Ethernet Past and Future
Finding The Right Lever

Peter Jones – Principal Engineer – Cisco Systems
CHI-NOG 08
Ethernet Past and Future
Finding The Right Lever

Peter Jones – Distinguished Engineer – Cisco Systems
CHI-NOG 08
I'm a Distinguished Engineer within the Catalyst development team, and have been with Cisco for since 2005.

I work on capabilities and solutions in Catalyst system architecture (ASIC/Hardware/Software) that may be up to 5 (or more) years out.

I work in industry bodies (e.g. IEEE 802.3, NBASE-T Alliance, Ethernet Alliance, ...) to define and promote new Ethernet Standards.

I'm interested in Infrastructure Evolution and Consumable Technology.

Peter Jones - Principal Engineer
petejone@cisco.com
@petergjones
about.me/petergjones
Agenda

- The First 4 Decades
- Forecasts
- Ecosystem
- NBASE-T
- 25G outside the DC
- 10Mb/s Single Pair Copper
- Wrapup

“The Ethernet Memo” by Bob Metcalfe, May 22, 1973
The First 4 Decades
When did it start?

Ethernet is older than lots of the people in this room

- Bob Metcalf wrote “The Ethernet Memo” at Xerox PARC May 22 1973
- “Multipoint data communication system with collision detection” patent March 31 1975
- IEEE 802.3a (10Base2 10MBit/s over thin coax) Standard approved in 1983
Twisted Pair

How much?
• **4+ Billion** 100/1000BASE-T switch ports in last 20 years
• **~1Billion** BASE-T ports/year port total

Why choose BASE-T?
• Ease of use (e.g., Structured cabling)
• Incremental speed upgrades
• Power and data on single cable
2.5G/5G BASE-T?

Between 2003 to 2014 ~70 billion meters of Cat 5e and Cat 6 cabling were sold….

• ~90% of installed base
• 1.3B outlets in 2014, plus 110M per year
• Enormous network infrastructure asset

10 meters of cabling for everyone on Earth
Released March 2018
Activity in 10Mb/s to 400Gb/s

Get it from https://ethernetalliance.org/the-2018-ethernet-roadmap/
Forecasts
Copper Cable

It’s here to stay

Global sales of copper cabling in LAN, million outlets/drops, 2015 – 2021

Source: BSRIA survey and modelling May 2017
Copper Cable

Used for?

Outlets/nodes/links, Data, WAPs and IoT, US, million units, 2015 – 2021

Source: BSRIA survey and modelling May 2017
Switch ports 2001 - 2022
Ethernet Switch Ports
Dell’Oro Group Ethernet Switch 5-year Forecast Jan 2018

New, fast, exciting != volume
Lots of <=10Gb/s ports
Installed Base by Speed

Enterprise Ethernet Switch Installed Base (1.2 B at end of 2017)
650 Group Ethernet Switch Long-Term Forecast Dec 2017

- 100 Mbps
- 1 Gbps
- >1 Gbps
Move to wireless

Ethernet vs 802.11 connections
650 Group Unified Access Long-Term Forecast Dec 2017
WiFi Trends

802.11 connections by type
650 Group WLAN Long-Term Forecast Dec 2017

AP Units


- 802.11n and earlier
- 802.11ac-1
- 802.11ac-2
- 802.11ax
802.3 & 802.11

“NBASE-T will transition wireless LAN to being additive to the Ethernet switch market”
Ecosystem
Industry Ecosystem

- IEEE 802.3 Ethernet Working Group (link)
- IETF (link)
- Optical Inter-networking Forum (link)
- NB-TE Alliance (link)
- Ethernet Alliance (link)
- ISO/IEC JTC1/SC25 WG3 (link) TIA TR-42 (link)
- BICSI - Building Industry Consulting Service International (link)
From Customers/Field

Customers/Field (you) → Me

IEEE 802.3 Ethernet Working Group (link)
IETF (link)
Optical Inter-networking Forum (link)
IEEE 802.3 Ethernet Working Group (link)
Ethernet Alliance (link)
BICSI - Building Industry Consulting Service International (link)
ISO/IEC JTC1/SC25 WG3 (link)
TIA TR-42 (link)
NBASE-T Alliance (link)
From Industry

Customers/Field (you)

Me

IEEE 802.3 Ethernet Working Group (link)

IETF (link)

Optical Inter-networking Forum (link)

NBAS-T Alliance (link)

IEEE 802.3 Ethernet Working Group (link)

Ethernet Alliance (link)

BICSI - Building Industry Consulting Service International (link)

ISO/IEC JTC1/SC25 WG3 (link)

TIA TR-42 (link)
What’s IEEE 802.3 doing? (and what I am doing there?)

IEEE 802.3 ETHERNET WORKING GROUP

- The IEEE 802.3 Working Group develops standards for Ethernet networks. We have a number of active projects, study groups, and ad hocs as listed below:
  - IEEE P802.3bt **DTE Power via MDI over 4-Pair Task Force.**
  - IEEE P802.3ca **25 Gb/s, 50 Gb/s, and 100 Gb/s Ethernet Passive Optical Networks Task Force.**
  - IEEE P802.3cb **2.5 Gb/s and 5 Gb/s Backplane Task Force.**
  - IEEE P802.3cd **50 Gb/s, 100 Gb/s, and 200 Gb/s Ethernet Task Force.**
  - IEEE P802.3.2 (IEEE 802.3cf) **YANG Data Model Definitions Task Force.**
  - IEEE P802.3cg **10 Mb/s Single Twisted Pair Ethernet Task Force.**
  - IEEE P802.3ch **Multi-Gig Automotive Ethernet PHY Task Force.**
  - IEEE P802.3 Revision to IEEE Std 802.3-2015 (IEEE 802.3cj) **Maintenance #12 Task Force.**
  - IEEE 802.3 **Beyond 10 km Optical PHYs Study Group.**
  - IEEE 802.3 **10 Mb/s Backplane Ethernet Study Group.**
  - IEEE 802.3 **100 Gb/s per Lane Electrical Study Group.**
  - IEEE 802.3 **Next-generation 200 Gb/s and 400 Gb/s MMF PHYs Study Group.**
  - IEEE 802.3 **Bidirectional 10 Gb/s and 25 Gb/s Optical Access PHYs Study Group.**
  - IEEE 802.3 **New Ethernet Applications Ad Hoc.**
  - IEEE 802.3 **SCC18 Ad Hoc.**
  - IEEE 802.3 **Isolation Ad Hoc.**
NBASE-T/mGig

Thanks to the NBASE-T Alliance for providing reference material and images used in this presentation.
NBASE-T Alliance

Overview

- NBASE-T Alliance (www.nbaset.org/)
  - Vendor alliance for 2.5G/5G BASE-T
  - Public info – check http://www.nbaset.org/library/

- Who is in the Alliance?
  - Network infrastructure companies, e.g., components, systems, cabling, testing equipment, ....

- Alliance roles?
  - Educate the market
  - Facilitate interoperability
  - Enable widespread deployment
  - Augment the specification if needed

Strength: Full Ecosystem

Success: 802.3 standard in < 2 years, fastest growing market area
NBASE-T Application Areas

Enterprise:
- Switch
- Wireless AP
- Desktop
- Storage
- Small Cell

Industrial:
- Switch
- Wireless AP
- Workstation
- Storage
- Compute
- Machine Vision

Home:
- Switch
- Wireless AP
- Storage Server
- Home Gateway
- Streaming

Service Provider:
- Small Cell
- Home Gateway

NBASE-T Application Areas

Enterprise:
- Switch
- Wireless AP
- Desktop
- Storage
- Small Cell

Industrial:
- Switch
- Wireless AP
- Workstation
- Storage
- Compute
- Machine Vision

Home:
- Switch
- Wireless AP
- Storage Server
- Home Gateway
- Streaming

Service Provider:
- Small Cell
- Home Gateway

NBASE-T Application Areas

Enterprise:
- Switch
- Wireless AP
- Desktop
- Storage
- Small Cell

Industrial:
- Switch
- Wireless AP
- Workstation
- Storage
- Compute
- Machine Vision

Home:
- Switch
- Wireless AP
- Storage Server
- Home Gateway
- Streaming

Service Provider:
- Small Cell
- Home Gateway

[Diagram showing different application areas for NBASE-T]

NBASE-T Application Areas

Enterprise:
- Switch
- Wireless AP
- Desktop
- Storage
- Small Cell

Industrial:
- Switch
- Wireless AP
- Workstation
- Storage
- Compute
- Machine Vision

Home:
- Switch
- Wireless AP
- Storage Server
- Home Gateway
- Streaming

Service Provider:
- Small Cell
- Home Gateway

NBASE-T Questions and Answers

Three Questions

- Who needs > 1Gb/s?
- Roadblocks?
- Value of NBASE-T?

Three Answers

- Digital Transformation is here
- Installed cabling asset
- Upgrade the network, not the building
Use Cases
Overview

Enterprise Wireless - University of British Columbia

Scientific Compute - Monash Pharma

Cruise Ships - Carnival/Princess
UBC and Wireless

- Good WiFi is table stakes for universities.
- Huge wireless network (5000 APs), < 6 SSIDs in all.
- Policy/VRF based on identity

- 802.11AC Wave2 and NBASE-T.
- Supporting challenging environment.
- Excellent service delivered.
Monash Pharma & NBASE-T
Massive Data Capture and Analysis

Needs and restrictions:
- High bandwidth for large data transfers
  - One microscope produces 500GB images
  - Others only 200-300GB.
- Using “regular enterprise network service”, not funded for a dedicated network

Q: “How can we get more done?"

Impact of NBASE-T:
- Cisco switches & ASUS NICs (~$130) delivering 5-10Gb/s.
- Data transfers 4-5X faster, enables new work
- IT/networking able to say “Yes”

A: “Remove the bottleneck with NBASE-T”
Resort Hotel vs. Cruise Ship

Encore Las Vegas

https://www.emporis.com/buildings/216660/encore-las-vegas-nv-usa
https://en.wikipedia.org/wiki/Encore_Las_Vegas

Opened: 2008
Rooms: 2,034
Floors: 48

Floor Space: 4.5 million sqft
Height: 631 feet
Width: 93 feet

Regal Princess


Inaugural Cruise: 2014
Cabins/Guests: 1,780/3,560
Decks: 19

Tonnage: 141,000
Length: 1,083 feet
Height: 217 feet
Networks on Cruise Ships
Like an Enterprise Network, but…


- Fire zones
- Power/cooling/airflow
- Built Offshore
- 30 year design lifespan
Product Sampler
more at www.nbaset.org

https://www.apple.com/imac-pro

https://www.e2v.com/products/imaging/cameras/uniiqa-4k-mono-and-colour/

Pro Gaming Multi-Gig Ethernet Switch
http://www.netgear.com/npg/sx10/

NBASE-T – Key Industry Messages

NBASE-T will transition wireless LAN to being additive to the Ethernet switch market. NBASE-T will require higher speeds through the network and drive higher prices which will amplify revenue growth.

NBASE-T will play a critical role as PCs, APs, and other IOT devices begin to drive connections in excess of 1 Gbps. NBASE-T is continuing to gain traction with all campus switch vendors expected to ship offering by the end of 2018 and port shipments expanding to be a significant portion of the enterprise market.

The growth of NBASE-T in the enterprise market is accelerating rapidly. It’s key that CIM help its readers maximize the benefits for their customers and networks. I look forward to working with the NBASE-T alliance and the Ethernet ecosystem to continue to deliver trusted advice to the industry.

Tam Dell’Oro
Founder & CEO, Dell’Oro Group
January 2018

Alan Weckel
Founder & Technology Analyst
650 Group
January 2018

Patrick McLaughlin
Chief Editor –
Cabling Installation and Maintenance
February 2018
Where Next?

802.3 rule: 10X the speed for 3x the cost

OK – then what?

Speciation fills in ecosystem

25G outside the DC
25Gb/s Ethernet

What
25Gb/s single lane Ethernet over Twinax (3-5m), BASE-T (30m), MMF (100m), SMF (10km, 40km)

Why
Evolution from 10Gb/s, first in DC, then spreading to SP, Campus

Status
IEEE Std 802.3by-2016 approved June 2016
802.3cc 25 Gb/s Ethernet over SMF Task Force targeting completion October 2017
25Gb/s Ethernet plus what?

What Are We Talking About?

- Application spaces that could move to 25Gb/s lanes (1X or 4X) over SMF.
- 25GbE SMF provides optimized single lane switch/router connectivity
- Enable 25GbE to move from DC to campus and beyond.

25Gb/s SMF Ethernet

IEEE Standard for Ethernet

Amendment 11: Physical and Link Parameters for Serial Data on Single-Mode Fiber Optic Links

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee

Connect with us on:
Facebook: https://www.facebook.com/ieee
Twitter: @ieee
LinkedIn: http://www.linkedin.com/groups/IEEE-Offical-IEEE-Standards-Association-1791118
IEEE-SA Standards Insight blog: http://standardsinsight.com
YouTube: IEEE-SA Channel

IEEE
standards.ieee.org
Phone: +1 732 981 0060 Fax: +1 732 562 1571
© IEEE

Started November 2015
Finished December 2017
10Mb/s again?
Really?
Why 10Mb/s (Back to the Future)

Ethernet Gap in Industrial Networking

- Desire to converge on one network type
- Ethernet adoption is happening where technically possible
- Non-Ethernet fieldbuses still required to complete communications to the edge
  - Cable lengths > 1km
  - 1200 baud to hundreds of kb/sec
  - Challenges: Combined reach & rate, special environments, cost of operation

Credit: Dr. Raimund Sommer, Endress + Hauser, ODVA Industry Conference, Oct. 2014.
10Mb/s Ethernet – Fieldbus Upgrade

Why 10Mb/s and Extended Reach?

- A new solution is required to cover a range of reach and rate with a single design
- 10Mb/s (a standard MAC) and 1200m address most fieldbus applications
- Study group will consider, but not expected to cover all extremes/outliers

Fieldbus Reach and Rate

- PROFINET DP
- CANopen
- Modbus RTU
- CC-Link
- HART
- DeviceNet
- ControlNet
- Interbus
10Mb/s Ethernet – Fieldbus Upgrade

Why Single Twisted Pair?

- Enables cable reuse
  - Installed base of Single Twisted Pair, usually shielded
  - Certain cables are certified
  - Lengthy fieldbus cables are expensive to install (often in filled conduit)
- End nodes are easier to replace
- Similar value proposition to 2.5G/5GBASE-T Task Force
- Enables constrained form factor applications (sensors etc.)
  - Reduced size and cost

<table>
<thead>
<tr>
<th>Fieldbus</th>
<th>Cable Type</th>
<th>Cable Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOUNDATION H1</td>
<td>FF-844 specified</td>
<td>Yes</td>
</tr>
<tr>
<td>HART</td>
<td>Various</td>
<td>Yes</td>
</tr>
<tr>
<td>PROFIBUS PA</td>
<td>IEC 61158 Type A</td>
<td>Yes</td>
</tr>
<tr>
<td>4-20mA</td>
<td>SP-50 instrumentation cable</td>
<td>Yes</td>
</tr>
<tr>
<td>CANopen</td>
<td>EIA-485</td>
<td>Yes</td>
</tr>
<tr>
<td>Modbus RTU</td>
<td>EIA-485</td>
<td>No</td>
</tr>
<tr>
<td>CC-Link</td>
<td>CC-Link, Ver.1.10 specified Shielded, 3- &amp; 5-core</td>
<td>No</td>
</tr>
<tr>
<td>DeviceNet</td>
<td>ODVA DeviceNet specified (5-core, various classes)</td>
<td>Yes</td>
</tr>
<tr>
<td>ControlNet</td>
<td>RG-6/U Coaxial</td>
<td>No</td>
</tr>
<tr>
<td>INTERBUS</td>
<td>3 / 6 no. twisted pairs, various</td>
<td>Yes</td>
</tr>
<tr>
<td>PROFIBUS DP</td>
<td>IEC 61158 Type A (22AWG?)</td>
<td>No</td>
</tr>
</tbody>
</table>
10Mb/s Ethernet – Fieldbus Upgrade

IEEE 802.3cg – 10Mb/s Single Pair Ethernet (10SPE)
http://www.ieee802.org/3/cg/

CSMA/CD is BACK!
Multidrop + power over ~25-50m
10SPE Example
Kone & Elevators
Who is Kone?

KONE Corporation was founded in 1910 and is headquartered in Espoo near Helsinki, Finland. Kone is an international engineering and service company employing some 52,000 personnel worldwide.

The firm is the 4th largest manufacturer of elevators and escalators worldwide, and also provides maintenance services and modernization.

https://en.wikipedia.org/wiki/Kone
What’s the goal?

IMPROVING THE FLOW OF URBAN LIFE

We provide industry-leading elevators, escalators, autowalks, automatic doors and access, as well as innovative solutions for maintenance and modernisation.
On their mind?

Intelligent elevators are here: let them talk in real-time around the clock.

Coming soon - service updates on the go with KONE Mobile.

www.kone.com.au
Kone elevator network structure

A typical elevator

Layered architecture (bottom-to-top):
- User I/O and sensors
- Elevator and motion control
- Group control
  - Single units are often linked into groups of 2-16 single units via networks
- Site control and supervision
  - Groups are often linked into site control and supervision groups via networks
- Cloud
  - Sites are monitored and controlled remotely
Kone elevator network requirements

Requirements for elevator communication systems

- Requirements of today's communication systems include but is not limited to following:
  - Edge computing
  - Functional safety, time deterministic behavior
  - Voice and video streaming
  - Power over network
  - Software upgrade possibility
  - Cyber security
  - Single common frame format
  - Single diagnostic process/tool for all comm. wires

- Ethernet based communication networks can meet all these needs
  - Problem so far has been cost and size of components as well as lack of multidrop technology
10SPE for Elevators

IEEE 802.3cg 10 Mb/s Single Pair Ethernet (10SPE)

- IEEE 802.3cg single pair Ethernet could be a driver to transform elevators and escalators into Ethernet World
  - 10SPE gives over two magnitudes better bandwidth than legacy systems
  - Multidrop included
  - Power over data line
  - Strong standardization support

- It can be estimate that half of the 20 million nodes per year market could be Ethernet-based in ten years' time
My next windmill

https://en.wikipedia.org/wiki/Tilting_at_windmills

Don Quixote


Single Pair Ethernet
Single Pair Ethernet: Follow the BASE-T journey

• 1000 BASE-T most successful Ethernet standard
• 4+ Billion 100/1000 BASE-T switch ports
• BASE-T port total is ~1Billion/year

Key Attributes:
• Power+Data
• Structured cabling
• Standard Connectors
Wrap-up
The fastest speeds... need specific infrastructure!

Rethink possible...

... add Value

Evolve the network, enable the business

Cat5e/6

Cat6A
Thanks
Thank you