

IEEE-SA Standardization Activities for Smart Grid in Communications & Networking

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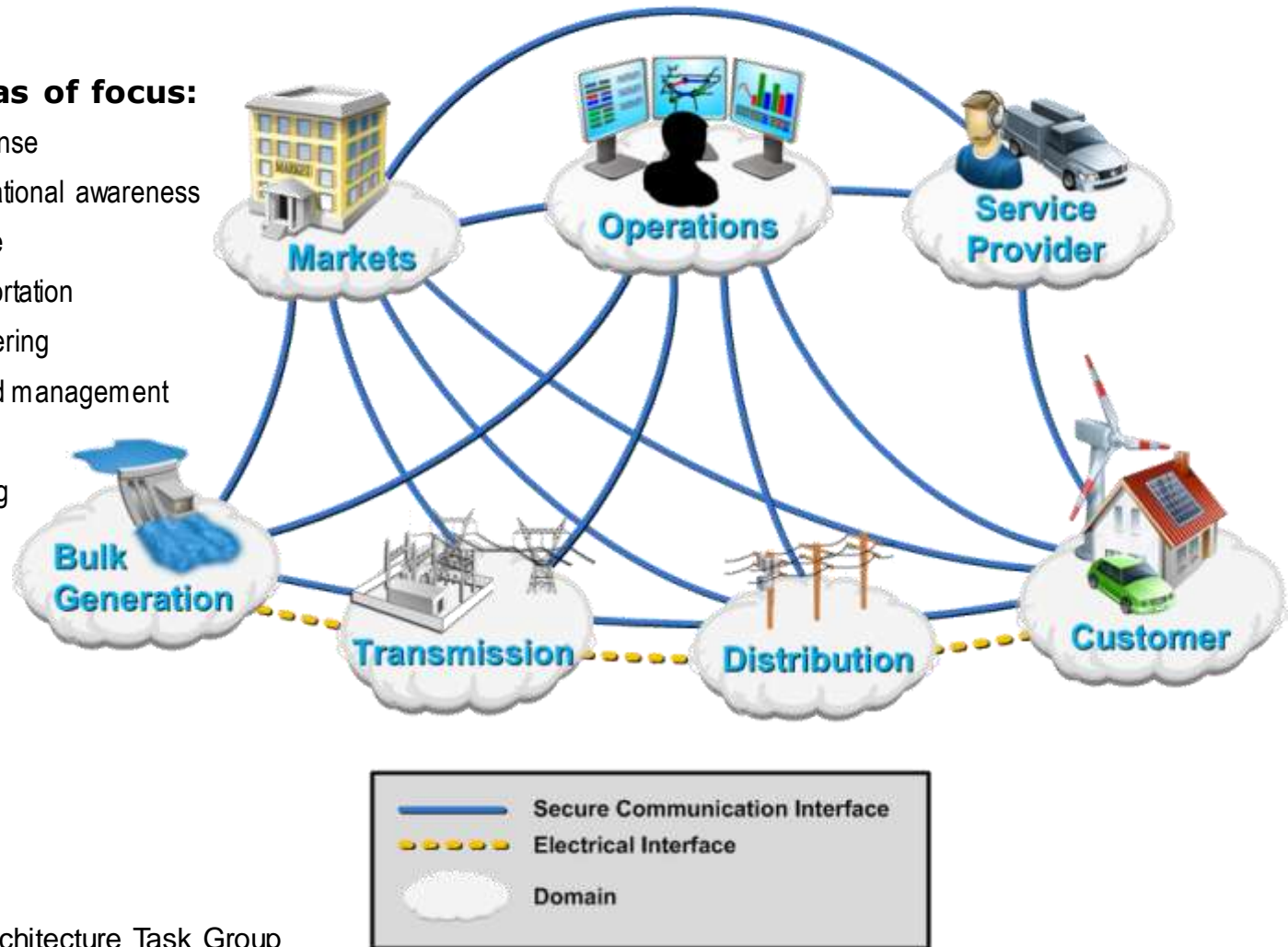


Smart Grid

Smart Grid Conceptual Model

Priority areas of focus:

- Demand response
- Wide-area situational awareness
- Electric storage
- Electric transportation
- Advanced metering
- Distribution grid management
- Cybersecurity
- Data networking



Source: NIST/EPRI Architecture Task Group

Broad Categories of Smart Grid Standardization

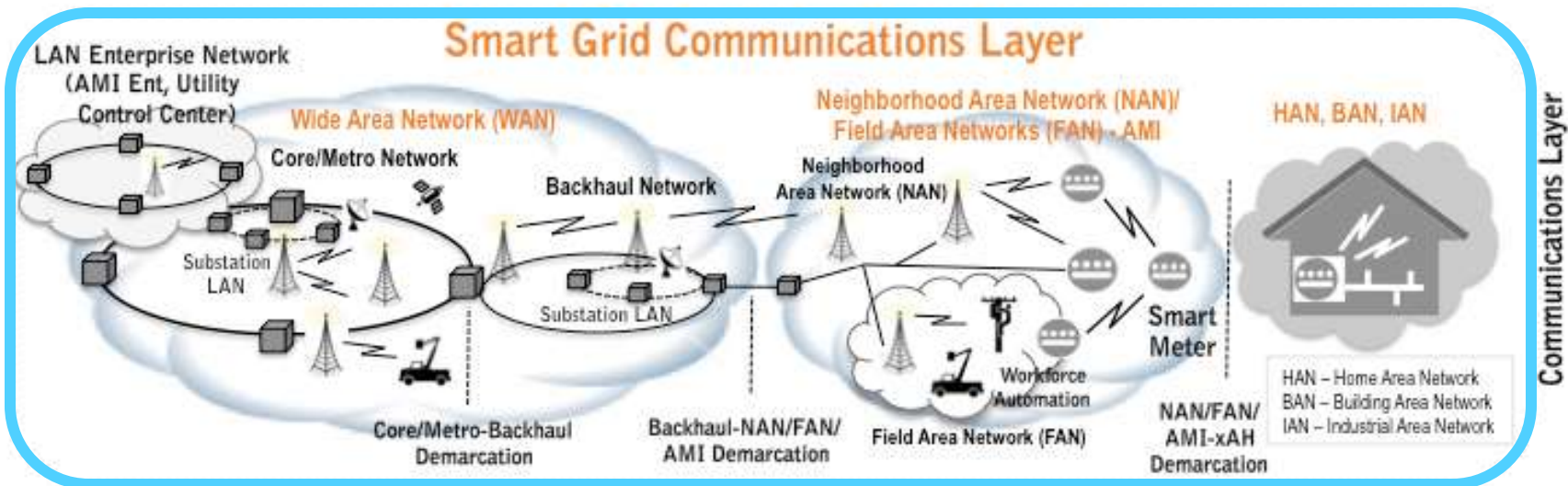
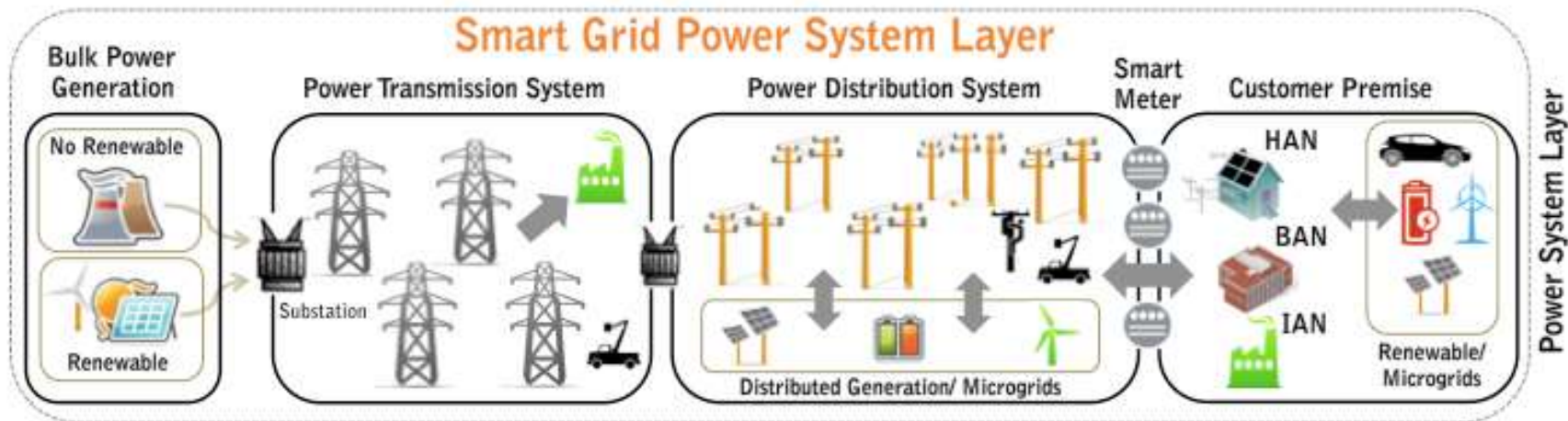


- Devices used in the Smart Grid
- Information and data structures
- Communications
- Physical Interfaces

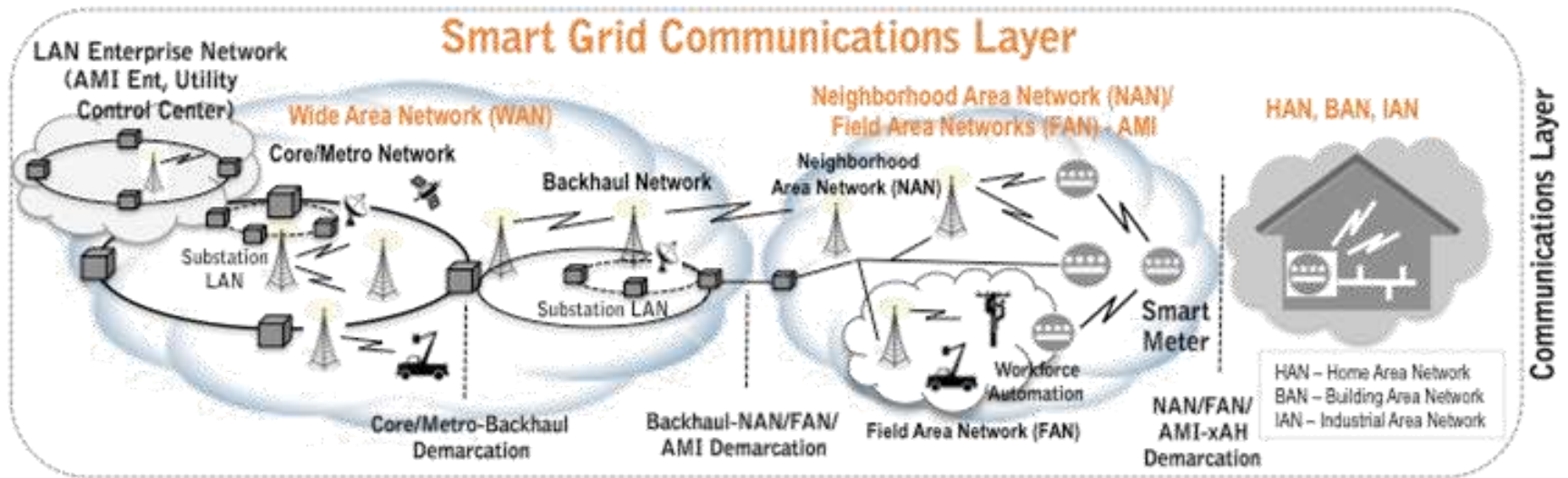


IEEE P2030

IEEE P2030 Smart Grid Communications Network



IEEE P2030 Network Technology Standards Mapping



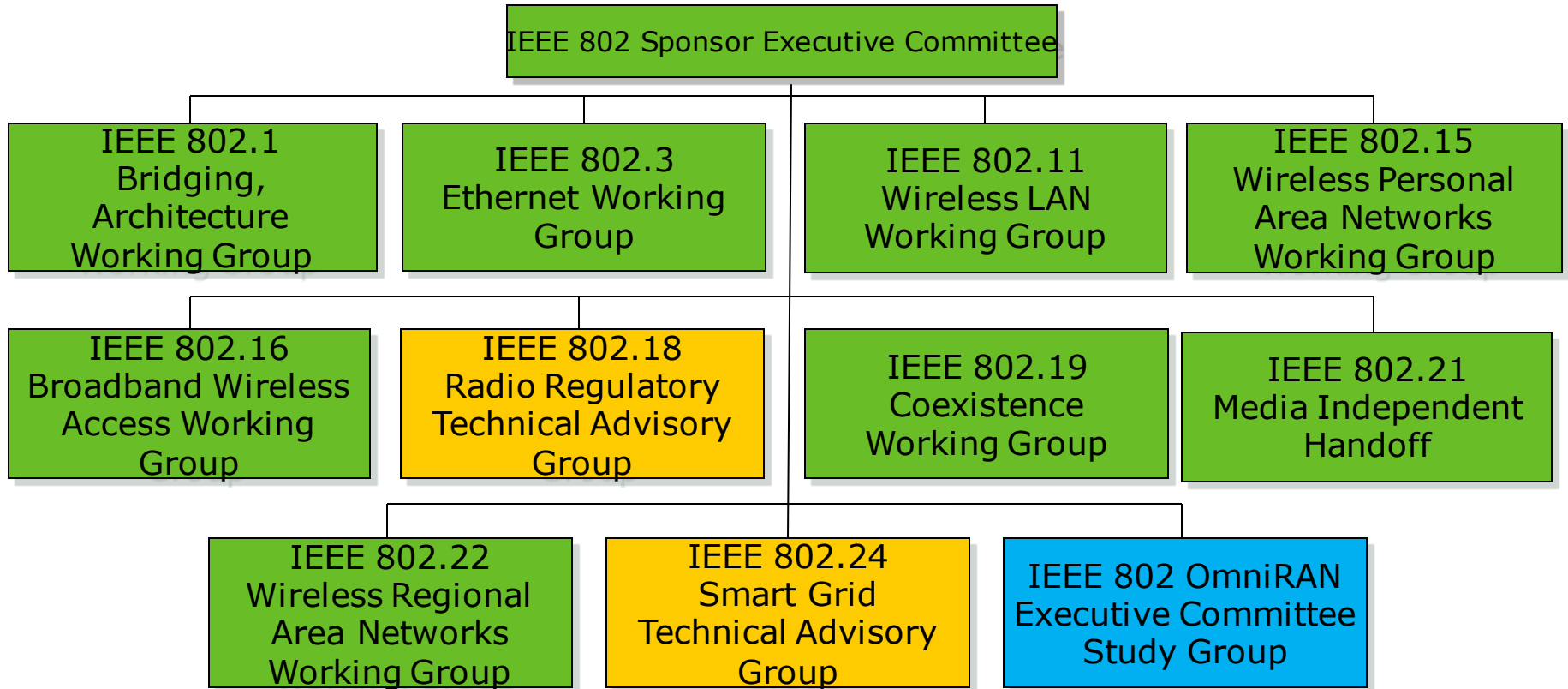
Smart Grid Network Technology & Protocols Standards Mapping

Wide Area Network (WAN) (public/private)					(NAN/ FAN) AMI Networks (public/private)			Smart Meters	HAN, BAN, IAN	
Substation	Core/Metro Network		Backhaul Network		Substation	(licensed/unlicensed)		ANSI C.12.22	wireless	wireline
	wireline	wireless	wireless	wireline		wireless	wireline			
LAN (several options) DNP3/IEC 61850	IP-MPLS/T-MPLS	SONET-SDH	3G-3GPP/1XRTT/EVDO	802.16/LMDS	LAN (several options) DNP3/IEC 61850	RF Mesh/802.15.4g	FTTP/FTTH/Ethernet	ANSI C.12.22	802.2.15.4/ZigBee	ITU-T SG15 G.hn
	STP-Mesh/DWDM	Wimax/802.16d/e	RF Pto-to-Pto/MAS	DSL/POTS/PDH		Wimax/802.16d/e	RFoG-DOCSIS		6LowPAN	HomePlug
	Packet/Metro-Ethernet	Trunked Radio	Mesh RF/mm-Wave			3G-3GPP/1XRTT/EVDO	PLC/BPL P1901			
						GPRS/EDGE/HSDPA				
						RF Radio Pto-Mtp/MAS				
						WLAN/802.11n/g				
						802.2.15.4/ZigBee				

Technology Standards

IEEE 802

IEEE 802 Groups



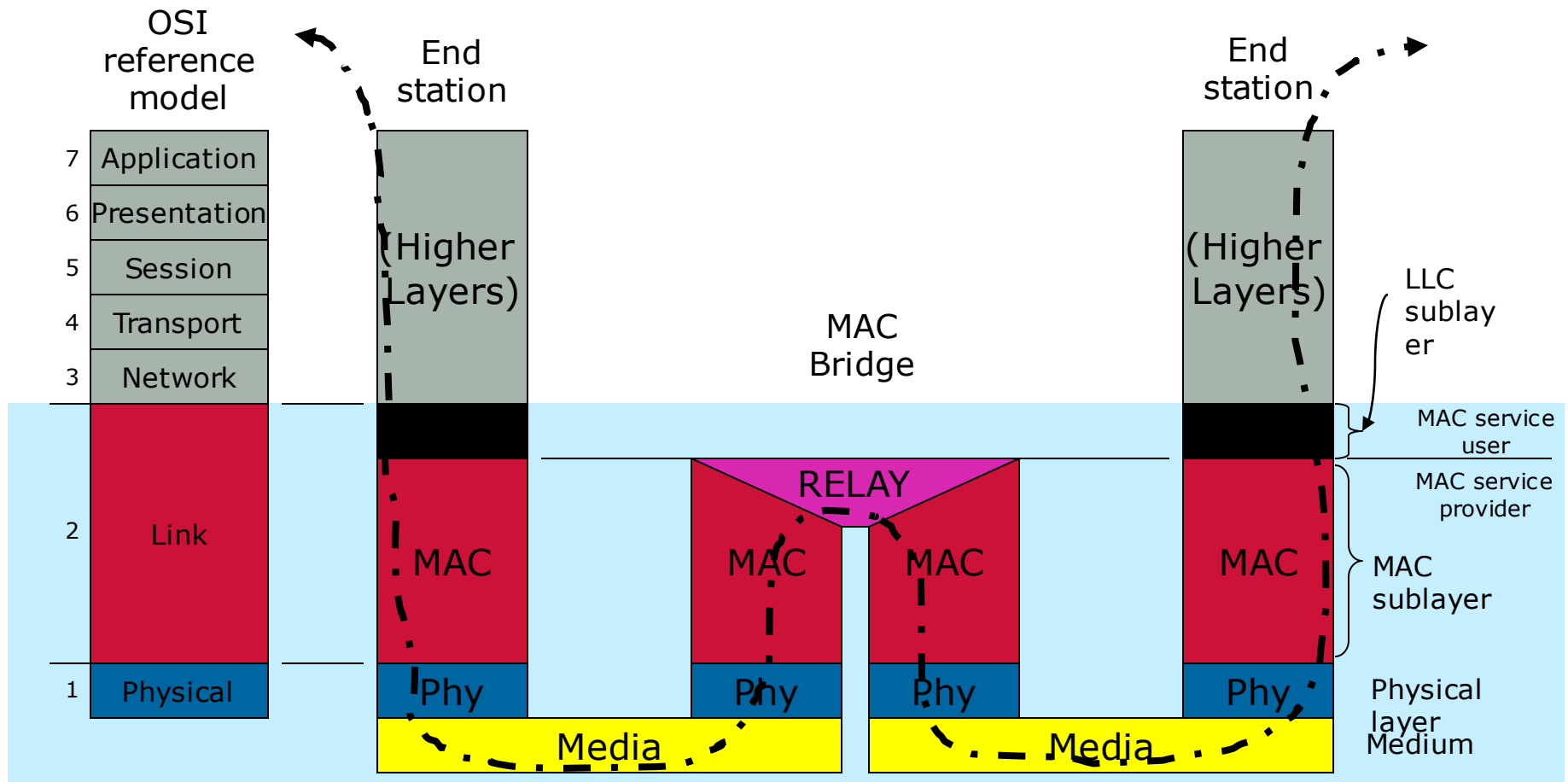
Disbanded (Inactive and standard withdrawn)

IEEE 802.4 Token Bus Working Group
 IEEE 802.6 Distributed Queue Dual Bus Working Group
 IEEE 802.7 Broadband Technical Advisory Group
 IEEE 802.8 Fiber Optic Technical Advisory Group
 IEEE 802.9 Integrated Service LAN Working Group
 IEEE 802.10 Security Working Group
 IEEE 802.14 CATV Working Group
 IEEE 802.23 Emergency Services

Hibernation (Inactive, standard active)

IEEE 802.2 LLC Working Group
 IEEE 802.5 Token Ring Working Group
 IEEE 802.12 Demand Priority Working Group
 IEEE 802.20 Mobile Broadband Wireless
 IEEE 802.17 Resilient Packet Ring

The 802 LAN Architecture



Objective: Specify the means to reliably deliver packets over a wide range of media types, speeds and distances

IEEE 802.11

Standards that Define Future

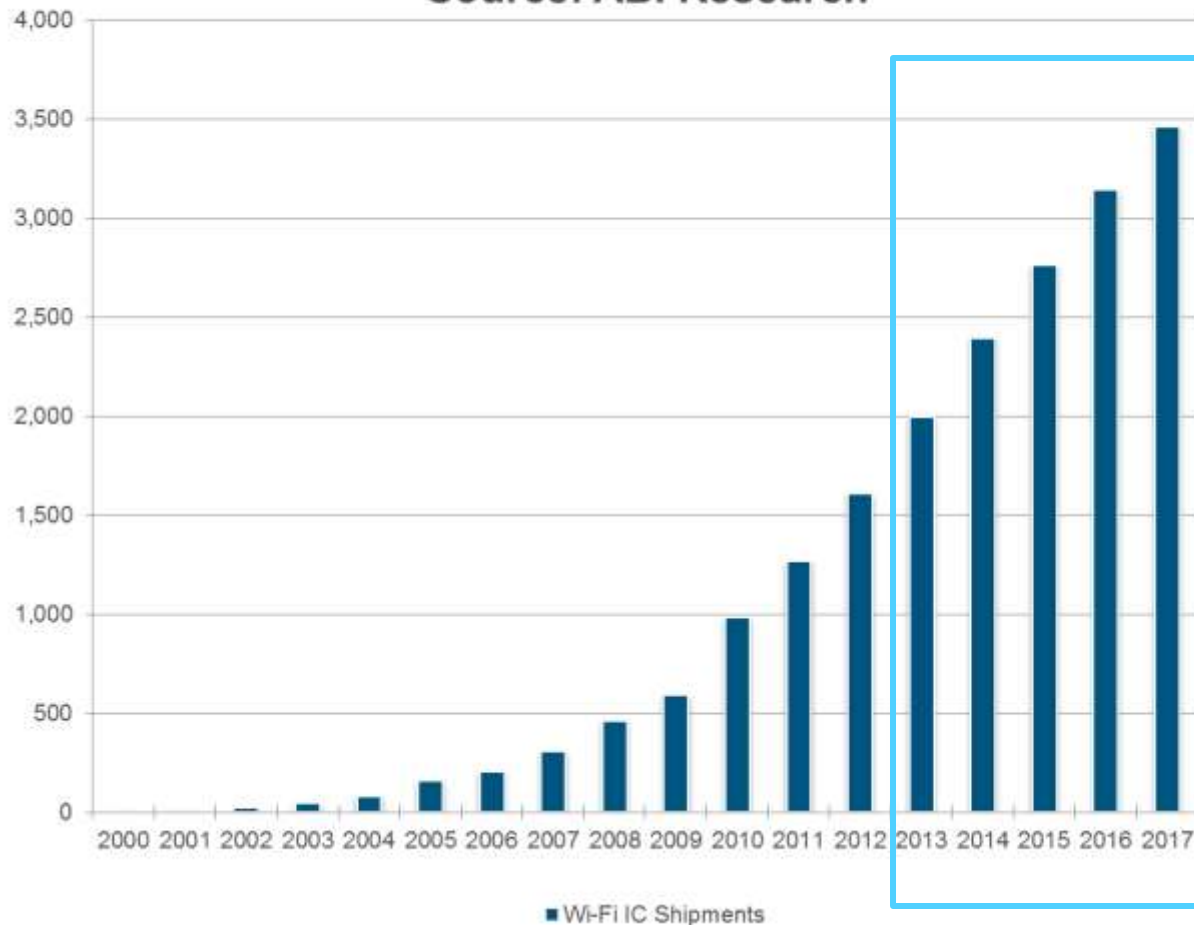
IEEE 802.11TM, "Wi-Fi"

- Originally conceived to link wireless cash registers
- Today underpins revolutionary mobile devices and ever-growing range of applications

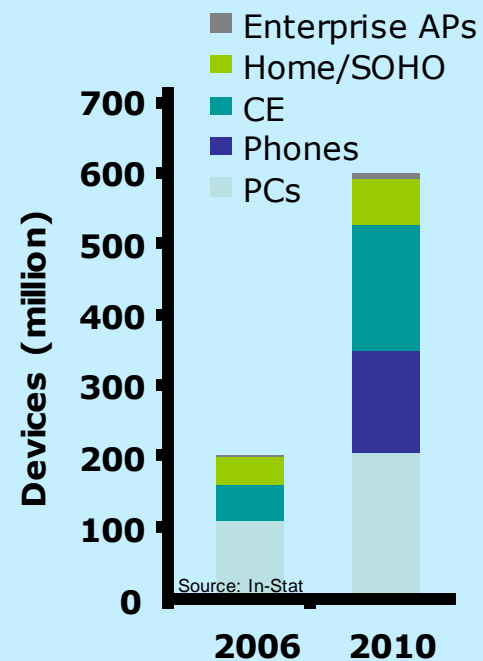


Market Size and Trends

Wi-Fi Chipset Shipments, millions of units
Source: ABI Research



Market size & segment diversity continues to increase



Wi-Fi Alliance

- Founded 1999
- > 400 member companies
- The Wi-Fi Alliance provides:
 - *Interoperability certification programs*
 - *Over 9000 products certified*
 - *Market messaging*



<http://www.wi-fi.org/>

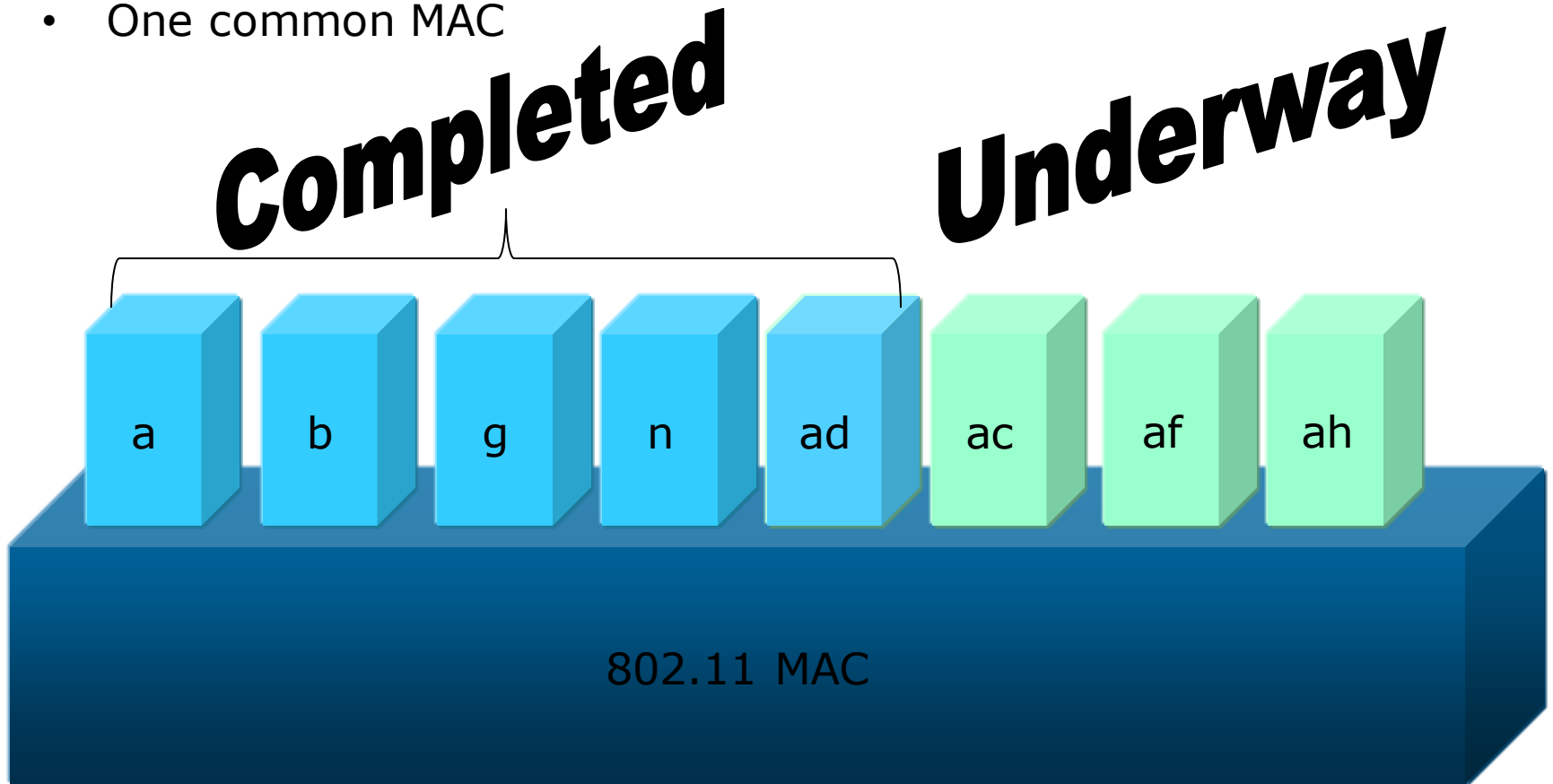


- 517,242 hot spots in 144 countries

Source: JiWire
<http://v4.jiwire.com/search-hotspot-locations.htm>

802.11 Architecture Overview

- Multiple Over the Air PHY options
- One common MAC



P802.11ah – Sub 1 GHz

- Project proposes to use spectrum below 1 GHz.
- Lower frequency will increase range
- Channel bandwidths have typically been 20 MHz or more, channel bandwidth down to 1 MHz specified.

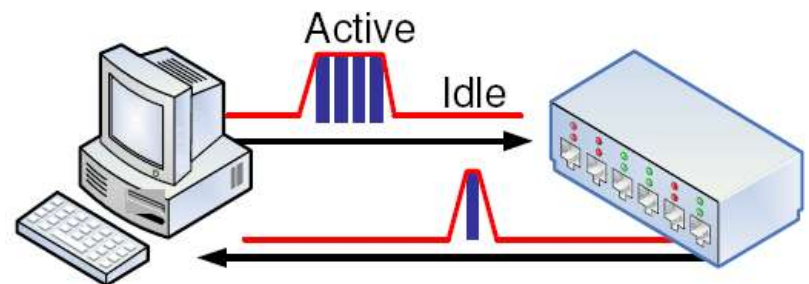
Application Targets

- Sensors and meters for Smart Grid and Healthcare
- Sensors and meters with mobility
- Backhaul Sensor and meter data
- Extended range hotspot and cellular offloading
- Indoor/Outdoor streaming data
- Electronic Menu & Coupon Distribution
- Indoor & Outdoor Location

IEEE 802.3

Energy-Efficient Ethernet

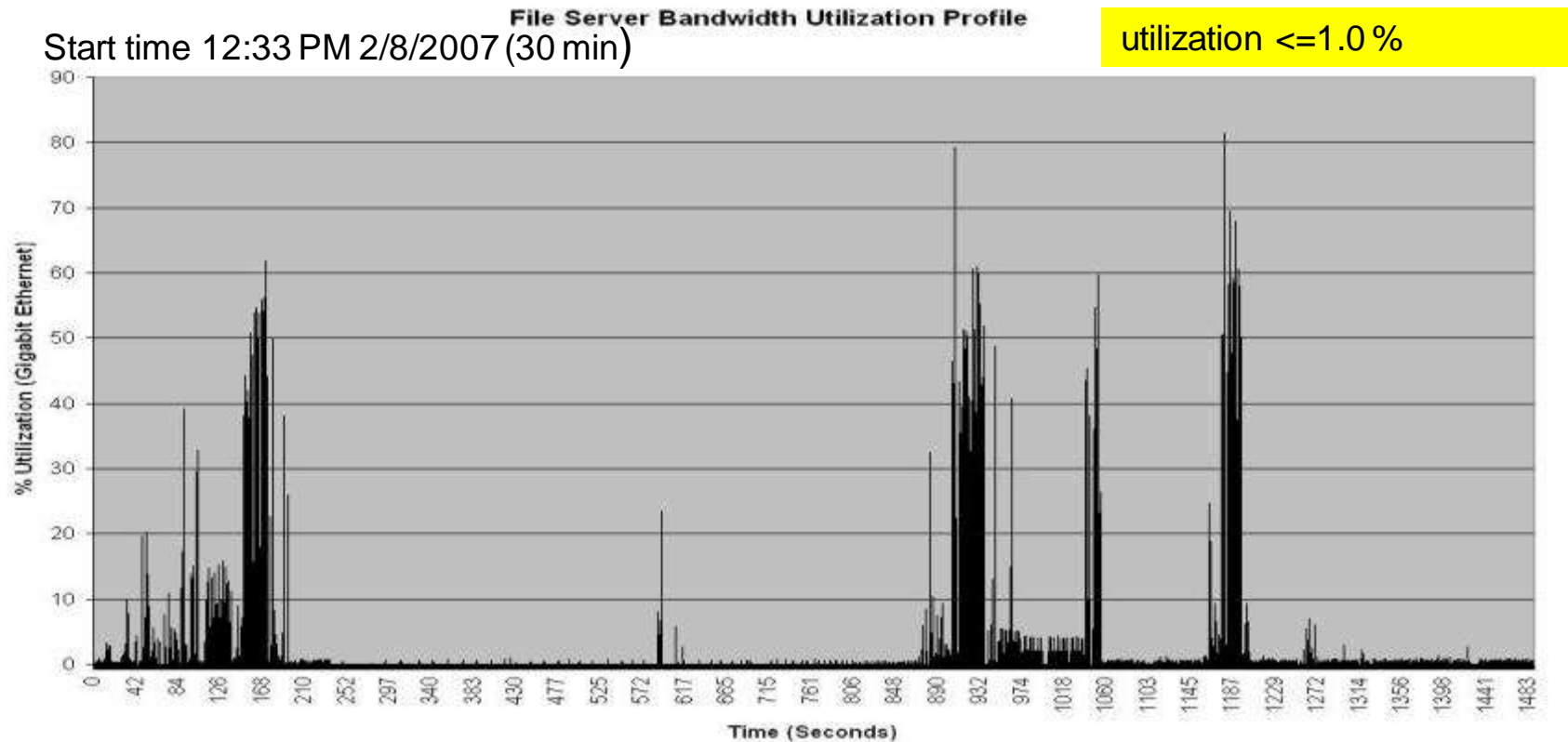
- Energy Efficient Ethernet (EEE) is a method to reduce energy used by an Ethernet device during periods of low link utilization
- Specified in IEEE 802.3az-2010™
- The premise for EEE is that Ethernet links have idle time and thus opportunity to save energy
- The method is called Low Power Idle (LPI)
 - Concept: Transmit data as fast as possible, return to Low-Power Idle
 - Saves energy by cycling between Active and Low Power Idle
 - Power reduced by turning off unused circuits during LPI
 - Energy use scales with bandwidth utilization
- Specified for copper interfaces
 - “BASE-T” s’
 - Backplane (except 40G)



Example: link utilization

Snapshot of a File Server with 1 Gb Ethernet link

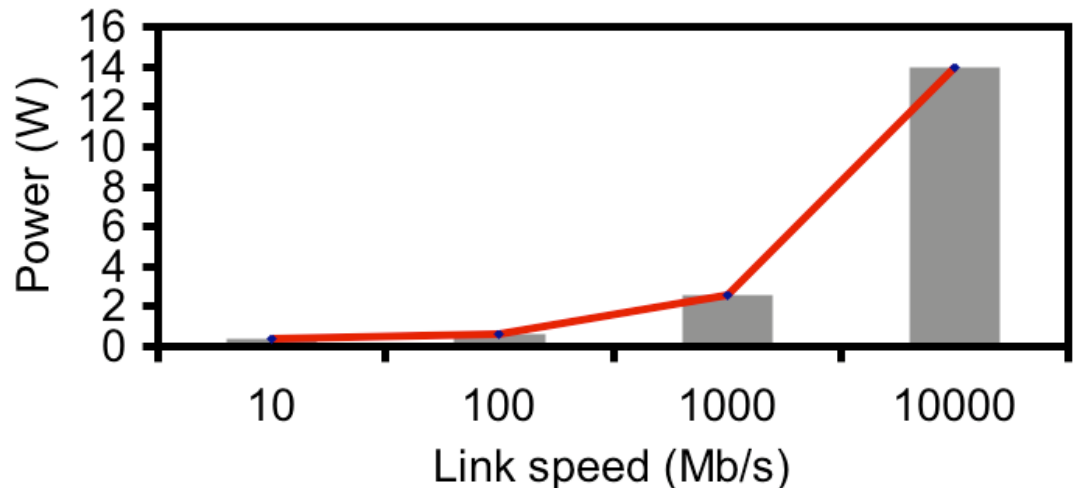
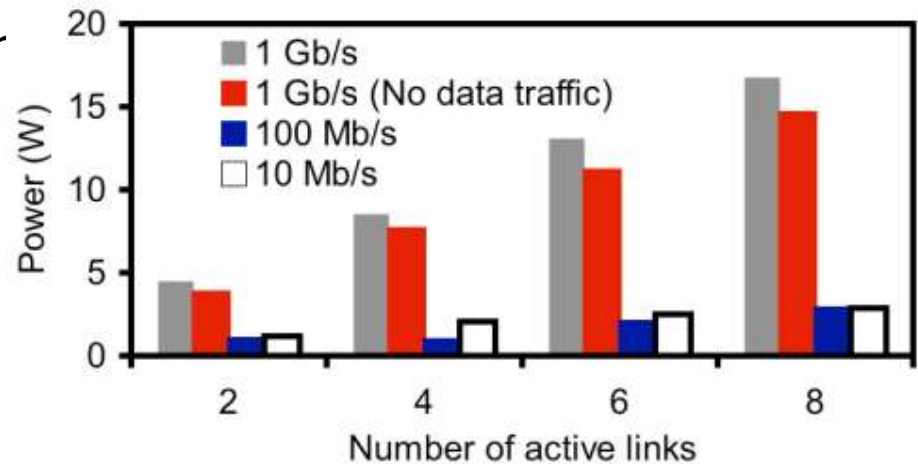
- Shows time versus utilization (trace from LBNL)



Link power

Results from (rough) measurements

- all incremental AC power
- measuring 1st order
- *Typical switch with 24 ports 10/100/1000*
- *Various computer NICs averaged*



Note: Measurement data from 2006

Energy Efficient Power over Ethernet

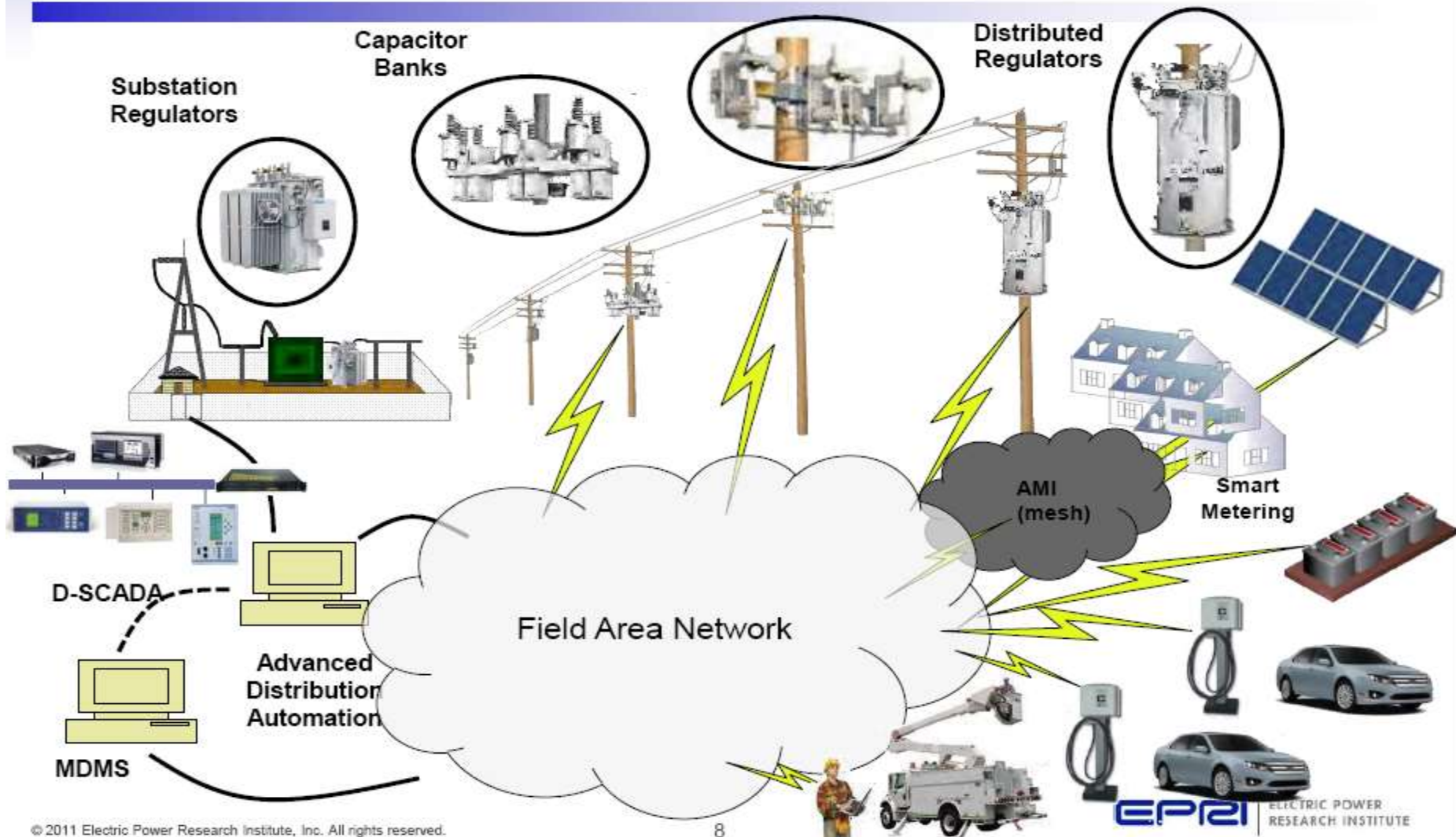
- Power over Ethernet was initially specified by IEEE 802.3af-2003
 - Enhanced by IEEE 802.3at-2009 to up to 25.5 W per device
- Main sources of power savings:
 - Devices can be remotely powered down when not being used
 - Better switching efficiency of power supplies
 - Shared power supply can better balance load and avoid idle switching losses
- EEPoE further reduces DC power losses over Ethernet cables by making use of all 4-pairs wiring by up to 3.13W per link
 - IEEE 802.3af devices as well as IEEE 802.3at devices are able to receive power over all the 4-pairs of wires

Technology	Savings	When becoming effective
EEE over GbE	~ 1W per link	when link is idle
EEPoE w/ .3af	~ 0.6W per link	when power is supplied over wires
EEPoE w/ .3at	~ 2.1 W per link	when power is supplied over wires

IEEE 802.16

Market Size and Trends

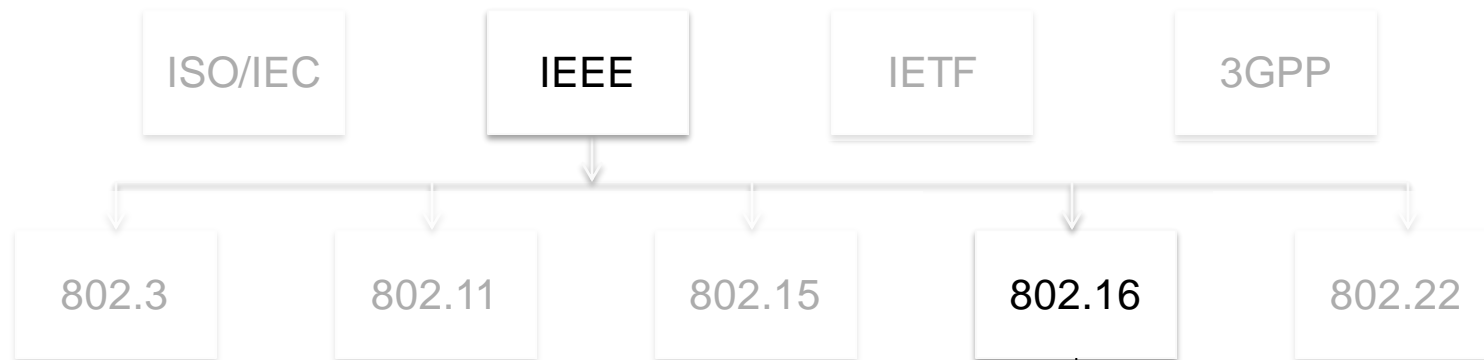
Sectionalizers



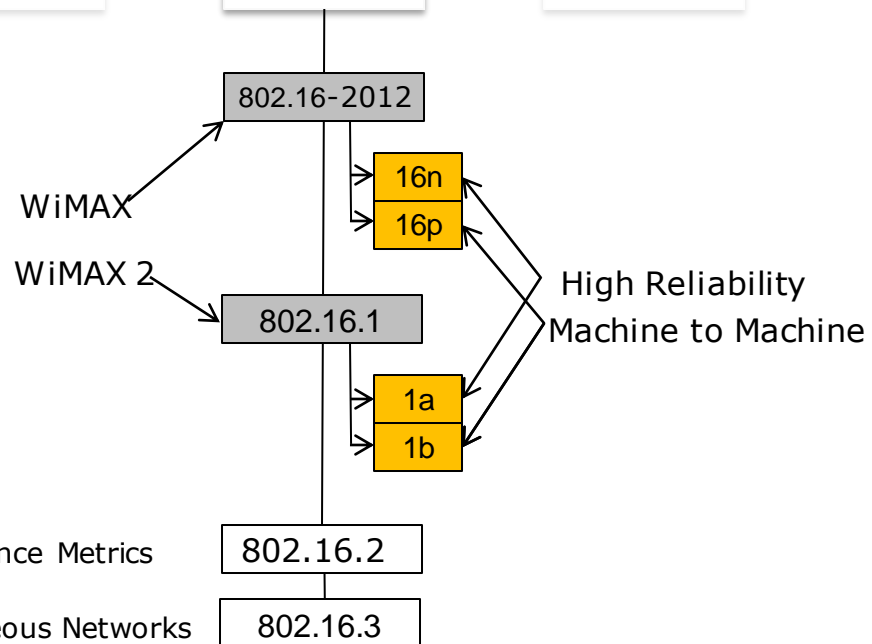
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IEEE 802.16 (WiMAX) standards hierarchy



- Completed
- Active – Grid relevant
- Active – Not grid relevant
- Initiating work



802.16/WiMAX for Smart Grid FAN

- Flexibility to operate in various spectrum allocations from 700MHz to 5GHz
- Able to support TDD and FDD spectrum
 - TDD primary (most common)
 - TDD enables a wider, dynamic mix of UL / DL bandwidth
- Evolutionary path –same network, same spectrum, incremental upgrade possible moving to 802.16m
- Specific enhancements for SG applications
 - 802.16n –addresses utility grade reliability
 - 802.16p –addresses machine to machine
- Architecture meets Smart Grid (utility) needs

IEEE 802.15

Smart Energy & Home Automation

ZigBee Home Automation solutions based upon 802.15.4 Standards



ZigBee Smart Energy Standard

Supported Features Include:

- Basic metering [measurements, historical info, etc]
- Demand Response (DR) and Load Control

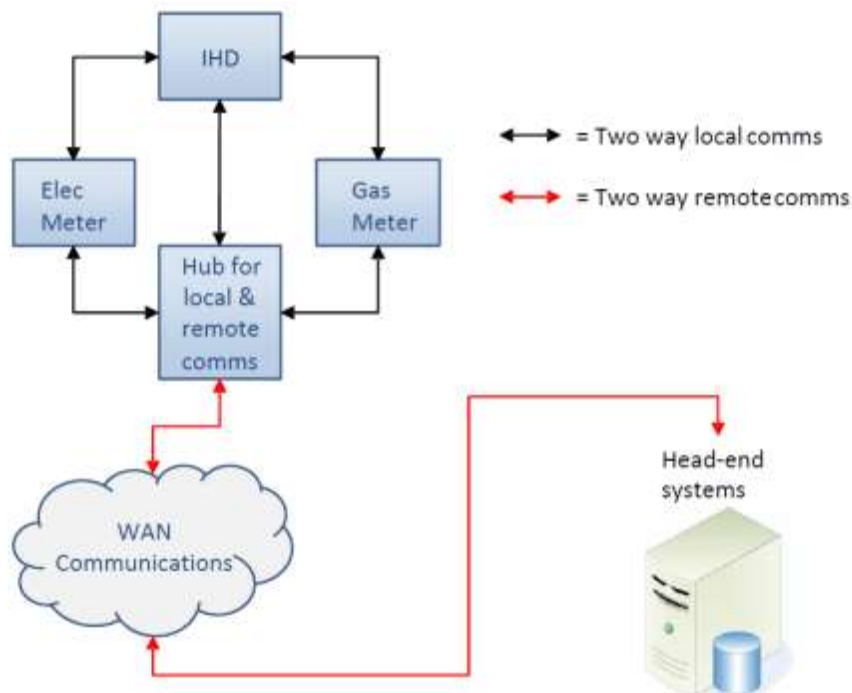
Pricing

[multiple units & currencies, price tiers, etc.]

- Text messages
- Device support for Programmable Communicating Thermostats (PCTs), Load Controllers, Energy Management Systems, In Home Displays (IHDs), etc.
- Security to allow consumer only, utility only, or shared networks
- Support for water and gas



British Gas Deployment



- British Gas plans to install up to 2 million ZigBee Smart Energy equipped gas and electric smart meters
- The in-home system architecture has 4 main components:
 1. Gas Meter
 2. Electricity Meter
 3. Telecommunications Hub (comms hub)
 4. In home display unit (IHD)
- Business partners include: mobile operator Vodafone; billing systems SAP; software and communications firms, OSIsoft and Trilliant; and global smart meter manufacturer, Landis+Gyr

IEEE 1901

IEEE 1901.2

IEEE 1905.1

Other IEEE Standards for Smart Grid Networks

- IEEE 1901™ – Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specifications
- IEEE P1901.2™ – Standard for Low Frequency (Less Than 500 kHz) Narrow Band Power Line Communications for Smart Grid Applications
- IEEE 1905.1™ – Standard for a Convergent Digital Home Network for Heterogeneous Technologies

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Hvala!