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Ethernet Past and Future Finding The Right Lever

Peter Jones – Principal Engineer – Cisco Systems

CHI-NOG 08





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Peter Jones – *Distinguished* Engineer – Cisco Systems

CHI-NOG 08



By Way of Introduction ...

Sandgroper

means

a person from Western Australia

Sandgroppers!
Living 4 times
as big as Texas!

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**

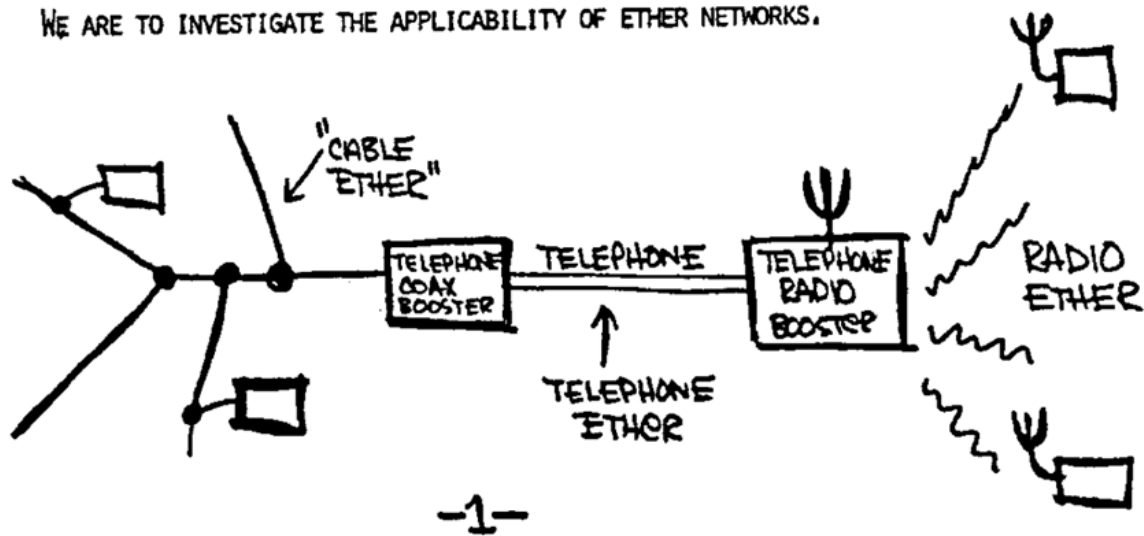
Peter Jones - Principal Engineer

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



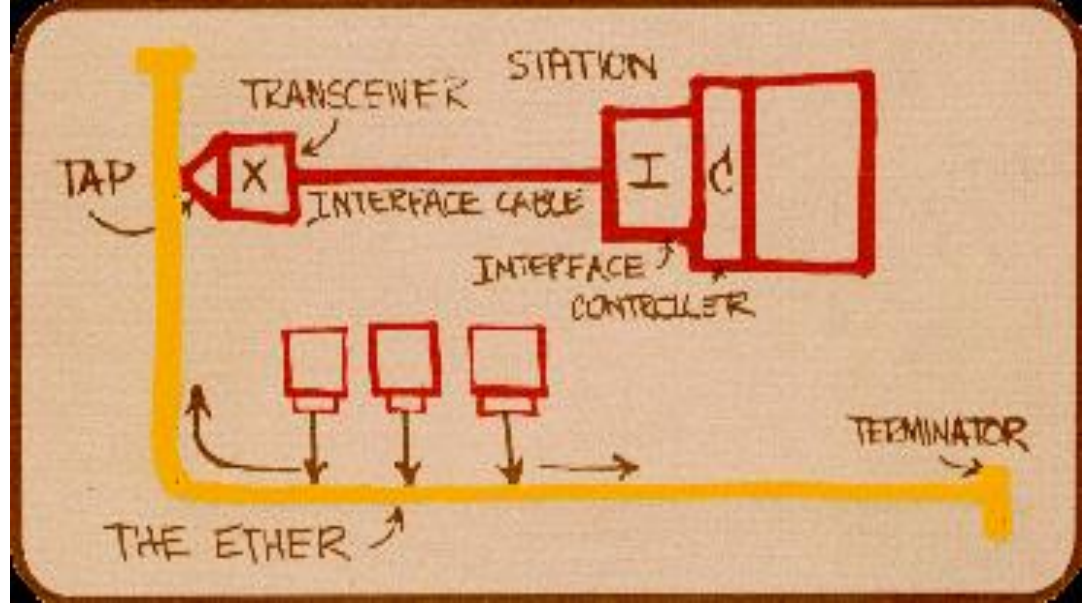
"The Ethernet Memo" by Bob Metcalfe, May 22, 1973



The First 4 Decades



When did it start?



Hand drawn by Robert M. Metcalfe in 1976, photographed by David R. Boggs for a 35mm slide to present Ethernet to the National Computer Conference.

http://www.ieee802.org/3/ethernet_diag.html

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

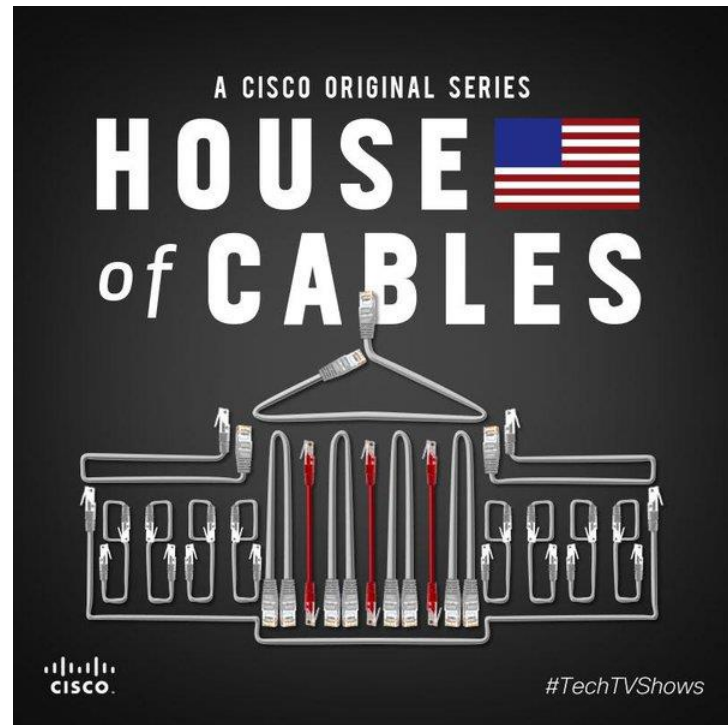
Twisted Pair

How much?

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

Why choose BASE-T?

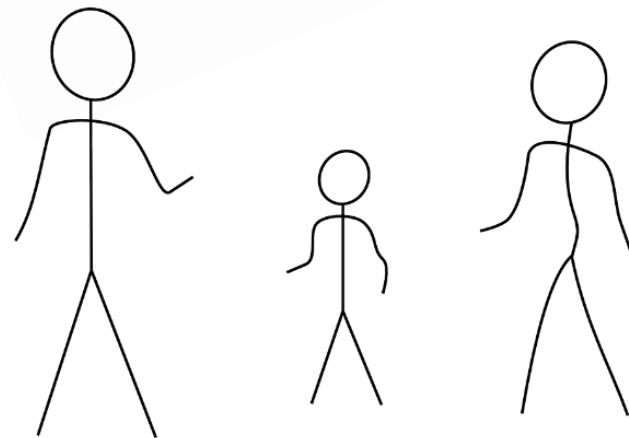
- Ease of use (e.g., Structured cabling)
- Incremental speed upgrades
- Power and data on single cable



2.5G/5G BASE-T?

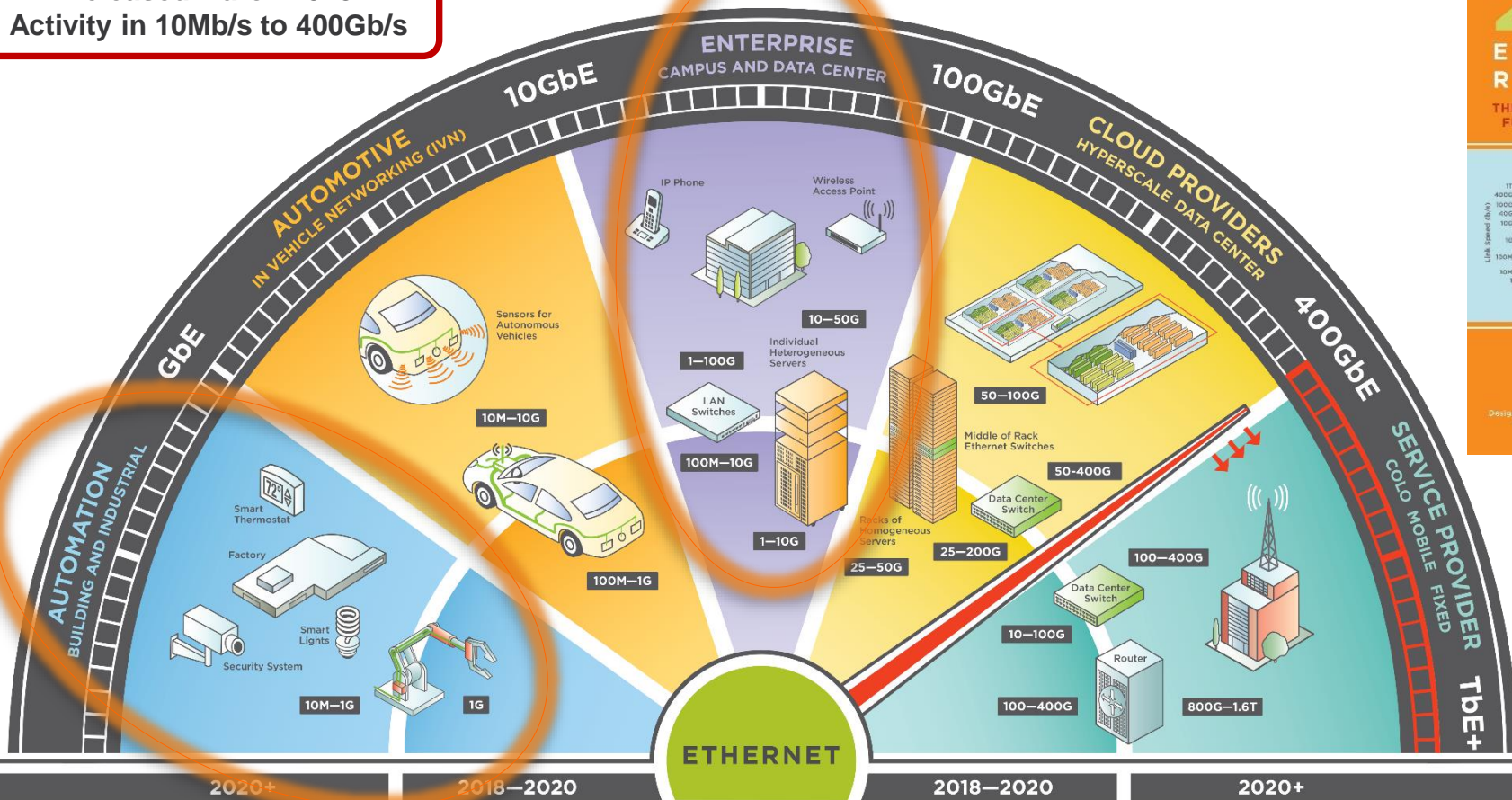
Between 2003 to 2014 **~70 billion meters** of Cat 5e and Cat 6 cabling were sold....

- ~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



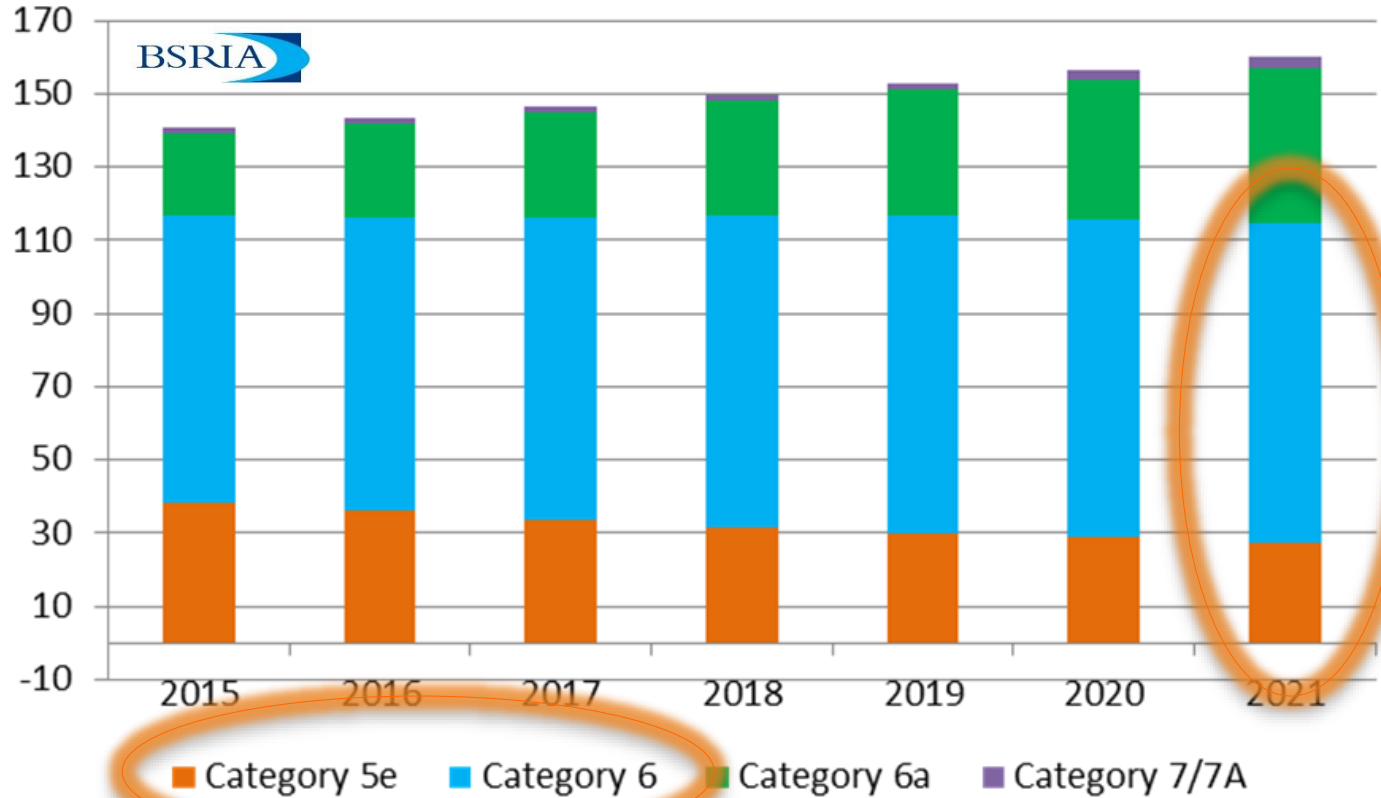
Get it from <https://ethernetalliance.org/the-2018-ethernet-roadmap/>

Forecasts

Copper Cable

It's here to stay

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



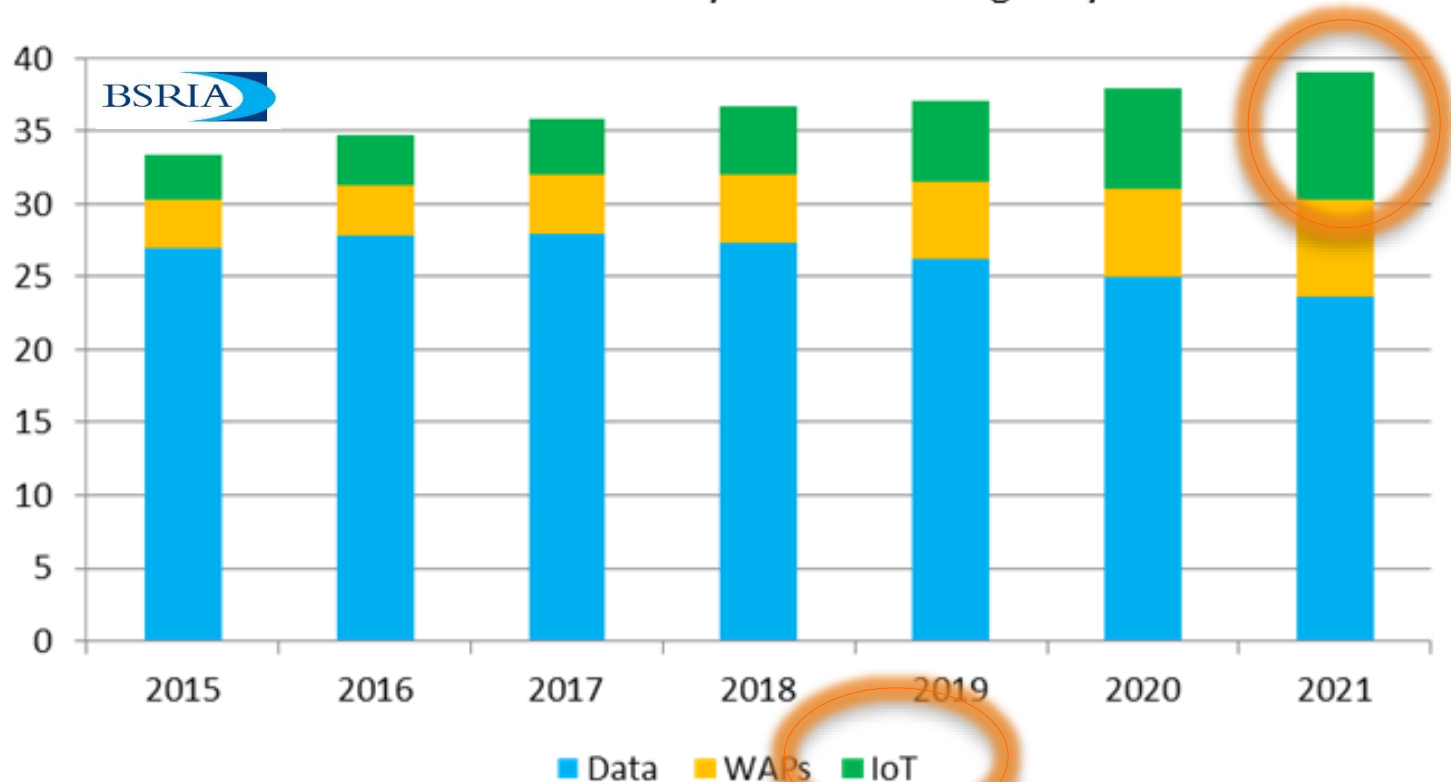
Source: BSRIA survey and modelling May 2017

Copper Cable

Used for?

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

Source: BSRIA survey and modelling May 2017

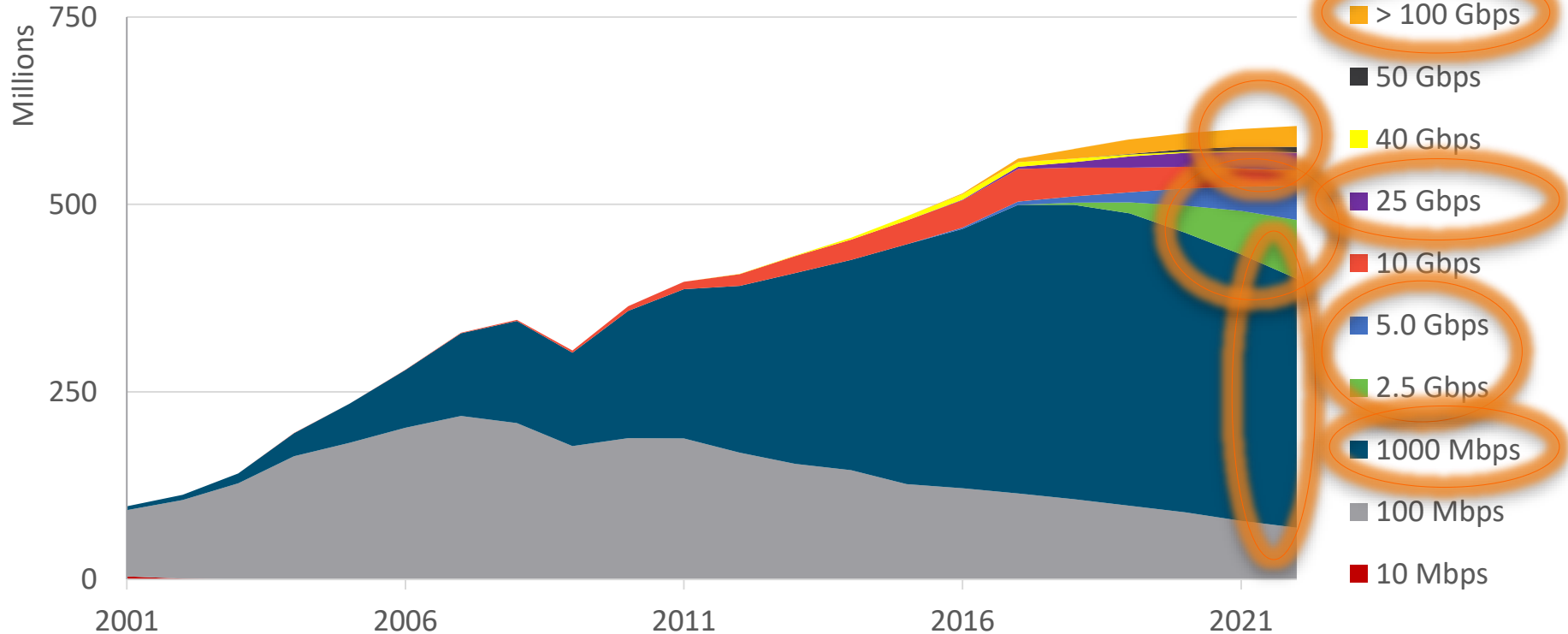


Switch ports 2001 - 2022

Ethernet Switch Ports

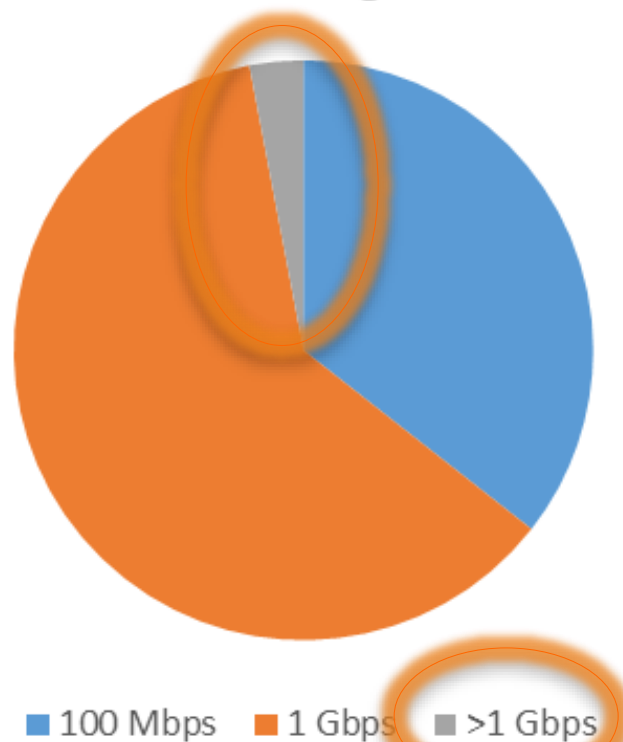
Dell'Oro Group Ethernet Switch 5-year Forecast Jan 2018

New, fast, exciting != volume
Lots of $\leq 10\text{Gb/s}$ ports



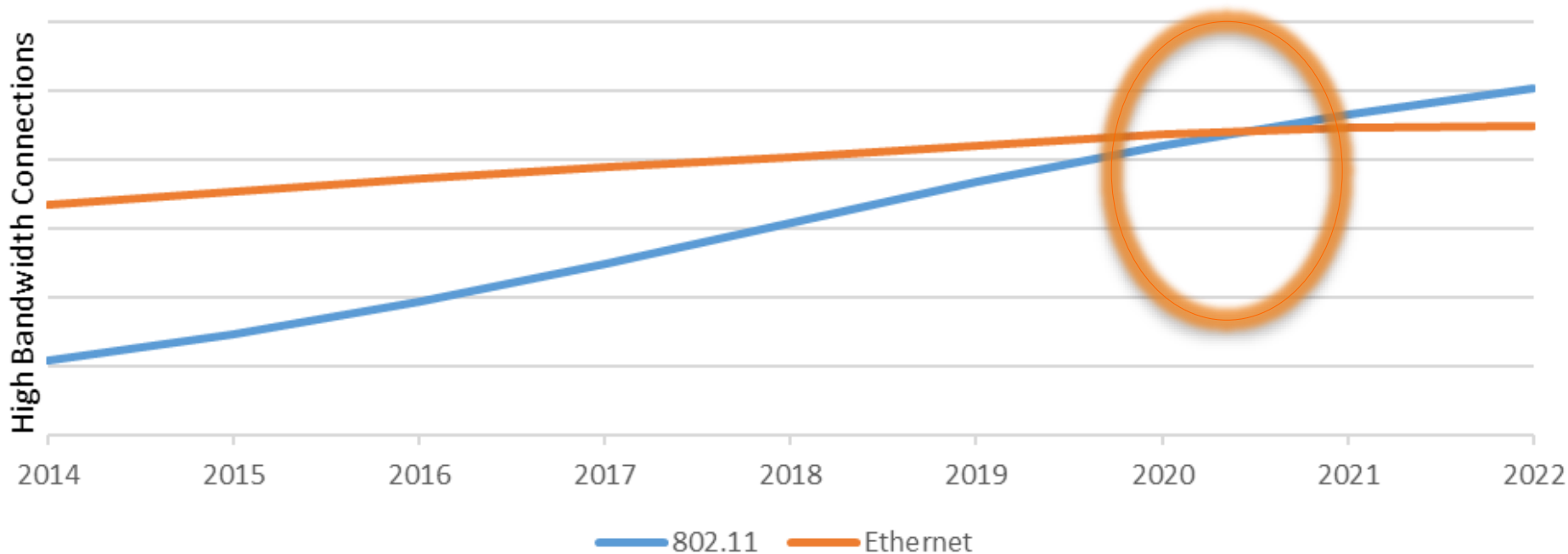
Installed Base by Speed

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



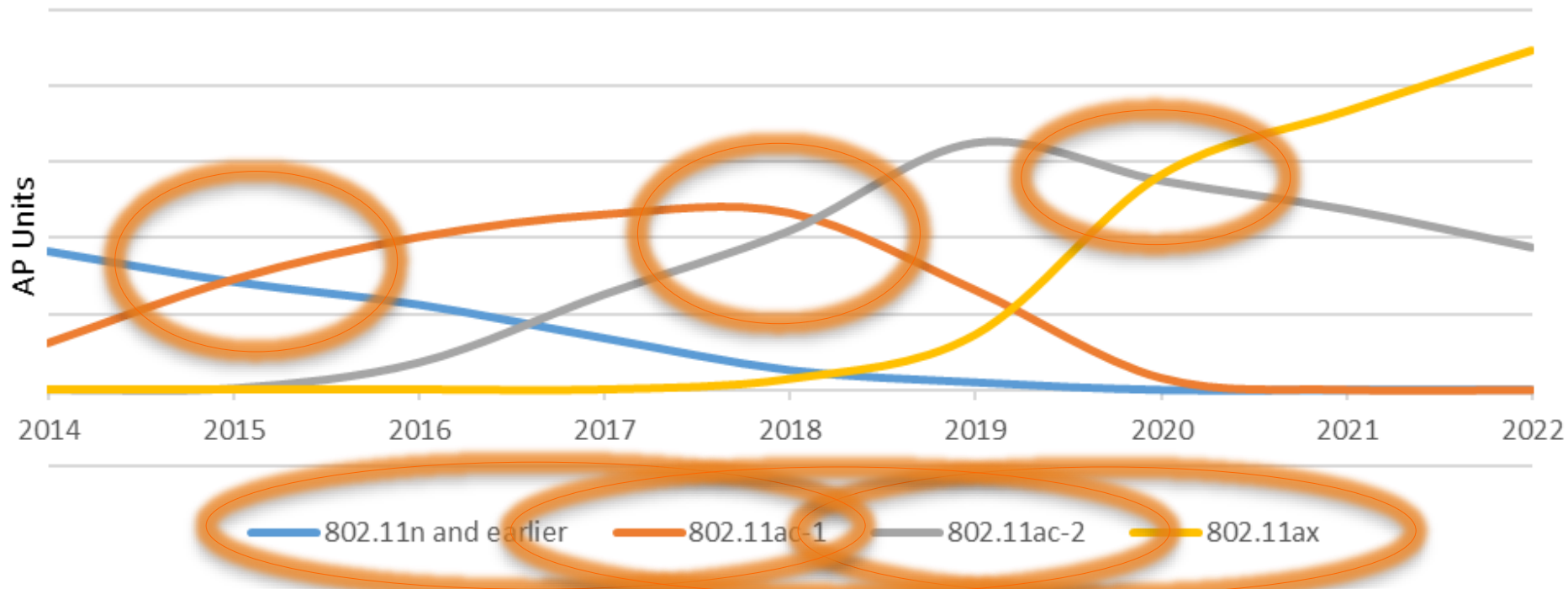
Move to wireless

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

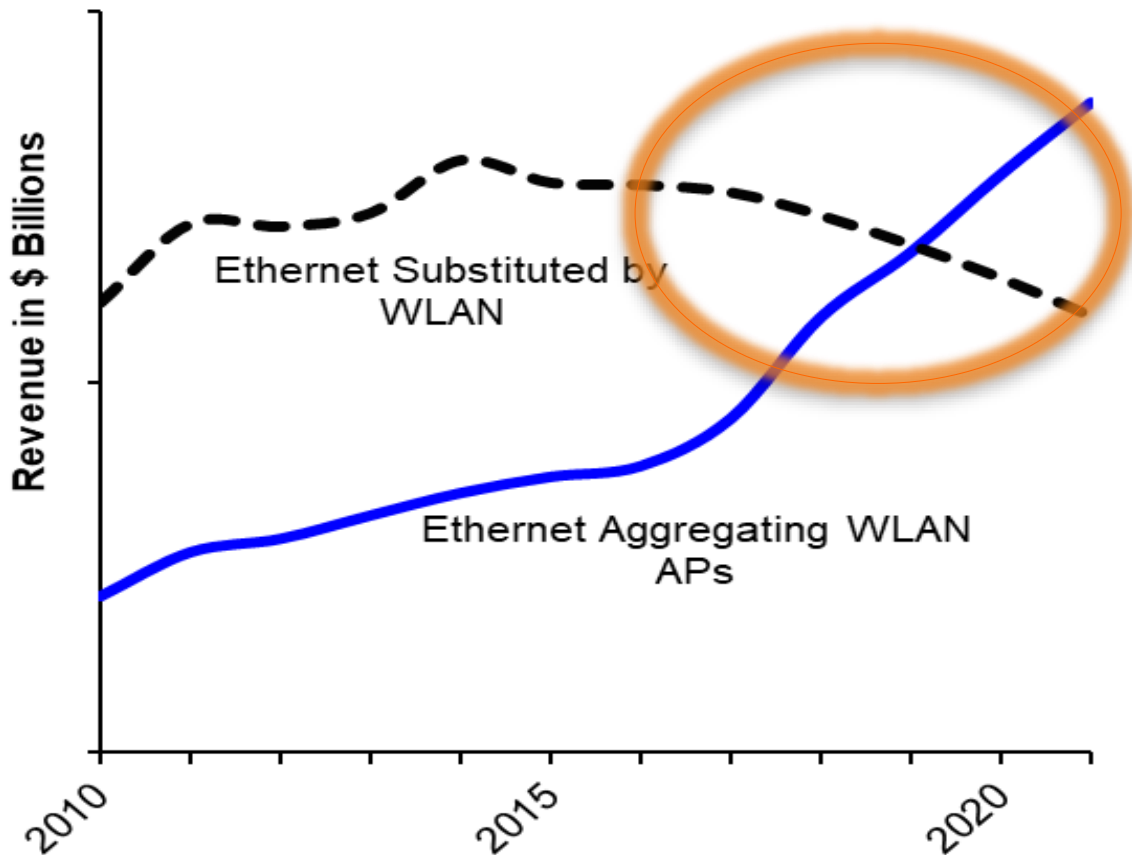


802.3 & 802.11

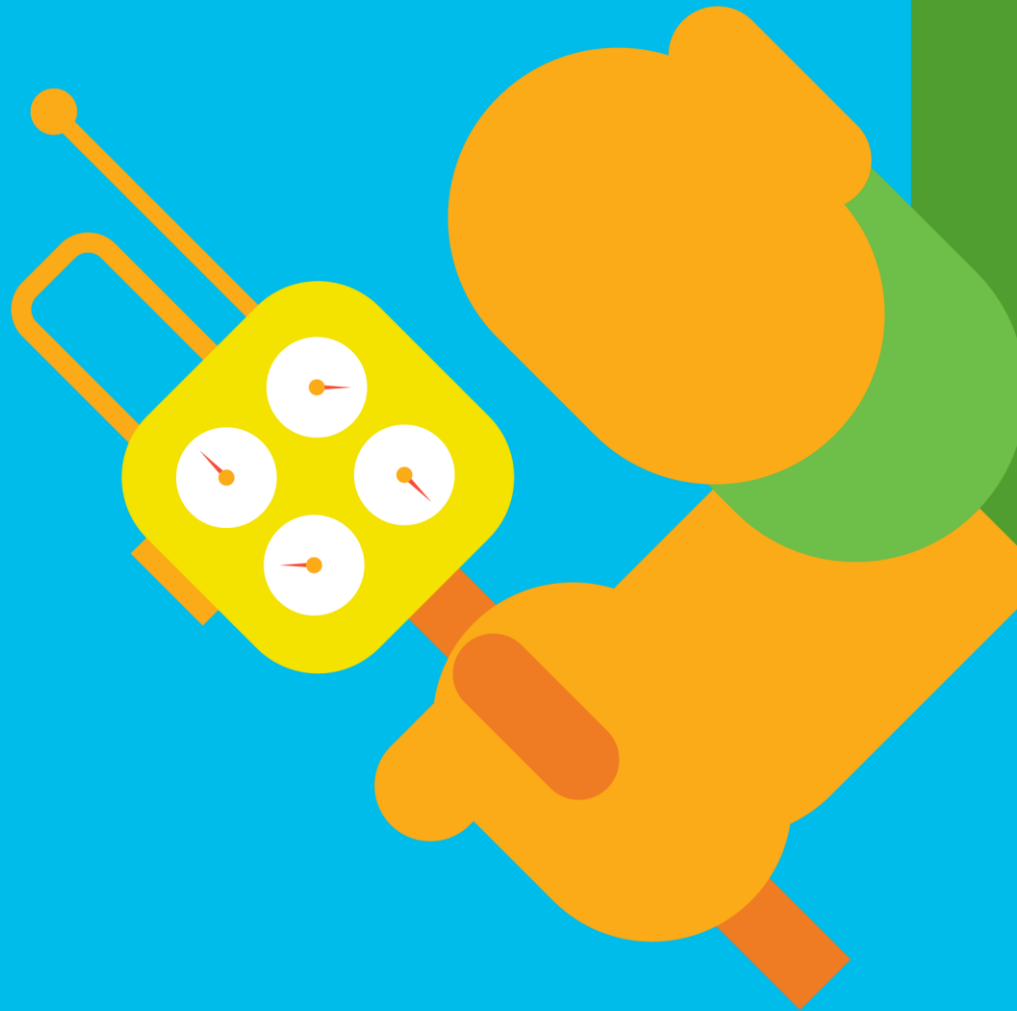
“**NBASE-T** will transition **wireless LAN to being additive** to the **Ethernet switch market**”

WLAN's Impact on Ethernet Switch Revenue

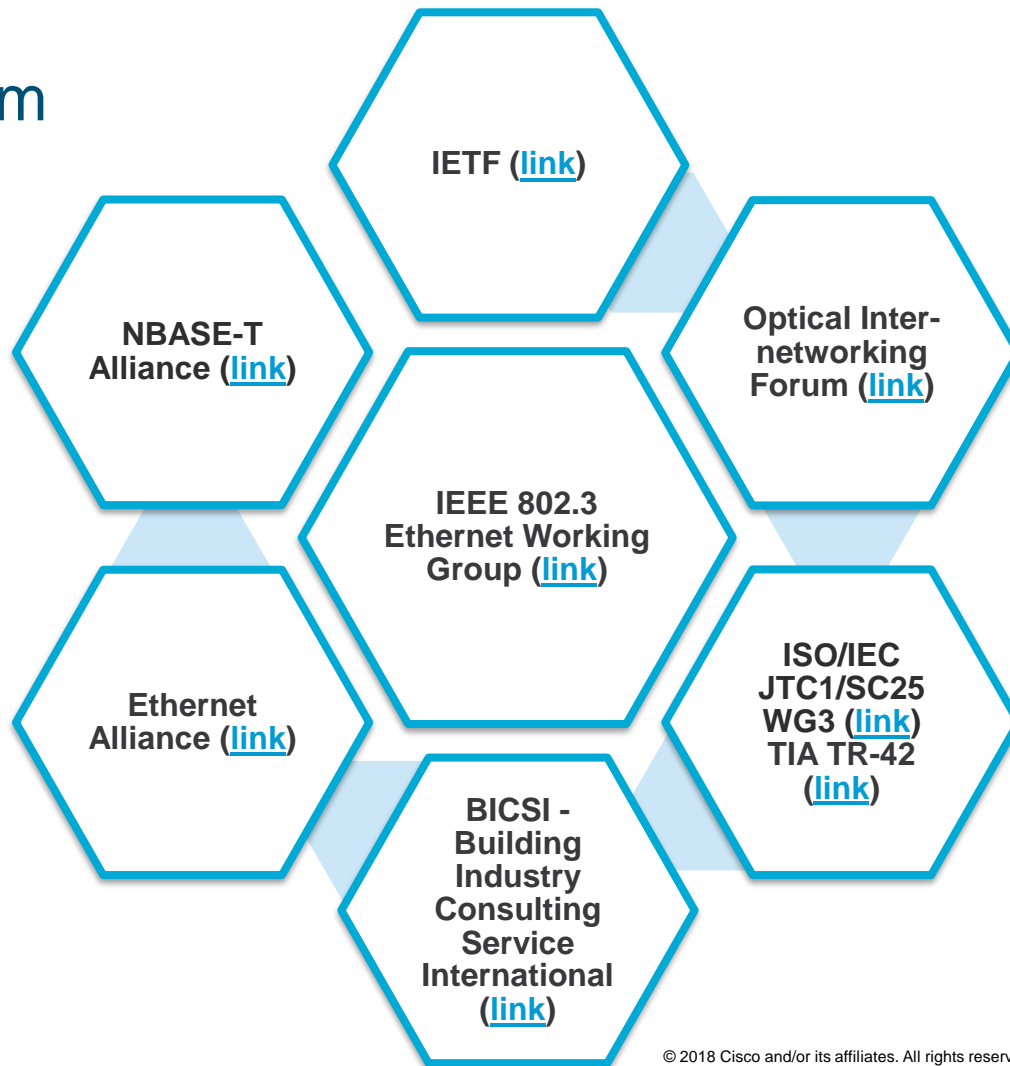
Dell'Oro Group Advanced Research Report Campus Networks Jan 2018



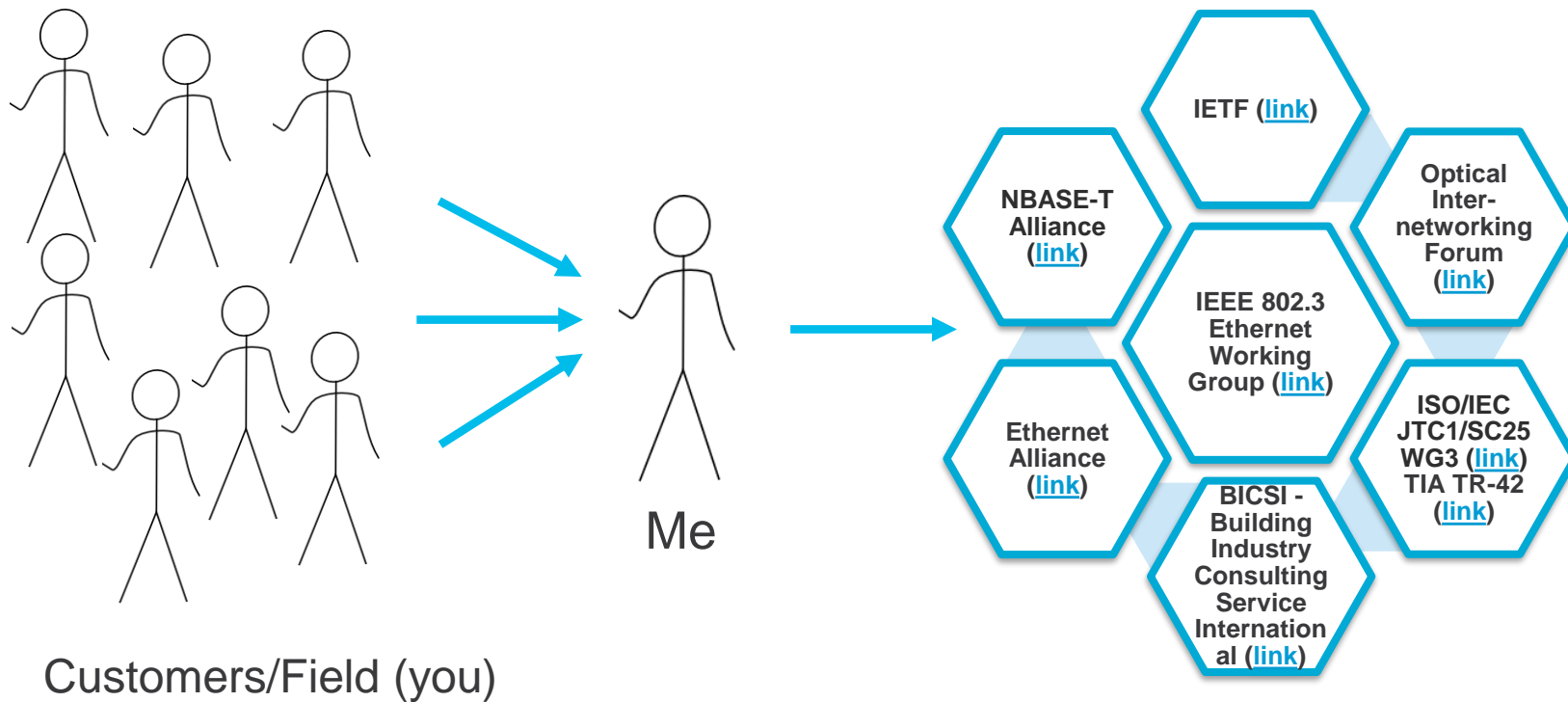
Ecosystem



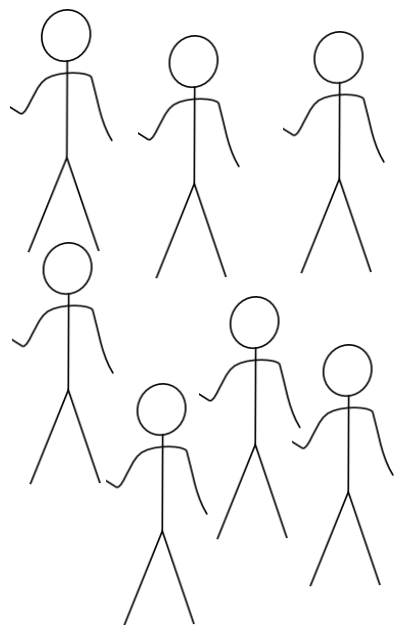
Industry Ecosystem



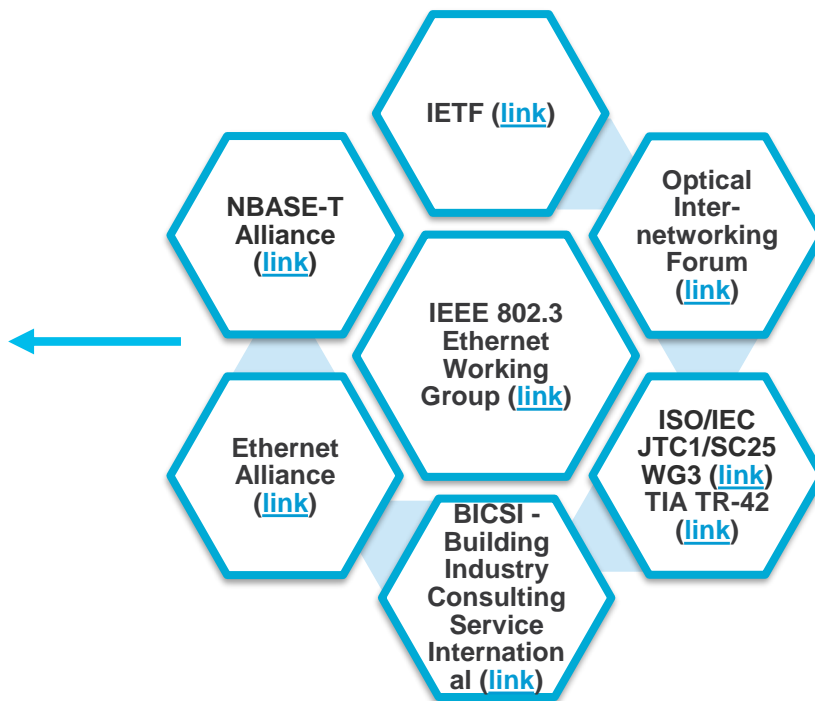
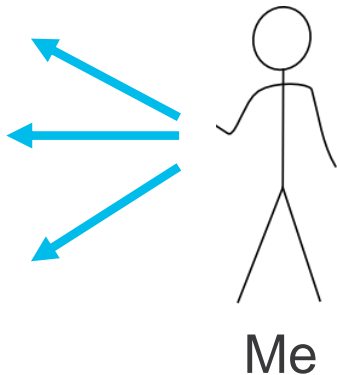
From Customers/Field



From Industry



Customers/Field (you)



What's IEEE 802.3 doing? (and what I am doing there?)

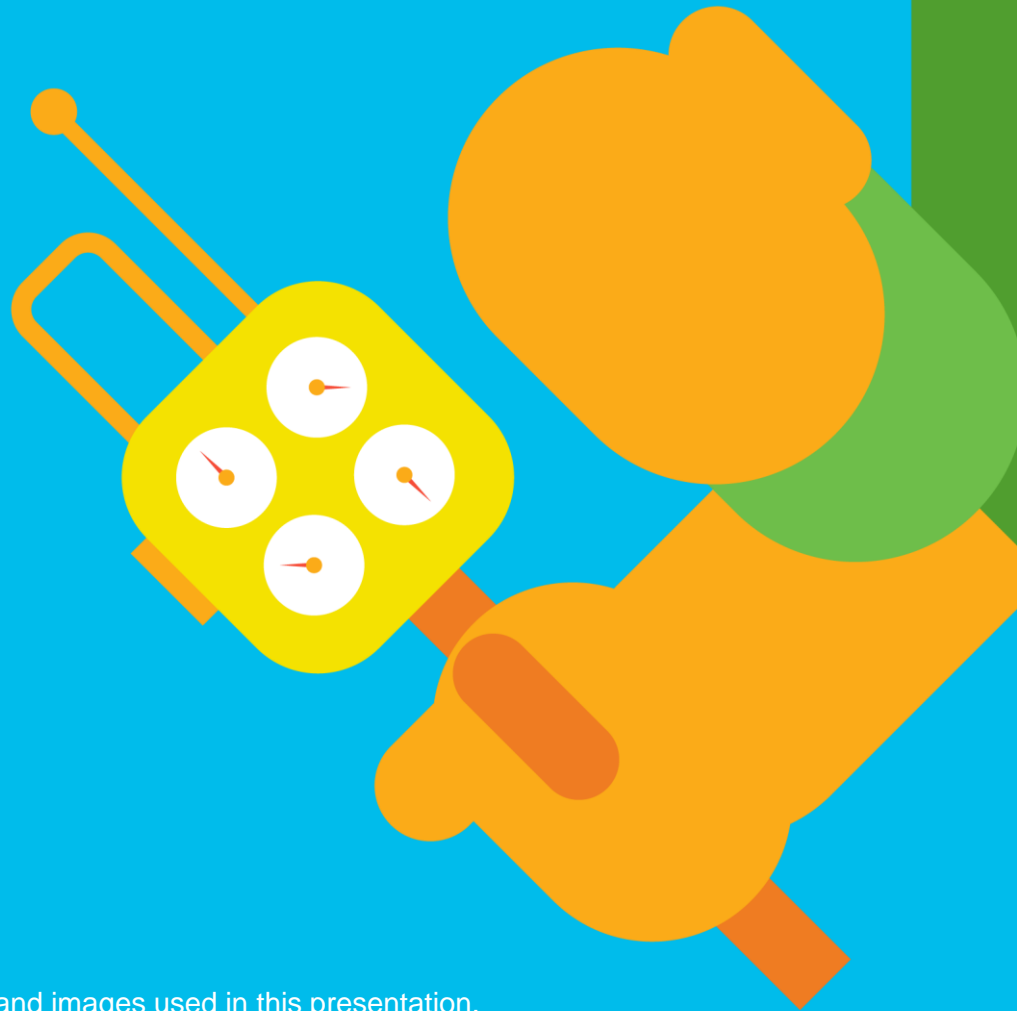


IEEE 802.3 ETHERNET WORKING GROUP



- 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

Promoters



Contributors



Adopters



Liaisons



NBASE-T Application Areas



Enterprise:

Switch
Wireless AP
Desktop
Storage
Small Cell

Industrial:

Switch
Wireless AP
Workstation
Storage
Compute
Machine Vision

Home:

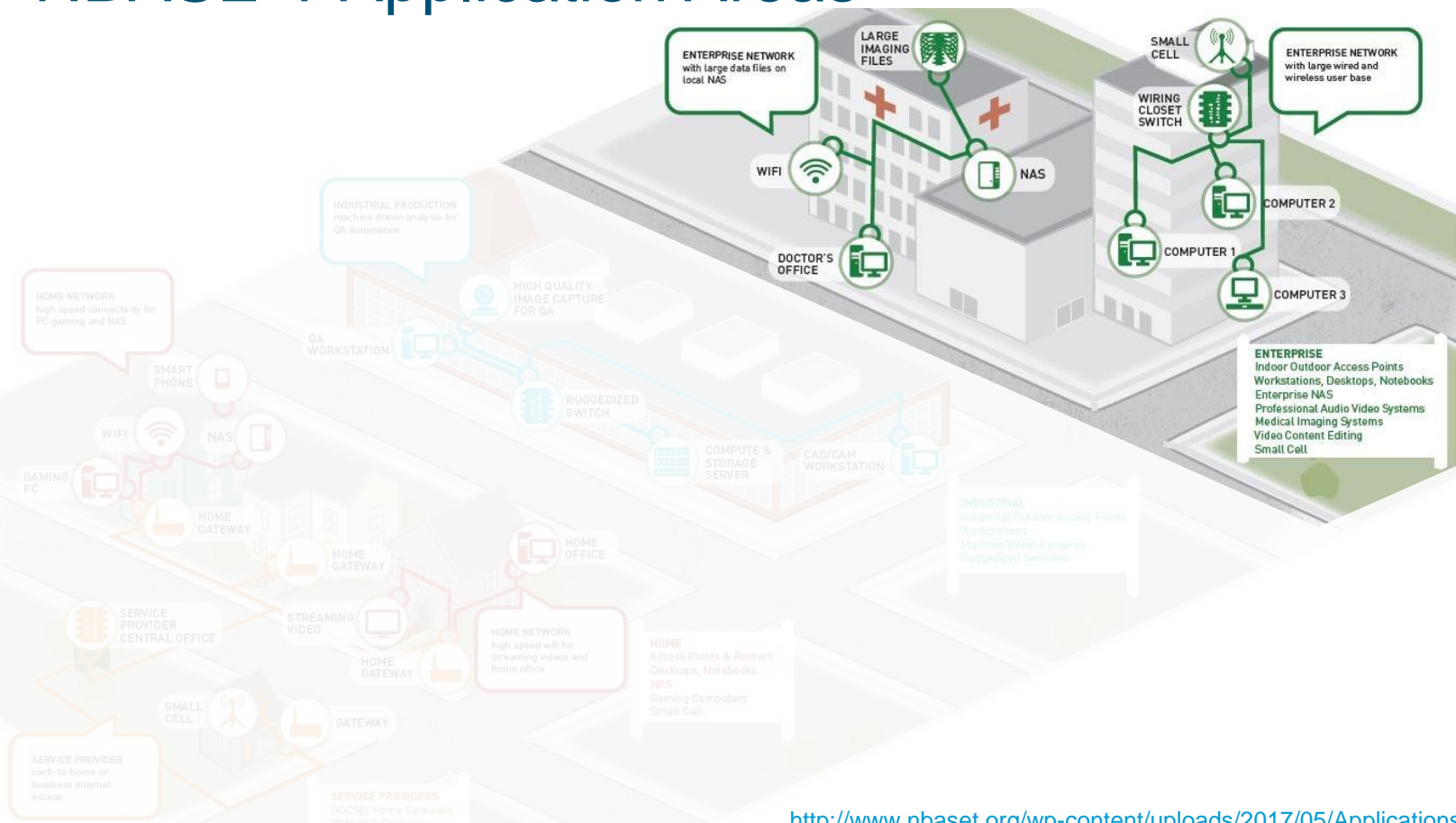
Switch
Wireless AP
Storage Server
Home Gateway
Streaming

Service Provider:

Small Cell
Home Gateway

http://www.nbase-t.org/wp-content/uploads/2017/05/ApplicationsGraphic_051517.pdf

NBASE-T Application Areas



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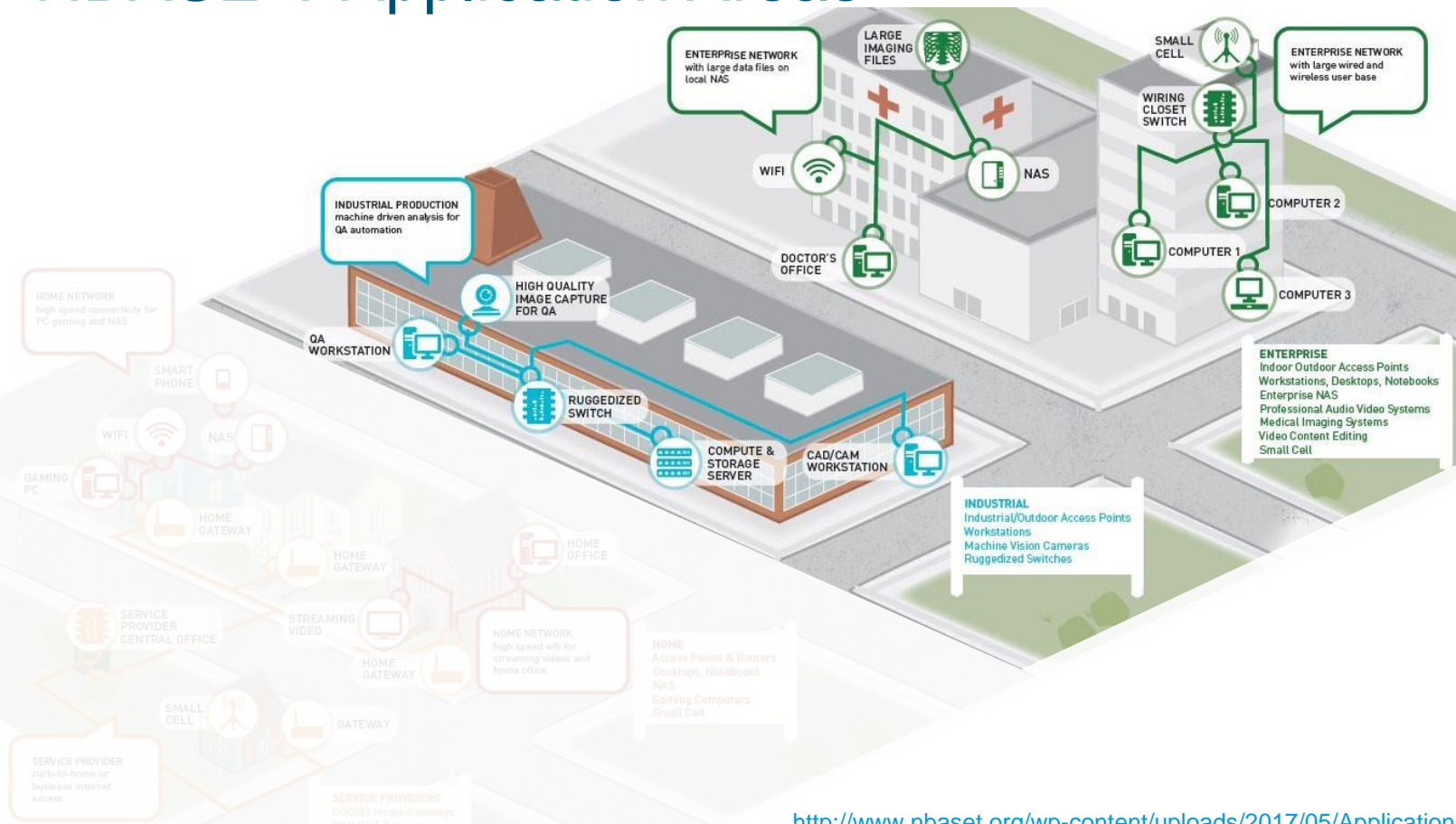
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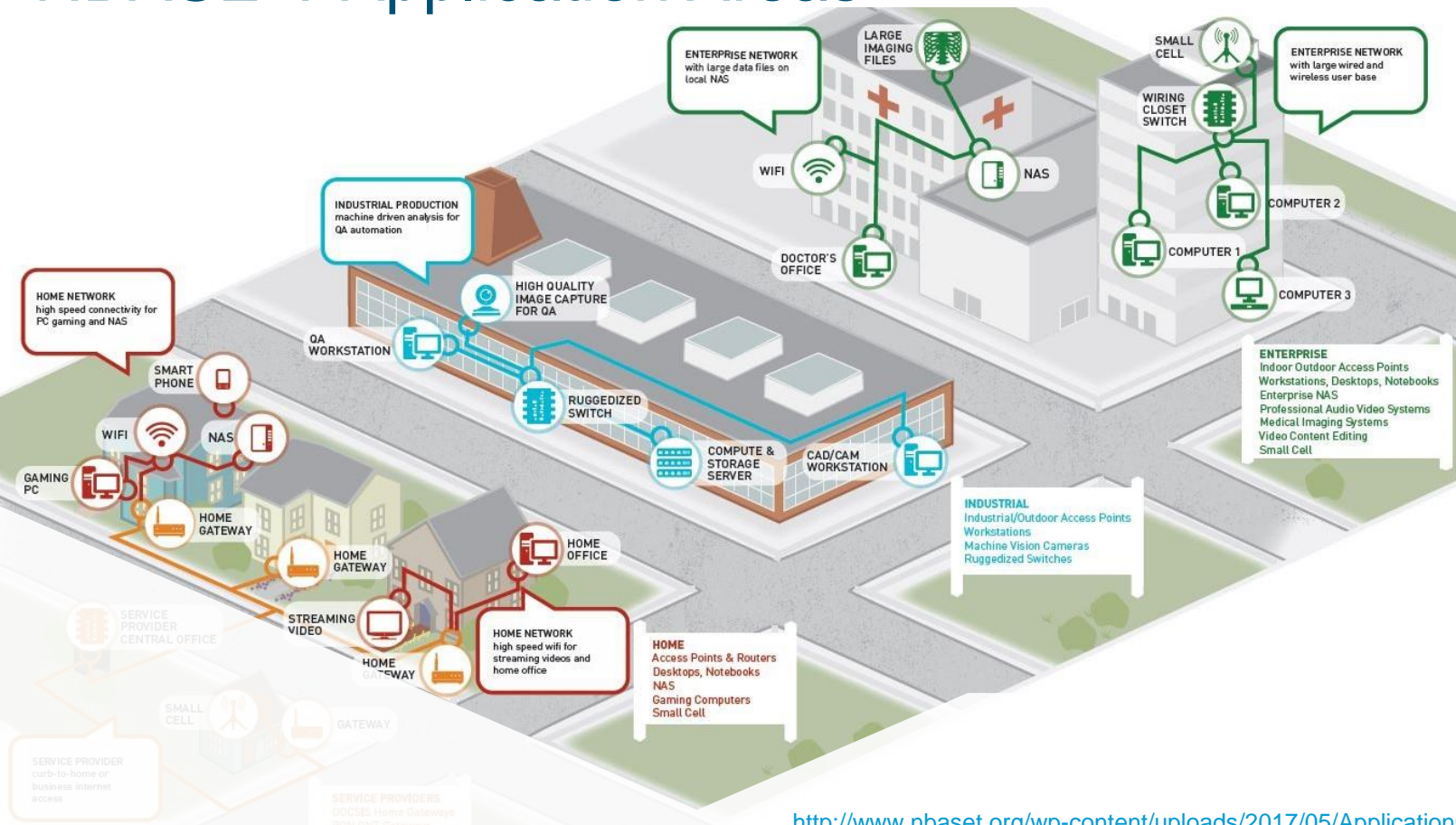
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http://www.nbase.org/wp-content/uploads/2017/05/ApplicationsGraphic_051517.pdf

NBASE-T Application Areas



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http://www.nbase-t.org/wp-content/uploads/2017/05/ApplicationsGraphic_051517.pdf

Cisco *live!*

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

Switch
Wireless AP
Workstation
Storage
Compute
Machine Vision

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

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

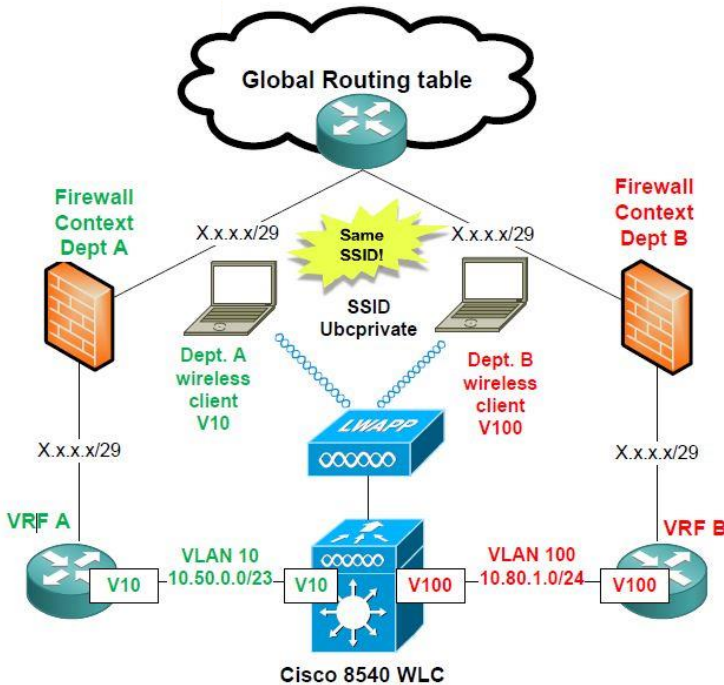
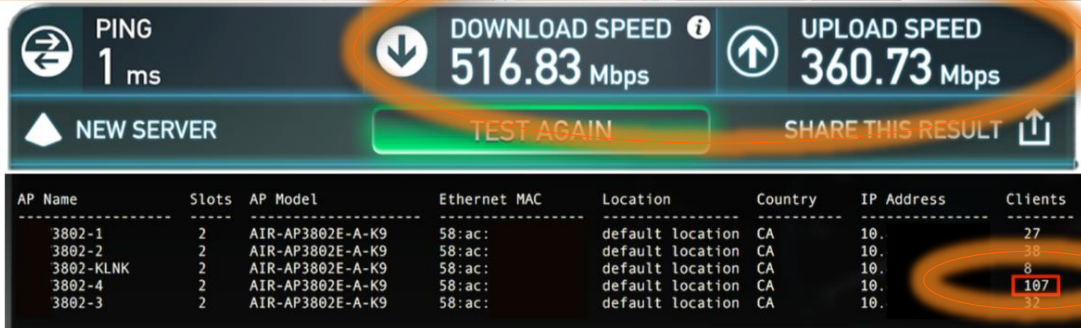


Cruise Ships -
Carnival/Princess



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:

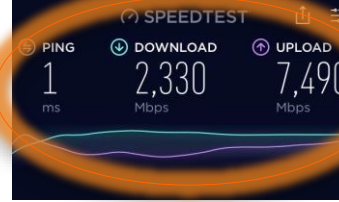
- High bandwidth for large data transfers
 - One microscope produces 500GB images
 - Others *only* 200-300GB.
- Using “regular enterprise network service”, not funded for a dedicated network

Q: “How can we get more done?”

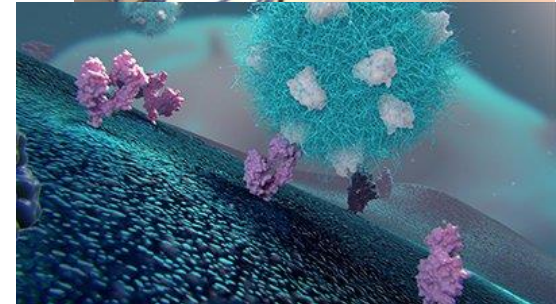
Impact of NBASE-T:

- 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”



ASUS XG-C100C



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

<https://www.princess.com/ships-and-experience/ships/gp-regal-princess/>
[https://en.wikipedia.org/wiki/Regal_Princess_\(2014\)](https://en.wikipedia.org/wiki/Regal_Princess_(2014))

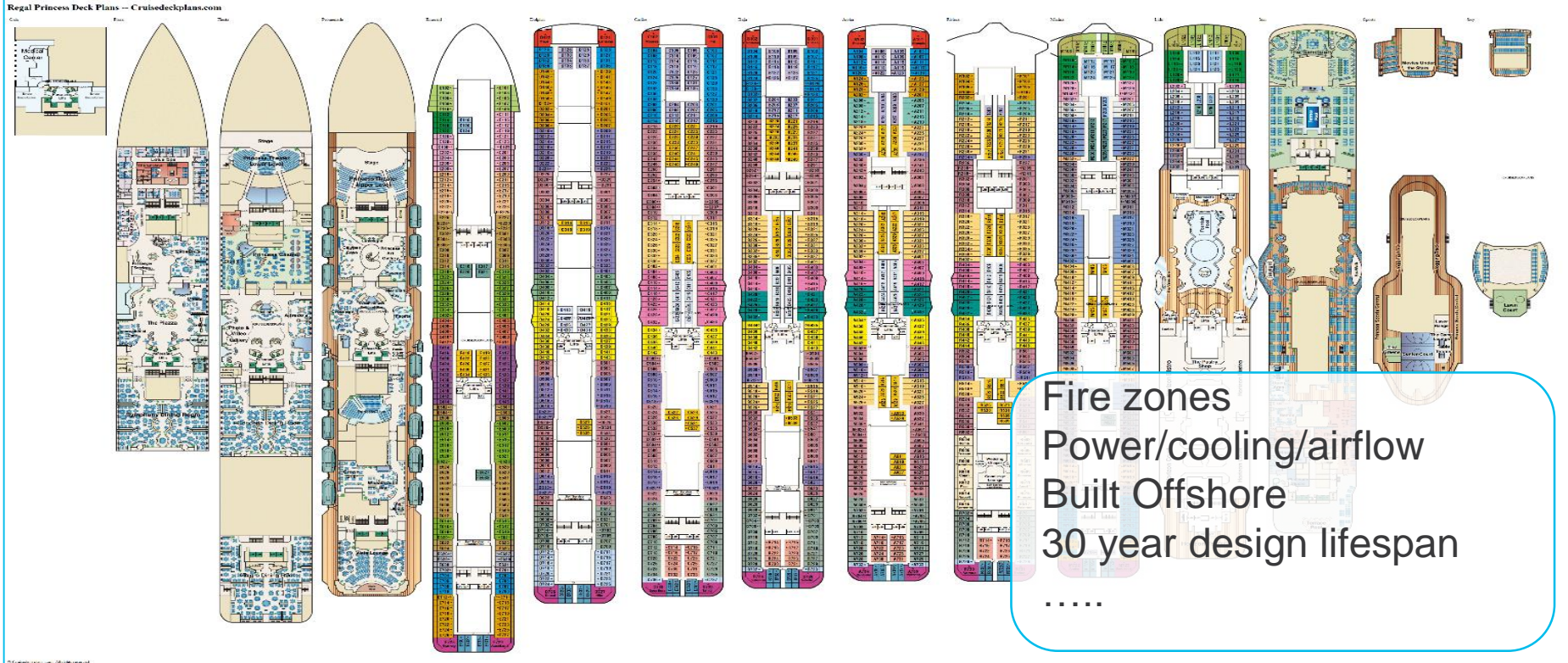
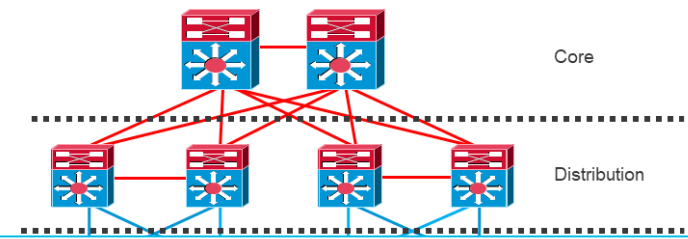
Inaugural Cruise: 2014
Cabins/Guests: 1,780/3,560
Decks: 19

Tonnage: 141,000
Length: 1,083 feet
Height: 217 feet

Networks on Cruise Ships

Like an Enterprise Network, but...

<https://www.cruisedeckplans.com/assets/deckimages/org/www.cruisedeckplans.com-deckplan.php-ship=Regal-Princess.png>



Fire zones
Power/cooling/airflow
Built Offshore
30 year design lifespan

Product Sampler

more at www.nbaset.org



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

VisionSystems
DESIGN
2017 **Innovators
Awards**
GOLD



<https://www.e2v.com/products/imaging/cameras/uniqa-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**.

Tam Dell’Oro

Founder & CEO, Dell’Oro Group
January 2018

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**.

Alan Weckel

Founder & Technology Analyst
650 Group
January 2018

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**.

Patrick McLaughlin

Chief Editor –
Cabling Installation and Maintenance ”
February 2018

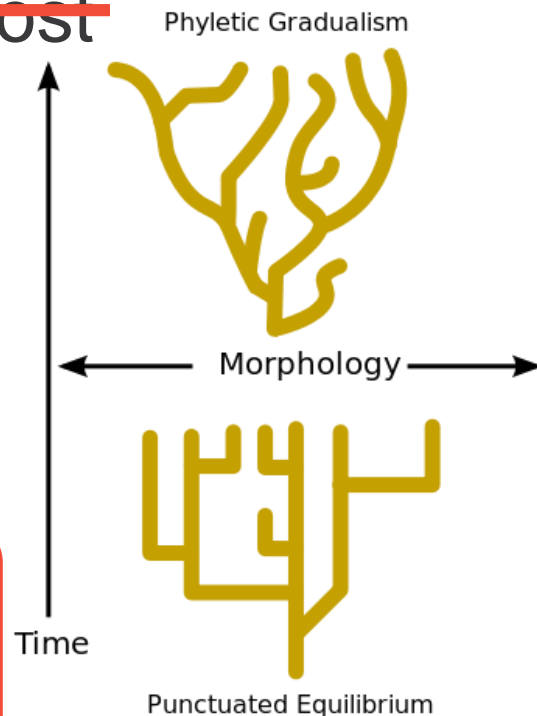
Where Next?

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

OK – then what?

Speciation fills in ecosystem

Standards active in –
10M, 2.5G, 5G, 10G, 25G, 50G, 100G, 200G



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

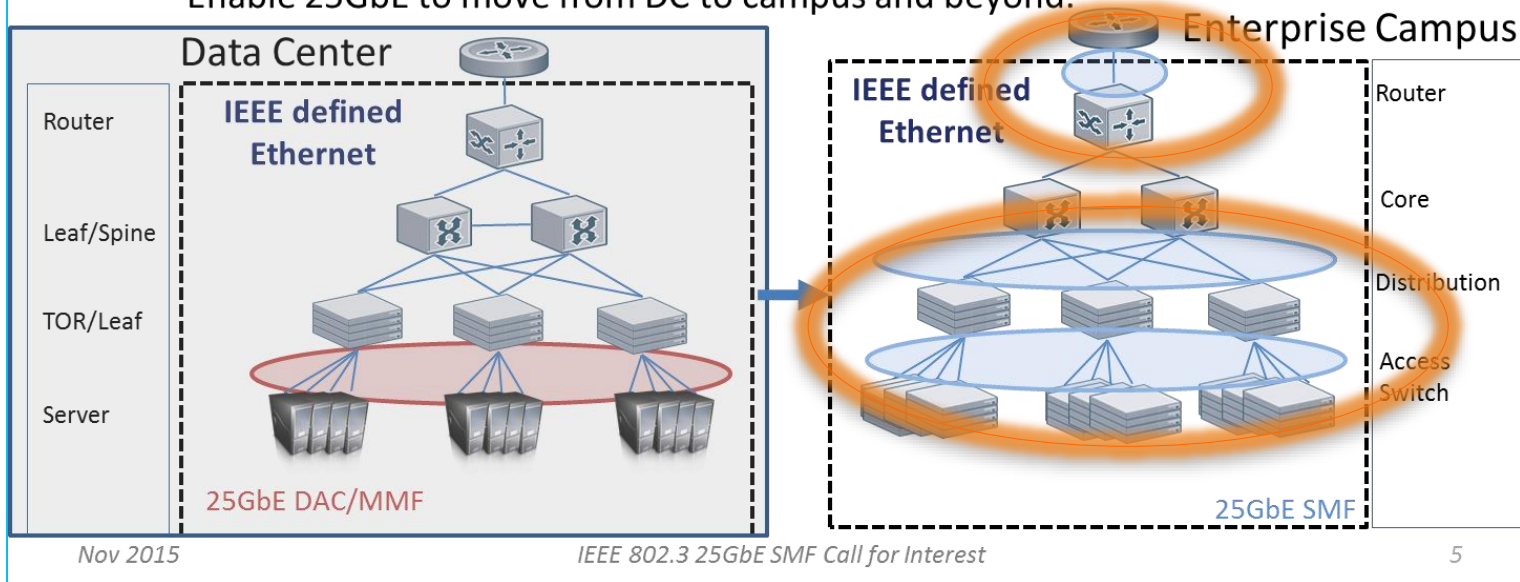
IEEE Std 802.3by-2016 approved June 2016

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.



25GSMF CFI : http://www.ieee802.org/3/cfi/1115_2/CFI_02_1115.pdf

25Gb/s SMF Ethernet

IEEE STANDARDS ASSOCIATION 

IEEE Standard for Ethernet


Amendment 11: Physical Layer Parameters for Serial Multi-Lane Ethernet Over Single-Mode Fiber

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee


IEEE
3 Park Avenue
New York, NY 10016-5997
USA


IEEE Std 802.3cc™-2017
(Amendment to
IEEE Std 802.3™-2015
as amended by
IEEE Std 802.3bw™-2015, IEEE Std 802.3by™-2016,
IEEE Std 802.3bz™-2016, IEEE Std 802.3bp™-2016,
IEEE Std 802.3br™-2016, IEEE Std 802.3bn™-2016,
IEEE Std 802.3bu™-2016, IEEE Std 802.3bw™-2017,
and IEEE Std 802.3bs™-2017)


IEEE STANDARDS ASSOCIATION 


Started November 2015
Finished December 2017


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 **IEEE-SA Standards Insight blog:** <http://standardsinsight.com>

 **YouTube:** IEEE-SA Channel

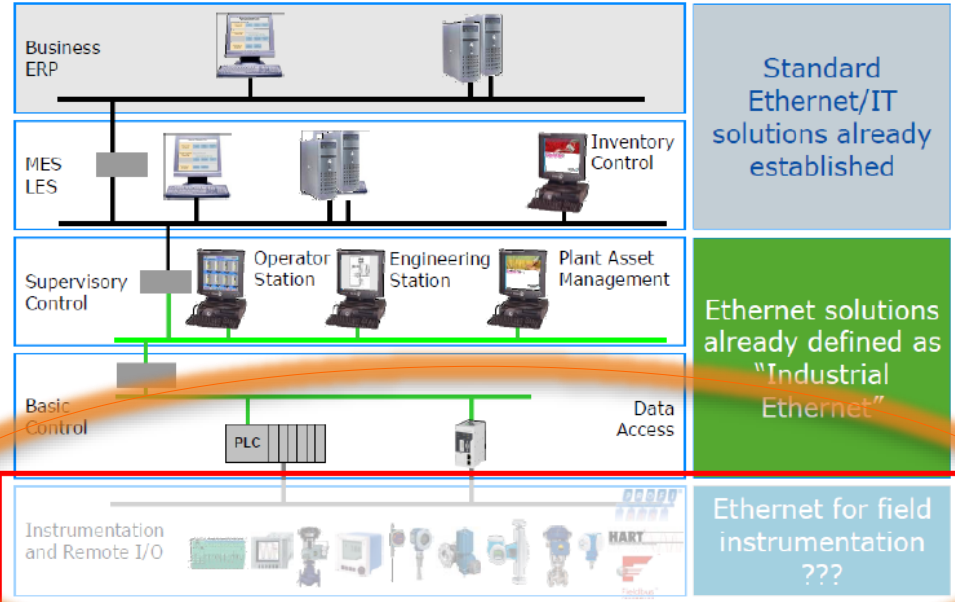
IEEE
standards.ieee.org
Phone: +1 732 981 0060 Fax: +1 732 562 1571
© IEEE

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



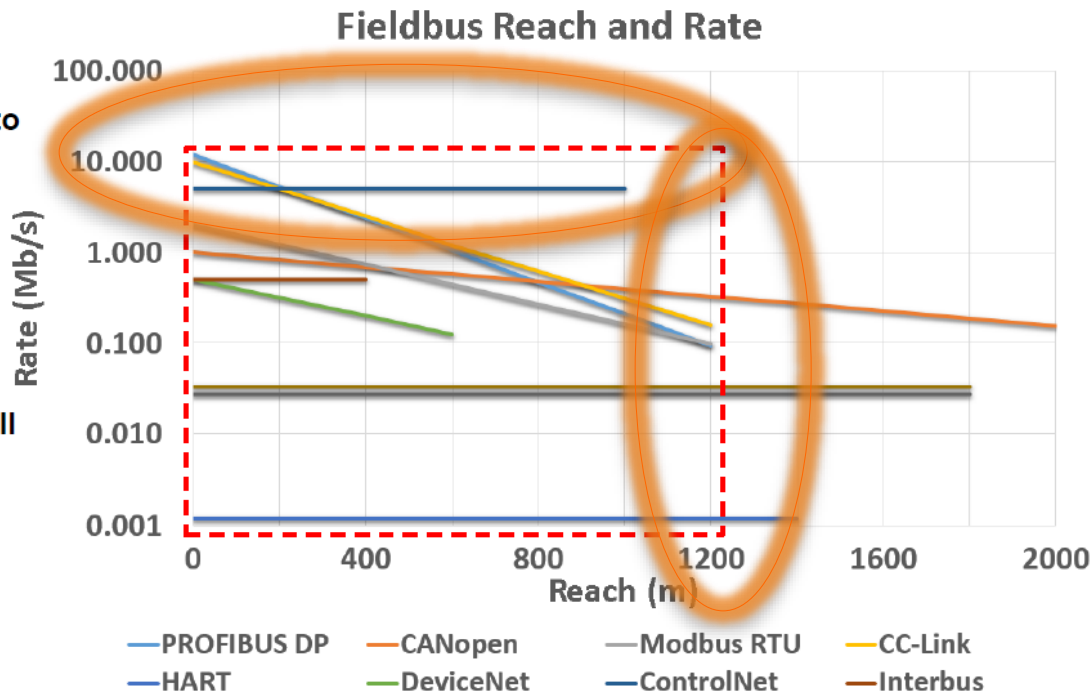
Ethernet Gap at the 'Edge'

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



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

High Cable Reuse Value

Fieldbus	Cable Type	Cable Power
FOUNDATION H1	FF-844 specified	Yes
HART	Various	Yes
PROFIBUS PA	IEC 61158 Type A	Yes
4-20mA	SP-50 instrumentation cable	Yes
CANopen	EIA-485	Yes
Modbus RTU	EIA-485	No
CC-Link	CC-Link, Ver. 1.10 specified Shielded, 3- & 5-core	No
DeviceNet	ODVA DeviceNet specified (5-core, various classes)	Yes
ControlNet	RG-6/U Coaxial	No
INTERBUS	3 / 6 no. twisted pairs, various	Yes
PROFIBUS DP	IEC 61158 Type A (22AWG?)	No

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

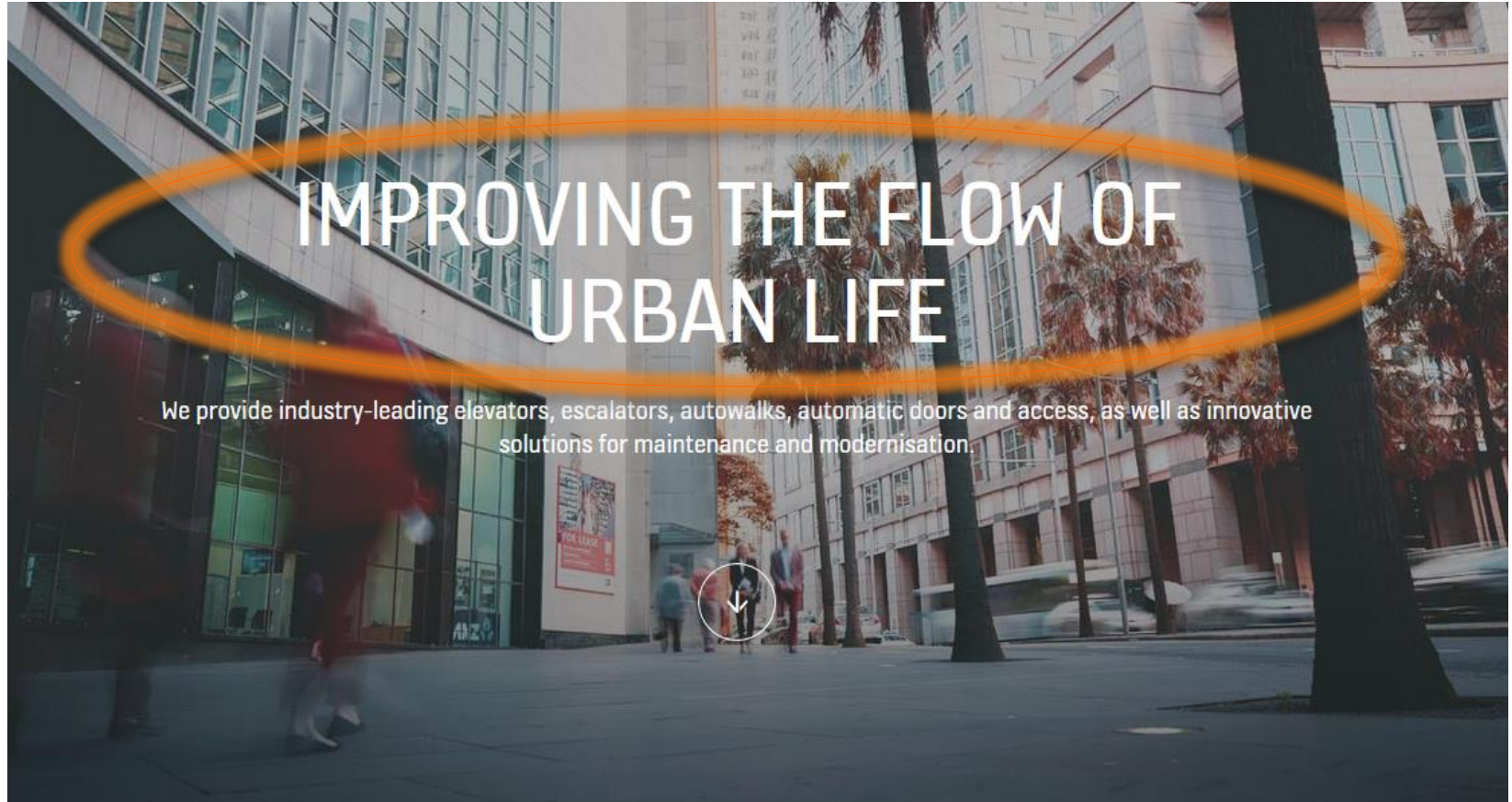
10SPE Example Kone & Elevators

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***.

What's the goal?



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

On their mind?



What does nbn
network mean



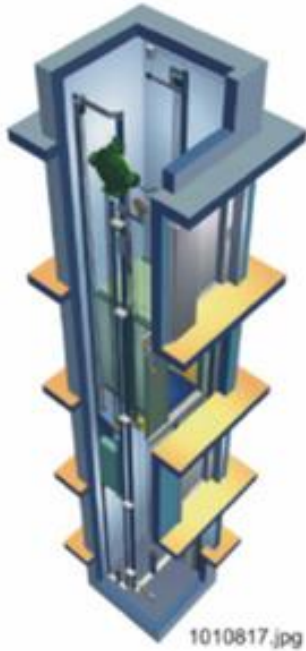
Intelligent elevators are here
they talk in real-time around



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

Kone elevator network structure

A typical elevator



ELEVATOR SHAFT BUNDLE (CABLES AND CONNECTION BOXES WITHOUT TRUNKING)



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

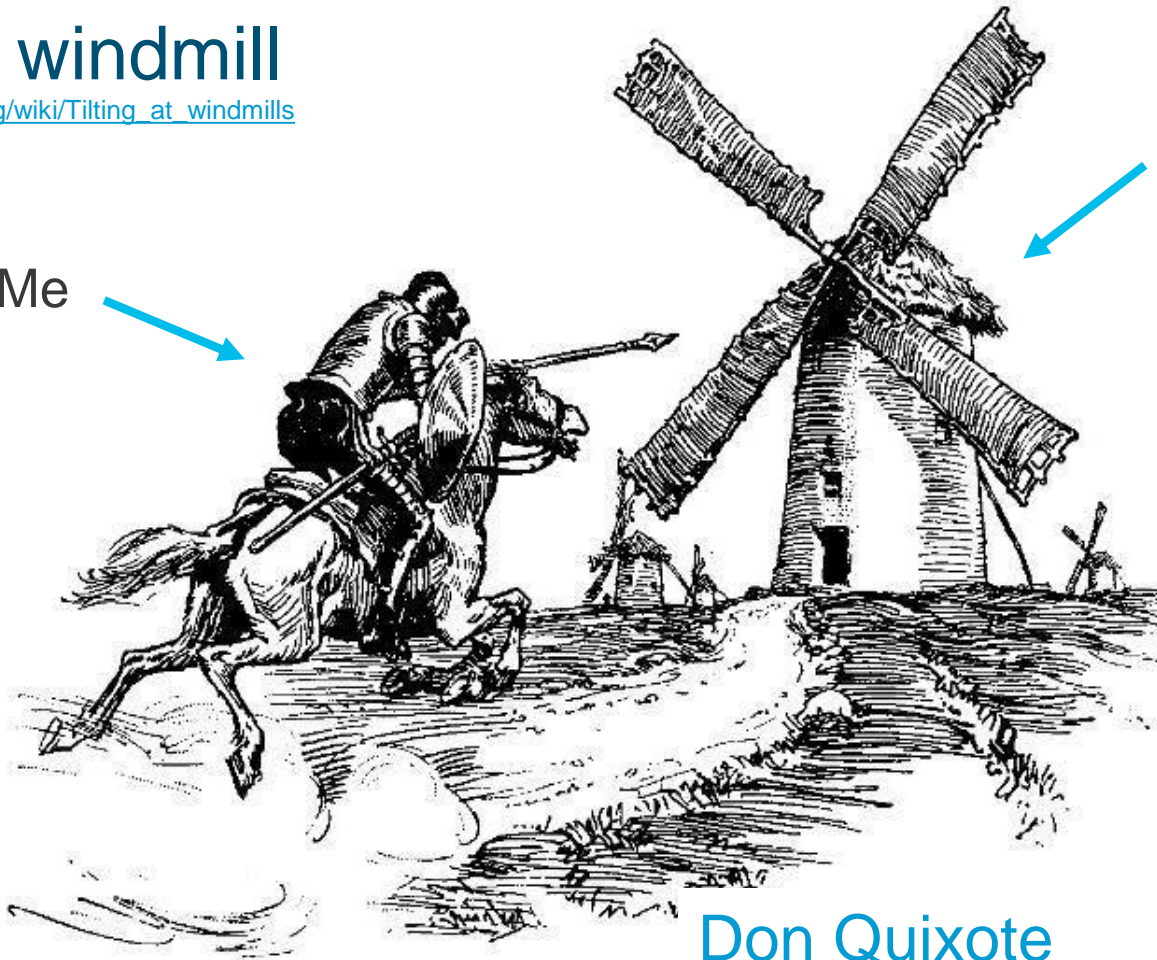
IEEE 802.3cg 10 Mb/s Single Pair Ethernet (10SPE)

- 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

Me



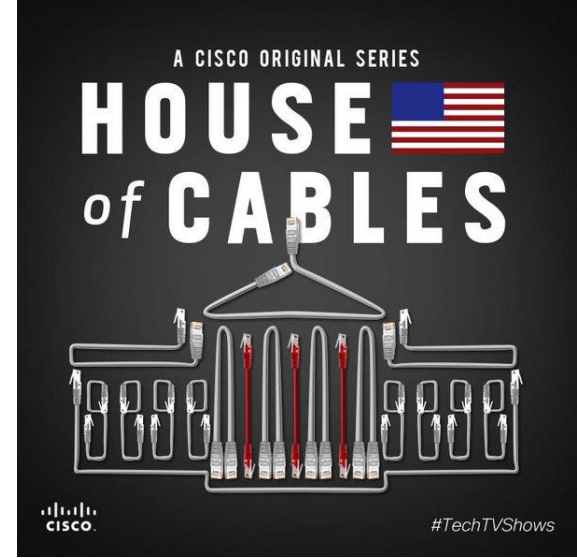
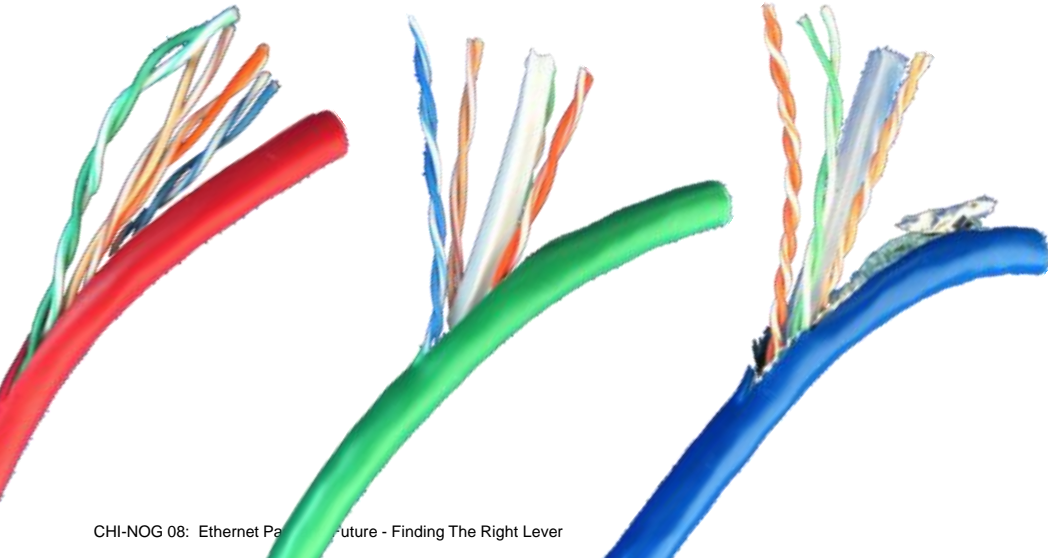
Single Pair
Ethernet

Don Quixote

<http://interlochenpublicradio.org/post/kids-commute-don-quixote-week-tuesday>

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...



Rethink possible..



Cat5e/6

... add Value

Cat6A

... need specific
infrastructure!

Evolve the network,
enable the business

MEMBER
NBASE-T
ALLIANCESM

Thanks



First edition - 1605

Thank you



Chicago Network
Operators Group

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05.10.2018
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