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Challenges and Benefits of AMI Development in the USA

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APEC Workshop on Addressing Challenges in AMI Deployment and Smart Grids in APEC

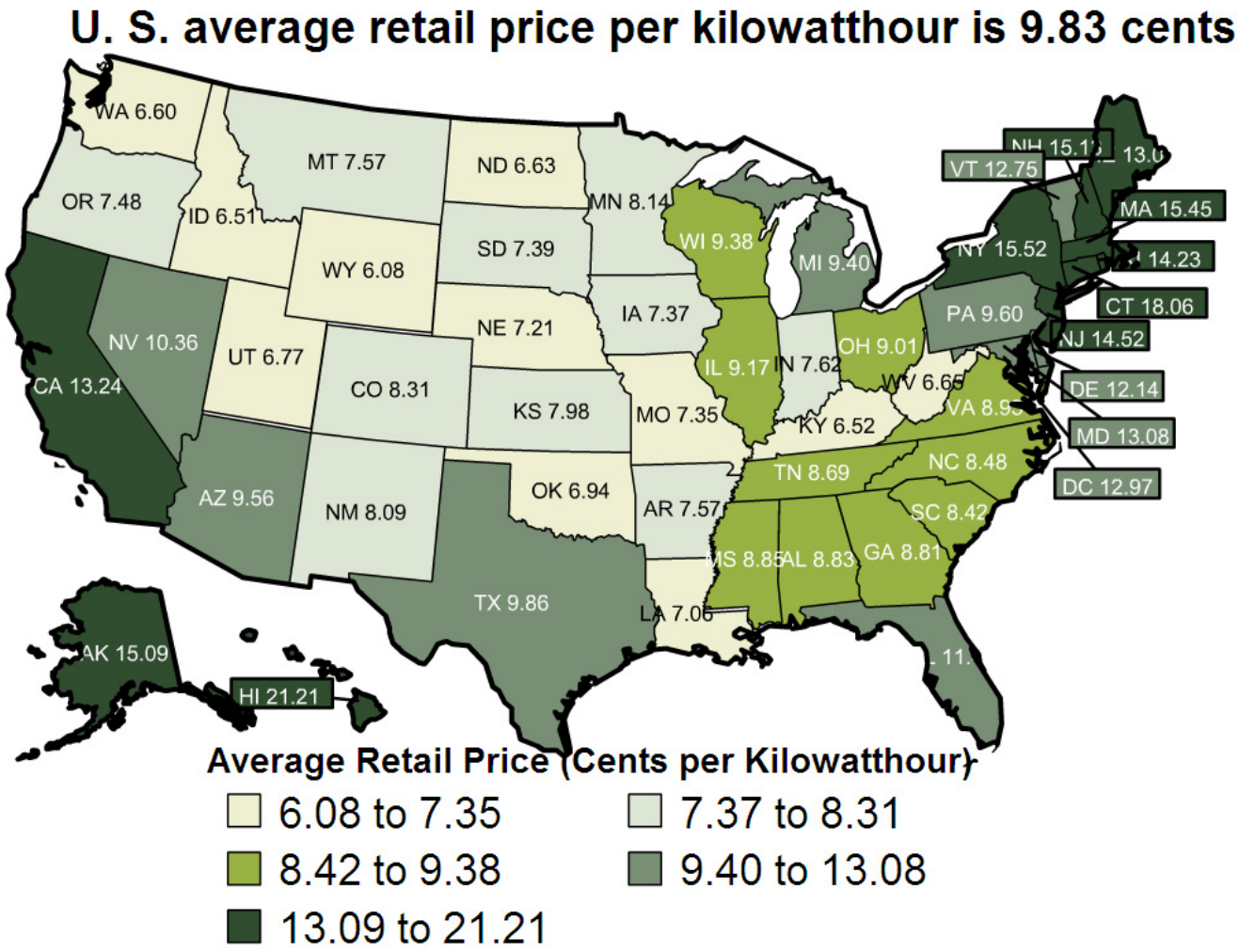
August 24th & 25th , 2011

Outline

- AMI Definition and Context
- AMI Application Examples
- AMI Challenges and Change

U.S. Electricity Cost Profile

- Average Residential Consumption = $925KWh
- Average Monthly Cost = $103
- Median Household Income ~ $50,000/yr
- Cost of Electricity ~ **2.5%** of Annual Income



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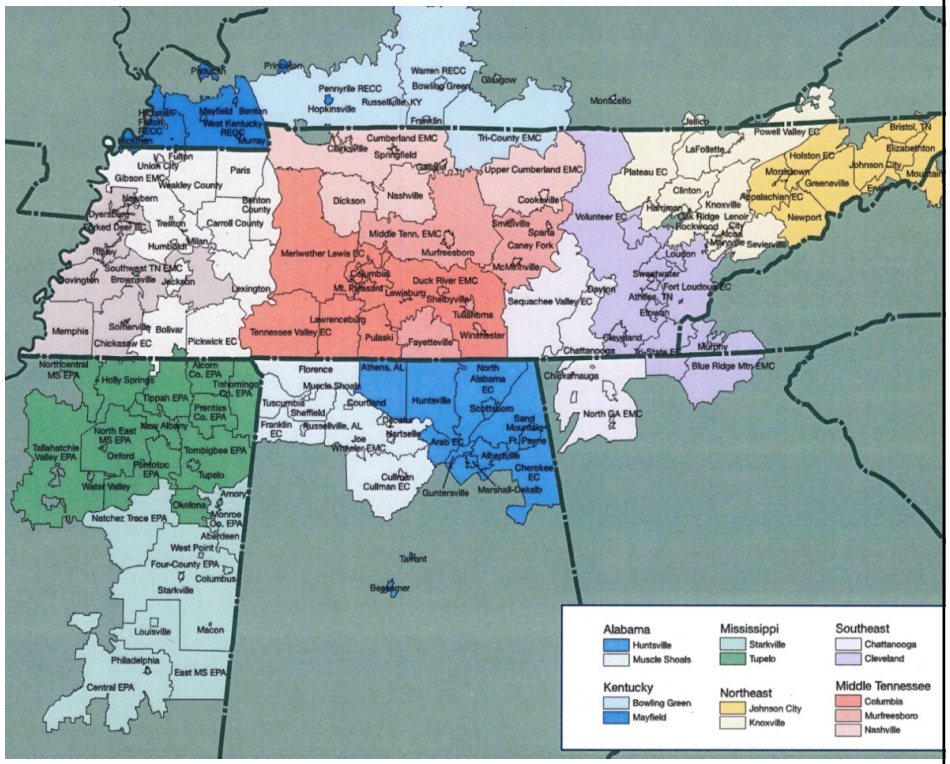
Diversity Among U.S. Utilities

3,270 Utilities in the United States

- 210 Investor Owned
- 2000+ Municipalities
- 900+ Cooperatives

Tennessee Valley Distributors Example:

- 155 Munis and Cooperatives
- Sizes: 900 to 430,000 customers
- Employees: 3 – 2700
- Density: 5 - 65 customers per mile



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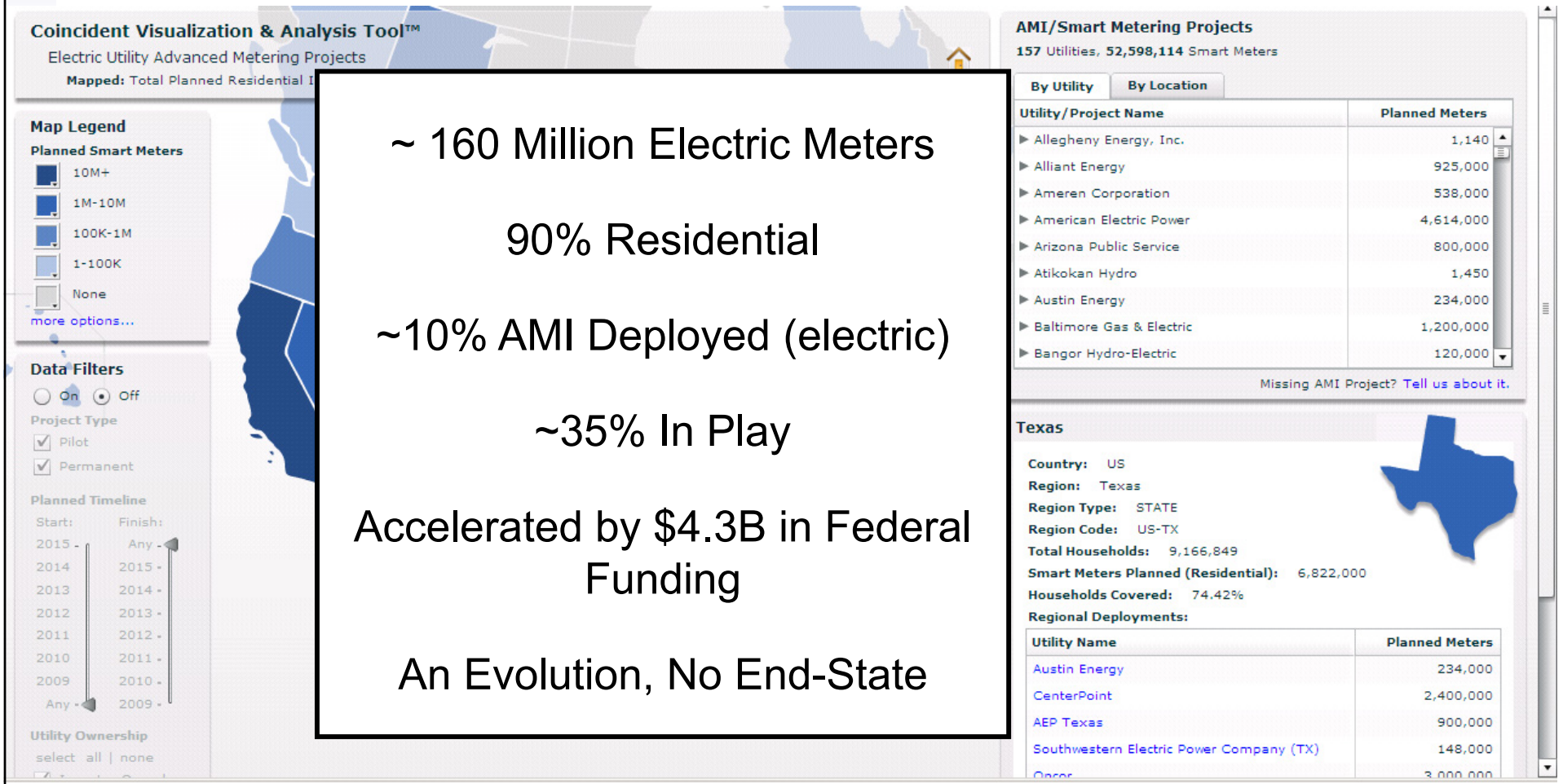
Tracking Advanced Metering Infrastructure



~ 160 Million Electric Meters

90% Residential

~10% AMI Deployed (electric)

~35% In Play

Accelerated by $4.3B in Federal Funding

An Evolution, No End-State

Map from: http://www.coincident.com/smart-meters/main.html

What is “Advanced Metering Infrastructure”?

AMR (Automated Meter Reading) 1990 to 2004

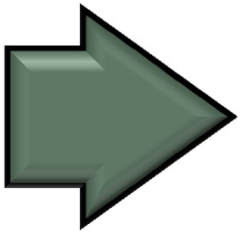
One-way communication

May be mobile, or intermittent

Monthly billing reads

No outage reporting

The application is a given. I need to read meters. What systems can I use for this?



AMI (Advanced Metering Infrastructure) 2004 – ?

Two-way communication

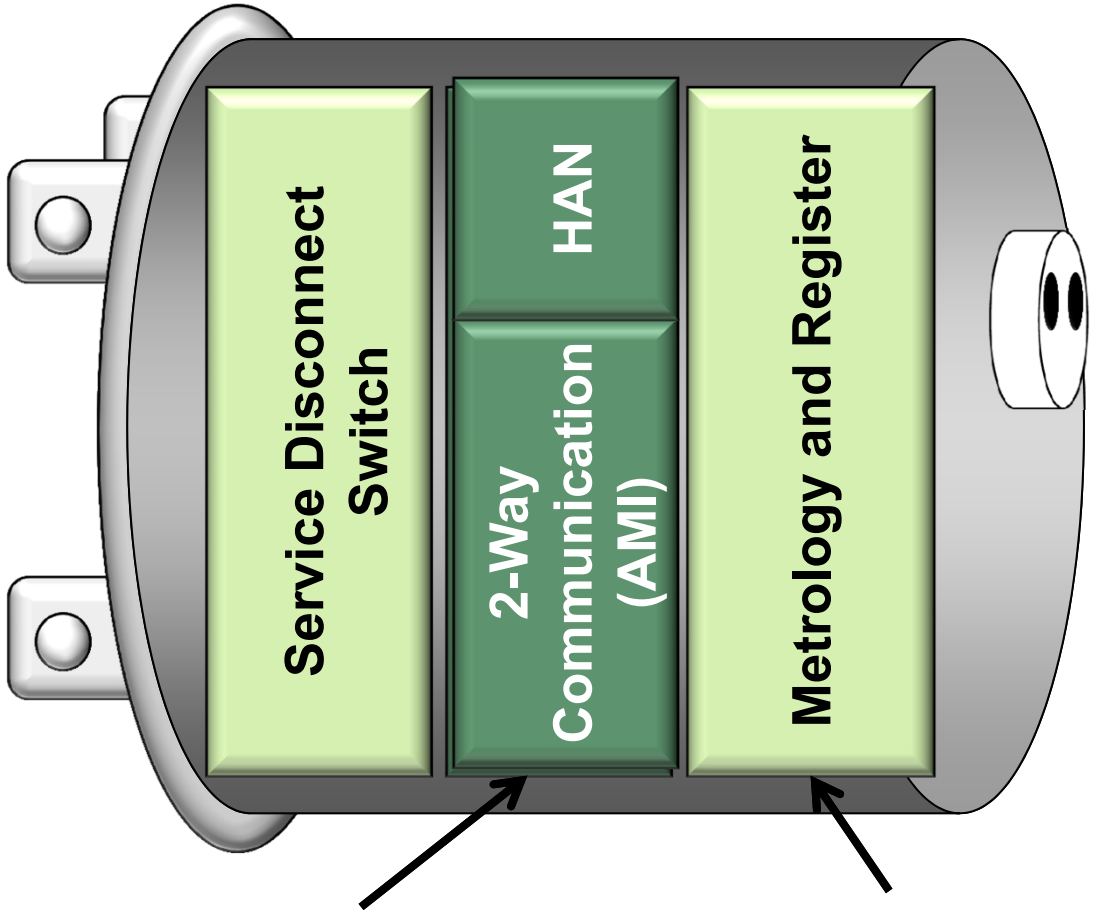
Fixed network

Interval data

Outage reporting

I need a flexible, two-way communication system, through which I will do many things.

U.S. Smart Meter Makeup

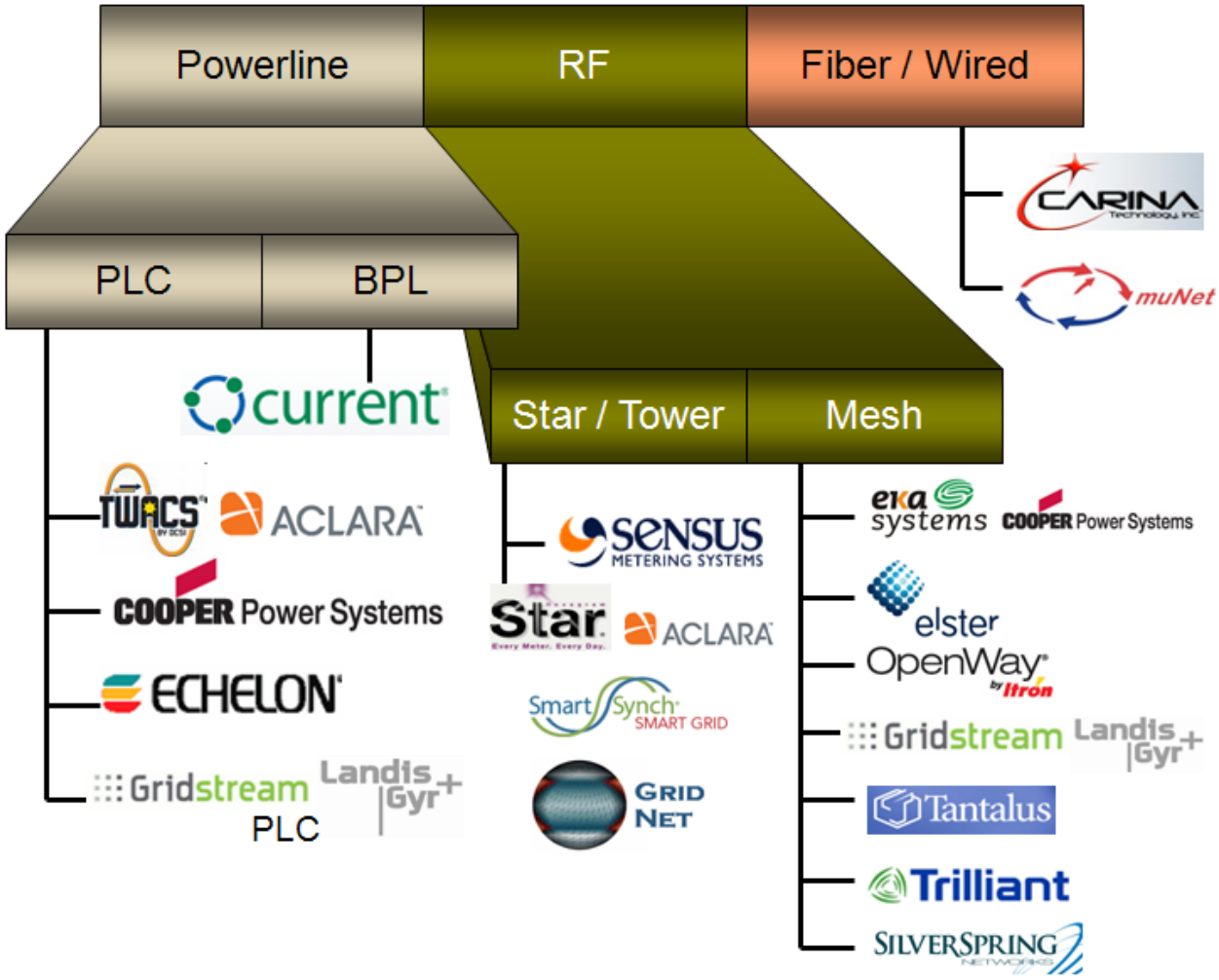


Dozens of AMI Providers

6 Meter Providers

AMI Technology Diversity

- PowerLine, RF, Wired
- Public/ Private
- Licensed/ Unlicensed
- Diverse Frequencies



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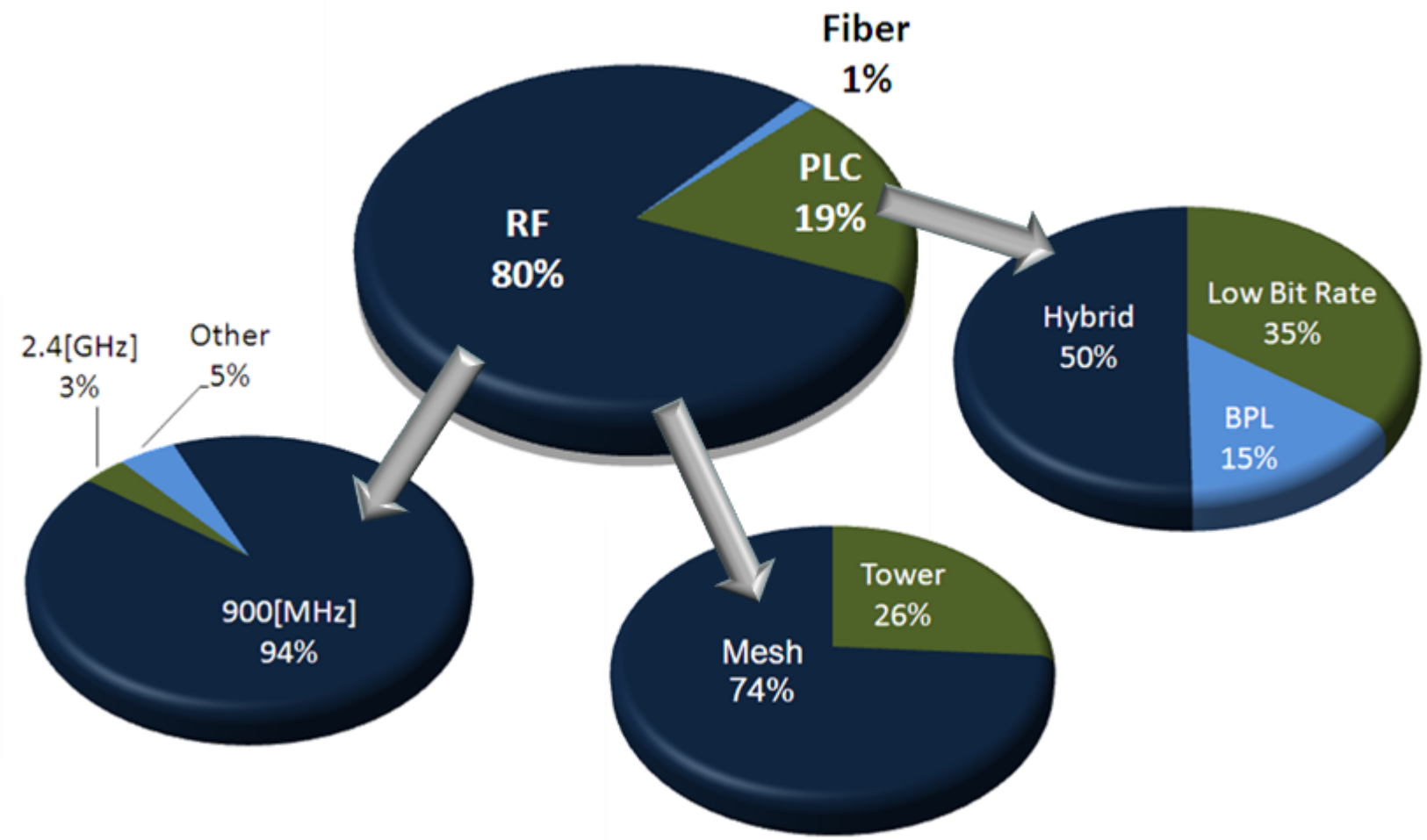
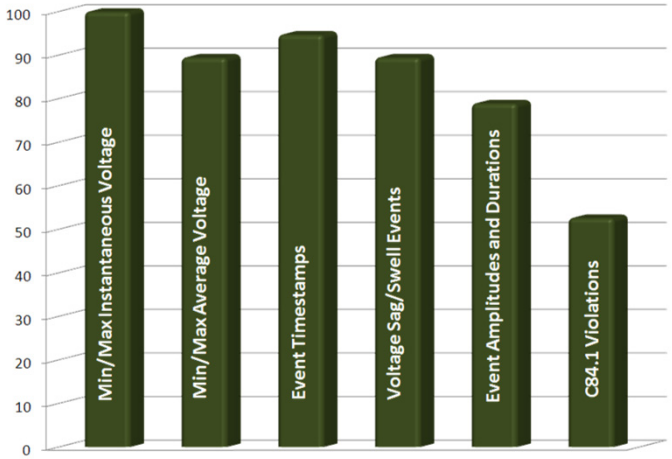
U.S. AMI Technology Breakout

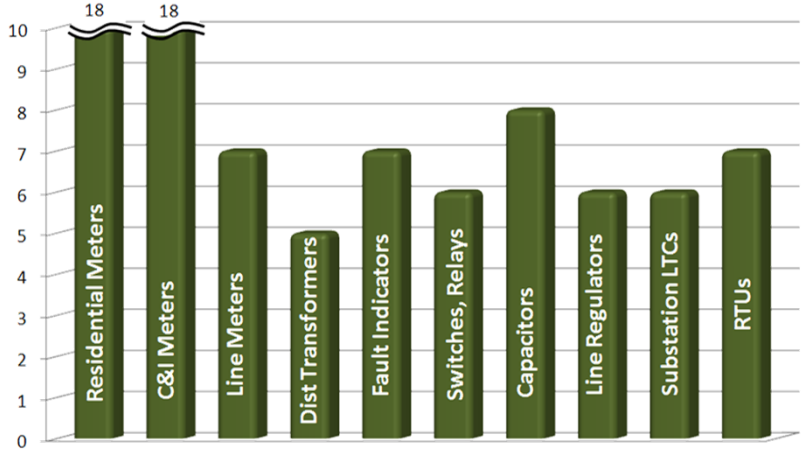


- AMI Definition and Context
- AMI Application Examples
- AMI Challenges and Change

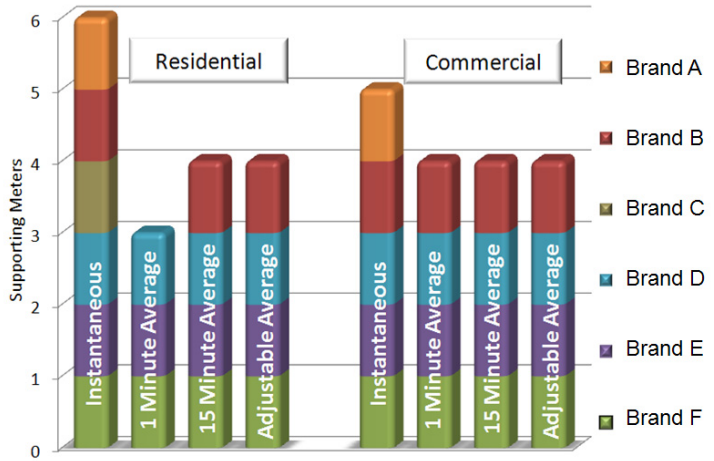
AMI Supporting Distribution Operations



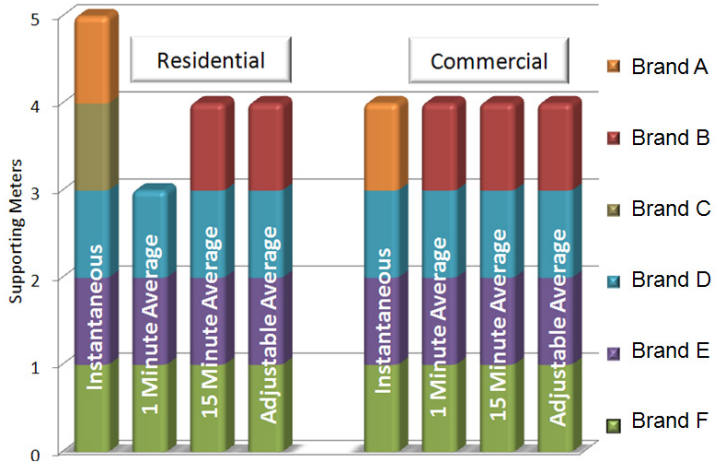
Voltage Data via AMI



Distribution Equipment via AMI



Meter Support of Voltage Measurements



Meter Support of real-time Watts

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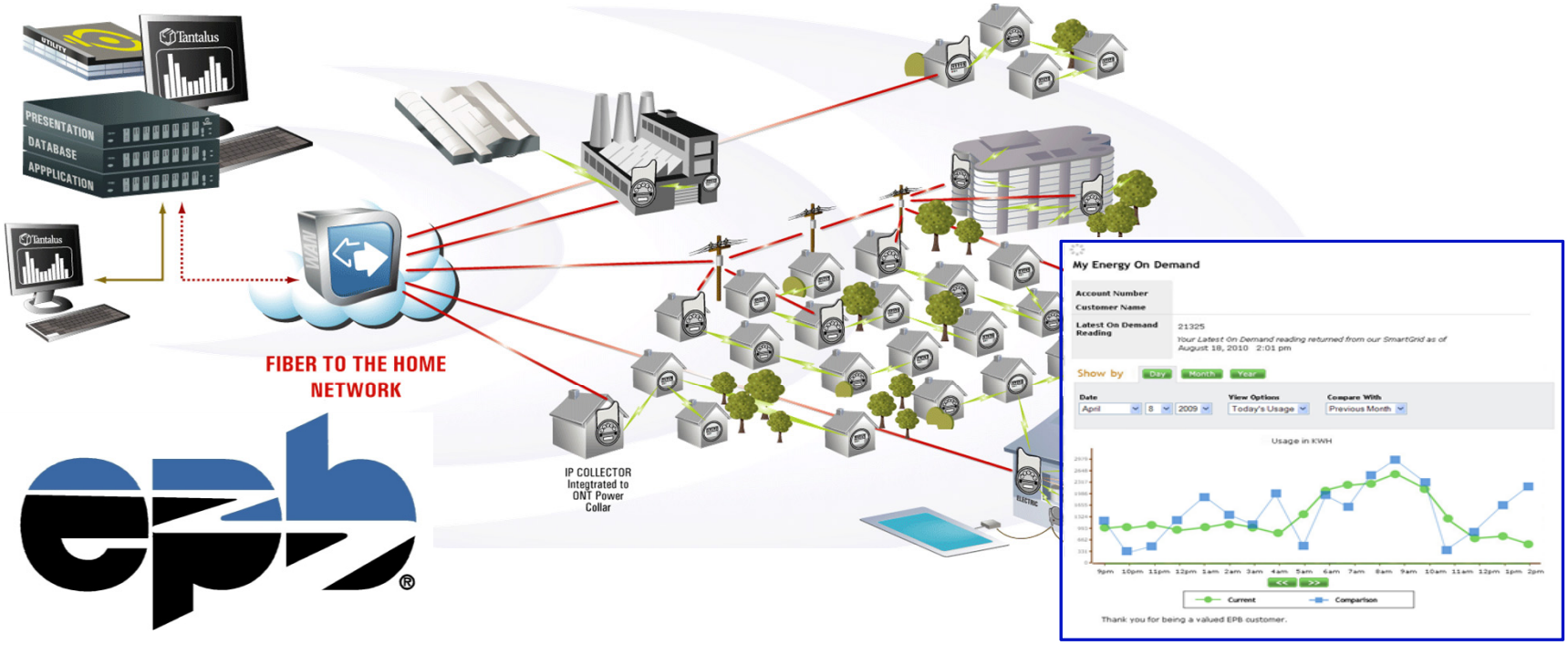
AMI Providing Real Time Consumption Feedback



170,000 Meters

- 125,000 Residential
- 25,000 Disconnects
- 20,000 C/I

Fiber to the Home Network includes

- Every collector connected to fiber network
- Estimated 3-5 meters per collector at final build out
- 15 minute interval data sent every 15 minutes

AMI Enabling Pre-Pay

- Offered only to new members, 75% choose pre-pay
- Customer satisfaction rate of 98%
- Reduction of bad debt expense of 30%
- Increased customer communication on daily usage
- Giving customers an alternative to higher initial deposit
- Flexibility of timing and amounts of payment
- Increased customer energy efficiency

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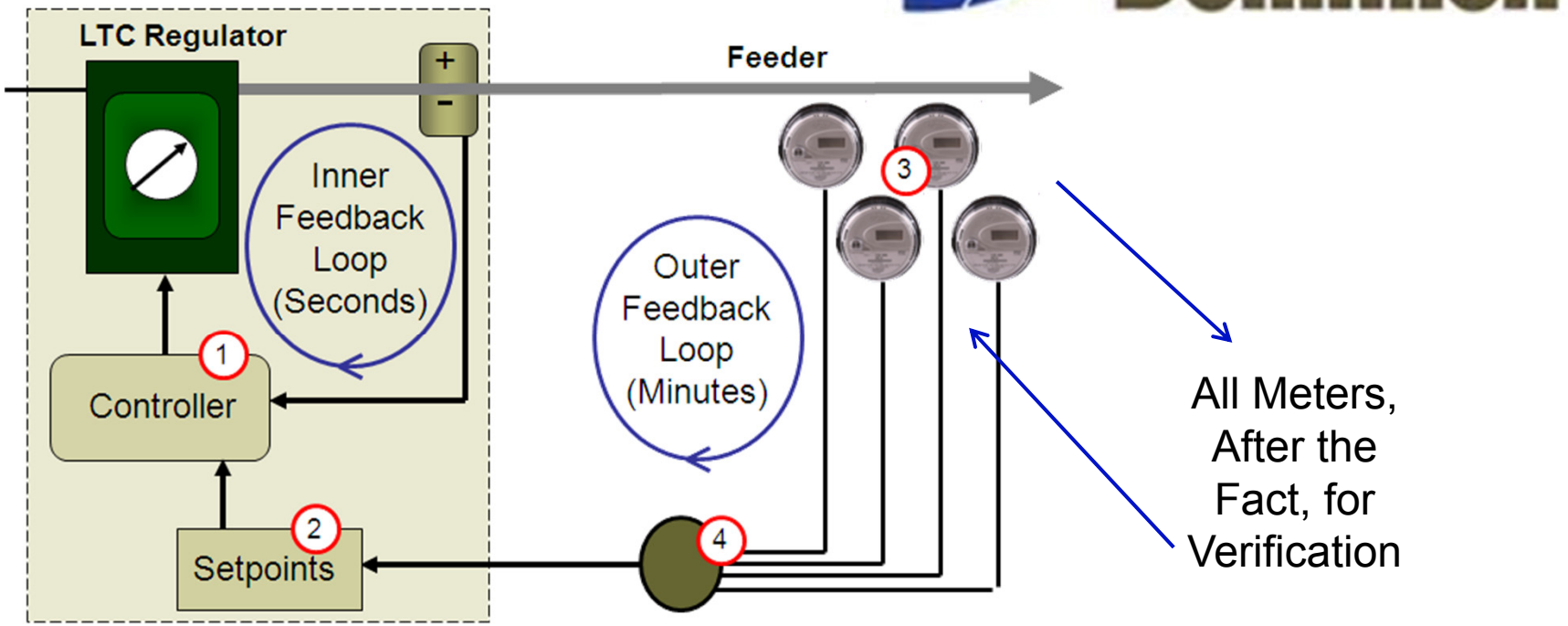
AMI Supporting Remote Connect/Disconnect

Clarksville Department of Electricity:

- 60,000 customers
- College & Military base
- 120,000 per year: C/D, move-in/out
- Selectively installing Remote C/D Meters – approximately 40% get switch
- $50 per truck roll ? = $6M/yr

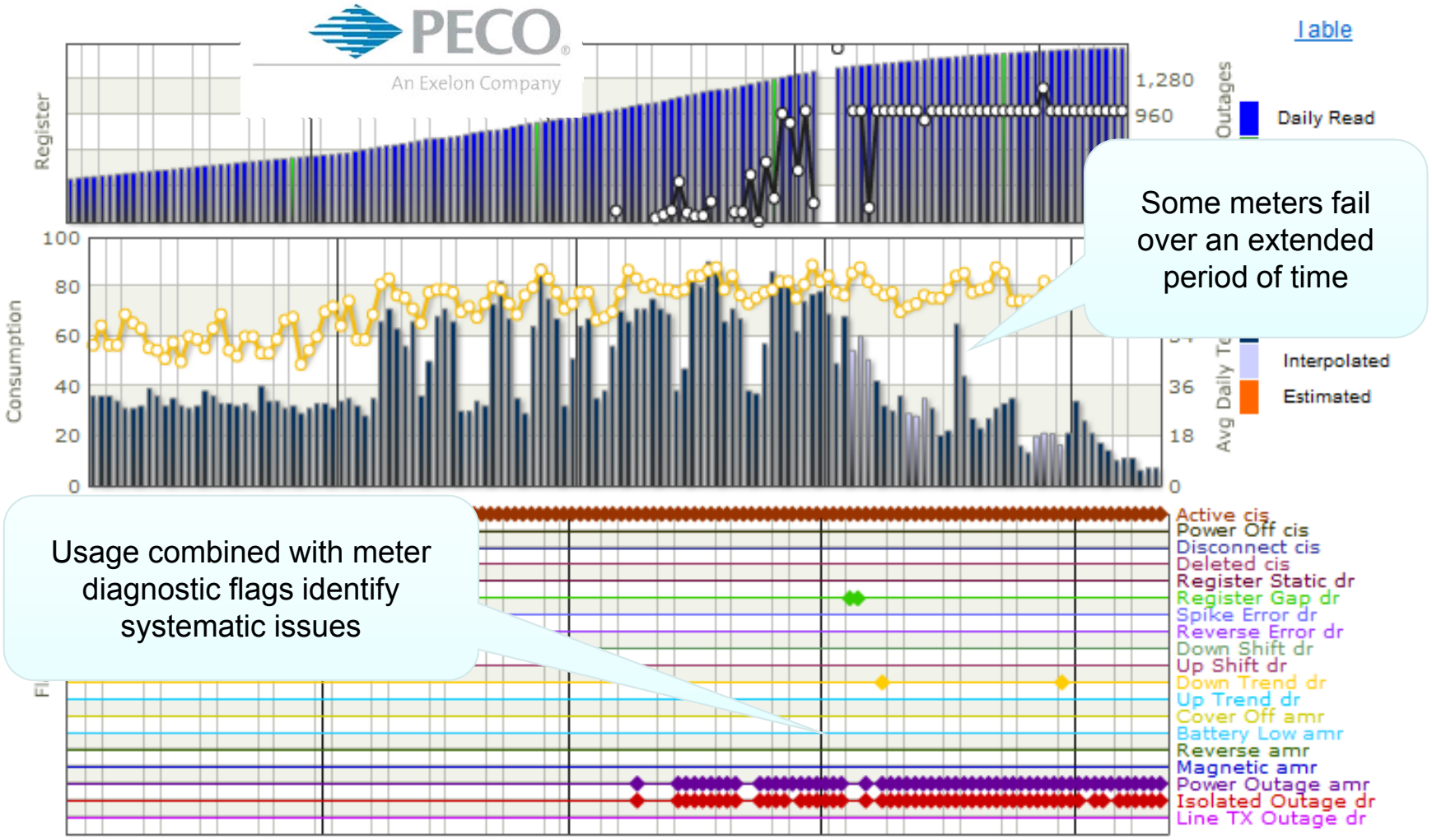
AMI Enhancing Conservation Voltage Reduction



AMI Data Enabling Theft Detection

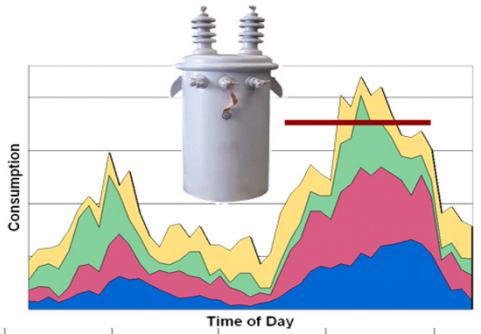
16

AMI Data Identifying Defective Meters

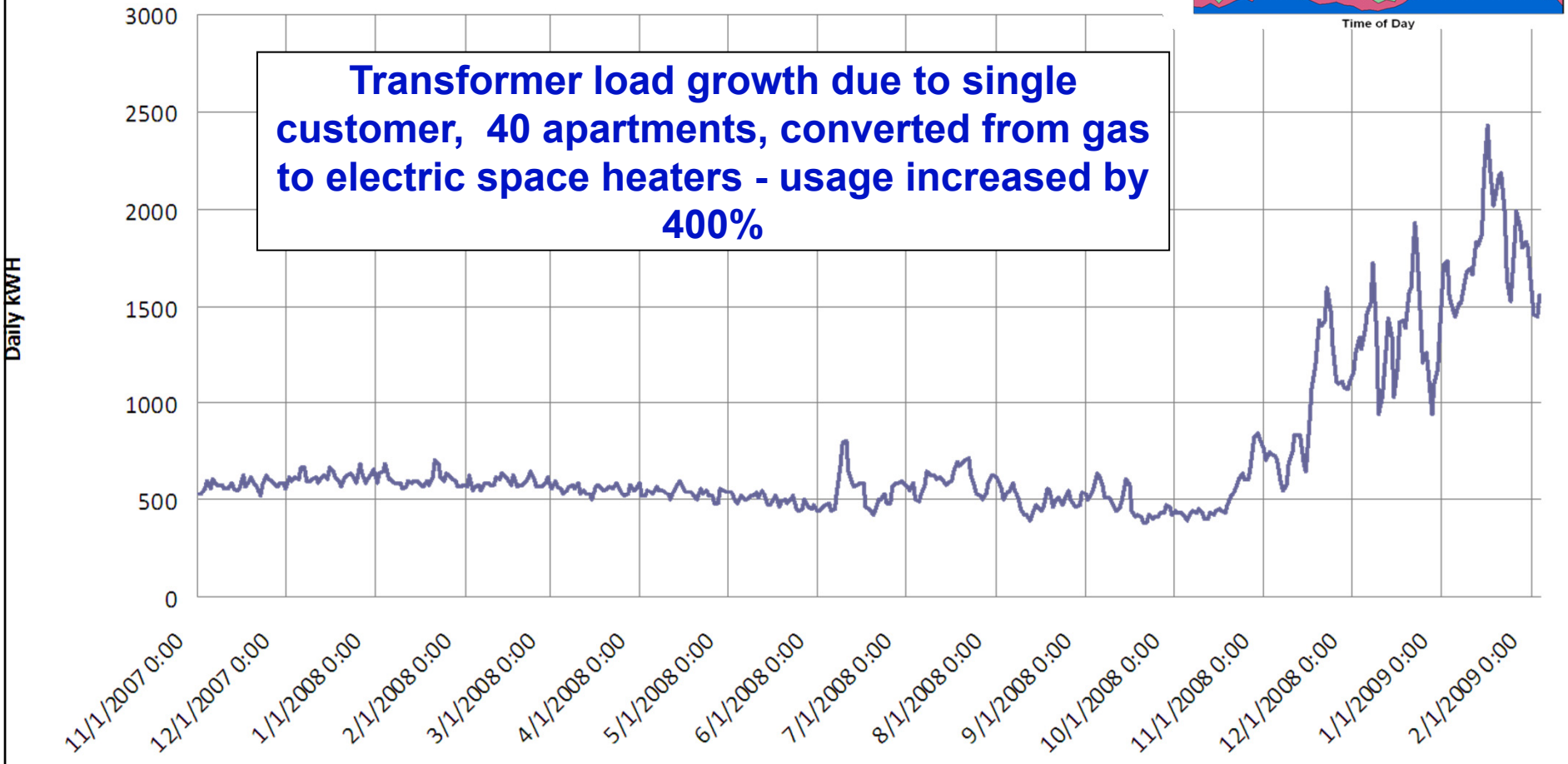


17

AMI Detecting Stressed Assets



Transformer load growth due to single customer, 40 apartments, converted from gas to electric space heaters - usage increased by 400%



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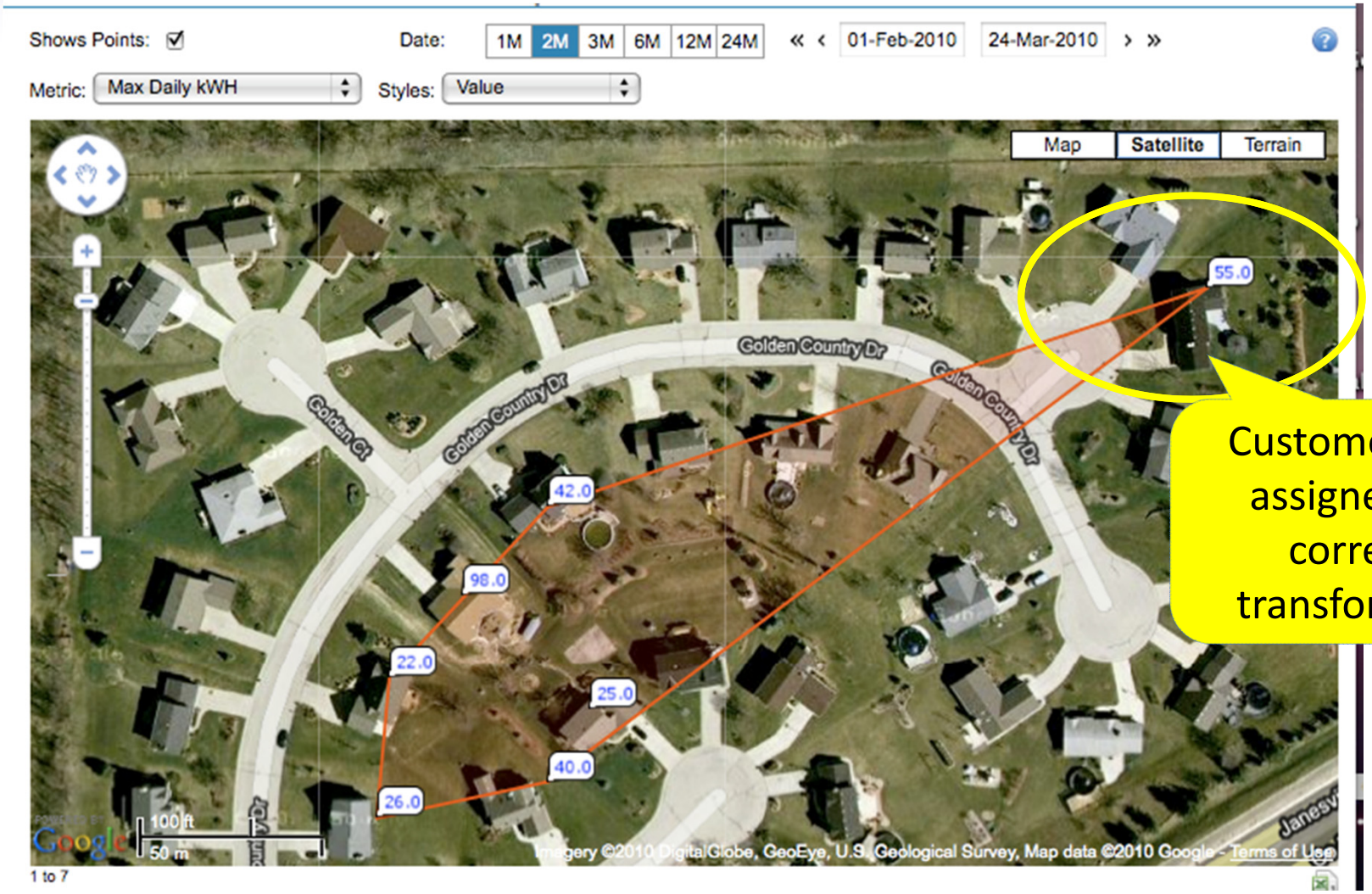
AMI Improving GIS Data
Customer-to-Transformer Mapping



Customer not assigned to correct transformer!

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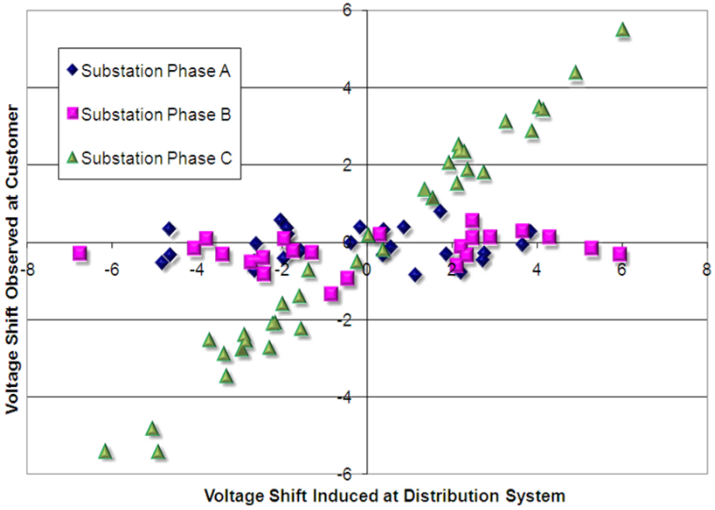
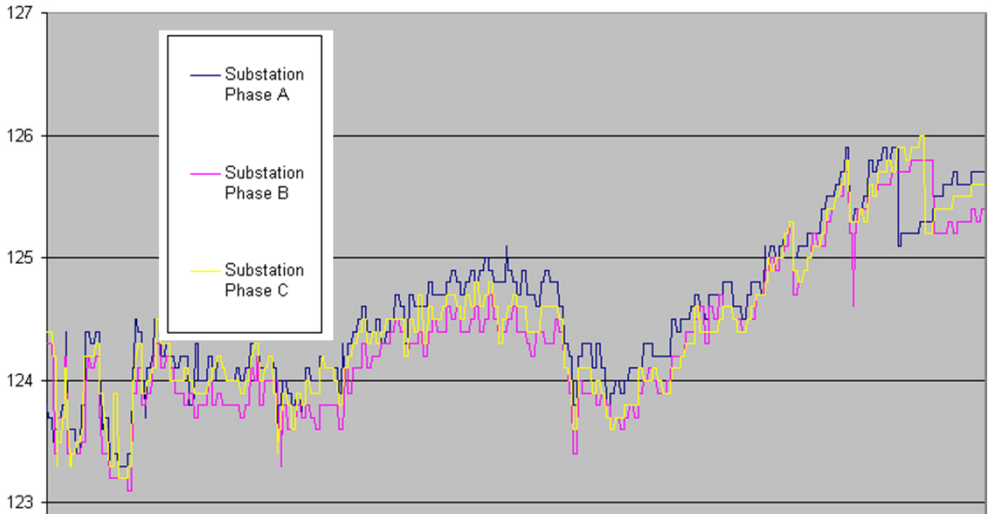
AMI Enabling Automatic Customer Phase ID

- Automatically maintain an accurate record of the primary phase association of every customer
- To benefit outage management
- To enable advanced volt/var optimization
- To guide phase balancing
- For advanced distribution automation





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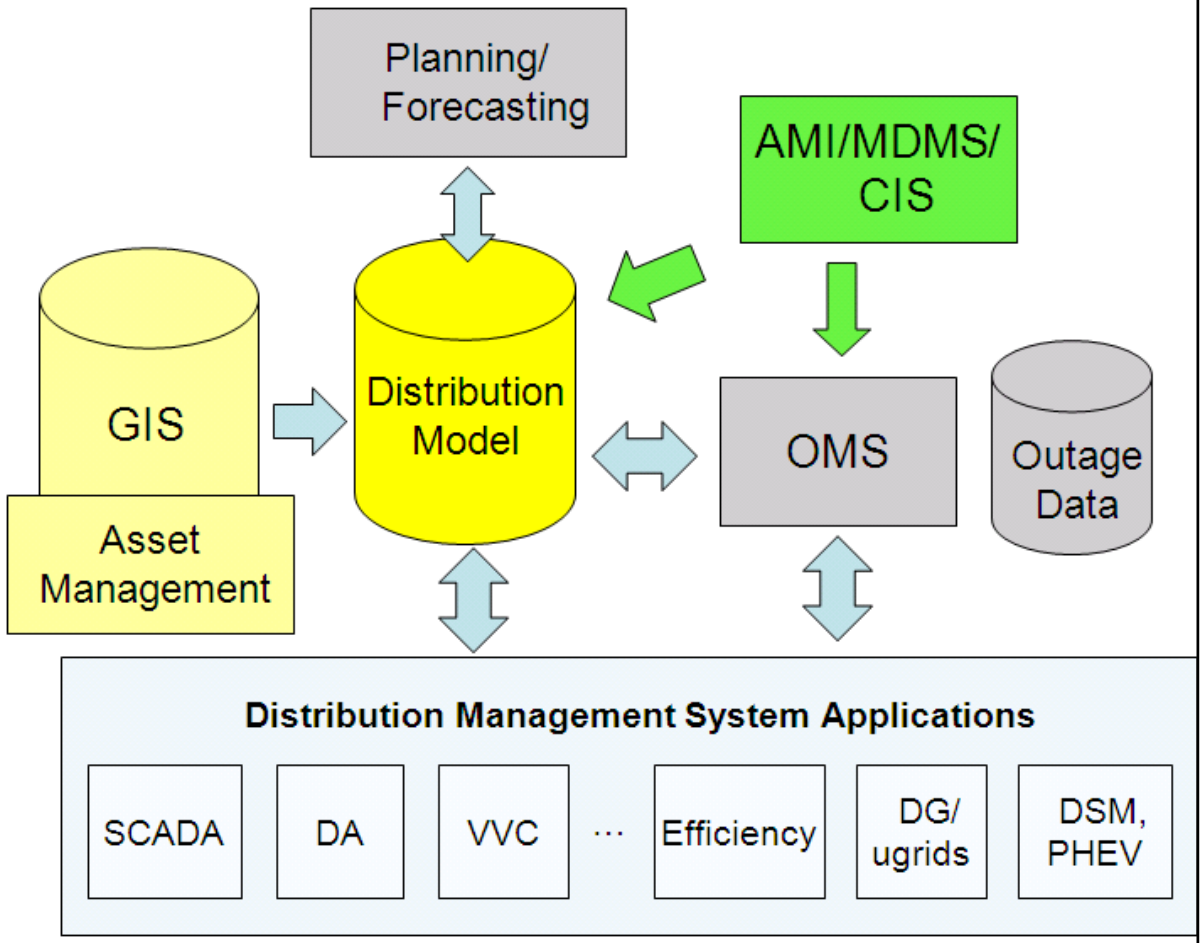
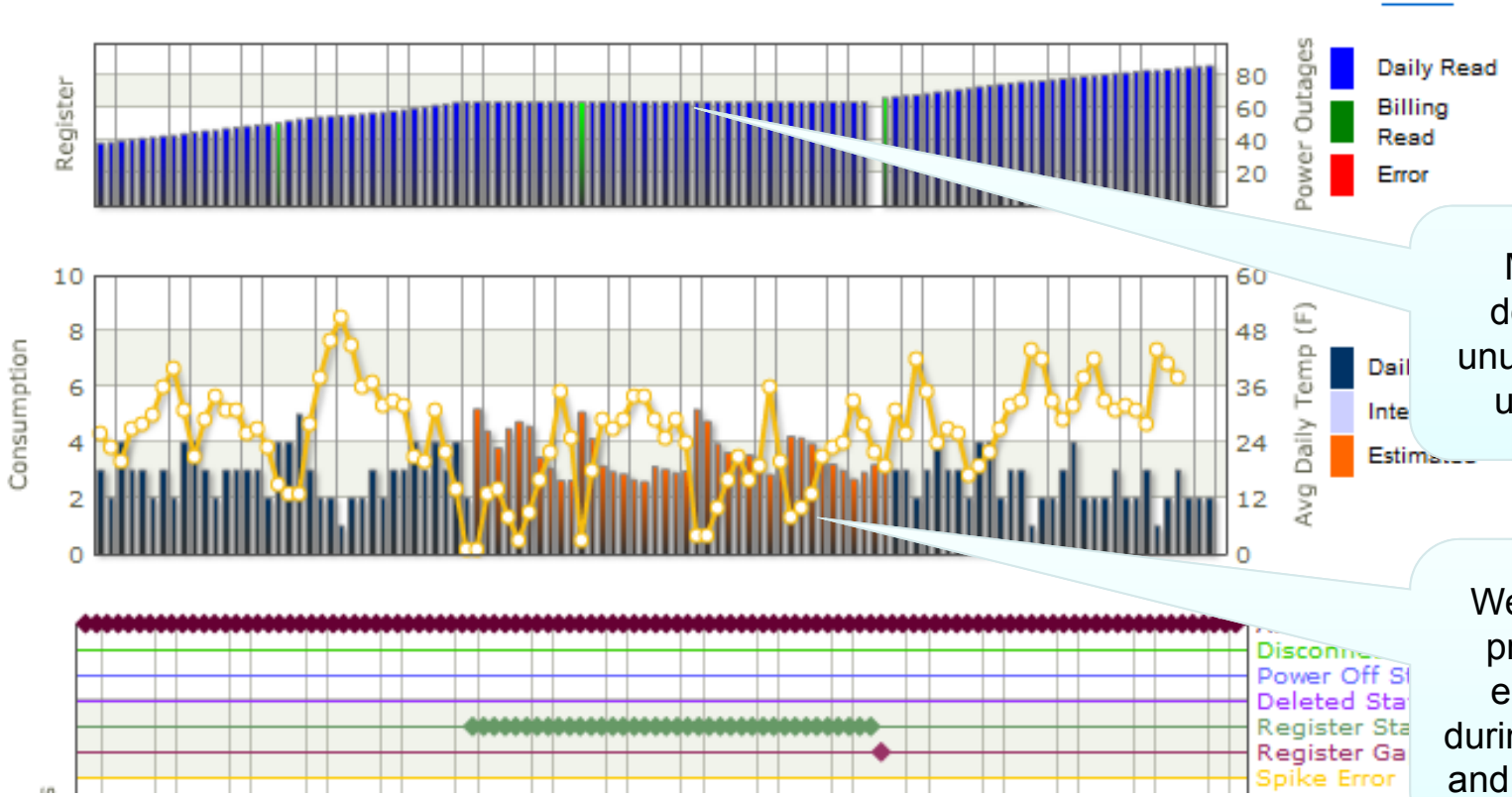
AMI Used to Improve Load Models

- Verifying customer models
- Revamping customer classes
- Reclassifying customers
- Converting static models to dynamic models (switching decisions)



AMI Improving Billing Support
Assisting in Back Bill Estimation



Meter failures detected based unusual changes in usage patterns

Weather-adjusted profiling used to estimate usage during failure periods and passed to billing

22

- AMI Definition and Context
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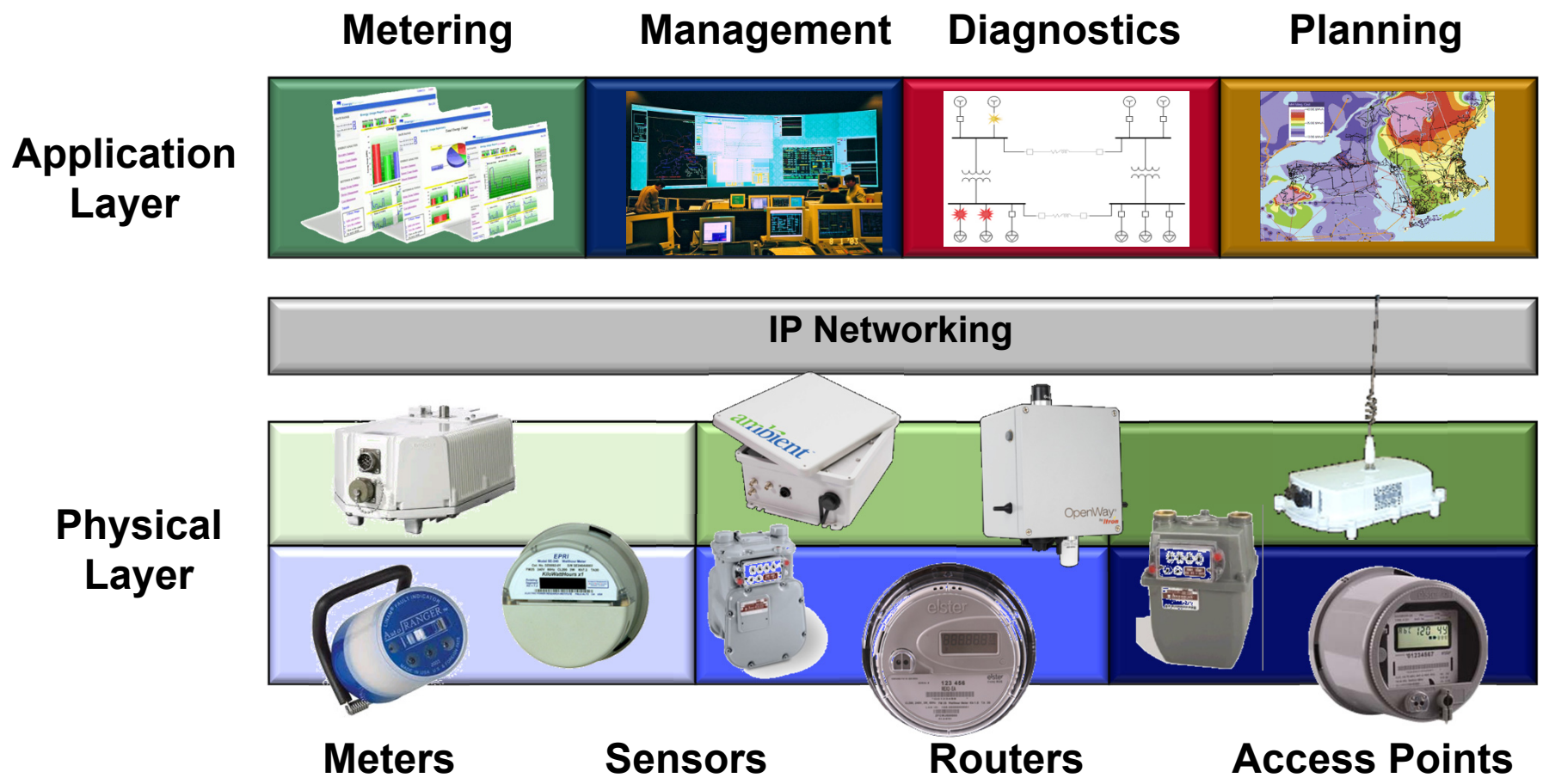
- AMI Challenges and Change

AMI Challenge: Open Architecture

Multi-Vendor Interoperability



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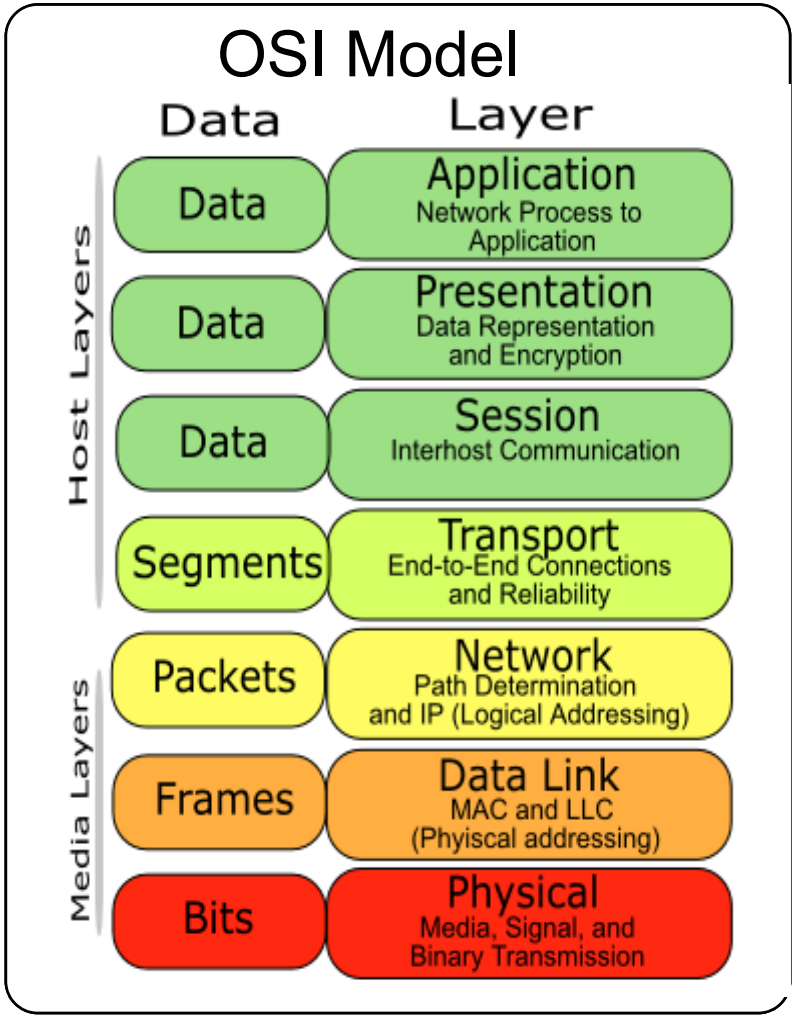
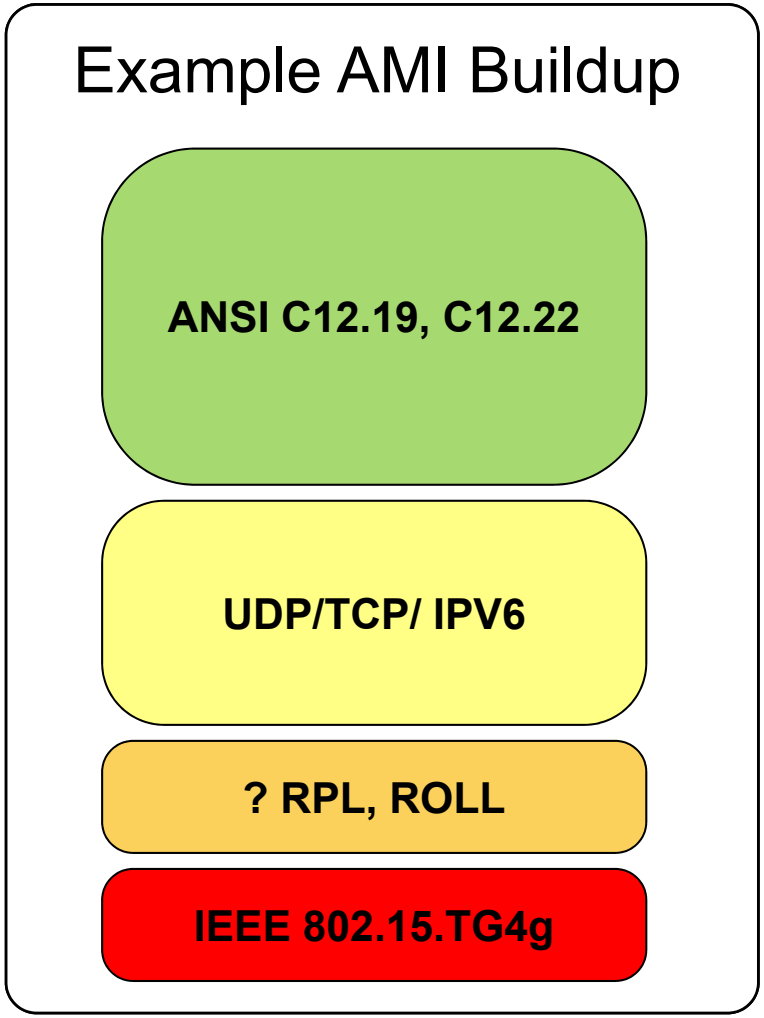
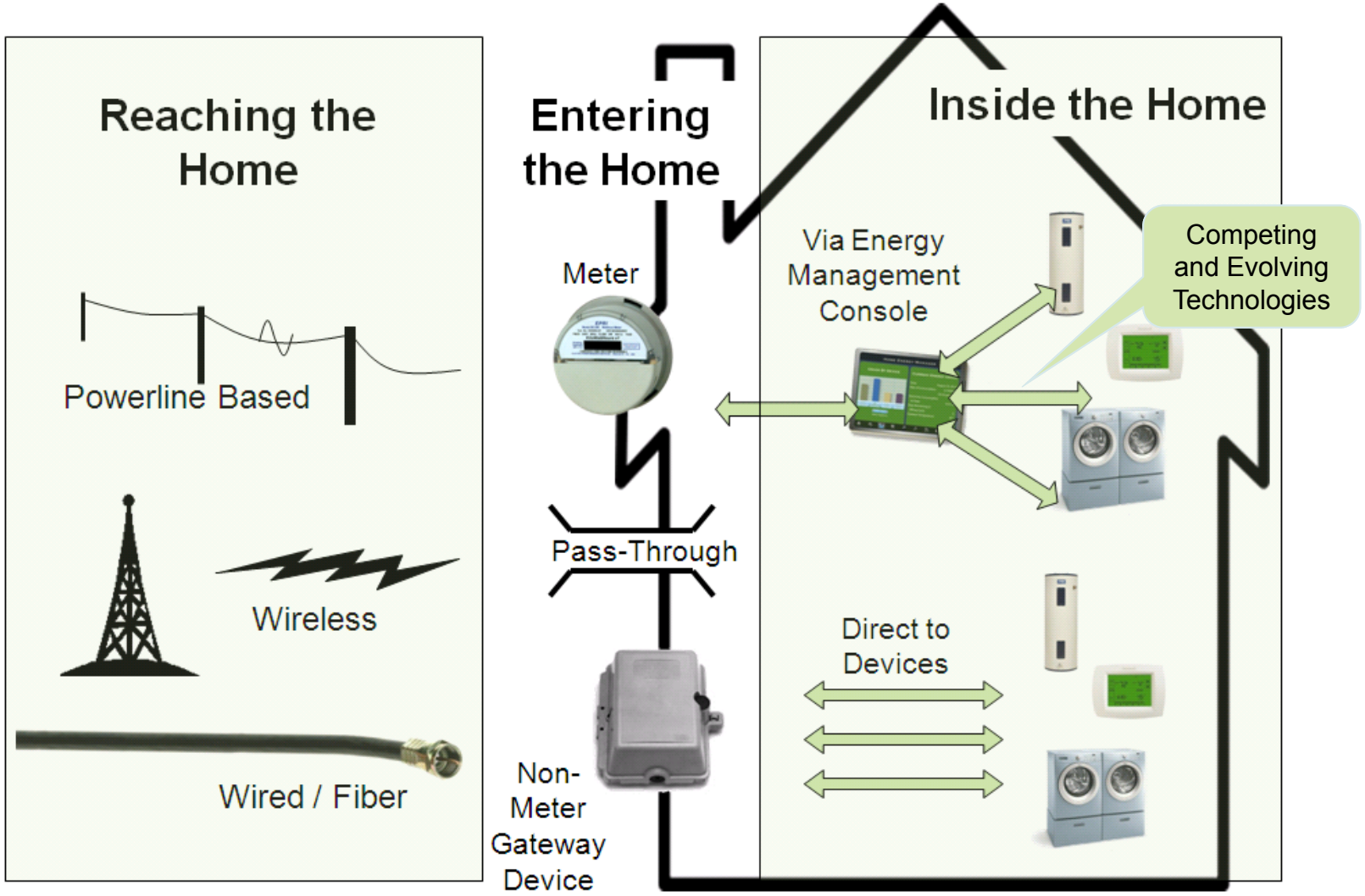
AMI Challenge: Standards at All Layers



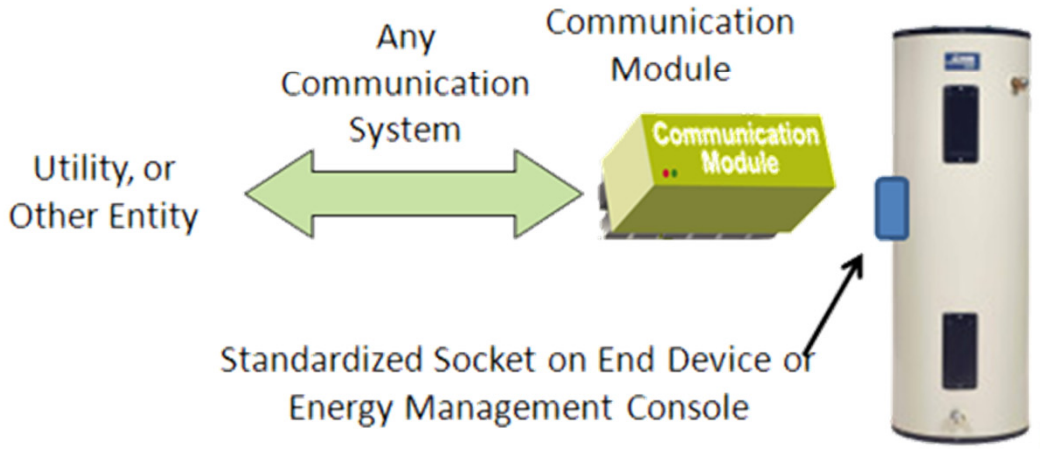


http://en.wikipedia.org/wiki/Ad_hoc_routing_protocol_list

AMI Challenge: Residential DR Integration



Emerging Standard:
Modular Communication Interface Concept



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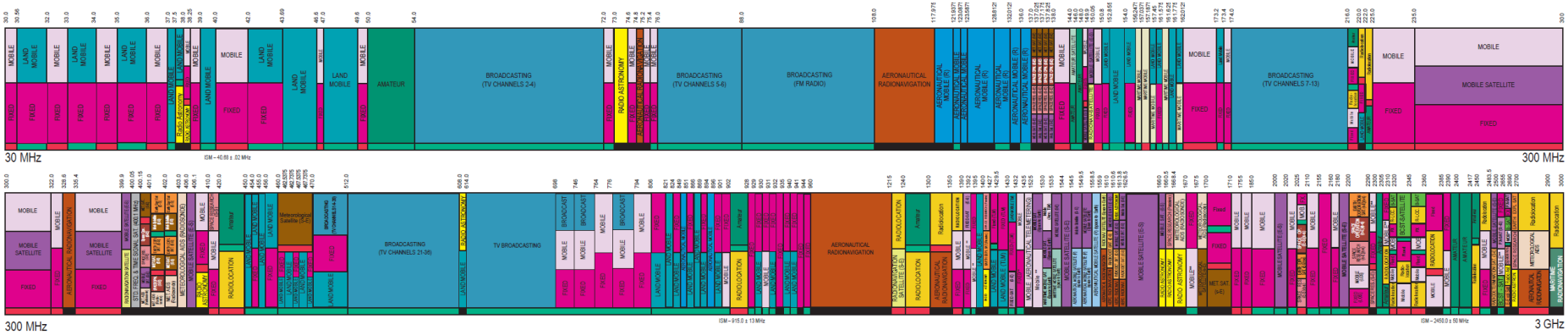
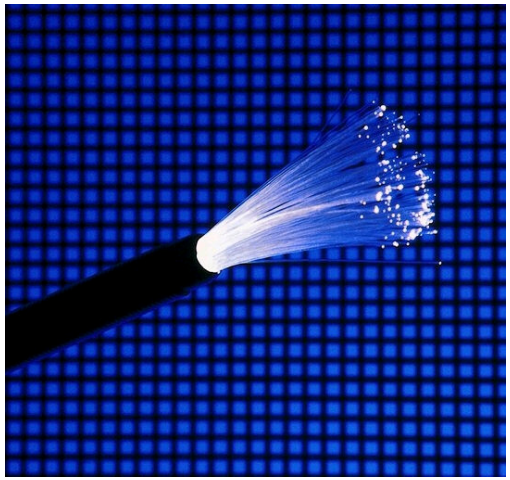
AMI Challenge: No Dedicated RF Spectrum



www.ntia.doc.gov/files/ntia/publications/2003-allochrt.pdf

- FCC: No dedicated RF spectrum for AMI
- Licensed vs. unlicensed question – liability associated with ISM band from new products
- Sub 1GHz propagation characteristics needed

AMI Challenge: Wired vs. Wireless



- Increasing demand for wireless spectrum for cell phone, media, & entertainment (mobile individuals, mobile vehicles)
- Houses and meters are not mobile, do not require a wireless solution
- Availability of broadband connectivity to customer premises rising
- Cost of wired/fiber systems (private vs. shared debate, cyber security concerns)

AMI Challenge: Customer Satisfaction

Meter Accuracy

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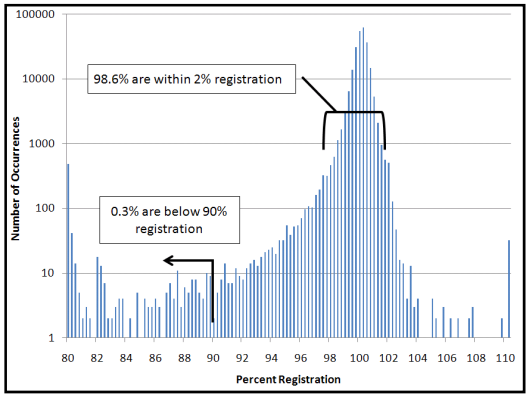

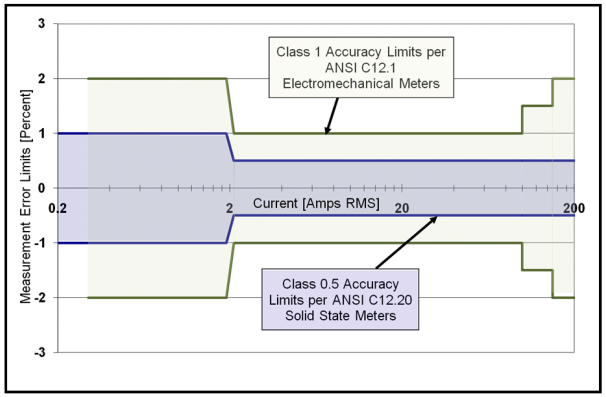

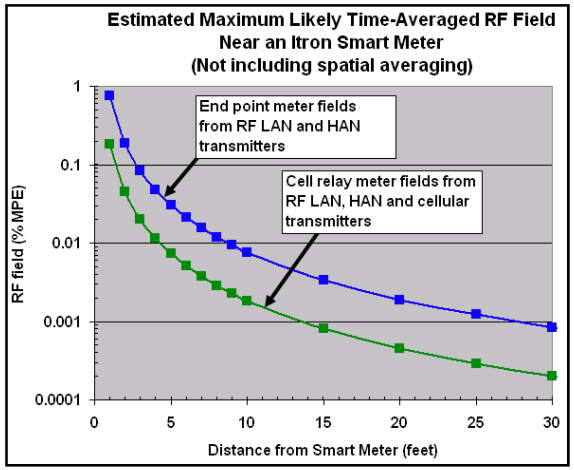

RF Health Effects

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Privacy

? Further Research

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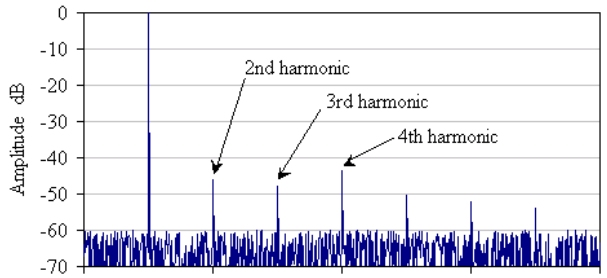
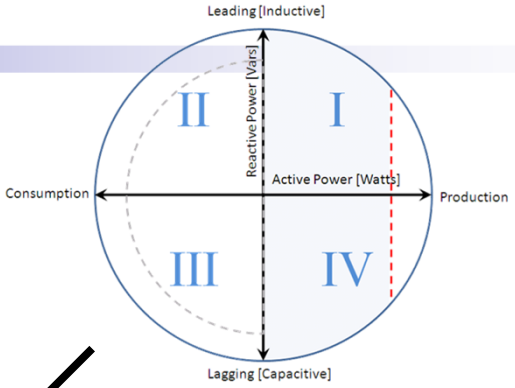
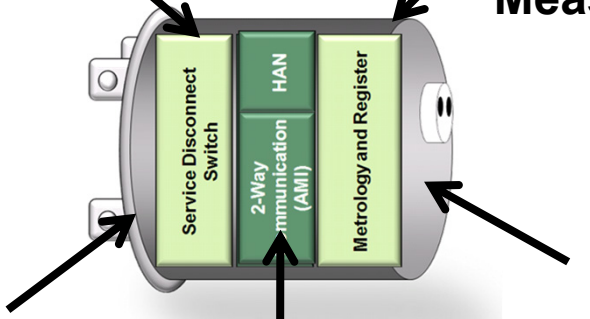
Expected AMI Evolution:
More Advanced Measurements

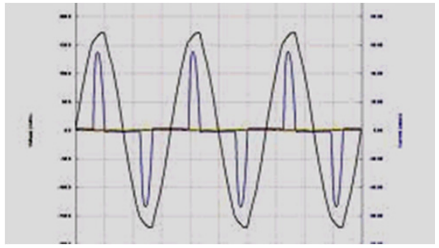


Harmonics

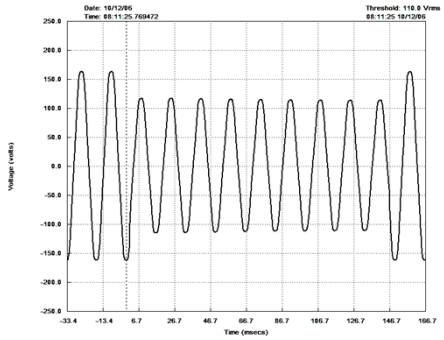


Measured Quantities

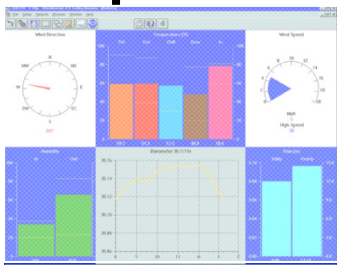




Waveform Capture



Event Logging



Situational Reporting

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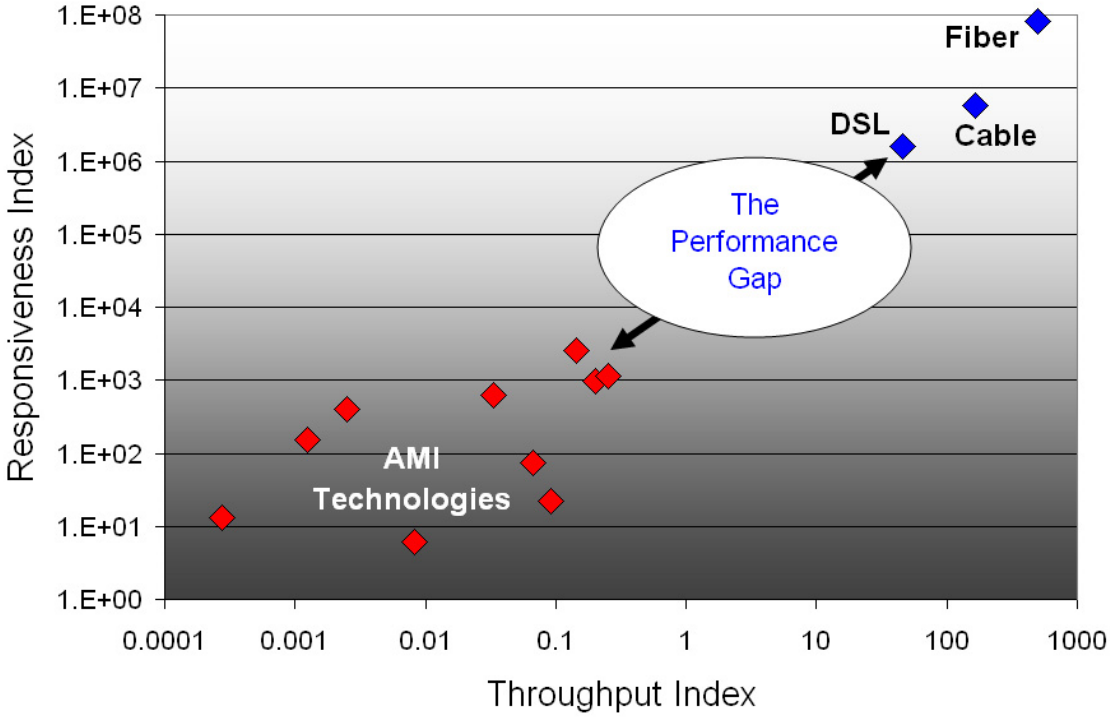
Expected AMI Evolution:
More Data, More Often

- Real-time collection
- Additional devices/applications
- Shorter intervals
- Additional quantities
- Back-of-the-envelope calculation:

  "All-In" AMI is less than one browse to yahoo.com



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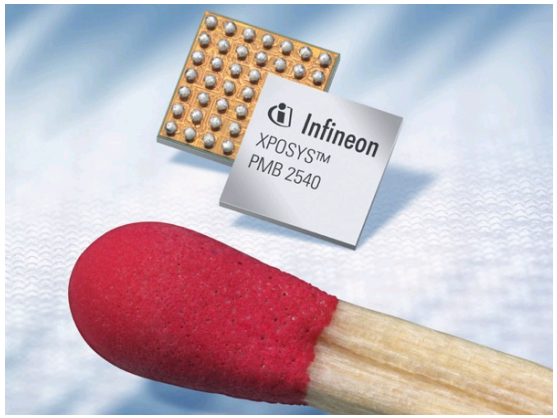
Expected AMI Evolution:
GPS in the Meter (and other devices)

- Exact asset location
- Precision time-stamping
  - Support for advanced fault location
  - Cause and effect analysis - tracing events
  - Improved customer phase identification
  - Improved customer transformer association



Summary Observations

- AMI deployment level still low nationally
- Utilities focused on getting metering and billing working first, will focus on “additional benefits” later
- Integrated service disconnect switches showing great promise
- Flexibility required in integrating customer devices
- AMI performance is trending upward to support ancillary functions
- Value of historical AMI data is immediate, real-time data use is emerging, direct sharing of the AMI network is uncertain

Together…Shaping the Future of Electricity

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Email	bseal@epri.com	
Website	www.epri.com	
Educational Background	Bachelor of Electrical Engineering, Georgia Institute of Technology Master of Science in Electrical Engineering, Georgia Institute of Technology	
Work Experience	Electric Power Research Institute, 2008 to Present Cellnet (Landis+Gyr) 2004 to 2008 Schlumberger (Itron) 1990 to 2004	

Autobiography

Prior to joining EPRI, Brian worked in the vendor community for Cellnet+Hunt (now Landis+Gyr) and Schlumberger (now Itron) where he was engaged in system architecting and product design and development. He is the holder of several patents related to advanced metering and utility communication systems. Collectively, Brian has served in the energy industry for 21 years.