



University of New Hampshire
**InterOperability
Laboratory**

Testing The Limits: TSN and SPE Updates

Presented by Bob Noseworthy

June 22, 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

**Automotive Ethernet Congress and
UNH-IOL 10BASE-T1S and 10BASE-T1L Activities**

TSN and SPE Updates from May'22 802 Interim

- 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

Automotive Ethernet Congress - 2022



UNH-IOL former student & staff,
Curtis Donahue, now with R&S,
presenting on 10GBASE-T1 Testing
Challenges

Industry Updates – AEC 2022 Highlights

Naturally many topics were covered, below are just a few highlights:

- o Max Turner (Ethernovia & IEEE 802.1DG ({Automotive TSN Profile Chair}))
 - o Presented on challenges with Time Aware Shaper (TAS) limits its usefulness in a vehicular setting except in limited cases with low line rates, static networks, and stringent latency needs.
Note: This is not the first time or only time Max & others have argued against the complexity of TAS for in-vehicle use.
- o Marty Gubow / Ionel Ghita (Keysight/Ixia) Note: Many talks/booths on use of MACsec in-vehicle
 - o Presented on challenges of testing TSN with MACsec, especially with Frame Preemption
- o Frank Bähren (Cariad) Note: Many talks on Zonal architecture benefits
 - o Presented on Zonal architecture and the need for a group to address configuration and test issues currently omitted by OPEN & Avnu. Autosar may be the place to do the work.
- o Kamal Dalmia (Aviva Links) Note: Many talks / panels on asymmetrical links & optical / POF links
 - o Presented on Asymmetrical Ethernet for sensors, cameras and displays. For unidirectional high data rate links, 'classic' full duplex Ethernet (including SPE) is power inefficient compared to either an asymmetric energy efficient ethernet (EEE) solution - only now being looked at by OPEN's TC16 - or Automotive Serdes Alliance's Time Domain Duplexing (TDD) solutions.
Which will be the optimal solution in 5 years? ASA TDD, TC16 EEE, or 'classic' SPE

Industry Updates – O-RAN / 5G

- UNH-IOL officially Members as of late Jan'22
- Completed our first ORAN Plugfest
Thanks to participants:
 - Analog Devices, Cisco, IP Infusion, Keysight, Rohde & Schwarz, Viavi
- <https://oranalliance.atlassian.net/wiki/spaces/PLUG/pages/2522710173/Final+Presentations+from+O-RAN+Global+PlugFest+Spring+2022>
- Future steps
 - Continue to establish an End-to-End Interoperability testbed, with intent to host year-round activities, coordinated with Linux Foundation 5G Super Blueprint and others
 - Continue to support S-Plane (Synchronization Plane) O-RU and Ethernet infrastructure with support of Calnex and ORAN WG9 efforts, potentially leveraging existing UNH-IOL draft ITU-T 8275.1 and 8275.2 protocol conformance test plans



Industry Updates – Ethernet Alliance

- High Speed Networking Plugfest Completed April 25 – 29, 2022
 - 50 and 100 Gbps/lane technologies tested
 - Next Plugfest tentatively October 10-14, 2022 @ UNH-IOL
- EA SPE Committee meeting to discuss validation/plugfests for SPE, notably 10BASE-T1L / PoDL{SPoE}
 - Next meeting June 27th 1pm EDT
 - Encourage participation in EA SPE Committee for more direct communications under the EA membership rules.
 - EA Members, please reach out if you have further questions



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>

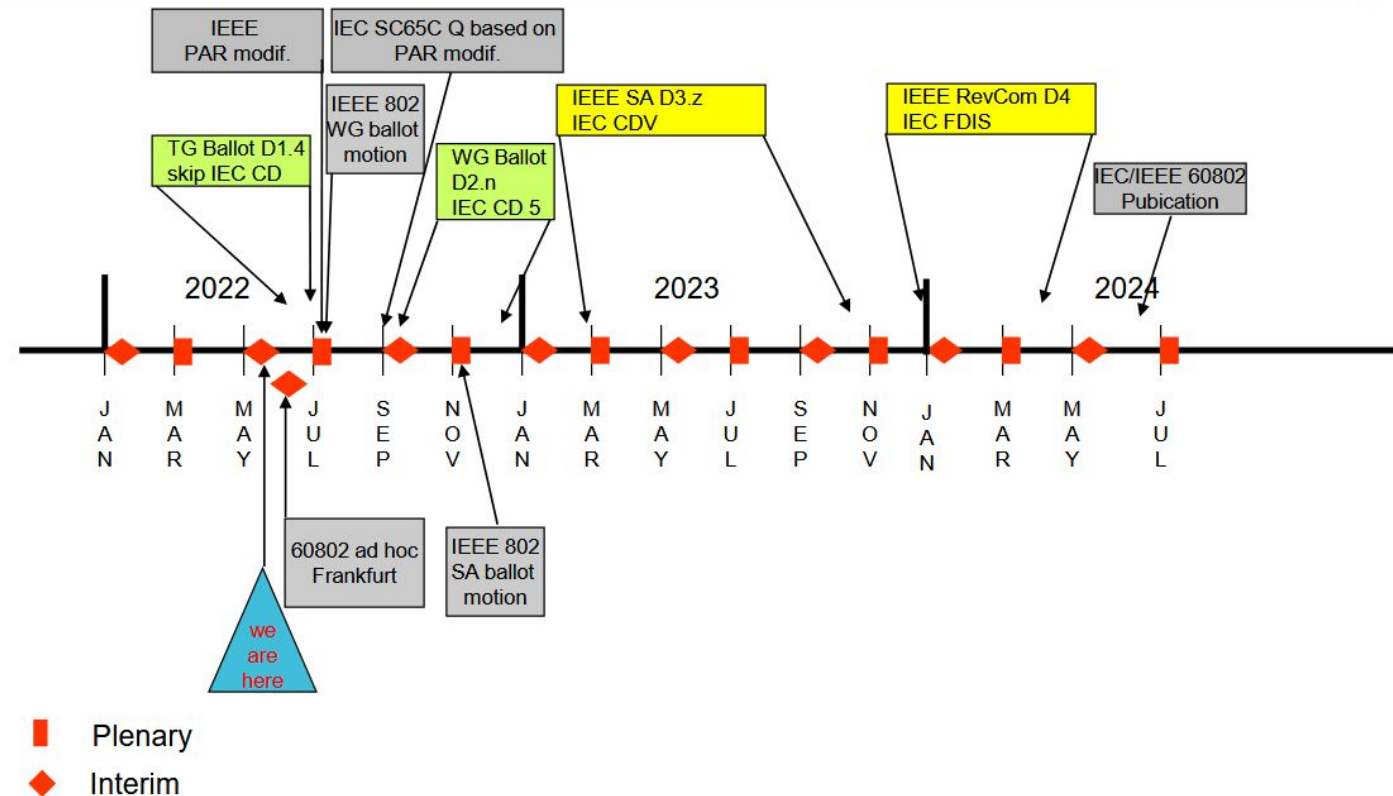
May IEEE 802.1 Plenary Update

- May'22 Updates (see [ieee802.org/1/tsn](https://www.ieee802.org/1/tsn) for more)
 - 60802 - all technical comments in the 1010 comments submitted against D1.3
 - May 4, 9-11am EDT, 802.1 “Common TSN for converged networks”
 - Günter Steindl (Siemens) and Henning Kaltheuner d&b Audio)
<https://www.ieee802.org/1/files/public/docs2022/new-Steindl-Kaltheuner-Common-TSN-0522-v01.pdf>
 - János Farkas (802.1 TSN TG Chair) and Greg Schlechter (Avnu)
<https://www.ieee802.org/1/files/public/docs2022/new-Farkas-Common-TSN-0522-v01.pdf>
 - P802.1ASds – adding support for 802.3 Half-duplex MAC (10BASE-T1S need)
- 802.1 July Plenary - Montreal, Quebec, Canada - July 11-15 {hybrid meeting}
- PAR for enhancing Cyclic Queuing and Forwarding
<https://www.ieee802.org/1/files/public/docs2022/dv-draft-PAR-0522-v01.pdf>

May IEEE 802.1 Plenary Update

Updated IEC/IEEE 60802 timeline

A 60802 ad-hoc
also met
June 13-15
in Frankfurt to prepare
D1.4 for the next
Plenary (July 10-14)



May IEEE 802.3 Interim 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”)
 - https://www.ieee802.org/3/dg/public/May_2022/index.html
- 802.3de continuing (10Mbps SPE support for Time Synchronization Service Interface) {May focused on initial SA ballot comments on D3.0}
- 802.3cy continuing (Greater than 10Gbps SPE) {May resolved D1.1 comments leading to D1.2 recirculation}

SPE Summary Updates - $\geq 100\text{Mbps}$

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

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

Working toward 2 1000BASE-T1 PCS/PhyC tools !

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*)

Expected to be in coordination with EA SPE committee, though open to others (eg: OPEN TC14 for 10BASE-T1S)

SPE Summary Updates - T1L

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

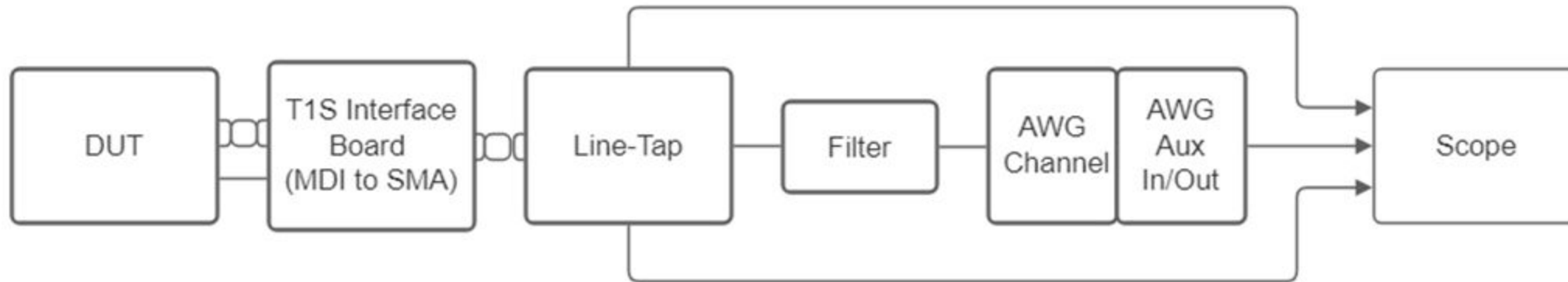
- Bias Tees for Spur/Trunk Source/Load
- Line taps + more

<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

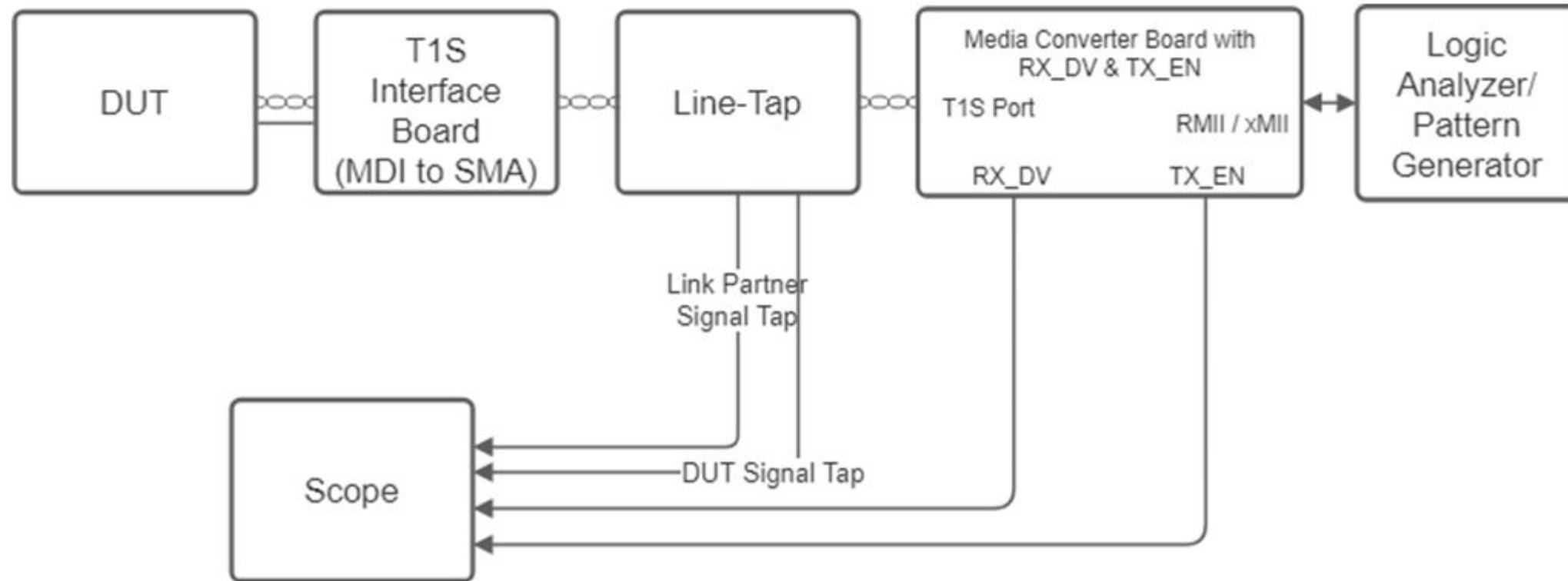
Example 10BASE-T1S Test Setup (from AWG)



Most test cases can be performed with UNH-IOL developed MATLAB code to generate the required test signaling is provided to a suitable AWG with Filter as needed for PSD mask standards compliance.

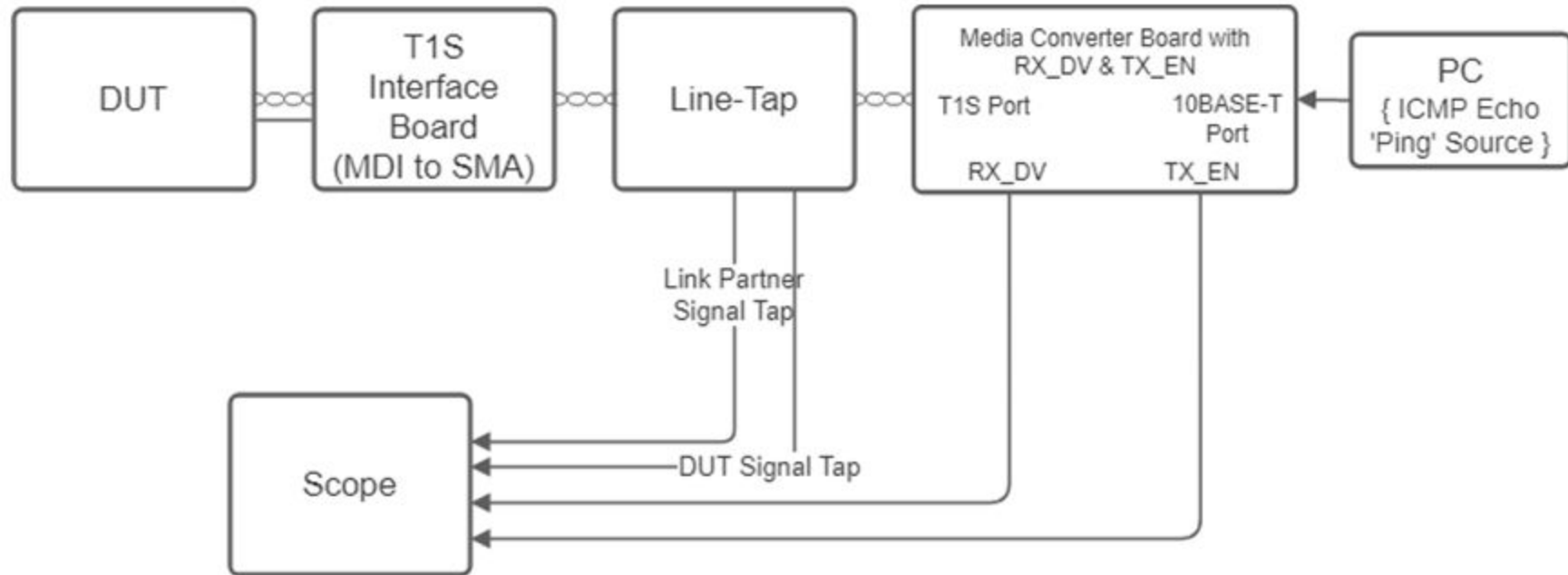
Post processing of scope capture via UNH-IOL developed MATLAB code to decode and verify that the AWG signal and DUT transmissions were proper, at the symbol/code-group level and above (PCS, PhyC, PLCA, CI 98 Auto-Neg, etc)

Example 10BASE-T1S Test Setup (to/from MII)



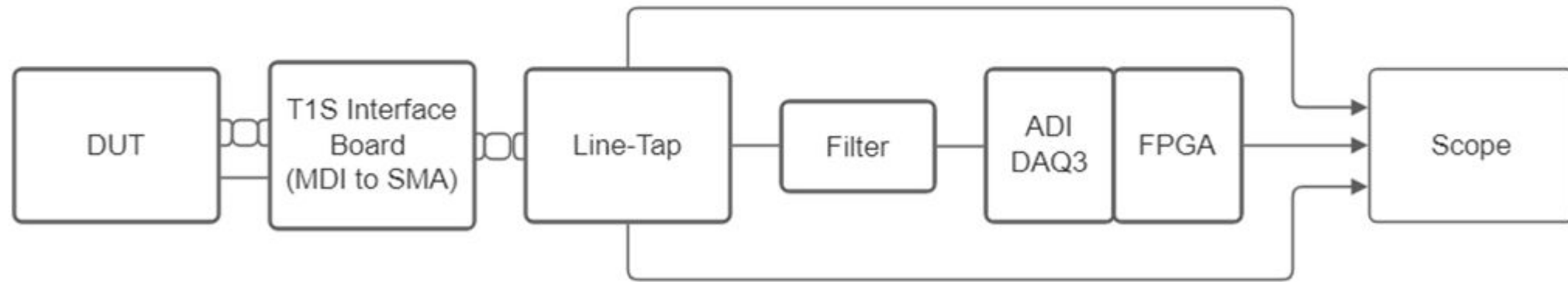
Some test cases could be performed simply from MII level observations of link partner signaling (including some simple PCS tests, MAC, Flow Control, etc)
(Note, a "Link Status" from the "Media Converter / MII" board might be needed for some tests)

Example 10BASE-T1S Setup (to/from Base-T)



Some higher-level test cases can benefit from simpler setups with Media Converters and monitoring when needed – this can also include stressed receiver environment tests where packet error rate to estimate bit error rate is useful

10BASE-T1S Test Setup(to/from custom FPGA)



This is a longer-term goal, replacing the static and non-interactive AWG with a dynamic FPGA system

SPE 10BASE-T1S Updates

Call to join UNH-IOL's 10BASE-T1S effort

Leveraging existing UNH-IOL test solutions, including for T1L, to enable rapid T1S test solution creation.

10BASE-T1S PMA, PCS, PLCA and Auto-Negotiation In development

Enabling existing Half-Duplex MAC testing via 10BASE-T1S PHY (with PLCA disabled)

Test software and tooling to be made available

10BASE-T1S Service group

Meet with us in-person Montreal, July 11-15 to discuss

- Schedule private meeting times Mon July 11 and Tues July 12.

-or-

- We can schedule Zoom meetings to discuss activities.

Continuous Improvement Cycle

Standards:

- Eg: IEEE 802.3 / OPEN TC14
 - Defines:
 - Interoperability requirements
 - Conformance requirements
 - Testability requirements

Test Plan:

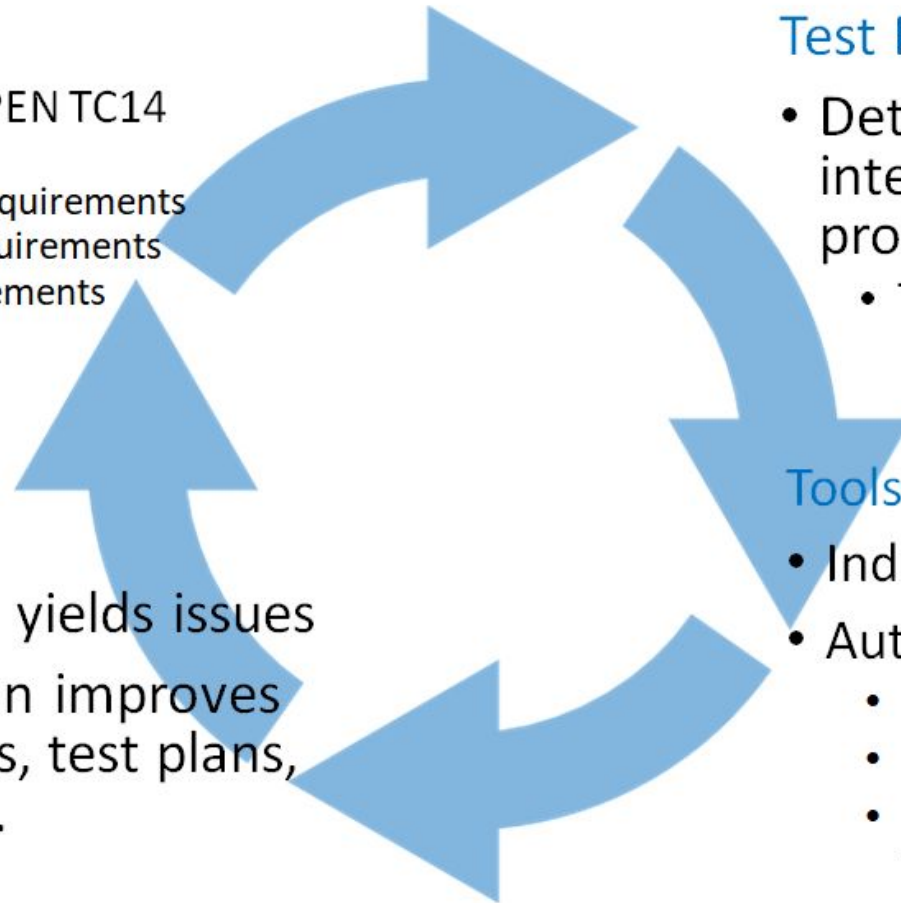
- Details conformance & interoperability test procedures
 - Tool agnostic

Tools:

- Industry standard tools
- Automation Test Harnesses
 - Instantiate Test Plans
 - Multiple solutions
 - Enables 1st & 3rd party common test

Testing:

- Test execution yields issues
- Issue resolution improves products, tools, test plans, and standards.



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 April'22:

Interest expressed / updates given on:

- Any research on TSN for vehicle networks with mixed physical layers (SPE, CAN, LIN, FlexRay)? {yes, see AEC update! hope you were able to attend!}
- Any plans for an open source project for TSN, to accommodate the newer IEEE standards being included? {see OpenAvnu}
- Schedules for profiles in flight {see 60802 timeline in this update, others lack explicit timelines}
- 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!



Contact Information

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