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About

Welcome to the fifteenth issue of Smart Grid Communications ("Comms") Intelligencer, a triannual newsletter published by EPRI's Information and Communications 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.

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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 eight task groups working on amendments. 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

TGah	802.11ah	Operation in the sub-1GHz bands (other than TV White Space)	●
TGai	802.11ai	Fast Initial Link Setup	○
TGaj	802.11aj	China Millimeter Wave Band	○
TGak	802.11ak	Transit Links (Bridging between networks)	◕
TGaq	802.11aq	Pre-Association Service Discovery	○
TGax	802.11ax	High Efficiency WLAN	●
TGay	802.11ay	Next Generation 60 GHz	◑
TGaz	802.11az	Next Generation Positioning	◕

Task Group TGah is working on an amendment for 802.11 in the sub-1GHz bands. This is primarily focused on the 915MHz ISM band. (The TV White Space Bands are also sub-1GHz, but are not included since they operate under a different regulatory context - that operation is defined in 802.11af). One objective for TGah is to support longer range "Neighborhood Area Networks" for AMI, taking advantage of the superior propagation characteristics of the 915 MHz band. The 802.11ah amendment has been in development since 2010. After completing three sponsor ballot cycles from September 2015 through May 2016, the balloting process is now complete. The amendment is expected to receive final approval from IEEE 802 in July 2016, with RevCom approval and publishing expected by September 2016.

Task Group TGak is developing 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. There are many applications that could benefit from interconnecting a network of devices (with wired or wireless connections), to another network using a wireless link. This standard will be important to utilities, because it makes 802.11 one step closer to providing all the functionality of wired Ethernet networks. Virtual Local Area Networks (VLANS) are widely used in utility LANs and WANs. Today, 802.11 does not support carrying VLAN over a wireless link. 802.11ak will enable networks employing VLANs to be bridged over 802.11. Whether in substations, generating plants, or operations centers, there may be cases where a wired or fiber connection is impractical or costly. The addition of inter-network bridging will enable new options for linking devices and networks in a variety of utility applications where copper or fiber are not cost effective. 802.11ak may also find application in Field Area

Networks or in premises-based energy management networks where clusters of devices need to be interconnected wirelessly.

The Task Group conducted a recirculation ballot on draft D2.0 following the January 2016 meeting. In the March and May meetings, the group resolved 227 of our 346 comments, and will continue comment resolution in July. The group has relatively small participation, so progress has been slow. Final approval is predicted for March 2017.

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. The recently completed 802.11ac and 802.11ad amendments enable 802.11 to reach peak (aggregate) data rates above 6.7 Gb/s. The need for even higher rates (and the technical means to achieve them) is no longer as clear cut. The 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 TGax Task Group has completed the Specification Framework[1] and is now developing a pre-draft document. Draft 0.2 was made available for comment in June 2016. Review of comments and resultant updates to the draft will take place during the July and September 2016 meetings. The draft is expected to be updated to Version 1.0 after the September 2016 meeting. At that time a formal letter ballot will be conducted. The 802.11ax amendment is currently scheduled to reach final approval in December 2018 or early 2019, which is consistent with the time frame of previous major developments.

Task Group TGay - Next Generation 60 GHz. The objective of the amendment is to increase the data rates of the existing 802.11ad standard for 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 (actually 57-64GHz) 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. See the discussion on 802.15.3e below, which addresses very similar use cases.

This task group is continuing to refine the specification framework with submissions on topics such as the channel model, usage model, evaluation methodology, and candidate implementation technologies.

Task Group TGaz (Next Generation Positioning). The NGP Task Group met for the first time in September 2015. 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 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

[1] https://mentor.ieee.org/802.11/dcn/15/11-15-0132-17-00ax-spec-framework.docx

location mechanism. In the May 2016 meeting, the group reviewed and approved a working draft Functional Requirement Doc, based on an agreed set of 17 functional requirements on accuracy/coverage and scalability sections.

Long Range Low Power (LRLP) Topic Interest Group (TIG). The TIG is the first step in creating a new amendment in 802.11. In the July 2015 meeting EPRI presented "*Integrated Long Range Mode for the 2.4 GHz Band*[2]" at the May 2015 meeting of WNG (Wireless Next Generation). Integrated refers to integration into broad-market, commodity Wi-Fi devices. The objective is to develop a longer range capability in the 2.4 GHz band which would be supported at little to no incremental cost in "entry level" 802.11 Wi-Fi devices. See [14] for further details.

Although the LRLP TIG developed a significant amount of interest (with over 100 people attending), there has been opposition from influential groups within the membership of 802.11. Members with a stake in 802.11ax had concerns that LRLP will draw interest and resources away from their group, and members with a stake in the success of 802.11ah did not support LRLP because they felt it could be a competitive threat to the success of that amendment. At the March 2016 meeting, the LRLP TIG planned to seek approval to form a study group and continue development. However, the opposition had sufficient support to prevent approval. At the May 2016 meeting, the LRLP TIG attempted to narrow the focus to increase the level of support among the membership. At the same meeting, a competing proposal to form a study group on the "Low Power Wakeup Receiver" was presented. This concept was previously presented in LRLP as one aspect of a comprehensive low-power solution. LP-WUR only addresses the receiver standby power, but does not reduce operational power or provide a capability for longer range. The Low Power Wakeup Receiver study group proposal was approved. This had the effect of completing the LRLP TIG, which was chartered to form a study group, although the result is more limited. The broader concepts of long range and low power operation may be revisited again in the future, as the TGax amendment process nears completion in 2018. At that time the group may be ready to consider the concepts defined in LRLP as a comprehensive, system level advancement. The output report[3] from the LRLP TIG summarizes the requirements and technical approaches.

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. 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 AMI networks. In 2016, the number of 802.15 amendment projects that are relevant to utilities has started to ramp up.

802.15.4m Maintenance Standing Committee (TG4m)

This revision of the 802.15.4 standard consolidates completed amendments (including 802.15.4e, 4f, and 4g) into the main document, correct editorial issues that have been identified, and performs some re-organization to make the standard document more readable and understandable. This maintenance and "roll up" of amendments is important because it will be the first time that the entire 802.15.4 specification (including the 4e and 4g amendments) has been combined into a single document.

This is a significant accomplishment, resulting from an extended effort by the revision task group and editors. The IEEE 802.15.4-2015 standard was officially published on April 22, 2016, and is now available for purchase from IEEE. Like all IEEE 802 standards, will become available for free through the Get802 program 6 months after publication (Oct 22, 2016).

[2] https://mentor.ieee.org/802.11/dcn/15/11-15-0545-00-0wng-integrated-long-range-mode.pptx
[3] https://mentor.ieee.org/802.11/dcn/15/11-15-1446-12-lrlp-lrlp-output-report-draft.docx

802.15.4r "Distance Measurement Techniques" Task Group (TG4r)

The 802.15.4r task group was chartered to develop an amendment to support ranging (distance measurement) into 802.15.4 systems. The ranging feature targeted an accuracy of 1 meter. When integrated with 802.15.4g and 802.15.4m radios, a ranging capability could provide additional positional information to optimize AMI mesh network formation and management. After a promising start at the beginning of 2015, the group was "hibernated" at the September 2015 meeting due to lack of participation and interest. It may be re-activated at a future meeting if the level of interest warrants. As of May 2016, the task group remains inactive, but the working group has not taken action to withdraw its Project Authorization Request (PAR).

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

The SRU amendment's purpose is defined in the PAR: "As various wireless systems are deployed in the shared and license-exempt frequency bands including 2.4GHz and 915MHz bands, heavy interference has limited performance of the wireless systems. In order for these wireless systems to operate more effectively, a standardized set of spectrum resource measurements is needed that will facilitate management functions in these networks."[4] At the May 2016 meeting, the group completed their Technical Guidance Document, and is starting development of a pre-draft.

802.15.4t "Higher Rate Operation in 2.4 GHz Band" Task Group (TG4t)

This amendment will enhance the physical layer (PHY) most commonly associated with ZigBee, operating in the 2.4 GHz ISM band. The project requirements are to develop a PHY that will be capable of 2 Mb/s data rates, provide backwards-compatibility with (and the same occupied bandwidth as) the present 2.4 GHz O-QPSK PHY, and be simple to implement.

This project is moving at a very quick pace. It started in January 2016, and developed a draft in the March and May meetings. The first draft D1.0 was completed at the May 2016 meeting and a letter ballot is underway.

802.15.4u "India Sub 1 GHz PHY" Task Group (TG4u)

This project is a straightforward modification of the 802.15.4g PHY (used by Wi-SUN) to support 865-867 MHz bands in India. The draft contains only 5 pages of actual text. The task groups started in January 2016, completed a letter ballot after the March meeting, and is starting the Sponsor Ballot process in July 2016.

802.15.4v "Regional Sub 1GHz Band" Task Group (TG4v)

This project is another modification of the 802.15.4g PHY to support new global bands. It will provide changes to support 870-876 MHz & 915-921 MHz bands in Europe, the 902-928 MHz band in Mexico, the 902-907.5 MHz & 915-928 MHz bands in Brazil, and the 915-928 MHz band in Australia/New Zealand. It will also update the channel parameters for the 470-510 MHz band in China and the 863-870 MHz band in Europe to align them with current regulatory requirements. This amendment is also moving forward rapidly – a letter ballot on draft D1.0 is expected in July 2016.

802.15.9 "Key Management Protocol" Task Group (TG9)

IEEE 802.15.9 (Key Management Protocol or KMP) task group is developing a standardized approach for supporting common authentication protocols (such as IEEE 802.1X) to be carried 802.15.4 networks (including 802.15.4g which is intended for AMI networks). Due to the packet size limitation of the 802.15.4 MAC (which is common to all PHYs), standard authentication protocols from higher layers cannot be supported. IEEE 802.15.9 defines a KMP service that includes support for protocols such as 802.1X/MKA (MACsec Key

[4] https://mentor.ieee.org/802.15/dcn/13/15-13-0615-08-0sru-sru-working-draft-par.pdf

Agreement), 802.1X/KEY (Key Exchange), HIP (Host Identity Protocol), IKEv2 (Internet Key Exchange Version 2), PANA (Protocol for carrying Authentication for Network Access – RFC 5193), and Dragonfly[5].

The 802.15.9 Key Management Protocol is important because it defines mechanisms that are used for security in the Wi-SUN FAN specification, which is a key standard for interoperable AMI using RF Mesh technology. Wi-SUN defines the network through the transport layer, including interoperable security mechanisms.

The 802.15.9 standard is now complete. It was approved by the IEEE-SA Standards Board on March 4, 2016.

802.15.10 "Layer 2 Routing" (L2R) Task Group (TG10)

This project is primarily intended to complement the 802.15.4g Smart Utility Network standard in AMI applications, although it could find other uses as well. Today, most AMI networks use proprietary routing techniques (at the network layer, or the equivalent of the network layer in products that use non-IP protocols). An open standard for routing is one part of a complete set of standards that can enable vendor choice for utilities and mixed networks of different types of meters. Routing at layer 3 (the IP layer) is out of scope for IEEE 802 projects, but has been defined in **Internet Engineering Task Force (IETF)** as RPL (IPv6 Routing Protocol for Low-Power and Lossy Networks - RFC 6550 and family). This routing standard is used in the Wi-SUN FAN specification (see below). A background of mesh routing concepts and current practices was presented in Comms Intelligencer Issue 4 [4].

This project is nearing completion. Draft D6.0 of 802.15.10 has started the Sponsor Ballot process after the May 2016 meeting. The project is expected to reach final approval in Q2 of 2017.

802.15.12 "Upper Layer Interface (ULI) for 15.4" (TG12)

This new project promises to make IEEE 802.15.4 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 back to the time when Ethernet was young, the field is called an EtherType[6]. For example, the EtherType can distinguish between a packet containing IPv4 (0x0800) and a packet containing an IEC 61850 GOOSE[7] 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 of many of the higher layer protocol stacks used by 802.11 and 802.3 without changes.

The 802.15.12 standard will allow 15.4 to address new applications, yet maintain backward compatibility with existing devices and applications. It has the potential to consolidate L2R (802.15.10), KMP (802.15.9), 6TSCH (IETF), and 6lowpan (RFC 4944) into one Upper Layer Interface (ULI). This work will be based in IEEE 802.15, but will require tight coordination with 802.1 and IETF.

Other activities in IEEE 802.15

While the previous section highlights standards that are targeting utility applications by building on the previous work of 802.15.4g and 4e, there are other projects that have interesting, if less direct, potential for utility communication.

One amendment is IEEE 802.15.3e, High Rate Close Proximity (HRCP). It defines short range (<10m) point to point links with data rates up to 13 Gb/s with a single channel and up to 157 Gb/s with a multiple input, multiple output (MIMO) channel. The 802.15.3e PHY operates in the 57.0-66.0 GHz frequency band. 802.15.3e Draft

[5] https://tools.ietf.org/html/draft-irtf-cfrg-dragonfly-02
[6] https://en.wikipedia.org/wiki/EtherType
[7] https://en.wikipedia.org/wiki/Generic_Substation_Events

3.0 is in Letter Ballot. If the comments on D3.0 can be resolved in July 2016, the draft could proceed to Sponsor Ballot.

Another amendment is the 802.15.3d project, which is developing a standard for 100 Gb/s rates at frequencies above 275 GHz. This activity is in the early stages, but has the potential to provide fiber-like performance over a wireless link. This standard has similar use cases to the 802.11ad standard and its evolution into 802.11ay, but operates at an even higher frequency band. Of course, the propagation is strictly line of sight, but there may be cases where these high rates (and the corresponding very low latencies) could enable new utility applications. The task group developed the Channel Modeling Document (CMD), the Technical Requirements Document (TRD), and the Evaluation Criteria Document (ECD). The group has issued a call for proposals that closes June 27, 2016. The group has not projected a completion date.

IEEE 802.16 and WiMAX Forum

IEEE 802.16 is widely used in the utility industry as a point to multipoint Field Area Network technology with broadband capacity. The WiMAX Forum is the industry alliance that supports and promotes the IEEE 802.16 standards. The WiMAX Forum Smart Energy Working Group (SEWG) develops and certifies products to a profile for Smart Grid Applications called WiGRID. (A profile is a specific subset of the functionality and options defined in the IEEE 802.16 standards). The WiGRID Profile specifies feature sets such as uplink-centric modes, lower latency, extended range, and new frequency bands used by utilities (1.4 GHz, 1.8 GHz, 2.3 GHz, 3.65 GHz and 5.8 GHz). Profiles are used as the basis for WiMAX interoperability certification. To date, most 802.16 / WiMAX deployments by utilities have used the 3.65 GHz band in the US, and the 1.8 GHz band in Canada. FCC rules changes in the 3.65 GHz band (discussed in previous issues [12] [13]) have made it less attractive as a long term option, although it is still a viable and attractive operation in many circumstances. Further study into system operations under the authority of the Spectrum Access System[8] (SAS) is needed to understand the potential impact on utility operations and reliability.

An increasing number of utilities in the US have purchased licensed spectrum in the 700 MHz upper A-block. This spectrum includes two channels with a width of 1 MHz, which is too narrow to support LTE or WiMAX as currently defined. As a result, there are standards-based interoperable products available for that band. A project is underway to standardize a narrower channel variation of 802.16 and WiMAX. The WiMAX Forum and Utilities Telecommunications Council (UTC) conducted a survey of utilities that demonstrated a strong interest in the 700 MHz spectrum, and a desire for standards-based products to operate in that spectrum.

The IEEE 802.16 working group developed a PAR to initiate an amendment (802.16s) to support the 1 MHz channel width. This PAR was developed with the input and support of a number of utilities, the UTC, and equipment vendors. After failing to achieve approval in November 2015, the 802.16s PAR and CSD[9] was approved by the IEEE 802 executive committee at the March 2016 plenary meeting. At the May 2016 meeting the GRIDMAN Task Group prepared a draft System Requirements Document (SRD)[10] and developed a Call for Contributions. The IEEE-SA approved the PAR on June 30, 2016. The GRIDMAN task group will begin work on the 802.16s amendment in the July 2016 session.

IEEE 802.21 Multicast Group Management Task Group TGd

The IEEE 802.21 Working Group develops standards related to media-independent handover. The Working group developed the Multicast Group Management amendment (802.21d) to support management and

[8] http://www.tmtlawwatch.com/2015/04/fcc-adopts-innovative-spectrum-sharing-scheme-making-150-mhz-of-spectrum-available-for-wireless-broadband/
[9] https://mentor.ieee.org/802.16/dcn/16/16-16-0008-01-Gdoc-draft-par-and-csd-amendment-for-fixed-and-mobile-wireless-access-in-channel-sizes-less-than-1-25-mhz.docx
[10] https://mentor.ieee.org/802.16/dcn/16/16-16-0034-01-000s-draft-p802-16s-system-requirements-document.docx

handover of multicast groups. That amendment was completed in 2015. The amendment was intended to support mesh networks used in AMI systems (for example to improve efficiency of firmware updating in meters). The industry has not adopted 802.21 for use in any of the standards supporting metering networks to date.

As of May 2016, the 802.21 working group continues to ballot and address comments on the revision of the 802.21 standard which now contains the 802.21d amendment. The Draft D3.0 was developed at the May meeting, and is expected to proceed to Sponsor Ballot in July.

The working group is investigating the applicability of IEEE 802.21 in 5G. More specifically, in IMT-2020[11], which is the ITU term for the next generation of the International Mobile Telephone system, since terms like "4G" and "5G" become marketing buzzwords. The "IEEE 802.21 Framework and Its Applicability to IMT-2020"[12] document was presented to the 5G Executive Committee Study Group (5G-ECSG) meeting that followed the May 2016 session.

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.

As a result of the scope expansion approved in July 2014, the TAG is working in two areas. The Smart Grid work continues 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 is continuing 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). The TAG is also starting development of a new white paper to compare and contrast commercial cellular networks with privately owned networks based on IEEE 802 standards for utility and smart grid applications.

Industry Groups and Other Standards

3GPP and LTE in Unlicensed Bands

The 3GPP[13] organization (developers of GSM, 3G UMTS, and LTE specifications) initiated a Work Item to study the use of LTE in unlicensed bands. Given the already crowded status of unlicensed spectrum, the prospect of additional devices competing for the same spectrum is concerning for existing users. The term used by the 3GPP organization for operation of LTE in unlicensed bands is Licensed-Assisted Access (LAA).

The primary target for unlicensed LTE is the 5 GHz bands and the 3.5 to 3.7 GHz bands. The 3.65 GHz band is widely used today for utility field area networks, often using the 802.16 (WiMAX) standards (See previous section on the WiMAX Forum). The 5 GHz bands are increasingly used for Wi-Fi (802.11n and 802.11ac). There are some utility deployments of outdoor point to point links in the 5GHz bands, but it is less commonly

[11] http://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/imt-2020/Pages/default.aspx
[12] https://mentor.ieee.org/802-ec/dcn/16/ec-16-0079-00-5GSG-ieee-802-21-framework-and-its-applicability-to-imt-2020.pptx
[13] Third Generation Partnership Project

used compared to 915 MHz and 2.4 GHz. Please see the previous issue Smart Grid Communications Intelligencer [13] for more background on the issue.

Liaison letters are regularly exchanged between IEEE 802 and 3GPP regarding LAA. While it is helpful to have regular communication between the standards bodies, there are ongoing points of disagreement. Specifically, the Listen Before Talk signal levels are a point of contention. The 802.11 and Wi-Fi representatives have noted that the 3GPP proposed energy threshold that LAA devices would use to detect and avoid Wi-Fi networks is too high and would not result in fair coexistence[14]. The Wi-Fi Alliance is holding regular Coexistence Test Workshops and is developing a Coexistence Test Plan[15].

The consequences and impact of LAA, LTE-U, and MuLTEfire may be significant, especially in industries that rely on the limited set of unlicensed bands. Major stakeholders are actively conducting coexistence testing to support the common use cases for Wi-Fi and Cellular. EPRI will evaluate the need for further testing of these technologies with utility communications links when deployment commences.

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 standard. The Wi-SUN Field Area Network (FAN) Technical Profile Specification (TPS) has been approved as version 1.0. Further refinements and corrections are expected at upcoming Interoperability Test events during 2016.

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 using IEEE Std. 802.15.4g. As the FAN TPS matures, development proceeds as a sequence of iterations. Each iteration starts with a draft, and includes comment collection, Interoperability Test (IOT) events, and ultimately the release a new draft version that addresses the comments and becomes the starting point for the next iteration. In parallel with the FAN TPS document, the Wi-SUN Alliance FAN working group is continuing development of the FAN Interop Test Specification (currently at version 0.4 as of June 21, 2016) that will become the basis for certification. EPRI is developing an open-source reference implementation for Wi-SUN. EPRI continues to participate in Wi-SUN Interop events as they are scheduled. EPRI plans to certify the open source implementation to the FAN profile when certification becomes available, and intends to enable EPRI's open platform as the "gold standard" reference.

TV White Space Technology and Standards

TV White Space is a term given to unused channels in the VHF and UHF television broadcast bands. Please refer to previous issues **Smart Grid Communications Intelligencer** [2] [3] for a more detailed background and introduction. As a lightly-licensed spectrum resource in a band with very desirable propagation properties, TV White Space is relevant to utility communications. However, the already limited number of vacant TV channels will eventually become smaller when the FCC auctions more of the television spectrum in the 600 MHz band[16]. These auctions were initially planned for 2015, but actually started on March 29, 2016[17]. The first phase is the reverse auction, where TV broadcasters bid the amount they would accept to give up their spectrum (the lowest bid wins). The next phase is the forward auction, where the vacated spectrum is auctioned to the highest bidder. At the end of June, the reverse auction is close to completion[18], having met the spectrum

[14] http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_85/Docs/R1-166041.zip
[15] http://www.wi-fi.org/discover-wi-fi/unlicensed-spectrum
[16] https://www.fcc.gov/about-fcc/fcc-initiatives/incentive-auctions
[17] http://www.fiercewireless.com/story/incentive-auction-600-mhz-spectrum-kicks/2016-03-29
[18] http://www.fiercewireless.com/story/reverse-auction-600-mhz-spectrum-could-end-week-btig/2016-06-27

clearing target of 126 MHz. More details of the proposed 600 MHz band plan are presented in issue [9] of the Comms Intelligencer.

As a result of the uncertainties around the auction and future channel availability, TV White Space has become marginalized. Despite the availability of standards and initial excitement a few years ago, the prospects for the emergence of broad market and clear application direction for utility telecommunication seem to be fading.

EPRI Comms Research

EPRI Telecom Initiative

The Telecom Initiative is a new project that is launching in 2016. It addresses a broad range of key issues facing utilities in the area of telecommunication. Specific topics include:

- Approaches for 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
- Connectivity Beyond the Meter (DER Connectivity at the Edge of the Grid)
- Standards and Best Practices for Network Management and Reliability Metrics

The telecom initiative is underway and currently has a membership of 14 utilities. The first advisor meeting was hosted by XCEL Energy in Denver during the week of the UTC national conference. The second face to face advisors meeting will be held October 5-6 in St. Louis, hosted by Ameren. Several webcasts and workshops will also be held during 2016. The Telecom Initiative is a two-year project and will transition into a new project set in Program 161 (Information and Communications Technology) starting in 2018.

For further information on the Telecom Initiative, 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**

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