

An Overview of Smart Grid Standards



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Ontario Smart Grid Forum
November 2008*

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Why Use Standards?

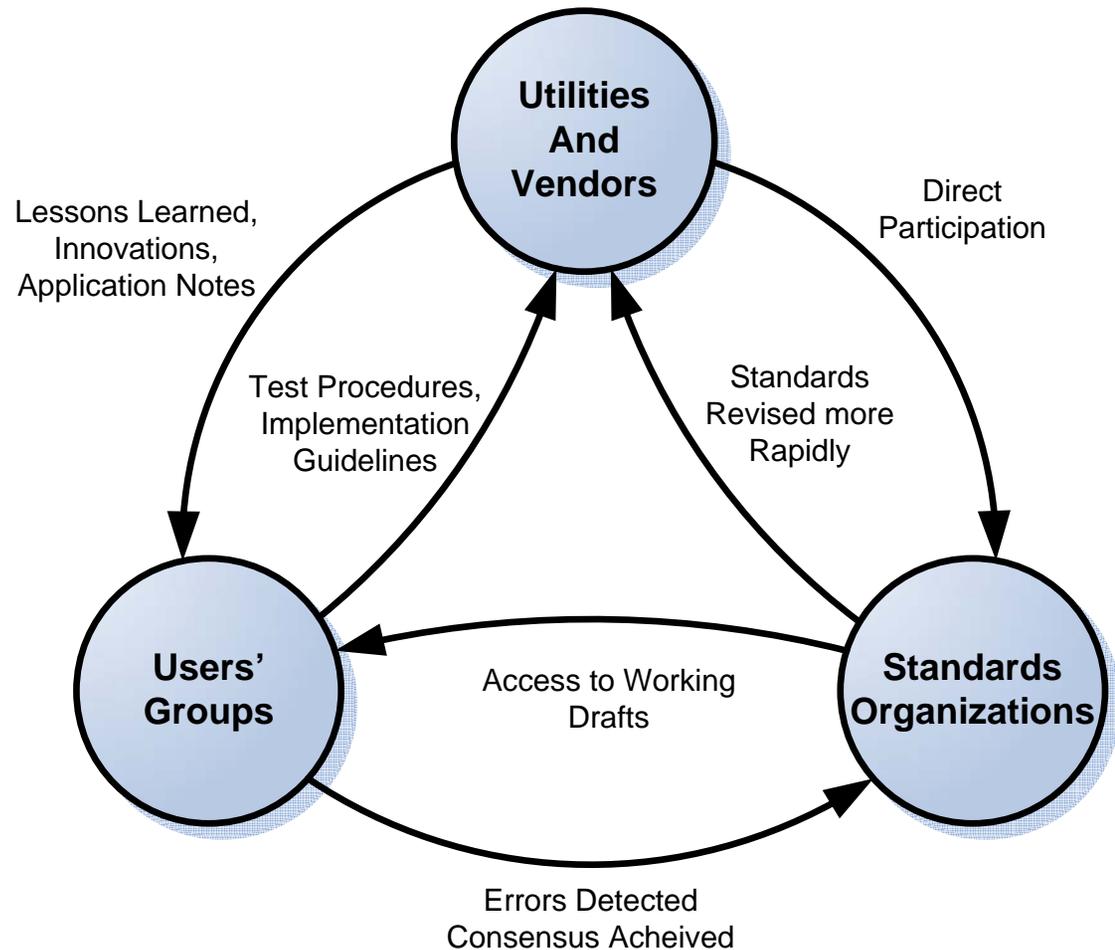
- Avoid re-inventing the wheel
- Learn from industry best practices
- Specify requirements more easily
- Reduce integration costs
- Prevent single vendor “lock-in”
- Vendors share a much larger market



Making Standards Work

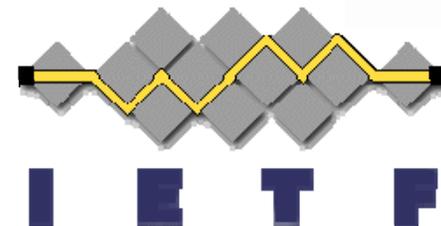
Items critical to a successful standard:

- Mature spec
- Involved user group
- Certification process
- Revision process
- Marketing, labeling
- Implementations
- Tool sets

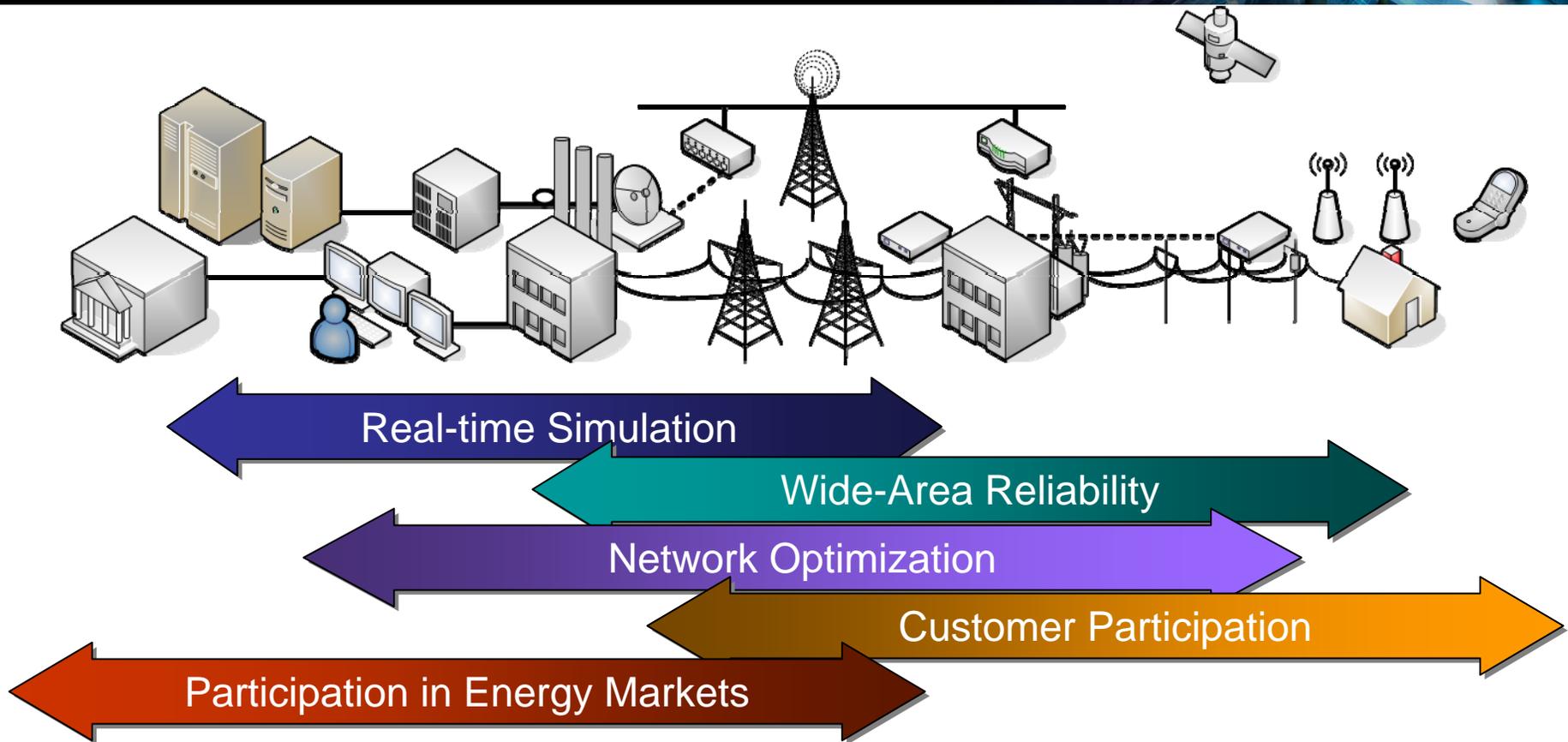


Why International Standards?

- Several Advantages
 - Time-tested process
 - Proven fair and open
 - Can be accelerated if needed
- Other alternatives:
 - “de Facto” needs a market-maker
 - Industry consortia can work well
 - Work even better if endorsed by a standards org

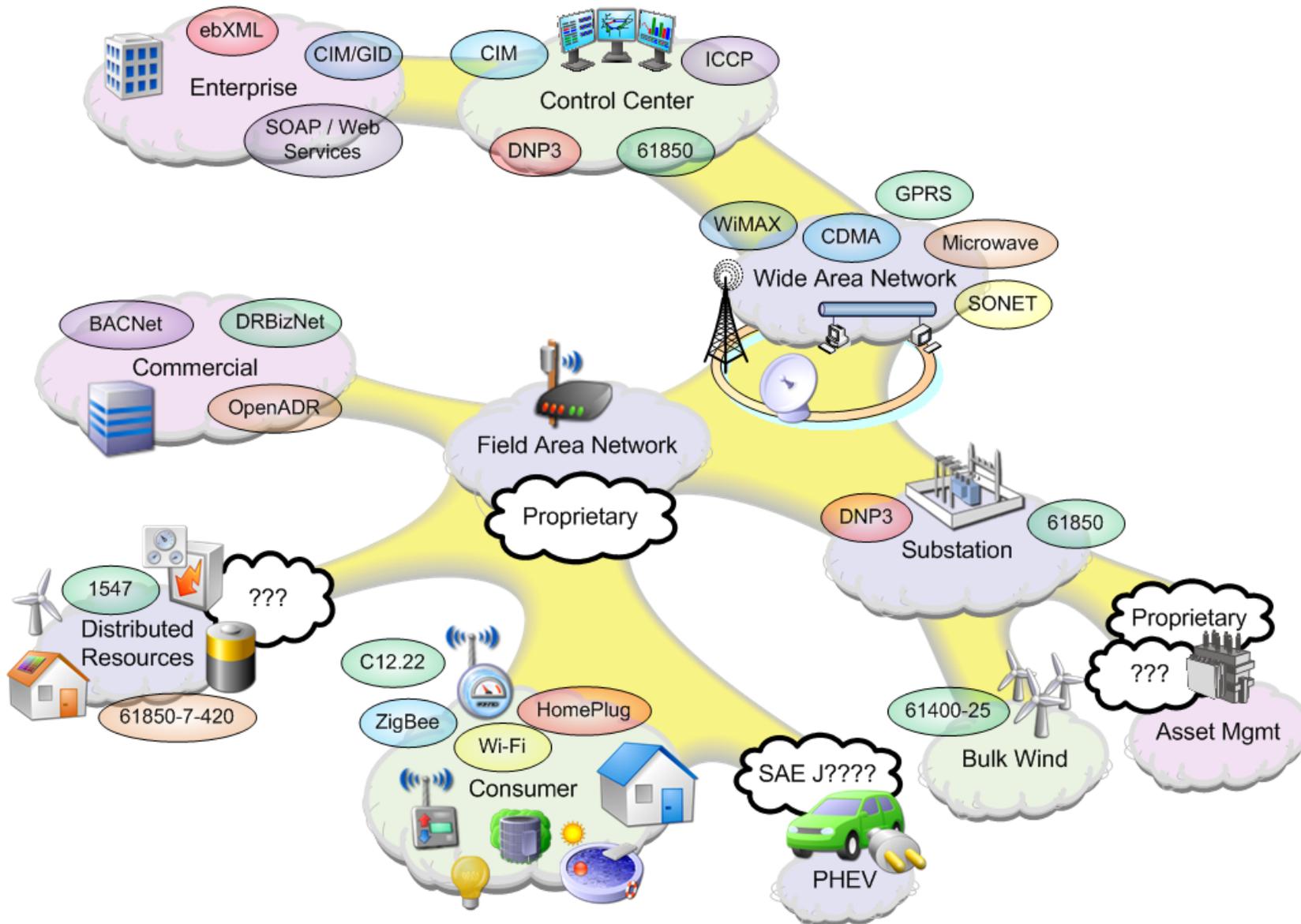


Standards in the Smart Grid



- EPRI IntelliGrid Architecture, <http://www.intelligrid.info>
- Catalog of Use Cases, Standards, Technologies

Smart Grid Comm Standards Domains



Enterprise and Control Center

Name / No.	Description	Status
IEC 60870-6	Inter-Control Center Protocol	Widespread
IEC 62325	ebXML for Power Systems	In development
IEC 61970	Common Information Model / Generic Interface Definitions (CIM/GID)	In use; mostly single-vendor
IEC 61968	Interfaces for Distribution Management	Mostly still in development
Multispeak	NRECA Enterprise web services	In use; not flexible

- There is a culture of manual integration
- Very labour-intensive and costly
- Object models and services defined, but...
- A variety of underlying technologies: UML, XML, OWL, XSD, RDF, OPC
- Working on agreement on a design framework



T&D Wide-Area Networks

Name	Notes
Frame Relay	Packet-switched, no reliability guarantee
SONET	Campus or city backbones
WDM	Wavelength Division Multiplexing – follows SONET
<i>Microwave</i>	Proprietary, used in geographically difficult areas
<i>Satellite</i>	Various proprietary technologies, costly
<i>Trunked Radio</i>	Licensed, one broadcast channel, one return
<i>Spread-Spectrum</i>	Unlicensed frequencies, more efficient
<i>IP Radio</i>	Like trunked radio but with IP addressing

- Many of these are considered obsolete or aging in the general IT world
- Still in common use in the power system



T&D Substations

Name / No.	Description	Status
IEC 61850	Object models, self-describing, high-speed relaying, process bus	Widespread in Europe, beginning here
DNP3	Distributed Network Protocol	Most popular in NA
Modbus	Evolved from process automation	Close second
COMTRADE	Fault Capture file format	Widespread
PQDIF	Power Quality file format	In use
IEC 62351	Security for power systems	Recently released

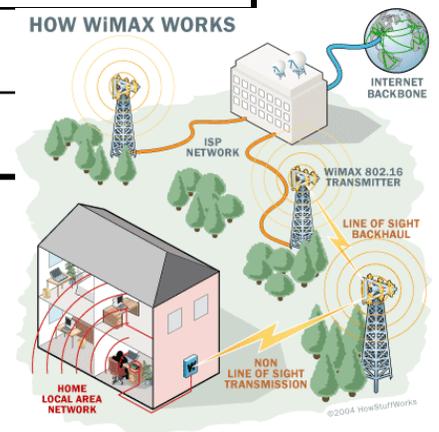
- Automation common in transmission
- Business case tough in distribution
- Well-known problems and solutions
- Moving to the next level



Access Wide-Area Networks

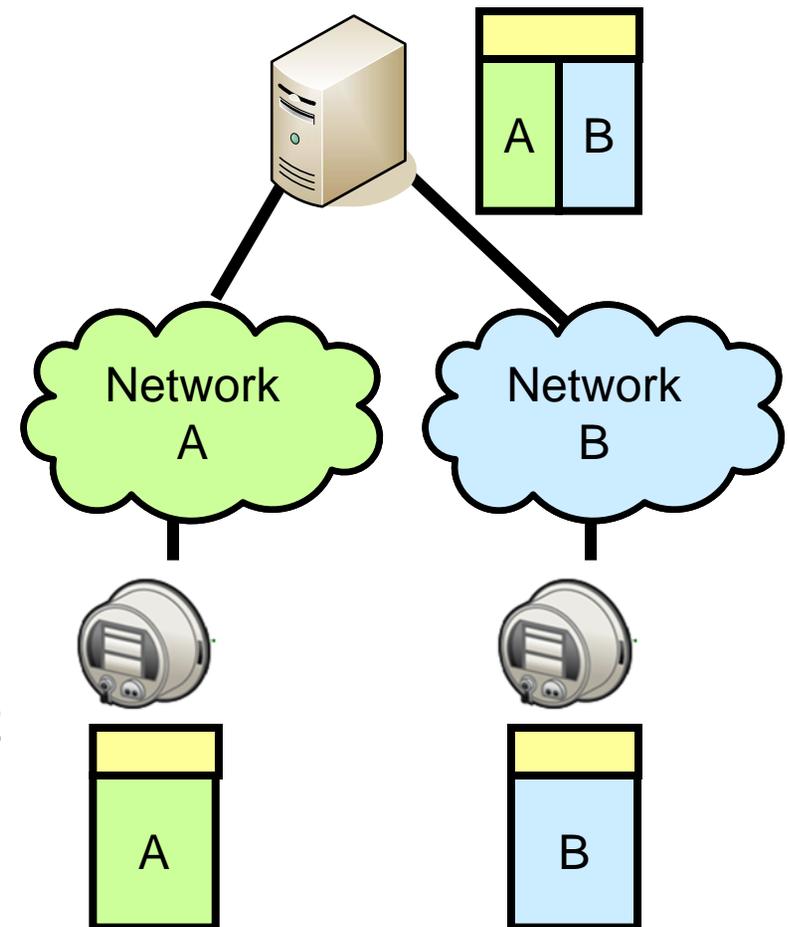
Name	Notes
PSTN	Public Switched Telephone Network – dial-up, leased lines
DSL	Digital Subscriber Line - Telco IP-based home access
Cable	DOCSIS standard for coax IP-based home access
WiMAX	WiFi with a backbone, cellular-type coverage
Cellular	Various technologies e.g. GSM/GPRS or CDMA/EVDO
FTTH	Fiber to the Home. Passive Optical Networks (PONs)
PLC	Narrowband Power Line Carrier – the “old stuff”
Access BPL	Broadband over power line to the home
Paging	Various proprietary systems, POCSAG

- Used to reach the Collector or Substation
- Too expensive, too unreliable or too slow for actual access to home



Field Area Networks – Distribution and AMI

- Offerings mostly proprietary
 - Wireless mesh, licensed or unlicensed
 - Power line carrier, narrowband or broadband
- Open standards not useful yet
 - Cellular, WiMAX, ADSL, Cable, FITL
 - Not economical or not reliable or both
 - Mostly only reach the Collector level
- Interop solution: common upper layer
 - Network layer preferred: IP suite
 - Most don't have bandwidth
- Application layer instead: ANSI C12.22
 - Too flexible, not enough interoperability
 - Need guidelines, profile from users
- More bandwidth the main solution!



Home Area Networks

Name	Number	Notes
Ethernet	IEEE 802.3	Substation LANs, usually fiber optic
WiFi	IEEE 802.11	Access by field tool, neighborhood AMI net
ZigBee	IEEE 802.15.4	Customer premises automation network
HomePlug	1.0, AV, BPL	Powerline comms, in and outside premises
6LowPAN	IEEE 802.15.4	The “approved” IPv6 wireless interface
OpenHAN		Power Industry requirements definition!

- ZigBee and HomePlug alliance
- LONWorks, Insteon, Z-Wave, X10 – popular proprietary networks
- Challenges coming in Electric Vehicles



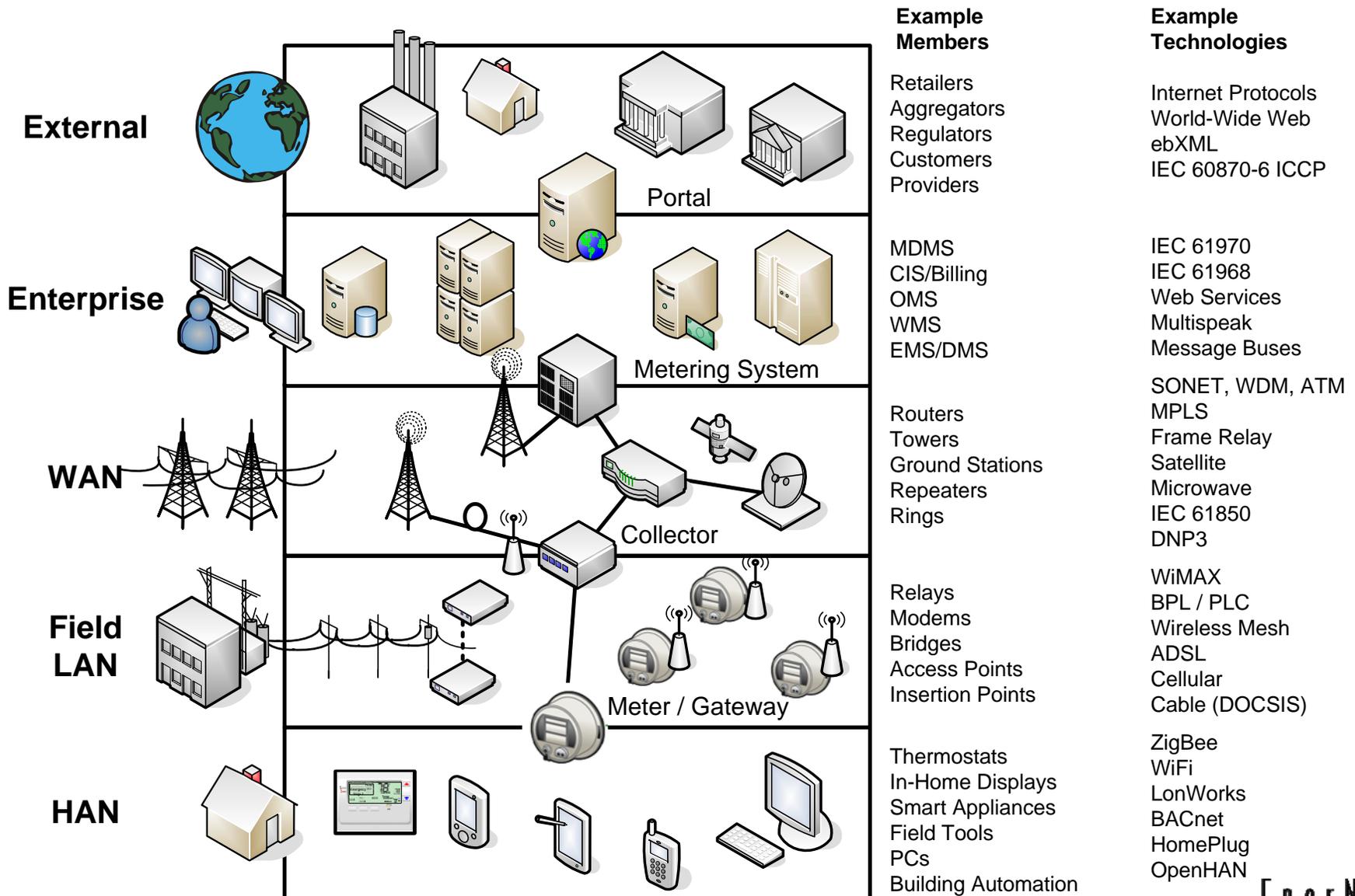
Distributed Resources and Commercial

Name / No.	Description	Status
OPC	Application interface	Widespread in industry
IEC 61400-25	Wind Power	In use; turf war
DRBizNet	California initiative	In development
BACNet	Building automation	In use; many profiles
OpenADR	Automated Demand Response	In development
IEEE 1547	Basic principles of DER	In use
IEC 61850-7-420	Information models for DER	Just released

- Rapidly growing, but tend to be “islands of automation”
- Concerns over integration with power utilities
- Need to get people talking

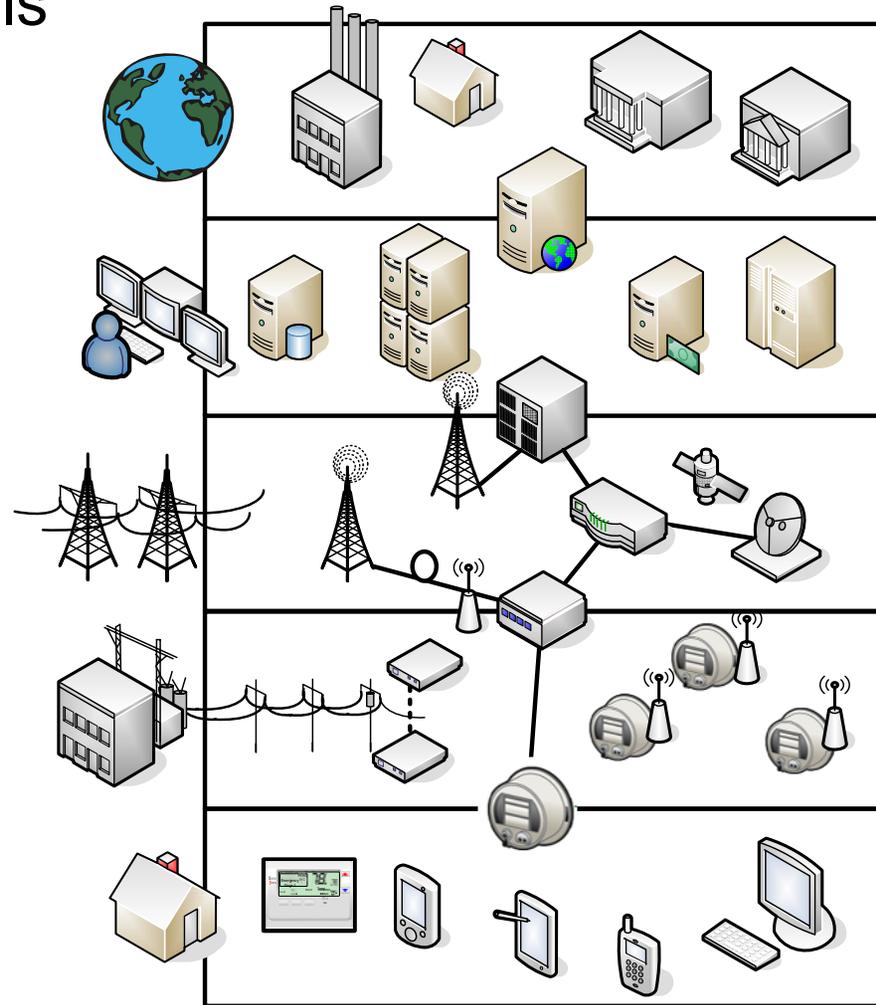


Another Look at Smart Grid Standards



Standards Challenges for Smart Grids

- Need Common Object Models
- Wishy-washy standards
- More bandwidth in the field
- Proprietary field networks
- Too many stds in the home
- Merging power and industry
- Merging meters and distribution automation
- Holistic security



Summary

Essential	Promising	Needed
IP-based networks!	WiMAX	Standard Field LANs
IEC 61970 CIM/GID	ZigBee / HomePlug	Modems for Field LANs
IEC 61968 Distribution	OpenADR	More field bandwidth!
IEC 61850 Substations	6LowPAN	CIM Design Framework
IEC 62351 Security	BACNet	CIM Application Security
DNP3	OPC/UA	CIM/61850 Harmonization
ANSI C12.19, C12.22	NERC CIPs	IEC 61850 Outside Sub
AMI-SEC		ANSI C12 Guidelines
OpenHAN		Finish AMI-SEC
		Asset Mgmt, DER, PHEV

We have the technology.

We have the lessons learned.

We just have to apply it!

Appendix: Networking Standards



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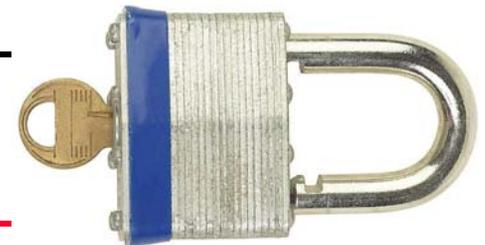
Core Networking Technologies

Name	Notes
IPv4	What everyone uses
IPv6	More addresses, better security, standard for China, DoD
TCP	Provides a connection, reliability, flow control
UDP	When you don't want any of those
HTTP	Basis of the world-wide web
MPLS	Latest of many to try to provide guaranteed bandwidth



Security Technologies

Name	Notes
TLS	Transport Layer Security – device-to-device
IPSec	Security for IP – site-to-site
HTTPS	Secure web traffic – application layer
Secure Shell	SSH, SCP, SFTP – secure login and file transfer
X.509	Key and certificate management
RADIUS	Centralized password management
Kerberos	Centralized key management
WPA2	IEEE 802.11i – wireless security (don't use WEP)
IEC 62351	Security for Electric Utility Protocols



Network Management Technologies

Name	Notes
ARP	Address Resolution Protocol
DNS	Domain Name Service
DHCP	Dynamic Host Configuration Protocol
SNMP	Simple Network Management Protocol
CMIP	Common Management Information Protocol
SNTP, NTP	(Simple) Network Time Protocol
IEEE 1588	Precision Time Protocol