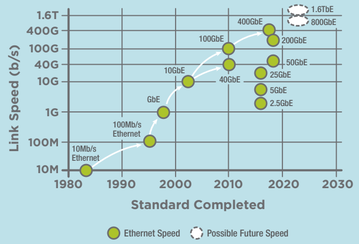
2020 ETHERNET ROADMAP

THE PAST, PRESENT AND FUTURE OF ETHERNET

ETHERNET SPEEDS



NEXT ETHERNET ERA

ethernet alliance

www.ethernetalliance.org

INTEROPERABILITY AND CERTIFICATION

The Ethernet Alliance is committed to leading the charge to instilling industry confidence in Ethernet standards through its multivendor interoperability demonstrations and plugfests. Our PoE Certification Program takes this mission to the next level!

Our industry-defined PoE Certification Test Plan is based on the Ethernet PoE standard, and products passing this test will be granted the Ethernet Alliance PoE Certification Logo. This logo will provide instant recognition for products that are based on the IEEE 802.3 PoE standard, and provide confidence in the multi-vendor interoperability of those products bearing it. The logos will also provide clear guidance on which devices will work with each other.

The first generation of the program certifies Type 1 and Type 2 products that use 2-Pair of wires. The second generation of the program tackles the IEEE802.3bt standard. This table explains the capabilities of the Types.

PoE Types and Classes	2-Pair PoE+ – Type 2 / 2-Pair PoE – Type 1					4-Pair PoE in Standardization			
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			

EA Certified™

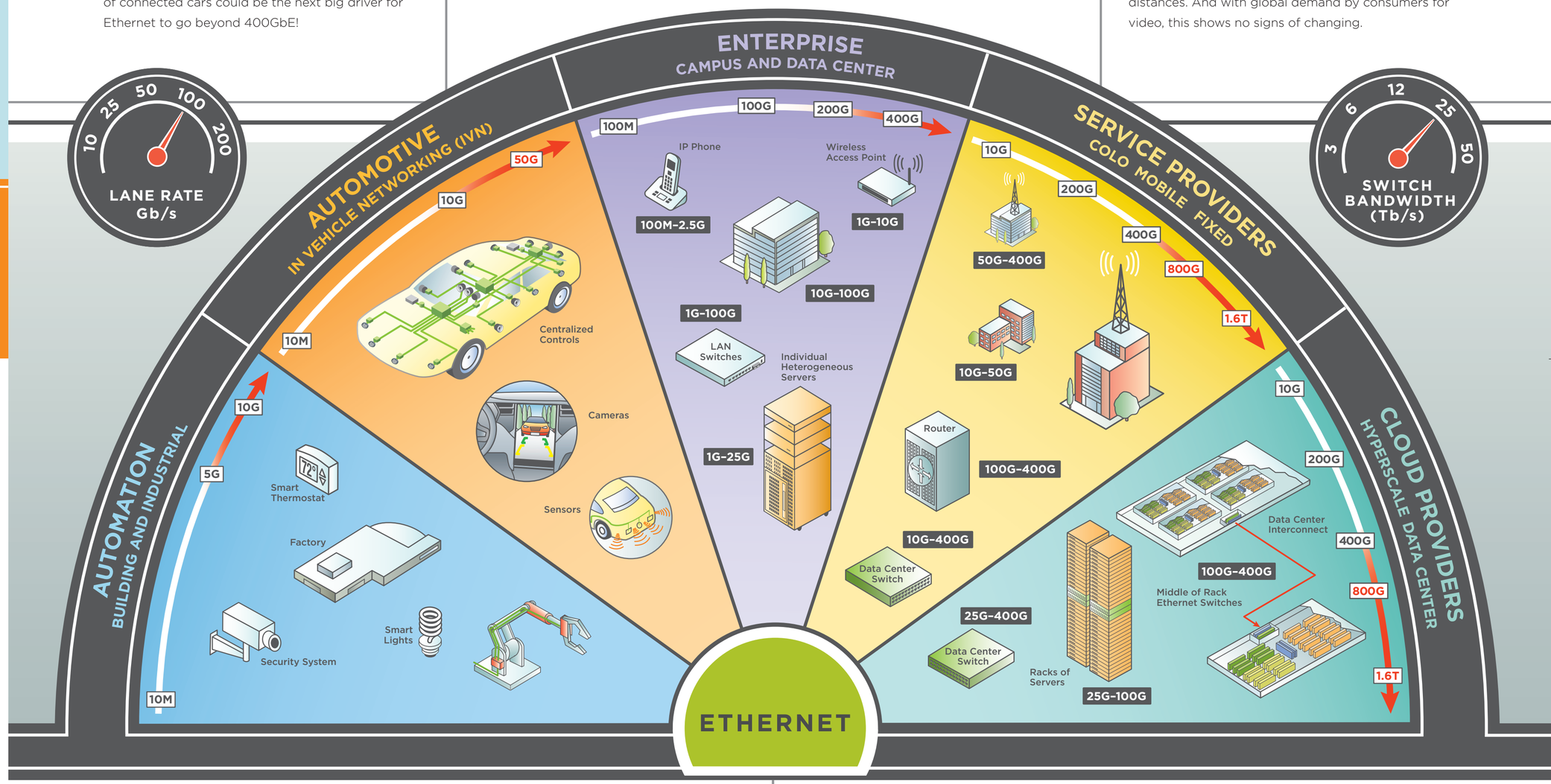
https://ethernetalliance.org/poecert/

ETHERNET APPLICATIONS

AUTOMOTIVE Ethernet is one of Ethernet's latest success stories. Forecasts predict up to 500 million ports of Ethernet will ship in over 100M vehicles by 2021. Ethernet links within cars provide data and power to reduce the cost and weight in vehicles while providing economies of scale and interoperability. The bandwidth demand of connected cars could be the next big driver for Ethernet to go beyond 400GbE!

ENTERPRISE and Campus applications drive the bulk of Ethernet port shipments with hundreds of millions of ports shipping per year. Ethernet's roots are in enterprise local area networks (LANs) where the entire Ethernet family, including the BASE-T products, can be found. LANs are rich in copper where over 70 Billion meters of cable have been deployed over the past 15 years. Enterprise data centers are very cost sensitive and most servers deploy GbE and 10GbE, and are expected to transition to 25GbE.

SERVICE PROVIDERS have driven higher speed Ethernet solutions for decades. Router connections, EPON, client side optics for optical transport network (OTN) equipment, and wired and wireless backhaul. In particular, the 5G mobile deployment is driving dramatic increases in both fronthaul and backhaul applications, and continues to push Ethernet to higher rates and longer distances. And with global demand by consumers for video, this shows no signs of changing.



AUTOMATION, BUILDING, AND INDUSTRIAL applications highlight the need for lower speed Ethernet solutions in harsh environments. Today this space is leveraging BASE-T solutions from the enterprise space. The Ethernet community defined the IEEE 802.3cg standard for 10Mb/s operation plus power delivery over a single twisted pair. This will consolidate a landscape of multiple legacy protocols, driving the promise of Ethernet's multi-level interoperability to new heights .

CLOUD PROVIDERS were the first to adopt 10GbE servers on a large scale in 2010 for hyperscale data centers. With voracious appetites for applications like AI and Machine Learning, hyperscale servers have moved to 25GbE, and are transitioning to 50GbE and beyond. Unique networking architectures within these warehouse scale data centers have driven multiple multimode and single-mode fiber solutions at 100, 200 and 400 GbE. The bandwidth demands of hyperscale data centers and service providers continue to grow exponentially and in a similar direction that blurs the lines between the two.

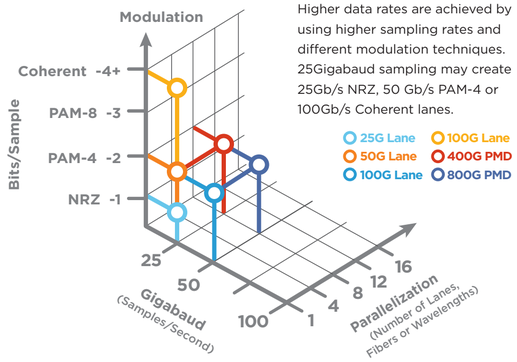
To get a PDF version of the roadmap and to find out more about the roadmap, please go to: **www.ethernetalliance.org/roadmap/**

LATEST INTERFACES AND NOMENCLATURE

	Backplane	Twinax Cable	Twisted Pair (1 Pair)	Twisted Pair (4 Pair)	MMF	500m PSM4	2km SMF	10km SMF	20km SMF	40km SMF	80km SMF	Electrical Interface
10BASE-	T1S		T1S/T1L									
100BASE-			T1									
1000BASE-			T1	T								
2.5GBASE-	KX		T1	T								
5GBASE-	KR		T1	T								
10GBASE-			T1	T				BIDI Access	BIDI Access	BIDI Access		
25GBASE-	KR	CR/CR-S		T	SR			LR/ EPON/ BIDI Access	EPON/ BIDI Access	ER/ BIDI Access		25GAUI
40GBASE-	KR4	CR4		T	SR4/eSR4	PSM4	FR	LR4				XLAUI XLPPI
50GBASE-	KR	CR			SR		FR	EPON/ BIDI Access LxR	EPON/ BIDI Access	BIDI Access ER		LAUI-2/50GAUI-2 50GAUI-1
100GBASE-	KR4 KR2 KR1	CR10 CR4 CR2 CR1			SR10 SR4 SR2 SR1	PSM4 DR	10X10-2km CWDM4/ FR1 100G-FR	10X10-10km LR4/ 4WDM-10 LR1 100G-LR	4WDM-20	ER4/ 4WDM-40	ZR	CAUI-10 CPPI CAUI-4/100GAUI-4 100GAUI-2 100GAUI-1
200GBASE-	KR4 KR2	CR4 CR2			SR4 SR2	DR4	FR4	LR4		ER4		200GAUI-4 200GAUI-2
400GBASE-	KR4	CR4			SR16 SR8/SR4.2 SR4	DR4	FR8 FR4 400G-FR4	LR8 LR4-6 400G-LR4-10		ER8	ZR	400GAUI-16 400GAUI-8 400GAUI-4

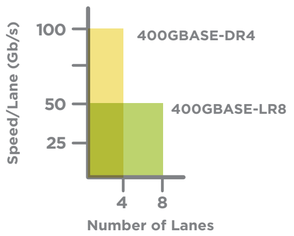
Gray Text = IEEE Standard Red Text = In Standardization Green Text = In Study Group
Blue Text = Non-IEEE standard but complies to IEEE electrical interfaces

FATTER PIPES



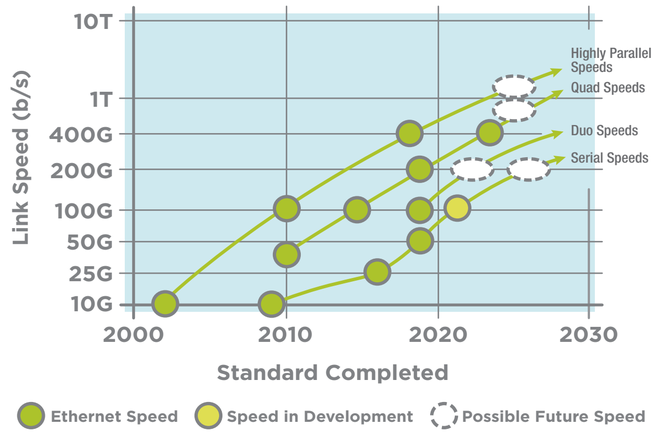
Higher data rates are achieved by using higher sampling rates and different modulation techniques. 25Gigabaud sampling may create 25Gb/s NRZ, 50 Gb/s PAM-4 or 100Gb/s Coherent lanes.

25G Lane 100G Lane
50G Lane 400G PMD
100G Lane 800G PMD



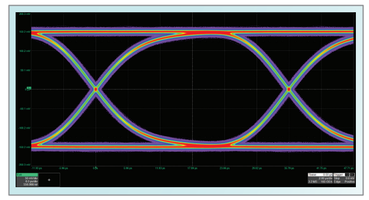
After the data rate/lane is chosen, the number of lanes in a link determines the speed. This chart shows how 4 or 8 lanes can be used to generate 400GbE links.

PATH TO SINGLE LANE

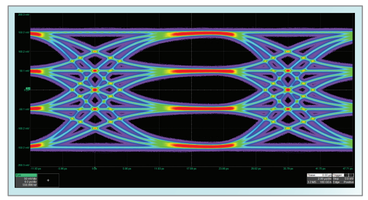


SIGNALING METHODS

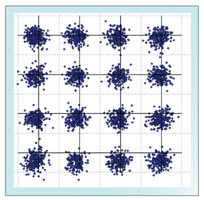
Signaling for higher lane rates is transitioning from non-return-to-zero (NRZ) for 25Gb/s per lane to four level Pulse-amplitude modulation (PAM-4) for 50Gb/s per lane, and Coherent Modulation for 100Gb/s per lane.



NRZ



PAM-4

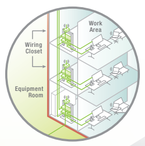


Coherent

ETHERNET ECOSYSTEM

As streams turn into rivers and flow into the ocean, small Ethernet links flow into large Ethernet links and flow into the Internet. The Internet is formed at Internet Exchange Points (IXPs) that are spread around the world. The IXPs connect Telecommunications Companies, Cable companies, Providers and Content Delivery Networks over Ethernet in their data centers.

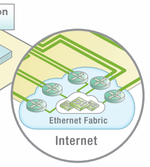
Homes use Ethernet to connect personal computers, printers, wireless access points, security cameras and many more devices. Power over Ethernet enables data and power to be delivered over one cable.



Enterprises use Ethernet to connect hundreds or thousands of devices together over Local Area Networks (LANs). Most LANs use BASE-T connectivity, but large buildings and campuses use multi-mode and singlemode fiber too.

Enterprise Data Centers deploy heterogeneous servers with various service level agreements and requirements.

Hyperscale Data Centers deploy tens or hundreds of thousands of homogeneous servers across warehouse scale data centers in pods.



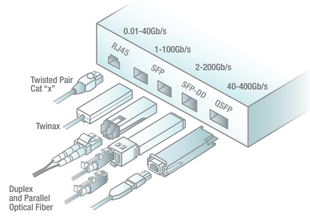
The Internet Exchange Point (IXP) is where the Internet is made when various networks are interconnected via Ethernet. Co-location facilities are usually near the IXP so that they have excellent access to the Internet and long haul connections.

FORM FACTORS

This diagram shows the most common form factors used in Ethernet ports. Hundreds of millions of RJ45 ports are sold a year while tens of millions of SFP and millions of QSFP ports ship a year.

This diagram shows new form factors initially designed for 100GbE and 400GbE Ethernet ports.

1–4 Lane Interfaces



4+ Lane Interfaces