

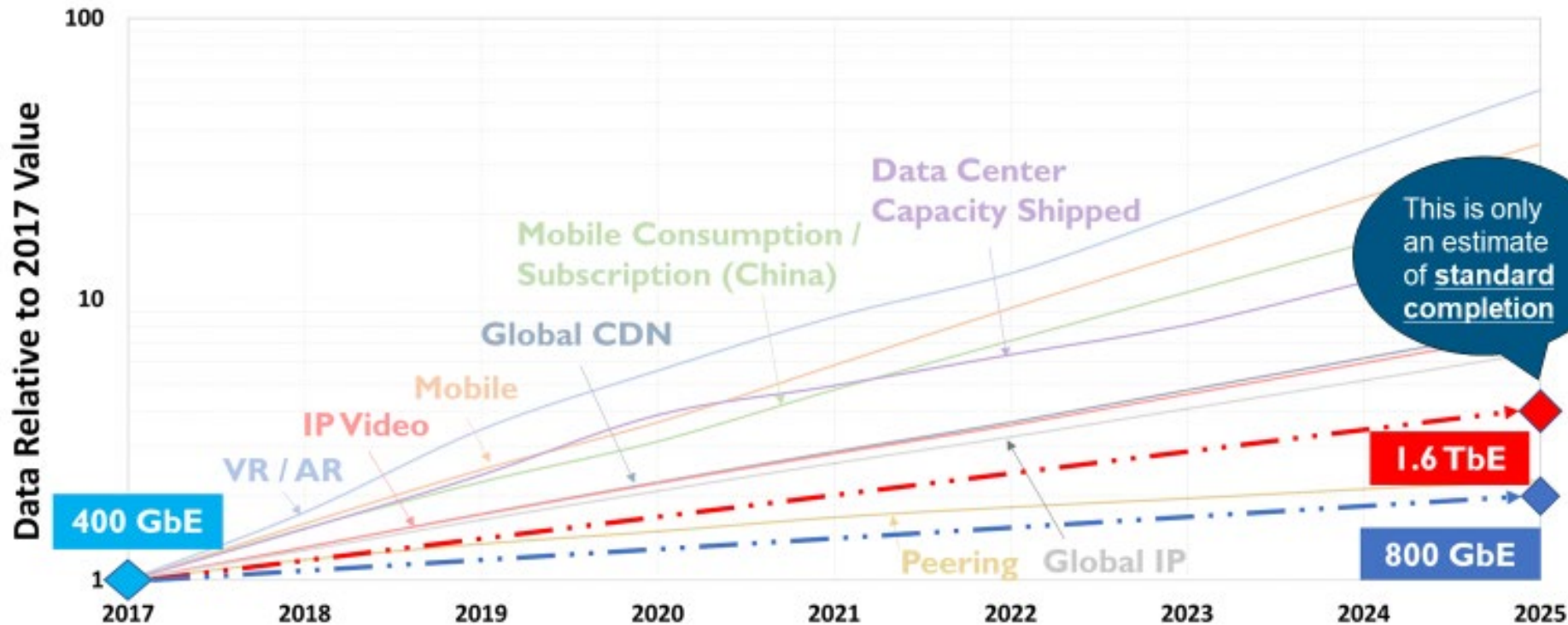
Long Term Consideration Regarding Rate Choice

**IEEE 802.3 Beyond 400 Gb/s Ethernet Study Group
February 2021 Series**

**John D'Ambrosia,
Futurewei, U.S. Subsidiary of Huawei
08 Feb 2021 Interim Electronic Meeting**

The Start of Interest in the Study Group

CONSIDERING THE NEXT ETHERNET RATE STANDARD

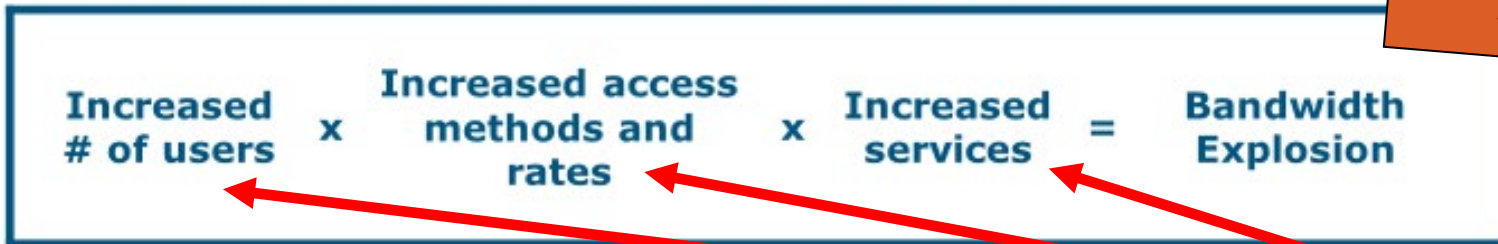


Source: <https://bit.ly/802d3bwa2>

From the CFI Consensus Presentation

THE SONG REMAINS THE SAME

- 2020 Ethernet Bandwidth Assessment (BWA) documented latest analysis of industry bandwidth needs and driving factors



Primary Interest

- 2020 Ethernet BWA
 - Report - <https://bit.ly/802d3bwa2>
 - Tutorial - https://bit.ly/802d3bwa2_tut
- Reference slides in Appendix: Backup Slides

Underlying Factors

Internet Usage Estimates – Total World *

| | As of 3/31/19 ** | As of 12/31/20*** | Change |
|------------------|------------------|-------------------|--------|
| Population | 7 716 223 209 | 7,838,004,158 | +1.6% |
| Internet Users | 4 383 810 342 | 4,949,868,338 | +12.9% |
| Penetration Rate | 57% | 63.2 % | 6.2% |

Per IEEE 802.3 2020 Ethernet Bandwidth Assessment – Average Traffic Per user per month forecasted to grow from 29 to 85 GB per month for 2017 to 2022 period (193% Growth!)

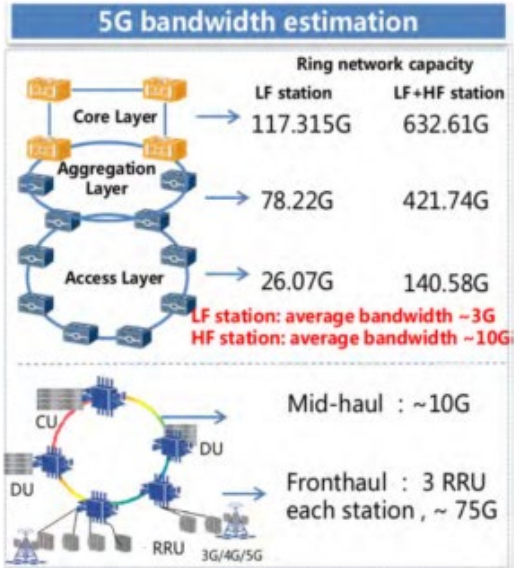
* Internet World Stats - [World Internet Users Statistics and 2021 World Population Stats \(internetworldstats.com\)](https://www.internetworldstats.com)

** Recorded in IEEE 802.3 2020 Ethernet Bandwidth Assessment

*** Noted on 2/5/21

5G Deployment Forecast

EXAMPLE EMERGING APPLICATION – 5G BACKHAUL



Source: http://www.ieee802.org/3/B10K/public/18_01/wang_b10k_01b_0118.pdf

| # of Networks Deployed | LTE | LTE Advanced | 5G |
|---------------------------|-----|--------------|-----|
| Africa | 145 | 42 | 4 |
| Asia & Pacific | 162 | 74 | 29 |
| Eastern Europe | 93 | 59 | 14 |
| Latin America & Caribbean | 127 | 50 | 8 |
| Middle East | 44 | 29 | 12 |
| U S & Canada | 20 | 11 | 7 |
| Western Europe | 88 | 70 | 31 |
| Global Totals | 683 | 335 | 105 |

Source: as of 8/14/2020, <https://www.5gamericas.org/resources/deployments/>



Update

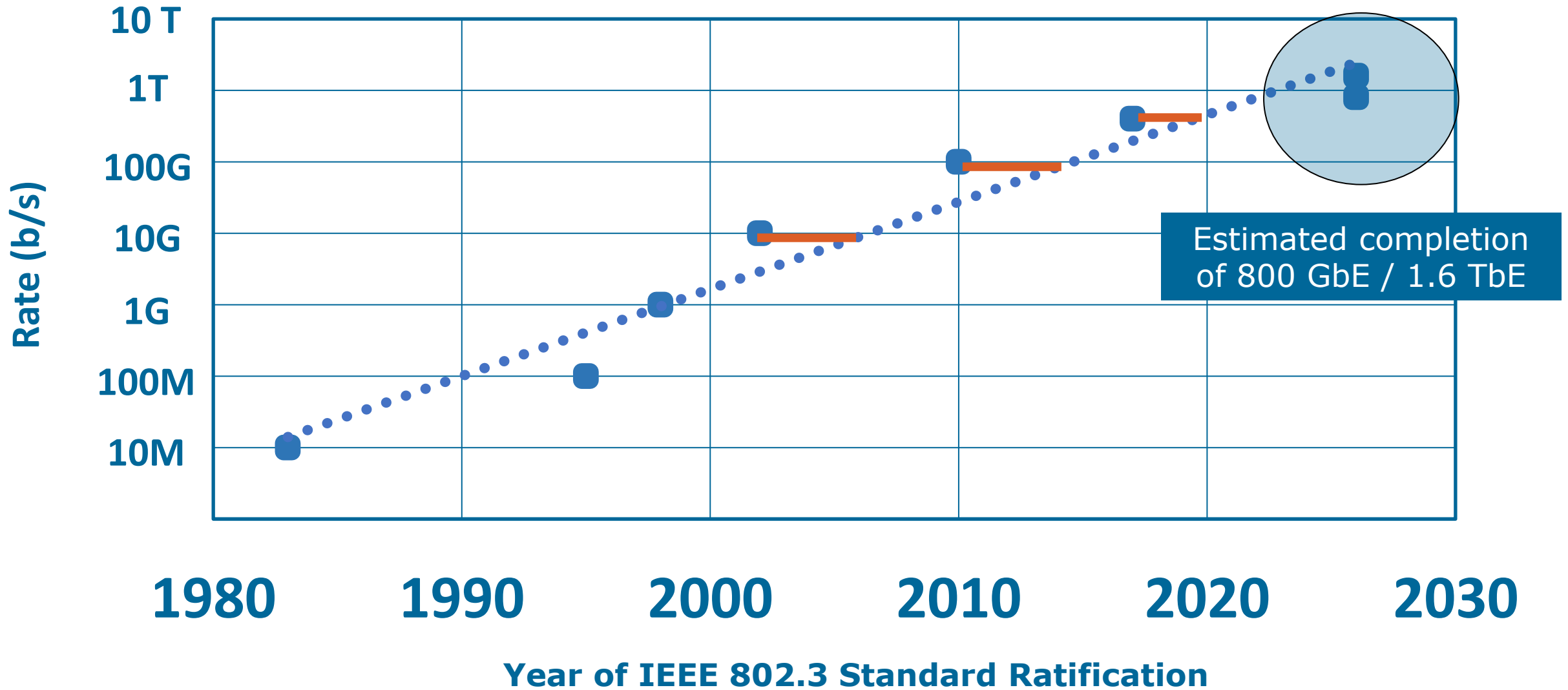
- As of 1/18/21 - 5G Networks Deployed – 156 *
- Forecast Global 5G Connections – 1.3 Billion by end of 2023 **

* Noted on 2/5/21 - <https://www.5gamericas.org/resources/deployments/>

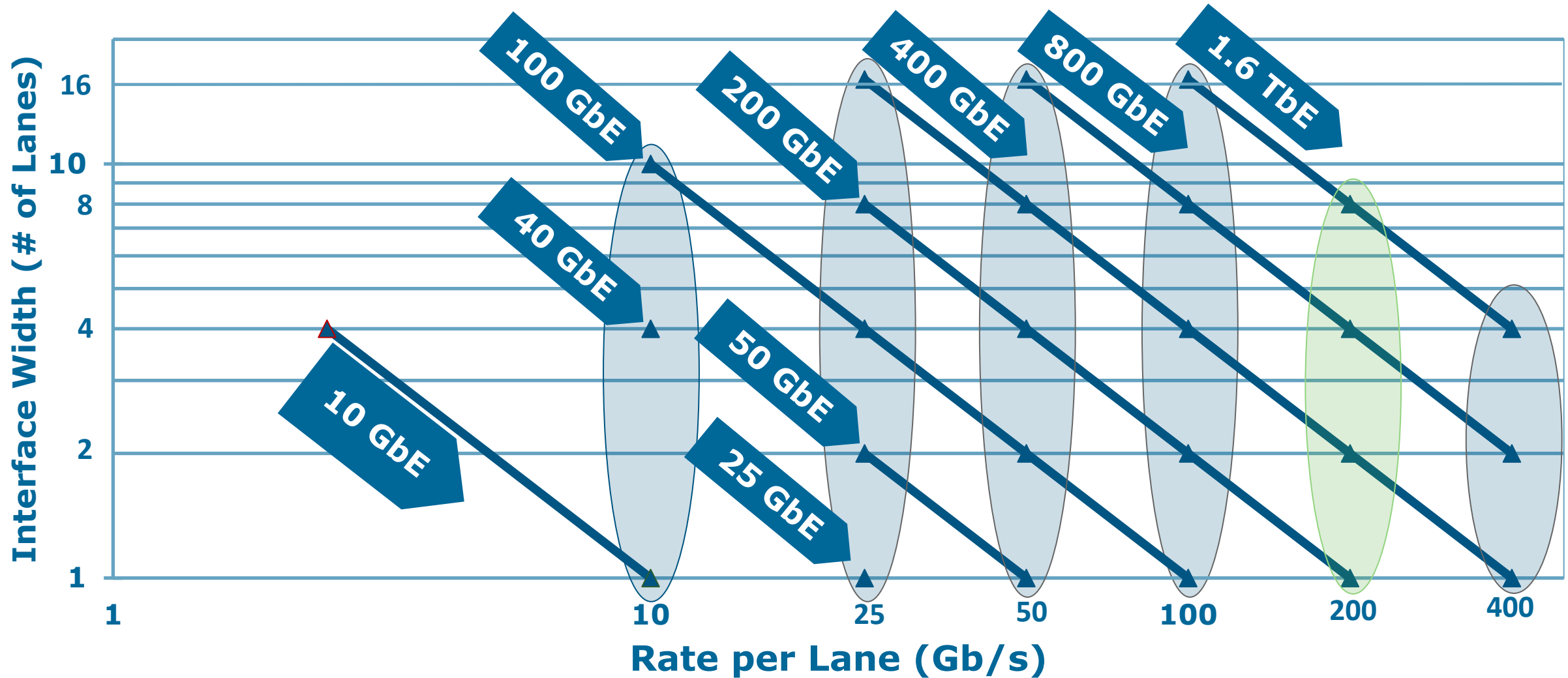
** <https://www.5gamericas.org/global-forecast-2023-10-billion-mobile-connections-including-1-3-billion-5g-connections/>

Per Beyond 400 Gb/s Ethernet CFI Consensus Presentation

Considering Ethernet Rate Development



The Basic Math of Ethernet



The Move to 200 Gb/s Signaling

Potential for Technology Reuse

Reuse of signaling rate technologies developed for higher Ethernet rates enables existing lower speed Ethernet rate specifications (AUI, -KR, -CR, -SR, -DR, -FR, -LR, -ER)



Image courtesy of David Piehler, Dell Technologies

- 32 - 400 Gb/s capacity ports
- Can be configured to support 32 - 400 GbE ports
- Can be configured to support 128 - 100 GbE ports

Per
nowell_b4000g_01_210118 –
“Lack of 1.6 TbE doesn’t preclude
1.6T pluggable modules (e.g. 2x
800 GbE)”

TODAY

A POSSIBLE FUTURE



“It has been my experience at Google that we have used optical and copper modules to support different configurations of a given port, including applications that require the maximum capacity of the single port.”

Cedric Lam, Google

Source: IEEE 802.3 NEA Ad hoc - Beyond 400 Gb/s Ethernet CFI Consensus Presentation, https://bit.ly/B400G_CFI

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Source: dambrosia_B400G_02a_210114

Looking Ahead

- **Bandwidth consumption will continue “up and to the right”**
- **Underlying factors for “bandwidth consumption” engine continue**
 - **Internet Usage Growth**
 - **Average Consumption Per User**
 - **Higher speed access through 5G being deployed rapidly**
- **IMO (based on my discussions as SG Chair) – there is strong interest in developing 200 Gb/s signaling for this project**
 - **Assuming x8 modules will exist – 1.6Tb/s capacity based on 200 Gb/s are already being considered**
 - **The development of 200 Gb/s signaling for parallel electrical interfaces enables both 800 Gb/s and 1.6 Tb/s Ethernet rates**
 - **If a PHY targeting an optical parallel medium (SR / DR) based on 200 Gb/s signaling is viable and desirable, then objectives for all of the “1/2/4/8 lanes” variants (i.e existing and new Ethernet rates) should be considered**

Recommendations

- **If Study Group determines that 200 Gb/s electrical signaling for AUI's is viable for this effort, then the following objectives should be included in this project –**
 - **Support a MAC data rate of 800 Gb/s**
 - **Support a MAC data rate of 1.6 Tb/s**

- **If a PHY targeting an optical parallel medium (such as SR or DR) based on 200 Gb/s signaling is viable and desirable, then objectives for all of the “1/2/4/8 lanes” variants (i.e existing and new Ethernet rates) should be considered**
 - **Note – each objective needs to be evaluated independently to confirm it meets 5 criteria before adopting**