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Smart Grid Communications Intelligencer

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About

Welcome to the eleventh 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.

Since this newsletter tracks standards development activities that continue over an extended period of time, 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 growing exponentially. The recently completed FCC auctions of the AWS-3 bands brought in a record $44.9 billion. This outcome clearly demonstrates the value and importance of licensed spectrum. The use of licensed spectrum for utility communications is the topic of the EPRI Spectrum Assessment project. The full range of communications technologies and standards are being evaluated in the Field Area Network Demo, which will soon be entering its third year. These (and other) ICT projects are built around many communications technologies that originate from the standards development activities covered in this newsletter.

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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. Although a minority opinion

cannot force changes, committees are generally very receptive to good ideas that improve the functionality or usefulness of a standard.

If you are unfamiliar with the sometimes cryptic numbering system used for IEEE 802 standards, 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 six task groups working on amendments:

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	✓
NG60		Next Generation 60 GHz	**?**

A check in the right column indicates those activities that have relevance to utility communications.

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. In the November 2014 and January 2015 meetings, a total of 506 comments on Draft 3.0 were resolved. A new Draft 4.0 will be balloted before the March 2015 meeting. Slow but steady progress is being made. The group's schedule for completion is unchanged, with final approval expected in March 2016. In practice, the specification is now becoming fairly stable. As is often the case with new 802.11 standards, chipsets and products will start to become available during the 2015 year in advance of the final approval. The 802.15.4g / Wi-SUN standards will be several years ahead in the marketplace, but products may shift towards 802.11ah networking before a "second generation" of AMI deployments begins toward the end of the decade.

802.11ah is also targeting applications of Wi-Fi in sensor networks and M2M applications. In addition to the range and penetration improvements due to the lower frequency band (compared to 2.4 GHz), 802.11ah also specifies a two hop relay function, which can provide additional range extension. MAC enhancements to sleep modes enable further improvements to low power operation. With these enhancements, 802.11ah will be able to address emerging markets for sensors, displays, and load control currently occupied by 802.15.4 (ZigBee). 802.11ah is also likely also find application in line sensors and other outdoor applications where the 915MHz frequency band can provide a benefit.

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. For example, a rack of equipment internally connected with an Ethernet switch could be connected to a LAN in another building using an 802.11 wireless link. The availability of 802.11ac with throughput above 1Gbps make replacement of Ethernet or fiber with wireless LAN feasible in some cases. There are 802.11-based wireless network bridges available on the market, but they are vendor-specific. The

802.11 TGak task group is working in conjunction with the 802.1 TGqbz task group to enable wireless network-to-network bridging.

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 has been working on resolving comments that have been submitted through several iterations of internal "pre-drafts", which are currently at version 0.7. The first letter ballot (D1.0) is expected to be released after the March 2015 meeting, with final approval predicted in January 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 data rates above 1 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 there isn't a specific focus on grid-centric applications, the benefits of this work 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 been hearing presentations on a diverse set of topics during the November 2014 and January 2015 meetings. The technical direction for the eventual amendment has not yet come together in a coherent manner. The task group has established four "ad hoc" subgroups to organize the work. These are the Medium Access Control (MAC), Physical Layer (PHY), Multi-User (MU), and Spatial Reuse groups. A specification framework has been established, but it is an empty outline at this point. The 802.11ax task group is currently expecting to reach final approval in 2019, which is consistent with the time frame of previous major developments.

Next Generation 60 GHz (NG60) Study Group. This study group was formed at the September 2014 meeting. The objective is to increase the data rates of the existing 802.11ad standard for operation in the 60 GHz band (57.05 to 64 GHz in the USA, up to 66 GHz in Europe and Japan). This group is just starting, but early feasibility study proposals point to the possibility of maximum rates above 100 Gb/s.

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 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.

IEEE 802.15 Working Group

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). Currently, 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 services that includes support for protocols such as 802.1X/MKA (MACsec Key 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[1].

The task group released Draft 1.0 to Letter Ballot following the November 2014 meeting, and started comment resolution during the January 2014 meeting.

802.15.10 "Layer 2 Routing" 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 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 Issue 4 [4].

The 802.15.10 Task Group (TG10) holds regular joint sessions with 802.1 (the working group that standardizes Layer Two bridging, primarily for Ethernet). They take place at plenary meetings (3 per year), to coordinate the development of the 802.15.10 standard. At the November 2014 and January 2015 meetings of the Task Group, the four proposals have been harmonized and merged into a single baseline proposal. The set of required functionalities for 802.15.10 are defined in the Technical Guidance Document (TGD)[2]. In January, the L2R task group met with the 802.15.9 Key Management Protocol (KMP) task group. The two groups will coordinate to incorporate the 802.15.9 KMP into the L2R specification as one of the security modes. The L2R task group is planning to release the first draft for balloting after the March 2015 meeting. The project is expected to reach final approval in mid-2016.

Other activities in IEEE 802.15

While TG10 is directly 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 is the 802.15.3d project, which is developing a standard for 100 Gbps rates at frequencies above 275 THz. This activity is in the early stages, but has the potential to provide fiber-like performance over a wireless link. 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. This group has completed the Applications Requirements Document (ARD), and is now developing the Channel Modeling Document, and Technical Requirements Document. These define the scope for proposals that will be submitted later this year.

The 802.15.4r task group is developing an amendment for including distance measurement into 802.15.4 systems. The ranging feature will provide an accuracy of 1 meter. When integrated with 802.15.4g and 802.15.4m radios, the ranging feature could provide additional positional information to optimize AMI mesh network formation and management. The group completed its Technical Guidelines Document in January 2015, and expects to issue a call for proposals in March 2015. The first draft is planned for early 2016.

[1] https://tools.ietf.org/html/draft-irtf-cfrg-dragonfly-02
[2] 15-13-0753-19-0010-technical-guidance-document.docx

The "Dependability" Interest Group (IG[3]) is looking for applications that require higher "dependability" from 802.15 systems. The IG issued a call for interest to identify potential applications that could benefit from greater dependability. Some suggested applications are wireless versions of in-vehicle networks such as CAN and LIN, medical devices, and factory automation. In theory, many utility applications could benefit, including the 802.15.4g standard for AMI systems and 802.15.4 ZigBee in the 2.4 GHz band. However, there is no clear definition of what dependability means, or how it would actually work (given that 802.15 standards mostly operate in unlicensed spectrum). One possible direction for a project is to implement priority classes, but it is yet to be seen if a technical approach can be identified. In the November and January meetings, the IG did not find a clear technical direction that could enable the topic to progress towards a Study Group.

The TG4m maintenance standing committee (SC) continued comment resolution on the revision draft. The revision will consolidate completed amendments (including 802.15.4e, 4f, and 4g) into the main document, correct editorial issues that have been identified, and perform some re-organization to make the 802.15.4 standard more readable and understandable. The comment resolution process on Draft 2 was completed at the January 2015 meeting, and Draft 3.0 was released for a recirculation ballot. This revision is expected to reach final approval at RevCom by late 2015. 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. In addition, as is the case with all revision projects, the entire standard is open to changes as required and approved by the members. This work has seen strong participation from the stakeholders for AMI systems.

IEEE 802.21 Multicast Group Management Task Group TGd

The IEEE 802.21 Working Group develops standards related to media-independent handover. Within 802.21's overall scope of network handover, the Multicast Group Management Task Group (TGd) is developing an amendment to support management and handover of multicast groups. One targeted application is the IEEE 802.15.4g mesh networks used in AMI systems. Multicast is an important functionality to optimize data transfer to large groups of devices when common data is being sent. One example use case is firmware updating in meters. IEEE 802.21d also supports secure distribution of keys to groups of meters, to enable them to be re-assigned to a different collector.

The 802.21d draft is at the end of the Sponsor Ballot process. In January 2015, Draft D8 was released for a recirculation ballot. Unless new comments are submitted, it will proceed to final approval, likely in March or April.

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.

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 24.1 task group, and a new scope statement for the 24.2 task group on Internet of Things (IoT) applications has been submitted for approval at the March 2015 plenary meeting. The Smart Grid TG is starting work on a new white paper that will compare and contrast the two 802 standard with smart grid

[3] An Interest Group is a phase that precedes a Study Group, before a specific direction for standard development has been identified

applications in the 915 MHz ISM band: IEEE 802.15.4g and 802.11ah. As the 802.11ah standard nears completion, the industry will need to understand the best ways to apply these standards.

Update on the 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 Alliance has been conducting certification events for the 802.15.4g PHY.

The Wi-SUN Field Area Network (FAN) spec has been approved, and is now at revision 1.0. It 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.

Update on WiMAX Forum Smart Energy Working Group

The WiMAX Forum is the industry alliance that supports and promotes the IEEE 802.16 standards. The IEEE 802.16 Working Group is still active, but the projects currently underway[4] are not relevant to utility communications. This newsletter no longer includes a specific section on 802.16 above with 802 standards updates. In the WiMAX Forum, the 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.

The possibility of standardization of a narrower channel variation of 802.16 and WiMAX is still of interest to the SEWG and the industry. The challenge is finding support from vendors who are willing and able to modify their existing products. Research into technical options that would involve minimal modification will continue.

The WiMAX Forum SEWG has also been following the FCC NPRM on the 3.65 GHz band. A response was submitted by the WiMAX Forum[5], which was developed with the input from a number of utilities that are using this band. The forum recommended that the FCC leave the rules for the existing 3650-3700 MHz band unchanged, and apply new rules only to the CBRS band at 3550-3650 MHz. Many utilities also filed comments directly with the FCC expressing the same opinion.

[4] 802.16q Multi-Tier Networks, 802.16r Small Cell Backhaul, 802.16.3 Mobile Broadband Network Performance Measurements

[5] http://apps.fcc.gov/ecfs/document/view?id=7521375861

LTE in Unlicensed Bands

The 3GPP[6] organization (developers of GSM, 3G UMTS, and LTE specifications) had initiated a Work Item[7] 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 Work Item was revised in the 3GPP RAN (Radio Access Network) meeting in December 2014 and is expected to complete in June 2015. The resulting specifications are expected to be incorporated into Release 13 in March 2016. The wireless industry is not waiting for the specification to be complete, though. Ericsson demonstrated[8] LAA-enabled small cell infrastructure at the CES show in January, and T-Mobile[9] has announced that they plan to implement LAA. There is considerable technical work to be done to develop a modification to LTE for this application, as LTE is not designed for coexistence or operation in shared spectrum. Technical approaches being explored involve using licensed spectrum as a control channel, which would help with managing the LTE devices. It is unclear at this time what mechanisms would be adopted to protect existing users of the unlicensed spectrum, but the need for coexistence is clear. The primary target for unlicensed LTE is in the 5 GHz bands and the 3.5 to 3.7 GHz bands (which are currently the topic of an FCC FNPRM). The 5 GHz bands are increasingly used for Wi-Fi (802.11n and 802.11ac). There are some utility deployments in the 5GHz bands, but it is less commonly used compared to 915 MHz and 2.4 GHz. The 3.65 GHz band is widely used today for utility field area networks, often using the 802.16 (WiMAX) standards.

The potential impact of LAA on existing standards is being addressed in IEEE 802. The IEEE 802.19 Coexistence Working Group has formed a Study Group (SG) called Coexistence in Unlicensed Bands (CUB). This SG was formed at the November 2014, with the charter to address "Coexistence Methods for Wireless Dissimilar Systems over Unlicensed Bands", specifically between IEEE 802 systems and non-802 systems in bands below 6 GHz. The SG is evaluating whether to develop a new coexistence standard, or amend the existing coexistence standard, IEEE 802.19.1. A liaison has been established between IEEE 802 and 3GPP on the topic of coexistence and LAA. IEEE 802 sent representatives to the December 2014 meeting of 3GPP, and 3GPP sent the chairman of TSG RAN (Dino Flore) to the January meetings of IEEE 802. He presented 3GPP's perspective on LAA development[10].

This is an important matter, and it is unclear how it will play out. The consequences may have a significant impact, especially in industries that rely on the limited set of unlicensed bands.

TV White Space Technology and Standards

Introduction

TV White Space is a term given to unused channels in the VHF and UHF television broadcast bands. Please refer to previous issues [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. These auctions were initially

[6] Third Generation Partnership Project
[7] ftp://ftp.3gpp.org/tsg_ran/TSG_RAN/TSGR_66/Docs/RP-141817.zip
[8] http://www.rcrwireless.com/20150105/network-infrastructure/lte/ericsson-launches-laa-small-cell-ces-tag4
[9] http://newsroom.t-mobile.com/issues-insights-blog/unleashing-lte-potential-integrating-new-spectrum.htm
[10] https://mentor.ieee.org/802.19/dcn/15/19-15-0008-00-0000-3gpp-and-unlicensed-spectrum.pdf

planned for 2015, but have been delayed to 2016[11]. This is the second delay, as the auctions were originally slated for 2014. More details of the proposed 600 MHz band plan are presented in a previous issue [9] of the Comms Intelligencer.

Update on IEEE 802.22

IEEE 802.22 was the first standard to start development for TV White Space, published in 2011. Since then two other TVWS standards (IEEE 802.11af and 802.15.4m) have been published. IEEE 802.22 continues its evolution with the 802.22b amendment. New features include: 1) support for broadband and monitoring services, 2) higher data rates, 3) more than 512 devices in a network. The 802.22b Task Group completed the comment resolution on the second recirculation letter ballot. The WG planned to submit the draft for sponsor ballot after the November 2014 meeting, but the motion was withdrawn due to procedural issues. Final approval is expected mid to late 2015.

The new 802.22 project on spectrum occupancy sensing was approved in July 2014. The 802.22.3 project is addressing the requirement for dynamic spectrum access, and will address bands in the 2.7 to 3.7 GHz range in addition to TV White Space. The purpose of 802.22.3 is to specify operating characteristics of the components of the Spectrum Characterization and Occupancy Sensing System. This project is intended to complement existing standards for dynamic spectrum access that have been developed by IEEE Std. 1900.6 and its amendments. The 802.22.3 project has shown little visible progress during the second half of 2014.

CEA-2045

EPRI has just completed year one of a three year project to evaluate the CEA-2045 modular communication interface standard. A total of 21 utilities are now participating, making it one of the largest demand response projects undertaken to date. The project is a field demonstration, involving consumer products such as water heaters, thermostats, pool pumps, EV chargers and solar inverters. Utilities are engaging their communication partners and a range of system technology providers are getting involved.

In the past few months, EPRI has received the first CEA-2045 products, including end-use devices and communication modules. Lab pre-deployment testing of resistive and heat pump water heater prototypes is almost complete and testing of a PV inverter prototype is underway. The first CEA-2045 thermostat has just been received and testing will begin shortly. Seven companies are developing communication modules and EPRI has received and is testing the first two. EPRI continues to compile and provide input to the Consumer Electronics Association's R7.8 working group, based upon feedback from developers implementing the standard.

The nature of this project requires broad utility participation. Manufacturers are seeking to find strategies that enable DR-Ready products to be mass-produced and work in utility programs everywhere. The project is open to new utility participants throughout 2015. For additional information, please contact Chuck Thomas, cthomas@epri.com.

[11] http://www.fiercewireless.com/story/fcc-delays-start-600-mhz-incentive-auction-early-2016/2014-10-24

Smart Energy Profile 2.0

The Smart Energy Profile (SEP) is a specification that was originally developed by the ZigBee and HomePlug Alliances for application layer messaging in Home Area Network (HAN) environments. SEP 2.0 was released by the ZigBee Alliance in April 2013. Future development is taking place in the IEEE 2030 working group as project P2030.5. A PAR for an amendment to P2030.5 has been submitted and approved. The P2030.5 working group holds monthly teleconferences, and meets face to face in conjunction with ZigBee Alliance meetings. A liaison has been established with Consortium for SEP 2 Interoperability (CSEP), and the interoperability testing results from CSEP are being used to identify revisions needed in the spec during the amendment process. Although a Project Authorization Request (PAR) has been approved for an amendment project, there is not a specific work plan or revision process for the specification underway currently.

EPRI Comms Research

Spectrum Assessment Project

Many utilities utilize wireless systems operating in licensed spectrum for both operational and non-operational applications on the transmission and distribution systems. Several research questions arise when considering the selection of licensed spectrum for utility applications, including:

- What are the present and future communications requirements for transmission and distribution applications?
- Which parts of the spectrum bands best meet these requirements?
- What standards and equipment support the identified spectrum bands?
- What is the current use and availability of the identified spectrum bands?

The project launched in November 2014, with nine utilities as members. The work has moved at a relatively quick pace, due to the timeliness of the subject. A requirements review webcast was held in early December 2014. This established the scope and parameters for the assessment. An advisors meeting was held in mid-January 2015 to review the initial findings. The final report is currently being developed, and is planned to be completed at the end of March 2015.

FAN Demo Program Update

The Field Area Network (FAN) program includes utilities in various stages of FAN development, from technology selection to full deployment of a FAN. The project will raise the level of industry knowledge and practice around FAN reliability by publishing the results of FAN trials that the project will support. In particular, the research centers on high-reliability FAN architectures, design principles, guidelines for implementation and operation.

The design and implementation of a FAN involves many competing variables and decisions. There is a complex interaction between network technology options, private, public, and hybrid networks, spectrum choices, the set of supported applications, and the overall system cost/benefit analysis. The Field Area Network Demo employs a collaborative research model that quantifies these relationships and demonstrates how the optimum solution can be achieved.

The members of the FAN Demo include Salt River Project, Duke Energy, Hydro One, United Illuminating, Great River Energy, Nebraska Public Power District, Hydro Quebec, Ameren, and San Diego Gas & Electric. The next meeting will be hosted by Salt River Project in Phoenix on March 18-19, 2015.

For further information on the Spectrum Assessment or FAN Demo 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**

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