

What is IEEE 802.24?

Contributors (Alphabetically)

- Bill Ash, IEEE-SA
- Phil Beecher, Beecher Communications
- John D'Ambrosia, Dell
- Subir Das, Applied Communications Sciences
- James Gilb, Tensorcom
- Tim Godfrey, EPRI
- Hiroshi Harada, NICT
- Bob Heile, Zigbee Alliance
- Farrokh Khatibi, Qualcomm Incorporated
- Bruce Kraemer, Marvell
- Apurva Mody, BAE systems

Outline

- Introduction to 802.24
- Smart Grid standardization outside of IEEE SA
 - SGIP, ITU-T, M490, etc. - Khatibi
 - Zigbee Smart Energy - Heile
 - Wi-SUN Alliance – Beecher
 - Regulatory and Interoperability for SUN in Japan - Harada
- Smart Grid efforts in IEEE SA - Ash
- Smart Grid applications in 802 WGs
 - 802.3 - D'Ambrosia
 - 802.11 - Kraemer
 - 802.15 - Beecher
 - 802.16 - Godfrey
 - 802.21 - Das
 - 802.22 - Mody
- Closing - Gilb

IEEE 802.24 Smart Grid TAG

- Formed in March 2012 as Smart Grid Executive Committee Study Group
 - Met at wireless interim meeting, May 2012
 - Met again at IEEE 802 plenary meeting, July 2012
- Approved as IEEE 802 TAG on 20 July, 2012.
 - Meet officially only at IEEE 802 plenary meetings
 - Conference calls as needed.

802.24's Smart Grid definition

- Derived from IEEE Std 2030
 - Smart Grid: The integration of power, communications, and information technologies for an improved electric power infrastructure serving users while providing for an ongoing evolution of end-use applications.

Scope of 802.24

- The 802 Smart Grid TAG
 - 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.

Smart Grid Standardization outside of IEEE

Farokh Khatibi

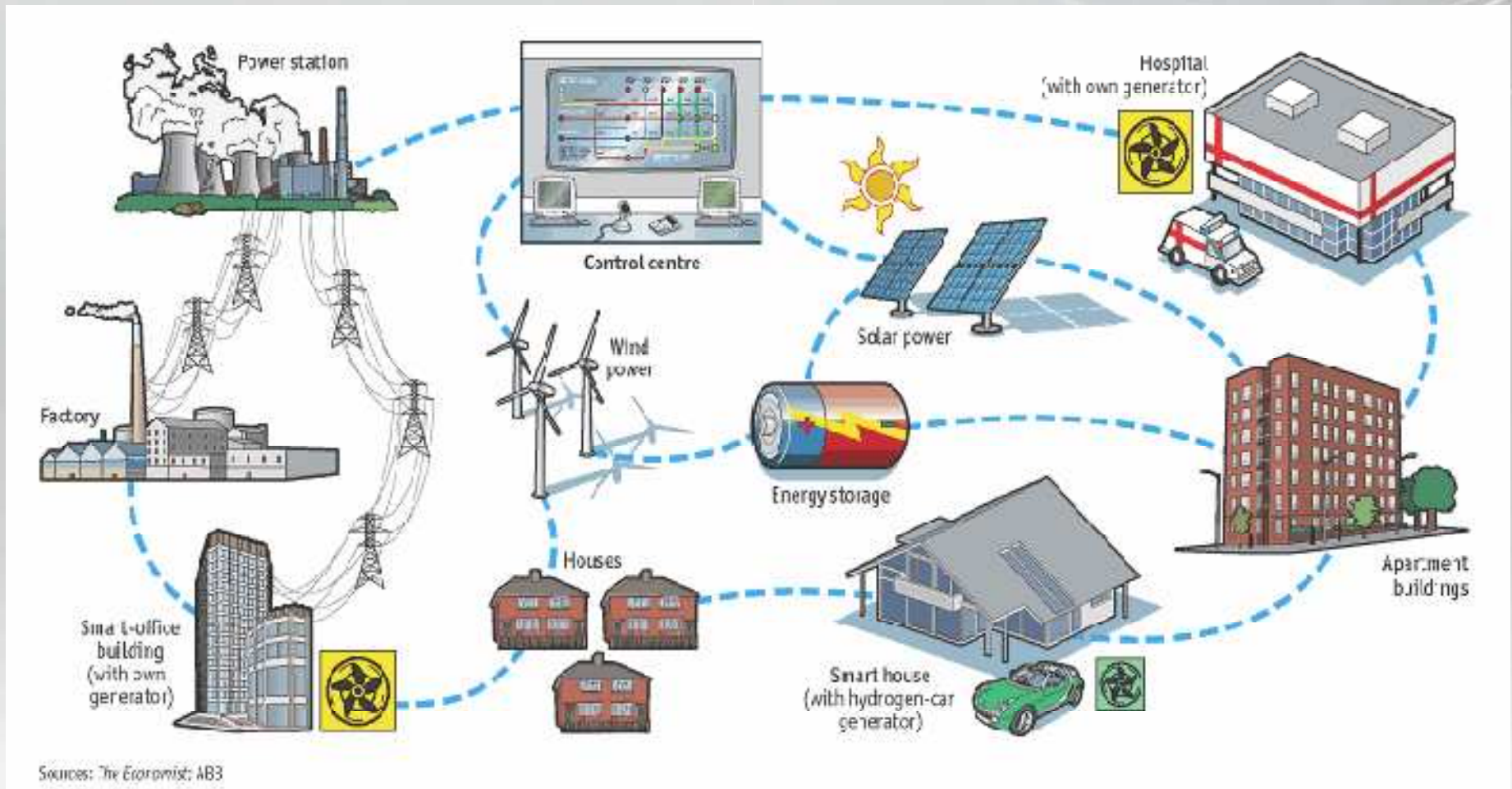
SmartGrid

Farrokh Khatibi
November 05, 2010

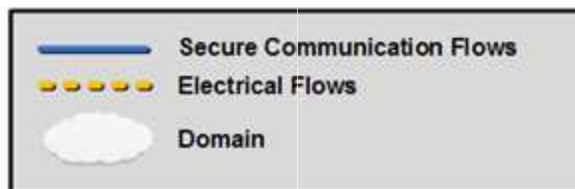
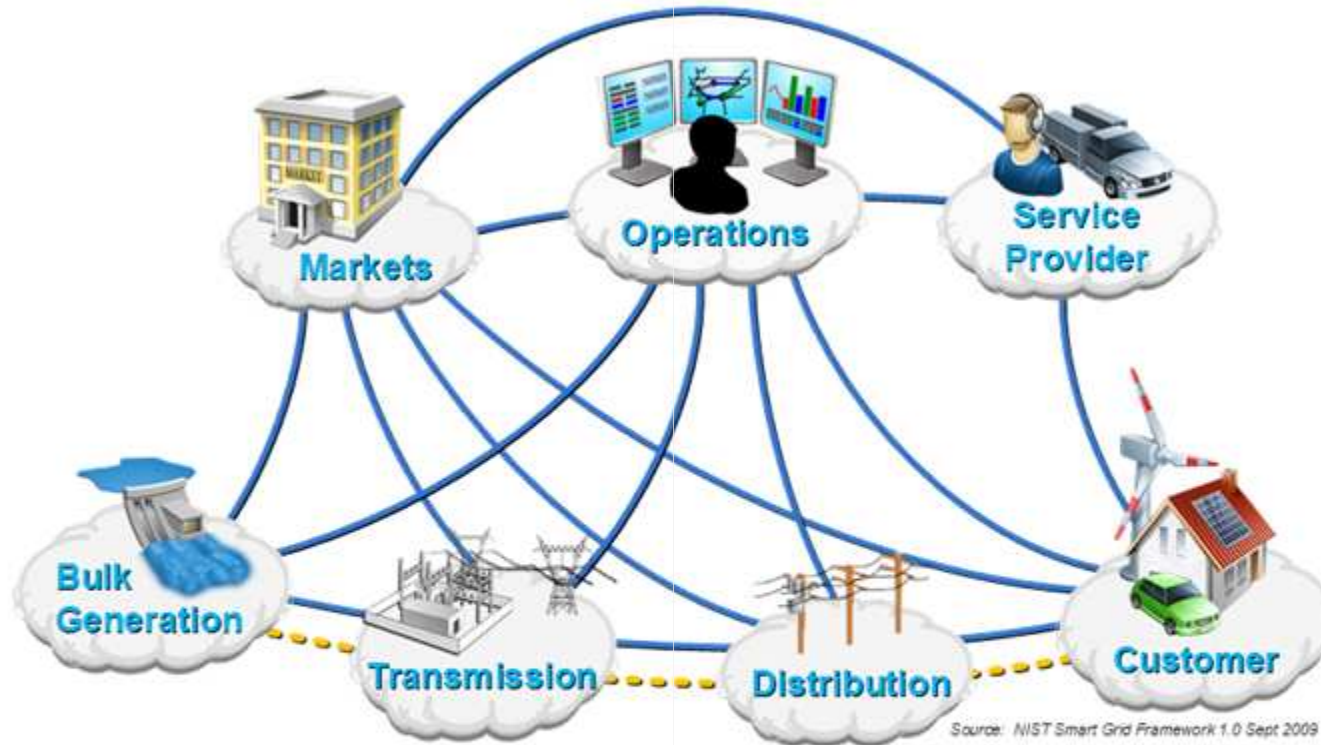
The Smart Grid = Electric Grid + Intelligence

- Concern over the environment (CO2 emissions), scarcity of resources (fossil fuels), safety (nuclear plants) are precipitating a universal move to re-examine the Electric Grid.
- The *smart grid* is defined as a radical evolution of the energy supply and consumption infrastructure that will provide providers and consumers with unprecedented levels of reliability and control while reducing the adverse environmental impact of energy generation and consumption
- A smart grid delivers electricity from suppliers to consumers. It also enables two-way digital technology to control appliances at consumers' homes to save energy, reduce cost and increase reliability and transparency.
- Smart meters are part of a smart grid, but alone do not constitute a smart grid.

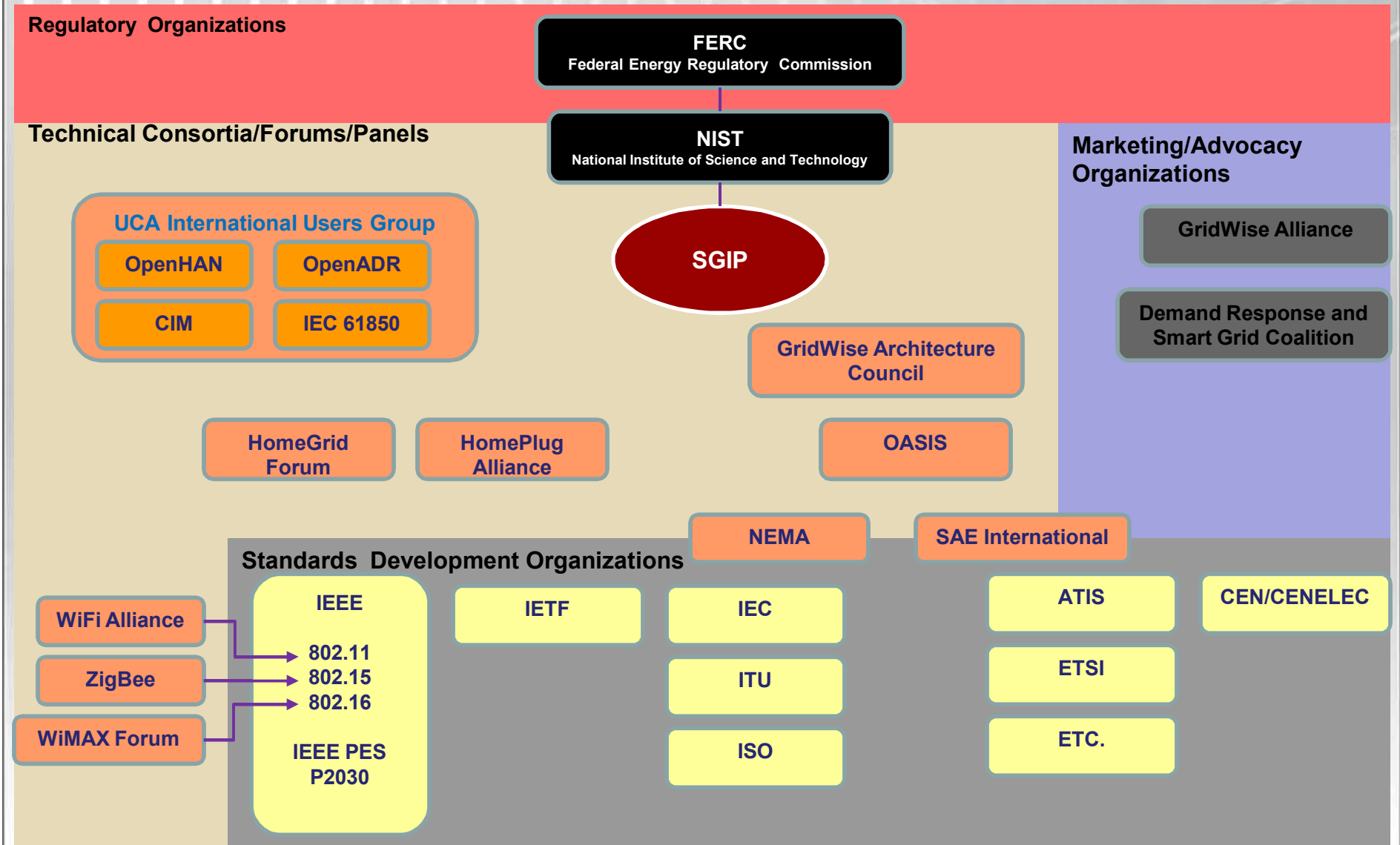
The Smart Grid = Electric Grid + Intelligence (cont.)



Conceptual Model



Smart Grid Standards Environment



Smart Grid Interoperability Panel (SGIP)

*Energy Independence and Security Act (EISA) of 2007
Title XIII, Section 1305. Smart Grid Interoperability Framework*

- In cooperation with the DoE and other stakeholders, **NIST** has “primary responsibility to **coordinate development of a framework** that includes protocols and model standards for information management **to achieve interoperability of smart grid devices and**

#	Priority Action Plan	#	Priority Action Plan
2	Wireless Communications for the Smart Grid	5	Standard Meter Data Profiles
6	Common Semantic Model for Meter Data Tables	7	Electric Storage Interconnection Guidelines
8	CIM for Distribution Grid Management	9	Standard DR and DER Signals
10	Standard Energy Usage Information	12	Mapping IEEE 1815 (DNP3) to IEC 61850 Objects
13	Harmonization of IEEE C37.118 with IEC 61850 and Precision Time Synchronization	14	Transmission and Distribution Power Systems Model Mapping
15	Harmonize Power Line Carrier Standards for Appliance Communications in the Home	16	Wind Plant Communications
17	Facility Smart Grid Information Standard	19	Wholesale Demand Response (DR) Communication Protocol
20	Green Button ESPI Evolution		

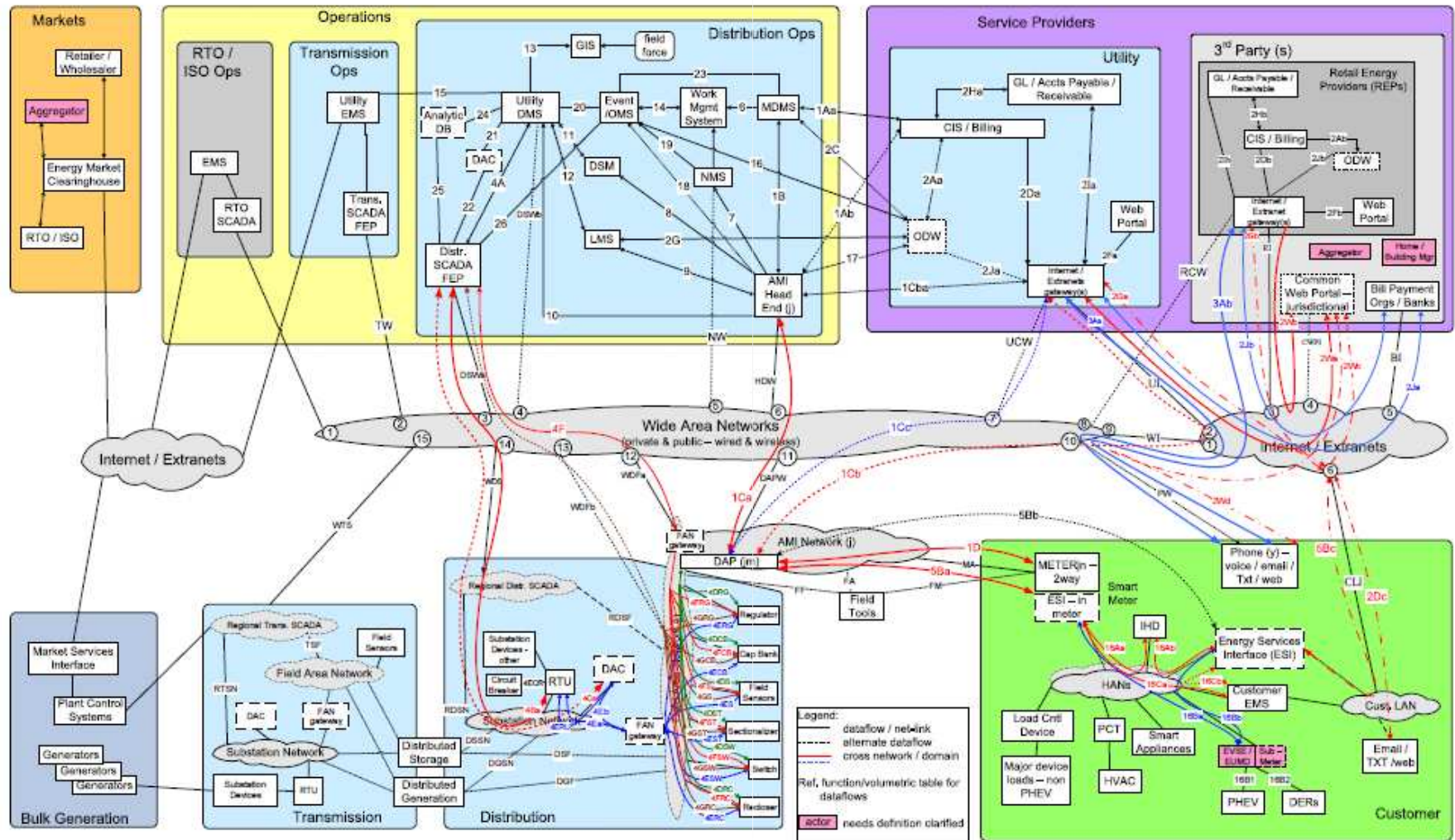
Source [SGIP](#)

SGIP 2.0

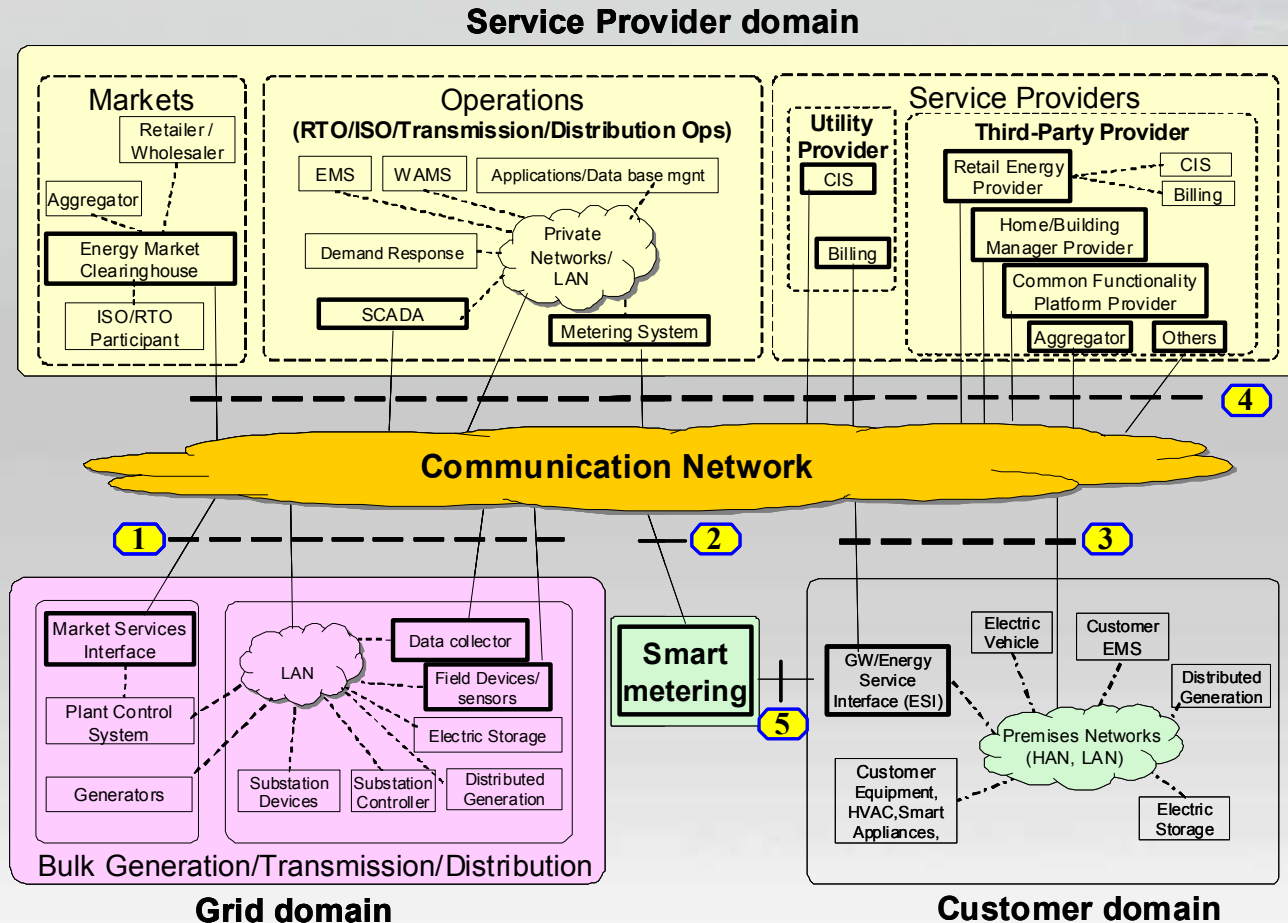
At the December 2011 SGIP Governing Board meeting, George Arnold, National Coordinator for Smart Grid Interoperability at NIST, requested the SGIP Governing Board to begin planning for the SGIP's transition into a legal entity funded primarily by the private sector and with a continuing, but reduced level of federal funding beginning January 2013.

- SGIP 2.0 will be a tax-exempt legal entity
- Starting in January 2013, membership in the SGIP will require the payment of dues by member organizations.

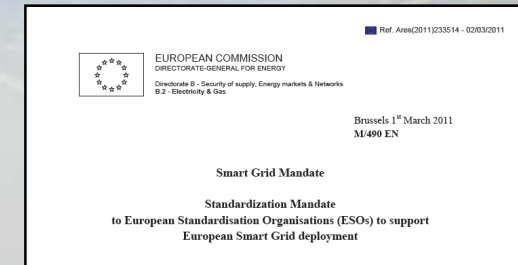
SG Network Architecture



ITU-T Reference Architecture



European Commission Smart Grid Mandate M/490



To be coordinated with the outcomes of the existing mandates M/441 (smart metering) and M/468 (electric vehicles)

- The M/490 Mandate, as issued, expires on 31 December 2012;
- Mandate Iteration (i.e., extend the term and scope of the M/490 mandate) was agreed on 23 October 2012.

Main strands of the mandated work

- **Technical Reference Architecture**
to represent the functional information data flows between the main domains and integrate many systems and subsystems architectures.
- **Set of Consistent Standards**
to support the information exchange (communication protocols and data models) and the integration of all users into the electric system operation.
- **Sustainable standardization processes**
and collaborative tools to enable stakeholder interactions; a first set of Use Case management.
- **Smart Grid Information Security**
integration of Security into all aspects of the Smart Grid Architecture.

EU Smart Grid Co-ordination Group (SG-CG)

JWG continues as SG-CG; in essence, the SG-CG role is to ensure that:

- the M/490 process is transparent
- the widest group of stakeholders is represented
- the deliverables meet the requirements of the mandate & stakeholders

The SG-CG will:

- Further maintain the report on smart grid standardization in Europe.
- Manage the whole work process concerning the smart grid mandate and clarify non-technical questions to avoid unnecessary discussions in technical groups
- Provide a suitable platform for discussion of smart grid standardization-related issues with the ESOs and European Commission
- Etc.



But , the SG-CG shall not itself produce standardization deliverables.

Relevant Links

- [SGIP PAP02 Twiki](#)
- OpenSG SG Network System
 - [Requirements Specification 5.1 \(.xls\)](#)
 - [Requirements Database Usage \(.doc\)](#)
 - [SG NET Diagram \(.vsd\)](#)
- [ITU-T Focus Group on Smart Grid \(FG Smart\)](#)
- [ITU-T Focus Group on M2M Service Layer \(FG M2M\)](#)
- [ETSI M2M M490 Deliverables](#) (requires password)

Zigbee Smart Energy

Bob Heile

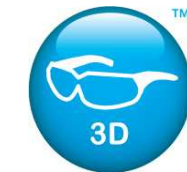


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Smart Energy Standards





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Smart Energy & Home Automation



***Urgent need for residential demand response
+ compatibility with mainstream Home Automation systems
drove the development of the Smart Energy Standard***





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ZigBee Smart Energy Standard Key Functions

- High performance link security
- Pricing Communication
- Demand Response and Load Control
- Metering / Energy Usage Information
- Messaging
- Pre-Payment
- Plug-In Electric Vehicles
- Distributed Energy Resources
- Billing
- Firmware Download
- Time
- Support for electric, water, & gas





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ZigBee Smart Energy Versions

- ZigBee Smart Energy 1.x
 - Operates with ZigBee PRO stack and IEEE802.15.4
 - In widespread global deployment today
- Smart Energy Profile 2.0 (SEP2)
 - Operates with an Internet Protocol based Stack
 - Can be used with several IP compatible communications protocols, wired and wireless
 - Currently in multi vendor interoperability testing phase with completion expected later this year
- Over the Air Updater capability supported in both versions for remote migration from one environment to the other within the same communications protocol
- ZigBee Smart Energy being developed in conjunction with a global community of stakeholders using an open consensus process



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Smart Energy Profile 2.0

- IP based version of ZigBee Smart Energy
- MAC/PHY (link layer) independent – intended to run over generic Internet Protocol stack
- Range of backhaul (AMI, Internet, etc.) bandwidths and cost kept in mind during development
- Developing with several organizations including:
 - ZigBee Alliance
 - HomePlug Powerline Alliance
 - Wi-Fi Alliance
 - EPRI
 - SunSpec Alliance
 - SAE
 - IETF
 - UCAIug



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Smart Energy Profile 2.0

- Selected by US NIST as one of 16 “Low Hanging Fruit” for the Smart Grid
- Key stakeholder in US NIST PAPs 3, 4, 9, 10, 11, 18
- Working closely with SAE on vehicle communications
- Designed to exploit the benefits of wireless and wired
- Continuing trend of reaching out to market (AHAM, IEC, EPRI, SAE, ESMIG, ...)
- Continuing to add new features (PEVs, MDUs, etc.)



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(Some) Goals of SEP 2.0

- IP stack / Link Layer (MAC/PHY) Agnostic – runs over ZigBee, HomePlug, Wi-Fi, Two Cans and a String, ...
- Smart Energy Profile information model clearly described in UML
- Information model objects derived from IEC CIM (61968) and 61850
- RESTful HTTP architecture
- “Standards Selection” (IETF, IEC, etc.) as opposed to “Standards Definition”
- SDO feedback
- Well-defined end-to-end architecture
- Continuing momentum

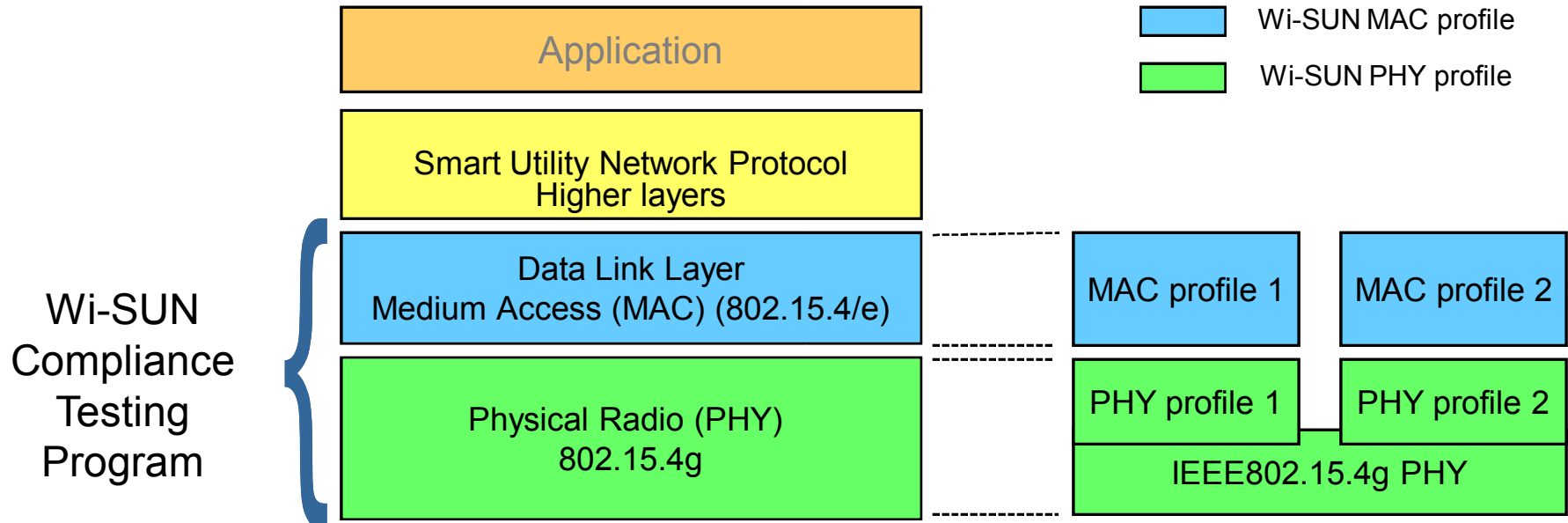
Wi-SUN Alliance

Phil Beecher

Wi-SUN Alliance

- Wi-SUN Alliance was formed specifically to focus on Wireless Smart Utility Networks and particularly for 802.15.4g applications
- Wi-SUN Alliance is focusing on
 - specifying PHY and MAC functionality (Profiles) required for variety of Smart Utility Network Applications, and...
 - Developing Conformance and Interoperability Test Plans for these profiles.
- Further information at www.wi-sun.org

Wi-SUN Alliance Scope



- Wi-SUN Alliance develops specifications of Physical Layer (PHY) and Medium Access Control (MAC) layers (profiles) for specific Smart Utility Network Application Domains
- Develops Conformance and Interoperability Test Programs for defined “profiles”
- Wi-SUN Physical layer profiles are derived from IEEE802.15.4g PHY with options defined by Use cases for Application Domain (and Regulatory Constraints)
- Wi-SUN MAC layer profiles dependent on Application Domain and Regulatory Constraints

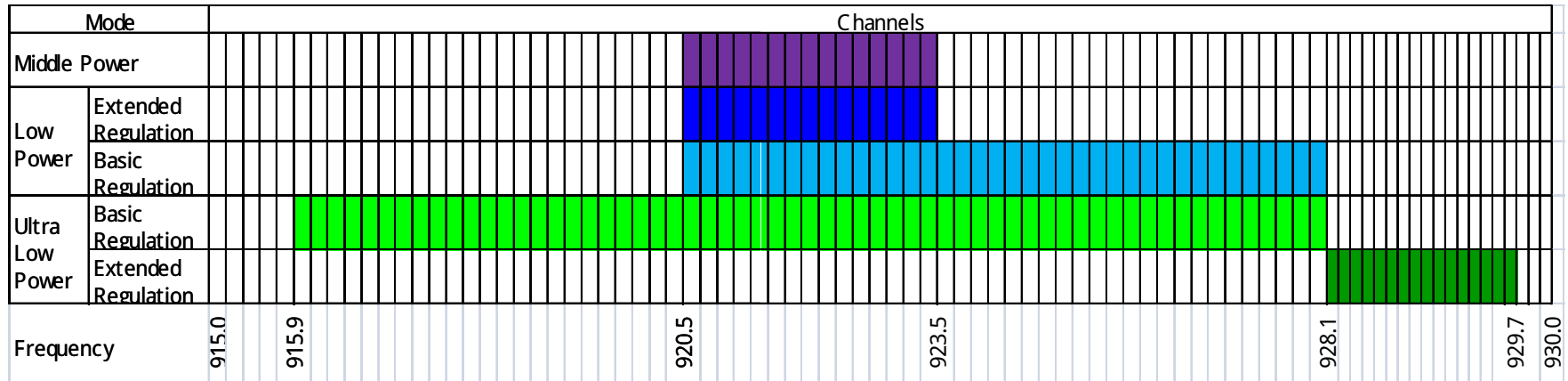
Regulatory and Interoperability for Smart Utility Networks in Japan

Hiroshi Harada

Regulatory and Implementation in Japan: Status

- 700-900MHz reallocation plan and issued and 920 MHz band (920.5 - 928.1MHz) band has been assigned for Smart metering SUN and 802.15.4g based system is one of big candidates
(See Doc. 15/11-510-r4)
- Large utility users such as TEPCO and Tokyo Gas are preparing their smart metering network for AMI and HEMS. ECHONET lite protocol stack is a big candidate for upper layer protocol stack for HEMS
- Important issues on AMI and HEMS introduction is interoperability between wireless devices
- Wi-SUN alliance has strongly involved to provide the interoperability test plan and has successfully finished the first interoperability plug festa on Aug. 2012

Channel Plan and output power in 920MHz Band

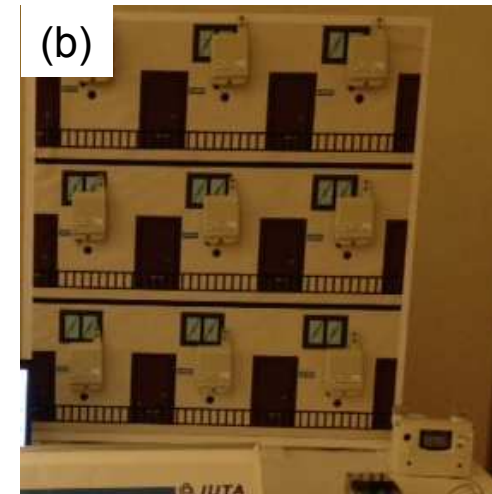


- 5 Regulatory Mode
 - Middle Power Mode ($\leq 250\text{mW}$)
 - 920.5 - 928.1MHz
 - Low Power Mode ($\leq 20\text{mW}$)
 - Basic Regulation
 - Extended Regulation
 - 920.5 - 923.5MHz
 - Ultra low Power Mode ($\leq 1\text{mW}$)
 - Basic Regulation
 - 915.9 - 928.1MHz
 - Extended Regulation
 - 928.1 - 929.7MHz

Middle Power Mode

- Frequency: 920.5 - 928.1MHz
- Antenna Power:
 - $\leq 20\text{mW}$ ($920.5\text{MHz} \leq f \leq 928.1\text{MHz}$)
 - $\leq 250\text{mW}$ ($920.5\text{MHz} \leq f \leq 923.5\text{MHz}$)
- Antenna Gain: $\leq 3\text{dBi}$
- Channel Width: 200kHz*n (n=1-5)
- Adjacent Channel Leakage Power:
 - 15dBm (Output Power $\leq 20\text{mW}$)
 - 5dBm (Output Power $> 20\text{mW}$)
- Carrier Sense Level: -80dBm

Implementation examples



- a) NICT
- Multi-purpose smart metering systems based on 802.15.4g and 802.15.4e (LE superframe) (Meters and Dosimeter...)
- b) JUTA: Japan Utility Telemetry Association
- U-Bus Air: Ubiquitous metering systems for gas meter based on 802.15.4g
- c) Interoperability plug festa of Wi-SUN alliance
- World's first plug festa for interoperability of 802.15.4g/4e based systems



IEEE-SA Smart Grid Activities

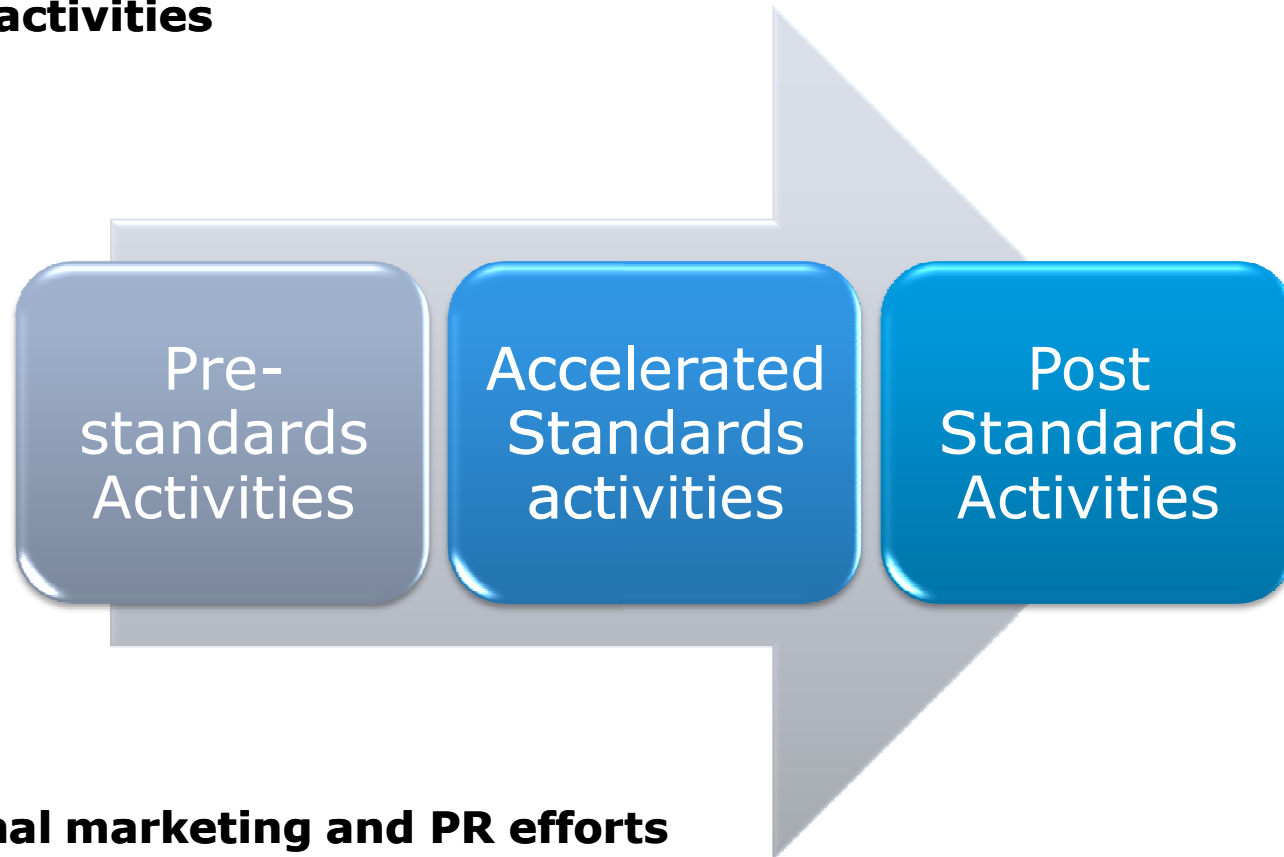
Bill Ash

IEEE-SA Smart Grid



IEEE-SA Smart Grid

Support full life cycle of standards to develop a pipeline of standards related activities



International marketing and PR efforts

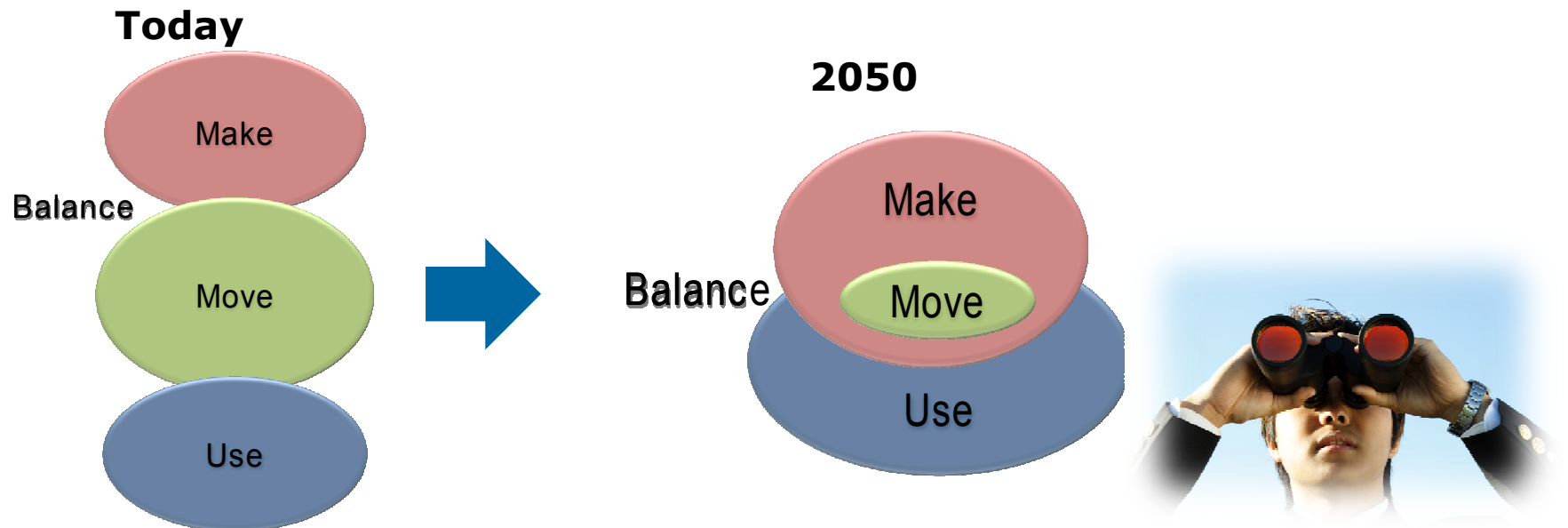
Increase awareness and participation in the IEEE-SA SG activities: China, India, Japan, Korea, Germany, No. America

Form strategic partnerships; build collaboration and cooperation:

International and regional SDOs, Industry forums, Gov.

Pre-standards Activities

- IEEE Smart Grid Visions for Communication, Power, IT, Control Systems, and Vehicular Technologies.
- Long term visions of what the smart grid in each technology space will look like 20 to 30 years out.
- Forward looking use cases, applications scenarios for SG, and corresponding enabling technologies for SG of the future snap shots of years 2015, 2020, 2030, and beyond

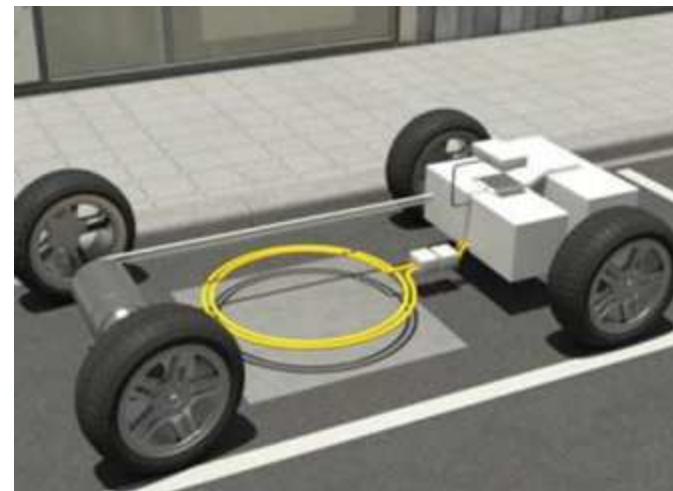
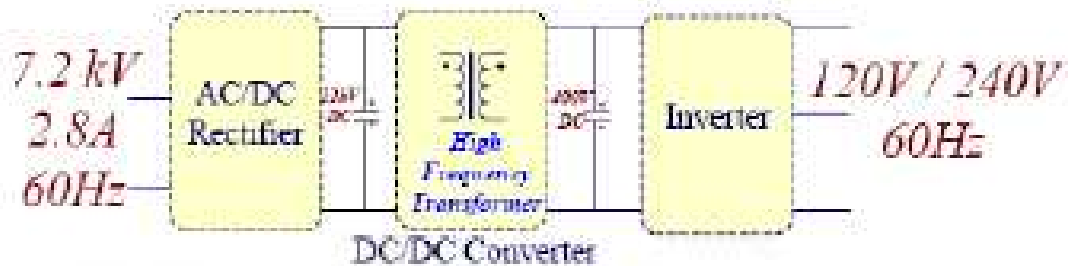


IEEE Smart Grid Research Technology Initiatives



- Electric Vehicles/Wireless Power Transfer
- Power Magnetics/Power Electronics for Distributed Resources
- Data Analytics
- Nano and Molecular Communications

➤ Solid State Transformer (SST)



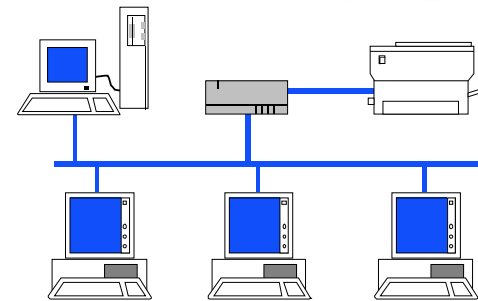
Standards Acceleration

❖ Standards Acceleration

- Implement support services to facilitate the acceleration of standards development, approval, and publication
- <http://smartgrid.ieee.org/>

Some Areas Covered

- Interoperability
- Networking and Communications (including the home)
- Cyber Security
- Substations Automation
- Distribution Automation
- Renewables
- AMI
- Power Quality and Energy Efficiency
- Electric Vehicles



IEEE-SA Smart Grid – Cont.

- ❖ Post-standards activities
 - Enable SG interoperability and market acceptance via support and/or creation of: Market implementation activities; Conformity assessment programs; Testing & Certifications; Branding; etc.





Thank You!

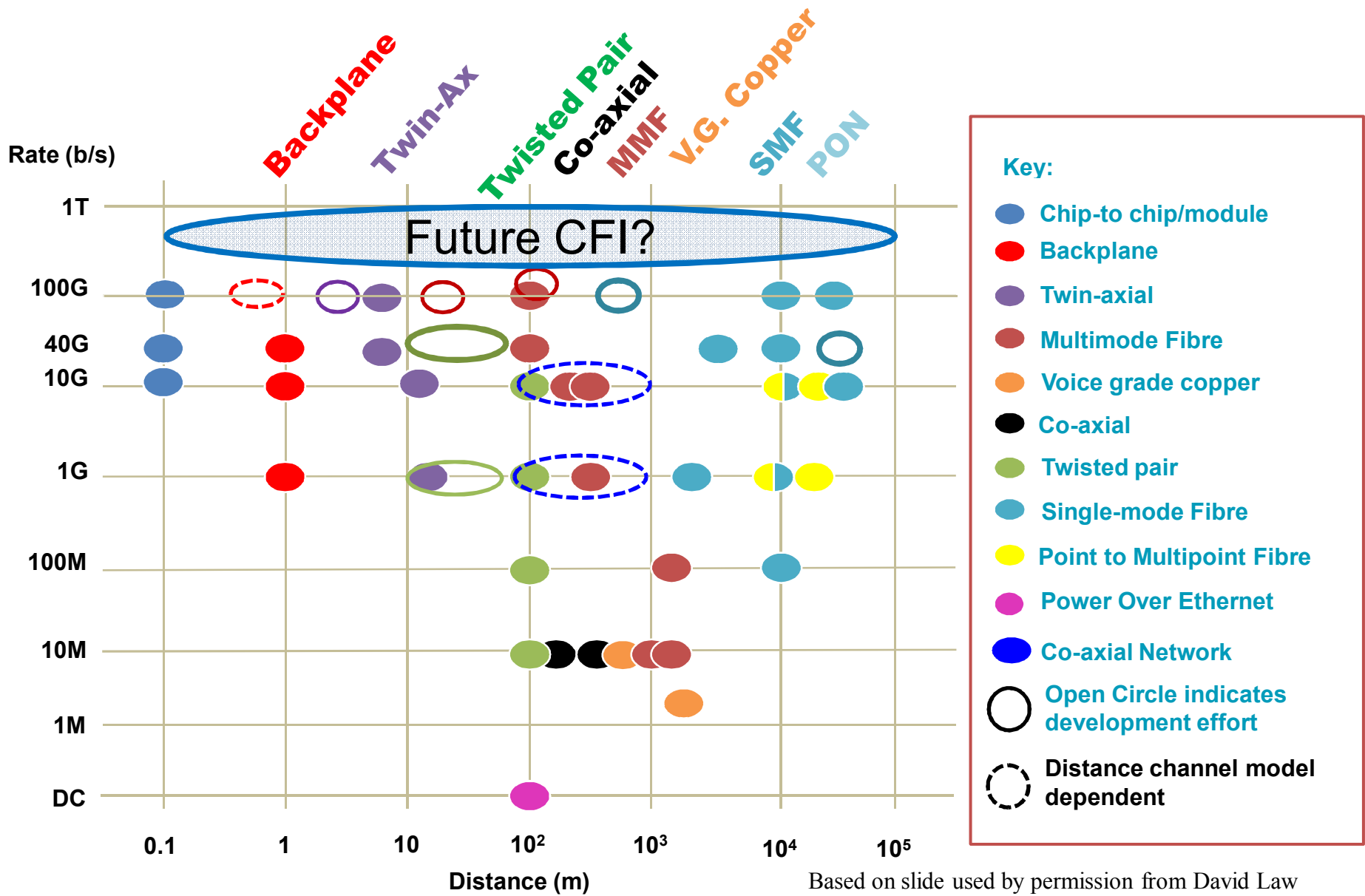
Bill Ash
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IEEE Standards Association
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November 2012

Smart Grid in IEEE 802.3

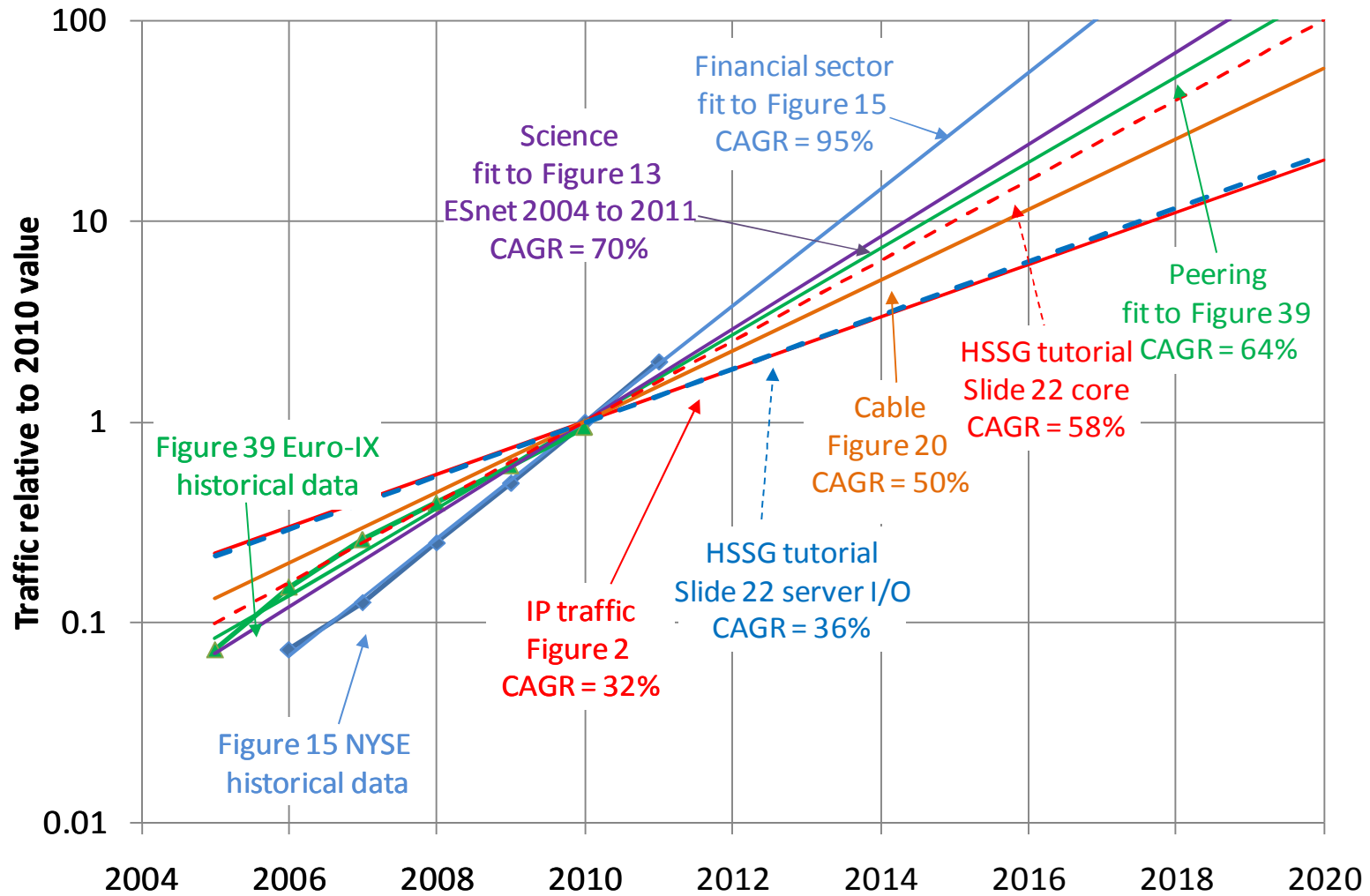
John D'Ambrosia

IEEE 802.3 Working Group

- Develops Standards for Ethernet based networks
- Expanded beyond its Enterprise roots.
- Examples include:
 - At the component level
 - The Data Center Network
 - Transportable over OTN
 - Access Networks
 - Automotive / industrial
- <http://grouper.ieee.org/groups/802/3/index.html>



Bandwidth Growth Rate Trends

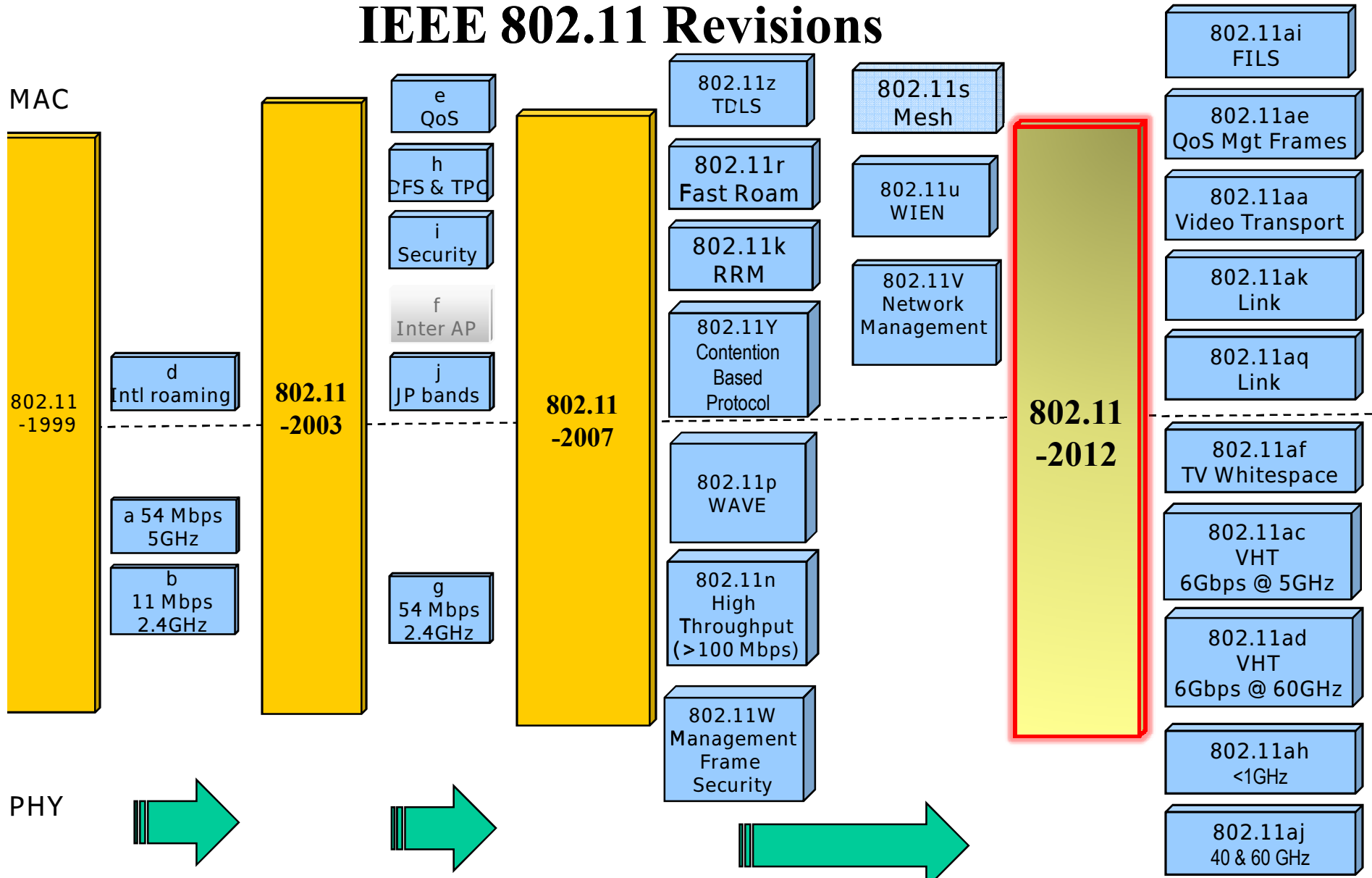


Source: http://www.ieee802.org/3/ad_hoc/bwa/BWA_Report.pdf

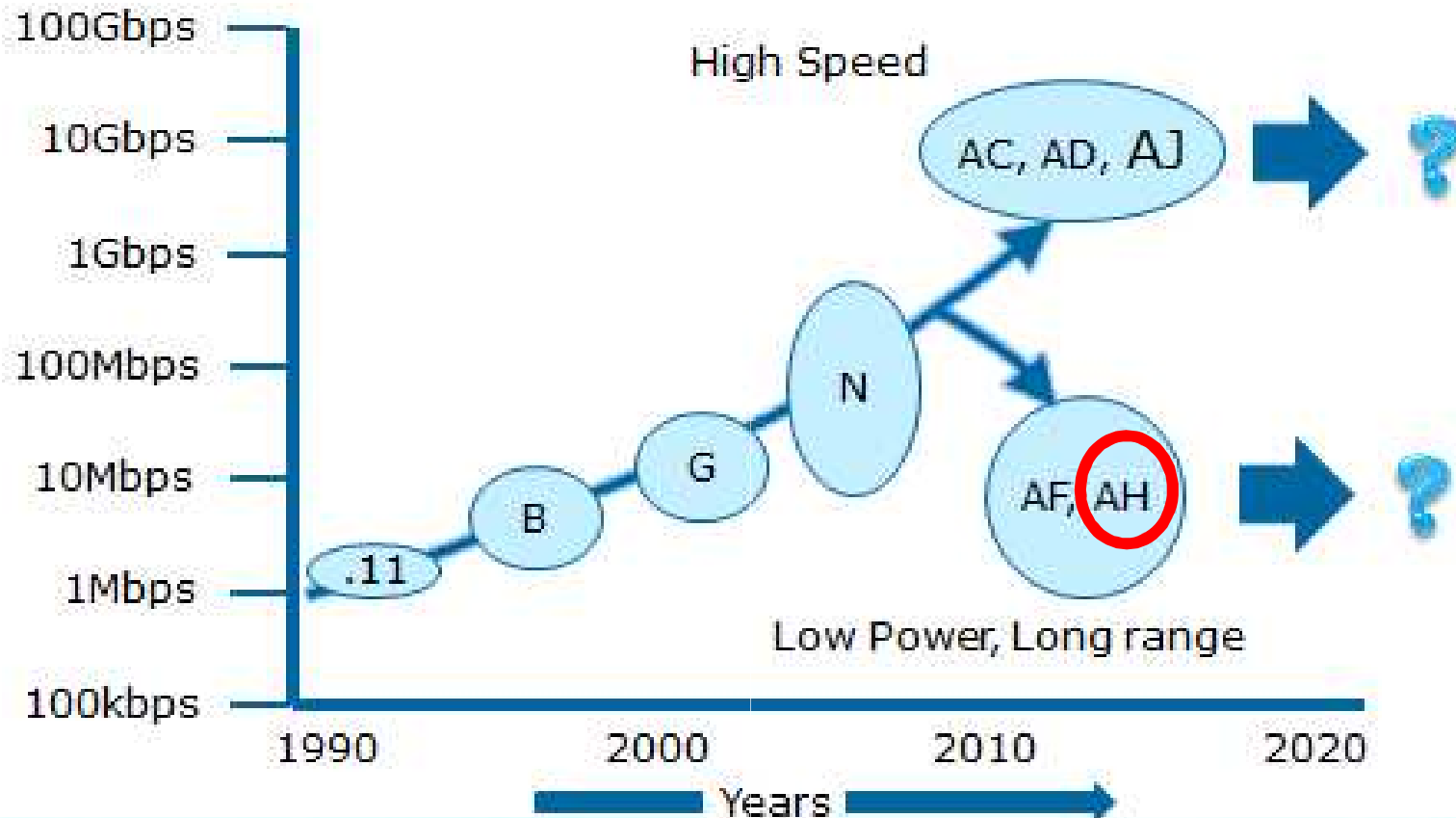
Smart Grid in IEEE 802.11

Bruce Kraemer

IEEE 802.11 Revisions



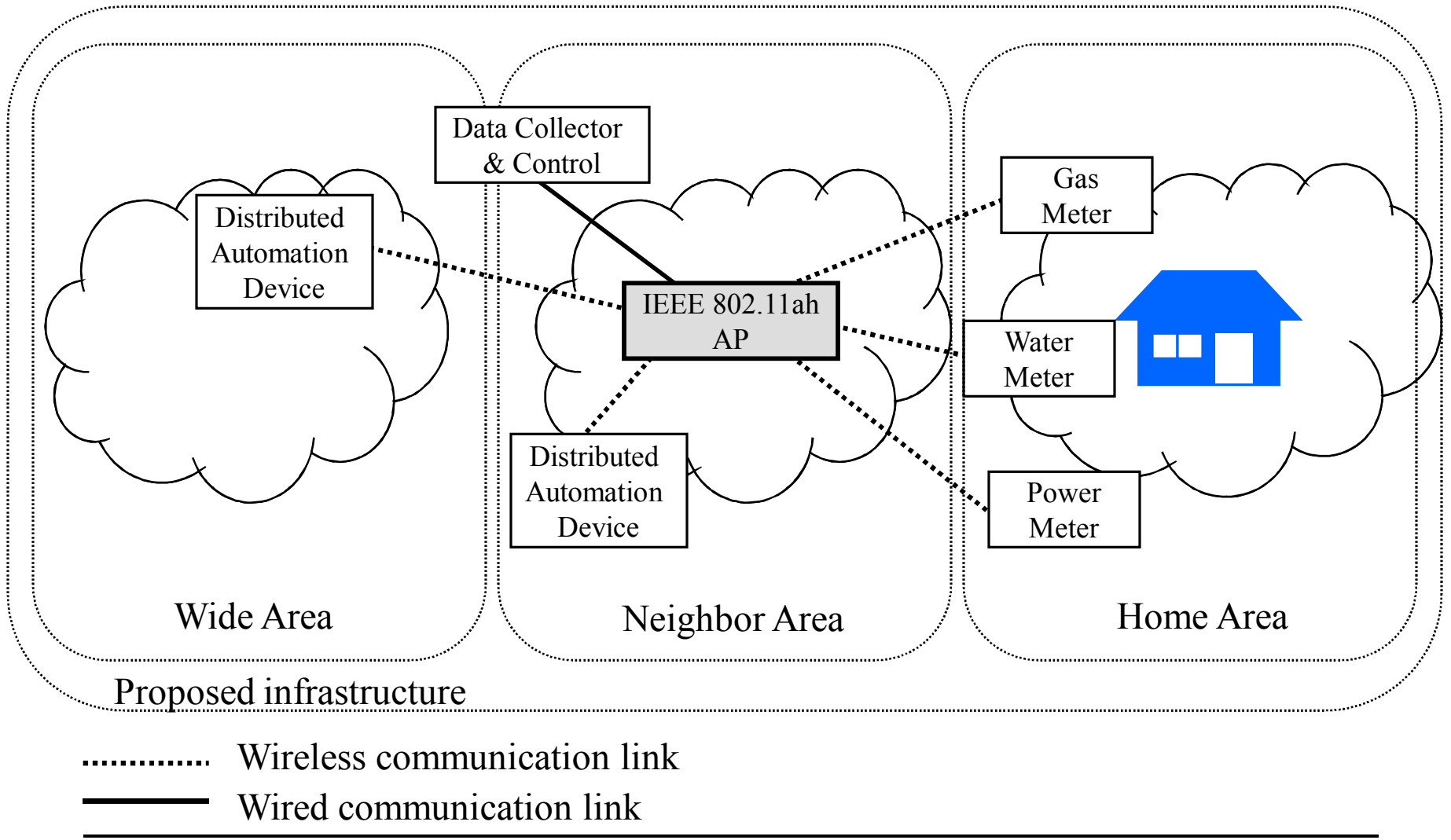
802.11 Data Rate Options



Use Case Categories

- **Use Case 1 (a-h) : Sensors and meters**
- **Use Case 2 (a-b) : Backhaul Sensor and meter data**
- **Use Case 3 (a-b) : Extended range Wi-Fi**

Use Case 1a: Smart Grid – Meter to Pole



Use Case 1a: Smart Grid – Meter to Pole : Requirements

#	Category	Comment
1	Location	Outdoor, indoor
2	Environment type	Urban, sub-urban, rural
3	STA/AP communication	2-way (meter data & control)
4	Data rate	100 kbps
5	BER/PER requirement	PER<10%
6	Mobility	Stationary
7	Traffic type	Continuous/periodic/burst
8	Security requirement	High
9	Reliability	High
10	STA/AP capacity	STA (outdoor): 6000 [4], :AP: 1
11	STA/AP category	STA: fixed (outdoor/indoor), AP: fixed (outdoor)
12	STA/AP elevation	STA: 1m,...,10m [8], AP: 2m,...,30m [8]
13	Actors	Meter device (power, gas, water), Distributed Automation Device, IEEE 802.11ah AP

Use Case 2 : Backhaul Sensor/Meter data

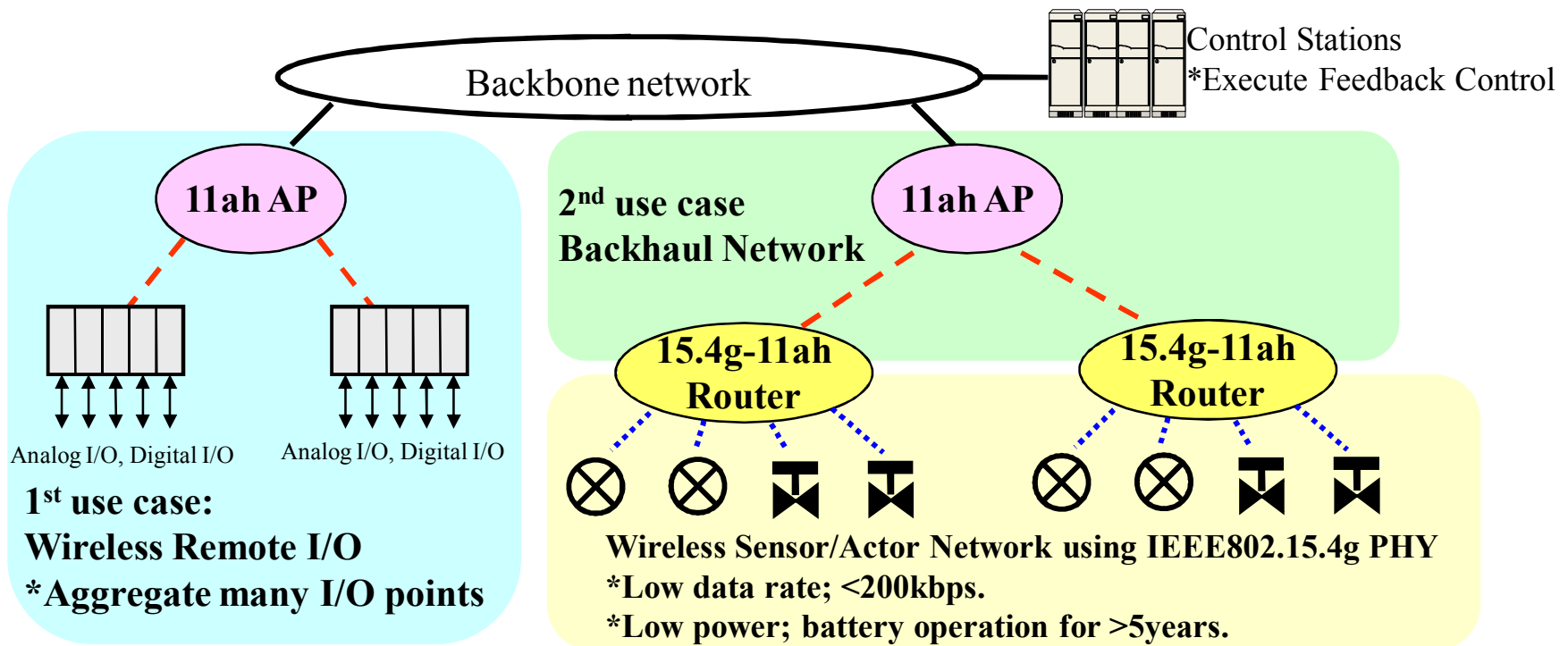
- **11/14r2, slide 5** **Backhaul aggregation of sensors**
- **11/260r1, slide 4** **Backhaul aggregation of industrial sensors**

Use Case 2a : Backhaul link for 15.4g

- IEEE802.15.4g provides a link for lower traffic leaf sensor with battery power constraints.
- IEEE802.11ah is going to provide an mode of operation that supports a backhaul link to accommodate;
 - **the aggregated traffic of leaf sensors,**
 - **and stream of camera images or surveillance videos.**
- IEEE802.11ah will **co-exist** with 15.4g.

Use Case 2b : Backhaul for industrial process automation

- 1st use case is wireless remote I/O.
- 2nd use case is wireless backhaul network for wireless sensor / actor network (WSAN).



TGah & SmartGrid

- From [requirements](#), include changes in MAC and PHY that allow:
 - Greater distance
 - Lower power consumption
 - Access Point support to more than 2007 clients
- From [use cases](#), traffic may be characterized by:
 - Periodic, low duty cycle
 - Higher uplink traffic rather than downlink
- Throughput can be sacrificed to achieve requirements and use cases

PHY (examples)

- **Use spectrum below 1 GHz for better free space propagation**
 - Greater distance, lower power consumption
- **Smaller channel widths provide for**
 - Greater distance
 - Lower power consumption
 - Better use of limited unlicensed bandwidth available below 1 GHz
- **P802.11ac down-clocked by 10**
 - 20/40/80/160 MHz -> 2/4/8/16 MHz
 - 1 MHz wide achieved by using 32 FFT
 - 2x block wise repetition for lowest 1 MHz rate

MAC (examples)

- **Increase efficiency of MAC**
 - Decrease size of frame overhead
- **Reduce power by extending sleep time**
- **Create new sensor device/traffic type**
 - Increase client per AP
 - Channel access changes for periodic traffic
 - Traffic Indication Map (TIM) operation changes

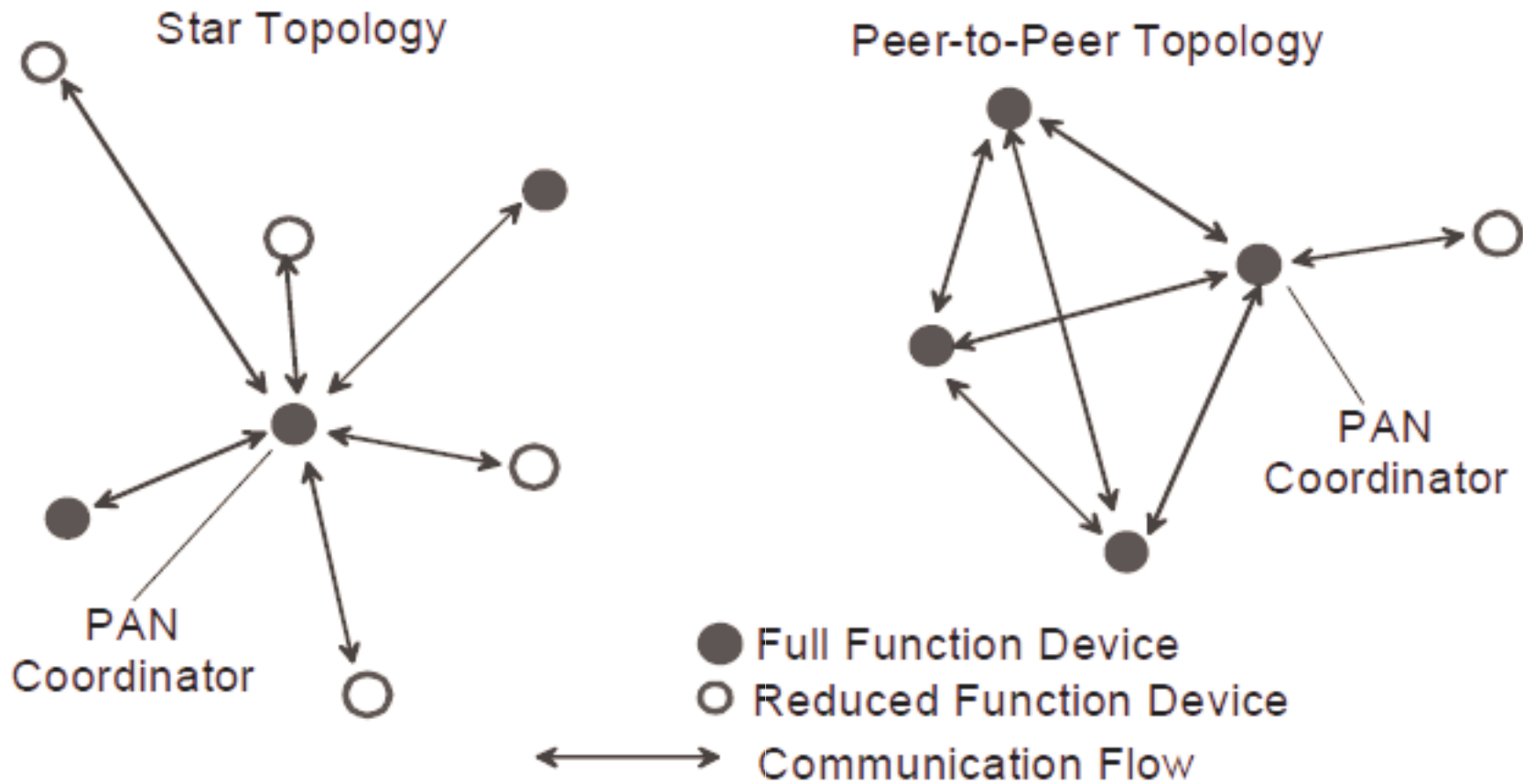
Smart Grid in IEEE 802.15

Phil Beecher

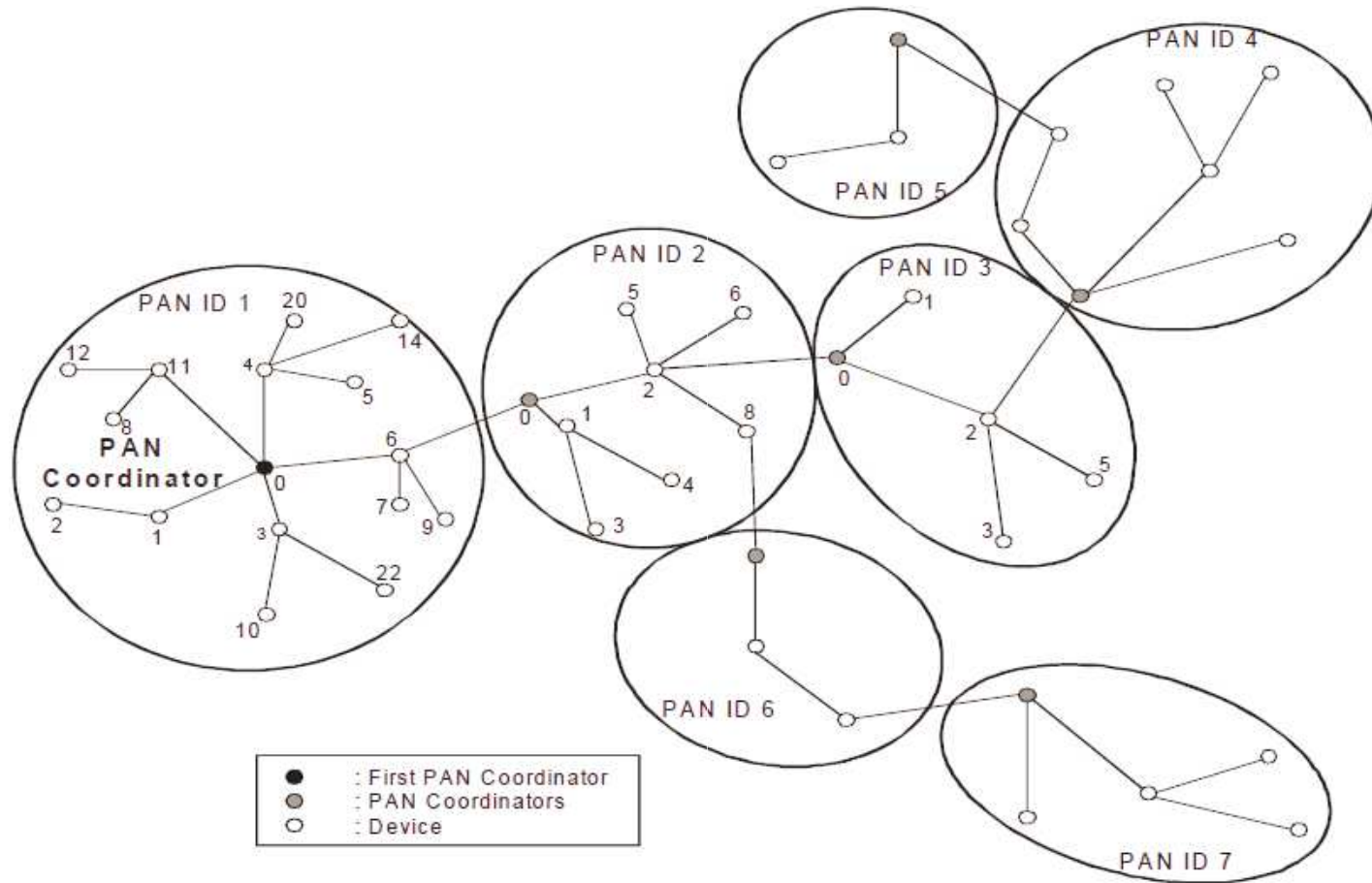
802.15.4-2011 Characteristics

- PHY Features (2.4GHz DSSS)
 - 2.4GHz Global ISM band
 - Direct Sequence Spread Spectrum OQPSK Modulation
 - 127 octet Frame Size
 - 2 octet Frame Check Sequence
 - 250 kbps data rate
- MAC Features
 - Support for Star and Peer to Peer Network Topologies
 - 2 octet PAN identifier
 - Short or Extended Device Addresses
 - Beacon enabled or non-beacon enabled networks
 - Mechanisms for supporting low energy operation
 - Ideally suited for Battery applications, particularly for End devices (leaf nodes)
- Security Features
 - AES / CCM*
 - Data confidentiality
 - Data authenticity
 - Replay protection

802.15.4 Network Topologies



802.15.4 Cluster Tree



802.15.4g Technical Characteristics

- PHY Amendment to 802.15.4 supporting a range of PHY operating modes and data rates, specifically targeting Smart Utility Network applications such as AMI and DA.
- Proven RF technology
- 50kbps FSK mandatory mode
- Flexibility to support additional data rates
- Support for global and regional frequency bands
- Robust error detection (4 octet Frame Check Sequence)
- Optional forward error correction
- Large frame sizes supporting IP

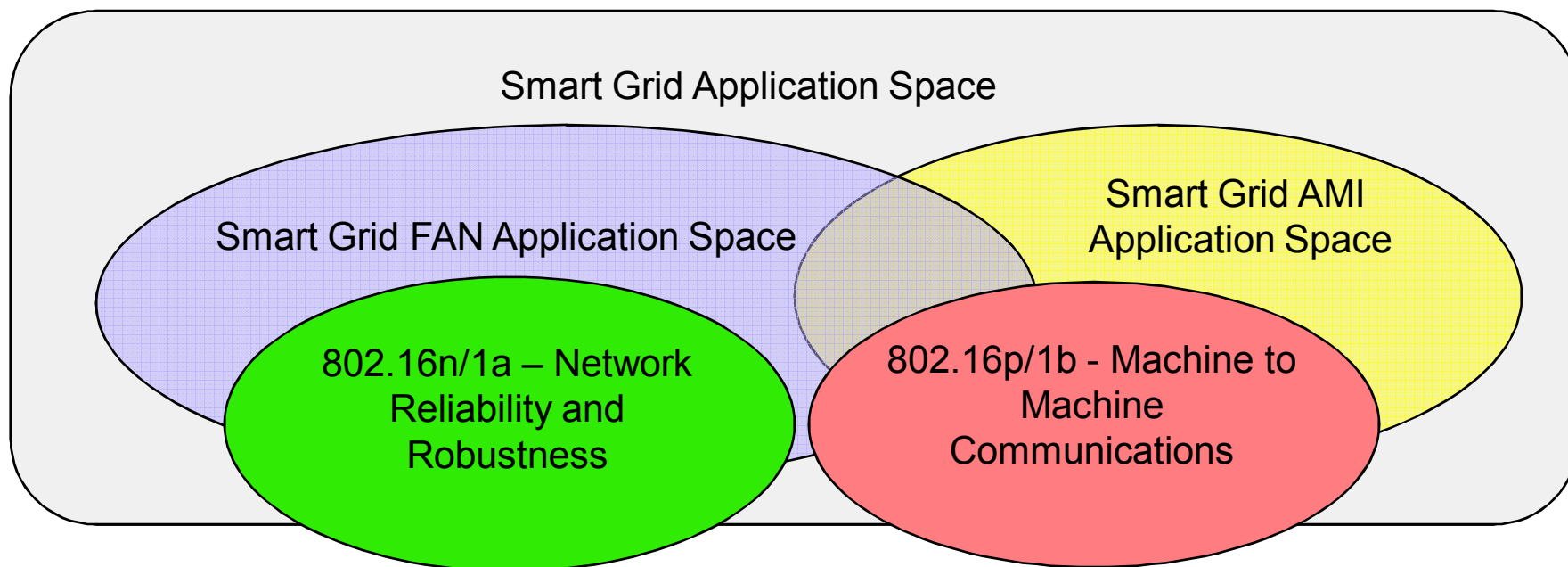
802.15.4g Applications

- There are a wide range of requirements for different Smart Utility Network Applications, e.g. :
 - Advanced Metering Infrastructure
 - Demand/Response
 - Distribution Automation
 - Gas and water metering
- These applications lead to a variety of communication requirements
- 802.15.4g PHY implementations with appropriate MAC options and higher layers can support these application needs

Smart Grid in IEEE 802.16

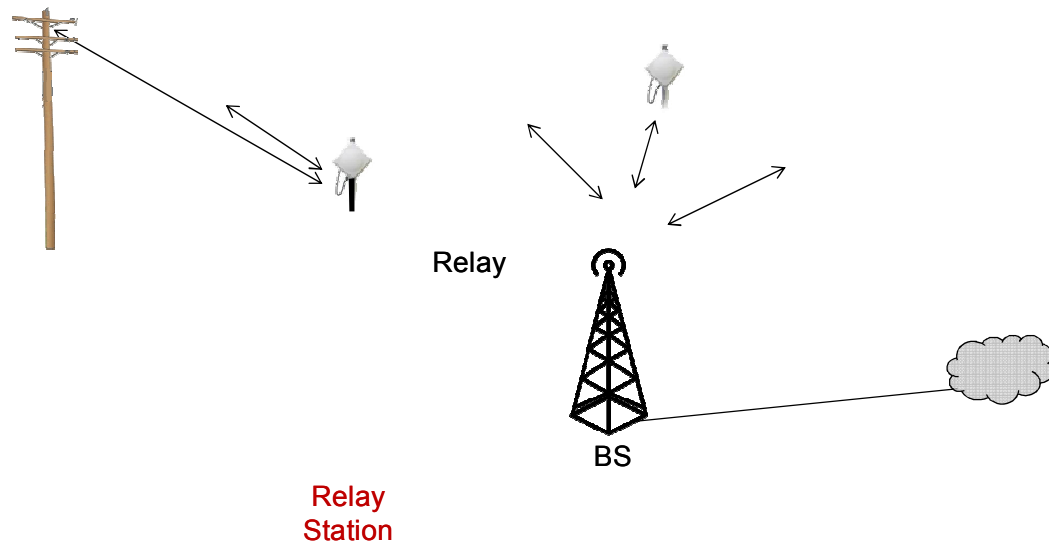
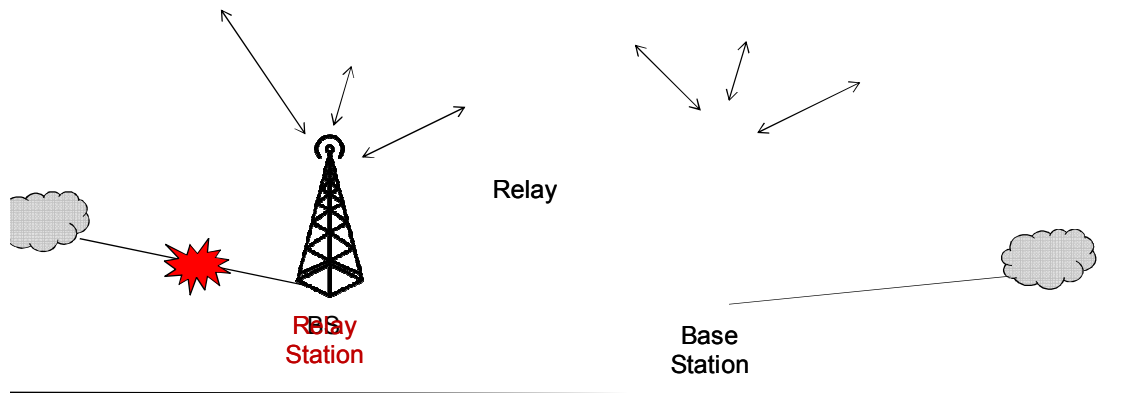
Tim Godfrey

802.16: GRIDMAN and M2M



- 802.16n / 16.1a (GRIDMAN) – Reliability and robustness
- 802.16p / 16.1b (M2M) – Machine to Machine enhancements
- Each task group addresses unique Smart Grid requirements
- Scoped to minimize overlap

GRIDMAN : High Reliability Field Area Network



- Base Station becomes Relay station upon failure of backhaul
- “Mobile” station becomes relay station upon failure of Base Station

802.16: Other areas

- 802.16p / 16.1b M2M
 - Application areas
 - AMI – WiMAX to the meter
 - Sensors and DA devices
 - Key features:
 - Low power – enhanced sleep
 - More devices per BS
- 802.16q Heterogeneous Networks
 - Utility Grid Networks are already heterogeneous: Wired, wireless, fiber, public carriers, etc.
 - HetNet improves functionality:
 - Common network-to-user interface for multiple MAC/PHY technologies
 - Unifies network services (authentication, provisioning, QoS, etc) across multiple MAC/PHY technologies
 - See Tutorial – July 2012



- Grid-specific WiMAX Profiles
- Interoperability PlugFest series

Smart Grid in IEEE 802.21

Subir Das

IEEE 802.21d: Media Independent Handover Services Amendment: Multicast Group Management

Subir Das

sdas at appcomsci dot com

WG Officers

Office	Officer
WG Chair	Subir Das
WG Vice Chair	Anthony Chan
WG Secretary	Charles E. Perkins
802.21d TG Chair	Yoshihiro Ohba

Document Server and PAR

- Document Server:
 - <http://mentor.ieee.org/802.21/documents>
- 802.21d PAR Details
 - http://www.ieee802.org/21/802_21d_PAR.pdf

IEEE 802.21d

- Scope (c.f. Section 5.2 of PAR)

“To add support in Media-Independent Handover (MIH) framework for management of multicast groups.”
- Purpose: (c.f. Section 5.3 of PAR)

“The purpose of this standard is to enable the handover for group of users across the same or multiple access networks. Additionally, this standard will define mechanisms to secure multicast MIH protocol exchanges.”

802.21d Schedule

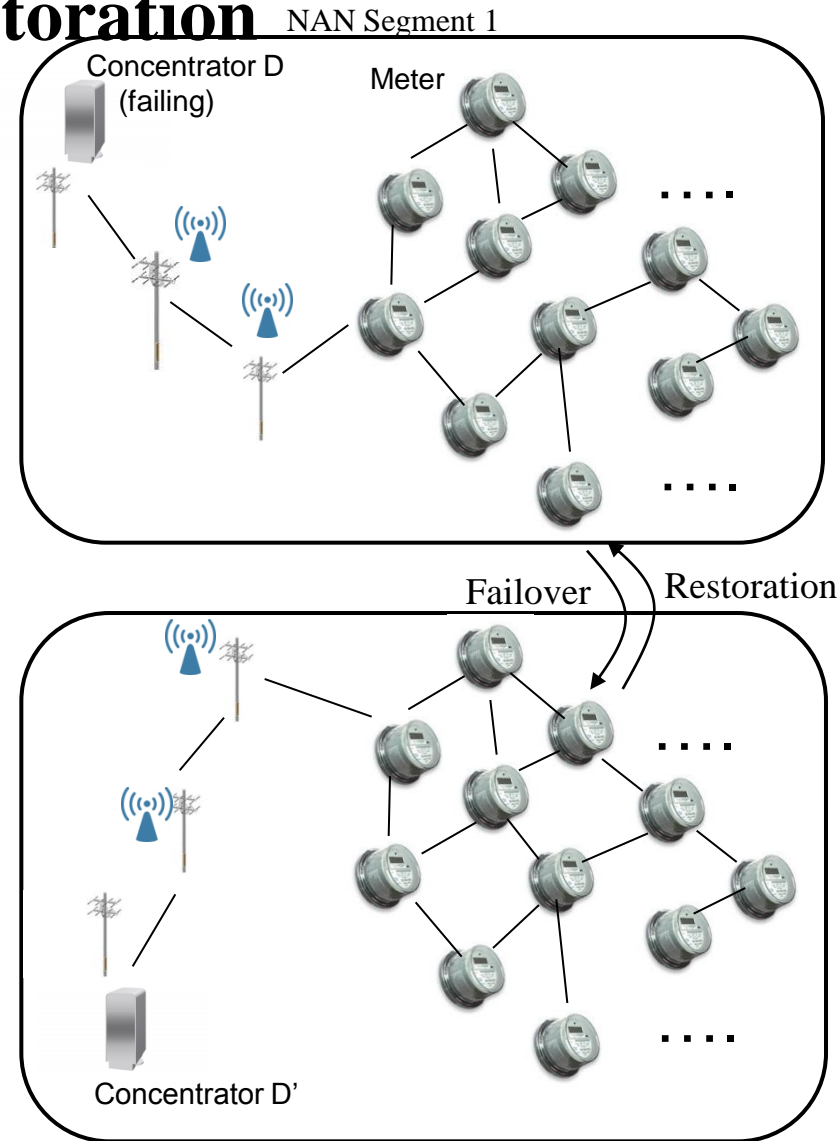
We are here

TGd Schedule	2012				2013						2014					
	5	7	9	11	1	3	5	7	9	11	1	3	5	7	9	11
Use Case, Requirements	x	x	x													
Call for Proposal			x													
Harmonization / Down-selection				x	x	x	x	x								
Letter Ballot								x	x	x	x					
Sponsor Ballot												x	x	x	x	
802.21d draft sent to RevCom																x

- **802.21d CFP has been issued in September, 2012**
- **7 initial proposals have been received in response to the CFP**

Use Case 1 – Failover and Restoration

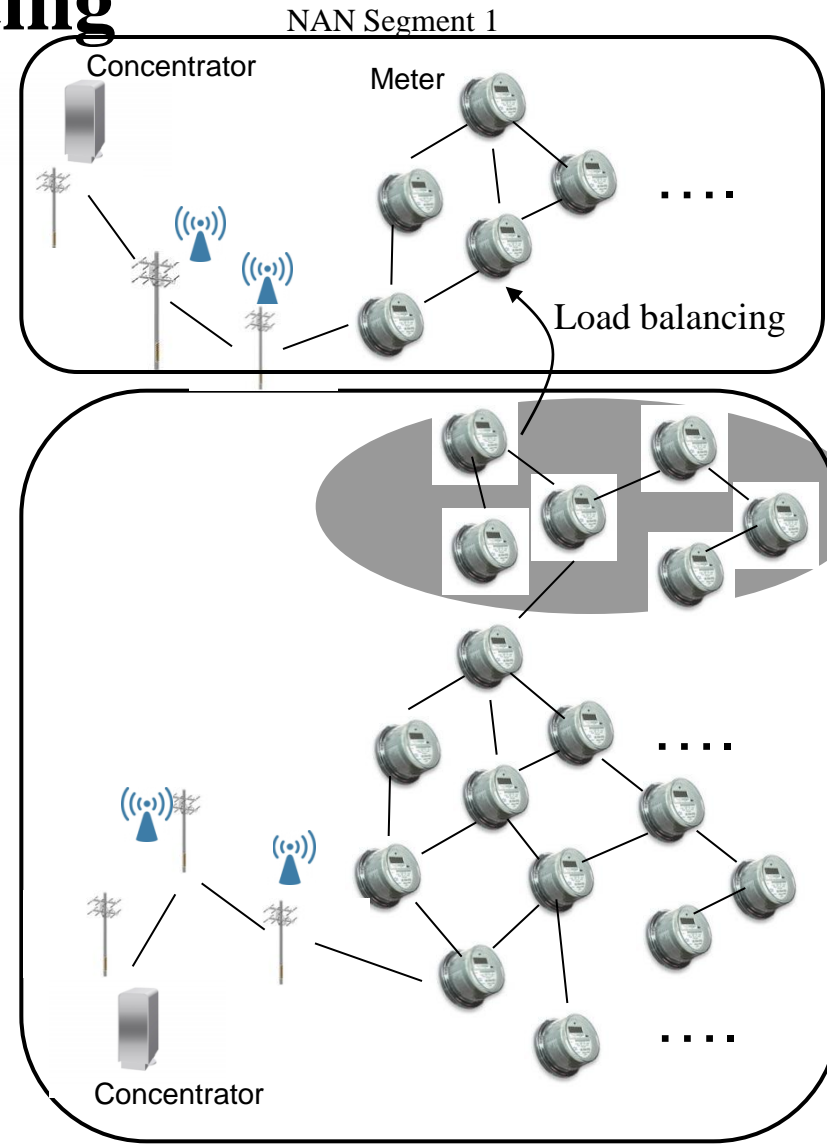
- **Failover/Failback** of an AMI network
 - If a device D is (going to be) no longer on one network, it is needed to perform failover or **migrate/handover** devices connected under D to another network
 - The takeout device D (e.g., concentrator) is typically associated with a NAN (Neighborhood Area Network) segment
 - If that device goes down, other devices will failover to a second NAN segment



Reference: <https://mentor.ieee.org/802.21/dcn/12/21-12-0028-03-0000-mih-group-management.pptx>

Use Case 2 – Load Balancing

- If a NAN segment is overloaded, a group of devices belonging to the NAN segment is moved other NAN segment(s)



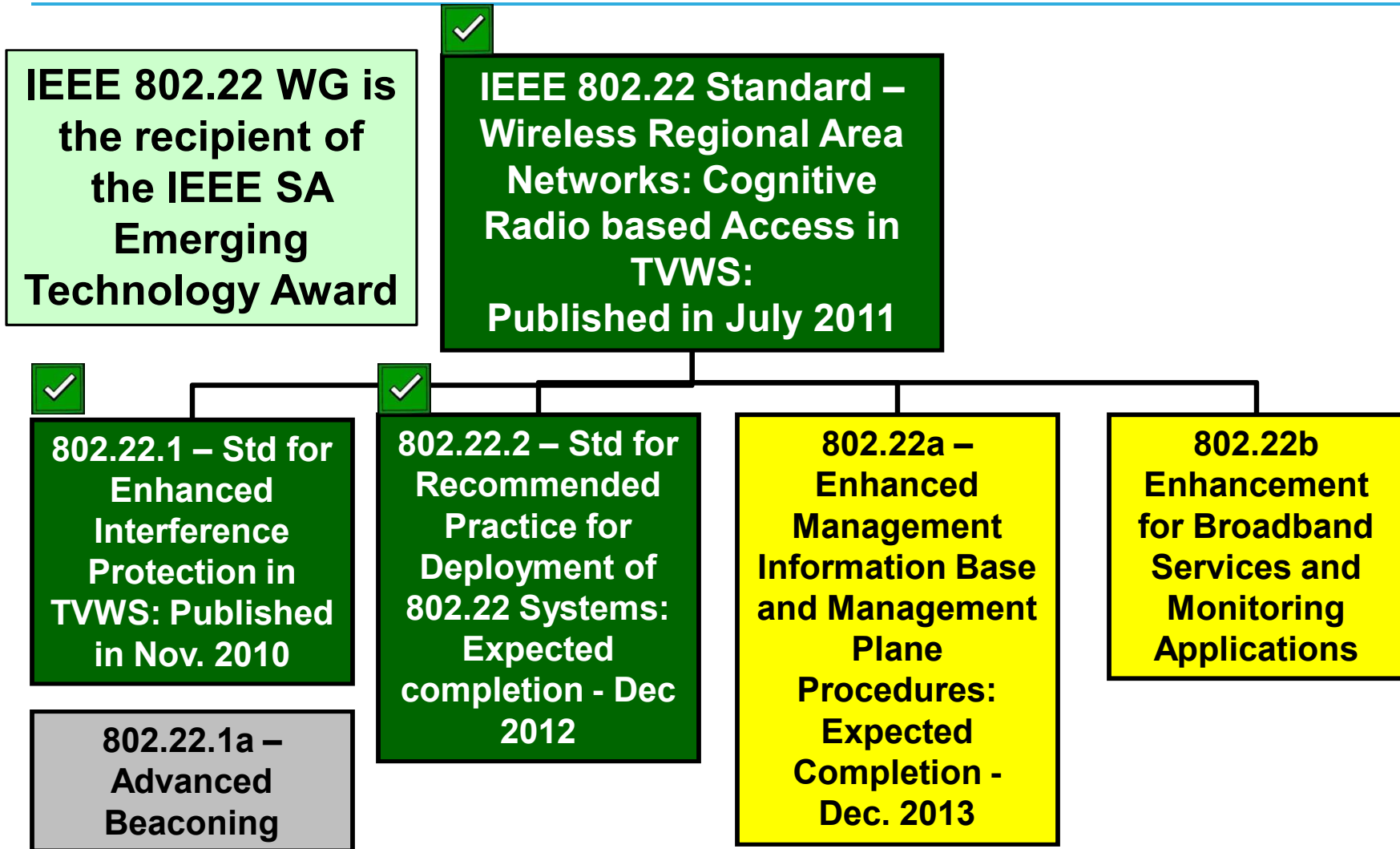
IEEE 802.21d Requirements

- Multicast Communication
 - 802.21d shall support multicast communication between a Point of Service (PoS), source of a multicast tree, and a group of nodes.
- Multicast Transport
 - Need for mechanisms for the MIHF (Media Independent Handover Function) to deliver information in a multicast way
 - 802.21d shall rely on already established L2, L3 or application layer multicast mechanisms to perform the multicast transport
- Addressing
 - 802.21d shall provide an addressing mechanism suitable for identifying the group
- Group Management
 - Need for functionalities for managing groups of nodes. These functionalities include the creation/destruction of groups, join and leave operations and modifications to the group subscription.
- Security Requirements
 - Need for mechanisms to perform authentication, confidentiality and integrity protection at the receiving node.
 - Need for key management mechanisms.

Smart Grid in IEEE 802.22

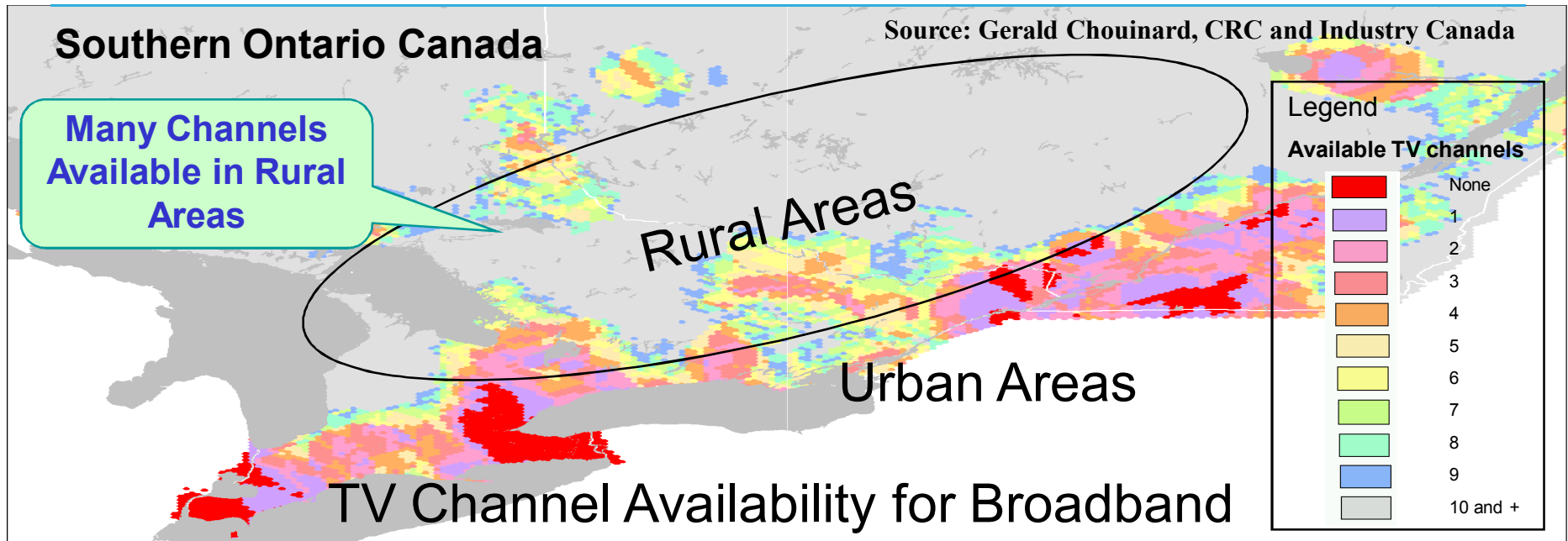
Apurva Mody

IEEE 802.22 WG on Cognitive Radio Based Wireless Regional Area Networks



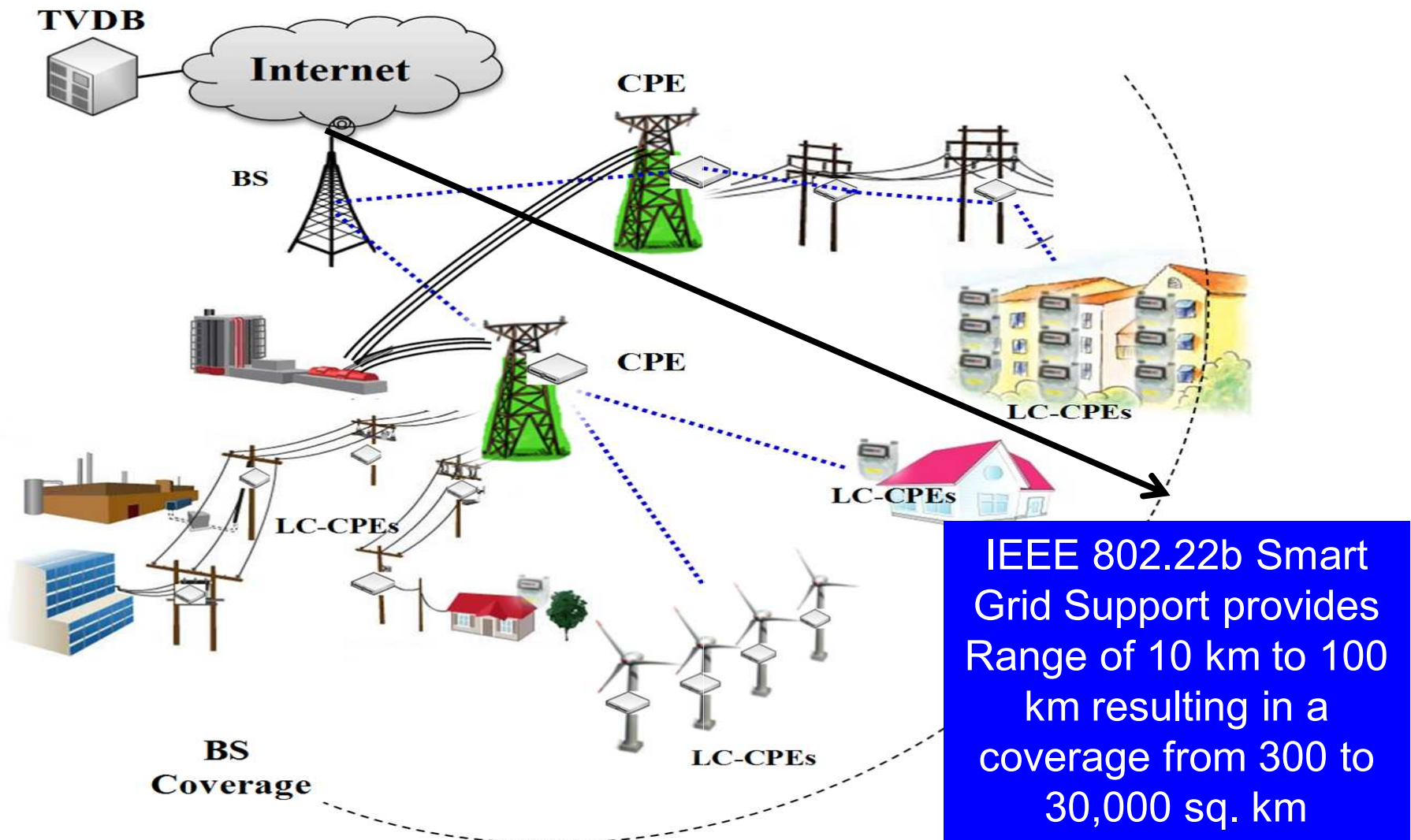
www.ieee802.org/22

WhiteSpaces: An Enabler

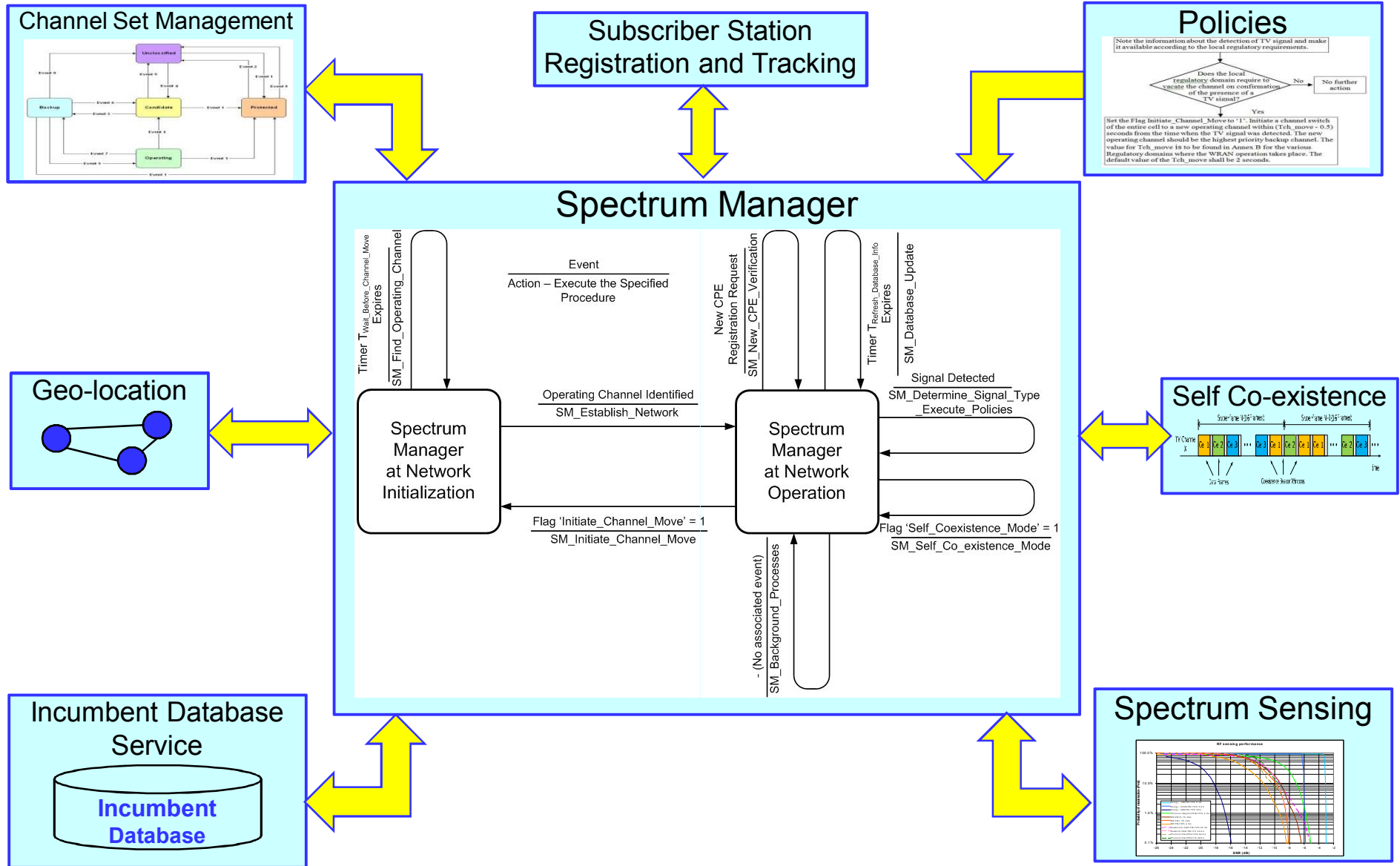


- VHF / UHF bands traditionally reserved to broadcasters have highly favorable propagation characteristics. Penetrating through foliage and structures, they reach far and wide
- The worldwide move from analog to digital TV frees up spectrum creating what is called 'WhiteSpaces'
- These WhiteSpaces will deliver quality high speed internet access

IEEE 802.22 can provide regional area smart grid backhaul using White Spaces



IEEE 802.22 – Cognitive Radio Capability

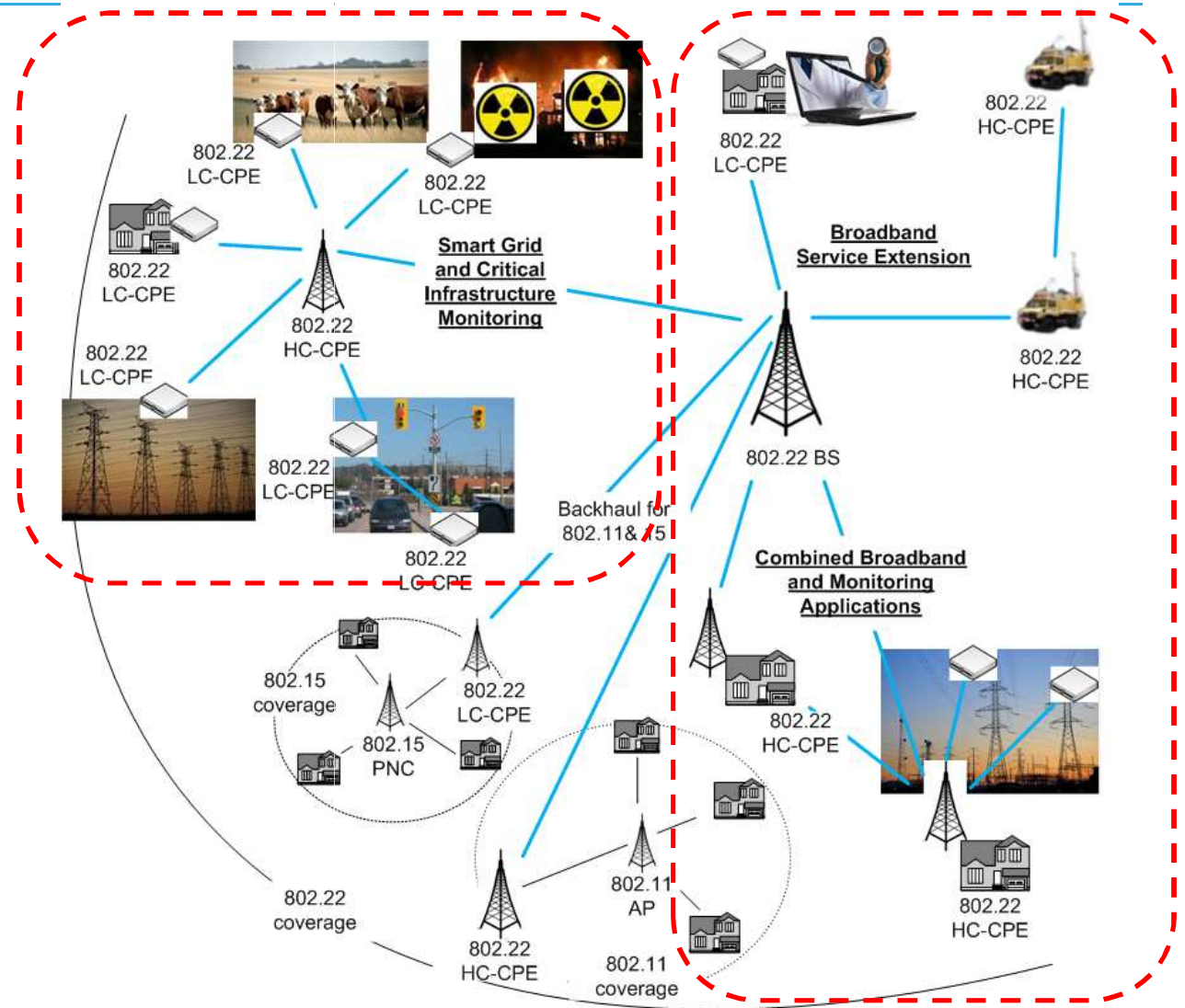


IEEE 802.22b Smart Grid Applications Support

Smart Grid Applications	Requirements Addressed by 802.22 and 802.22b Systems
Distribution Automation (DA) <ul style="list-style-type: none">• Volt-VAR management• Conservation Voltage Reduction (CVR)• Sensor monitoring, management and control• Other transmission control (e. g. synchrophaser)	<ul style="list-style-type: none">• Higher speeds required<ul style="list-style-type: none">• Volt-VAR management , CVR and other DA applications (Tens of kbits/s) Sensor Monitoring and Management (Up to 1 Mbps / node)• Reliability and security important• Low latency needed (Few ms for synchrophaser up to Few seconds for others)• Low round trip delay requirements• Star, peer to peer and multi-hop support desired• In general bi-directional communications• Interference resilience
Smart Metering <ul style="list-style-type: none">• AMI	<ul style="list-style-type: none">• Thousands of devices• Typically lower speeds per node but trending towards higher refresh rates resulting in higher aggregate throughput – e. g. Tens of kbps/ node• Non real time is okay• Star, peer to peer and multi-hop support desired• Interference resilience

IEEE P802.22b Comined Regional Area Smart Grid Monitoring and Broadband Extension

Combined Broadband and Smart Grid/Monitoring



22-11-0073-02-0000-
usage-cases-in-802-22-
smart-grid-and-critical-
infrastructure-monitoring

Conclusions

- *IEEE 802.22 is the First* IEEE Standard for operation in Television Whitespaces
- *IEEE 802.22 is the First* IEEE Standard that is specifically designed for rural and regional area broadband access aimed at removing the digital divide
- *IEEE 802.22 is the First* IEEE Standard that has all the Cognitive Radio features
- **Emerging Breakthrough Technology:** IEEE 802.22 Working Group is the recipient of the 2011 IEEE SA Emerging Technology of the Year Award
- IEEE 802.22-2011 and IEEE P802.22b Amendments can benefit the **Smart Grid and Cognitive Machine to Machine Ecosystems**

Get involved with 802.24

- Meetings
 - At plenary every 4 months
 - As needed at wireless interim meeting and via conference call
- Web page
 - <http://www.ieee802.org/24>
- Mailing list
 - STDS-802-24@listserv.ieee.org
- Document archive
 - <http://mentor.ieee.org/802.24/documents>