IEEE 802.3 Ethernet

www.ieee802.org/3/

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Before I Share My Opinion…

"At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position, explanation, or interpretation of the IEEE."

IEEE-SA Standards Board Operation Manual (subclause 5.9.3)

Agenda

IEEE 802.3 Overview

IEEE 802.3 Ethernet Physical Layers

Rate, distance, media

IEEE 802.3 Ethernet emerging technologies

New physical layers, new technologies

Conclusion

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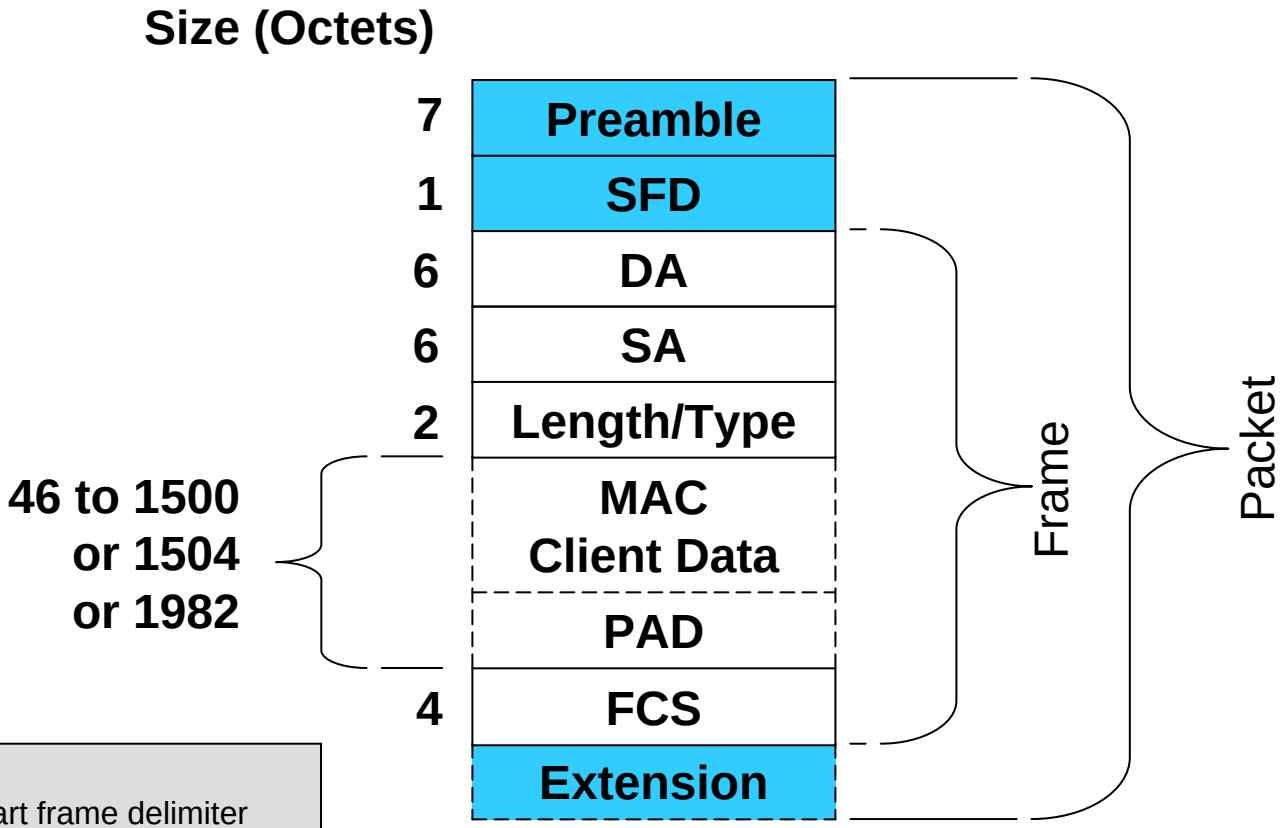
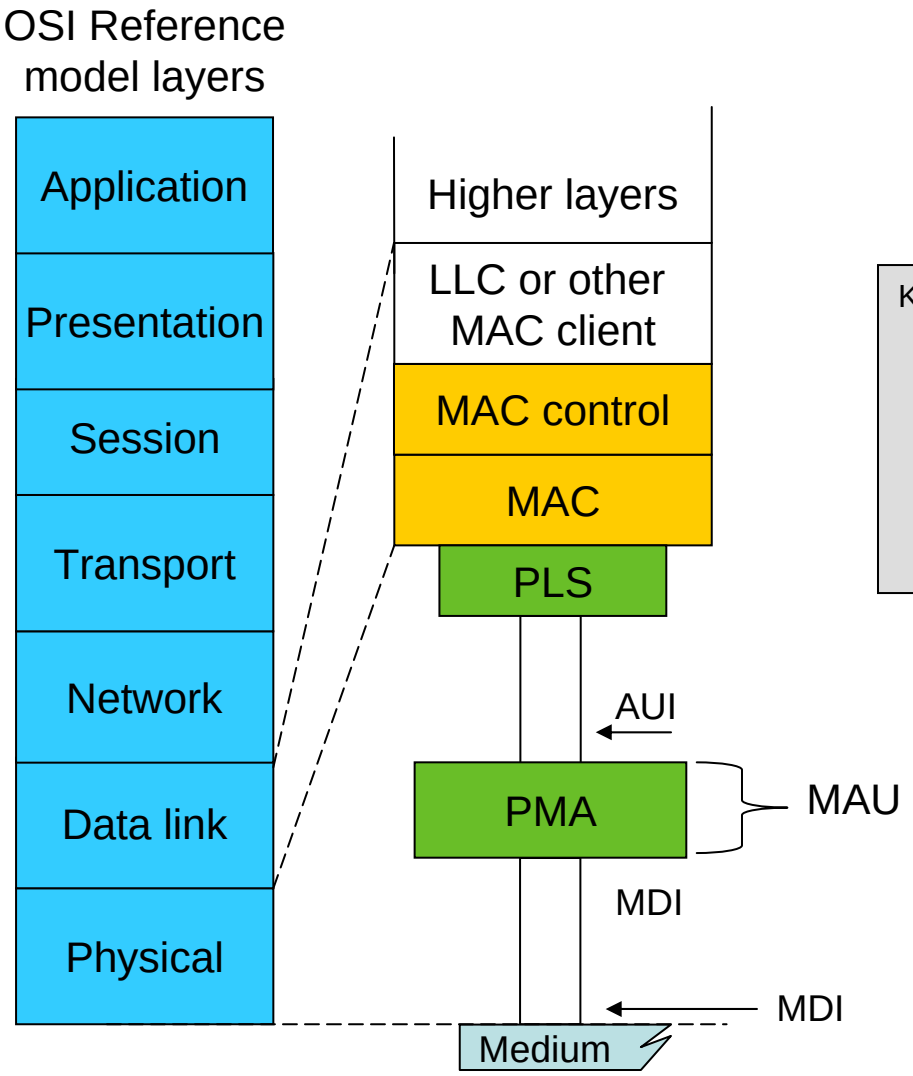
IEEE Std 802.3 Frame format



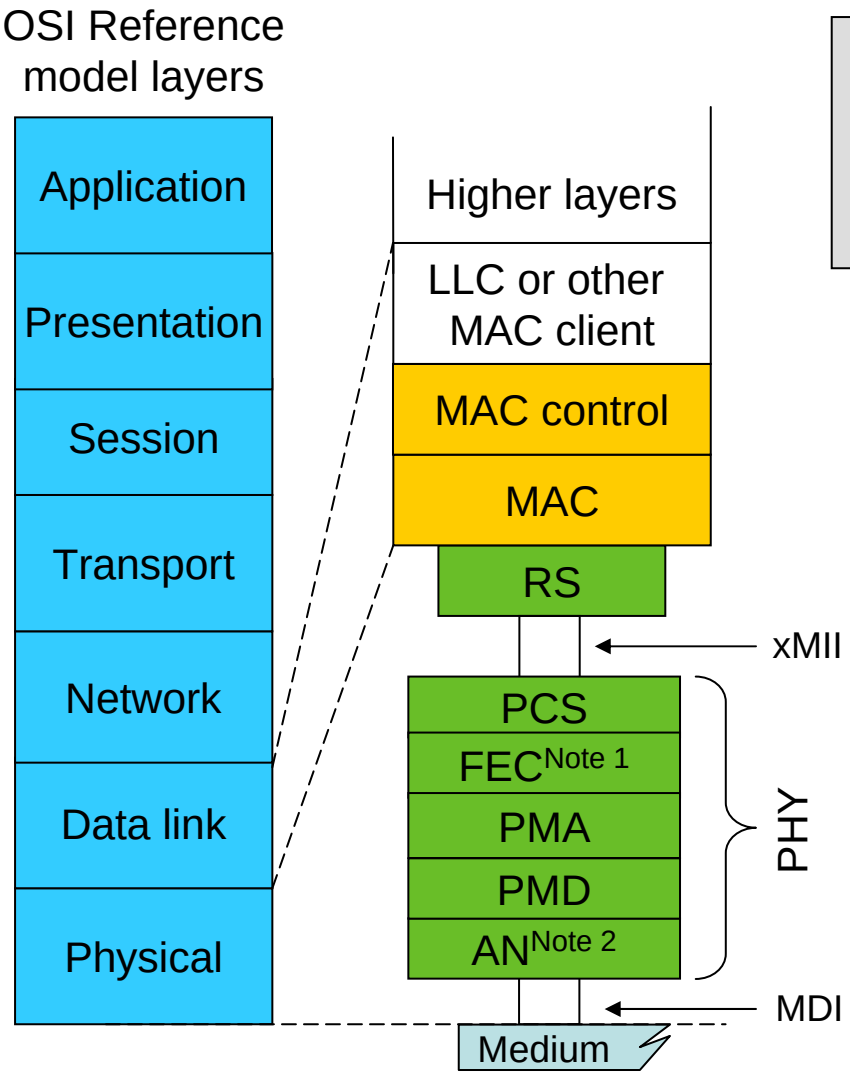
Key:
SFD – Start frame delimiter
DA – Destination address
SA – Source address
MAC – Medium access control
FCS – Frame check sequence

IEEE Std 802.3 layer diagram 1Mb/s and 10Mb/s



Key:
- LLC – Logical link control
- MAC – Medium access control
- PLS – Physical layer signalling
- AUI – Attachment unit interface
- MAU – Medium attachment unit
- PMA – Physical medium attachment
- MDI – Media dependant interface

IEEE Std 802.3 layer diagram 100Mb/s and above



xMII:
- MII – 100Mb/s Medium independent interface
- GMII – 1 Gb/s Medium independent interface
- XGMII – 10 Gb/s Medium independent interface
- XLGMII – 40 Gb/s Medium independent interface
- CGMII – 100 Gb/s Medium independent interface

Key:
- LLC – Logical link control
- MAC – Medium access control
- RS – Reconciliation sublayer
- xMII – Medium independent interface
- PHY – Physical layer device
- PCS – Physical coding sublayer
- FEC – Forward error correction
- PMA – Physical medium attachment
- PMD – Physical medium dependant
- MDI – Media dependant interface
- AN – Auto-Negotiation

Notes:
1 – Optional or omitted depending on PHY Type
2 – Conditional based on PHY Type

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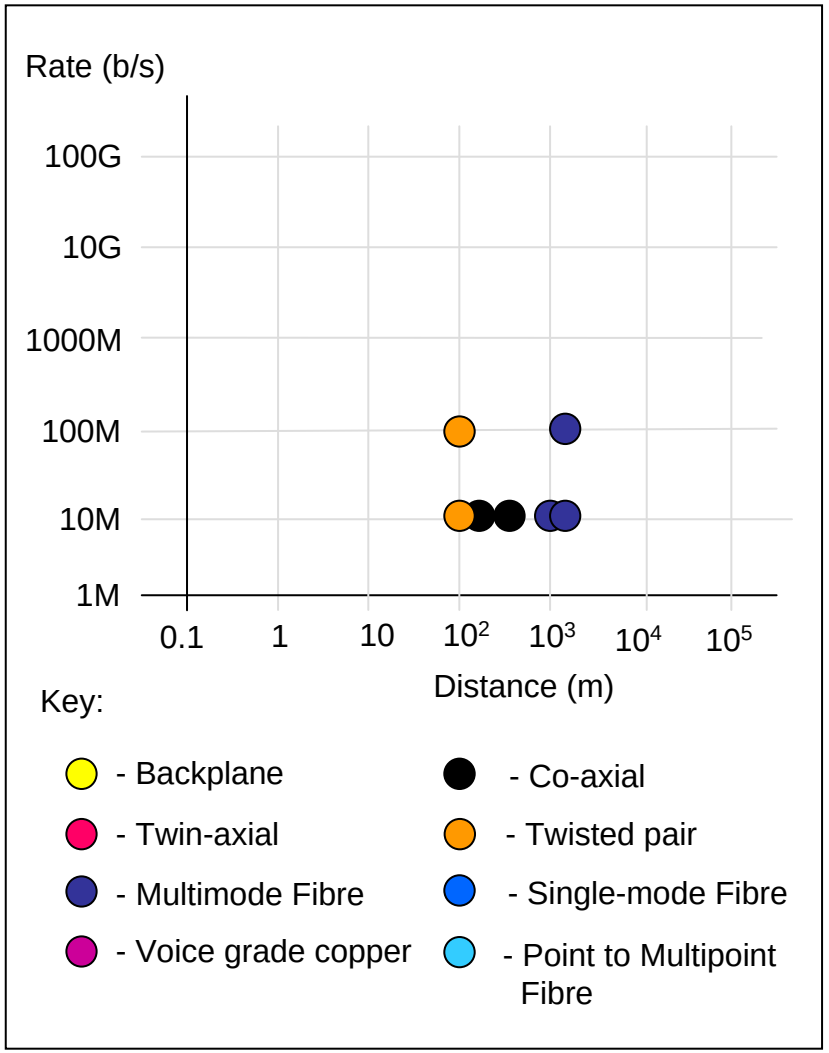
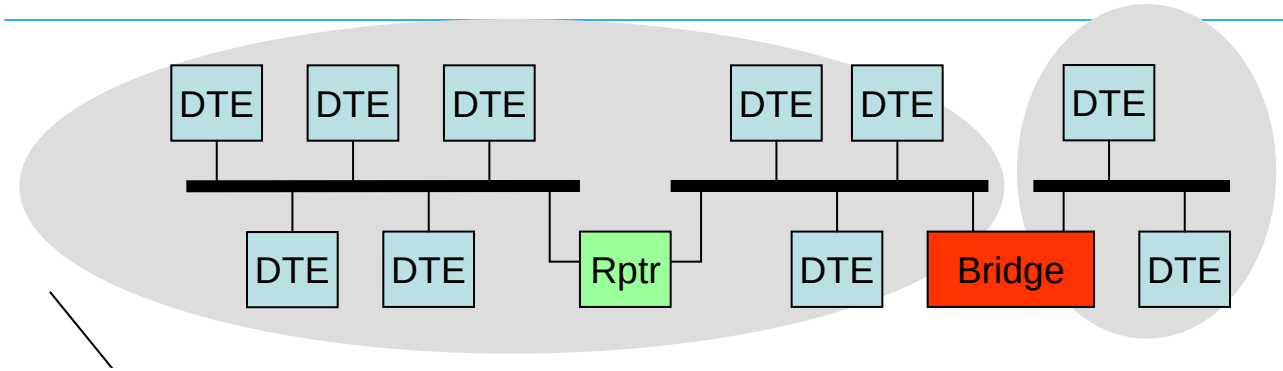
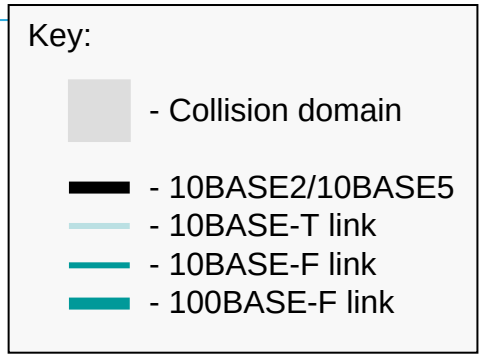
10Mb/s and 100 Mb/s Ethernet

PHY Type	Data rate	Distance	Media
IEEE Std 802.3-1985 Ethernet MAC, 10BASE5			
10BASE5	10Mb/s	500m	Coaxial
IEEE Std 802.3c-1985 Repeater, FOIRL			
FOIRL	10Mb/s	1km	Two multimode
IEEE Std 802.3a-1988 10BASE2			
10BASE2	10Mb/s	185m	Coaxial
IEEE Std 802.i-1990 10BASE-T			
10BASE-T	10Mb/s	100m	Twisted-pair
IEEE Std 802.3j-1993 10BASE-F			
10BASE-FP	10Mb/s	1km	Two multimode
10BASE-FL	10Mb/s	2km	Two multimode
10BASE-FB	10Mb/s	2km	Two multimode
IEEE Std 802.3u-1995 100BASE-T			
100BASE-TX	100Mb/s	100m	2 pair Cat 5
100BASE-T4	100Mb/s	100m	4 pair Cat 3
100BASE-FX	100Mb/s	2Km	Two multimode
IEEE Std 802.3x-1997 Full Duplex			
IEEE Std 802.3y-1997 100BASE-T2			
100BASE-T2	100Mb/s	100m	2 pair Cat 3

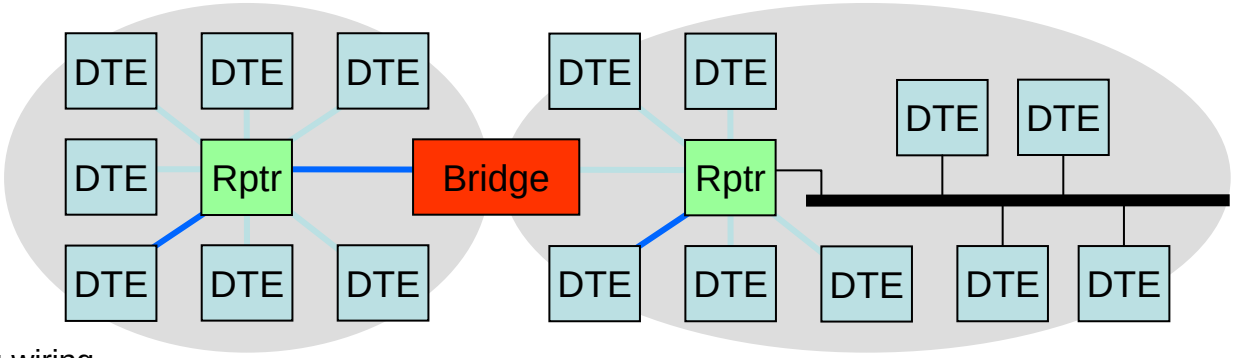


Topology evolution

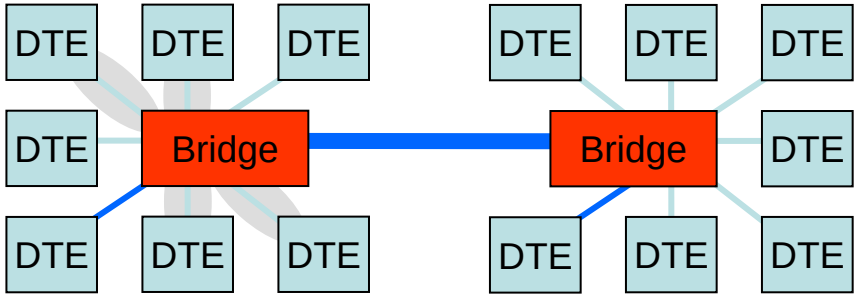




IEEE Std 802.i-1990 10BASE-T
IEEE Std 802.3j-1993 10BASE-F

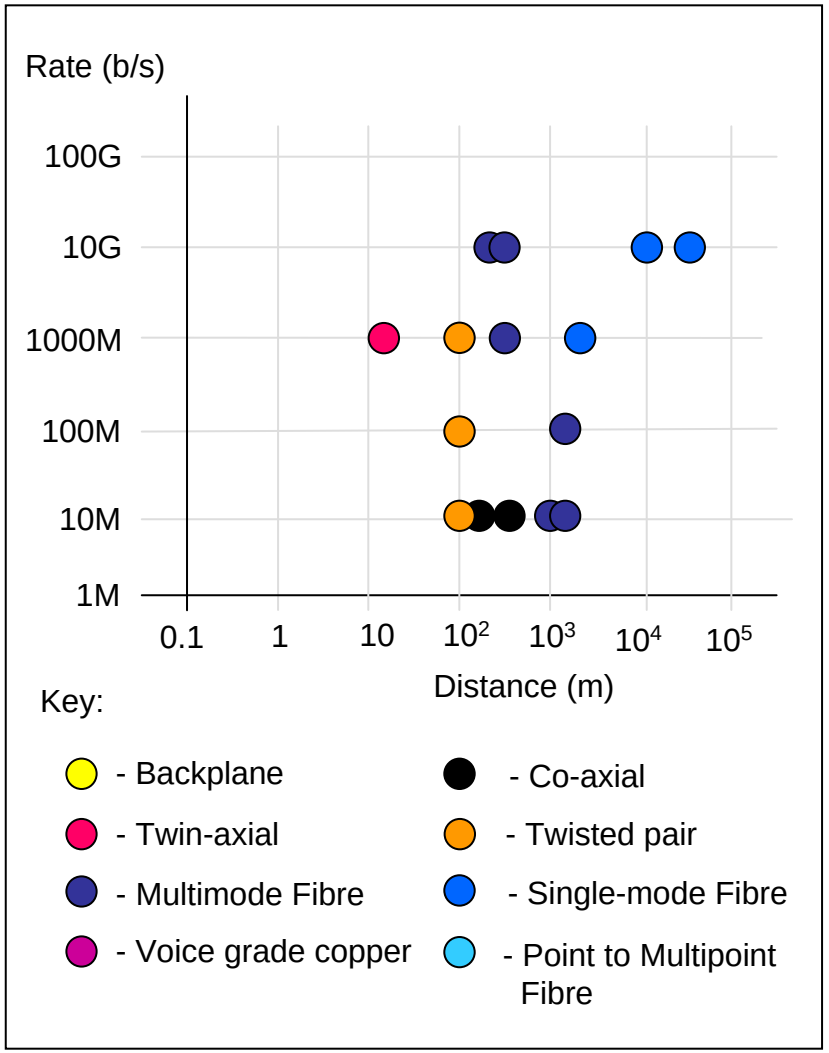


IEEE Std 802.3u-1995 100BASE-T
IEEE Std 802.3x-1997 Full Duplex
TIA/EIA 568:1991 Structured building wiring
ISO/IEC 11801:1995 Structured building wiring



1Gb/s and 10 Gb/s Ethernet

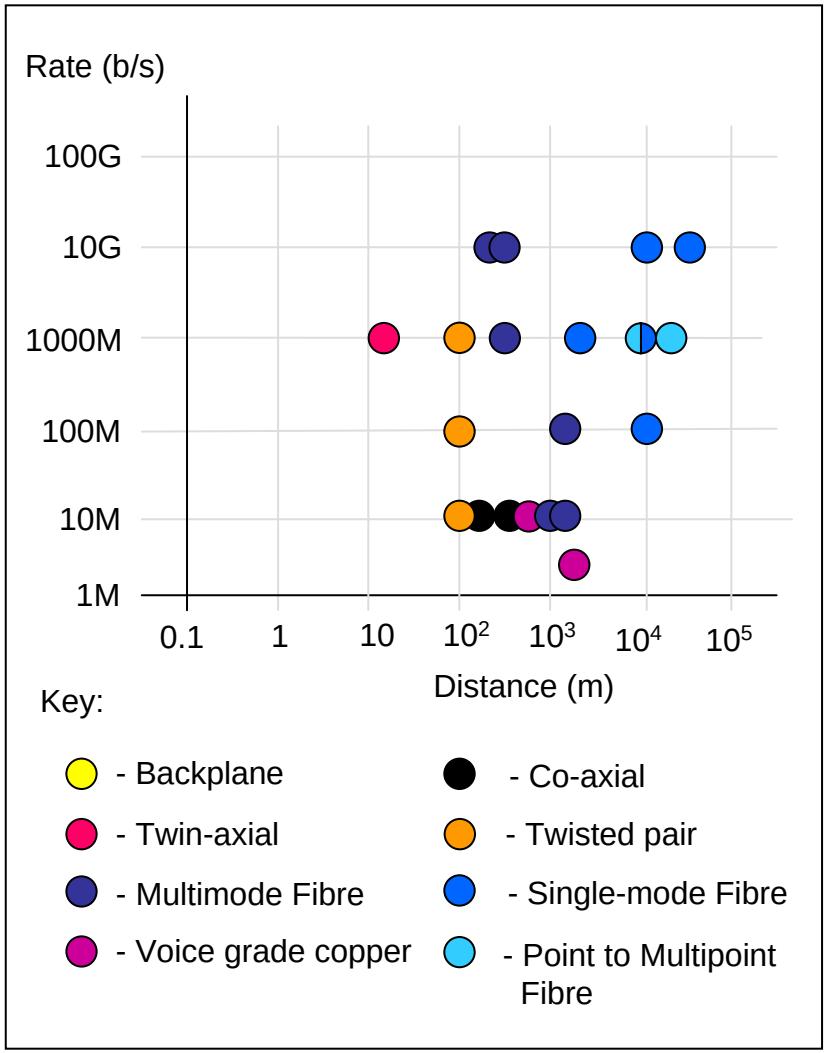
PHY Type	Data rate	Distance	Media
IEEE Std 802.3z-1998 1 Gb/s Operation			
1000BASE-SX	1Gb/s	220m 550m	Two multimode fibres
1000BASE-LX	1Gb/s	5Km 550m	Two single-mode Two multimode
1000BASE-CX	1Gb/s	25m	Copper cable assembly
IEEE Std 802.3ab-1999, 1000BASE-T			
1000BASE-T	1Gb/s	100m	Twisted-pair
IEEE Std 802.3ad-2000 Link Aggregation			
IEEE Std 802.3ae-2002 10 Gb/s Operation			
10GBASE-SR/W	10Gb/s	33m 300m	Two multimode
10GBASE-LX4	10Gb/s	10Km 300m	Two single-mode Two multimode
10GBASE-LR/W	10Gb/s	10Km	Two single-mode
10GBASE-ER/W	10Gb/s	40Km	Two single-mode



Ethernet in the First Mile

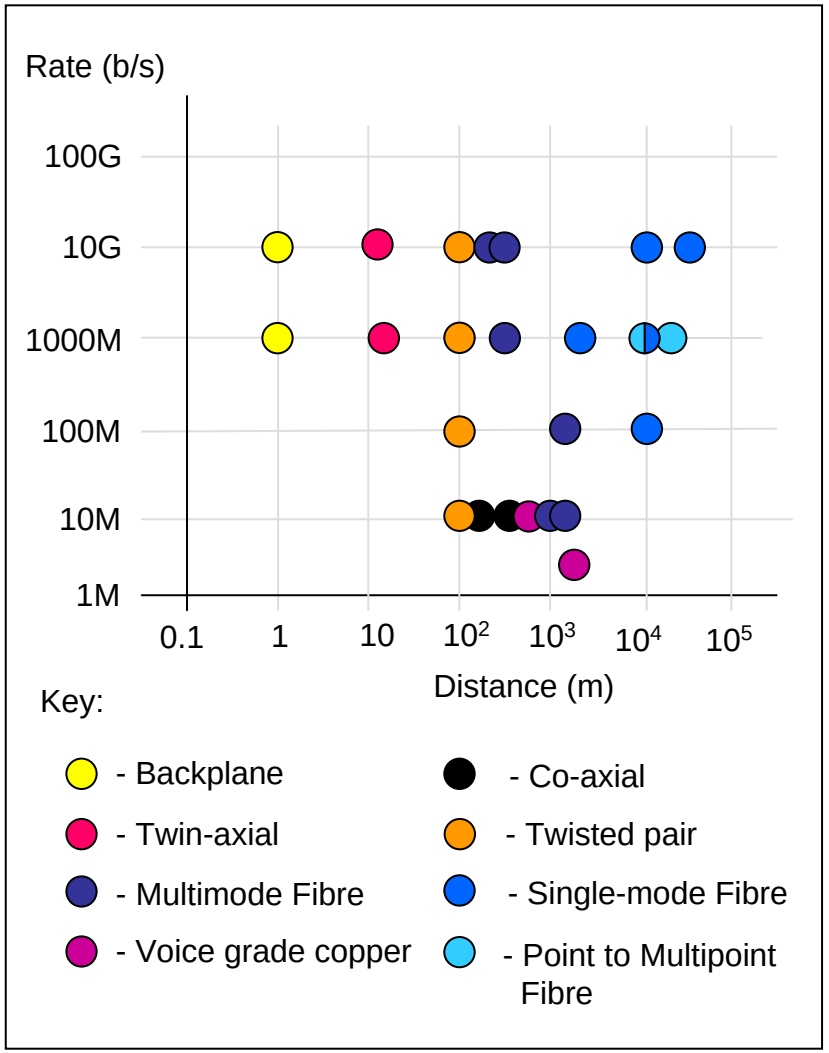
PHY Type	Data rate	Distance	Media
IEEE Std 802.3ah-2004 Ethernet in the First Mile			
100BASE-LX10	100Mb/s	10Km	Two single-mode
100BASE-BX10	100Mb/s	10Km	One single-mode
1000BASE-LX10	1000Mb/s	10Km 550m	Two single-mode Two multimode
1000BASE-BX10	1000Mb/s	10Km	One single-mode
1000BASE-PX10	1000Mb/s	10Km	One single-mode Point to Multipoint
1000BASE-PX20	1000Mb/s	20Km	
10PASS-TS	10Mb/s*	750m*	Voice grade copper
2BASE-TL	2Mb/s*	2Km*	Voice grade copper

* Nominal speed and reach



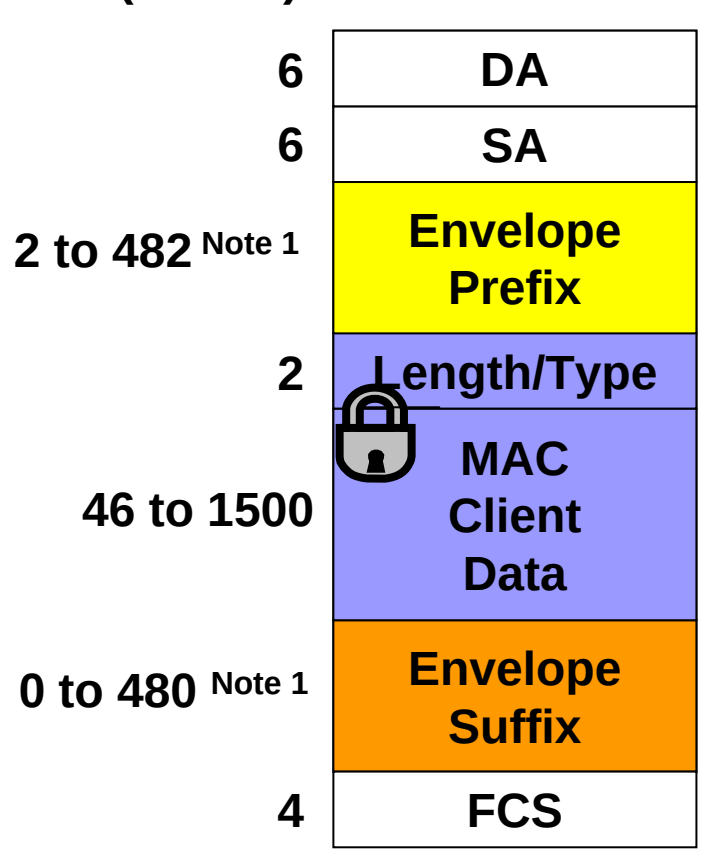
10 Gb/s PHYs, Backplane Ethernet

PHY Type	Data rate	Distance	Media
IEEE Std 802.3ak-2004, 10GBASE-CX4			
10GBASE-CX4	10Gb/s	15m	Copper cable assembly
IEEE Std 802.3an-2006, 10GBASE-T			
10GBASE-T	10Gb/s	100m	Twisted-pair
IEEE Std 802.3ap-2007,Electrical Backplanes			
1000BASE-KX	1000Mb/s	1m	Backplane
10GBASE-KX4	10Gb/s	1m	Backplane
10GBASE-KR	10Gb/s	1m	Backplane
IEEE Std 802.3aq-2006, 10GBASE-LRM			
10GBASE-LRM	10Gb/s	100m 220m	Two multimode



IEEE Std 802.3as-2006 Frame Extension

- Drivers
  - IEEE Std 802.1ad Provider Bridging
    - Tag in Tag
  - IEEE Std 802.1AE MAC Security
    - Cipher block
- Approach
  - Minimal changes
    - Provide for envelope round frame
  - No expansion of MAC Client Data
    - Jumbo frames not supported
- Frame sizes supported
  - 1518 decimal – basic frames
  - 1522 decimal – Q-tagged frames
  - 2000 decimal – envelope frames



Note 1: Envelope prefix + suffix ≤ 482

Agenda

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Rate, distance, media

IEEE 802.3 Ethernet emerging technologies

New physical layers, new technologies

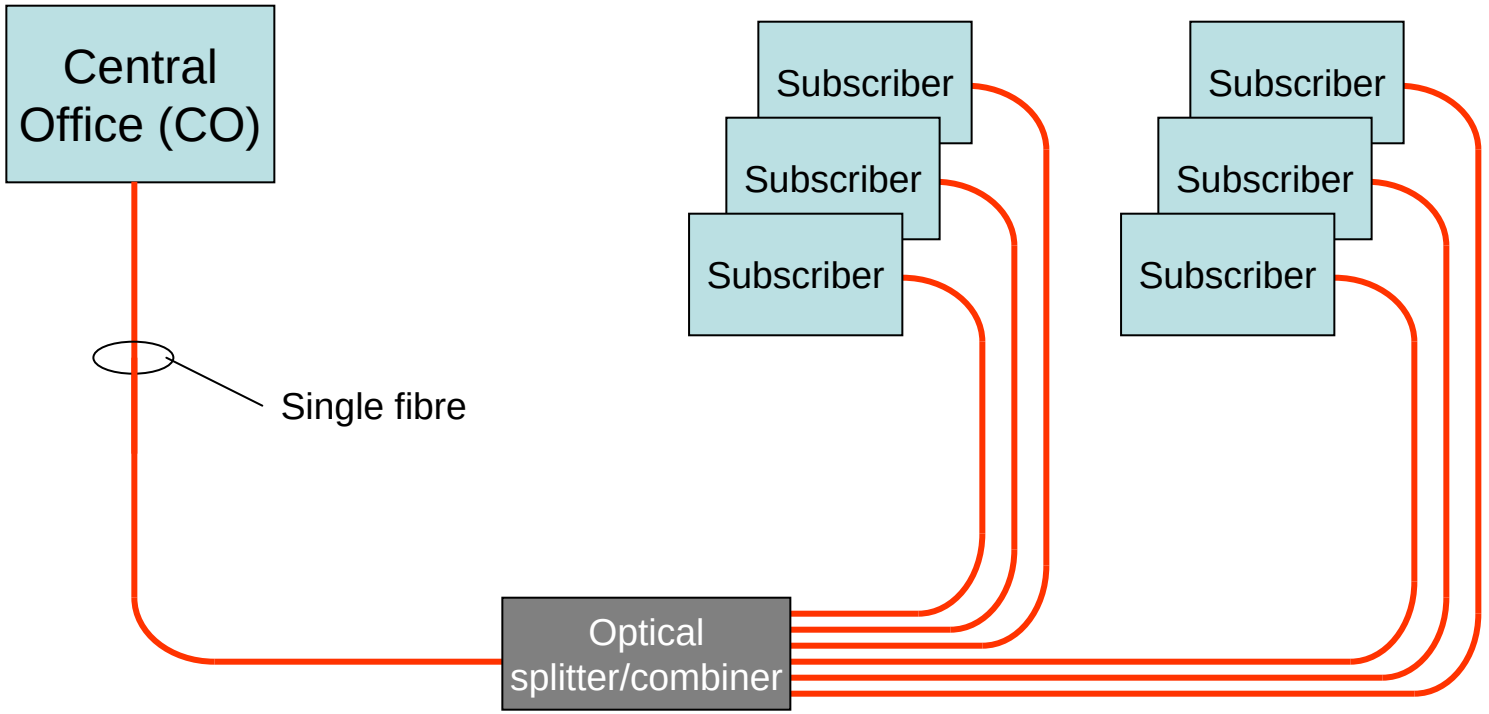
Conclusion

IEEE 802.3 Ethernet emerging technologies

- Demand for increased bandwidth
  - By connected devices
  - By devices aggregating these devices
- Continuing evolution of Ethernet
  - DTE Power via MDI
  - Energy-efficient Ethernet
  - Mapping to OTN
- Convergence around Ethernet
  - Data Centre Bridging (e.g. FCoE, iWARP)
  - Audio/Video Bridging

IEEE Std 802.3 Ethernet Passive Optical Network (EPON) Architecture

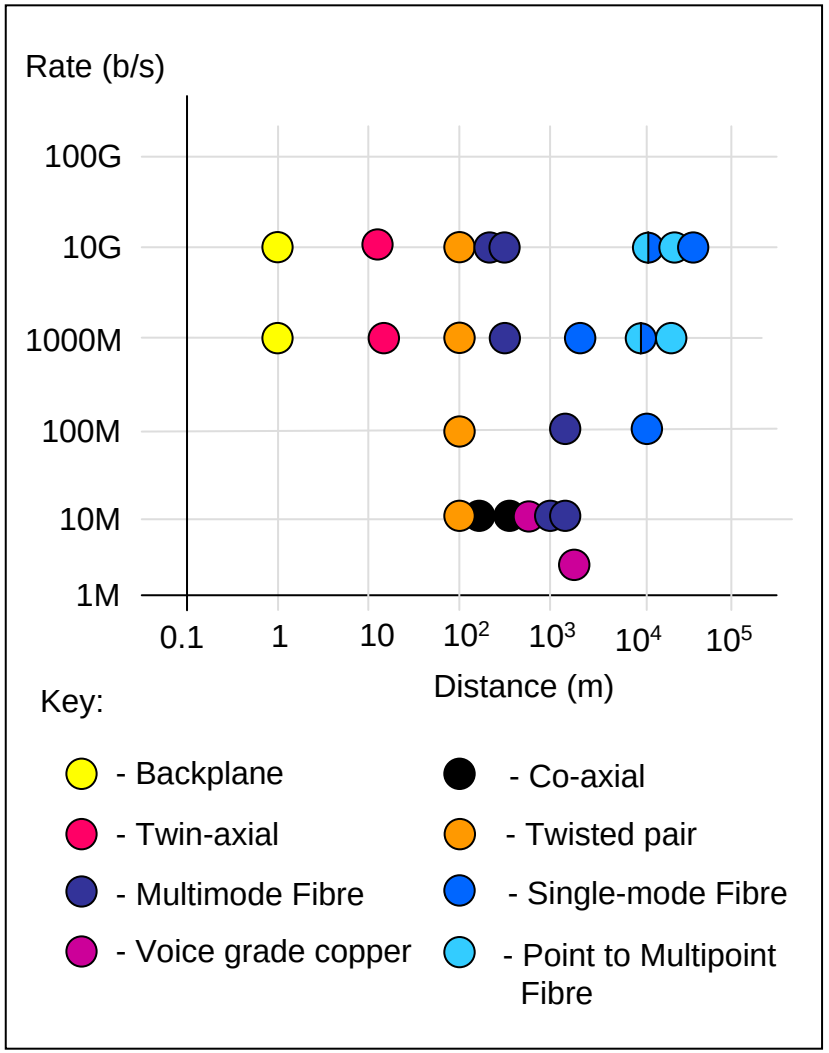
- First mile (subscriber access) technology
  - Point to multipoint fibre media



IEEE Std 802.3av-2009 10Gb/s EPON Ethernet PHY Types

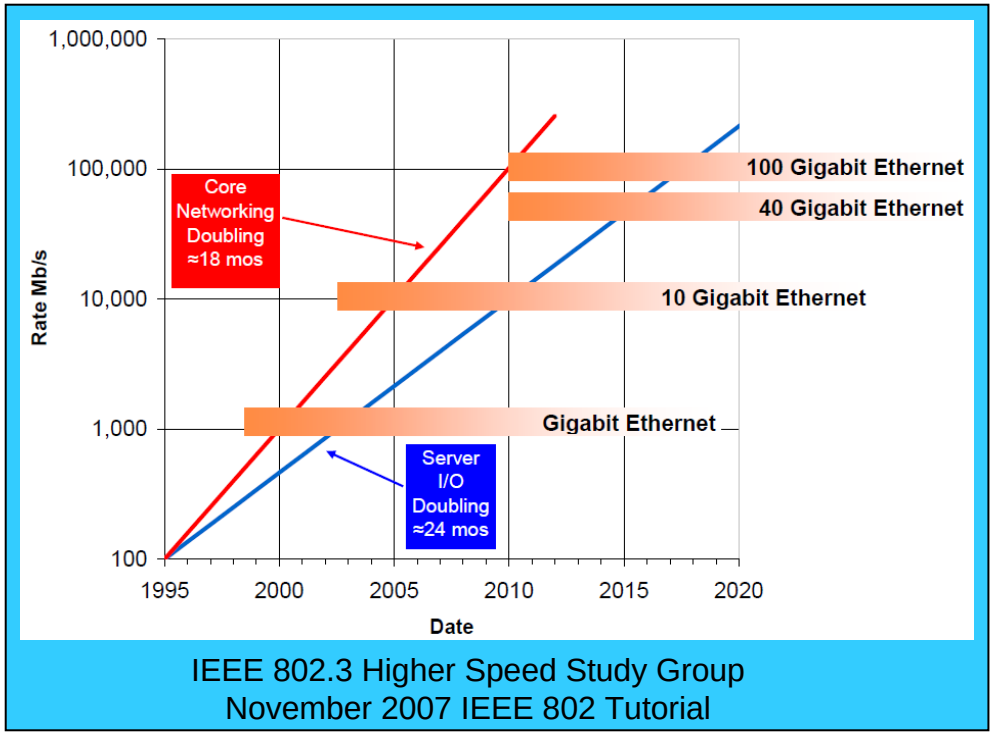
PHY Type	Data rate		Split ratio	Distance
	Up	Down		
10/1GBASE-PRX1	1Gb/s	10Gb/s	1:16	10km
10/1GBASE-PRX2	1Gb/s	10Gb/s	1:16	20km
			1:32	10km
10/1GBASE-PRX3	1Gb/s	10Gb/s	1:32	20km
10GBASE-PR1	10Gb/s	10Gb/s	1:16	10km
10GBASE-PR2	10Gb/s	10Gb/s	1:16	20km
			1:32	10km
10GBASE-PR3	10Gb/s	10Gb/s	1:32	20km

- 1Gb/s Passive Optical Networks already supported
  - IEEE Std 802.3ah-2004 Ethernet in First Mile
  - 1 Gb/s downstream and upstream
- Bandwidth demands increasing
  - IPTV, VoD
- IEEE Std 802.3av-2009 10Gb/s EPON
  - Symmetric 10 Gb/s downstream and upstream
  - Asymmetric 10 Gb/s downstream, 1Gb/s upstream



IEEE Std 802.3ba-2010 40Gb/s and 100Gb/s Ethernet - Generic Market Drivers

- Computing
  - Driven by key technologies
    - Internal bus and memory performance
  - System throughput doubles approximately every 2 yrs
- Core networking
  - More users, bandwidth, and applications
  - Wide area, ISPs, IXs
    - Increase number of users
    - Increase in bandwidth available; xDSL, xPON, Cable, 3G
    - Increase number of applications; YouTube, Facebook, Netflix
  - Core throughput doubles approximately every 18 months



IEEE 802.3 Higher Speed Study Group
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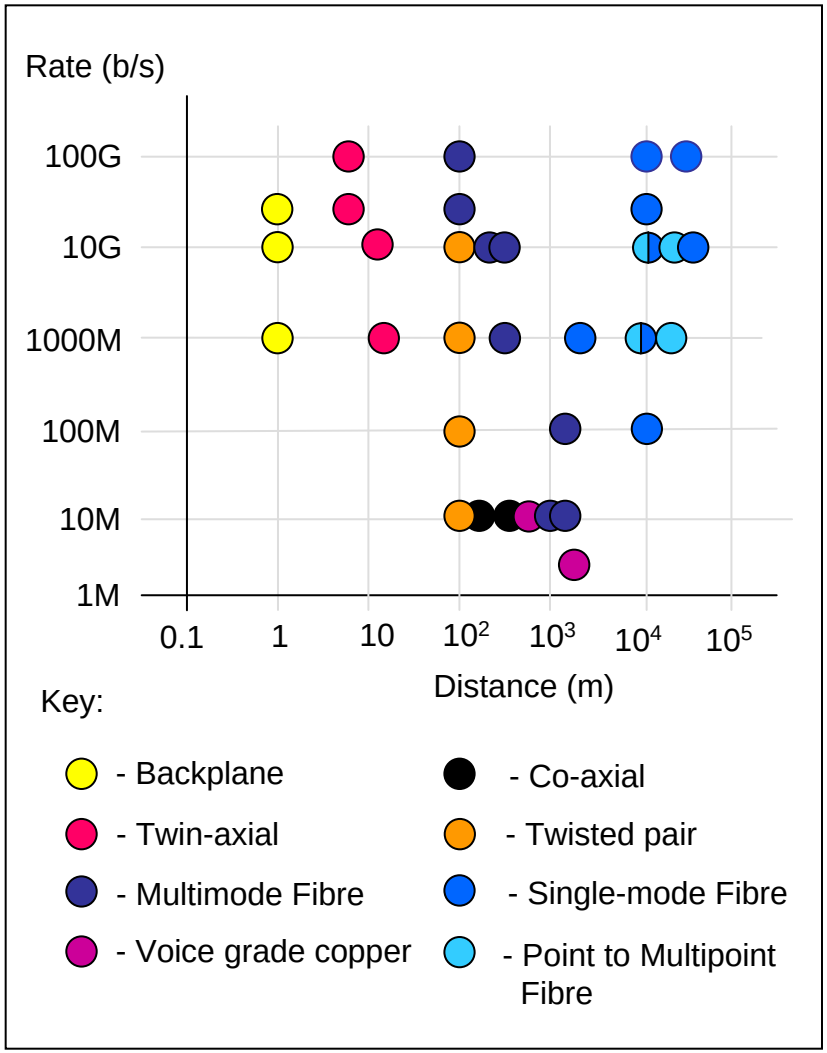
IEEE Std 802.3ba-2010 40Gb/s and 100Gb/s Ethernet PHY Types

PHY Type	Data rate	Distance	Media
100GBASE-ER4	100Gb/s	40km	Dual Single-mode fibres
100GBASE-LR4	100Gb/s	10km	
40GBASE-LR4	40Gb/s		
100GBASE-SR10	100Gb/s	100m 125m	Multiple multimode fibres
40GBASE-SR4	40Gb/s		
100GBASE-CR10	100Gb/s	7m	Copper cable assembly
40GBASE-CR4	40Gb/s		
40GBASE-KR4	40Gb/s	1m	Backplane

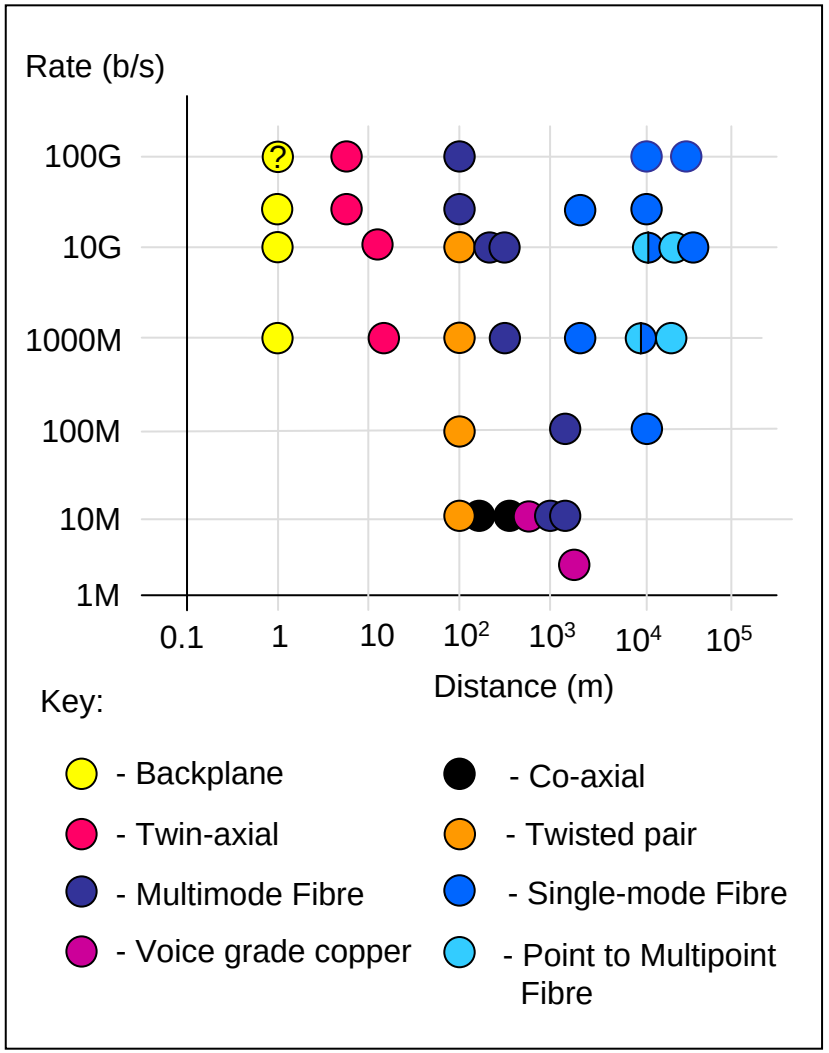


- ITU-T Optical Transport Network (OTN)
  - Supports 40Gb/s (OTU3) and 100Gb/s (OTU4)
  - Rate and encoding alignment
    - Through liaison relationship with ITU-T

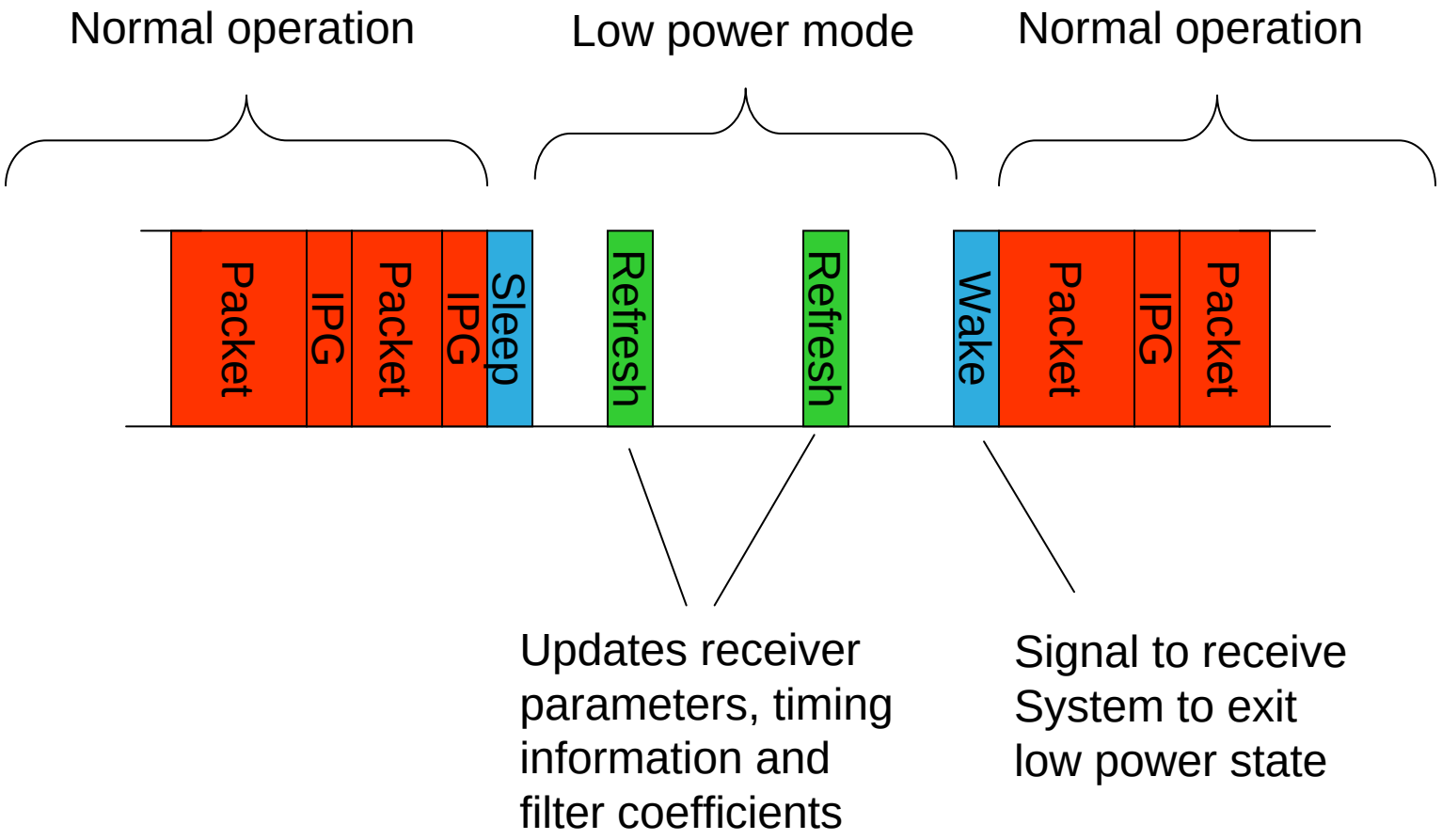
IEEE P802.3bg 40Gb/s Ethernet Single-mode Fibre PMD
IEEE 802.3 100 Gb/s Backplane and Copper Study Group

PHY Type	Data rate	Distance	Media
40GBASE-FR	40Gb/s	2km	Dual Single-mode fibres
100GBASE-TBD	100Gb/s	TBD	Copper cable assembly
100GBASE-TBD	100Gb/s	TBD	Backplane

- IEEE P802.3bg objectives
  - Operation over at least 2 km of SMF, optical compatibility with existing carrier client interfaces
    - OTU3/STM-256/OC-768/40G POS
  - Applications
    - Carrier networks equipment interconnection
    - Uplink interconnections into carrier networks
- IEEE 802.3 100 Gb/s Backplane and Copper Study Group
  - Study group for 100Gb/s Ethernet Electrical Backplane and Twinaxial Copper Cable Assemblies



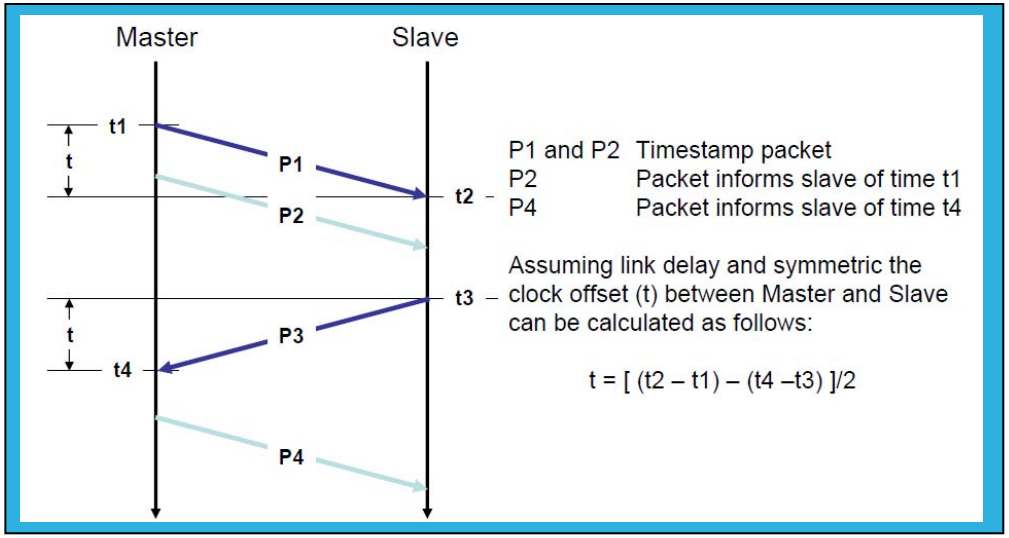
IEEE Std 802.3az-2010 Energy-efficient Ethernet Idle operation overview



Enables energy efficiency in attached systems

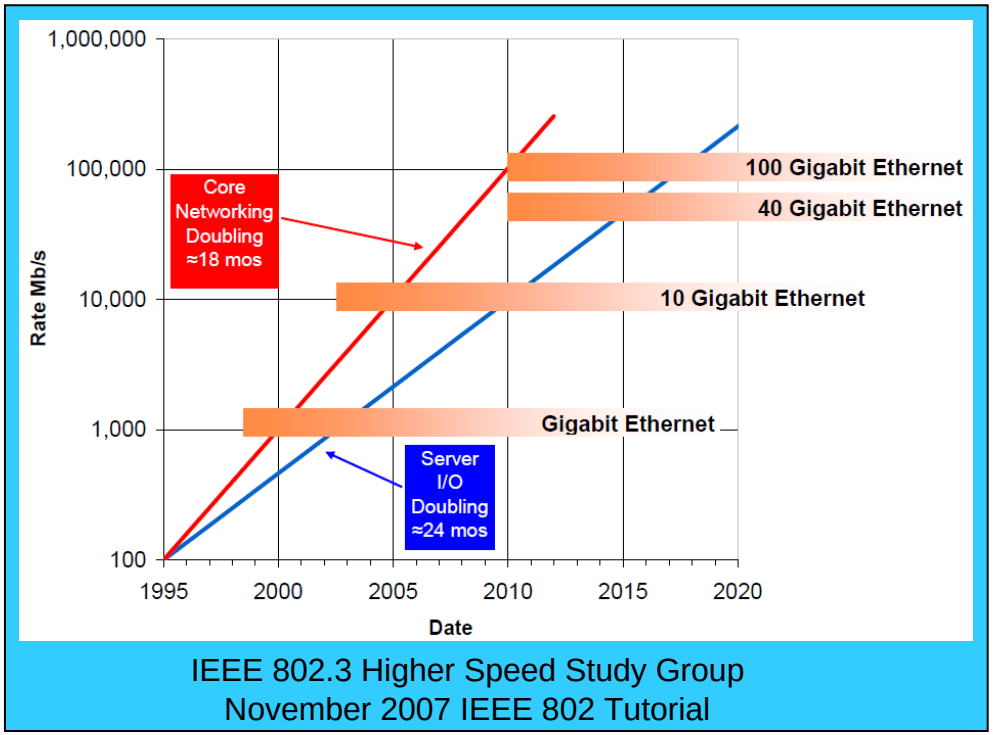
IEEE P802.3bf Time Synchronization
IEEE P802.3.1 Ethernet MIBs

- IEEE P802.3bf Time Synchronization
  - Support for time synchronization protocols such as IEEE Std 802.1AS
  - Small project in IEEE 802.3
    - Addition of new IEEE 802.3 abstract service interface
    - New PHY registers to provide device delays



- IEEE P802.3.1 Ethernet MIBs
  - IETF used to develop Ethernet SNMP MIBs but decided to stop
  - IEEE 802.3 Working Group now has to do work
  - IEEE 802.3.1 is the initial project
    - GDMO MIB from IEEE Std 802.3-2008
    - IEEE Std 802.1AB Annex F (IEEE 802.3 TLVs) SNMP MIB
    - RFCs 2108, 3621, 3635, 3637, 4836, 4837,4878, 5066
  - Future revisions expected

IEEE 802.3 Ethernet Bandwidth Assessment Ad Hoc



IEEE 802.3 Higher Speed Study Group
November 2007 IEEE 802 Tutorial

- Gathering information that will enable an evaluation of the bandwidth needs for Ethernet applications, including, but not limited to, core networking and computing
  - First teleconference held 28th February 2011
  - Refinement of deliverables

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Conclusions

- Ethernet is the ubiquitous wired connectivity
  - < 0.01m to 1,000s of kilometres
  - 10Mb/s to 100Gb/s
    - Link Aggregation
  - Backplane to fibre (and everything in between)
- New speeds, media, features and applications reinforce this
  - 40Gb/s and 100Gb/s
  - Energy-efficient Ethernet
- Continued convergence on Ethernet
  - Data Centre Bridging
  - Audio/Video Bridging

IEEE 802.3 Standards

- IEEE Std 802.3™-2008 Ethernet Access Method and Physical Layer Specifications*
  - IEEE Std 802.3av™-2009 10Gb/s EPON*
  - IEEE Std 802.3bc™-2009 Ethernet TLVs *
  - IEEE Std 802.3at™-2009 DTE Power Enhancements *
  - IEEE Std 802.3ba™-2010 40Gb/s and 100Gb/s Ethernet *
  - IEEE Std 802.3az™-2010 Energy-efficient Ethernet
- Available through Get IEEE 802 http://standards.ieee.org/getieee802/802.3.html
- Working group web site htttp://www.ieee802.org/3/