



University of New Hampshire
**InterOperability
Laboratory**

Testing The Limits: TSN and SPE Updates

Presented by Bob Noseworthy
April 6, 2022



UNH-IOL at a Glance

The UNH-IOL as founded in 1988. Main UNH campus is located in Durham, New Hampshire, USA

The UNH-IOL is a non-profit neutral, third-party laboratory dedicated to testing data networking technologies through industry collaboration.

The UNH-IOL has been involved with TSN since the days of Residential Ethernet ('05) and in Ethernet Physical layer test since 1988.

- Principal developer of Avnu Automotive Certification Test Plans & Tools
- Principal developer of OPEN Alliance Physical layer, PCS, Phy Control and Sleep/Wake Test Plans



Today's Speaker

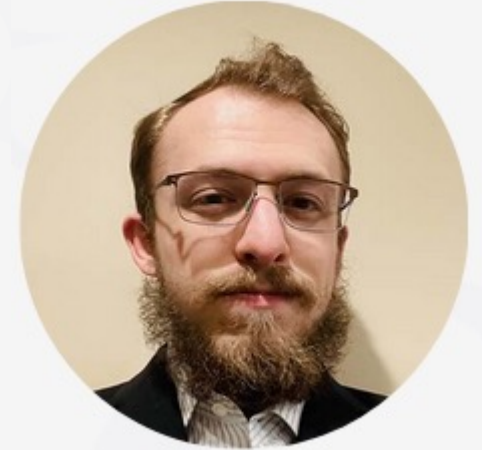
Bob Noseworthy



Principal Engineer,
TSN, SPE, 1588 Technologies

Involved with:
APL Group Certification,
Avnu Alliance's Certification,
IEEE PTP Certification,
Open Alliance Certification,
End-user TSN Profile development &
IEEE 802.1 TSN Working Group

Jason Sisk



Technical Manager, SPE,
Automotive and Industrial
Technologies

Actively involved in OPEN
Alliance and IEEE 802.3 working
groups

Agenda

IEEE-SA Conformity Assessment Program
1588 Power Profile Certification Program

TSN and SPE Updates from March'22 802 Plenary

- Ethernet Alliance and O-RAN Alliance Plugfests !

Q/A and Open Discussion {30 Mins}

- Put questions in Zoom Q&A Box
- Those asking a question will be given permission to speak

Industry Updates – IEEE 1588 Certification

IEEE Conformity Assessment Advancing toward approved Test Specification

- IEEE 1588 Power Profile Certification
 - Pilot testing of OCs (GrandMaster-capable, GrandMaster-only & Slave-only clocks) finally at end
 - Pilot testing of TCs and BCs ongoing
 - Interested parties can still join the pilot to receive early testing at reduced rates
 - <https://www.iol.unh.edu/1588/power>
 - Join the IEEE Certification Steering Committee here:
 - <https://standards.ieee.org/products-programs/icap/programs/ptp-power-profile/>
 - Test Suite Specification in review prior to ballot
 - Join the program and pass testing to become certified and listed in the IEEE Registry

IEEE SA
**STANDARDS
ASSOCIATION**

IEEE
1588
Certified

Industry Updates – IEEE 1588 Testing

Validate IEEE 1588

- Validation of IEEE 1588-2008 & IEC/IEEE 61850-9-3 & optionally IEEE C37.238-2017
- PTP-Violett for in-house pre-testing
- <https://www.iol.unh.edu/solutions/test-tools/ptp>
 - NIST and UNH-IOL collaboration and correlation effort
 - PTP-Violett Power Profile Package remains our current focus – packages for ITU-T 8275.1/.2 in draft/dev
- <https://www.power-grid.com/td/overcoming-substation-timingoverethernet-challenges/>



Industry Updates – O-RAN / 5G

- UNH-IOL officially Members as of late Jan'22
- Selected as a Plugfest site - coordinating with AT&T
- <https://www.iol.unh.edu/event/2022/03/o-ran-global-plugfest-spring-2022>
 - Focus on establishing initial End-to-End Interoperability testbed, with intent to host year-round activities,
 - Coordinating with Linux Foundation 5G Super Blueprint and others
 - 2nd Focus on S-Plane (Synchronization Plane)
 - O-RU testing from OTA 5G to Ethernet PTP timing
- Exploring potential to further assist with:
 - o Leveraging existing UNH-IOL draft ITU-T 8275.1 and 8275.2 protocol conformance test plans
 - o Current O-RAN S-Plane conformance tests are more 'performance' based
 - o Leveraging existing UNH-IOL expertise with hosting end-to-end interoperability test beds



Industry Updates – Ethernet Alliance

- High Speed Networking Plugfest
- 50 and 100 Gbps/lane technologies tested
- Fast approaching – April 25 – 29, 2022
- <https://www.iol.unh.edu/event/2022/04/high-speed-networking-plugfest>
- NDA event, contact Kae Dube (kdube@iol.unh.edu or morgan@ethernetalliance.org)



Industry Updates – 39th IBTA Plugfest

- Infiniband (IB) and RoCE Plugfest
- NDR (400Gbps Switches) and slower technologies tested
- Fast approaching – May 2 - 6, 2022
- <https://www.iol.unh.edu/event/2022/05/ibta-39th-infiniband-and-roce-plugfest>
- Register here by April 15 - <https://www.infinibandta.org/plugfest/>
- Unfamiliar? RDMA (Remote Direct Memory Access) enables high performance computing (eg: Super computers)), RDMA over Converged Ethernet (RoCE) runs on standard Ethernet Phys, whereas IB runs on similar but different serial standards,
- EDR (25Gbps/lane); HDR (50Gbps/lane); and NDR (100Gbps/lane)



IEEE 802.1 Workload

- There is a lot happening!
- At one point in time, IEC/IEEE 60802 (Industrial TSN Profile) referenced 42 other IEEE 802 standards
- Calling something “TSN” is akin to describing your network needs as just “Ethernet” – TSN is many standards, many features, profiles remain essential!
 - Only the ProAV Profile 802.1BA is done today!

| Project | Short Title | Last Motion | Current Stage | Draft# | Next action | PAR ends |
|--------------|---|-----------------|--------------------|--------|-----------------|----------|
| 802.1Qcj | Auto Attach to PBB | PAR extension | WG ballot | D1.3 | WG ballot | Dec '23 |
| 802.1CQ | Multicast and Local Address Protocol | TG Ballot | TG Ballot | D0.7 | TG Ballot | Dec '22 |
| 802.1ACct | support for 802.15.3 | RevCom | Published - Dec 17 | D2.0 | | Dec '21 |
| 802.1ABcu | LLDP YANG | RevCom | Approved - Dec 8 | D2.3 | Publication | Dec '21 |
| 802.1CBcv | FRER YANG & MIB | RevCom | Published - Feb 18 | D2.1 | | Dec '22 |
| 802.1Qcw | TSN (Qbu, Qbv, Qci) YANG | PAR Extension | WG ballot | D1.3 | WG ballot | Dec '23 |
| 802.1Qcz | Congestion Isolation | SA Ballot | SA Ballot | D2.1 | SA Ballot | Dec '22 |
| 60802 (DA) | TSN Profile for Industrial Automation | TG Ballot | TG Ballot | D1.3 | TG ballot | Dec '22 |
| 802.1CBdb | FRER (CBcv) extensions | RevCom | Approved - Dec 8 | D2.1 | Publication | Dec '22 |
| 802.1DC | QOS provision by network systems | WG Ballot | TG Ballot | D1.2 | WG Ballot | Dec '22 |
| 802.1Qdd | Resource Allocation Protocol | TG Ballot | TG Ballot | D0.5 | TG ballot | Dec '22 |
| 802.1DF | TSN Profile for Service Provider Networks | TG ballot | TG ballot | D0.1 | TG ballot | Dec '23 |
| 802.1DG | TSN Profile for Automotive Networks | TG Ballot | TG Ballot | D1.3 | TG ballot | Dec '23 |
| 802.1ABdh | LLDPv2 | RevCom | Approved - Dec 8 | D2.1 | Publication | Dec '23 |
| 802.1Qdj | TSN Configuration Enhancements | TG ballot | TG ballot | D0.2 | TG ballot | Dec '23 |
| 802.1AEdk | MAC Privacy protection | TG Ballot | TG ballot | D1.2 | WG ballot | Dec '23 |
| 802f | EtherType YANG | WG Ballot | WG Ballot | D1.0 | WG Ballot | Dec '23 |
| 802.1ASdm | Hot standby | TG Ballot | TG Ballot | D0.5 | TG Ballot | Dec '24 |
| 802.1Q-REV | Bridges and Bridged Networks | SA Ballot | SA Ballot | D1.0 | SA Ballot | Dec '24 |
| 802.1ASdn | Time Synch YANG | TG Ballot | PAR approved | | Editor's draft | Dec '24 |
| 802.1DP | TSN Profile for Aerospace | TG Ballot | PAR approved | | Editor's draft | Dec '24 |
| 802.1BA-rev | AVB Systems | RevCom | Published - Dec 12 | D2.0 | | Dec '24 |
| 802.1AS/cor1 | Timing and Synchronization corrigendum | RevCom | Approved - Dec 8 | D4.0 | Publication | Dec '24 |
| 802.1Qdq | Tspec | TG Ballot | PAR approved | D0.1 | TG Ballot | Dec '25 |
| 802.1ASdr | Inclusive Language | TG Ballot | PAR approved | | Editor's draft | Dec '25 |
| 802.1ASds | half-duplex support | PAR Approval | PAR approved | | TG Ballot | Dec '26 |
| 802.1Qdt | PFC MACsec | PAR Development | PAR Development | | NesCom | |
| 802.1DU | Cut-through forwarding | PAR Development | PAR Development | | PAR Development | |
| 802.1Qdv | Cyclic Queueing and Forwarding | PAR Development | PAR Development | | PAR Development | |
| 802-rev | O&A | PAR Development | PAR Development | | NesCom | |
| 802.1Qdw | Source Flow Control | | | | PAR Development | |
| 802g | O&A rework | | | | PAR Development | |

Source: <https://www.ieee802.org/1/files/public/minutes/2022-03-closing-plenary-slides.pdf>

March IEEE 802.1 Plenary Update

- March'22 Updates (see ieee802.org/1/tsn for more)
 - 802.1 & 802.3 to hold joint meetings for cut-through forwarding (P802.1DU)
 - 802.1DP and SAE AS6675 bi-weekly joint meetings for Aerospace TSN profile (next is April 13, 10am-Noon EDT)
 - May 4, 9-11am EDT, 802.1 discussing “Common TSN for converged networks”
 - P802.1ASds – adding support for 802.3 Half-duplex MAC
- 802.1 May Interim (virtual) – May 9-13.
- Expected May'22 – PAR for enhancing Cyclic Queuing and Forwarding

March IEEE 802.3 Plenary Update

- Project started: 802.3dg - Physical Layer Specifications and Management Parameters for 100Mb/s Operation and Associated Power Delivery over a Single Balanced Pair of Conductors (you can think of this as “100BASE-T1L”)
- 802.3de continuing (10Mbs SPE support for Time Synchronization Service Interface)
- 802.3cy continuing (Greater than 10Gbps SPE)

SPE Summary Updates

10BASE-T1L and APL (Advanced Physical Layer)

APL Certification testing online and expanding to the APL Group membership and organization labs

10BASE-T1L PMA, PCS, PHY-Control and Auto-Negotiation In development

- PMA fully available and PCS partially available

APL-Violett Test Software Available
enabling in-house APL testing

Tooling available: PCB Test Fixtures

- Bias Tees for Spur/Trunk Source/Load
- Line taps + more

<https://license.unh.edu/products/iol/APL>

Service offering migrating to a 10BASE-T1 Service group

- APL Testing available as Pay-per-test
- Silicon conformance testing moving out of “Low-speed SPE” group

SPE Summary Updates (2)

100BASE-T1 to MultiGig, OPEN Alliance and Ethernet Alliance + Plugfests!

Contributing to Open Alliance Errata and ISO process for 100BASE-T1 test plans.

Continuing to develop MultiGig PMA test capability launch and work with industry leaders for MultiGig PCS/PhyC compliance testing

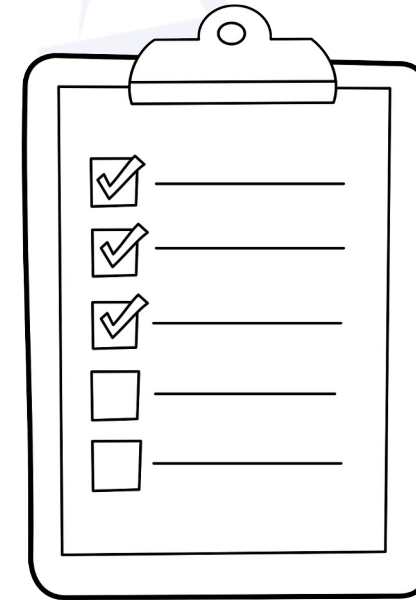
Participating in discussions with the Ethernet Alliance SPE group on potential activities for further EA driven validation

Anticipating Summer 2022 plugfests for SPE interests *(potential for 10BASE-T1L through MultiGig SPE – possibly include 1000BASE-T1 Type B and 40Meter reach)*

TSN Updates - Beyond AVB

Validation of TSN Standards

- .1Qbu/.3br: UNH-IOL Pre-emption conformance testing, including negative test cases, available since 2017
- .1Qbv: Time aware scheduling (TAS) testing performed for some IP & silicon providers
- .1Qci: Ingress Policing (Per-Stream Filtering and Policing) in development
- IEEE 802.1AS-2020, IEEE 1588-2019, and related profiles: C37.238-2017, IEC/IEEE 61850-9-3{2016}, ITU-T G.8275.1 & G.8275.2 available or in dev.
- Test plans currently available or expected in '22



TSN Updates - TSN Profiles

TSN Standards → TSN Profiles

- AVB was ~5 IEEE standards, TSN has >42 & climbing
- Most standards have multiple options, some orthogonal
- TSN Profiles must exist to define interoperable solutions for a given use case
 - Example: IEEE 802.1BA (AVB Profile)
- Several profiles are in-flight, none complete:
 - IEEE 802.1DG (Automotive) – draft 1.4 commenting review on going
 - IEC/IEEE 60802, (Industrial Automation) – draft 1.3 comment review
 - IEEE 802.1DF, (Telecom Service Provider) draft 0.1
 - IEEE 802.1DP (Aerospace) – none as of yet
- UNH-IOL's Bob Noseworthy currently authored 2 profiles for large end-user needs (not yet publicly available, expected to be in 2022)



Industry Updates

Industrial Automation / Process control

- Supporting needs of the APL Group
 - PNO, FieldComm Group, ODVA, OPC Foundation
 - In discussions with several member organizations and member companies to offer further services
- Tracking APL further specification definitions
- Tracking IEEE 802.3 100BASE-T1L
- Developing full Silicon Validation for 10BASE-T1L
- Tracking IEC/IEEE 60802 and related CA discussion
- Supporting Research interests in Industry 4.0 / Digital Factory



Future Needs / Q&A

Several areas are open to further development, **with sufficient interest:**

With sufficient interest:

- Deeper dive on specific TSN standards ? (Pre-emption, TAS, CM)
- ORAN S-Plane / Telecom TSN validation
- 10BASE-T1S (OPEN Alliance TC14) support
- 100/1000BASE-T1 Interoperability testing (per OPEN definition)
 - Extending our TC1/TC12 service offering
- Full coverage of OPEN TC8 ECU & TC11 Silicon validation
 - Could be provided via Violet® and supported hardware solutions
 - Potential partnership with T&M equipment provider
- Accelerate & expand Timing Security / Quality of Time testing
- Accelerate & expand custom FPGA TSN NIC development
- Accelerate coverage of TSN Profiles In I.A., Telecom, Automotive, etc.

Questions and Requests ?
Contact us on how to 'kickstart' such efforts.

We want to hear from you!



Q&A

Input from the discussion in Feb'22:

Interest expressed / updates given on:

- Details on IEEE 1588 Certification Program
- 1000BASE-T1 Type B and 40Meter reach
- Interoperability
- More on TSN details (specific standards)
- Multiple inquiries around plugfest activities and organization, MultiGig SPE, TSN, Management, Security all potential topics of focus/event.

Thanks for your Questions!
Contact us (see next slide) for options on
how to 'kickstart' such efforts.

We want to hear from you!



- We invite industry and academia for a two-day summit, consisting of paper presentations, workshops, an evening reception, recognition, and networking!
- Future of Moving Data: Network Measurement, Performance, and Tuning is designed for all tech gurus in the networking industry.



<http://bit.ly/IOLsummit22>

Contact Information

Single Pair Ethernet and Time Sensitive Networking Testing Services

Bob Noseworthy

Principal Engineer
ren@iol.unh.edu

Jason Sisk

Technical Manager
jsisk@iol.unh.edu

Mike Goding

Sales Support
MikeG@iol.unh.edu

Michelle Whisnant

Operations Manager
mwhisnant@iol.unh.edu

