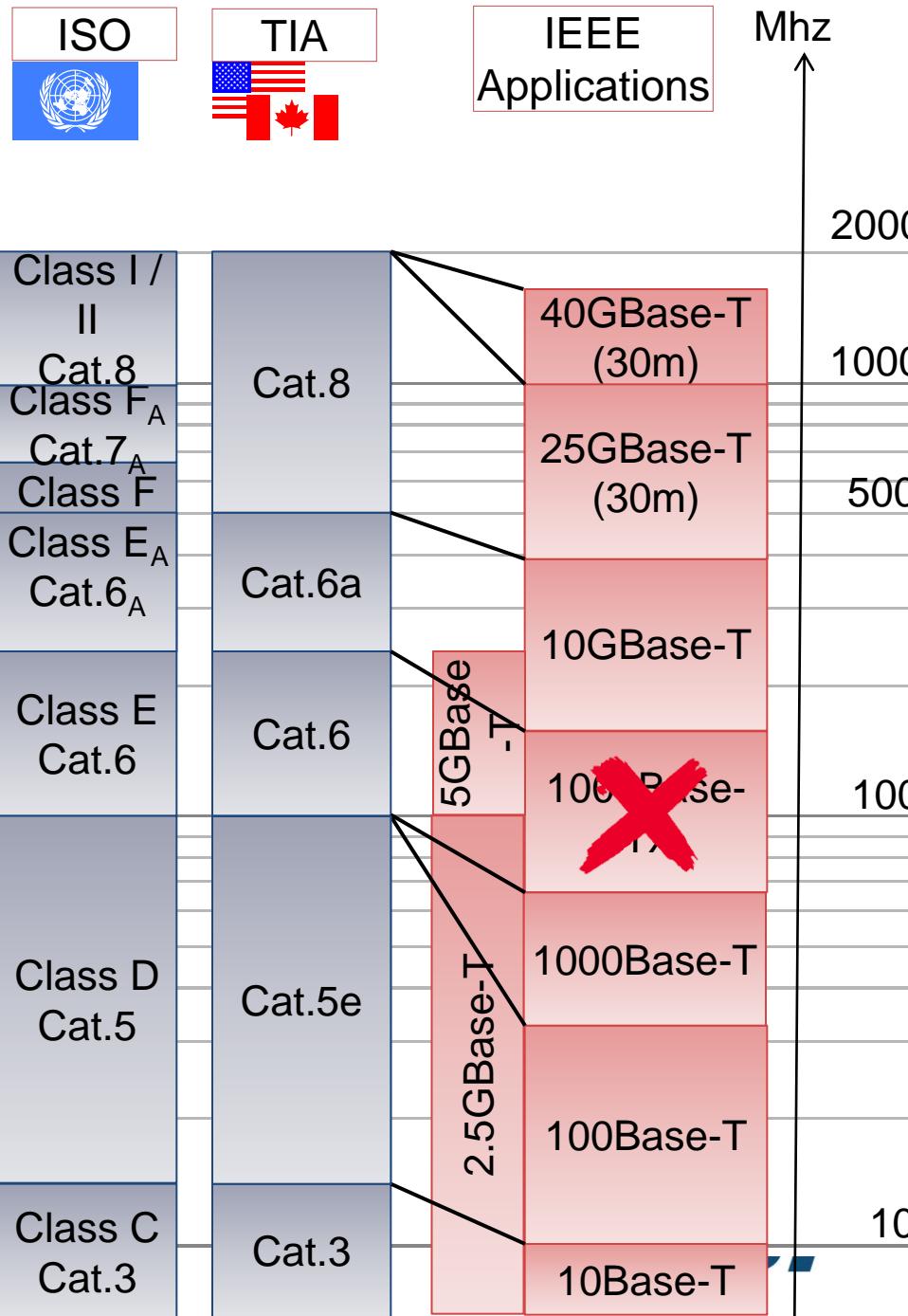
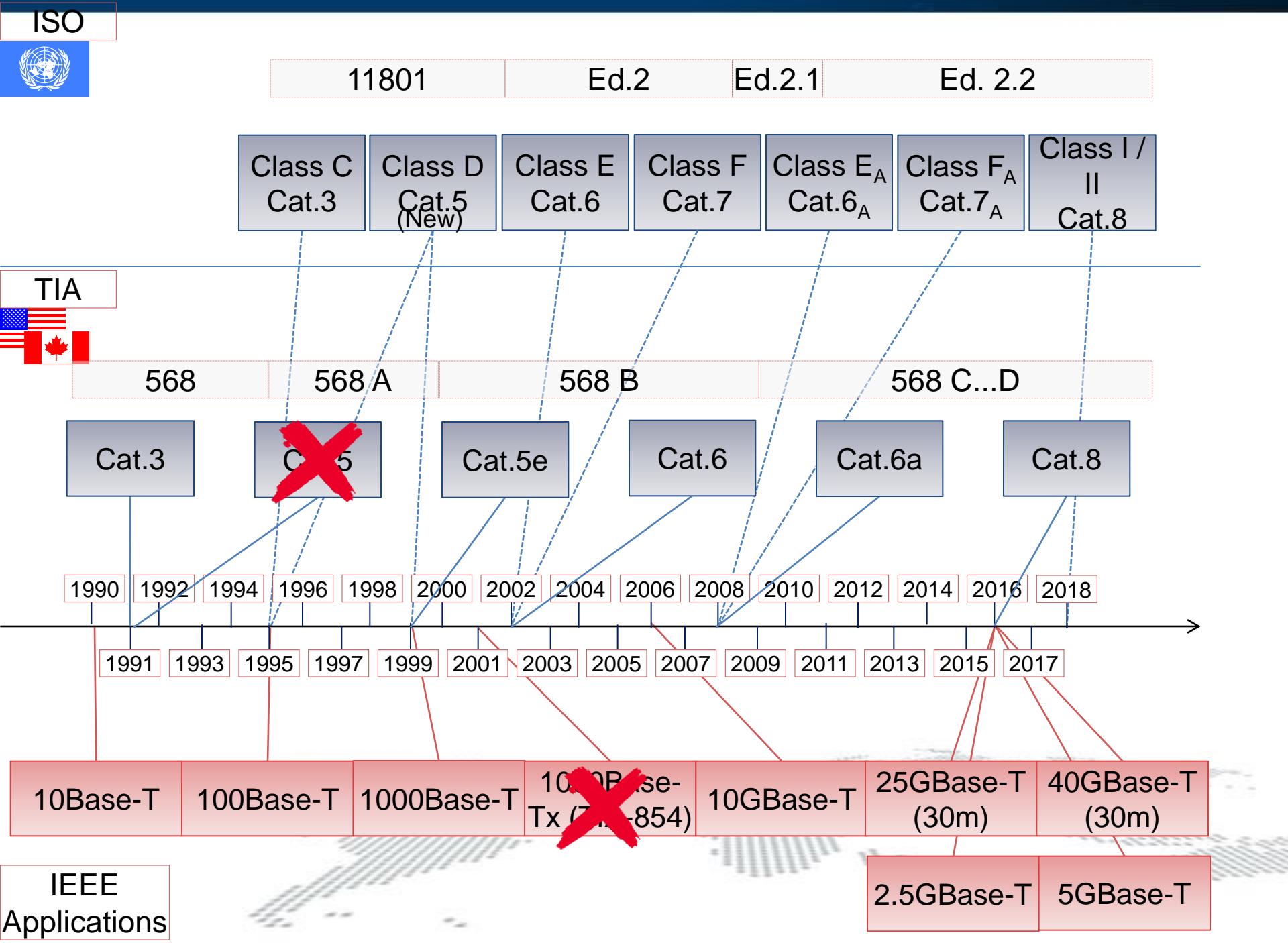
# Copper Categories



# Copper Categories

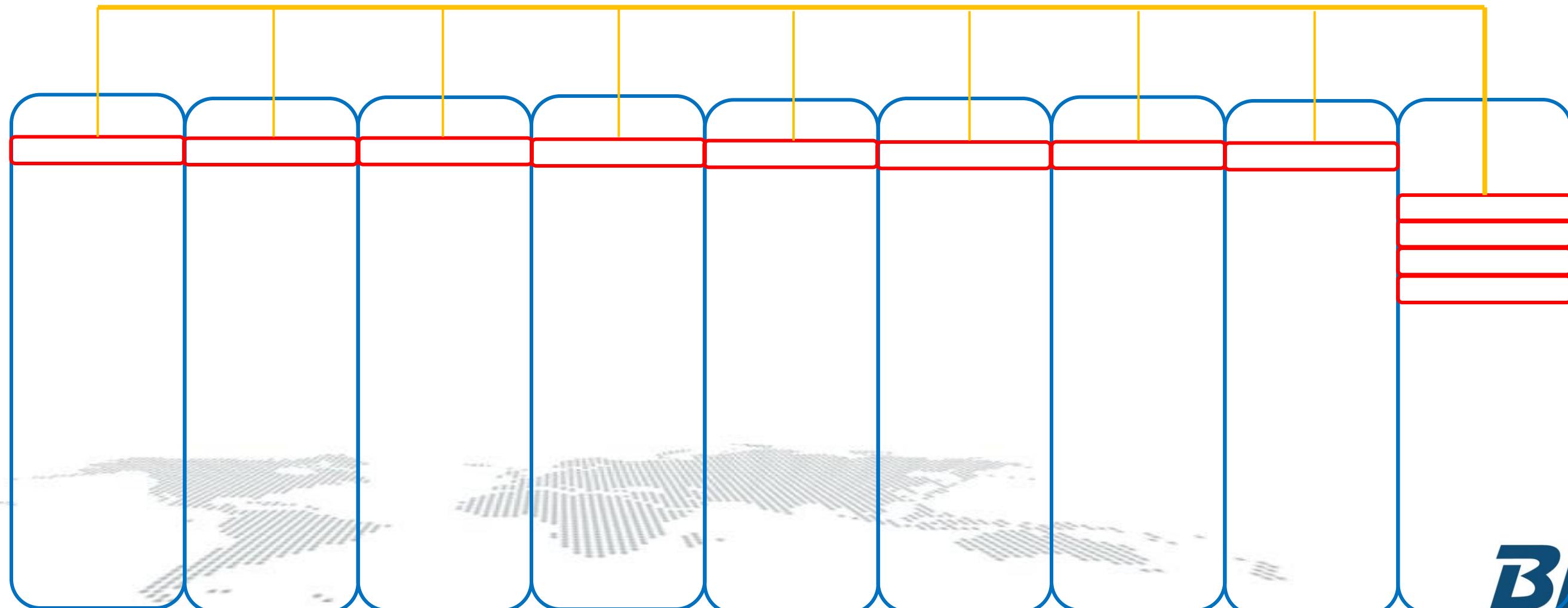


# Copper Categories



# 25G and 40G

- IEEE 802.3bq 25Gbase-T and 40Gbase-T is designed for the horizontal cabling in datacenters.
- The maximum distance is 30m.



# Cat.8, Class I and Class II

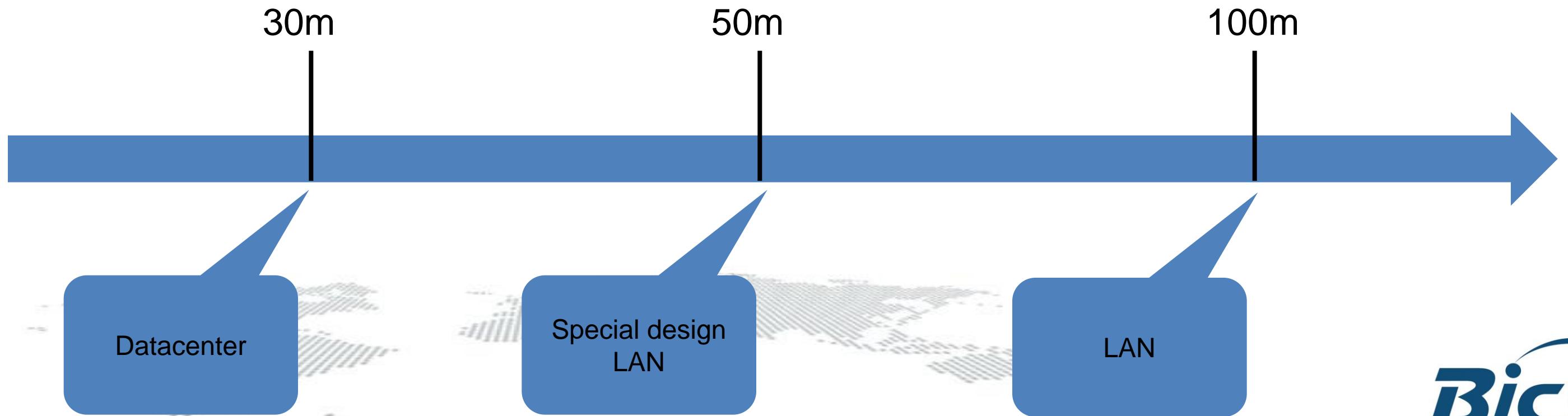
	Frequency	Distance	25 and 40 GBase-T	Cable	Connectors
TIA Cat.8				F/UTP or S/FTP Cat.8	"RJ45" Cat.8
ISO Class I	2 GHz	30m	Yes	Cat 8.1 = TIA Cat8	"RJ45" Cat.8.1 = TIA Cat.8
ISO Class II				S/FTP Cat.8.2	"Non-RJ45"



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# What's next?

- There is currently no work on any future Category 9.
- 40G is limited to 30m on category 8.
- Best solution for LAN is currently 10G, working on Category 6<sub>A</sub>.
- But 25G could work for longer distance on Cat.8. (will not work on Cat.7<sub>A</sub>)
- Currently in development in the standards: New 25G on Category 8 for 50m.



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# Multimode vs. Singlemode

10GBASE-LR SFP+ transceiver module for SMF, 1310-nm wavelength, 10km, LC

duplex connector



Price: \$395.00

Model/Part #: SFP-10G-LR

Availability: In Stock

Ships: In 24 hours

Warranty: Lifetime

Qty: 1

+ Add to Cart

- OR -  
Add to Wish List  
Add to Compare

★★★★★ 0 reviews | Write a review

Singlemode for distance,  
multimode for price

10GBASE-SR SFP+ transceiver module for MMF, 850-nm wavelength, 300m, LC

duplex connector



Price: \$145.00

Model/Part #: SFP-10G-SR

Availability: In Stock

Ships: In 24 hours

Warranty: Lifetime

Qty: 1

+ Add to Cart

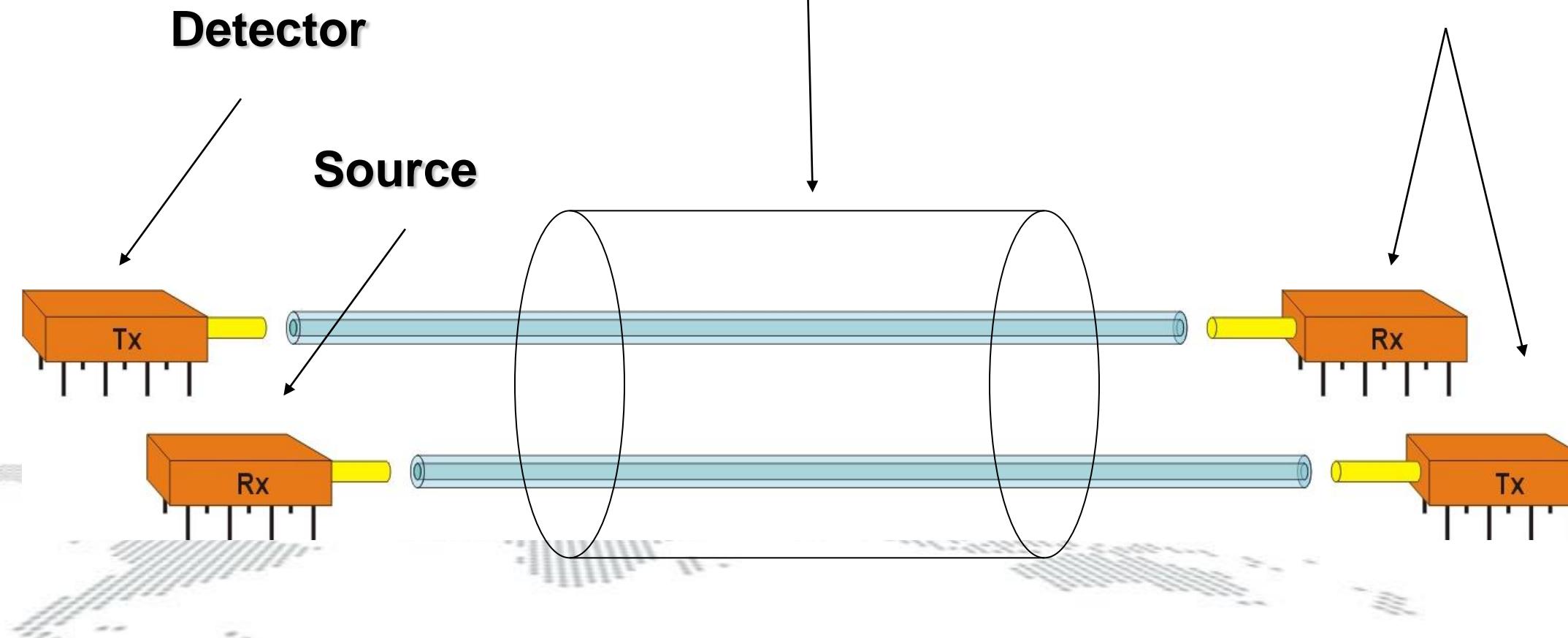
- OR -  
Add to Wish List  
Add to Compare

★★★★★ 0 reviews | Write a review

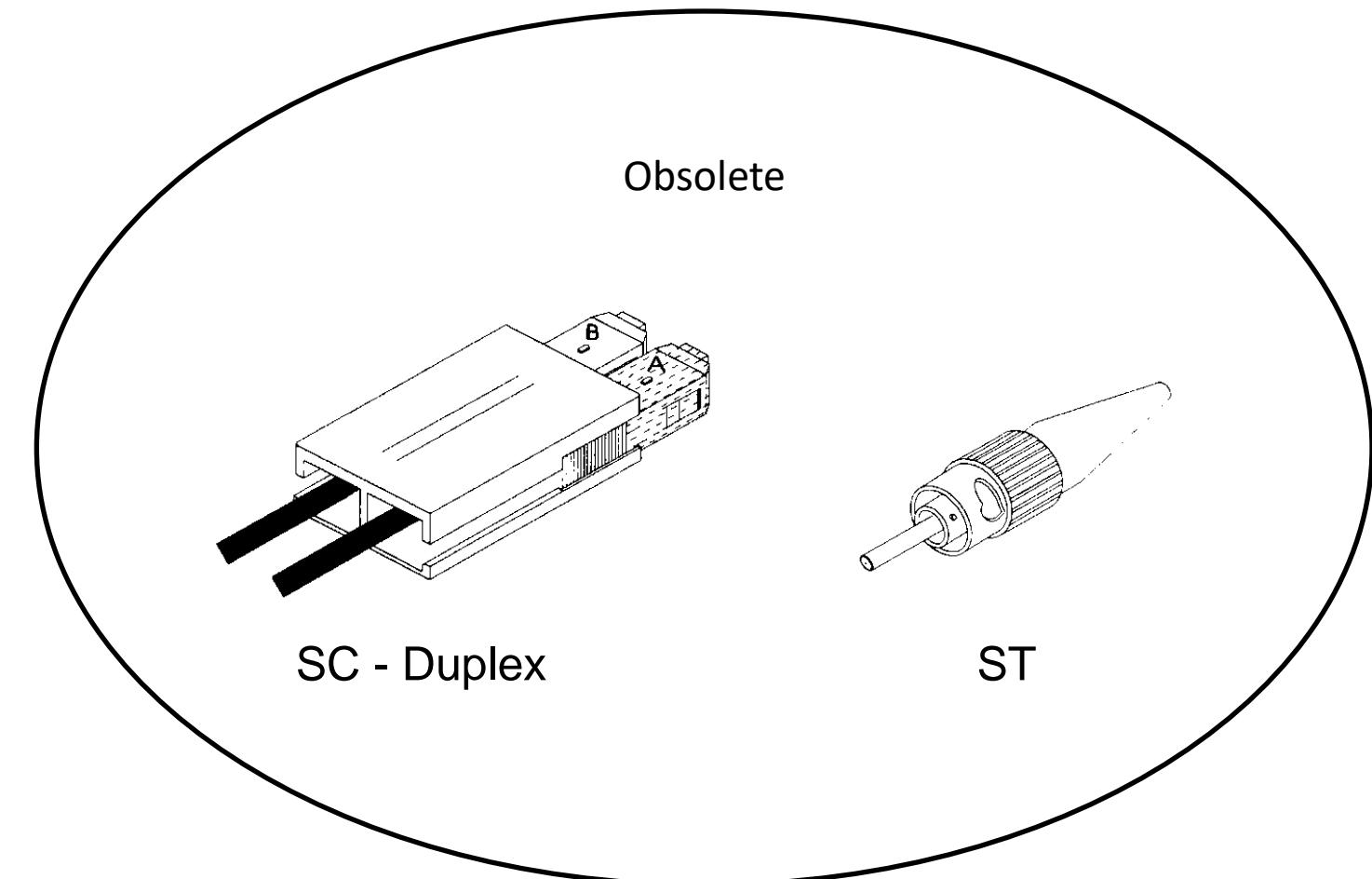
# Duplex transmission

Duplex optical  
fiber cable

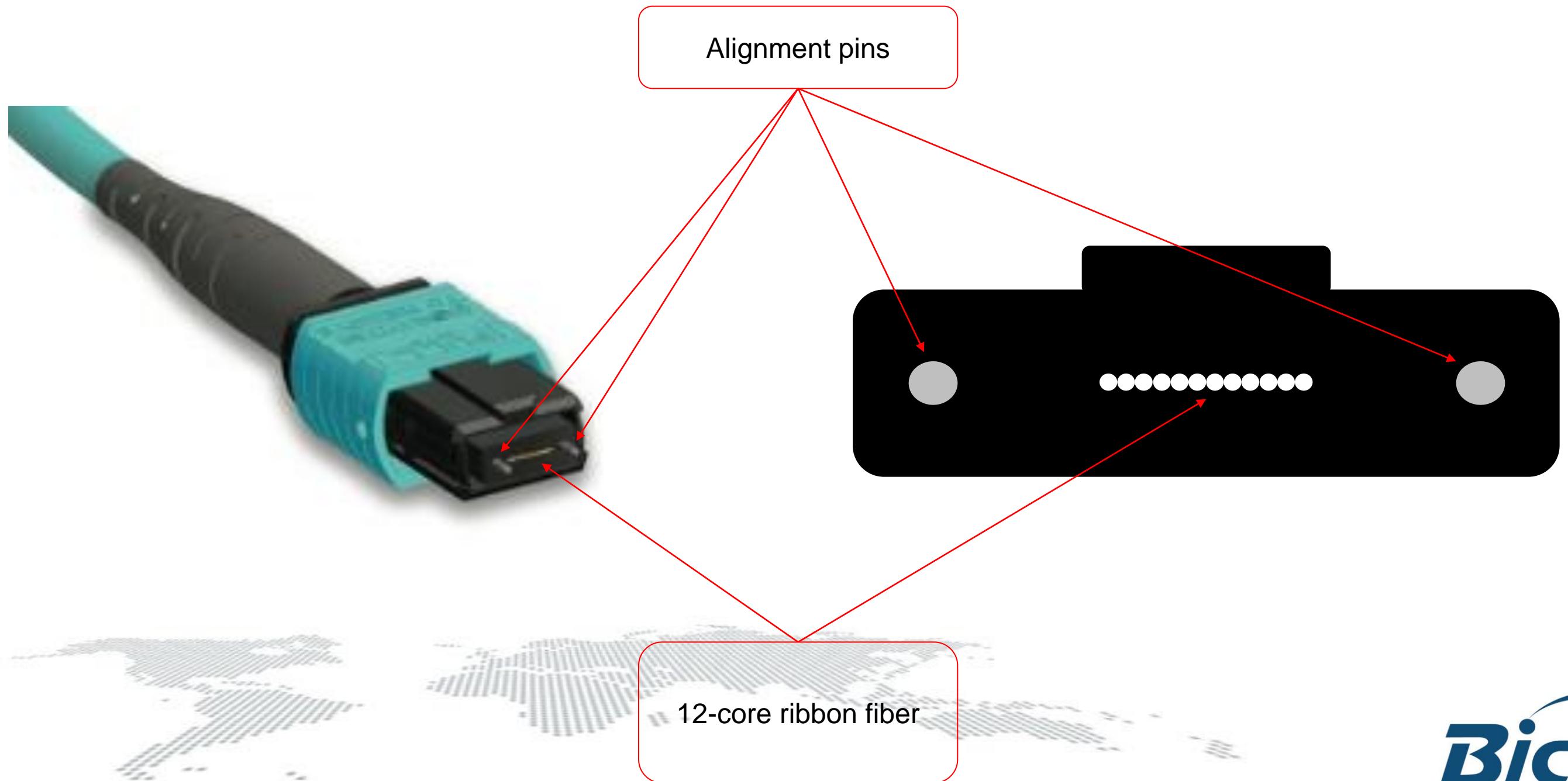
Transmitter and receiver  
together often referred to  
as a transceiver



# Connector choice

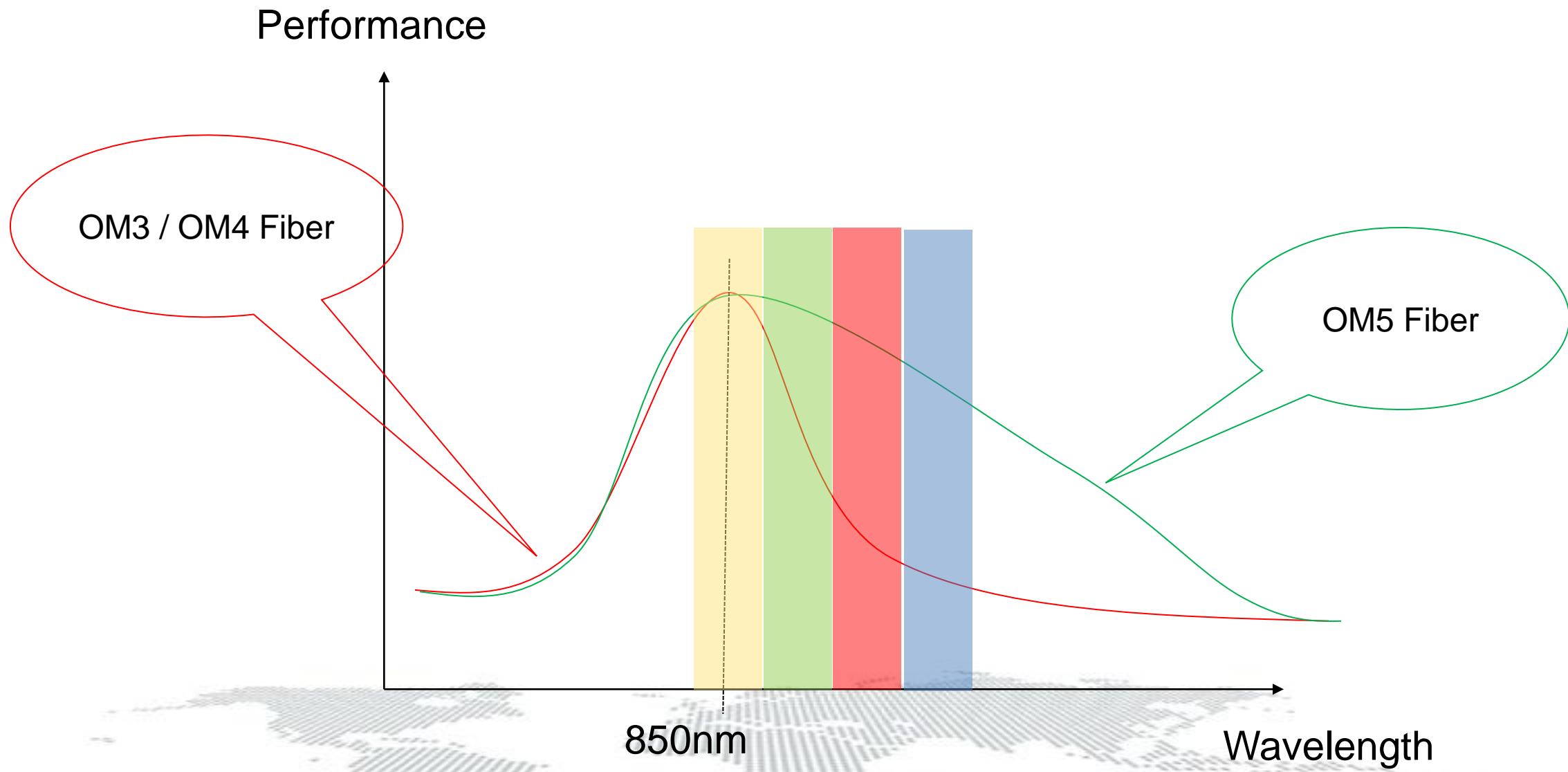


# Alternate: the MPO

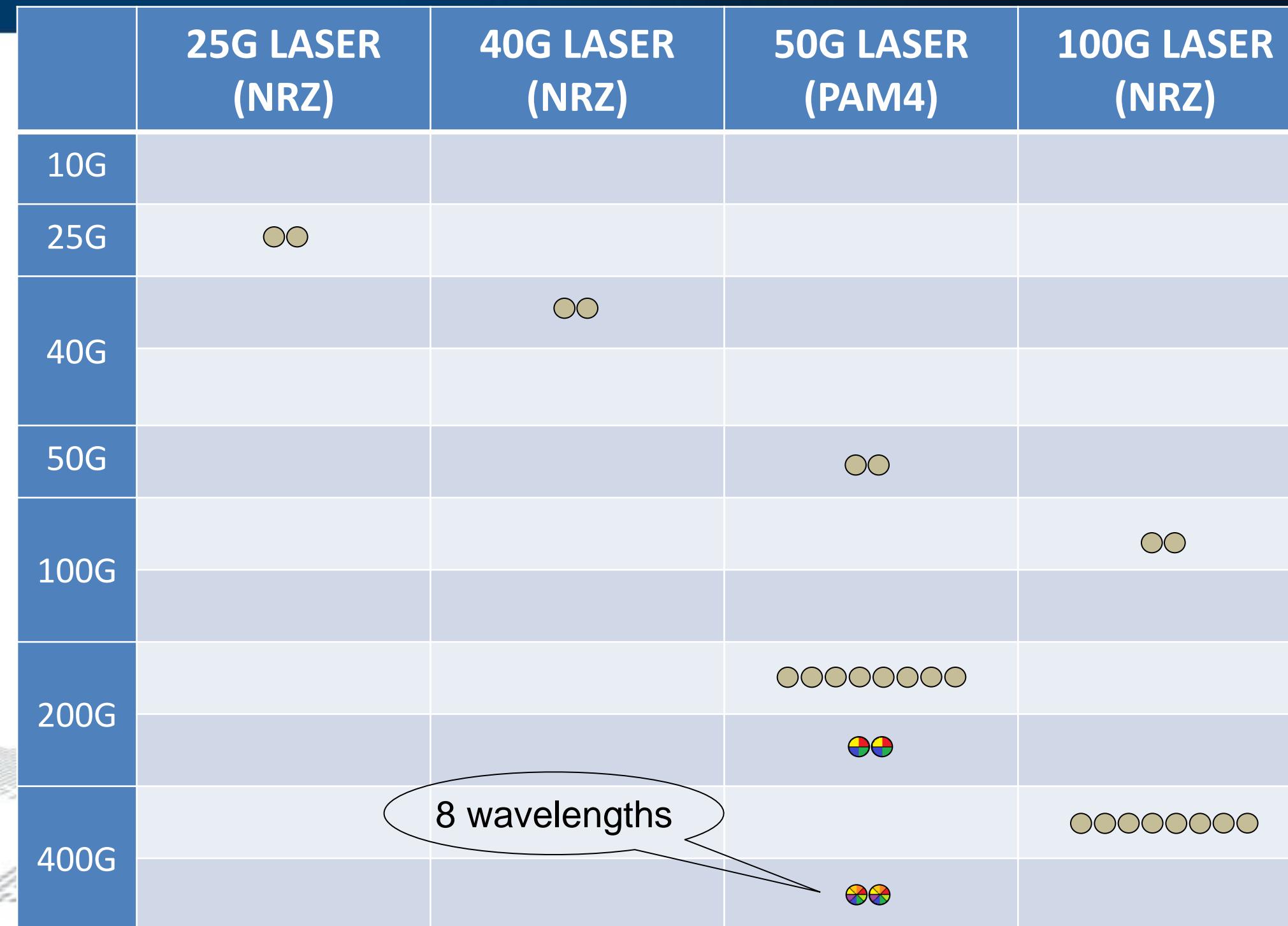


# Increasing the performance on MM Fiber

# OM5 Fiber

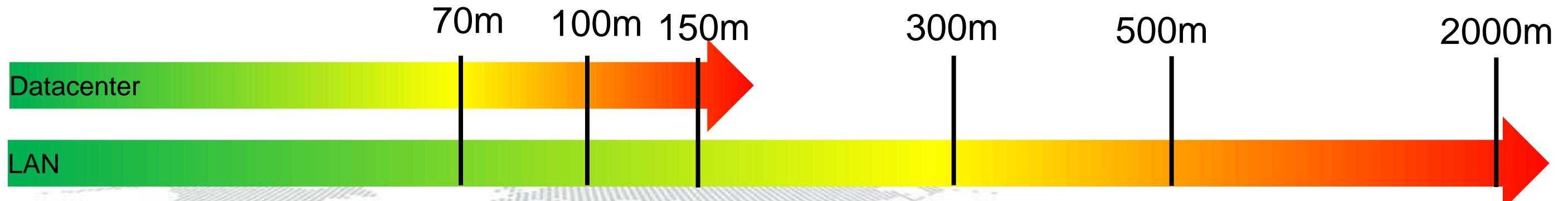


# Singlemode New Developments



# What's next?

- Continued Higher data rates in the datacenter.
- New applications based on signals of 25G, 50G and 100G, not on 40G.
- Parallel optics use 4, 8 16 cores instead of the base 12 originally in the MPO connectors.
- (financial) Distance limit between parallel optics and wavelength multiplexing not clear yet.
- For backbone cabling based on 2-core cabling, OM5 seems to have far more probability of future application than OM3 or OM4.



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# Development of Poe:

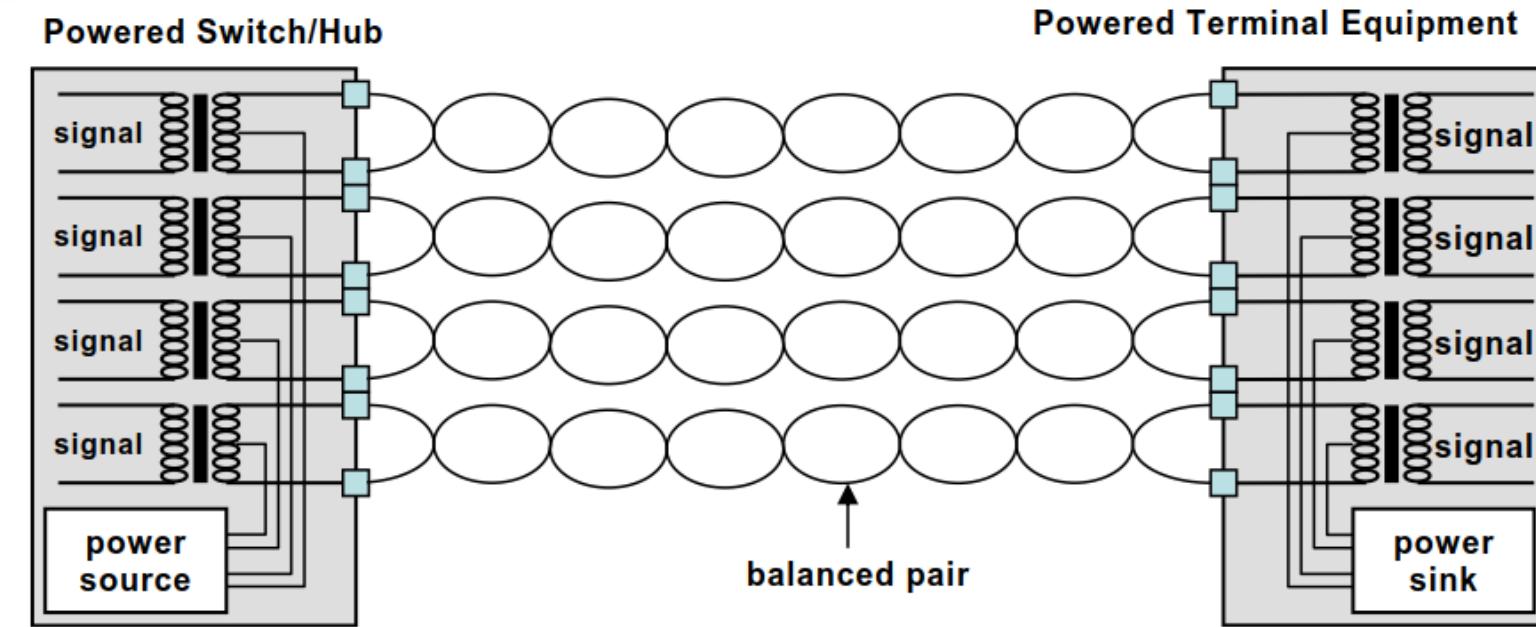


Figure 1 – Examples of end point powering systems using signal pairs (top) and spare pairs (bottom)

Table 6-2 PoE and HDBaseT Power Specifications

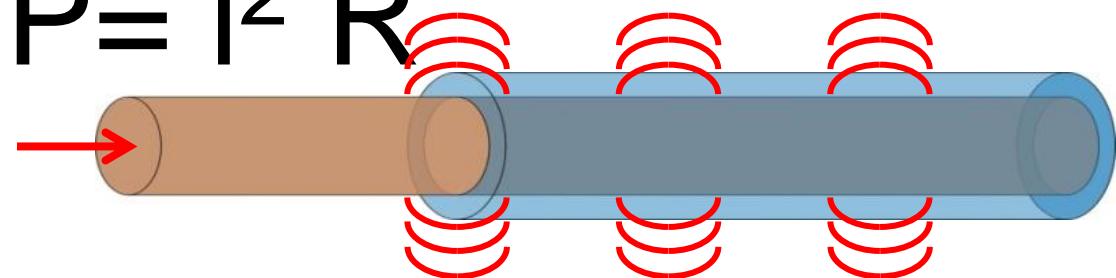
Draft ISO/IEC TS 29125

<i>Transmission Method</i>	<i>Power at Source (W)</i>	<i>Maximum Current per Conductor (A)</i>	<i>Notes</i>
PoE Type 1	15.40	0.175	IEEE 802.3af, uses two pairs to transmit power
PoE + Type 2	30	0.3	IEEE 802.3at, uses two pairs to transmit power
PoE ++ Type 3	60	0.3	IEEE 802.3bt, uses all pairs to transmit power
PoE ++ Type 4	100	0.5	IEEE 802.3bt, uses all pairs to transmit power
HDBaseT	100	0.5	HDBaseT 1.0 and HDBaseT 2.0 have the same power specifications. Also known as POH (power over HDBaseT)

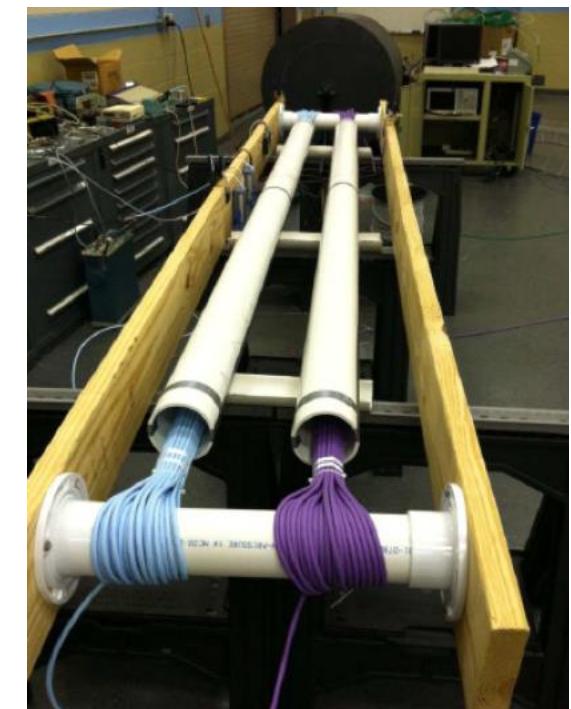
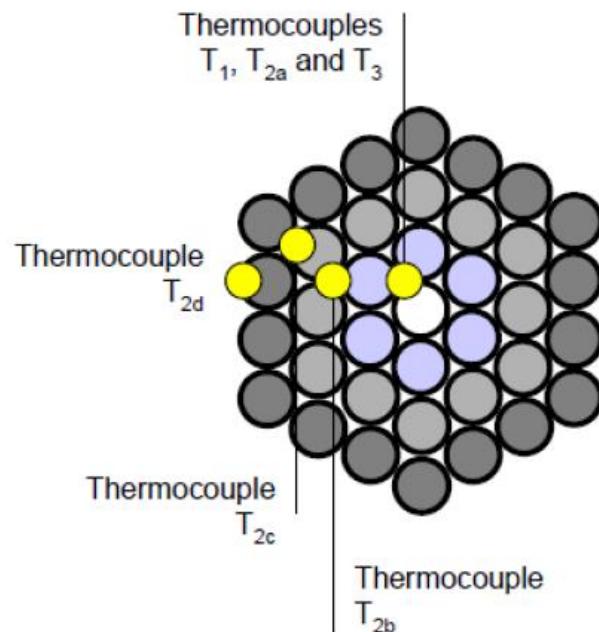
# Risks:

## Heat:

$$P = i^2 R$$



$\Delta T \sim 10^\circ\text{C}$  to  
30°C depending  
on test  
conditions\*



This can lead to:

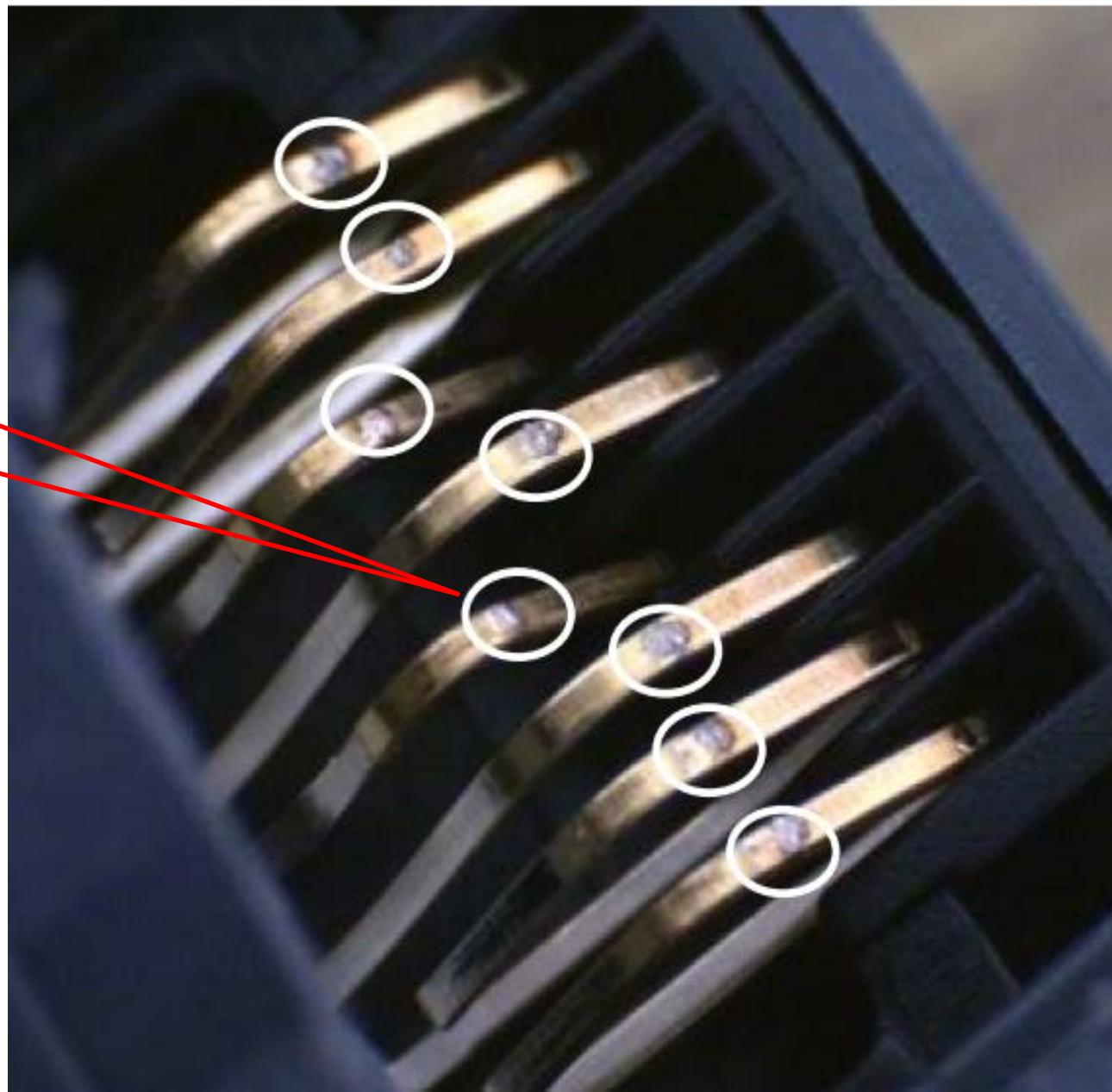
- More strain on the A/C
- Inefficiency
- Reduced application distances
- Reduced cable life

Draft IEC 61156-1-4

# Risks:

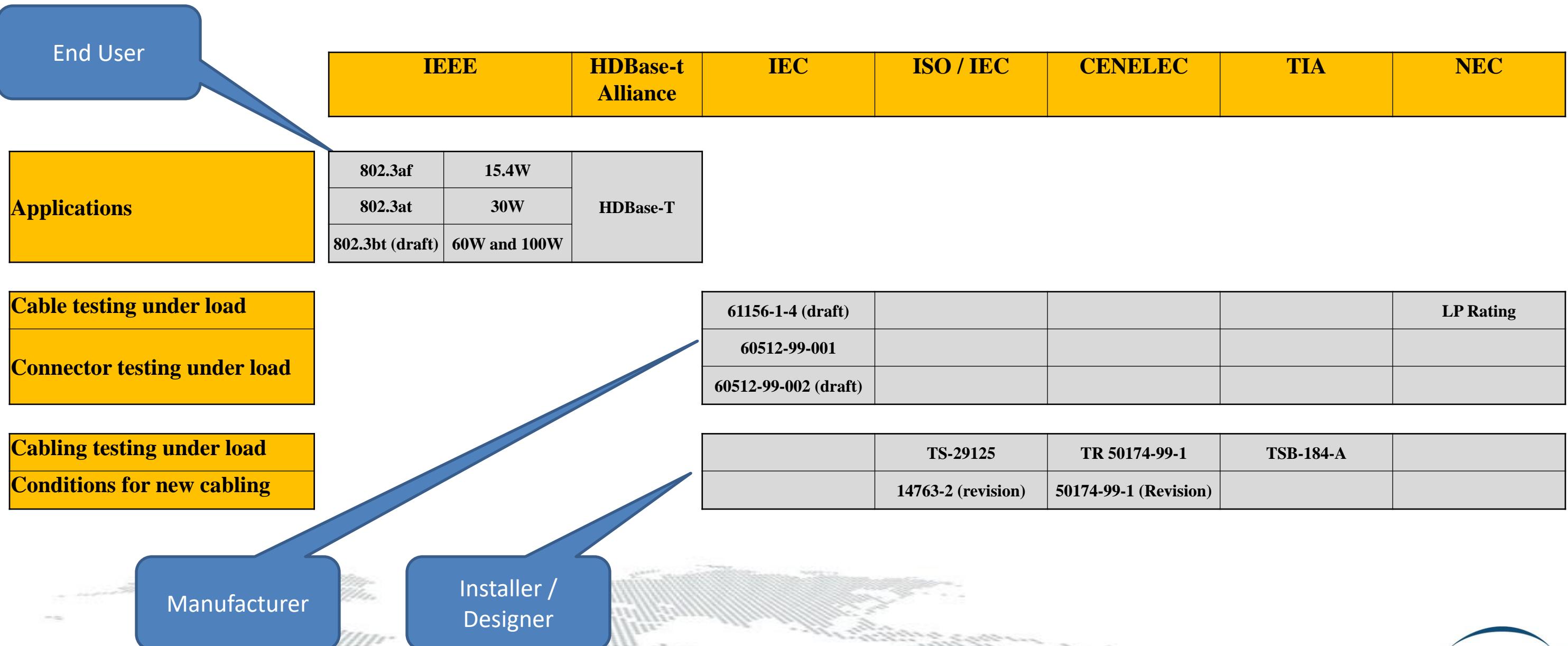
The RJ45 is not designed for this !!!

Contacts  
burned



PoE can  
destroy the  
connector !

# Current Status of PoE Standards



# IoT

- From HIS Markit:

The number of connected IoT devices worldwide will jump 12% on average annually, from nearly 27 billion in 2017 to 125 billion in 2030.

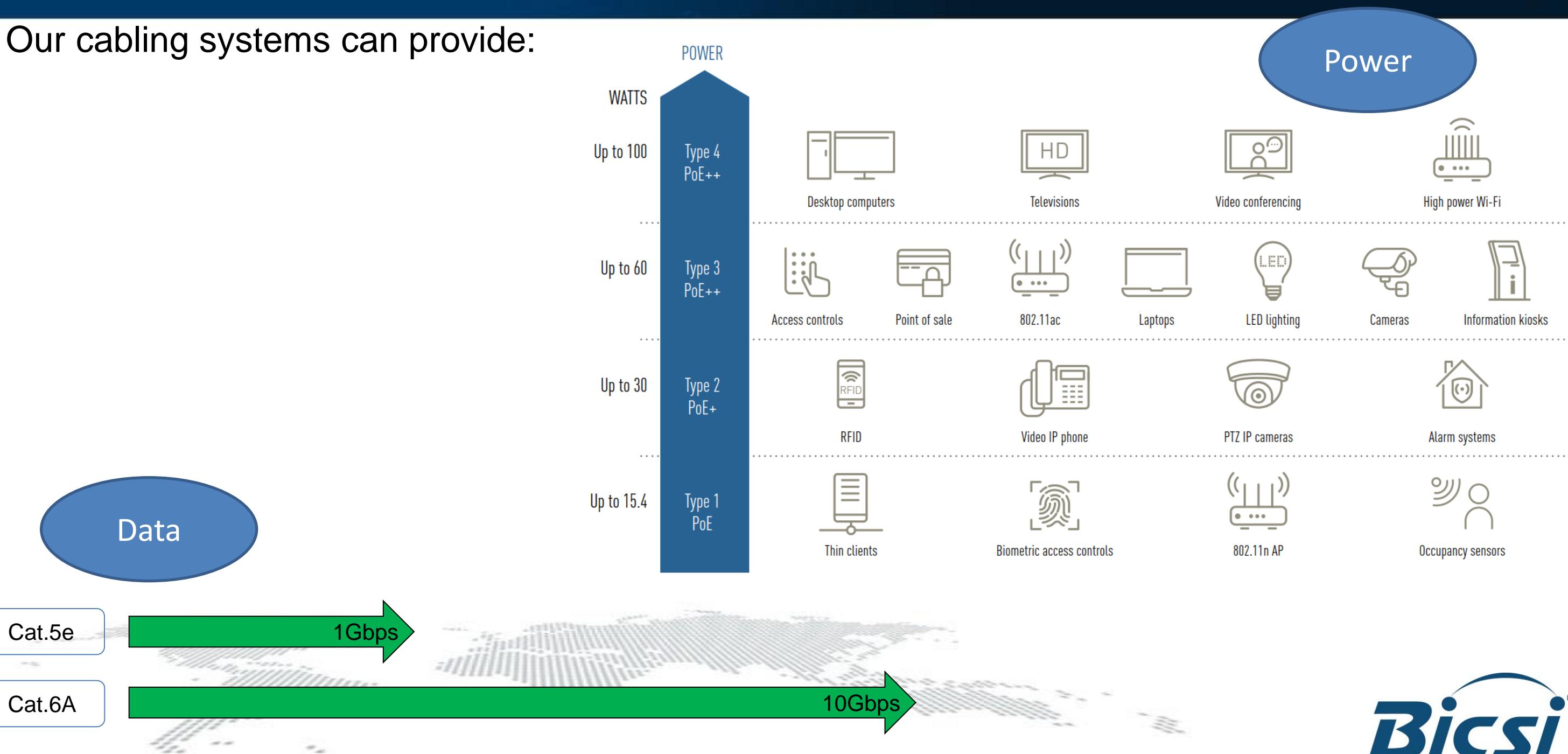
**822.6 million devices in 2017**

19.61% CAGR 2016-2021



# What we offer

- Our cabling systems can provide:



# Needs

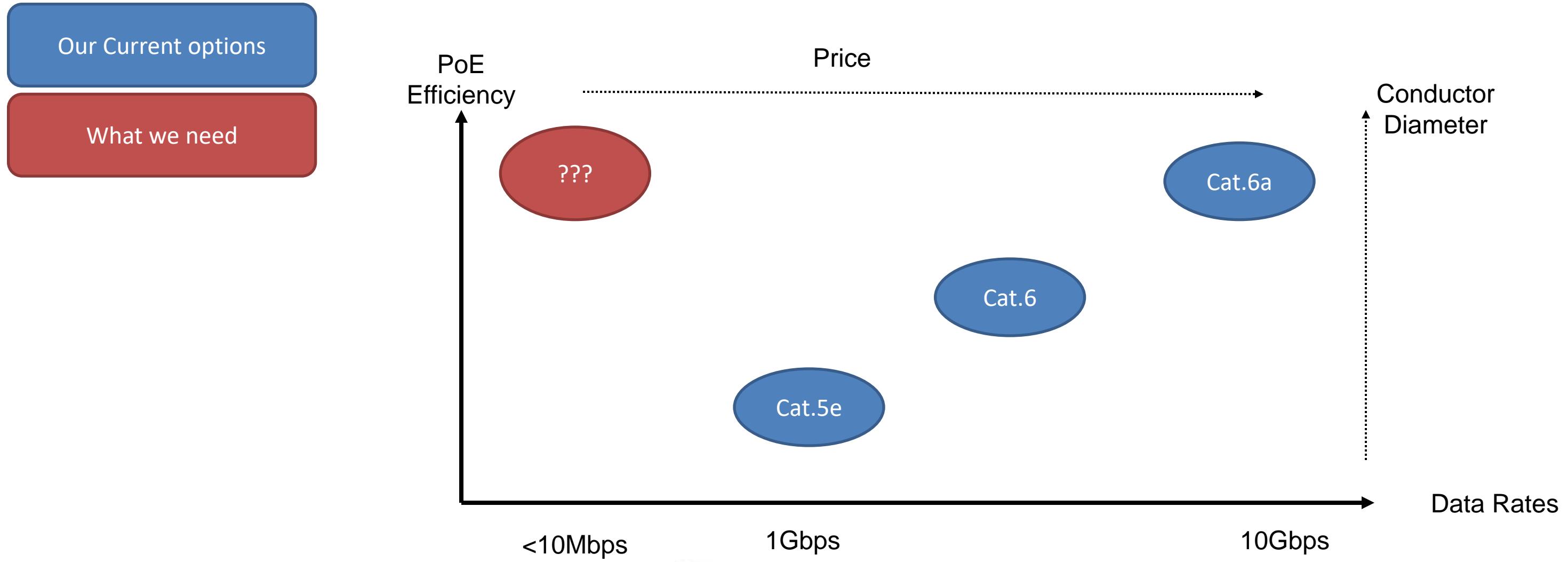
## Major Uses Cases ISO/IEC 11801-6 Distributed Services

Use Case	Application Data Rate (Mb/s)	In-Building Range of Reach (m)	Remote power (watts)	Remote Termination
IoT	< 10	15 - 100	< 5	NCP/device
BAS	< 10	15 - 100	15 - 30	NCP/device
WIFI (ac)	1000 – 10 G	< 15	15 - 50	NCP/AP
Lighting	< 10	15 - 100	10 - 50	NCP/device
Surveillance	100 - 1000	15 - 100	10 - 30	NCP/camera
VoIP phone	< 10	15 - 100	40	phones
Fire/smoke alarm	< 10	15 - 100	5 - 10	Console/speakers
Audio/speakers	< 10	15 - 100	5 - 10	speakers

## Building Controls Protocols

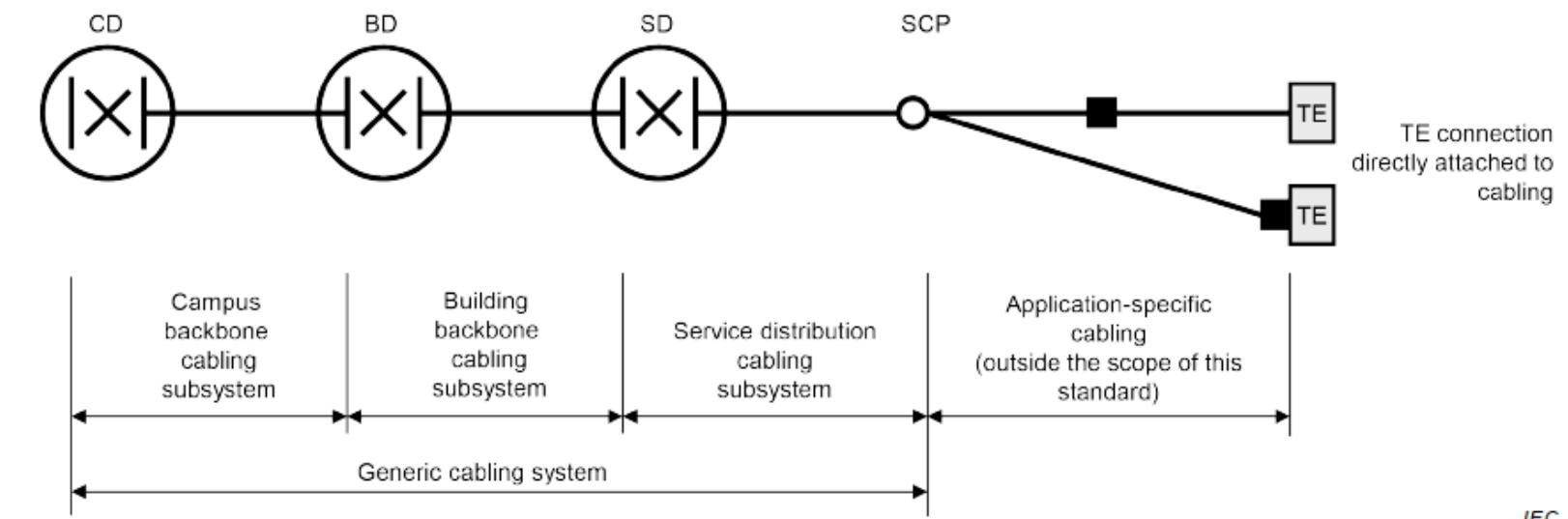
- BACnet: Physical Interface can be RS-485 (MS/TP), RS-232, LONTalk, Ethernet,
- LONTalk: Physical interface is twisted pair or Power Line
- MODBus: Physical Interface is RS-485 or RS-232
- Profibus/Fieldbus/ControlNet: Physical Interface is RS-485 or RS-232
- KNX (formerly EIB & BatiBus & EHS): Physical Interface is twisted pair, RF or Power Line
- DALI: Physical Interface for control signal is RS-485
- OPC (Open Platform Communications): can interface with LONTalk, BACnet or DALI

# A new solution?

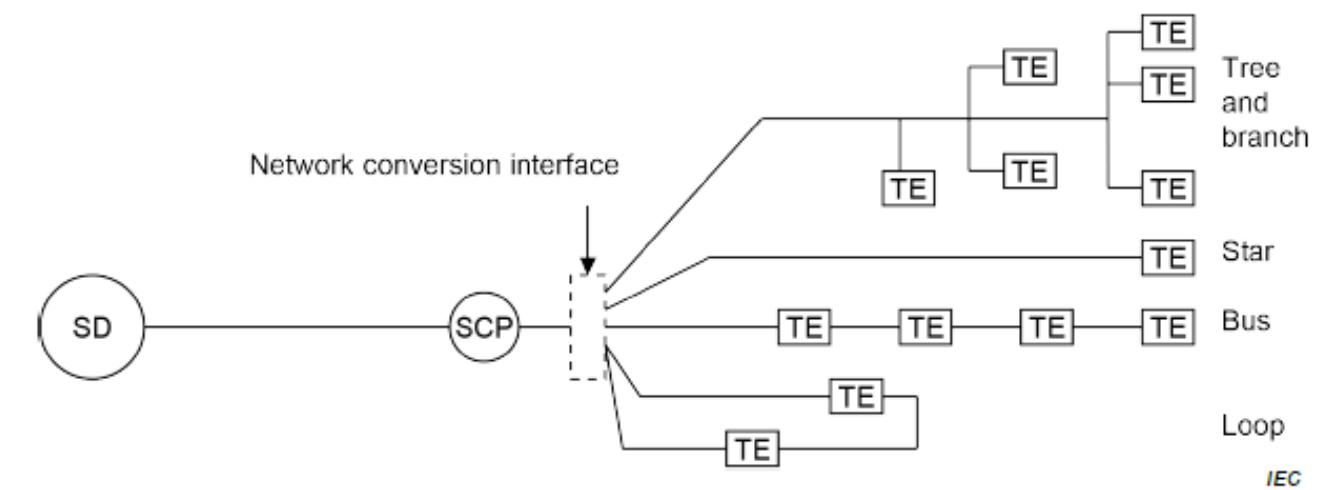


# Single Pair Ethernet

- Objective: to offer a solution for IoT (and industrial) providing, compared to current 4-pair:
  - Lower data
  - Similar power
  - Daisy-chain (Bus) ?
  - Allow longer distances
  - Lower cost
  - Compliance to standards



**Figure 4 – Structure of Type B generic cabling**  
*Extracts from ISO / IEC 11801-6*



# Applications

- IEEE

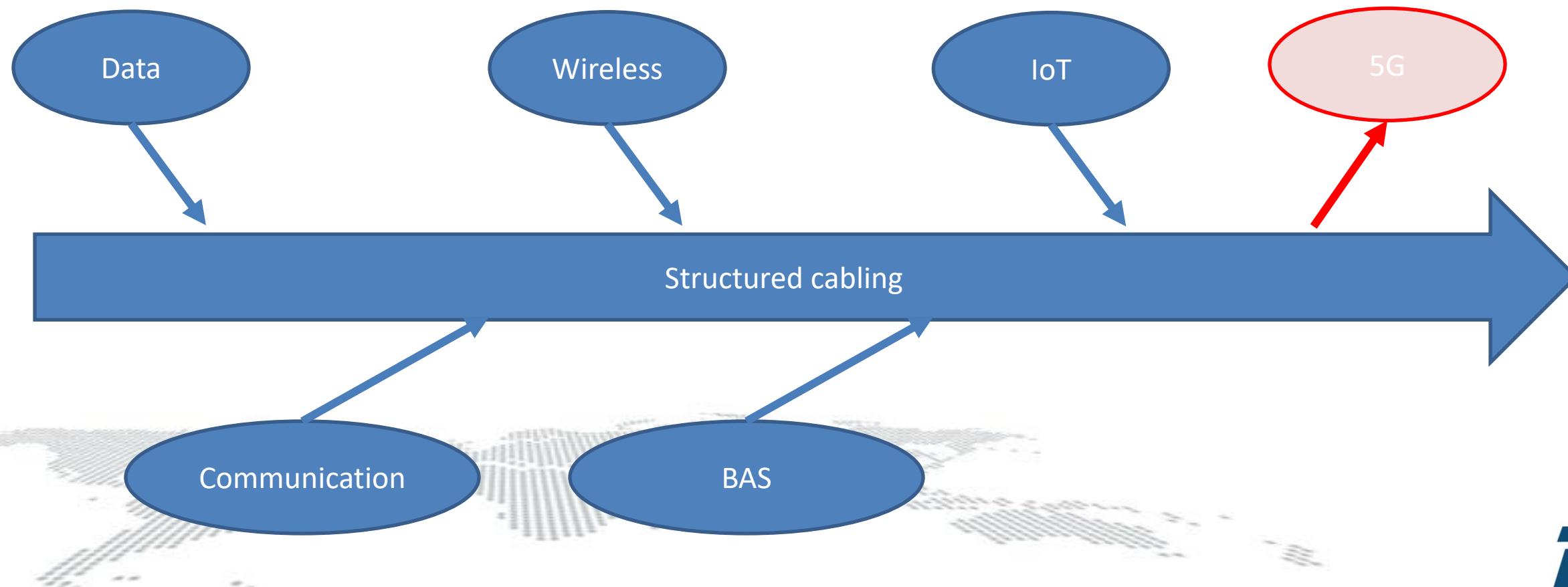
Standard	Content	Target	Distance	Specifics	Status
802.3bw	100mbps	Automotive	30m		Ratified
802.3bp (Type A)	1Gbps	Automotive	30m	4 connectors	Ratified
802.3bp (Type B)	1Gbps	Transport / industrial	40m		Ratified
802.3bu	PoDL	802.3 bw / bp	All	50V, 1.36Amp	Draft
802.3cg (Short and Long)	10mbps + Power	Industrial / Commercial	Up to 1km	Up to 10 connectors	Draft

# Cabling

- ANSI / TIA 568-5 Draft
  - Components for single pair Ethernet
  - Systems (Channel and Permanent Link) for commercial buildings.
- ISO /IEC 11801 – Amendment
  - Systems performance for single pair Ethernet (Application Specific)
  - Future integration into the 11801-1
  - 2 connectors have been chosen: one for commercial (variant 1), one for industrial. (variant 2)
- IEC - Drafts 63171-x
  - Connectors for single pair use (not limited to Ethernet)
  - All 5 variant will be defined
- IEC – Drafts 61156-x
  - Cables and cords defined to 600MHz
  - Cables and cords defined to 125MHz

# What's next

- For years our industry has been targeting the highest performance.
- While this is still true for fiber, copper is taking a turn.
- The new markets for copper involve lower performance, better energy efficiency, and more flexibility in design.
- But it has an enemy on the new markets



# Thank You

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