



About

Welcome to the twentieth issue of Smart Grid Communications (“Comms”) Intelligencer, a triannual newsletter published by EPRI’s Information and Communication Technology (ICT) Program. Our mission is to highlight issues of relevance and interest to utility communications engineers and managers. Our focus is on developments in communication technologies and standards, and business issues that can affect the design, deployment, or operation of utility communications infrastructure.

This newsletter tracks standards development activities that continue over an extended period of time. To make the material understandable without requiring reference to previous issues, some text is retained from issue to issue to provide a context for the topic. To make it easier to find updates, **new text is formatted with this shade of purple.**

Communications technology continues to evolve at a rapid pace, and the demand for wireless connectivity in all industries is growing exponentially. Utility telecommunications networks use a variety of technologies out of necessity, since no single technology is able to meet all requirements. Many networks use a combination of wireless, copper, and fiber media, and operate wireless networks in both licensed and unlicensed spectrum. The licensed spectrum may be utility-owned, or accessed through a commercial cellular operator. Standards-based communications technologies enable interoperability, vendor choice, a broader product ecosystem, and ultimately lower costs. Many of the wide range of wireless communications technologies that are deployed today, or may be deployed in the future, originate from the standards development activities that are covered in this newsletter.

Tim Godfrey
 Technical Executive
 Information and Communication Technology
tgodfrey@epri.com

IEEE 802 Communications Standards

How to apply this information

As a utility communications manager or engineer, you may wonder why new communications standards matter to you, since the timeframe for the development of new standards may be measured in years. The primary value is in providing you with knowledge of what is coming, and what will be possible. As you discuss your utility’s plans and requirements with vendors today, awareness of emerging standards gives you insights into the roadmap presented by vendors. If a vendor is proposing a proprietary communications protocol, you can ask how an upcoming standard fits into their roadmap. If a vendor indicates they are committed to supporting that standard, then asking the same questions to other vendors can put you on the path toward

alternate sources. A secondary benefit is the opportunity to contribute or influence standards during development. IEEE standards follow an open process with voting for approval. EPRI's Information & Communications Technology (ICT) staff is actively involved in many standardization activities. The IEEE 802 standards represent many of the core communications technologies, both wired and wireless. EPRI leads and contributes to projects in IEEE 802 that are relevant to the utility industry.

If you are unfamiliar with the seemingly cryptic numbering system used for IEEE 802 standards, there is a rational explanation behind them. An explanation was presented in the first issue of the Comms Intelligencer [1] in the section titled "IEEE 802 Working and Task Group Naming Conventions."

IEEE 802.11 Wireless LAN Working Group

The 802.11 working group has multiple task groups concurrently working on amendments and revisions. These are ranked in terms of relevance to utility applications:

- Limited utility relevance, or unknown at this time
- Possibly relevant – certain aspects could be applied
- Likely relevant – identified utility application
- Very relevant – expected to have a major impact

TGak	802.11ak	Transit Links (Bridging between networks)	<input checked="" type="radio"/>
TGaq	802.11aq	Pre-Association Service Discovery	<input checked="" type="radio"/>
TGax	802.11ax	High Efficiency WLAN	<input checked="" type="radio"/>
TGay	802.11ay	Next Generation 60 GHz	<input checked="" type="radio"/>
TGaz	802.11az	Next Generation Positioning	<input checked="" type="radio"/>
TGba	802.11ba	Low Power Wake Up Receiver	<input checked="" type="radio"/>
SG	LC-SG	Light Communications Study Group	<input type="radio"/>
SG	BCS-SG	Broadcast Services Study Group	<input checked="" type="radio"/>
SG	NGV-SG	Next Generation Vehicle (V2X) Study Group	<input type="radio"/>
TIG	FD-TIG	Full Duplex Topic Information Group	<input checked="" type="radio"/>

IEEE Std 802.11ah is an amendment for 802.11 in the sub-1GHz bands. It operates in the 915MHz ISM band in the USA, with different bands in other regions. It was published July 18, 2017, and is now available for free through the [IEEE Get802 program](#). Products based on this amendment have been slow to roll out, but chipsets are beginning to appear. Two vendors, [Methods2Business](#) and [NewRaCom](#) have chipsets and development boards, and have conducted informal interoperability demonstrations. A [Wi-Fi Alliance certification](#) program is under development, but not yet available.

IEEE Std 802.11ak is an amendment for standardizing the use of 802.11 to link two networks. The official title is "Enhancements for transit links within bridged networks". Today, the 802.11 standard only specifies the operation of an 802.11 device as a network endpoint. The addition of inter-network bridging will enable new

options for linking groups of devices and networks in a variety of utility applications where copper or fiber are not cost effective.

The Task Group has completed the Sponsor ballot process. Draft D6.0 was recirculated after the November 2017 meeting. It was approved by IEEE 802 in January 2018, and approved by IEEE SA RevCom on March 7, 2018. The amendment will be published in the next few months.

Task Group TGax (High Efficiency Wireless - HEW) has been active since the May 2014 meeting. This amendment is the next “big thing” for 802.11, with hundreds of people participating. Instead of focusing only on the raw data rate, development effort is now focusing on improving spectrum efficiency (users per unit of area) and improving performance in dense deployments through more effective spatial re-use. This will be accomplished while maintaining or improving power efficiency. Some of the use cases involve outdoor applications. While TGax isn’t specifically chartered to focus on grid-centric applications, support for IoT devices is a consideration. The requirements for IoT communication are aligned with utility applications in sensors, DER, DR, and other customer-premises applications. The benefits of 802.11ax will affect utility users of 802.11 from the enterprise to field and sensor applications. This standard will define the next generation of 802.11 devices that are widely used for both IT and operational purposes.

The task group modified the PAR in September 2017, to “raise the top end of the frequency band from 6 GHz to 7.125 GHz, and indicate that new Operating Classes will be required to support the new channels.”¹

Following the September 2017 meeting, a letter ballot on Draft 2.0 was initiated. Like Draft 1.0, this ballot failed with 63% approval, below the 75% threshold. There were 3550 comments on the ballot. The task group has worked on resolving these comments at the November, January, and March meetings, as well as during three interim meetings and weekly teleconferences. Draft 3.0 is expected to be ready for ballot following the May 2018 meeting. The schedule for the 802.11ax amendment has slipped by six months. The first Sponsor Ballot is now expected in May 2019, with final approval in December 2019.

Task Group TGay - Next Generation 60 GHz. The objective of the amendment is to increase the data rates of the existing 802.11ad standard in unlicensed bands above 45 GHz. (57.05 to 64 GHz in the USA, up to 66 GHz in Europe and Japan). From a utility perspective, the 60 GHz band is differentiated from the (typically) 4 to 40 GHz bands used for point-to-point outdoor microwave links. The 60 GHz band is unlicensed globally, but more importantly, it falls in a frequency range where atmospheric absorption (primarily Oxygen) is at a maximum. So, it isn’t usable for traditional microwave links with a range of kilometers. The expected application is shorter range links, such as wireless HDMI video, and high-data-rate cable replacement in data centers. These bands are also expected to play a major role in future “5G” mobile cellular systems, as a basis for femtocell technology. Some use cases envisioned for TGay are related to short range (10 cm) and high rate (10 Gb/s) data transfer. For example, moving 5 GB of data to a portable device in under 6 seconds. Utility applications could include download of maps, GIS, and other equipment data for field workers operating in areas that are lacking wireless data coverage, or providing bulk data downloads to workers in mutual aid scenarios.

The group conducted its first letter ballot on Draft 1.0 following the November 2017 meeting. The ballot barely missed the threshold, with an approval of 74%. The task group resolved the 459 of the 1343 comments during the January and March meetings.

Task Group TGaz (Next Generation Positioning). The project objective is to define a mechanism to locate 802.11 devices with a precision of 0.1m. This technology could have immediate utility applications in generation and other indoor facilities where both data communication as well as asset location and tracking are required, and GPS is not available. Potentially, it could complement GPS in outdoor applications, either by

¹ <https://mentor.ieee.org/802.11/dcn/17/11-17-0913-02-00ax-par-modification-to-support-6-ghz-band.docx>

reducing cost for the localization (eliminating the need for a GPS system if Wi-Fi is already present for communications needs), or providing a redundant location mechanism.

During the November 2017, January 2018, and March 2018 meetings, the group continued development of the Specification Framework Document and continued to receive contributions. In March a pre-draft D0.1 was approved. The current timeline calls for a first draft (D1.0) in November 2018, and final approval in early 2021.

Task Group TGba (Low Power Wake Up Receiver - LP-WUR)

The Low Power Wake Up Receiver enables lower power operation by reducing receiver standby power. The normal 802.11 receiver requires significant power to execute the complex signal processing required to decode the data. The LP-WUR defines a simpler receiver (optimized for low power) to operate in parallel. When a special wake-up signal is received by the WUR, the normal 802.11 receiver is activated. This approach does not save any power during normal receiver or transmitter operation, or provide any capability for longer range. It allows devices to consume less power while passively sleeping and waiting for a signal to wake up.

During the November 2017, January 2018, and March 2018 meetings the group continued to revise its Specification Framework Document (SFD), and approved a pre-draft D0.1 that is mostly an outline. The group has experienced some “scope creep”, and the specification is becoming more complex than initially envisioned. The schedule has slipped another two months, and Draft 1.0 is now planned for July 2018. Final approval moves to Fall 2020.

Task Group TGmd (Maintenance)

Because of the pace of amendments in 802.11, the Maintenance Task Group is always working on the next revision of the base standard. The Maintenance task group is always designated TGm, unlike other task groups that select incrementing letter pairs from the same pool. The fourth character increments for each revision. TGmd will develop the fourth revision to the 802.11 standard. The revision is based on [IEEE Std 802.11-2016](#) and incorporate amendments 802.11ai, 11ah, 11aq, 11ak, 11aj, and 11ax. The first letter ballot was started following the March 2018 meeting. Assuming the revision is completed on schedule (Fall 2020), it will be published as IEEE 802.11-2020.

Light Communications Study Group

The Light Communications Study Group met for the first time in September 2017. The concept is to transmit data over light from LED fixtures. The concept has been called “Li-Fi.” It is unclear what utility applications would be a good fit for light communication. The short range and line of sight requirement limits the use cases. There may be potential applications in some plant environments where radio frequency energy must be limited. Li-Fi may be able to leverage the Power over Ethernet² LED Lighting technology, to provide a data communications capability at a small incremental cost. The overall objective is to provide additional network capacity by offloading data transfer out of the crowded RF bands into visible light. The Study Group developed a PAR³ (Project Authorization Request) and CSD⁴ (Criteria for Standards Development) in November 2017 and January 2018 meetings. They were approved in March 2018. The new TGbb task group will start in May 2018, and develop an amendment to 802.11, which will be referred to as 802.11bb.

Broadcast Services Study Group

The Broadcast Services Topic Interest Group met for the first time in January 2018, and in March 2018 it was approved as a Study Group. The SG will explore new use cases for 802.11 broadcast information. While IEEE 802.11 already supports the networking concepts of [broadcast and multicast](#) to associated and authenticated

² [IEEE 802.3af-2003](#) and [IEEE 802.3bu-2016](#)

³ <https://mentor.ieee.org/802.11/dcn/17/11-17-1604-10-00lc-a-par-proposal-for-light-communications.pdf>

⁴ <https://mentor.ieee.org/802.11/dcn/17/11-17-1603-09-00lc-a-csd-proposal-for-light-communications.docx>

devices, this SG will explore use cases for public broadcast to non-associated, non-authenticated devices. Example use cases could include local and area-specific information, indoor maps in a shopping mall, menus in restaurants, flight information at an airport, traffic information for vehicles (already present to some extent in [802.11p](#) - see NGV below), and emergency related information. Utility-focused applications could be identified and included, although the public nature of the proposed Broadcast Services may be a better fit for utility applications at the customer rather than on operational networks. The group plans to seek approval to start a study group in July.

Next Generation V2X (NGV) Study Group

The Next Generation V2X (Vehicle to Anything) Topic Interest Group met for the first time in January 2018, and in March 2018 it was approved as a Study Group (to be called NGV). It will consider a new amendment the 802.11p⁵ standard also known as Dedicated Short-Range Communication⁶ (DSRC) to better align with newer 802.11 physical layers. One interesting aspect of 802.11p (and its potential successor from NGV) is the availability of dedicated spectrum⁷ at 5.9 GHz that can be used by vehicles.

Full Duplex Topic Interest Group

The Full Duplex Topic Interest Group met for the first time in March 2018. Full Duplex operation of 802.11 could enable simultaneous uplink and downlink in the same spectrum, providing benefits in higher throughput and lower latency. The use of full duplex in mobile phones is well established and mature, using separated frequency channels for uplink and downlink. The proposed 802.11 full duplex would transmit and receive concurrently on the same frequency channel. This is a significant unsolved technical challenge, analogous to a person listening for a pin drop while shouting, but has progressed to the point where considering a standard is appealing. An introductory briefing was presented⁸. The group may seek approval to start a study group in July.

IEEE 802.15 Working Group

The 802.15 Working Group is officially the working group for Wireless Personal Area Networks (WPAN), but the WG has taken on a variety of projects. The working group has started to refer to itself as Wireless Sensor Networks (WSN), since WPAN is less descriptive. In some ways, it can be thought of as a home for wireless standards that don't clearly fit elsewhere. The first standard in 802.15 was Bluetooth (802.15.1) which is a "personal area network", but since that initial version, the Bluetooth SIG has developed the spec independently from IEEE 802.15. The 802.15.4 family has been the mostly widely adopted, and serves as the basis for ZigBee and the newer Wi-SUN specification for utility field area networks. Standards have been developed in 802.15 that are related to 802.15.4, but have a unique number since they are independent documents, and not an amendment. Examples include 802.15.9, 802.15.10, and 802.15.12.

802.15.4s "Spectrum Resource Utilization" (SRU) Task Group (TG4s)

The TG4s amendment defines the Spectrum Resource Measurement (SRM) capability, which consists of measurements, and messages to communicate spectrum measurements. The measurements include energy detection, noise measurements, link quality metrics, and MAC layer statistics on failed and deferred

⁵ <http://www.eenewsautomotive.com/design-center/why-80211p-beats-lte-and-5g-v2x>

⁶ US Dept of Transportation, Intelligent Transportation Systems Office
https://www.its.dot.gov/factsheets/dsrc_factsheet.htm

⁷ FCC: "Dedicated Short Range Communications (DSRC) Service" <https://www.fcc.gov/wireless/bureau-divisions/mobility-division/dedicated-short-range-communications-dsrc-service>

⁸ <https://mentor.ieee.org/802.11/dcn/18/11-18-0549-00-00fd-full-duplex-for-802-11.pptx>

transmissions. TG4s completed its final Sponsor Ballot recirculation with Draft D7 in November 2017. It was approved by IEEE 802 and RevCom, and is expected to be published in April 2018.

802.15.4w “Low Power Wide Area” (LPWA) Study Group (to be TG4w)

The LPWA Study Group operated as an Interest Group during 2017, and was approved to become a Study Group in November 2017. The group is investigating how 802.15 standards can address the types of low power sensor networks that are targeted by systems such as [LoRa](#), [SigFox](#), and [NB-IoT](#). As an amendment to 802.15.4, it would integrate with the existing MAC and set of PHYs. It is anticipated to be an extension to the Low Energy Critical Infrastructure Monitoring (LECIM) PHY that was defined in 802.15.4k. Products from [Ingenu](#) (formerly OnRamp) are loosely based on 802.15.4k, but their implementation is proprietary. Their systems have been deployed by some utilities.

The study group developed their PAR and CSD⁹ ([15-18-0050-06](#) and [15-18-0053-04](#)) in January 2018, and they were approved in March 2018. Task Group TG4w will first meet in May. The study group has already developed a [Technical Guidance Document](#) and issued a call for contributions.

802.15.4x “FAN Enhancements” (FANE) Study Group (to be TG4x)

The FAN Enhancements Study Group was formed in January 2018. It is developing an amendment to the Smart Utility Network (SUN) PHY (originally specified in the 802.15.4g amendment) to define modes with higher data rates, and modes with longer range. This is an important amendment for utility field area networks. These improvements are likely to be referenced in future versions of the Wi-SUN FAN specification.

The Study Group developed their PAR and CSD ([15-17-0624-05](#) and [15-17-0622-05](#)), and they were approved in March 2018. The TG4x Task Group will meet for the first time in May. A [PHY proposal](#) has already been submitted.

802.15.4y “Security Next Generation” (SECN) Task Group (to be TG4y)

The Security Next Generation Study Group was formed in November 2017. It is defining support for Advanced Encryption Standard (AES)-256 encryption and other security extensions and additional algorithms. This is an important amendment for utility field area networks. The intention is to keep ahead of advances in computing power, and corresponding best practices in security that are continually evolving. The amendment will define mechanisms to improve extensibility, to simplify adding additional security algorithms in the future. These improvements are likely to be referenced in future versions of the Wi-SUN FAN specification.

The Study Group developed their PAR and CSD ([15-18-0037-04](#) and [15-18-0040-07](#)), which were approved in March 2018. The TG4y Task Group will meet for the first time in May.

802.15.4z “Enhancements in Ranging” (EIR) Task Group (to be TG4z)

The Enhancements in Ranging Study group is preparing to develop an amendment to enhance the High Rate Pulse (HRP) and Low Rate Pulse (LRP) Ultra-Wide-Band (UWB) Physical Layers (PHYs) and their associated ranging techniques. These were first introduced in the 802.15.4a amendment that was completed in 2007. These PHYs are used in industrial applications for asset tracking and location.

The Study Group developed their PAR and CSD ([15-18-0059-03](#) and [15-18-0036-04](#)), which were approved in March 2018. The TG4z Task Group will meet for the first time in May.

⁹ www.ieee802.org/ec-17-0117-00-00EC-newcomer-tutorial.pdf

802.15.4md “Maintenance Revision 4” Task Group (TG4m)

The TG4m Maintenance Task Group is responsible for revisions of the 802.15.4 standard. The most recent published version is [802.15.4-2015](#). An errata document was published in July 2016 that changed the standard title from “IEEE Standard for Low-Rate Wireless Personal Area Networks (WPANs)” to “IEEE Standard for Low-Rate Wireless Networks”. Subsequently, a corrigendum project was initiated to correct errors and ambiguities in the transmission order of addresses. IEEE [802.15.4-2015/Cor 1-2018](#) was balloted in late 2017 and approved by RevCom in January 2018.

Now the Task Group is developing the fourth revision of 802.15.4, which will merge the [802.15.4n](#), [802.15.4q](#), [802.15.4u](#), [802.15.4t](#), [802.15.4v](#), and [802.15.4s](#) amendments (described in previous issues) and the 802.15.4-2015/Cor 1-2018 corrigendum into the base standard (802.15.4-2015). As with all revision projects, the entire standard is open to change, so it is possible that features could be added or removed, based on the votes of the Task Group members.

The Task Group anticipates a Letter ballot following the May 2018 meeting, Sponsor ballot following the March 2019 meeting, and final approval and publication at the end of 2019 or early 2020.

802.15.12 “Upper Layer Interface (ULI) for 15.4” (TG12)

This project is addressing some long-standing gaps in IEEE 802.15.4, making it easier to use in mixed network environments. Other IEEE 802 networks such as 802.3 and 802.11 use a special field to identify the type of protocol that is encapsulated in the frame. Because this approach dates to the time when Ethernet was young, the field is called an EtherType¹⁰ Protocol Discrimination (EPD). For example, the EPD can distinguish between a packet containing IPv4 (0x0800) and a packet containing an IEC 61850 GOOSE¹¹ message (0x88b8). The IEEE 802.15.4 standard has not yet defined an analogous identifier. As higher layer protocols and applications operating over 802.15.4 devices began to proliferate, support for multiple protocols was proprietary, or did not exist at all. This new standard is intended to enable 802.15.4 networks to use many of the higher layer protocol stacks used by 802.11 and 802.3 without changes.

¹⁰ <https://en.wikipedia.org/wiki/EtherType>

¹¹ https://en.wikipedia.org/wiki/Generic_Substation_Events

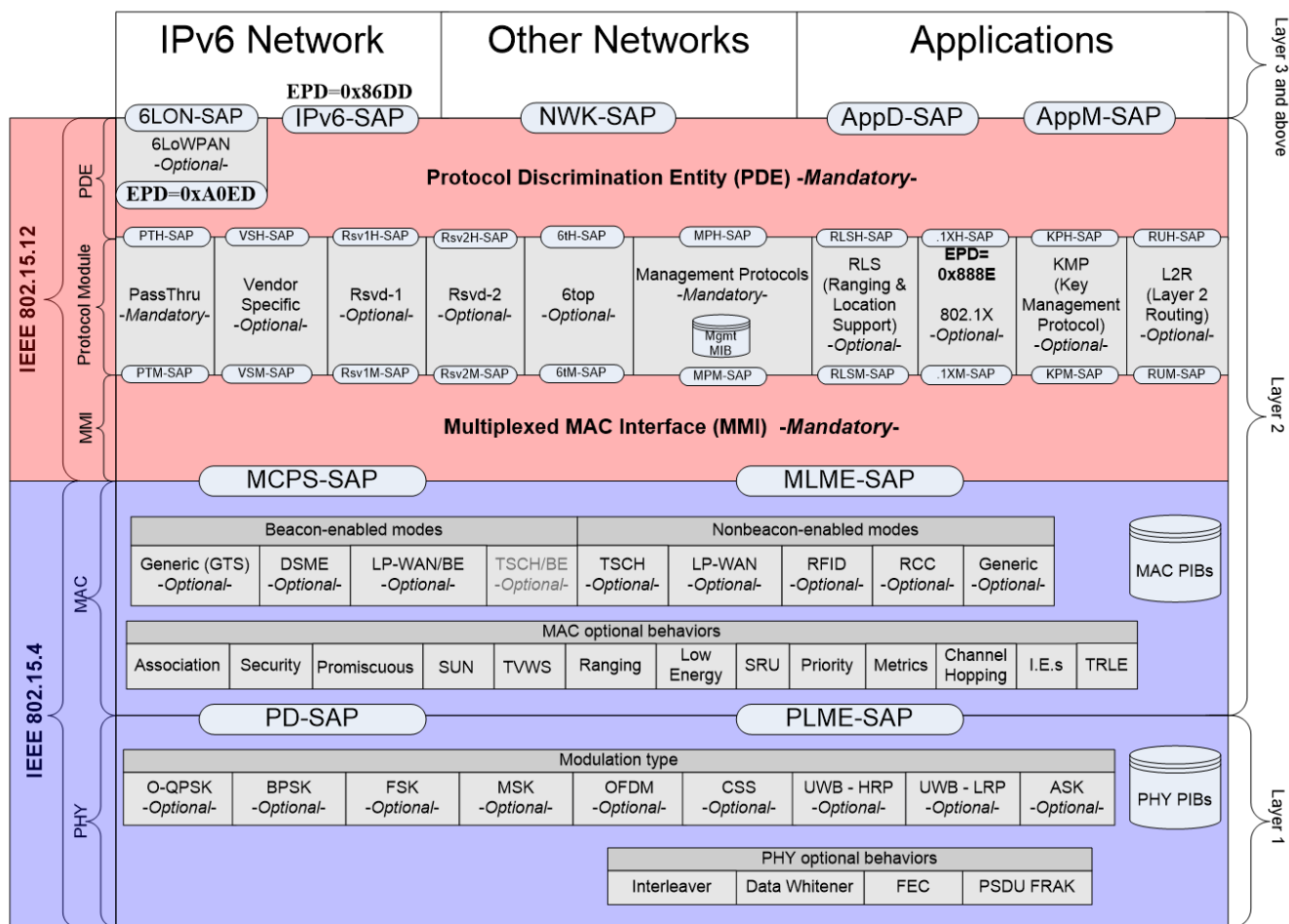


Figure 1 - 802.15.12 ULI Functional Architecture (March 2018)¹²

The 802.15.12 standard will allow IEEE 802.15.4 based networks to address new applications, yet maintain backward compatibility with existing devices and applications. It intends to provide an integration framework for L2R (802.15.10), KMP (802.15.9), 6TSCH (IETF), and 6lowpan (RFC 4944) into one Upper Layer Interface (ULI). This task group is based in IEEE 802.15, but will rely on tight coordination with 802.1 and IETF.

The task group has defined the components as shown above in Figure 1. See [19] for further details.

In November 2017, January and March 2018, the task group continued to work on specific features and functions. These include the primitives for the Service Access Point interfaces, the pass-through function, the Ranging and Location Support (RLS), Layer 2 Routing (L2R), the 48- to 64-bit address adaptation, and the management protocol. Progress has been slower than expected, and the first letter ballot on Draft 1.0 is now scheduled for November 2019, with final publication at the end of 2021.

¹² Source: <https://mentor.ieee.org/802.15/dcn/17/15-17-0113-07-0012-802-15-12-conceptual-overview.pptx> slide 7

802.15.13 “Multi-Gbit Optical Wireless Communication” TG13

As with the 802.11 Light Communications group, the applications and use cases for light communication for utilities are not entirely evident at this time.

In November, January, and March 2018, the group developed two pre-drafts D1 and D2 and informally collected comments. The specification will include two PHYs – a Pulsed Modulation PHY and an OFDM PHY. They continued exchanging information via a liaison with the [ITU G.vlc](#) working group that is developing a similar standard. The group plans to have its first letter ballot on draft D3 in May 2018, and anticipates final approval in mid-2019.

IEEE 802.16 Working Group

IEEE 802.16 is widely used in the utility industry as a point to multipoint Field Area Network technology with broadband capacity. The activities have been covered in depth in previous issues.

The IEEE 802.16 working group has completed the 802.16s amendment to support the 1 MHz channel width in the 700 MHz upper A block (as well as other narrower allocations that may exist or become available). The amendment was published in October 2017. The amendment is available for free download as part of the [Get802 program](#).

The set of completed amendments to 802.16 (consisting of 802.16n, 802.16p, 802.16r, and 802.16s) were merged into a revision of the base standard by the 802.16rev4 project. The completed revision was approved by IEEE 802 and RevCom. [IEEE Std 802.16-2017](#) was published by IEEE on March 2, 2018. As there are no other projects in development for 802.16, the Working Group entered hibernation following the March 2018 meeting. The WG remains in hibernation until a need for a revision or amendment brings it out of hibernation, or its standards are withdrawn (typically after 10 years without a revision), at which time it is disbanded.

IEEE 802.24 Technical Advisory Group

The 802.24 Technical Advisory Group (TAG) provides coordination across multiple Working Groups that are developing standards related to vertical applications of 802 standards, such the Smart Grid. A TAG is a peer to a Working Group in terms of the 802 organization, but a TAG does not develop standards. The other TAG operating in IEEE 802 is 802.18, which deals with Radio Regulatory issues. The 802.24 [web page](#) provides current information, meeting plans, and agendas. EPRI is chairing the 802.24 TAG.

The 802.24 TAG has two Task Groups. The Smart Grid is in the 802.24.1 task group, and the 802.24.2 task group is addressing the Internet of Things (IoT). The 802.24.2 task group is establishing liaisons with IoT-related industry groups such as Industrial Internet Consortium (IIC) and others. 802.24 has already established a liaison relationship with the IEEE P2413 IoT Architecture task group.

The Smart Grid TG completed development on a white paper to compare and contrast the two 802 standards with smart grid applications in sub 1 GHz spectrum (and in particular, the two standards for the 915 MHz ISM band: IEEE 802.15.4g and 802.11ah). It is now available as an [802.24 document](#), and will be published by IEEE. The TG completed the update of the wireless standards matrix developed by NIST / SGIP PAP02. Although this matrix was first developed over five years ago, it is still referenced by the industry. New amendments and changes to the IEEE 802 standards will be included into the matrix to reflect the current state of the standards. The updated matrix is in document [802.24-17-0004r6](#). It has been provided to SGIP/SEPA, where the Wireless Characteristics Matrix Task Force is collecting updates for the non-IEEE 802 standards that are referenced.

The 802.24 Smart Grid TG is also continuing development of a White Paper describing IEEE 802 Time Sensitive Network (TSN) in the context of utility applications. This paper is being developed jointly with the [802.1 TSN Task Group](#). The draft after the March 2018 meeting is available as [802.24-17-0006r11](#).

IEEE 802.1 and 802.3 Working Groups

The 802.1 working group is chartered to “develop standards and recommended practices in the following areas: 802 LAN/MAN architecture, internetworking among 802 LANs, MANs and other wide area networks, 802 Security, 802 overall network management, and protocol layers above the MAC & LLC layers”¹³. It is a cross cutting group that affects all the family of IEEE 802 standards.

The 802.3 working group is responsible for the development of Ethernet. Due to the long historical relationship, 802.1 and 802.3 are closely coupled, and the working groups meet at the same location for interim meetings (typically separate from the wireless working groups). Due to these logistics, I am unable to participate closely with these working groups, but I will briefly highlight developments that have potential relevance to the utility industry.

802.1

For historical reasons, 802.1 standards use a different nomenclature compared to other IEEE 802 standards. The convention of the rest of IEEE 802 is to add a new decimal number for a standalone standard document developed by a working group (as opposed to an amendment to an existing document.) For example, 802.15.4 was the 4th complete standard initiated by the 802.15 working group. The 802.1 working group uses capital letters to designate individual standards. Perhaps the most well-known 802.1 standard is 802.1X for port-based network access control. Like the rest of 802, 802.1 uses lower case letter for amendments. For example, the latest amendment project for the 802.1X standard is 802.1Xck. The standard designators and the amendment designators are one or two-letter fields, following the pattern a..z, aa..az, ba..bz, etc.

[802.1 Security Task Group](#)

[802.1X Port Based Network Access Control](#) (widely used in other IEEE 802 standards)

[802.1AE MAC Security](#) connectionless user data confidentiality, data integrity, and data origin authenticity

[802.1AR Secure Device Identity](#) globally unique manufacturer-provided Initial Device Identifier (IDeVID)

[802.1 Time Sensitive Networking Task Group](#) developing multiple standards defining deterministic services through IEEE 802 networks, i.e., guaranteed packet transport with bounded latency, low packet delay variation, and low packet loss.

[802.1 OmniRAN Task Group](#) Integration of multiple IEEE 802 technologies into a unified and managed Access Network. OmniRAN is developing [IEEE 802.1CF](#) titled “Network Reference Model and Functional Description of IEEE 802 Access Networks.”

802.3

The primary focus of the [802.3](#) working group is developing Ethernet, which has historically centered around continually increasing the data rates. On that front, The working group is currently developing rates up to [200 Gb/s](#), and looking at [400 Gb/s](#) for the next generation. These are primarily targeting data center applications. Below are a few 802.3 projects that may be more relevant to utility telecom and IT/OT converged networks:

[IEEE 802.3 Beyond 10 km Optical PHYs Study Group](#) Ethernet over fiber

¹³ <https://1.ieee802.org/>

IEEE P802.3cg [10 Mb/s Single Twisted Pair Ethernet Task Force](#) Enabling Ethernet to run over a single pair, trading rate for lower cost, size, and weight. Potential applications are in plants and industrial settings connecting or retrofitting new sensors onto existing wiring.

IEEE P802.3bu [1-Pair Power over Data Lines \(PoDL\) Task Force](#) single-pair Power over Ethernet to complement the single pair Ethernet above.

Industry Groups and Other Standards

Wi-SUN Alliance

The [Wi-SUN Alliance](#) is developing test and certification programs for the connectivity and interoperability of devices built to the 802.15.4g standard¹⁴. The Wi-SUN Field Area Network (FAN) Technical Profile Specification (TPS) was approved as version 1.0 in May 2016. [Further refinements and corrections identified during Interoperability Test events have been incorporated into incremental updates. As of March 2018, the latest version is TPS 1.22.](#)

Wi-SUN specifies the communications stack up to Layer 4 (transport). It defines the application and parameterization of RPL (IPv6 Routing Protocol for Low-Power and Lossy Networks - [RFC 6550 and family](#)). The Wi-SUN FAN specification also defines frequency hopping interoperability profiles. This specification builds on the Physical Layer Conformance and Interoperability Test specifications for Wireless Smart Utility Network devices. [In parallel with the FAN Technical Profile Specification \(TPS\) document, the Wi-SUN Alliance FAN working group is continuing development of the FAN Conformance Test Specification \(currently at version 34 as of March 2018\) that will define the certification process.](#)

EPRI is developing an open-source reference implementation of the Wi-SUN FAN. EPRI continues to participate in Wi-SUN Interop events as they are scheduled, and plans to certify the open source implementation to the FAN profile when certification becomes available. [EPRI is working with Wi-SUN Alliance Testing and Certification Working Group to make the EPRI platform one of the “Test Bed Units” that are the references for the certification process. Monthly interop events have been taking place in the fall of 2017 and spring of 2018 in anticipation of certification in the near future.](#)

The next generation of the Wi-SUN FAN Profile Specification will provide support for the OFDM PHY, which is defined in the IEEE 802.15.4g standard, but not currently used in the Wi-SUN FAN 1.0 specification. The FAN OFDM PHY provides throughput up to 800 Kbps, which enables a variety of new and more demanding applications. The 802.15.4x amendment (see above) will provide additional enhancements to rate and range. EPRI’s open source reference implementation will support the OFDM PHY. [The Marketing Requirements Document \(MRD\) for the FAN 2.0 profile specification is undergoing comment resolution, but work on a spec will not begin until FAN 1.0 certification starts.](#)

Wi-Fi Alliance

EPRI became a member of the Wi-Fi Alliance® in June 2017. The primary activity is developing the standardized functionality needed to support the Persistent Wi-Fi Demonstration (see below). While the Wi-Fi Alliance is well known for certifying interoperability for devices implementing IEEE 802.11, the Alliance also creates specifications apart from IEEE.

¹⁴ Technically, 802.15.4g no longer exists, since it was incorporated into the base standard IEEE 802.15.4-2015. The Smart Utility Network (SUN) PHYs defined by 802.15.4g are described in clauses 20-22 of 802.15.4-2015.

In October 2017, a security vulnerability affecting Wi-Fi called [krack](#) was published. The researcher who discovered it (Mathy Vanhoef) attended the Wi-Fi Alliance member meeting in October 2017, and gave a technical presentation. The Alliance released a public [update](#), which included a vulnerability detection tool available to Wi-Fi Alliance Members. This vulnerability was rapidly patched by vendors.

[New power saving features](#) and the associated certification program were launched in November 2017, making Wi-Fi better suited for sensors and battery powered devices. The Wi-Fi radio is not changed, but power savings are obtained through longer sleep periods and less frequent communication between clients and networks. [Highlights of the new features](#) were published.

[Wi-Fi Agile Multiband](#) certification began in December 2017. Historically, Wi-Fi devices made independent decisions on which access point and frequency band to connect to, based on limited information available to that device at its location. Wi-Fi Agile Multiband allows the network infrastructure to “steer” devices to the optimum access point, channel, and frequency, based on network RF measurements, loading, and interference at both ends of the link.

[Wi-Fi Optimized Connectivity](#) builds on Wi-Fi Agile Multiband, providing further improvements in network performance. It utilizes features defined in the 802.11ai Fast Initial Link Setup and 802.11k Radio Resource Management amendments. It provides additional information to devices prior to connection, which improves network discovery, reduces connection time through pre-authentication, and reduces network management overhead.

In January 2018, the Alliance outlined [New Wi-Fi® security features](#) available in 2018. From the release: “Four new capabilities for personal and enterprise Wi-Fi networks will emerge in 2018 as part of Wi-Fi CERTIFIED WPA3™. Two of the features will deliver robust protections even when users choose passwords that fall short of typical complexity recommendations, and will simplify the process of configuring security for devices that have limited or no display interface. Another feature will strengthen user privacy in open networks through individualized data encryption. Finally, a 192-bit security suite, aligned with the Commercial National Security Algorithm (CNSA) Suite from the Committee on National Security Systems, will further protect Wi-Fi networks with higher security requirements such as government, defense, and industrial.”

EPRI Telecom Initiative and Project Set 161G

Project Set 161G launches in 2018, carrying on the set of key topics from the Telecom Initiative

- Operating and migrating to packet-based networks for SCADA and protection
- Leveraging licensed, unlicensed, and shared spectrum for private networks
- Public network operation and network sharing
- The strategic deployment of fiber
- Standards and best practices for network management and reliability metrics
- Software Defined Networking for operational networks
- Telecom network planning, visualization, and co-simulation

The fifth and final advisory meeting of the Telecom Initiative, jointly with the first meeting of Project Set 161G will be held March 28-29, hosted by Salt River Project, in Phoenix, AZ.

EPRI Persistent Wi-Fi Demonstration Project

Utilities are challenged to effectively manage consumer loads found in a variety of devices such as thermostats, water heaters, charging stations, and other residential and commercial appliances. New utility programs for energy efficiency and demand response using connected devices can have issues with

persistence of the connection that can reduce program effectiveness over time. The project will define and demonstrate a Wi-Fi based communications platform that can facilitate secure integration of customer systems with grid operations (both distribution and system operator). This project will demonstrate the use of Wi-Fi to address these problems, and provide the foundation for standard, secure, and durable commercially-ready platforms for integration of customer technologies. This project is in the formation phase and has not yet launched. For further information see [Project Summary 3002011409](#).

For further information on these projects, please contact [Tim Godfrey](#).

Previous Issues

- [1] Issue 1: [Smart Grid Communications Intelligencer: Fall 2011](#)
- [2] Issue 2: [Smart Grid Communications Intelligencer: Winter 2011/2012](#)
- [3] Issue 3: [Smart Grid Communications Intelligencer: Spring 2012](#)
- [4] Issue 4: [Smart Grid Communications Intelligencer: Fall 2012](#)
- [5] Issue 5: [Smart Grid Communications Intelligencer: Winter 2012/2013](#)
- [6] Issue 6: [Smart Grid Communications Intelligencer: Spring 2013](#)
- [7] Issue 7: [Smart Grid Communications Intelligencer: Fall 2013](#)
- [8] Issue 8: [Smart Grid Communications Intelligencer: Winter 2013/2014](#)
- [9] Issue 9: [Smart Grid Communications Intelligencer: Spring 2014](#)
- [10] Issue 10: [Smart Grid Communications Intelligencer: Fall 2014](#)
- [11] Issue 11: [Smart Grid Communications Intelligencer: Winter 2015](#)
- [12] Issue 12: [Smart Grid Communications Intelligencer: Spring 2015](#)
- [13] Issue 13: [Smart Grid Communications Intelligencer: Fall 2015](#)
- [14] Issue 14: [Smart Grid Communications Intelligencer: Winter 2016](#)
- [15] Issue 15: [Smart Grid Communications Intelligencer: Spring/Summer 2016](#)
- [16] Issue 16: [Smart Grid Communications Intelligencer: Fall 2016](#)
- [17] Issue 17: [Smart Grid Communications Intelligencer: Winter 2017](#)
- [18] Issue 18: [Smart Grid Communications Intelligencer: Spring-Summer 2017](#)
- [19] Issue 19: [Smart Grid Communications Intelligencer: Fall 2017](#)

Together...Shaping the Future of Electricity®

3002012471

Electric Power Research Institute

3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com

© 2018 Electric Power Research Institute (EPRI), Inc. All rights reserved. Electric Power Research Institute, EPRI, and TOGETHER . . . SHAPING THE FUTURE OF ELECTRICITY are registered service marks of the Electric Power Research Institute, Inc.