Avnu Alliance: Advancing Time Sensitive Networking with IEEE

Greg Schlechter (Intel Corporation), President, Avnu Alliance

Founded in 2009 by a group of companies with delegates active in the IEEE work group that is now the 802.1 TSN work group [1] and wanting to provide an interoperable ecosystem, Avnu Alliance [2] is now moving past a decade of bringing companies together to facilitate time sensitive capabilities in networking.

Over the years, Avnu Alliance and the IEEE 802.1 TSN workgroup have expanded together. The workgroup, originally under the name of Audio Video Bridging due to the initial focus application on Professional AV and later Automotive use cases, is now the 802.1 TSN workgroup. 802.1 TSN has moved from just a few IEEE standards to dozens of standards addressing many different aspects, with both IEEE and Avnu addressing the needs of industries not even considered in the early days.

The role of Avnu Alliance, similar to organizations such as Wi-Fi Alliance, is providing a forum where companies across industries who are implementing the standards can discuss use cases, market requirements, and interoperability needs of a value chain including component suppliers, device manufacturers, software vendors and end users to facilitate a vibrant, interoperable ecosystem utilizing IEEE standards. This provides a critical role in bridging between the needs of rapidly transforming networks and the IEEE standardization. A key component toward this ecosystem is the certification programs supported by interoperability and conformance tests, and third-party test lab programs put in place and administered by Avnu Alliance, with input from all member companies.

Experiences in the field of member companies' products, market trends and technical insights are shared between Avnu and other organizations via liaison and mutual delegates, enabling a cycle of continuous innovation in network capabilities over the years as device connectivity continues to turn to networks to connect devices across industries. Avnu Alliance initiated the TSNA Conference [3] to provide a forum for discussion of time sensitive networking advancements and application needs, where IEEE-SA also exhibits and IEEE experts present and participate in the always interesting discussion and panels.

By creating a forum for involvement of a wide range of companies, Avnu Alliance has also provided a service not originally envisioned at its founding. Because many markets enabled by TSN were not previously using standard networking to now build on this foundation, many of the companies had not previously interacted with IEEE directly and were not familiar with the processes and culture that IEEE uses to develop standards, or how to be directly involved. Through the close relationship of Avnu and IEEE, members get a window to the time-tested IEEE SA processes and avenues to become more involved. One member's experience provides the best example of this:

"Meyer Sound joined Avnu Alliance because of our desire to use AVB. While we had used solutions that were IEEE standards, we did not have any direct experience with how standards were created and maintained. Because of the close working relationship of several IEEE working groups with Avnu, we came to realize the importance to our industry of the IEEE-SA process. Our relationship with IEEE-SA has grown over the years and I am now chair of a working group and an active participant in several others." – Richard Bugg, Avnu ProAV WG Chair and IEEE1722.1 Chair

With TSN being utilized by an ever-wider range of industries that rely on a common networking ecosystem, the relationship between Avnu Alliance and IEEE will be more important than ever over the next decade to advance networking in an increasingly connected and converged world.

References

[1] https://1.ieee802.org/tsn/
[2] https://avnu.org
[3] https://www.businesswire.com/news/home/20150324005133/en/AVnu-Alliance-Sponsors-First-Annual-Conference-on-TSNA

Current Work ETSI TC BRAN Relevant to Wi-Fi

Dr. Guido R. Hiertz (Ericsson GmbH), ETSI TC BRAN Chair

ETSI TC BRAN develops Harmonized Standards (HSs) that are relevant for manufacturers that want to put Wi-Fi (based on the IEEE 802.11 standard) products on the European market [1]. HS EN 301 893 (5 GHz) and HS EN 303 687 (6 GHz) address license-exempt bands traditionally used by Wi-Fi. HS EN 302 567 addresses the 60 GHz band where IEEE 802.11ad and IEEE 802.11ay compliant device are marketed as WiGig. IEEE 802.11af specifies the TV whitespace band (470 MHz to 790 MHz) operation that HS EN 301 598 governs.

At present, ETSI TC BRAN members mostly discuss how EN 301 893 and EN 303 687 should be designed so that dissimilar technologies equally share the same frequency channel. Whereas the 5 GHz HS will receive an update, the 6 GHz HS will be the initial version. Both HSs define a band plan based on 20 MHz channels, limits for unwanted emission and transmit power, adaptivity rules, and related tests. With respect to Wi-Fi, adaptivity is best described as a medium access control (MAC) scheme. Both HSs foresee that devices operate as Frame Based Equipment (FBE) or Load Based Equipment (LBE). With FBE, devices may sense the wireless medium at certain periods. If found unoccupied, a device may transmit. In contrast, LBE devices may sense the wireless medium any time. However, they must follow a detailed truncated exponential backoff procedure like the mechanism implemented by Wi-Fi. An Energy Detection Threshold (EDT) defines the power level at which a device must detect the wireless medium as occupied. The current draft of EN 303 687 defines a transmit-power dependent EDT that applies to all technologies. Version 2.1.1 of EN 301 893 currently permitted for use in Europe defines a second, transmit-power independent EDT. Devices may use this EDT if they implement IEEE 802.11a, IEEE 802.11n (Wi-Fi 4), or IEEE 802.11ac (Wi-Fi 5). ETSI TC BRAN members are presently discussing how to best modify EN 301 893 so that its next version 2.2.1 will grant this transmit-power independent EDT to Wi-Fi 6 (IEEE 802.11ax) equipment, too.

Since HSs classify as part of the European Union's law, another discussion item emerged recently. ETSI TC BRAN members discuss how HSs should implement and test User Access Restrictions (UAR). UARs are mechanisms that devices must implement to prevent users from disabling limitations that would cause it to interfere with other radio services, and consequently to become non-compliant. With respect to EN 301 893, UAR are needed to avoid that users disable (flight/weather) radar detection mechanisms. With respect to EN 301 598, UAR would prevent users from operating in TV white space channels currently unavailable. Since modern radio equipment is controlled by software, ETSI TC BRAN members consider describing inspection methods that serve as prima facie evidence.

References

[1] G. R. Hiertz, "ETSI and its Role in the Path to the European Market," *IEEE Commun. Standards Mag.*, vol. 4, no. 4, Dec. 2020, pp. 3–7.

Bridging Standards for Smart Cities

Ingo Friese, Deutsche Telekom (oneM2M member)

The construction of end-to-end IoT systems integrates a range of elements, from endpoints to gateways and cloud platforms.

They also rely upon many different technologies, for connectivity, data syntax and security, up and down the solution stack. As a result, developers face many choices, often mixing and matching proprietary and open standard components.

It follows that IoT systems, and especially smart city deployments, will not succeed because of any one standard. In practice, smart city systems will involve heterogenous architectures. These will combine the capabilities and strengths of many different standards. Therefore, interworking capabilities that connect elements between different standards becomes more important for future smart city infrastructures.

Building from a Geospatial Legacy: The starting point for smart city systems begins with the processes in place to support everyday operations. These involve activities such as the cataloging the location of city assets, charting of property zones, and provision of map data. Many large cities support these operations using systems based on Open Geospatial Consortium (OGC) standards. In the case of connected devices and sensors, the OGC's SensorThings API (STA) provides an open and unified framework to interconnect sensing IoT devices, data, and applications over the Internet.

oneM2M Interworking: An interworking capability between OGC/STA platforms with oneM2M systems broadens the reach of those platforms. This is because OGC/STA-based platforms can be connected with one or more oneM2M-based Sensor or Actuator Systems, effectively creating a bridging function between silo systems.

During oneM2M's 47th Technical Plenary, in October 2020, members proposed a new work to define an interworking capability between oneM2M and OGC SensorThings API. The solution arising from this work item will follow the same principles that apply to existing oneM2M interworking solutions with established industry protocols. The analysis and design will not be exclusive to smart cities and consider scenarios in other verticals. It will consider the pros and cons of different implementation approaches as well as interworking elements at different layers of the solution stack. These include standardized solutions for opaque data routing, and data model mapping between the oneM2M Smart Device Template (SDT) and the OGC ISO 19156 standard for geographic information. Systems architects will benefit from an additional tool that extends their platform capabilities and enables the design and deployment of cross-silo applications.

Beyond 400 Gb/s Ethernet

John D'Ambrosia (Futurewei Technologies), Chair, IEEE 802.3 Beyond 400 Gb/s Ethernet Study Group

Over the past 15 years, the Ethernet community has learned it must pay attention to industry bandwidth trends in order to ascertain when it is time to start developing the next speed of Ethernet. In the IEEE 802.3 Ethernet Working Group, there have been formal efforts undertaken to document its Ethernet Bandwidth Assessment. The last analysis, published in April 2020[1], highlighted that by 2025 the bandwidth of various applications would grow anywhere from 2.3x to 55.4x their 2017 levels, as shown in Fig. 1. This figure also includes comparison points to the potential introduction of 800 GbE and 1.6TbE. As highlighted in this figure, the growth rates of many applications are exceeding that of possible future Ethernet rates.

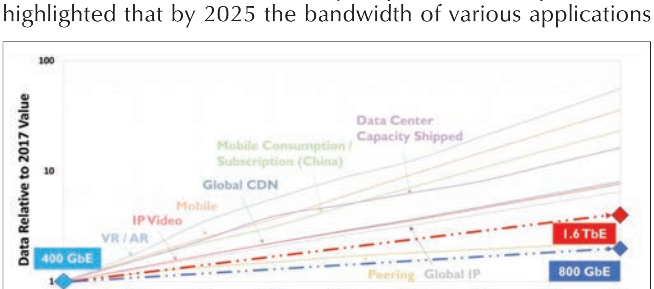

Figure 1. IEEE 802.3 2020 Ethernet Bandwidth Assessment.

This assessment helped forge consensus within the Ethernet community, and this past January, the IEEE 802.3 Beyond 400 Gb/s Ethernet Study Group was formed. The job of the Study Group will be to develop project documentation for an effort to define the next rate of Ethernet, as well as using any physical layer specifications developed to support the new higher speed that may be applicable to an existing Ethernet rate. For example, 800 GbE could be supported by four lanes of 200 Gb/s signaling. This new 200 Gb/s signaling technology could then be applicable to 200 GbE (1 x 200 Gb/s) and 400 GbE (2 x 200 Gb/s).

First of all, the next rate of Ethernet has not yet been determined. As already noted, 800 GbE would not be keeping up with any observed growth rates, which could lead to both 800 GbE and 1.6 TbE being selected as the next rates of Ethernet. This will be an interesting industry debate, and potential stakeholders should get involved.

While considering what the next rate of Ethernet will be, the study group will also be contemplating which physical layer specifications will be selected as objectives for the project. This is an enormous task given the current breadth of Ethernet physical layer specifications, such as for electrical backplanes, twin-axial cables, multi-mode fiber, single-mode fiber, and DWDM systems, as well as the various electrical interfaces that are defined for Ethernet. As part of the decision-making process, the Study Group will also need to consider the broad market potential, technical feasibility, and economic feasibility of each possible objective.

The Study Group is only just beginning its activities. As all meetings are currently being conducted via electronic teleconferences, this gives stakeholders the opportunity to participate in the process. For further information on the IEEE 802.3 Beyond 400 Gb/s Ethernet Study Group, please see https://www.ieee802.org/3/B400G/index.html.

[1] 2020 Ethernet Bandwidth Assessment, IEEE 802.3 Ethernet Working Group, April, 2020, https://bit.ly/802d3bwa2.

The Ethernet Evolution Continues

John D'Ambrosia (Futurewei Technologies), Chair, IEEE P802.3ct and IEEE P802.3cw Task Forces

Ethernet is built upon a foundation of evolving to meet the demands of history. Ethernet's expansion has often been associated with its never-ending evolution to address faster speeds, but the reality is Ethernet has expanded into new application spaces with existing speeds. Its latest evolution has been its expansion beyond 40km into running over DWDM systems for reaches 80km and beyond.

The IEEE P802.3 P802.3ct 100 Gb/s over DWDM Systems is the first effort to expand the footprint of Ethernet into the DWDM space. Leveraging dual polarization differential quadrature phase shift keying (DP-DQPSK) modulation and a staircase FEC (SC-FEC), the Ethernet solution, referred to as 100GBASE-ZR, will address cable/multiple-system operator (MSO) distribution networks and mobile backhaul networks where reaches in excess of 40 km are required or where fiber availability drives the need for multiple instances of Ethernet over a DWDM system. The solution is based on DP-DQPSK modulation and a SC-FEC where each wavelength will support 100 Gb/s Ethernet. Supporting 48 wavelengths on 100 GHz spacing, a total Ethernet-based solution would support 4.8 Tb/s. The IEEE 802.3ct draft is currently in the

IEEE Standards Association Ballot, having just completed its first recirculation ballot. It is anticipated that the standard will be ratified in Q3 of 2021.

The IEEE P802.3cw 400 Gb/s over DWDM systems effort targets the interconnect for distributed data centers where reaches in excess of 40 km are required or where fiber availability drives the need for multiple instances of Ethernet over a DWDM system. The 400GBASE-ZR specification will define 400 Gb/s Ethernet operation over a single wavelength. The standard will define operation over 64 wavelengths on a 75 GHz spacing, supporting a maximum Ethernet-based capacity 25.6 Tb/s over a single fiber. The solution is based on DP-16QAM modulation with coherent detection to achieve the 80 km reaches. With the shift from 100 GHz to 75 GHz channel spacing, optical crosstalk has become an important issue. The shift from 100 Gb/s to 400 Gb/s and the reduction in channel spacing has combined to create a complex challenge for the IEEE P802.3cw project, which is targeting standard ratification by Q3 2022.

The development of these two standards will expand the Ethernet family, and future speeds of Ethernet will eventually provide a future upgrade path for this given application. The IEEE 802.3 Beyond 400 Gb/s Ethernet Study Group, as the name implies, is currently defining the project that will specify operation beyond 400 Gb/s Ethernet. Whether operation beyond 400 Gb/s Ethernet gets defined at this time remains to be seen. Individuals interested in this effort are invited to participate.

Introduction for IEEE P802.1DF Project: TSN Profile for Service Provider Networks

Tongtong Wang (Huawei), Editor, IEEE P802.1DF

IEEE 802.1 TSN standards were primarily invented for small scale networks like Audio/Video Bridging networks to provide end to end bounded latency services in a converged Ethernet, where multiple classes of traffic streams traverse in one network with different latency bounds. In the last two years, the discussion in the TSN task group has extended to industrial automation scenarios in factories, in-vehicle networks and large-scale metro Ethernet networks. The capability of providing differentiated service levels for multiple customers or applications in one TSN-based infrastructure is an appealing feature for service provider networks and paves the way for latency reliable network slicing over metro Ethernet.

Use cases in some early 5G URLLC (ultra-reliable low-latency communication) trial projects for smart harbors[1], smart cities and smart grid scenarios[2] over carrier networks have studied the requirements for a TSN profile in service provider networks, namely bounded latency, high reliability and traffic isolation capability. The IEEE P802.1DF (TSN profile for service provider networks) project is investigating all quality of service techniques in the IEEE 802.1 standard including strict priority scheduling, credit-based shaper, scheduled traffic and asynchronous traffic shaping, and so forth. In addition, an informative annex on network calculus theory will also be provided by the IEEE P802.1DF standard to serve as the knowledge basis for a latency analysis model for all quality of service approaches, to help readers understand the comparison between schedulers and shapers and choose the recommended profile.

Contributions, discussion or comments on this project will be warmly welcomed by the entire P802.1DF TSN project team[3]. Thank you!

[1] https://www.maritime-executive.com/article/5g-smart-port-system-trialed-at-qingdao

[2] https://www.gsma.com/futurenetworks/wp-content/uploads/2020/02/5_Smart-Grid-Powered-by-5G-SA-based-Network-Slicing_GSMA.pdf

[3] https://1.ieee802.org/tsn/802-1df/