**IEEE 802.24**

**Smart Grid TAG**

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| Project | IEEE 802.24 Smart Grid TAG | |
| Title |  | |
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| Re: | [] | |
| Abstract | [DRAFT DOCUMENT: Not approved by IEEE 802. This document provides a list of 802 and related standards that provide solutions for smart grid networks.] | |
| Purpose | [] | |
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IEEE 802 recommendations on IEEE 802 related Smart Grid standards

22 March 2013

# Executive Summary

This document solely represents the views of IEEE 802 and does not necessarily represent a position of either the IEEE or the IEEE Standards Association.

This document provides a list of standards related to Smart Grid. Initially the IEEE 802.24 technical advisory group (TAG) will focus on PHY and MAC standards related to the Smart Grid, to recommend to the IEEE-SA, so the standards can be formally documented and publicized by the IEEE. This document will be of help in the following areas:

* IEEE-SA activities relating to Smart Grid Standards and Technologies
* IEEE 802 activities in the Smart Grid area
* SGIP activities in establishing Smart Grid Catalog of Standards (CoS)

The list of Smart Grid Standards, currently in the form of recommended PHY/MAC standards, is intended to be submitted to the IEEE 802 Executive Committee to forward to IEEE-SA. This document will be updated on an as needed basis to reflect the on-going work in IEEE 802. Future work will include identifying standards applicable to higher layers for each Smart Grid application area that can be combined with the PHY/MAC standardss.

Each standard is numbered for reference as 802-<working group#>-<standard #> where the working group number is replaced with the appropriate IEEE 802 “dot number” and the standard # is a incremented for each standard that is added for that IEEE 802 working group. For example, the third standard defined for 802.3 would be referenced as 802-WG3-3.

# IEEE 802.24 Scope

IEEE 802.24 Smart Grid TAG charter is:

* Acts as a liaison and point of contact with regulatory agencies, industry organizations, other SDOs, government agencies, IEEE societies, etc., for questions regarding the use of 802 standards in Smart Grid applications.
* Facilitate coordination and collaboration among 802 groups.
* Provides speakers as needed and available to present on 802 standards in Smart Grid applications.
* Develops white papers, guidelines, presentations and other documents that do not require a PAR that describe the application of 802 standards to Smart Grid applications.
* Acts as a resource for understanding 802 standards for certification efforts by industry bodies.

# Background

Standards play a key role in the development, deployment and operation of smart grid worldwide. They are a proven tool to safeguarding interoperability, enabling the different components of a grid to exchange information.

Various standards development organizations (SDOs) have developed/developing standards related to Smart Grid. Within IEEE 802, several working groups including 802.1, 802.3, 802.11, 802.15, 802.16, 802.18, 802.19, 802.21, and 802.22, are active in smart grid standards area. There are also various smart grid related activities going on in other SDOs with whom IEEE 802 has a collaborative relationship, such as Telecommunication Industry Association (TIA), European Telecommunications Standards Institute (ETSI), Internet Engineering Task Force (IETF), International Telecommunication Union (ITU), and others.

# Listing of Standards

The standards in this clause are listed in numerical order of the working group.

## Applicable to all PHY/MAC standardss

These standards are applicable to all PHY/MAC standards for Smart Grid applications.

**802-WG1-1 (security related)**

* **IEEE Std 802.1X™-2010 Port-based Network Access Control**  
  For the purpose of providing compatible authentication, authorization and cryptographic key agreement mechanisms to support secure communication between devices connected by IEEE 802 Local Area Networks (LANs), this standard  
  a) Specifies a general method for provision of port-based network access control.  
  b) Specifies protocols that establish secure associations for IEEE Std 802.1AE MAC Security  
  c) Facilitates the use of industry standard authentication and authorization protocols.
* **IEEE Std 802.1AE™-2006 Media Access Control (MAC) Security**  
  The scope of this standard is to specify provision of connectionless user data confidentiality, frame data integrity, and data origin authenticity by media access independent protocols and entities that operate transparently to MAC Clients. NOTE—The MAC Clients are as specified in IEEE Std 802, IEEE Std 802.2™, IEEE Std 802.1D™, IEEE Std 802.1Q™,and IEEE Std 802.1X™. To this end it  
  a) Specifies the requirements to be satisfied by equipment claiming conformance to this standard.  
  b) Specifies the requirements for MAC Security in terms of provision of the MAC Service and the preservation of the semantics and parameters of service requests and indications.  
  c) Describes the threats, both intentional and accidental, to correct provision of the service.  
  d) Specifies security services that prevent, or restrict, the effect of attacks that exploit these threats.  
  e) Examines the potential impact of both the threats and the use of MAC Security on the Quality of Service (QoS), specifying constraints on the design and operation of MAC Security entities and protocols.  
  f) Models support of the secure MAC Service in terms of the operation of media access control method independent MAC Security Entities (SecYs) within the MAC Sublayer.  
  g) Specifies the format of the MACsec Protocol Data Unit (MPDUs) used to provide secure service.  
  h) Identifies the functions to be performed by each SecY, and provides an architectural model of its internal operation in terms of Processes and Entities that provide those functions.  
  i) Specifies the interface/exchanges between a SecY and its associated and collocated MAC Security Key Agreement Entity (KaY, IEEE P802.1af [B2]) that provides and updates cryptographic keys.  
  j) Specifies performance requirements and recommends default values and applicable ranges for the operational parameters of a SecY.  
  k) Specifies how SecYs are incorporated within the architectural structure within end stations and bridges.  
  l) Establishes the requirements for management of MAC Security, identifying the managed objects and defining the management operations for SecYs.  
  m) Specifies the Management Information Base (MIB) module for managing the operation of MAC Security in TCP/IP networks.  
  n) Specifies requirements, criteria and choices of Cipher Suites for use with this standard. This standard does not  
  o) Specify how the relationships between MACsec protocol peers are discovered and authenticated, as supported by key management or key distribution protocols, but makes use of IEEE P802.1af Key Agreement for MAC security to achieve these functions.
* **IEEE Std 802.1AR™-2009 Secure Device Identity**  
  This standard specifies unique per-device identifiers (DevID) and the management and cryptographic binding of a device to its identifiers, the relationship between an initially installed identity and subsequent locally significant identities, and interfaces and methods for use of DevIDs with existing and new provisioning and authentication protocols.

**802-WG1-2 (bridging and link aggregation related)**

* **IEEE Std 802.1Q™-2011 Media Access Control (MAC) Bridges and Virtual Bridge Local Area Networks**  
  This standard specifies Media Access Control (MAC) Bridges that interconnect individual Local Area Networks (LANs), each supporting the IEEE 802 MAC service using a different or identical media access control method, to provide Bridged Local Area Networks and Virtual LANs (VLANs).
* **IEEE Std 802.1AX™-2009 Link Aggregation**  
  Link Aggregation allows one or more links to be aggregated together to form a Link Aggregation Group, such that a MAC Client can treat the Link Aggregation Group as if it were a single link. To this end, it specifies the establishment of data terminal equipment (DTE) to DTE logical links, consisting of N parallel instances of full duplex point-to-point links operating at the same data rate. This standard defines the MAC independent Link Aggregation capability, and general information relevant to specific MAC types that support Link Aggregation.

## IEEE 802.3

**802-WG3-1**

* **IEEE Std 802.3™-2012 Ethernet**  
  This standard defines Ethernet local area, access and metropolitan area networks. Ethernet is specified at selected speeds of operation; and uses a common media access control (MAC) specification and management information base (MIB). The Carrier Sense Multiple Access with Collision Detection (CSMA/CD) MAC protocol specifies shared medium (half duplex) operation, as well as full duplex operation. Speed specific Media Independent Interfaces (MIIs) provide an architectural and optional implementation interface to selected Physical Layer entities (PHY). The Physical Layer encodes frames for transmission and decodes received frames with the modulation specified for the speed of operation, transmission medium and supported link length. Other specified capabilities include: control and management protocols, and the provision of power over selected twisted pair PHY types.

## IEEE 802.11

**802-WG11-1**

* **IEEE Std 802.11™-2012 - Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications**The scope of this standard is to define one medium access control (MAC) and several physical layer (PHY) specifications for wireless connectivity for fixed, portable, and moving stations (STAs) within a local area.

## IEEE 802.15

**802-WG15-1**

* **IEEE Std 802.15.4-2011 - Part 15.4: Low-Rate Wireless Personal Area Networks (LR-WPANs).**

The standard provides for ultra low complexity, ultra low cost, ultra low power consumption, and low data rate wireless connectivity among devices typically found in sensor and control networks. The raw data rate is high enough to satisfy a variety of lower data rate applications but is also scaleable down to the needs of sensor and automation needs for wireless communications. In addition, one of the alternate PHYs provides precision ranging capability that is accurate to one meter. Multiple PHYs are defined to support a variety of frequency bands including

* + 868–868.6 MHz
  + 902–928 MHz
  + 2400–2483.5 MHz
  + 314–316 MHz, 430–434 MHz, and 779–787 MHz band for LR-WPAN systems in China
  + 950–956 MHz in Japan

The O-QPSK PHY specified in Clause 10 of this standard is widely deployed for home area networking and smart metering applications.

The following amendments, Included in the above standard, are of particular interest to Smart Grid networks:

* **IEEE Std 802.15.4g™-2012 (PHY) - Amendment 3: Physical Layer (PHY) Specifications for Low-Data-Rate, Wireless, Smart Metering Utility Networks**IEEE 802.15.4g defines a PHY amendment to IEEE 802.15.4 wireless standard to address outdoor Smart Utility Network (SUN). IEEE 802.15 working group formed the 802.15.4g task group for the purpose of standardizing the SUN physical layer protocol for Smart Grid. IEEE 802.15.4g standards effort was to establish industry-wide compatibility at the physical layer for SUN and remove the limitations imposed by the then-current IEEE 802.15.4-2006 standard.
* **IEEE Std 802.15.4e™-2012 (MAC) – Amendment 1: MAC sublayer**IEEE 802.15.4e defines a MAC amendment to enhance and add functionality to the 802.15.4-2006 MAC to better support the industrial markets. The recently approved IEEE802.15.4e-2012 MAC amendment has many features that apply to SUN networks. Specifically, the MAC enhancements specified in IEEE 802.15.4e are TDMA, channel hopping, GTS (to increase its flexibility such as supporting peer to peer, the length of the slot, and number of slots), CSMA, security and low latency.

**802-WG15-2**

* **IEEE Std 802.15.4g™-2012 (PHY) - Amendment 3: Physical Layer (PHY) Specifications for Low-Data-Rate, Wireless, Smart Metering Utility Networks**IEEE 802.15.4g defines a PHY amendment to IEEE 802.15.4 wireless standard to address outdoor Smart Utility Network (SUN). IEEE 802.15 working group formed the 802.15.4g task group for the purpose of standardizing the SUN physical layer protocol for Smart Grid. IEEE 802.15.4g standards effort was to establish industry-wide compatibility at the physical layer for SUN and remove the limitations imposed by the then-current IEEE 802.15.4-2006 standard.
* **ANSI\_TIA-PN4957\_200 (MAC) and ANSI\_TIA-PN4957\_210 (Multi-Hop Layer2)**TIA standard [ANSI/TIA-PN-4957.200] defines a MAC standard for Smart Utility Networks. The TIA MAC specification allows the deployment of small to very large scale networks of devices supporting applications in a wide range of markets from generic M2M communications to large scale utility networks. Particular attention is paid to the use of shared spectrum with very efficient distribution of devices across available channels to minimize the impact of interference to and from other spectrum users as well as collisions from other devices.  
  ANSI\_TIA-PN4957\_210 standard defines a forwarding sub-layer protocol and a routing sub-layer protocol for the data link layer including, processes, functions, service interfaces and externally visible frame formats. The forwarding protocol provides data transfer services between non-neighboring devices. The routing protocol provides discovery and maintenance of multi-hop routes between certain non-neighboring devices.

## IEEE 802.16

**802-WG16-1**

* **IEEE Std 802.16™-2012 - Air Interface for Broadband Wireless Access Systems**  
  This standard specifies the air interface, including the medium access control layer (MAC) and physical layer (PHY), of combined fixed and mobile point-to-multipoint broadband wireless access (BWA) systems providing multiple services. The MAC is structured to support the WirelessMAN-SC, WirelessMAN OFDM, and WirelessMAN-OFDMA PHY specifications, each suited to a particular operational environment.

**802-WG16-2**

* **IEEE Std 802.16.1™-2012 WirelessMAN-Advanced Air Interface for Broadband Wireless Access Systems**  
  This standard specifies the WirelessMAN-Advanced Air Interface, including the medium access control layer (MAC) and physical layer (PHY), of a broadband wireless access (BWA) system supporting multiple services. The WirelessMAN-Advanced Air Interface supports the International Telecommunication Union (ITU)’s IMT-Advanced requirements.

## IEEE 802.20

**802-WG20-1**

* **IEEE Std 802.20™-2008 - Air Interface for Mobile Broadband Wireless Access Systems Supporting Vehicular Mobility — Physical and Media Access Control Layer Specification**This standard specifies the physical and medium access control layers of an air interface for interoperable mobile broadband wireless access systems, operating in licensed bands below 3.5 GHz. The system is optimized for IP-data transport, with peak data rates per user in excess of 1 Mbps.

## IEEE 802.21

**802-WG21-1**

* **IEEE Std 802.21™-2008 - Media Independent Handover Services**  
  This standard defines extensible IEEE 802® media access independent mechanisms that enable the optimization of handover between heterogeneous IEEE 802 networks and facilitates handover between IEEE 802 networks and cellular networks.
* **IEEE Std 802.21a™-2012 - Media Independent Handover Services - Amendment for Security Extensions to Media Independent Handover Services and Protocol**  
  This standard defines mechanisms (i) to reduce the latency during authentication and key establishment for handovers between heterogeneous access networks that support IEEE 802.21 (ii) to provide data integrity, replay protection, confidentiality and data origin authentication to IEEE 802.21 MIH (Media-Independent Handover) protocol exchanges and enable authorization for MIH services.
* **IEEE Std 802.21b™-2012 - Media Independent Handover Services Amendment 2: Extension for Supporting Handovers with Downlink Only Technologies**  
  This amendment defines mechanisms that enable the optimization of handovers between IEEE 802.21 supported technologies and downlink-only (DO) technologies..

## IEEE 802.22

**802-WG22-1**

* **IEEE Std 802.22™-2011 - Cognitive Wireless RAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Policies and Procedures for Operation in the TV Bands**  
  This standard specifies the air interface, including the cognitive medium access control layer (MAC) and physical layer (PHY), of point-to-multipoint wireless regional area networks comprised of a professional fixed base station with fixed and portable user terminals operating in the VHF/UHF TV broadcast bands between 54 MHz to 862 MHz.
* **IEEE Std 802.22.2™-2012 Recommended Practice for Installation and Deployment of IEEE 802.22 Systems**  
  This document recommends best engineering practices for the installation and deployment of IEEE 802.22 systems to help assure that such systems are correctly installed and deployed.