NBASE-T in the Real World
Solving Your Customers' Problems Right Now

Peter Jones  Cisco Systems, Principal Engineer & NBASE-T Alliance Chairman
Daniel Shin  Cisco Systems, Technical Solutions Architect
What You Will Hear Today

• I’ll start with NBASE-T
  – Alliance, technology and market
• Daniel will cover NBASE-T in the wild
  – Opportunities and successes
• I’ll wrap up
  – Closing thoughts and call to action
NBASE-T OVERVIEW

2018 BICSI WINTER CONFERENCE & EXHIBITION
Orlando, FL | February 4-8
BASE-T Evolution

TWISTED PAIRS

Link Speed (b/s)

100G
10G
1G
100M
10M

Standard Completed

1990 — 10BASE-T
100m on Cat 3
1995 — 100BASE-TX
100m on Cat 5
1999 — 1000BASE-T
100m on Cat 6A
2006 — 10GBASE-T
30 m on Cat 8
2016 — 25GBASE-T and 40GBASE-T
2.5GBASE-T and 5GBASE-T
100 m on Cat 5e/Cat 6

Ethernet Speed

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802.11 Driving Wired Bandwidth Needs

With 802.11ac, wireless crosses a gigabit

11n to 11ac is a rapid transition

Enterprise AP Radio Bandwidth

Enterprise AP 802.11n/11ac Transition
Source: Dell’Oro Group Jan 2017

2018 BICSI Winter Conference & Exhibition
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The Application Spaces of BASE-T

George Zimmerman, CME Consulting - Spaces of BASE-T
BASE-T & Alien Crosstalk

• Modern BASE-T PHYs (>= 1Gb/s) are impacted by “Alien Crosstalk” from other cables
  – Cables tightly bundled over long distances and/or close to the transmitter impact performance
• With NBASE-T many links can support rates > 1Gbps
  – Links to Wireless Access Points fan out, reducing alien crosstalk
• Cat5e/Cat6 not specified for alien crosstalk
Why 2.5G and 5G BASE-T?

- Between 2003 to 2014 ~70 billion meters of Cat 5e and Cat 6 cabling were sold....
  - ~90% of installed base
  - Enormous network infrastructure investment
- Existing specifications supported 1Gb/s over this cable, but we knew faster data rates were possible
- BASE-T allows incremental upgrade

Lets increase the value of this asset!

Source: BSRIA December 14
NBASE-T Alliance - Overview

• NBASE-T Alliance (www.nbaset.org)
  – 2.5G/5GBASE-T vendor alliance, ~50 member companies

• Who is in the Alliance?
  – Components, silicon, systems, cabling, test, ....

• What is role of the Alliance?
  – Build and support the market

Alliance Strength - Full Ecosystem
NBASE-T/802.3bz Timeline

- **OCTOBER 2014**: NBASE-T Alliance launched
  - 10-11
- **2015**
  - **JANUARY**
    - Switch products announced
  - **OCTOBER**: NBASE-T Physical Layer Specification 1.0 available
    - November
  - **APRIL**: IEEE 802.3 Call for interest
    - 15
- **MAY 2015**: 802.3bz Technical Baselines adopted, compatible to NBASE specification
- **MAY 2015**: NBASE-T Alliance membership hits 45+ companies
- **MAY 2016**: NBASE-T and Ethernet Alliance joint webinar, plugfest results
- **JUNE 2016**: NBASE-T and Ethernet Alliance joint webinar, plugfest results
- **JULY 2015**: 802.3bz Task Force Review begins
- **AUGUST 2015**: First NBASE-T technology plugfest
- **APRIL 2016**: 10 companies showcase NBASE-T interoperability at Interop ITX Las Vegas
- **APRIL 2016**: 802.3bz standard approved
- **SEPTEMBER 2016**: 802.3bz standard approved
- **OCTOBER 2016**: NBASE-T and Ethernet Alliance joint plugfest
- **OCTOBER 2017**: 2nd NBASE-T and Ethernet Alliance plugfest
- **APRIL 2018**: NBASE-T at Interop ITX Las Vegas
  - 01-04
- **2018**
  - **JANUARY**: First multivendor interoperability demo for NBASE-T technology at Interop Las Vegas
    - 10-11
  - **APRIL**: First access points and test equipment products announced
    - 05-09
  - **JANUARY**: 802.3 Working Group Ballot initiated
  - **DECEMBER**: NBASE-T Physical Layer Specification version 2.3 available
    - 10-12
  - **MAY**: 10 companies showcase NBASE-T interoperability at interop ITX Las Vegas
  - **OCTOBER**: NBASE-T Alliance membership hits 45+ companies
    - 01-04
NBASE-T and 802.3bz Technology
Based on 10GBASE-T

• PAM-16 with the same LDPC code for good performance
  – Good interoperability, improved robustness
  – Upper frequency of \( \frac{3}{2} \) (5G) and \( \frac{3}{4} \) (2.5G) that of 10GBASE-T

• NBASE-T and 802.3bz are interoperable with each other
  – Joint Ethernet Alliance/NBASE-T Alliance plugfests in late 2016 & 2017
  – Auto Negotiation enables multi-mode PHY operation

• Supports PoE!
IEEE 802.3bz or NBASE-T

• NBASE-T adds “Downshift” to 802.3bz
  – Ethernet Auto Negotiation selects the fastest common rate (regardless of cable etc.)
  – With Cat5e/6, bandwidth capacity can depend on crosstalk from other links
  – Downshift automatically selects the speed based on the channel noise

• With downshift, users always get a reliable link
# NBASE-T vs IEEE 802.3bz

<table>
<thead>
<tr>
<th>Feature</th>
<th>NBASE-T</th>
<th>IEEE 802.3bz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto-Negotiation</td>
<td>Clause 28/55 for 10G - modified to use</td>
<td>Clause 28/55/126 - Infofield</td>
</tr>
<tr>
<td></td>
<td>Extended page with NBASE-T OUI</td>
<td>message during training</td>
</tr>
<tr>
<td>Fast Retrain</td>
<td>Specified in ENG-977716 Revision 2.0</td>
<td>Clause 126 – Infofield message during training</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for fast retrain ability advertisement</td>
</tr>
<tr>
<td>Energy Efficient Ethernet</td>
<td>NBASE-T PHY 2.3 - Clause 126 - Infofield</td>
<td>Clause 126 - Infofield message during training</td>
</tr>
<tr>
<td></td>
<td>message during training, as per 802.3bz.</td>
<td>for EEE ability advertisement</td>
</tr>
<tr>
<td></td>
<td>(Note NBASE-T PHY 1.x EEE using extended</td>
<td></td>
</tr>
<tr>
<td></td>
<td>next page is deprecated)</td>
<td></td>
</tr>
<tr>
<td>Downshift – Change speed</td>
<td>Yes – adjust data rate in case of issue</td>
<td>No – NBASE-T feature ONLY</td>
</tr>
<tr>
<td>speed in case of cable issues</td>
<td>due to cable and noisy environment – see</td>
<td></td>
</tr>
<tr>
<td></td>
<td>section 2.11</td>
<td></td>
</tr>
<tr>
<td>2.5G MDI Return Loss</td>
<td>2.5G spec to 125MHz</td>
<td>2.5G spec to 250MHz</td>
</tr>
<tr>
<td></td>
<td>5G spec to 250MHz</td>
<td></td>
</tr>
</tbody>
</table>

- **BASE-T AutoNeg enables 802.3bz/ NBASE-T coexistence**
- **NBASE-T Downshift selects lower data rate if link establishment fails** ([link](http://www.nbaset.org/technology/library/nbase-t-downshift-optimization-2-5gbs-5gbs-ethernet-data-rates-cables-cabling/))
- **NBASE-T/802.3bz MDI Return Loss harmonized via 802.3 Maintenance Request**
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

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NBASSE-T Alliance - InteropITX 2017 Demo

Going to #InteropITX 2018 in Vegas?
NBASSE-T alliance will be exhibiting again!

More at Why You Should Attend Interop ITX 2018!

NBASE-T IN THE WILD

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So what’s a TSA (Technical Solutions Architect)?

- Background (how I got here)
  - X1
  - X2
- Work
  - Partners with sales (AM – Account Manager).
  - Listen to customer, sales and corporate, and try to find balance.
  - Win the deal after this one by
- Current work obsession - Automation and Orchestration
  - What
  - Why
  - Result – consumable value
- Outside work
  - Pictures – diving and snow boarding
Typical Enterprise Network Structure

- Three tier design
- Proven, stable, adaptable
- BASE-T downlinks from access switches
Questions & Answers

Three questions:
1. Why > 1Gb/s access?
2. Pre NBASE-T roadblocks?
3. Value of NBASE-T?

Three answers:
1. Evolve to a smart network edge.
2. Installed cabling.
3. Leverage biggest asset, enable network evolution.
USE CASES

Enterprise Wireless - University of British Columbia

Scientific Compute - Monash University

Cruise Ships - Carnival
Enterprise Wireless – UBC Network

“As one of the world’s top research universities, the University of British Columbia has created positive change at home and abroad for more than a century. Today our two major campuses—in Vancouver and the Okanagan—attract, nurture and transform more than 60,000 students from Canada and 140+ countries around the world.”
Sir John Monash once said...."Adopt as your fundamental creed that you will equip yourself for life, not solely for your own benefit but for the benefit of the whole community."

Who we are - At Monash, the desire to make a difference informs everything we do. But we go beyond good intentions. We make an impact, both locally and internationally. We are a global university with a presence on four continents. And our plans for the future are ambitious.

Our world university rankings - At Monash, we take our reputation seriously. Monash has achieved an enviable national and international reputation for research and teaching excellence in a short 50 years. Monash is ranked in the top one per cent of world universities.

Scientific Compute – Monash University

Australian public research university Melbourne, Aus.
Founded in 1958
73,807 Students (50,461 + 22,848)
In 2016, Monash was ranked in the world top:
   20% in teaching
   10% in international outlook
   20% in industry income
   10% in research

https://www.monash.edu/
https://en.wikipedia.org/wiki/Monash_University
Las Vegas Resort vs Cruise Ship

**Encore Las Vegas**
- [https://disneyworld.disney.go.com/resorts/contemporary-resort/](https://disneyworld.disney.go.com/resorts/contemporary-resort/)
- **Opened**: 2008
- **Rooms**: 2,034
- **Floors**: 48
- **Floor Space**: 4.5 million sq. ft.
- **Height**: 631 feet
- **Width**: 93 feet

**Regal Princess**
- **Inaugural Cruise**: 2014
- **Cabins(Guests)**: 1,780 (3560)
- **Decks**: 19
- **Tonnage**: 141,000
- **Length**: 1,083 feet
- **Height**: 217 feet
Networks on Cruise Ships

Updates pending
Carnival – Ocean Medallion

Carnival Ocean Medallion: 5 takeaways from one of 2017's premier IoT projects

• A proprietary digital portal on board each ship
• Operates through a network of sensors
• Data analytics and machine learning
• Overcoming timing and technology challenges
• Multiple communication technologies at work

O·C·E·A·N — or One Cruise Experience Access Network FAQ
https://www.princess.com/ships-and-experience/ocean-medallion/

2017 CES Keynote https://youtu.be/7m7xeHzvKm
Product Sampler
more at www.nbaset.org

http://www.apple.com/imac-pro
https://www.e2v.com/products/imaging/cameras/uniiqa-4k-mono-and-colour/
http://www.marvell.com/transceivers/alaska/

https://www.aquantia.com/products/aqtion/nics/
Forecasts

There is a rapid transition from 11n to 11ac
Wave 2 started ramping in 2016, exceeds Wave 1 in 2017

Enterprise AP 802.11ac Wave Transition
Source: Dell’Oro Group Jan 2017

Updates pending: New data 2018

5.0 Gbps
2.5 Gbps
1000 Mbps
100 Mbps

NBASE-T Wrap-up

• NBASE-T provides 2.5Gbps and 5Gbps over installed cabling
  – Interoperable with IEEE 802.3bz (2.5GBASE-T and 5GBASE-T)
  – NBASE-T Downshift adapts to cabling to achieve the best performance
• NBASE-T supports use cases (including 802.11ac Wave 2) at > 1Gbps
• Cabling standards and guidelines for NBASE-T/802.3bz on the way
• Field test procedures to maximize performance are available

How can you make use of NBASE-T?
Thank You!
Blanks