



ethernet alliance

Ethernet Alliance Technology Roadmap

The Roadmap Subcommittee

Disclaimer



The views expressed in this presentation are the views of the Roadmap Subcommittee and the Ethernet Alliance.

Agenda

- Speeds, Media and Distance
- BASE-T Speedmap
- Access Roadmap
- PoE Roadmap
- 40GbE Roadmap
- 100GbE Roadmap
- Backplane Roadmap

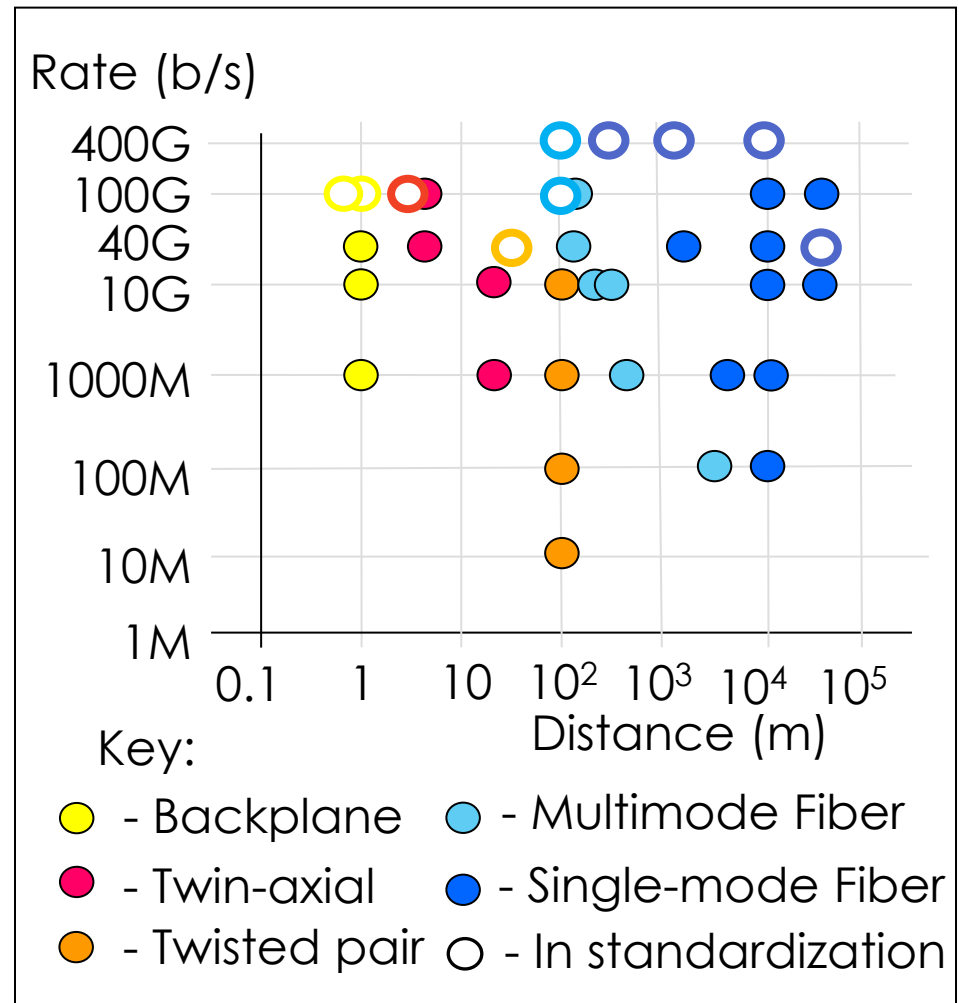
Media Types

- Ethernet operates over a number of technologies defined by IEEE 802.3 including:
 - Backplanes
 - Copper cables
 - Multimode fiber
 - Single-mode fiber
- The roadmaps, reach and speed for each of these technologies is different and will be discussed in this presentation

Distance vs Speed

Ethernet operates at different speeds over different distances depending on the media :

- backplanes up to 1m
- Twinax to 15m
- Twisted pair to 100m
- Multimode fiber to 5km
- Single-mode fiber to 40km



Ethernet Speedmap

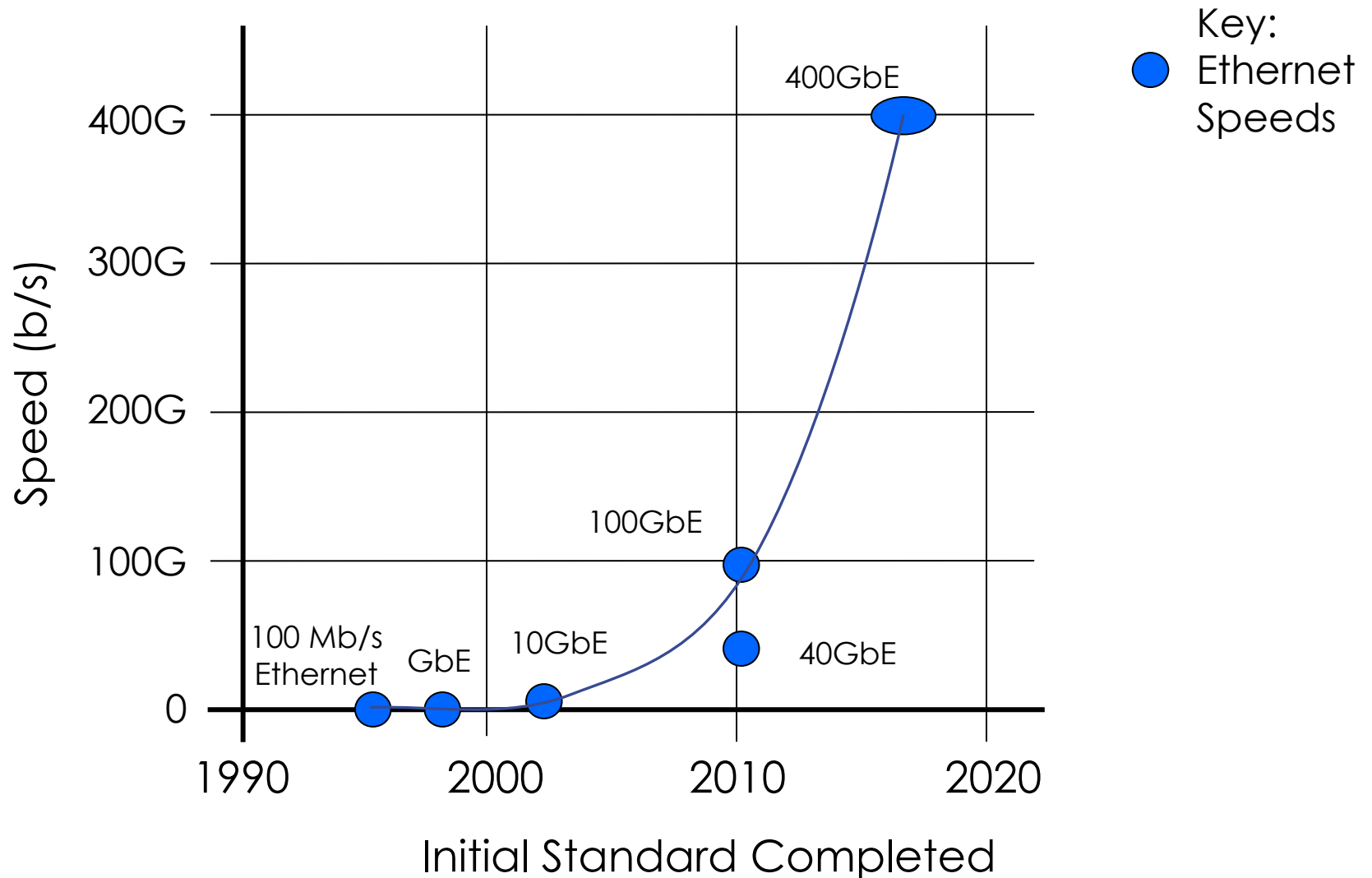


These dates are for the initial release of a new speed

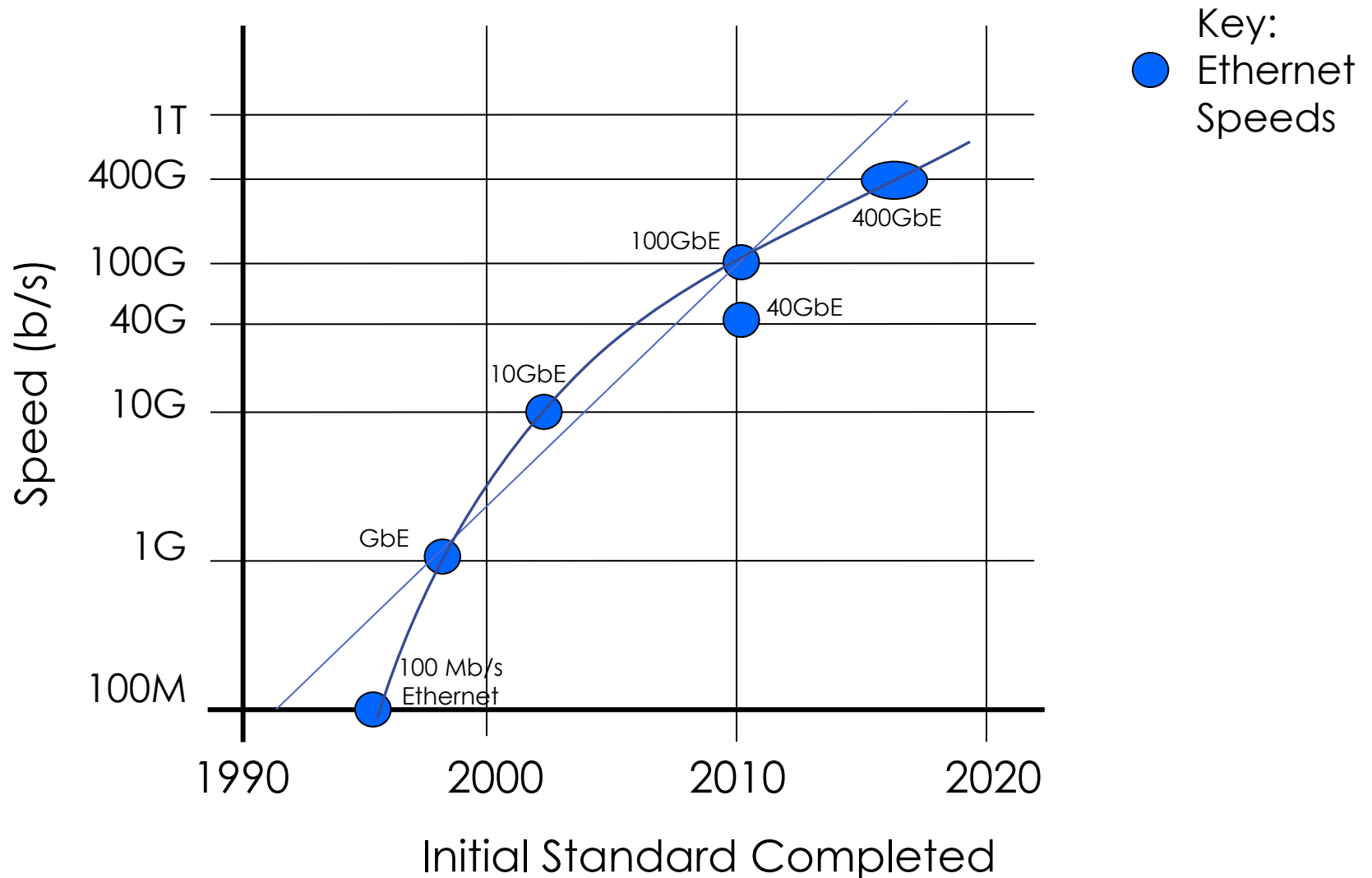
| Name | Speed | Date Initial Standard Ratified |
|----------------------|----------|--------------------------------|
| 10Mb/s Ethernet | 10 Mb/s | 1983 |
| 100Mb/s Ethernet | 100Mb/s | 1995 |
| Gigabit Ethernet | 1 Gb/s | 1998 |
| 10 Gigabit Ethernet | 10 Gb/s | 2002 |
| 40 Gigabit Ethernet | 40 Gb/s | 2010 |
| 100 Gigabit Ethernet | 100 Gb/s | 2010 |
| 400 Gigabit Ethernet | 400 Gb/s | 2017 (est.)* |

*Estimated on a 4-year standardization process that started with the CFI in March 2013

Ethernet Speeds - Linear



Ethernet Speeds – Log



BASE-T Speedmap

- This chart shows the speeds of BASE-T technology
- New generations of twisted pair have been tied to new speeds

| Name | Speed | Reach | Twisted Pair Medium | Date Standard Ratified |
|------------|---------|-------|---------------------|------------------------|
| 10BASE-T | 10 Mb/s | 100 m | Cat 3 | 1990 |
| 100BASE-TX | 100Mb/s | 100 m | Cat 5 | 1995 |
| 1000BASE-T | 1 Gb/s | 100 m | Cat 5e | 1999 |
| 10GBASE-T | 10 Gb/s | 100 m | Cat 6 _A | 2006 |
| 40GBASE-T | 40 Gb/s | 30 m | Cat 8 | 2016 (est.) |

Access Roadmap

- This chart shows the various speeds of Access technology that needs to be confirmed by the Access Networks Subcommittee

| Name | Speed | Date Standard Ratified |
|---------------|--|------------------------|
| GEPON | 1 Gb/s | 2004 |
| 10GEPON | 10 Gb/s symmetric 10 Gb/s & 1 Gb/s asymmetric | 2009 |
| Extended EPON | 1 Gb/s 10 Gb/s symmetric 10 Gb/s & 1 Gb/s asymmetric | 2013 |
| EPoC | up to 10 Gb/s | 2015 (est.) |

PoE Roadmap

| Name | Power from Power Sourcing Equipment (PSE) | Date Standard Ratified |
|------------------------------|---|------------------------|
| PoE | 15.4W | 2003 |
| PoE+ | 30W | 2009 |
| 4 Pair PoE | TBD or 60W (min) | 2015 (est.) |
| 1 Pair Power over Data Lines | TBD | 2015 (est.) |

| Name | Power at Powered Device (PD) | Date Standard Ratified |
|------------------------------|------------------------------|------------------------|
| PoE | 13W | 2003 |
| PoE+ | 25.5W | 2009 |
| 4 Pair PoE | TBD or 49W (min) | 2015 (est.) |
| 1 Pair Power over Data Lines | TBD | 2015 (est.) |

Backplane Roadmap



| PMD Name | Reach or Loss Budget | # of Lanes | Date Standard Ratified |
|--------------|----------------------|------------|------------------------|
| 1000BASE-KX | 1 m | 1 | 2007 |
| 10GBASE-KX4 | 1m | 4 | 2007 |
| 10GBASE-KR | 1 m | 1 | 2007 |
| 40GBASE-KR4 | 1m | 4 | 2010 |
| 100GBASE-KR4 | 35dB @ 12.9GHz | 4 | 2014 (est.) |
| 100GBASE-KP4 | 33dB @ 7GHz | 4 | 2014 (est.) |

40GbE Port Roadmap

- Physical Medium Dependent Sublayers for 40GbE

| PMD Name | Electrical Interface to Optical Module | Reach | Medium | Date Standard Ratified |
|-------------|--|-----------|---------|------------------------|
| 40GBASE-CR4 | Not Applicable | 7 m | Twinax | 2010 |
| 40GBASE-SR4 | XLAUI / XLPPI | 100/150 m | OM3/OM4 | 2010 |
| 40GBASE-LR4 | XLAUI / XLPPI | 10 km | OS1/OS2 | 2010 |
| 40GBASE-FR | XLAUI / XLPPI | 2 km | OS1/OS2 | 2011 |
| 40GBASE-ER4 | XLAUI / XLPPI | 40 km | OS1/OS2 | 2015 (est.) |
| 40GBASE-T | Not Applicable | 30 m | Cat 8 | 2016 (est.) |
| 40GBASE-SR* | XLAUI-1* | 100 m | OM4 | 2018 (est.) |
| 40GBASE-FR | XLAUI-1* | 2 km | OS1/OS2 | 2018 (est.) |

* Potential future development

100GbE Port Roadmap

- Physical Medium Dependent Sublayers for 100GbE

| PMD Name | Electrical Interface to Optical Module | Reach | Medium | Date Standard Ratified |
|---------------|--|-----------|---------|------------------------|
| 100GBASE-CR10 | N/A | 7 m | Twinax | 2010 |
| 100GBASE-SR10 | CAUI-10 | 100/150 m | OM3/OM4 | 2010 |
| 100GBASE-LR4 | CAUI-10 | 10 km | OS1/OS2 | 2010 |
| 100GBASE-ER4 | CAUI-10 | 40 km | OS1/OS2 | 2010 |
| 100GBASE-CR4 | N/A | 5 m | Twinax | 2014 (est.) |
| 100GBASE-SR4 | CAUI-4 | 70/100 m | OM3/OM4 | 2015 (est.) |
| 100GBASE-LR4 | CAUI-4 | 10 km | OS1/OS2 | 2015 (est.) |

400GbE Reach Objectives

The 400GbE Task Force has the following reach objectives that are subject to Working Group Approval:

- At least 100 m over MMF
 - At least 500 m over SMF
 - At least 2 km over SMF
 - At least 10km over SMF
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- For information on IEEE 802.3 projects, visit:
 - <http://www.ieee802.org/3/>

Summary

- Ethernet continues to improve with new standards and products that expand the Ethernet ecosystem
- Standards are increasing in speed to meet market demands
 - 100GbE Backplanes
 - 400GbE links
 - 40GBASE-T
- PoE is increasing the power delivered to end devices to enable more functionality
- New standards will be developed as they are needed and the Ethernet Alliance helps them progress