Smart Grid Information Sharing Call

The Future Roll of Retail Broadband for Grid Integration

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April 3, 2013

Agenda

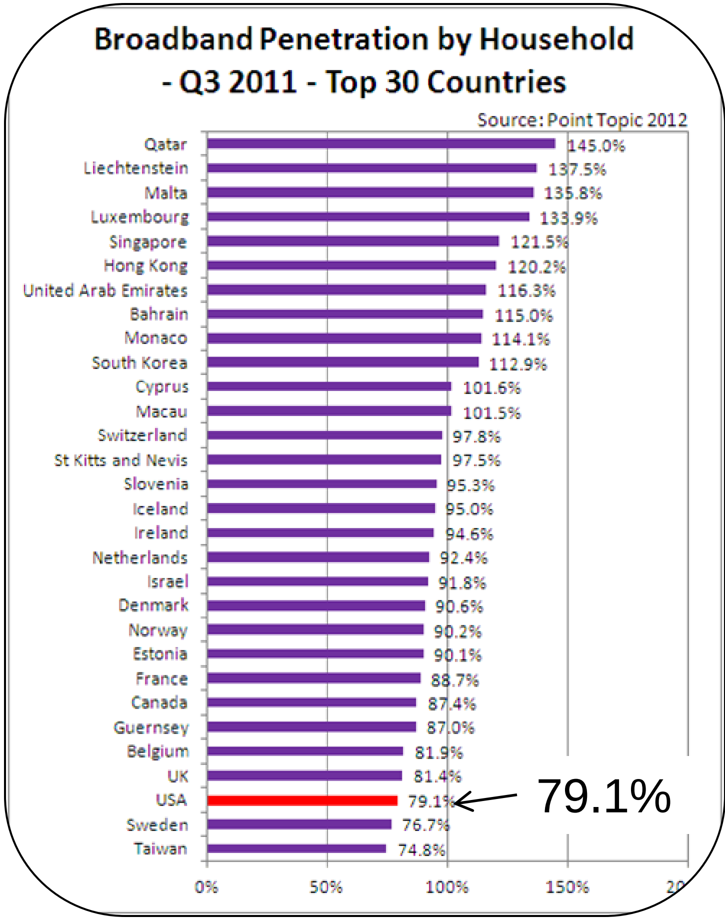
- Leveraging Retail Broadband Networks
  - Introduction
  - Utility Applications and Use Cases
  - Broadband Technology Options
  - Advantages of Customer Broadband
  - Addressing Potential Issues
- Open Interoperable AMI
- Conclusion

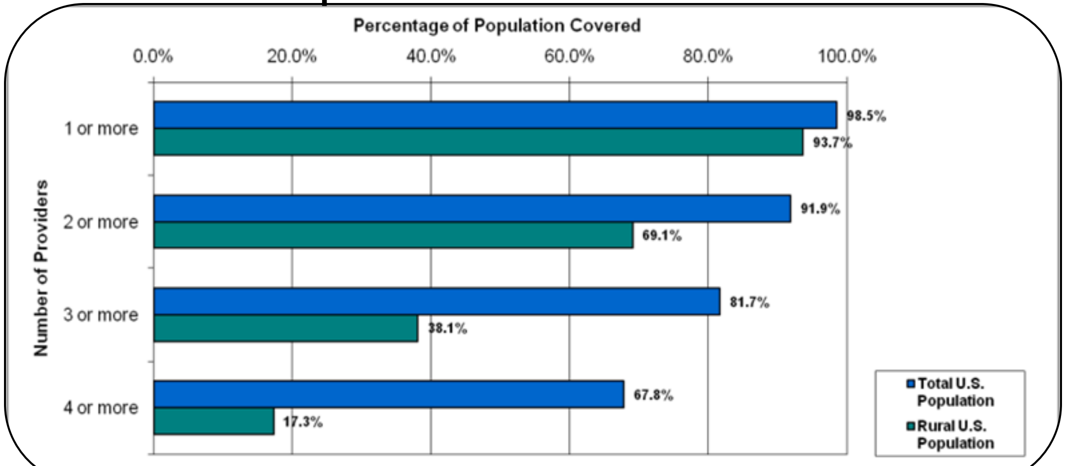
Introduction – Leveraging Retail Broadband

- Not focused on the NAN or FAN, but the connection to the customer premises
- Customer Integration: More than metering – a variety of applications
- Can existing broadband networks play a part in this subset of utility communications?

Introduction to the opportunity

- Broadband is widely deployed in the US
  - While the US is not at the top globally, 79.1% of homes have broadband *
    - Alternate: 90M US Subscribers, 132M Housing units: 68%
  - 99% of US population is in coverage area of at least one wireless carrier.
- Given the nearly ubiquitous presence of retail broadband networks, is it still necessary for utilities to deploy private networks to connect the customer premises?





Wireless Carriers

•Counting multiple subscribers per home

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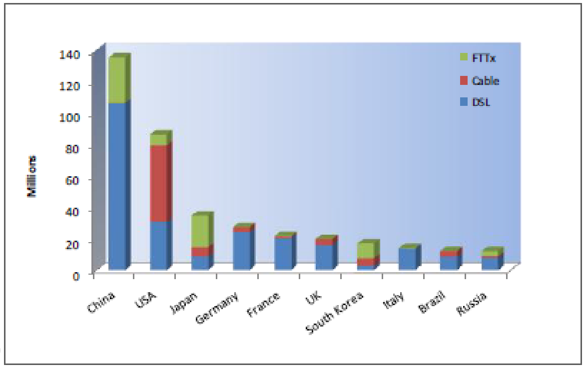
Introduction to the opportunity

Figure 12: Total Subscriber Numbers by Technology Adopted in Q1 2011



- There is not a simple answer – it depends on many factors
- To explore the pros and cons, we categorize "Retail Broadband" along two axes:

Fixed Broadband: ISP - DSL, Cable Modem, FTTH

Connection 'as-is': No provisioning

Utility relationship with broadband provider

Wireless Broadband: Mobile Carriers 3G/4G data services

Specific Use Cases (customer interactions)

- Collection of Interval Data for Billing
- Collection of Interval Data for Customer Feedback
- Collection of Customer Voltage and PQ Data
- Sending Energy Price to Customer
- Sending Load Management Signals to Customer
  - Basic Direct Load Control
  - Advanced Ancillary Services
- Management of Customer Distributed Energy Resources
  - Residential Photovoltaic
  - Residential Storage (& V2G)

Applications: Metering

- Performance gap between AMI and Broadband
- Consider an “aggressive” metering scenario:

Daily Activity	Traffic per Node
• Read consumption every minute	63 KBytes
• Add vars, volts, PF, amps, temp	34 KBytes
• Real-time knowledge of the state of key appliances	6 KBytes
• Streaming real-time price every 5 minutes	16 KBytes
• Read PV meter every minute	63 KBytes
• Dispatch DER for generation / regulation services	37 KBytes
• Stream data to in-home display every 5 minutes	13 KBytes
• Smart PHEV charging & local balancing	6 KBytes
Total:	**238 KBytes**

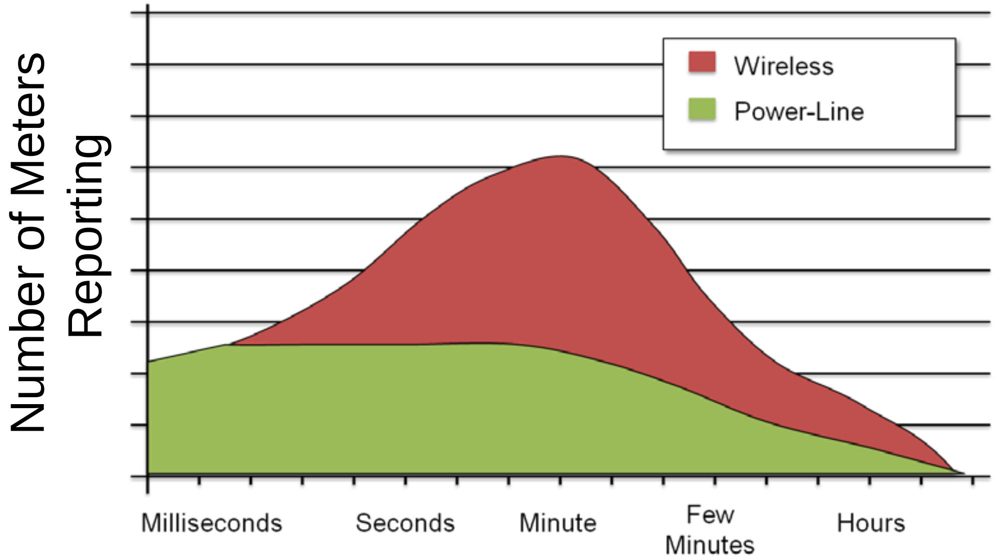
- Compared to:

Point browser once to yahoo.com	240 KBytes

- Conclusion: The data volume for metering is insignificant compared to normal broadband usage

Issues with conventional AMI networks

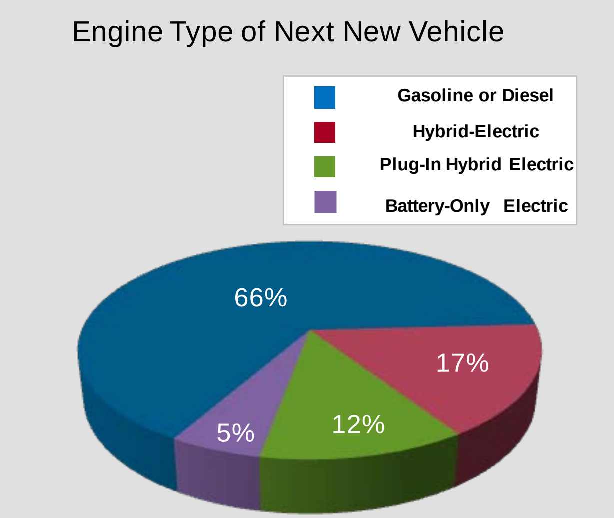
- Why don't existing AMI networks provide all the needed functionality?
  - For basic meter reading, they are just fine
- If and when new smart grid applications demand more frequent updates from the meter, throughput and latency are limited



Response Time – Bellwether Meters (1%)

Premise-based Smart Grid Applications

- Load Management (Demand Response)
  - Thermostats, Large Appliances (big loads) can communicate, and are able to reduce load at peak demand times.
  - In-home displays – can provide real-time information on energy use, and scheduling of loads.
- Distributed Generation
  - Photovoltaic production monitoring
  - Smart Inverter control
- Electric Vehicles
  - EVs have the potential to represent the largest load in a home. Level 2 fast chargers can draw up to 20KW.
  - Communication is needed for demand response, and sub-metering

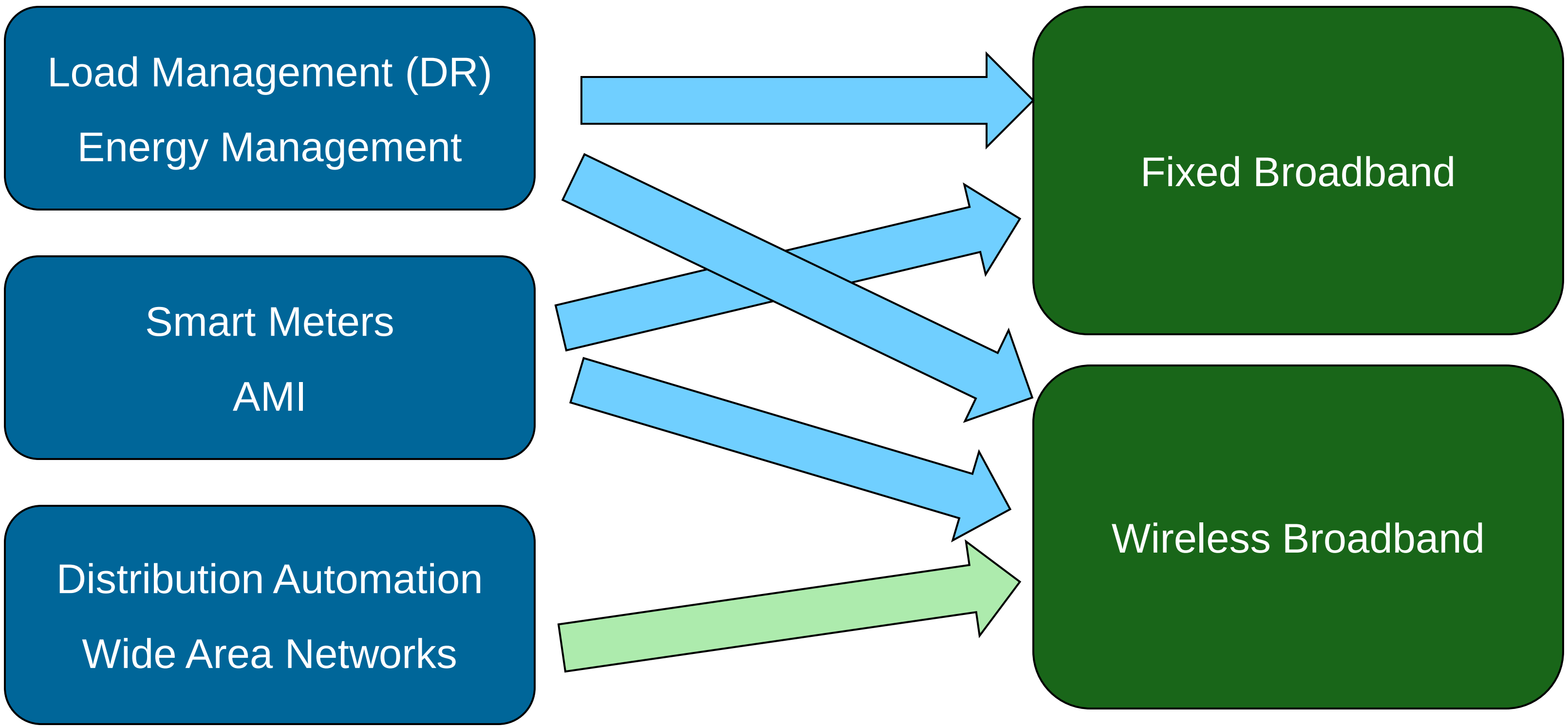


EPRI Report

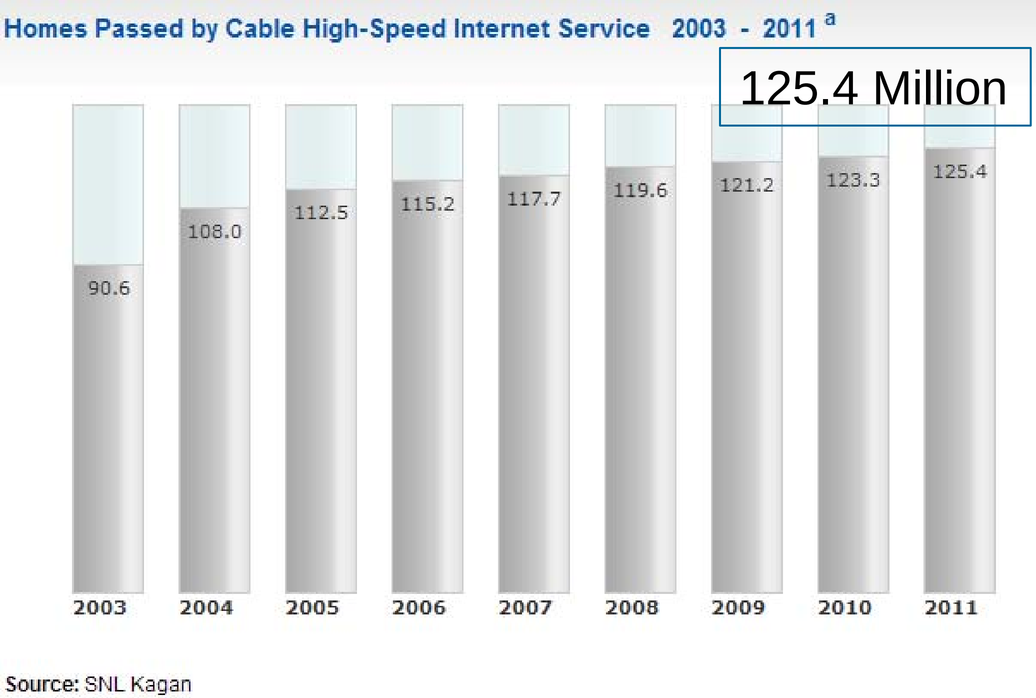
Southern Company Electric Vehicle Survey: Consumer Expectations for Electric Vehicles

Scope

- The focus is on the “customer integration” side of Smart Grid communications:
  - Smart Meters and Load Management
  - DA is not addressed (see Field Area Network Demo)



Fixed Broadband: Technology options



- Cable Modems
  - Wide deployment in US
    - Available to 93% of households (Dec 2011)
  - Less in other countries
- DSL
  - Globally deployed
- Fiber to the Home
  - Becoming more common, best in high density areas
- Wireless ISP
  - Sometimes the best option in rural areas
  - Sometimes used in urban areas as ISP alternative (WiMAX, MiFi, etc)

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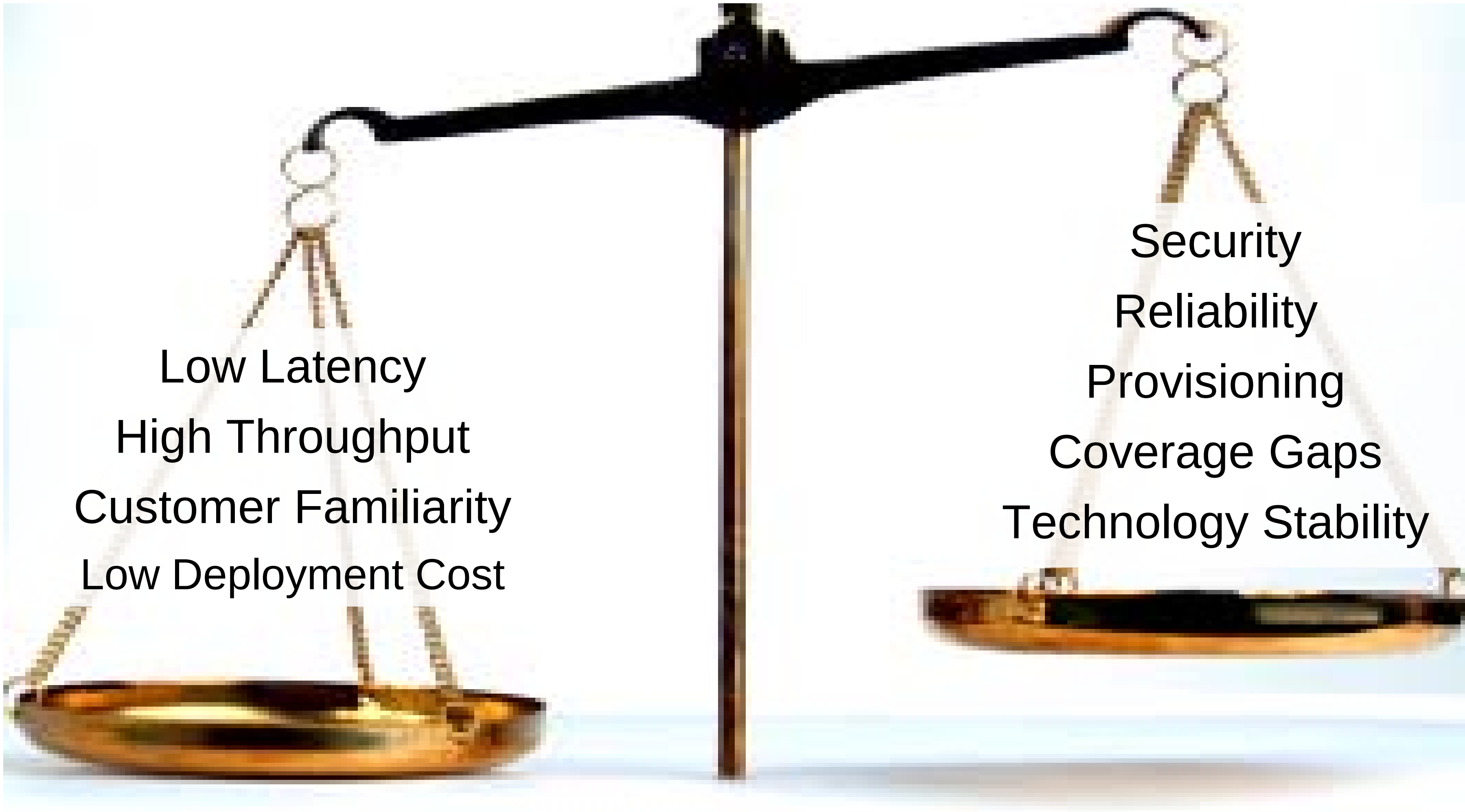
Wireless Broadband: Technology options

- Two types of systems in North America

	2G	3G	4G
Sprint	CDMA	CDMA/EVDO	WiMAX (now) LTE (starting)
Verizon	CDMA	CDMA/EVDO	LTE
AT&T	GSM	HSPA/HSPA+	HSPA+/LTE
T-Mobile	GSM	HSPA/HSPA+	HSPA+/LTE

- 3G and 4G necessary to achieve "broadband" data capability.
  - Most carrier's coverage maps show voice coverage only
  - Data coverage area may be smaller

Challenges and Opportunities of Leveraging Customer Broadband

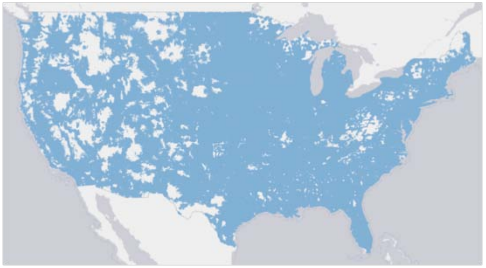


Advantages of Customer Broadband

- Higher Bandwidth, Faster Response (latency)
  - Enables additional customer interactions, applications, and services
  - Bandwidth required for utility applications is typically too small to be noticed by customer
  - Headroom to support future requirements and services

- Lower Deployment Cost
  - For new Smart Meter deployments, less utility-deployed infrastructure is required
  - Backhaul requirements may be reduced (public or private)

- Wireless provides almost ubiquitous coverage –
  - Within the carriers' service area of course
  - Always a few "dead spots"



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Customer Broadband: Addressing Security

- Concerns:
  - Prevent unauthorized access to utility network from Internet, operators network, or customer LAN
  - Prevent unauthorized access to utility devices (Smart Meter)
  - Prevent exposure of customer information (privacy)

- Approaches
  - End to End Encryption (TLS)
  - Firewalls
  - IPv6 tunneling over IPv4
  - VPN
  - Operator provisions secure tunnel over their network, with secure gateway to utility core network.
  - Specific details must be analyzed by utility security team

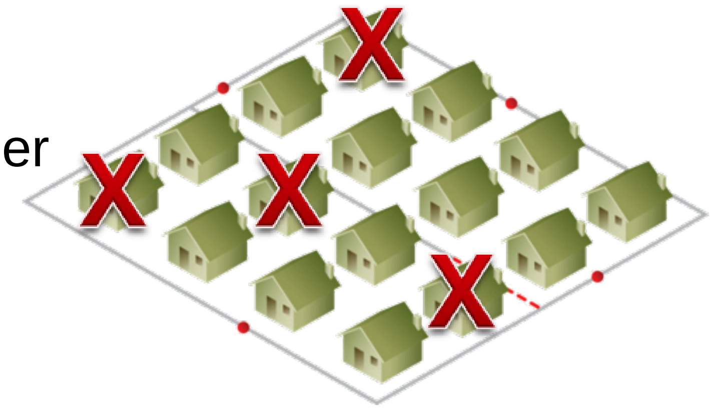
Customer Broadband: Addressing Reliability

- Concerns
  - In case of storm or disaster, what is the recovery time?
  - Operator's network reliability is out of the control of the utility
  - How long can an operators network sustain operation in a power outage situation?
  - Retail networks may have failures (system-wide or customer-induced for fixed ISP services)

- Approaches
  - Provides "backup meshing" between meters to provide link for small-scale outage
  - Utility designs in alternative backhaul technology for emergency backup and large scale outage
  - Take advantage of in-home display to notify user of local connectivity issues.
  - Operator provides extended backup power at cell sites or head-end
  - Operator provided redundancy in infrastructure and network core

Customer Broadband: Addressing Coverage Gaps

- Concerns
  - Fixed Broadband penetration is not 100% - what about homes with no broadband? (either by choice or because of geography)
  - Wireless coverage has holes, especially in rural areas. Even in voice coverage areas, there may be no data.



- Approaches
  - Utilize meshing capability between meters to fill in coverage gaps of one or a few homes.
  - Connect mesh to alternative backhaul technology for larger areas with no broadband
  - With relationship to provider, install terminals at non-subscriber locations

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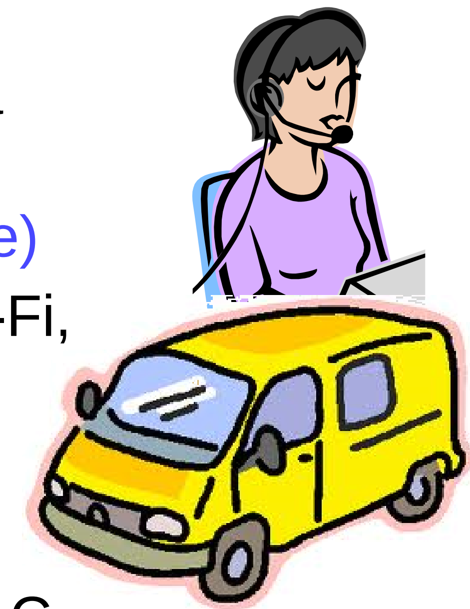
Customer Broadband: Addressing Provisioning

- Concerns (in the "as-is" case)
  - Will leveraging customer broadband result in a customer support problem for the utility?
- Approaches (if provider relationship is unavailable)
  - If connectivity to customer's ISP is through Wi-Fi, take advantage of new capabilities
    - Wi-Fi Protected Setup
    - Wi-Fi Direct
  - If connectivity to customer's LAN is through PLC, provide a simple plug-in device that is pre-configured to connect to the meter.
  - For cellular wireless devices, utility must depend on the carrier to provide appropriate tools for provisioning and management



Wireless Broadband: Addressing Stability

- Concerns apply to wireless carrier systems:
  - The evolution of the cellular system progresses at a faster rate than many utility systems.
  - 2G networks are being "re-farmed" now. What happens when the 3G and 4G networks become obsolete?

- Approaches
  - Carriers may guarantee longevity of a particular technology as part of a comprehensive relationship
  - "Smart" base stations can support multiple standards, allowing smoother evolution in the future.
  - Smart Grid devices may be designed with modular communication components

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Integration and Evolution

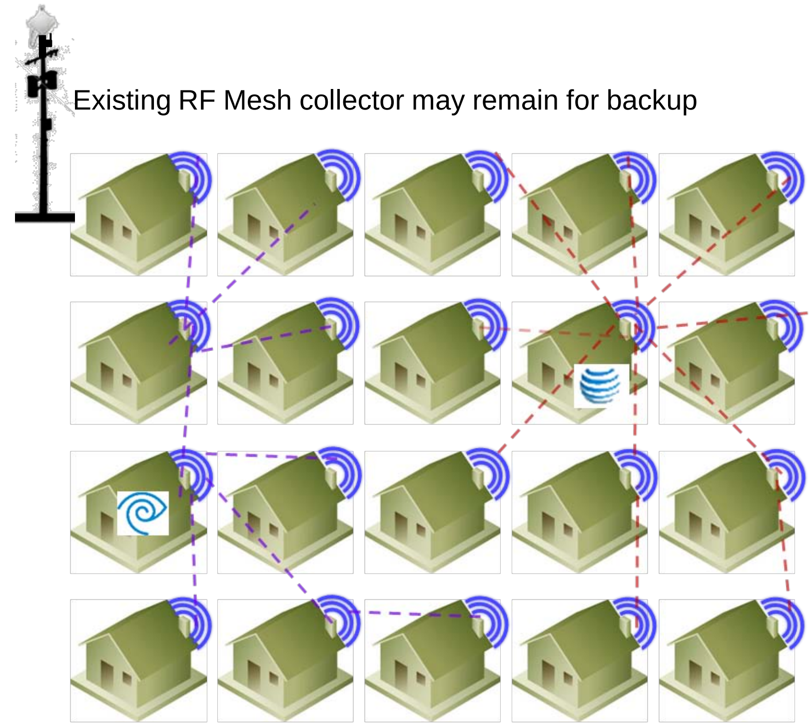
- Broadband may be integrated incrementally
  - Any existing AMI network can remain
  - Variety of options to connect from broadband to meter
  - In "as-is" case, consumer broadband added piecemeal initially"
    - Based on greater engagement with specific customers
    - Enabling new applications for customers

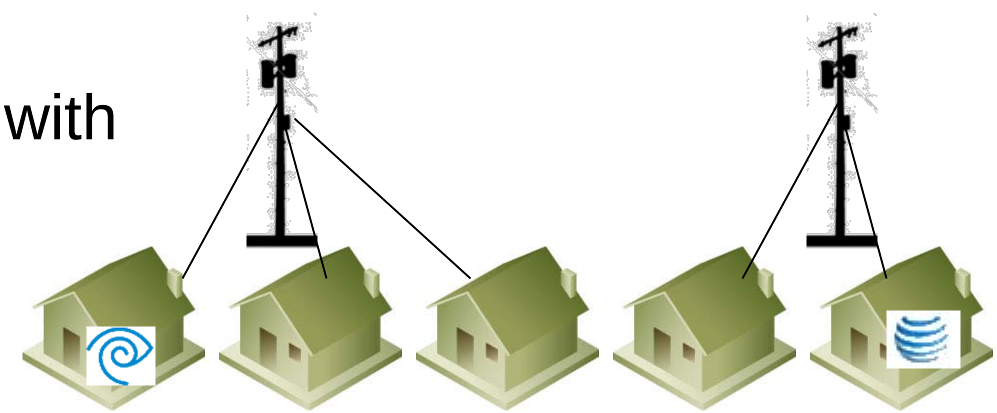
- With service provider partnership
  - Install broadband node at meter if necessary

- Hybrid network benefits
  - Mesh options to extend to non-connected meters
  - Use high bandwidth apps on consumer network where available
  - Metering data always has a path
  - Option to maintain existing collectors as backup

Hybrid Network

- A topic for testing and research
- A few locations with broadband initially serve as backhaul
- Meshed clusters can work with RF Mesh or PLC





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Report Details

- Further details on the topic of leveraging retail broadband are available in EPRI report with Product ID 1024306

Leveraging Retail Broadband is one aspect of establishing a full set of standards to enable Open Interoperable AMI systems.

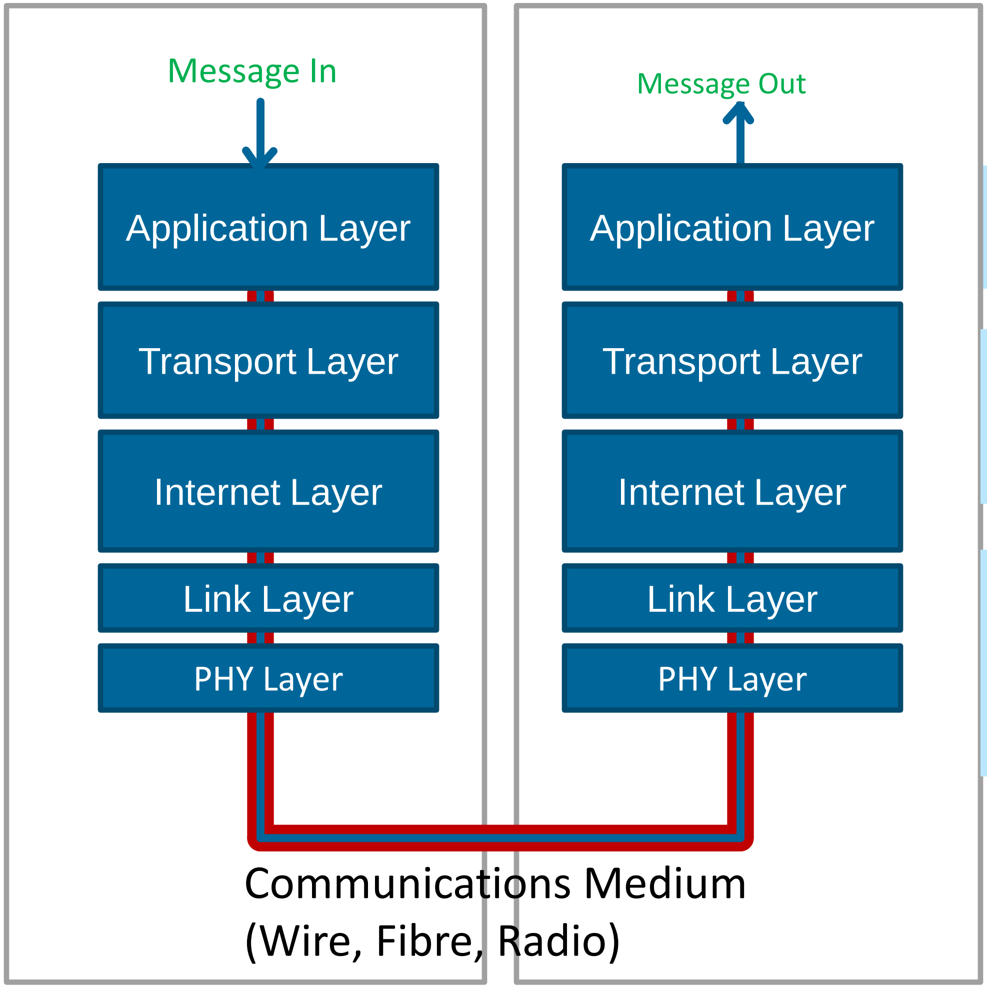
The following section will introduce EPRI's research initiative in this area

Open, Interoperable AMI

Open, Interoperable AMI

- Current State
  - Mostly vendor-specific systems
  - End-to-end solutions
- Desired Future State
  - Interoperable standards at every layer
  - Supplier choice at different layers
  - Ability to integrate and migrate mixed systems
- Roadmap
  - Prioritize key interoperability gaps with utilities
  - Conduct workshop to develop consensus on plan
  - Engage with industry organizations to facilitate and contribute to development of upper layer AMI standards

What is needed for an interoperable system?



- Standards must exist at every layer:

Semantics (meaning) of data, representation and encoding of data

Establishing an end-to-end logical connection, ensuring reliable delivery, routing through the network

Managing data flow on the communications medium, securing the link, formatting and transmitting the bits

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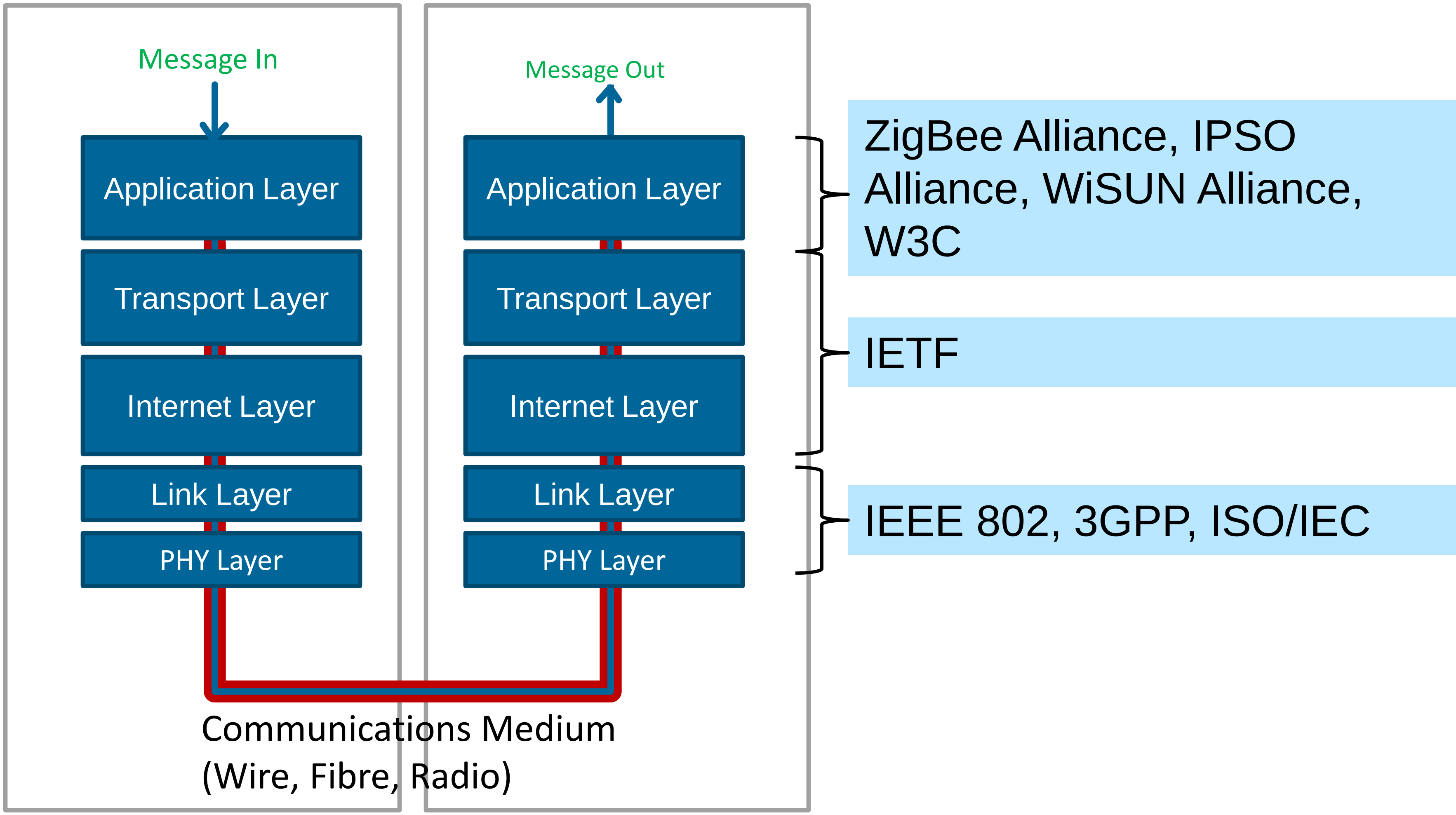
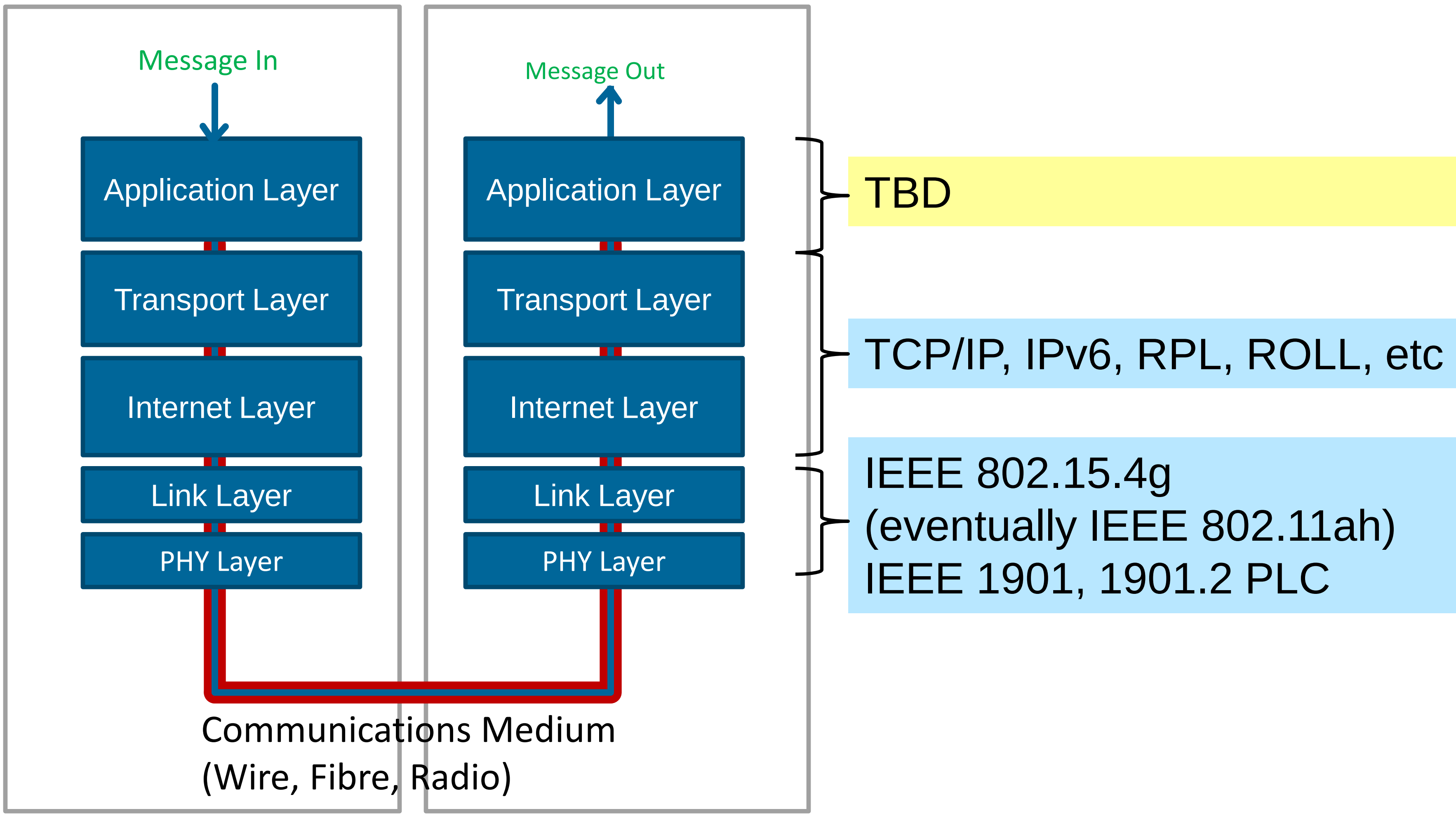
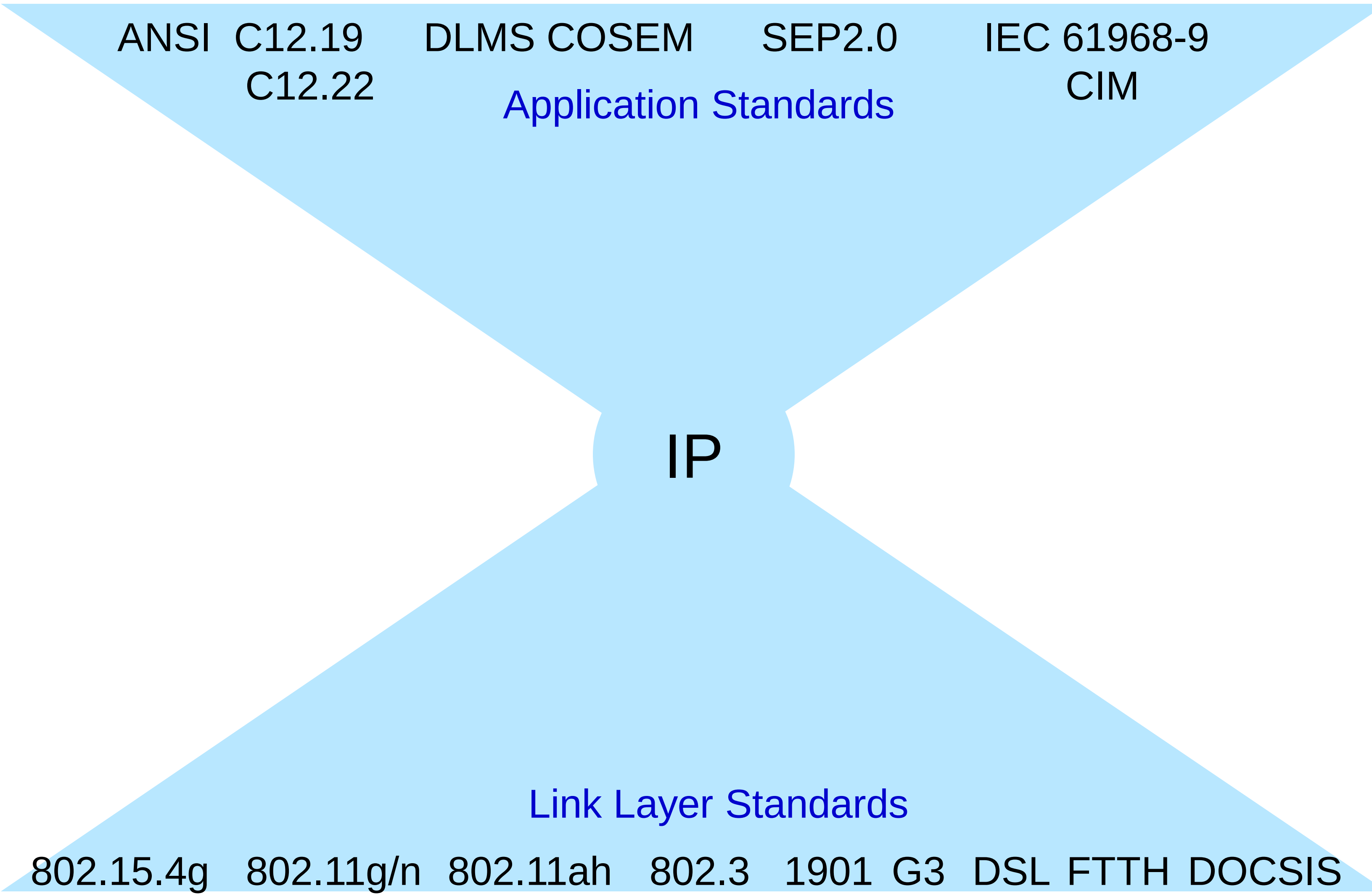
Who is responsible for these standards?



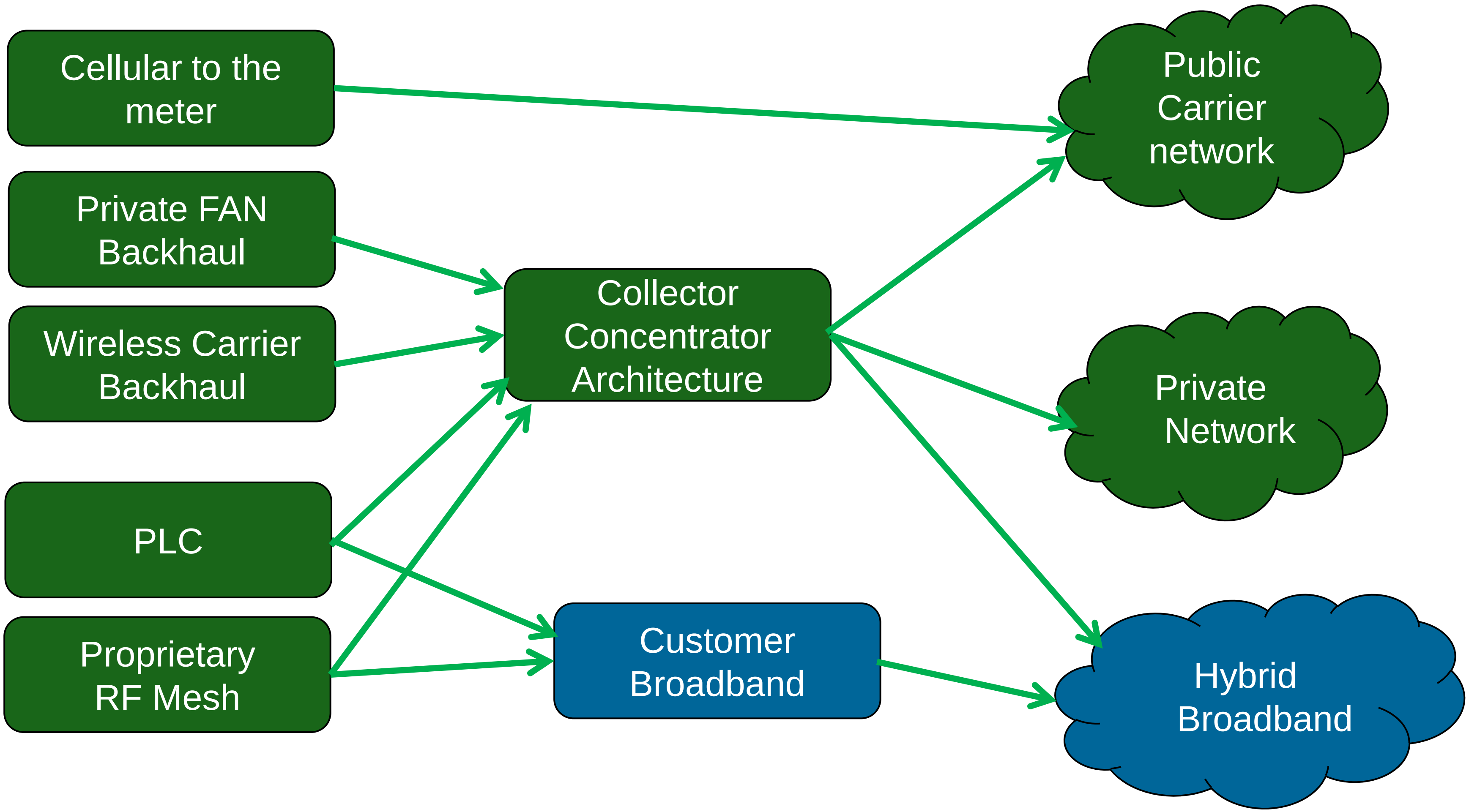
Status of open standards for AMI



Interoperability trend: the IP "pivot"



Conceptual Roadmap Lower Layers



End Goal – Capacity, Reliability, Security over interoperable, standardized links

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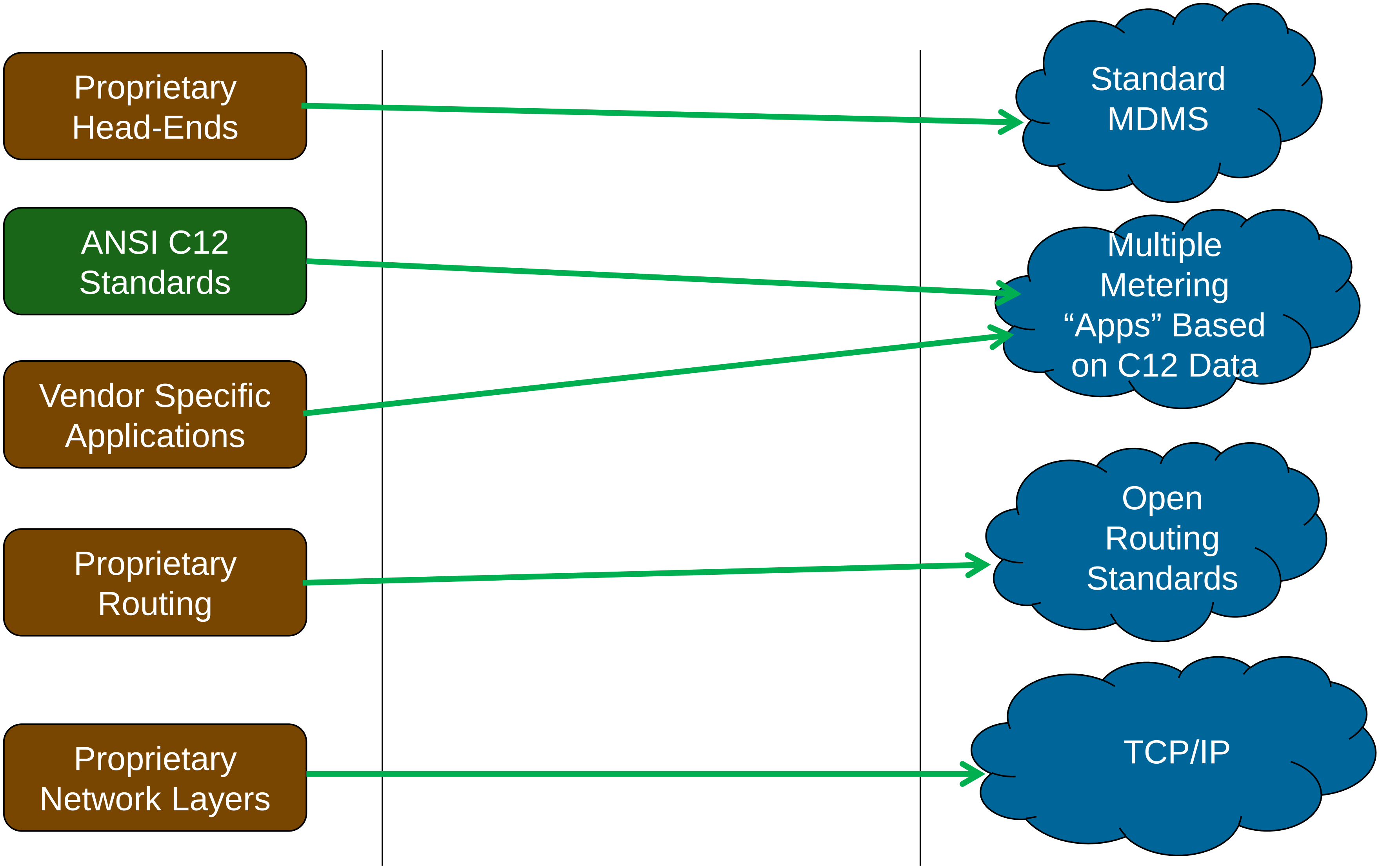
Conceptual Roadmap Upper Layers



Additional Long Term Research

Achieving Interchangeable Wireless Hardware

- **A Sustained Research Topic**: Build upon the 802.15.4g PHY/MAC with routing, network, transport, and management standards to create a fully-interoperable stack.

- **Approach**
  - Stakeholder engagement / large collaborative beginning
  - IEEE 802.15 L2 Routing Study Group
  - Alliances, SDOs, NIST
  - Design and demonstrate

Conclusions

- The high performance potential of consumer broadband is attractive
  – Enabler of new applications at the customer
- Concerns over availability (coverage), reliability, and security are manageable
  – No single solution
  – Hybrid connectivity (broadband + private) a possibility
- Open, Interoperable AMI standards can enable integration of broadband networks at the customer premises as a part of a comprehensive communication architecture.

Questions?

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