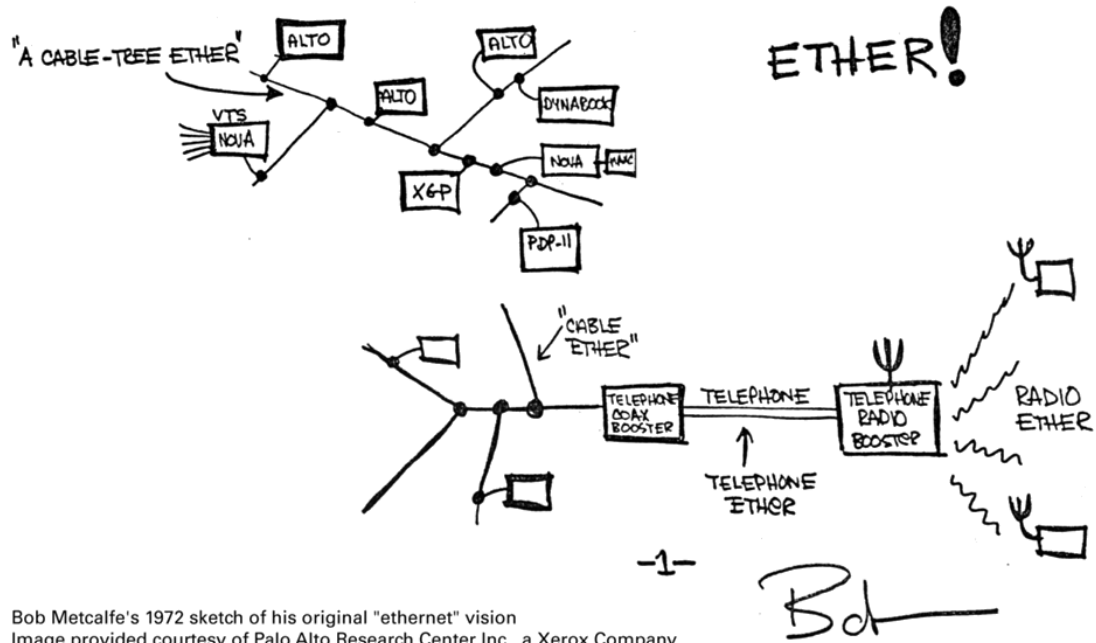


“Here is more rough stuff on the ALTO ALOHA network.”
Memo sent by Bob Metcalfe on May 22, 1973.



Bob Metcalfe's 1972 sketch of his original "ethernet" vision
Image provided courtesy of Palo Alto Research Center Inc., a Xerox Company

400 GBE: THE NEXT ETHERNET TECHNOLOGY EVOLUTION

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RIPE 66



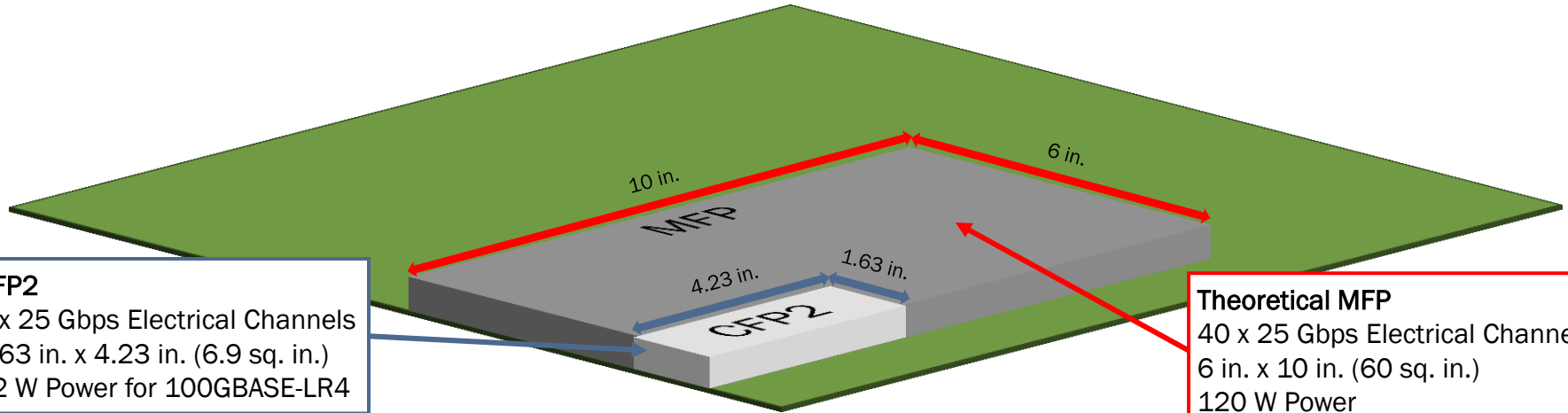
Why 400 GbE? Why not TbE?

- Given that TbE is technically and economically impractical to develop until 2020+ we had to make a choice
 - Wait... for >10 years between Ethernet speed increases (100 GbE June 2010)
 - Start a feasible higher speed Ethernet standard now that can be ready by 2016 when the market needs something faster
- IEEE 802.3 Ethernet Bandwidth Assessment (BWA) Ad Hoc and the IEEE 802.3 Higher Speed Ethernet (HSE) Consensus Ad Hoc spent a lot of time analyzing market demand and technical options
- High degree of consensus in the IEEE that 400 GbE should be the next Ethernet speed
 - CFI straw poll: yes 132, no 0, abstain 1
 - Motion for Study Group: yes 87, no 0, abstain 4
- This will make the standardization process faster compared to 802.3ba
 - IEEE 802.3 Higher Speed Study Group first had to analyze market demand and technical options
 - Eventually decided on 40 GbE and 100 GbE



Theoretical M (1000) Form-factor Pluggable

Using Today's Technology is Impractical



CFP2

4 x 25 Gbps Electrical Channels
1.63 in. x 4.23 in. (6.9 sq. in.)
12 W Power for 100GBASE-LR4

Theoretical MFP

40 x 25 Gbps Electrical Channels
6 in. x 10 in. (60 sq. in.)
120 W Power

- Using current technology 25 Gbps electrical signaling, a TbE module (MFP) would use 40 channels
- The size of the module can be estimated at $\frac{1}{2}$ sq. in. per W of power consumed
- If a CFP2 module consumes 12 W, then the MFP could consume 120 W
- This would require 60 sq. in. to cool and could make the module 6 in. by 10 in., taking up over 25% of the board space

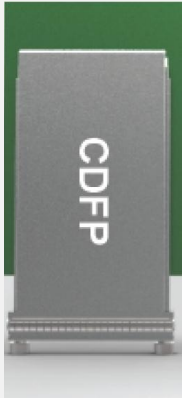
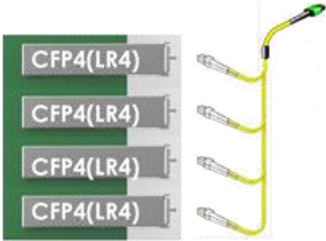


IEEE 802.3 400 Gb/s Ethernet Study Group

- 400 GbE Call-For-Interest (CFI) was presented at the March, 2013 IEEE Plenary
- Approved to be an official IEEE Study Group on March 22, 2013
 - 400 GbE Study Group will define the objectives for reach and media
 - 400 GbE standard expected in 2016
- Study Group web page <http://www.ieee802.org/3/400GSG/>
- CDFP (CD (400) Form-factor Pluggable) Multi-Sourcing Agreement (MSA) announced to develop specifications for high-density 400 GbE modules
- First interfaces expected to be available in 2016+



400 GbE Module Evolution Estimates

Each Module Increases Density, While Reducing Cost and Power

	1 st Generation		2 nd Generation	3 rd Generation
Year	2016	2016	2019+	2022+
Electrical Signaling	CDAUI-16 16 x 25 Gbps	CDAUI-16 16 x 25 Gbps	CDAUI-8 8 x 50 Gbps	CDAUI-4 4 x 100 Gbps
Media Module	 CDFP	 4 x CFP4	 CDFP2	 CDFP4

Images courtesy of TE Connectivity.

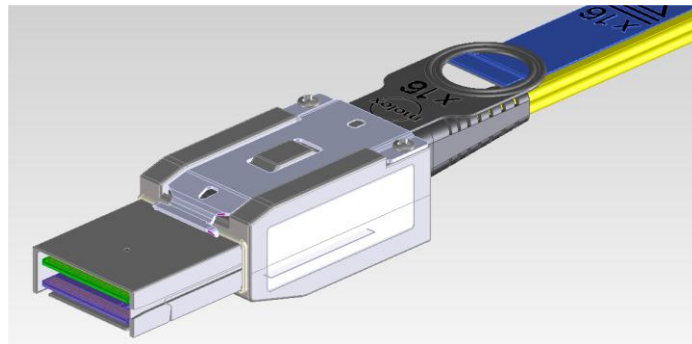
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400 GbE CDFP Module Overview

- The CDFP MSA will define a specification for a module and the supporting hardware for a high-density 400 Gigabit Ethernet (400 GbE) based on 16 x 25 Gbps signaling
 - CD = 400 in Roman numerals, C = 100 and D = 500
 - FP = Form-factor Pluggable, follows the naming convention started in 1999 with the SFP – Small Form-factor Pluggable
 - MSA = Multi-Sourcing Agreement, a legal document that defines a group that will define a specification for how to make and license the technology

Electrical Interface
16 x 25 Gbps in Each Direction



Optical Interface
With Two 16 Fiber Ribbons
(16 Transmit Fibers + 16 Receiver
Fibers)

Prototype CDFP Module

CDFP Switch Overview

- The CDFP module will be defined to support several modules in a 1 RU (19") switch or modular switch blade to yield 4 Tbps of throughput

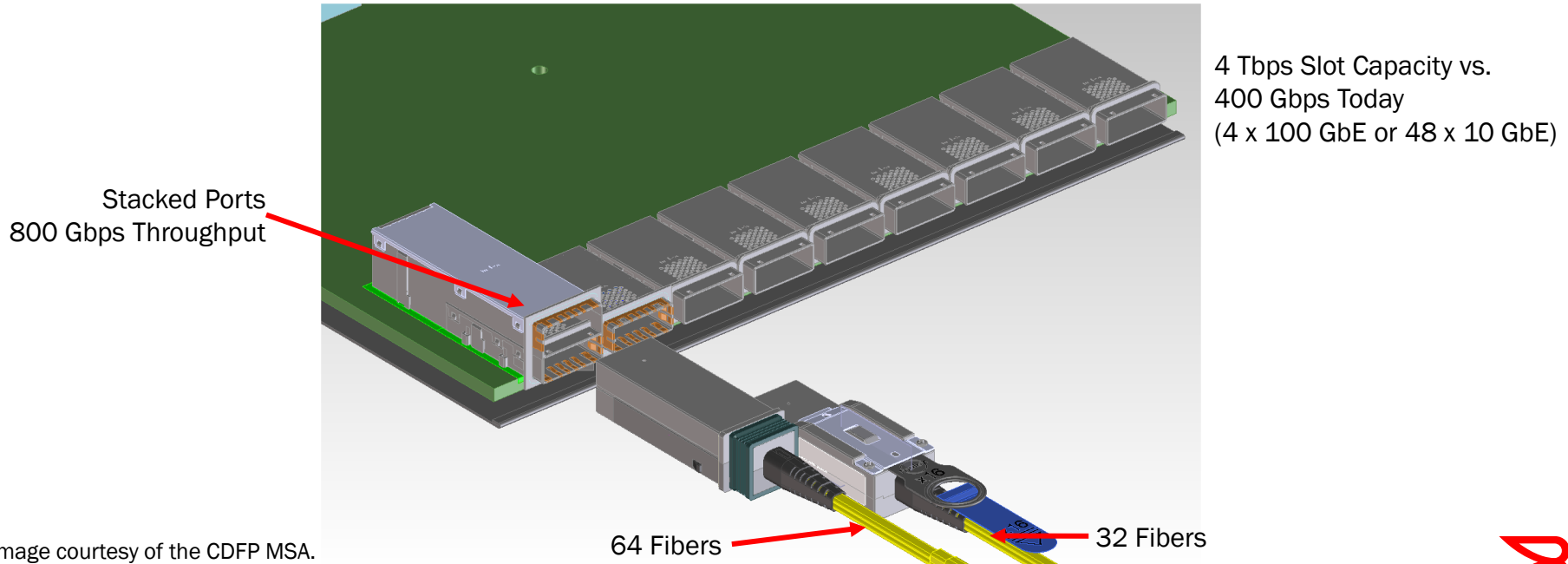


Image courtesy of the CDFP MSA.

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More Information

- IEEE 802.3 Industry Connections Ethernet Bandwidth Assessment Ad Hoc
http://www.ieee802.org/3/ad_hoc/bwa/index.html
- IEEE 802.3 Industry Connections Higher Speed Ethernet Consensus Ad Hoc
http://www.ieee802.org/3/ad_hoc/hse/public/index.html
- IEEE 802.3 Higher Speed Study Group
<http://www.ieee802.org/3/hssg/index.html>
- IEEE 400 GbE Call-For-Interest presentation
http://www.ieee802.org/3/cfi/0313_1/CFI_01_0313.pdf



QUESTIONS?

