

Structured Cabling 2.0

Evolution and New Concepts for the New IT
Environment

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Introduction

- The changing needs of digital information have generated a diversity of network technologies and their transmission media, which encompass
 - speeds from 10 Mbps to 400 Gbps
 - remote power from 0.5 W to 100 W
 - distances from 0.5 m to 40 km
- Structured cabling has evolved adapting to these changing needs and has been enriched with new transmission media, new design concepts and increasingly better installation practices

AGENDA



- Network technologies update
- Diversity in transmission media, speeds, distances and remote powering
- Cabling standards evolution
- New concepts in structured cabling systems
 - Duplex and array optical fiber systems
 - Category 8
 - Single-pair cabling

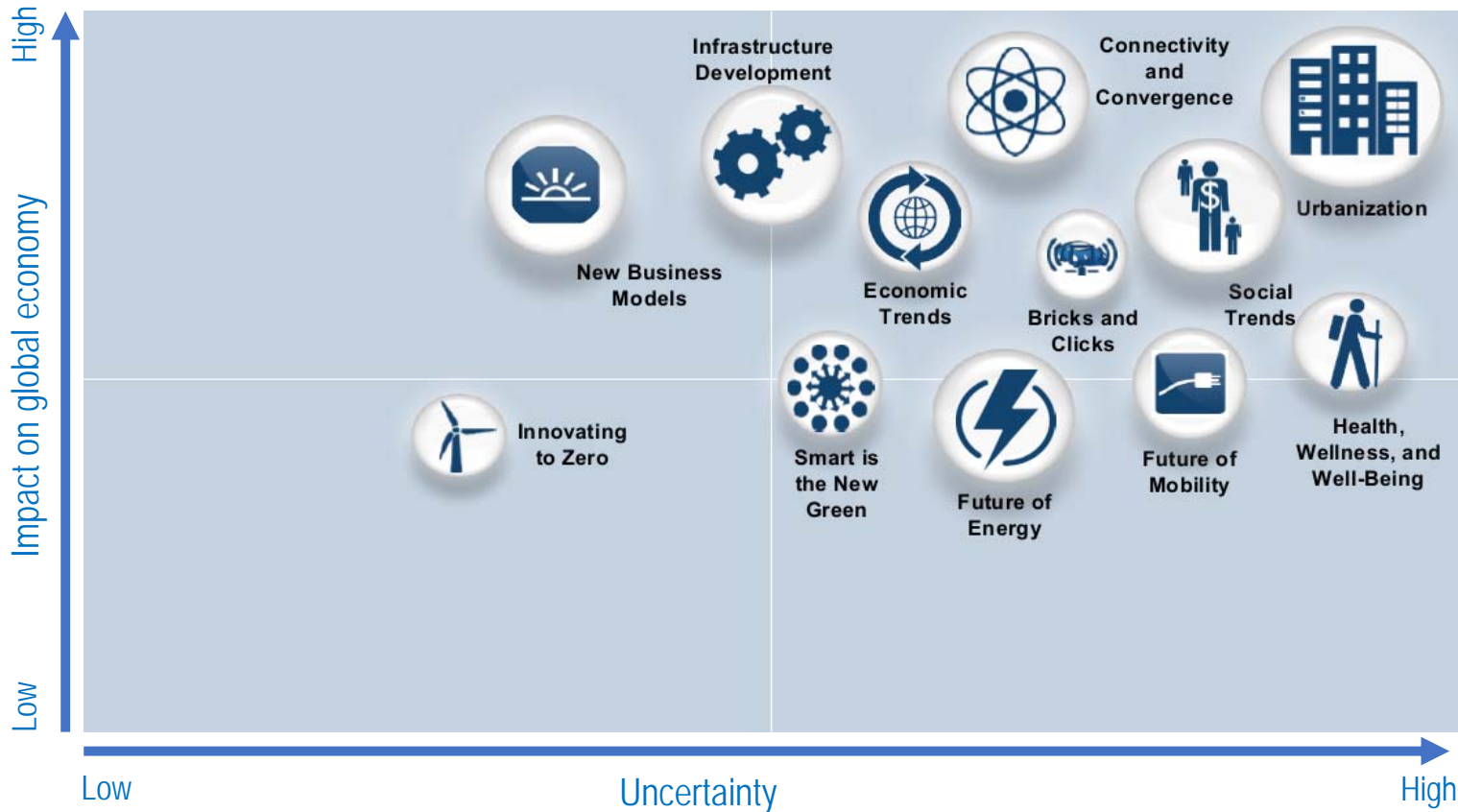
Network Technologies Update

- Exponential growth in volume and transfer of information caused by the increasing demand of IT megatrends
 - Convergence, Cloud Computing, Big Data, IoT, Industry 4.0, AI, 5G...
- Top network platforms
 - Ethernet
 - Fibre Channel
 - FTTX/PON



Source: <https://www.innodel.com/7-top-information-technology-trends-in-year-2019/>

Global Megatrends Matrix 2025 (Frost & Sullivan)

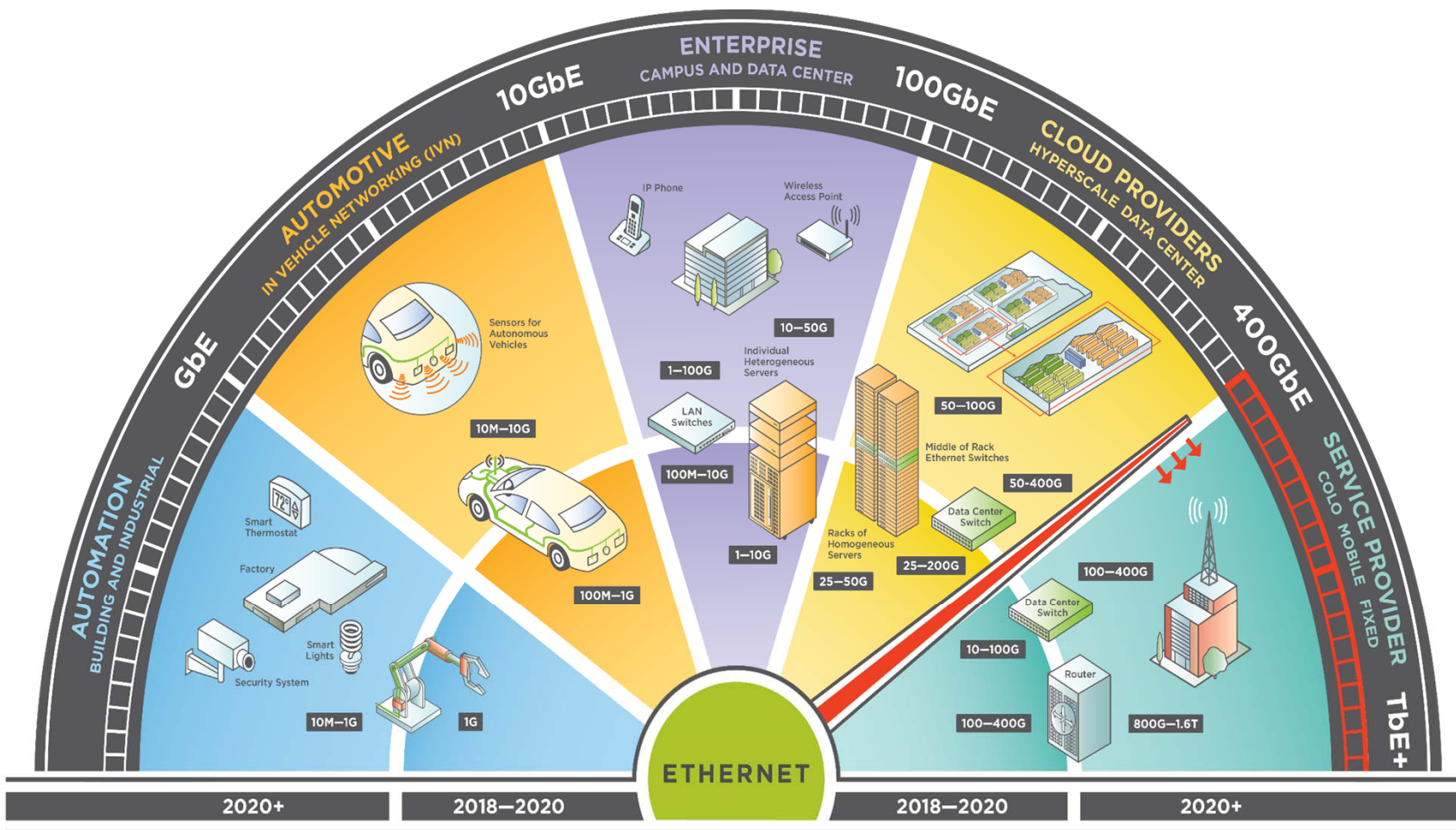


- “Blockchain, quantum computing, augmented analytics and artificial intelligence will drive disruption and new business models” (Gartner)
- IoT: >26 billion devices in 2019, >75 billion in 2025 (Statista)
- Big Data: 1.7 MB per second on 2020, 44 Zettabytes of cumulated volume (new gen apps)

Ethernet Roadmap

- The Ethernet Alliance's new roadmap traces Ethernet's path from 10 Mb/s through present-day speeds of 1 to 400 gigabit Ethernet (GbE), and looks ahead to future speeds achieving up to 1.6 terabits (TbE) and beyond. The forward-looking map also provides guidance into key underlying technologies, current and future interfaces, and the numerous application spaces where Ethernet plays a fundamental role

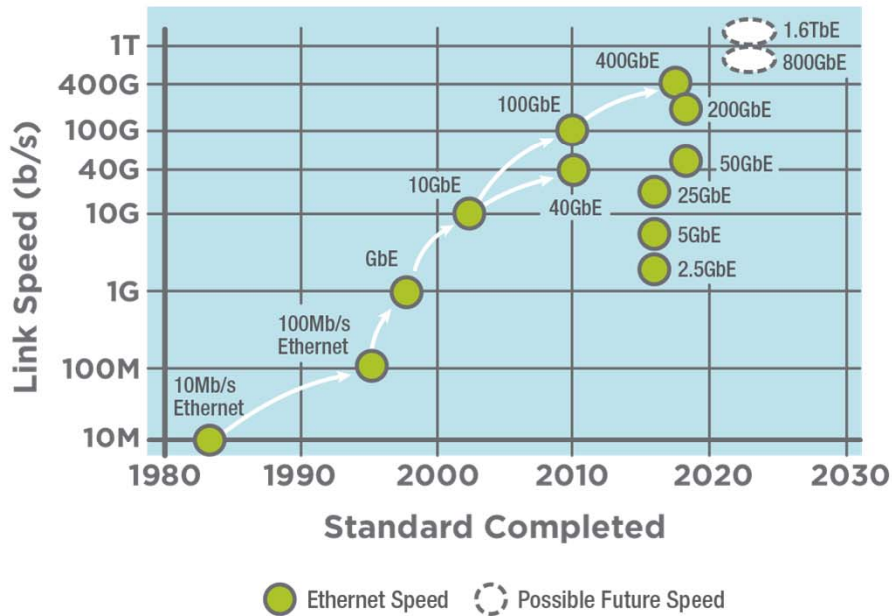
Source: <https://ethernetalliance.org/the-2019-ethernet-roadmap/>



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ETHERNET SPEEDS

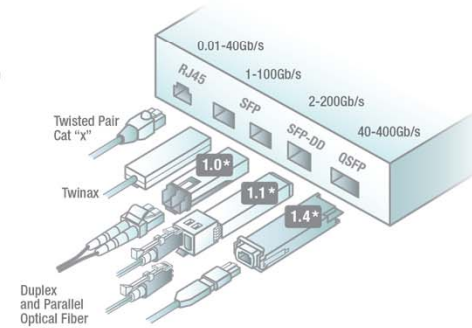


- Single-mode fiber, duplex and parallel optics
- Multimode fiber, duplex and parallel optics
- Balanced twisted-pair
- Coaxial
- Single-pair ethernet (SPE)

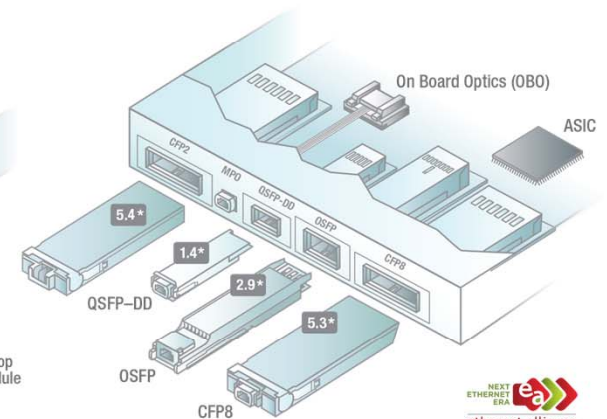
PoE Types and Classes	2-Pair PoE+ – Type 2					4-Pair PoE in Standardization			
	2-Pair PoE – Type 1								
Class	0	1	2	3	4	5	6	7	8
PSE Power (W)	15.4	4	7	15.4	30	45	60	75	90
PD Power (W)	13	3.84	6.49	13	25.5	40	51	62	71.3

4-Pair PoE-Type 3 4-Pair PoE Type 4

1–4 Lane Interfaces



4-16 Lane Interfaces



*Square inches of top surface of the module



Fibre Channel Roadmap

- Fibre Channel has a laser-focus on speed and continues to progress at a blistering pace. Fibre Channel is continually evolving to higher speeds to meet the high bandwidth needs of storage applications. When large blocks of data are moved between servers and storage, the performance of the application is directly dependent on how fast the data can fly. The storage industry has come to rely on Fibre Channel to deliver superior performance and reliability for mission-critical applications
- Source: www.fibrechannel.org/roadmap

Fibre Channel Speeds Maps

FC

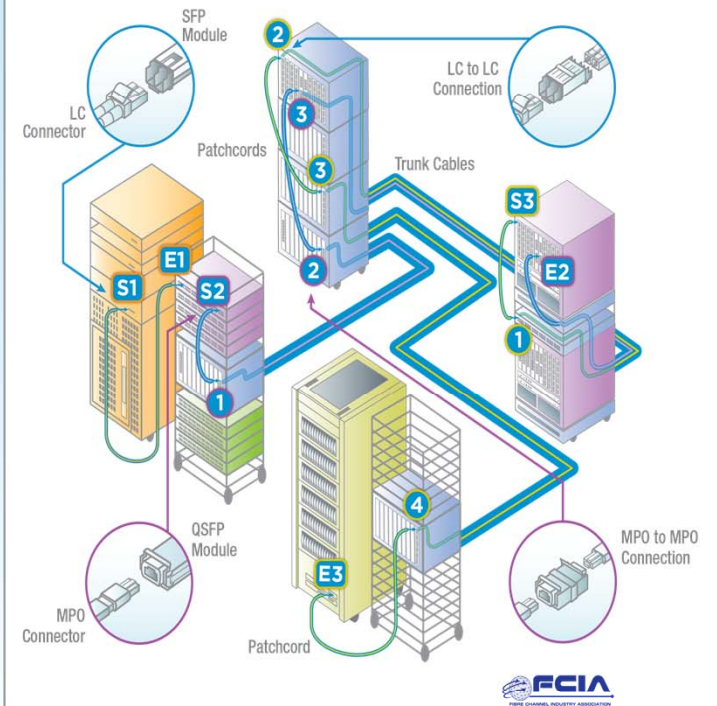
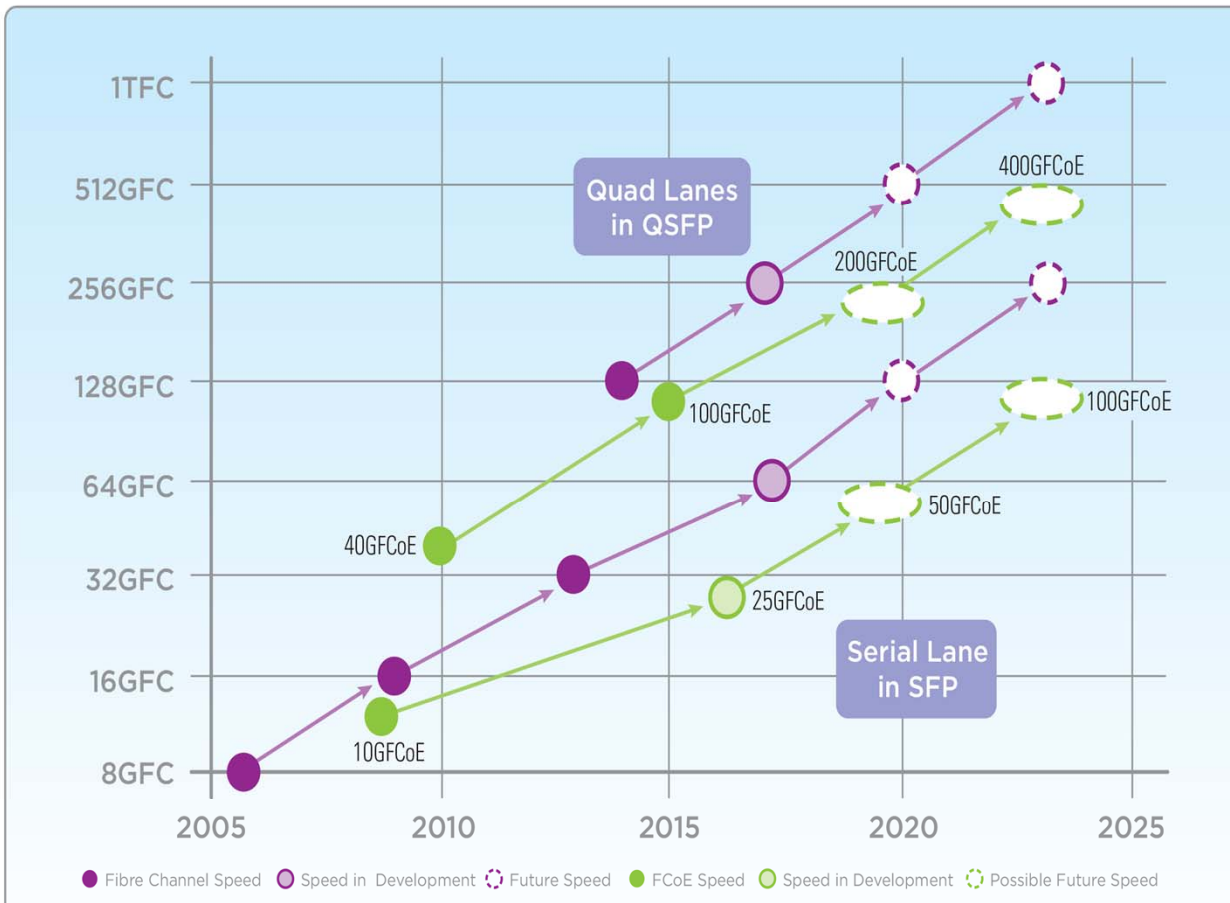
Product Naming	Throughput (Mbytes/s)	Line Rate (Gbaud)	T11 Specification Technically Complete (Year)*	Market Availability (Year)*
1GFC	200	1.0625	1996	1997
2GFC	400	2.125	2000	2001
4GFC	800	4.25	2003	2005
8GFC	1,600	8.5	2006	2008
16GFC	3,200	14.025	2009	2011
32GFC	6,400	28.05	2013	2016
128GFC	25,600	4X28.05	2014	2016
64GFC	12,800	28.9 PAM-4 (57.8Gb/s)	2017	2019
256GFC	51,200	4X28.9 PAM-4 (4X57.8Gb/s)	2017	2019
128GFC	25,600	TBD	2020	Market Demand
256GFC	51,200	TBD	2023	Market Demand
512GFC	102,400	TBD	2026	Market Demand
1TFC	204,800	TBD	2029	Market Demand

ISL (Inter-Switch Links)

Product Naming	Throughput (MBytes/s)	Line Rate (Gbaud)**	Standard Technically Complete (Year)*	Market Availability (Year)*
10GFC	2,400	10.52	2003	2009
20GFC	4,800	21.04	N/A	2008
40GFCoE	9,600	41.25	2010	2013
100GFCoE	24,000	10X10.3125	2010	Market Demand
100GFCoE	24,000	4X25.78125	2015	Market Demand
128GFC	25,600	4X28.05	2014	2016
200GFCoE	48,000	4X26.5625 PAM-4 (4X53.125 Gb/s)	2018	Market Demand
256GFC	51,200	4X28.9 PAM-4 (4X57.8 Gb/s)	2017	2019
400GFCoE	96,000	8X53.125	2017	Market Demand
1TFCoE	240,000	TBD	TBD	Market Demand

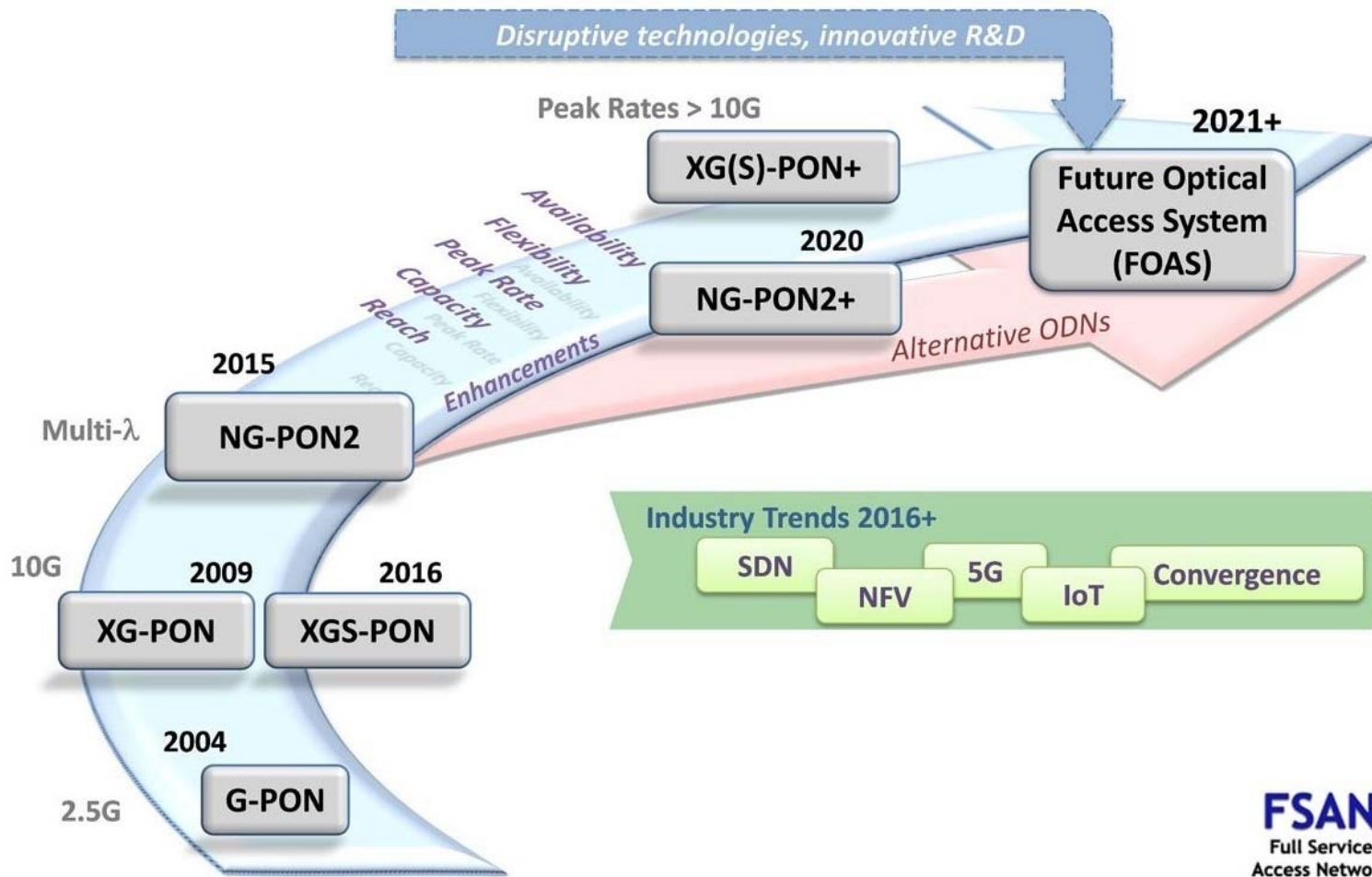
FCoE

Product Naming	Throughput (MBytes/s)	Line Rate (Gbaud)**	IEEE Standard Complete (Year)*	Market Availability (Year)*
10GFCoE	2,400	10.52	2002	2008
25GFCoE	6,000	25.78125	2016	Market Demand
40GFCoE	9,600	41.25	2010	2013
50GFCoE	12,000	26.5625 PAM-4 (53.125 Gb/s)	2018	Market Demand
100GFCoE	24,000	10X10.3125	2010	Market Demand
100GFCoE	24,000	4X25.78125	2015	Market Demand
200GFCoE	48,000	4X26.5625 PAM-4 (4X53.125 Gb/s)	2018	Market Demand
400GFCoE	96,000	8X53.125	2017	Market Demand



PON Roadmap

- With the publication of XGS-PON and NG-PON2 standards by the ITU-T, FSAN has delivered on their previous roadmap. In November 2016 FSAN released a new Standards Roadmap to help guide the wider industry and serve as a stimulus for future standardization and technology development
- Source: <https://www.fsan.org/roadmap/>

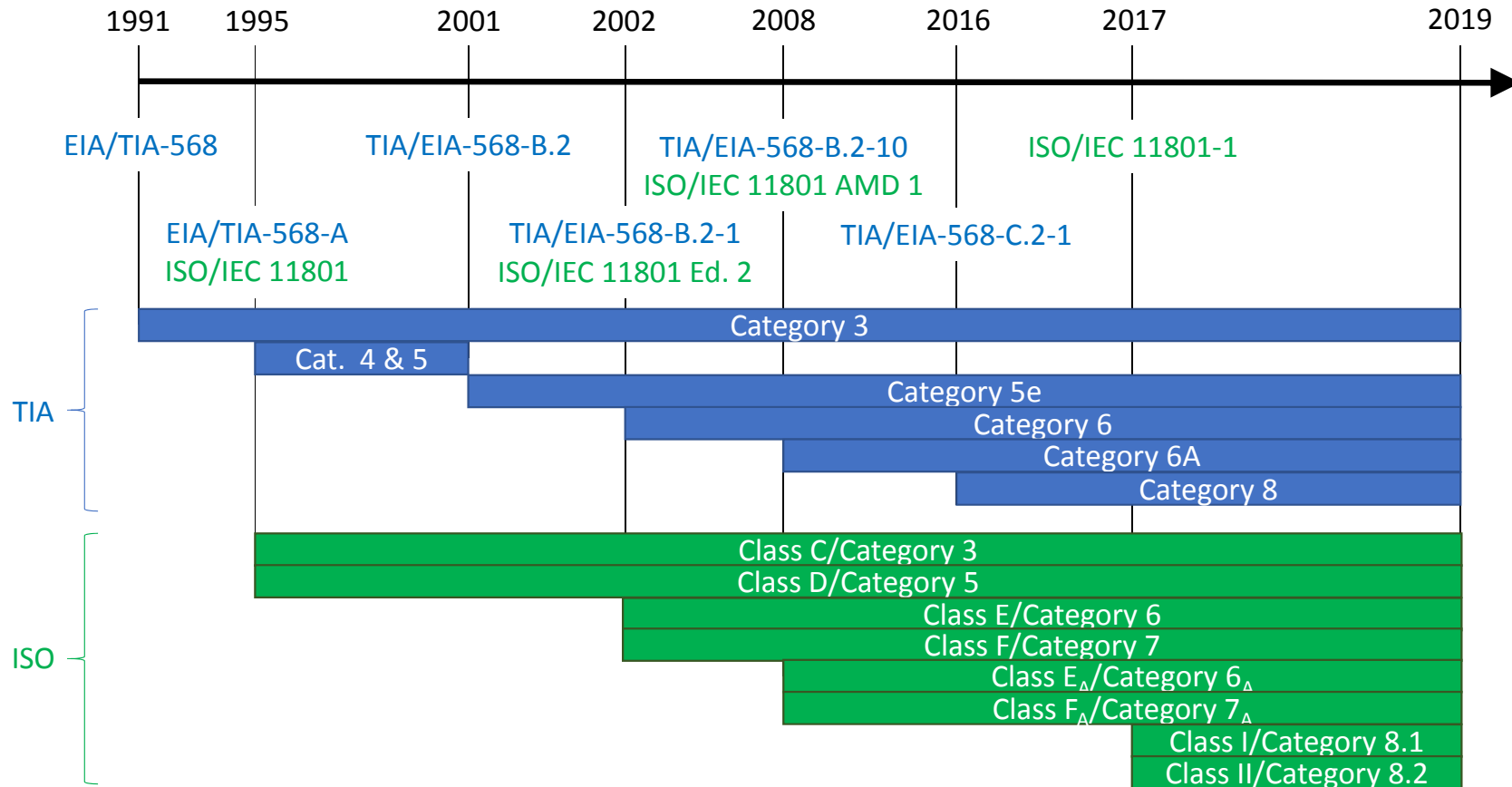


FSAN
Full Service
Access Network

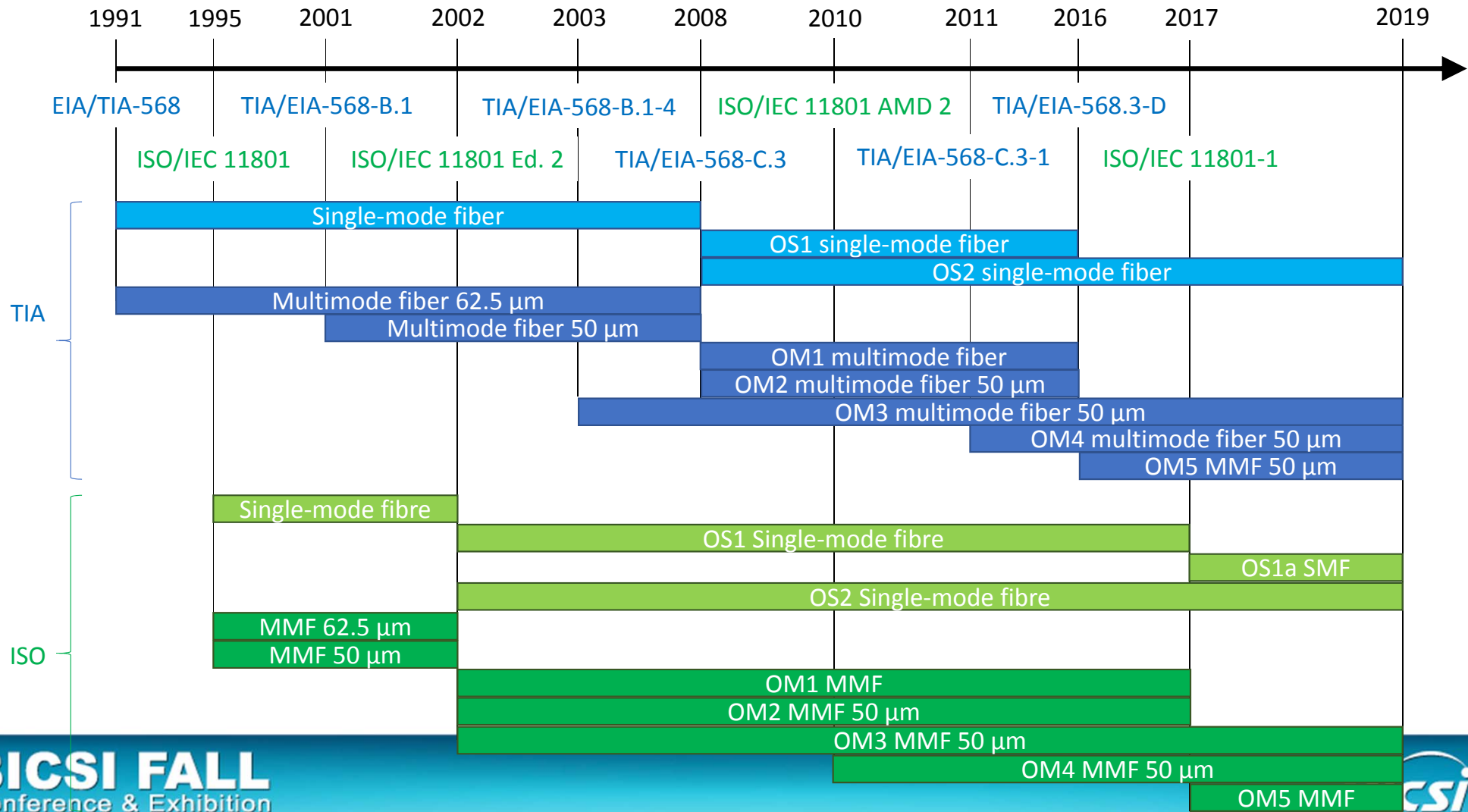
Diversity in Transmission Media, Speeds, Distances and Remote Powering

- Transmission media
 - Single-mode fiber (SMF) and multimode fiber (MMF)
 - Single-lane and multilane
 - Balanced twisted-pair
 - Four pairs and one pair
- Speeds
 - From 10 Mb/s to 400 Gb/s (1.6 Tb/s in study)
- Distances
 - From 0.5 m to 40 km
- Remote powering
 - From 0.5 W to 100 W

Cabling Standards Evolution - Balanced Cabling



Cabling Standards Evolution - Optical Fiber

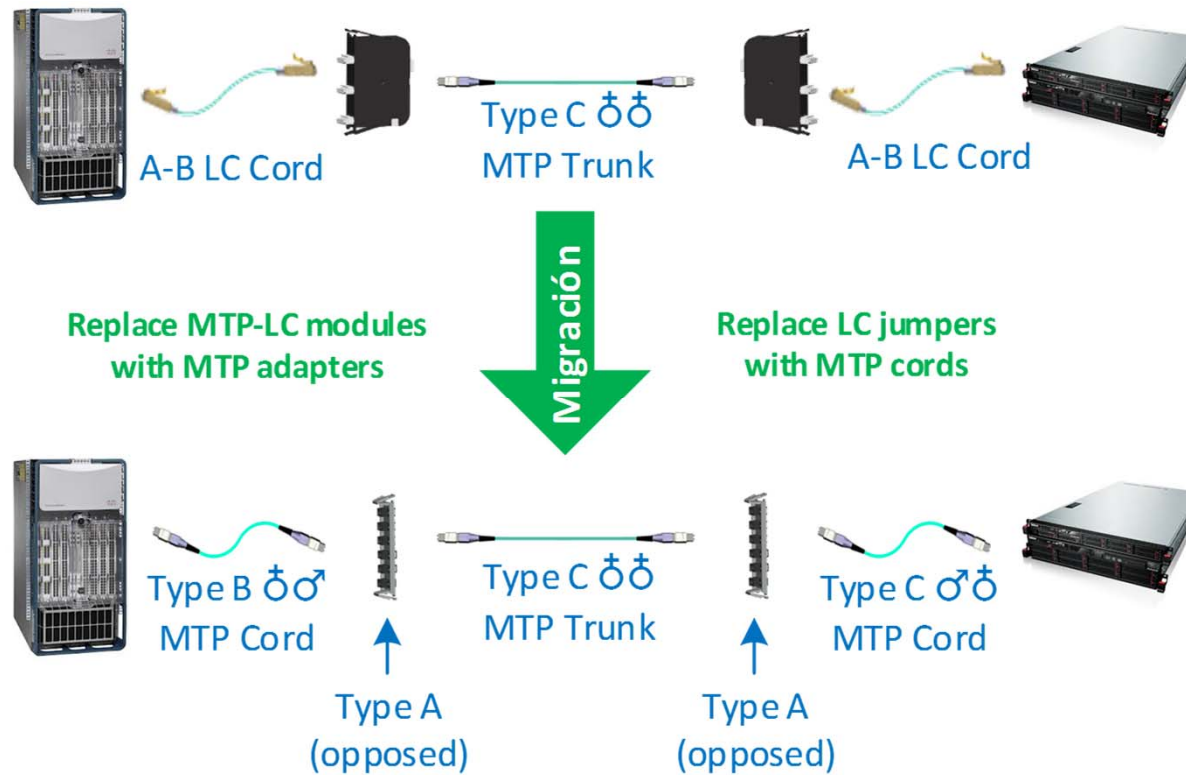


New Concepts in Structured Cabling Systems

- Duplex and array optical fiber systems
- Category 8
- Single-pair Ethernet

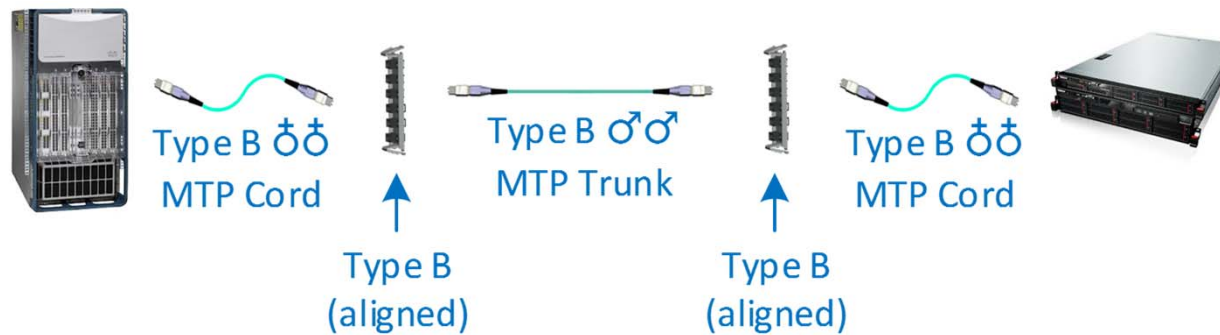
Migration from Duplex to Parallel Optics

Method C recommended (Siemon default)



Parallel Optics from Day One

Method B recommended



Ethernet Duplex Applications Support Over Multimode Fiber

Application	Wavelength	OM1	OM2	OM3	OM4/OM5
1000BASE-SX	850 nm	2.6 dB 275 m	3.6 dB 550 m	(See 1GFC)	(See 1GFC)
1000BASE-LX	1300 nm	2.3 dB 550 m	2.3 dB 550 m	2.3 dB 550 m	2.3 dB 550 m
10GBASE-S	850 nm	2.4 dB 33 m	2.3 dB 82 m	2.6 dB 300 m	2.9 dB 400 m
10GBASE-LX4	1300 nm	2.5 dB 300 m	2.0 dB 300 m	2.0 dB 300 m	2.0 dB 300 m
10GBASE-LRM	1300 nm	1.9 dB 220 m	1,9 dB 220 m	1.9 dB 220 m	1.9 dB 220 m
25GBASE-SR	850 nm	-	-	1.8 dB 70 m	1.9 dB 100 m
50GBASE-SR	850 nm	-	-	1.8 dB 70 m	1.9 dB 100 m

Fibre Channel Duplex Applications Support Over MMF

850 nm application		OM1	OM2	OM3	OM4/OM5
1G Fibre Channel	100-MX-SN-I	3.0 dB 300 m	3.9 dB 500 m	4.6 dB 860 m	4.6 dB 860 m
2G Fibre Channel	200-MX-SN-I	2.1 dB 150 m	2.6 dB 300 m	3.3 dB 500 m	3.3 dB 500 m
4G Fibre Channel	400-MX-SN	1.8 dB 70 m	2.1 dB 150 m	2.9 dB 380 m	3.0 dB 400 m
8G Fibre Channel	800-MX-SN	1.6 dB 21 m	1.7 dB 50 m	2.0 dB 150 m	2.2 dB 190 m
8G Fibre Channel	800-MX-SA	1.6 dB 40 m	1.9 dB 100 m	2.6 dB 300 m	2.2 dB 300 m
10G Fibre Channel	1200-MX-SN-I	2.4 dB 33 m	2.2 82 m	2.6 dB 300 m	2.9 dB 400 m
16G Fibre Channel	1600-MX-SN	-	1.6 dB 35 m	1.9 dB 100 m	2.0 dB 125 m
32G Fibre Channel	3200-MX-SN-I 3200-MX-SN-S	-	2.0 dB 20 m	1.9 dB 70 m	1.9 dB 100 m
64G Fibre Channel	64GFC-SW	-	-	1.8 dB 70 m	1.9 dB 100 m

Ethernet Duplex Applications Support Over SMF

Applications	Wavelength	Attenuation	Distance
1000BASE-LX	1310 nm	4.5 dB	5,000 m
10GBASE-LX4	1310 nm	6.3 dB	10,000 m
10GBASE-L	1310 nm	6.2 dB	10,000 m
10GBASE-E	1550 nm	11.0 dB	40,000 m
25GBASE-LR	1310 nm	6.3 dB	10,000 m
25GBASE-ER	1310 nm	18.0 dB	40,000 m
50GBASE-FR	1310 nm	4.0 dB	2,000 m
50GBASE-LR	1310 nm	6.3 dB	10,000 m
50GBASE-ER (Draft IEEE 802.3cn)	1310 nm	18.0 dB	40,000 m
40GBASE-LR4	1310 nm	6.7 dB	10,000 m
40GBASE-FR	1310 nm	4.0 dB	2,000 m
100GBASE-LR4	1310 nm	6.3 dB	10,000 m
200GBASE-FR4	1310 nm	4.0 dB	2,000 m
200GBASE-LR4	1310 nm	6.3 dB	10,000 m
200GBASE-ER4 (Draft IEEE 802.3cn)	1310 nm	18.0 dB	40,000 m
400GBASE-FR8	1310 nm	4.0 dB	2,000 m
400GBASE-LR8	1310 nm	6.3 dB	10,000 m
4000GBASE-ER8 (Draft IEEE 802.3cn)	1310 nm	18.0 dB	40,000 m

Fibre Channel Duplex Applications Support Over Single-mode Fiber

Applications	Wavelength	Attenuation	Distance
8GFC 800-SM-LC-I	1310 nm	2.6 dB	1,400 m
8GFC 800-SM-LC-L	1310 nm	6.4 dB	10,000 m
10GFC 1200-SM-LL-L	1310 nm	6.0 dB	10,000 m
16GFC 1600-SM-LC-L	1310 nm	6.4 dB	10,000 m
32GFC 3200-SM-LC-L	1310 nm	6.3 dB	10,000 m
64GFC 64GFC-LW	1310 nm	6.3 dB	10,000 m
128GFC-CWDM4	1310 nm	3.8 dB	5,000 m

Parallel Applications Over Multimode Fiber

Application		Fiber strands	OM3	OM4	OM5
Ethernet 40G	40GBASE-SR4	8	1.9 dB 100 m	1.5 dB 150 m	1.5 dB 150 m
Ethernet 100G	100GBASE-SR10	20	1.9 dB 100 m	1.5 dB 150 m	1.5 dB 150 m
	100GBASE-SR4	8	1.8 dB 70 m	1.9 dB 100 m	1.9 dB 100 m
	100GBASE-SR2	4	1.9 dB 100 m	1.5 dB 150 m	1.5 dB 150 m
Ethernet 200G	200GBASE-SR4	8	1.8 dB 70 m	1.9 dB 100 m	1.9 dB 100 m
Ethernet 400G	400GBASE-SR16	32	1.8 dB 70 m	1.9 dB 100 m	1.9 dB 100 m
	400GBASE-SR8 (Draft IEEE 802.3cm)	16	1.8 dB 70 m	1.9 dB 100 m	1.9 dB 100 m
	400GBASE-SR4.2 (Draft IEEE 802.3cm)	8	1.8 dB 70 m	1.9 dB 100 m	2.0 dB 150 m
Fibre Channel 128G	128GFC-SW4	8	1.4 dB 70 m	1.5 dB 100 m	1.5 dB 100 m

Parallel Applications Over Single-mode Fiber

Applications	Fiber strands	Attenuation	Distance
Ethernet 200G. 200GBASE-DR4	8	3.0 dB	500 m
Ethernet 400G. 400GBASE-DR4	8	3.0 dB	500 m
Fibre Channel 128G. 128GFC-PSM4	8	11.0 dB	40,000 m

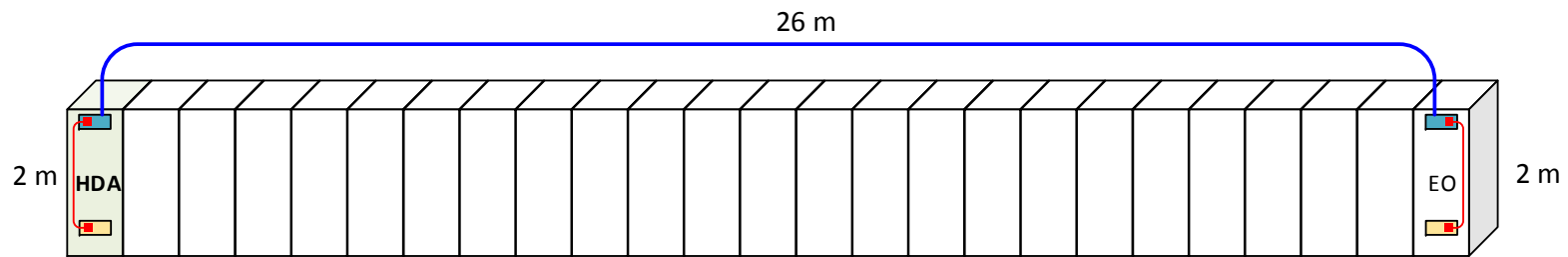
Category 8 Objectives

- Reduce the power consumption of next-generation BASE-T equipment
 - Reason for changes in channel length and shielding requirements
- Supports implementations for EoR, MoR and ToR on data centers
 - 30 meter channel with 2 connectors
- Auto-negotiation for compatibility with previous versions
 - The same balanced twisted pair wiring of 4-pairs from previous categories
- High speed applications especially in data centers
 - Cloud, Colo, Service Providers, Hyperscale, Internet Giants

Standards Specifying Category 8

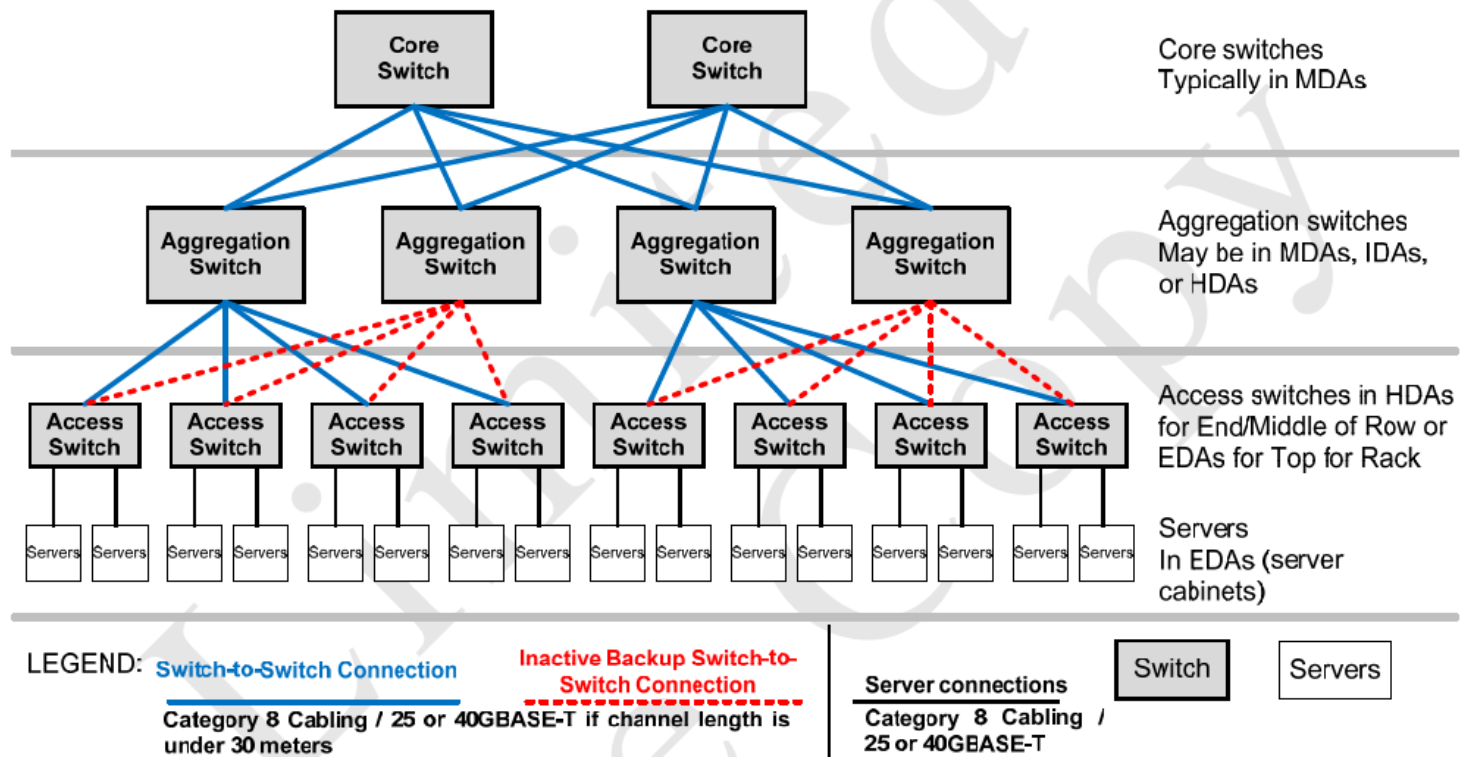
- **ISO/IEC 11801-1**
 - Class I cabling, Category 8.1 components
 - Class II cabling, Category 8.2 components
- **ANSI/TIA-568.2-D**
 - Category 8 cabling and components
- Requirements for:
 - Cabling (channel and permanent links)
 - Components (cables, connectors, connecting hardware, cords)
 - Test procedures for verification of installed cabling performance
 - TIA Category 8 similar to Class I/Category 8.1 of ISO/IEC
 - Shielded components only
 - Specifications up to 2000 MHz
 - Supports 25GBASE-T and 40GBASE-T in a 30 m channel with two connectors
 - Supports up to 10GBASE-T on a 100 m channel with four connectors

Data Center End of Row (EoR) Architecture

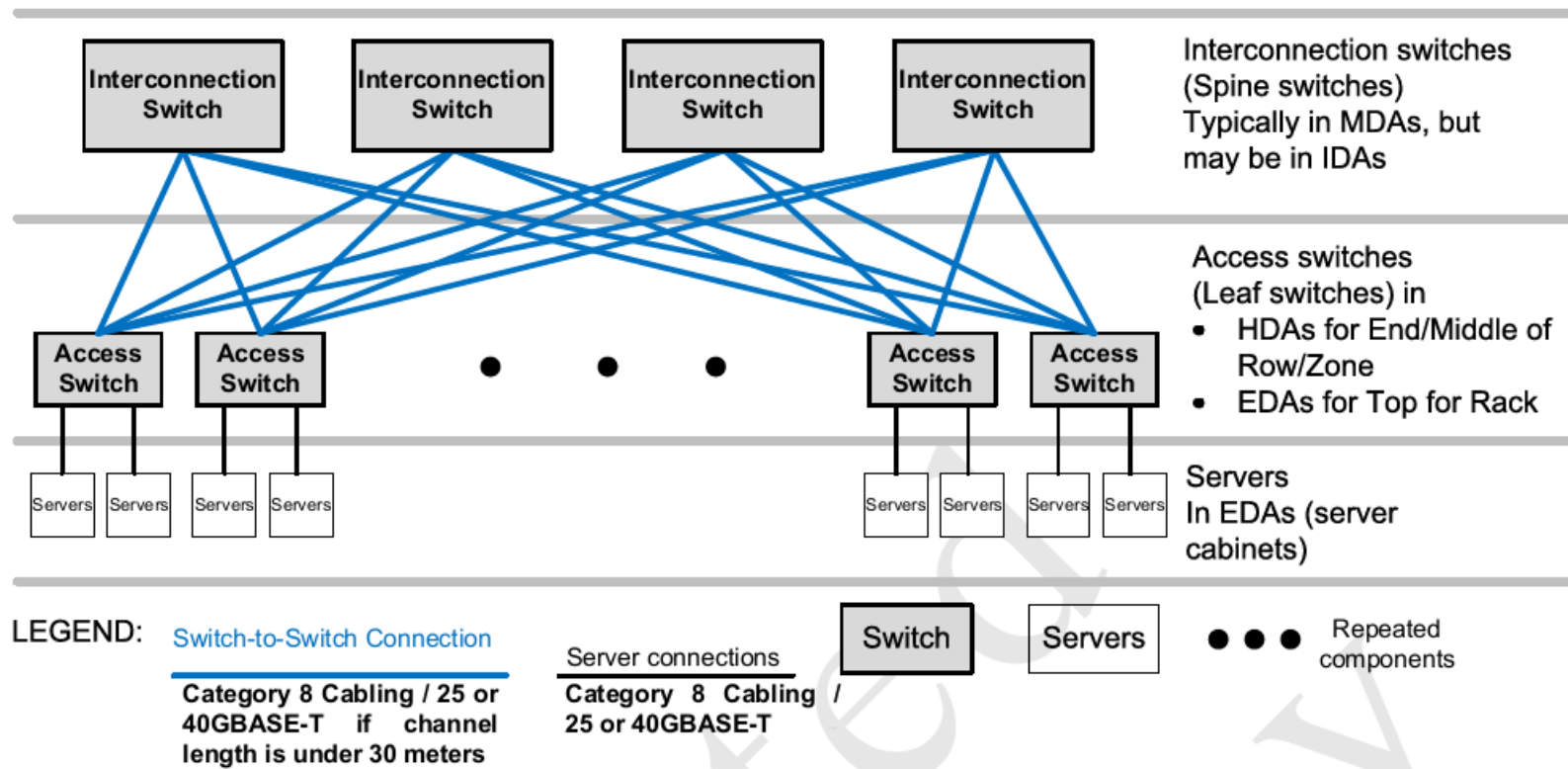


- Maximum Channel of 30 m:
 - TIA Category 8 and ISO Classes I y II
 - 25GBASE-T and 40GBASE-T
 - 10GBASE-T Short Reach Mode (SRM)

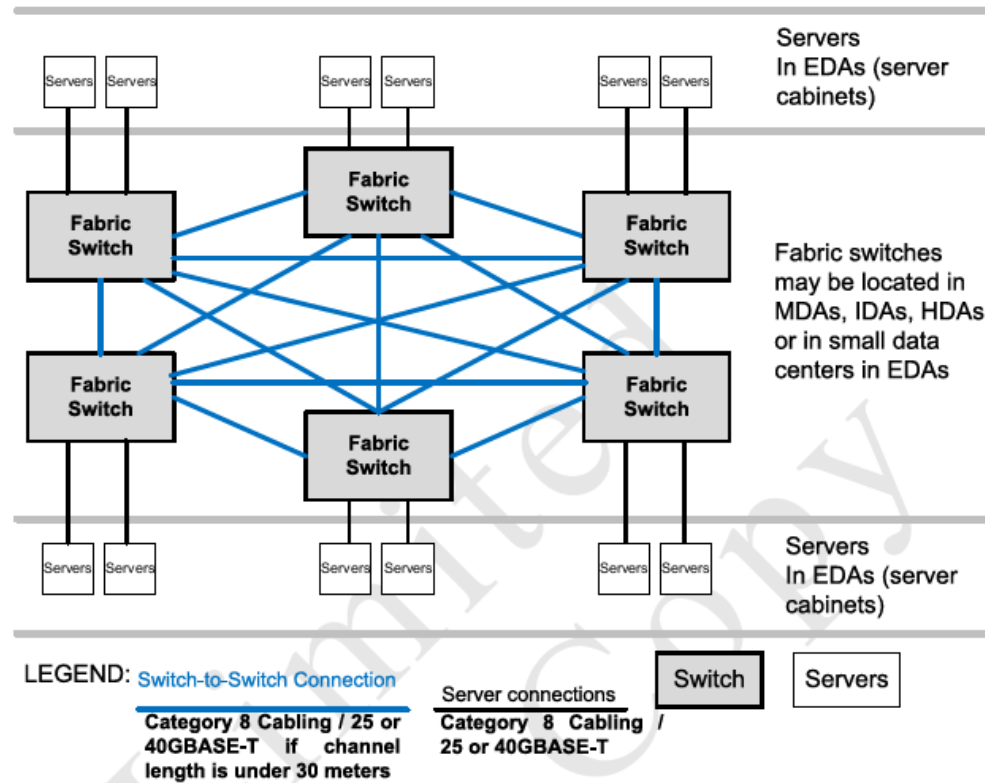
Traditional 3 Layer



Spine & Leaf

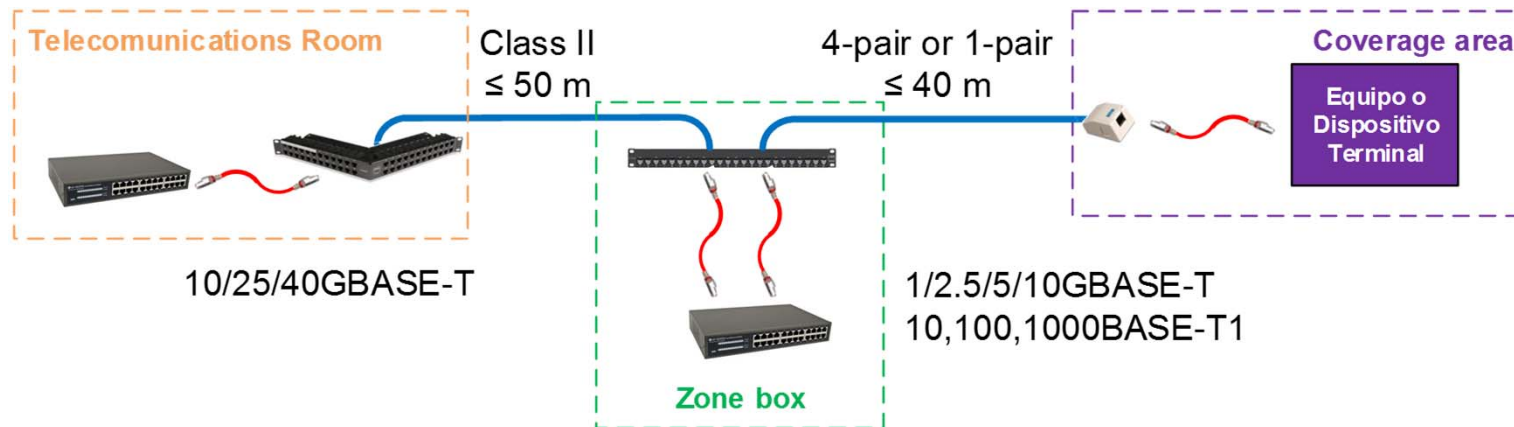


Full Mesh



Future Cabling Requirements

- Intelligent Buildings and Spaces (BAS, PoE lighting, IoT, LiFi)
- DAS and WiFi (IEEE 802.11ac & 802.11ax), require up to two Category 6A drops
- ISO/IEC 11801-6 (building distributed services) specify Class E_A as a minimum
- Possible future scenario:



Single-pair Ethernet (SPE)

- Single-pair Ethernet in continuous development with new applications for the automotive, industrial and IoT markets mainly. The IEEE has already developed the standards:
 - IEEE 802.3bp for 1 Gb/s (1000BASE-T1)
 - IEEE 802.3bu for PoDL (Power over Data Lines)
 - IEEE 802.3bw for 100 Mb/s (100BASE-T1)
- All of the above are already part of the IEEE 802.3: 2018 Ethernet standard. In addition, the development of IEEE 802.3cg standards for 10 Mb/s (10BASE-T1) continues, within the objectives of the latter is a range of up to 1000 m
- ISO/IEC/JTC 1/SC 25 subcommittee is developing several works aimed at the specification of cabling systems for single-pair applications, as well as the connectivity that will be required

Thanks for your attention.
Any question?

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