

The Real Story on AMI: From Conception to
Completion, Learning From Those That Have Lived It

AMI 101

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Agenda

- AMI Overview
 - What is it?
 - Where is it?
 - Why do we need it?
- AMI Technologies
 - Metering Endpoints
 - Communication Comparison
 - Data Management
- Value Added Information
 - Past, Present, Future

What is Advanced Metering?

- As defined by FERC...
 - **Advanced Metering** is a metering system that:
 - Records customer consumption (and possibly other parameters) hourly or more frequently
 - Available daily or more frequently
 - Travels via a communication network
 - Retrieved by a central collection point
 - **AMI** (Advanced Metering Infrastructure) is:
 - Full measurement and collection system, end-to-end
 - Including customer meters, communication networks and data management systems

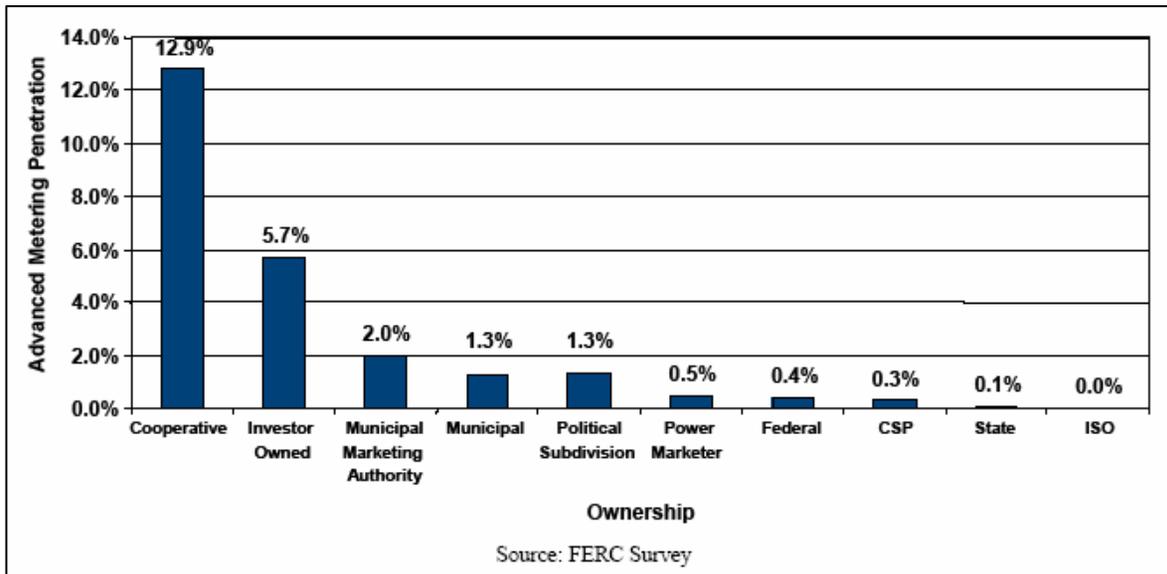
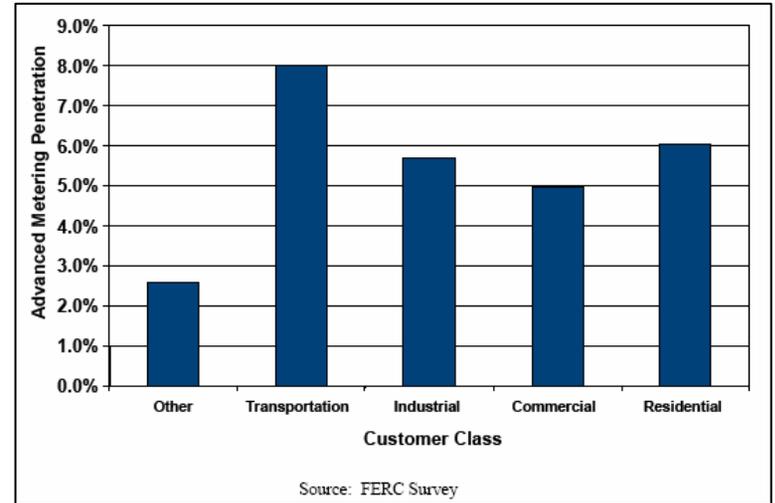
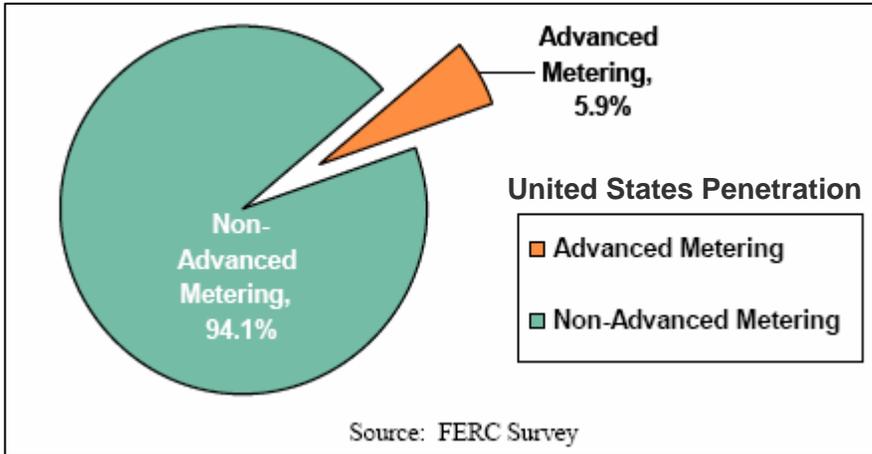
What was used to define Advanced Metering?

- Review of the state-of-the-art of metering and communications technology
- Specifications for “smart metering” or advanced metering in recent utility solicitations
- Type of meters and infrastructure necessary to support demand response and to provide additional utility operational benefits beyond reducing metering costs
- Definitions of advanced metering included in the EPA Act 2005

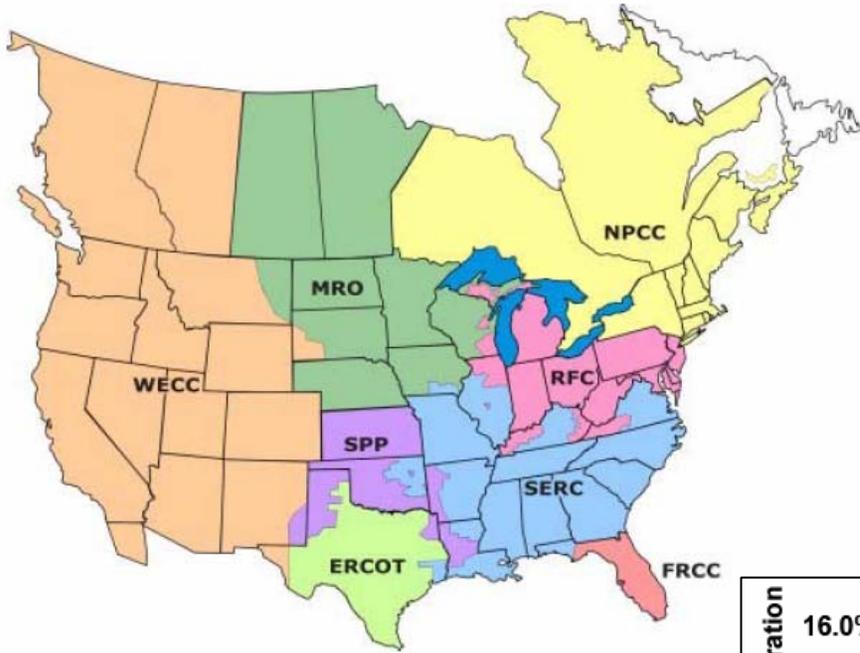
EPAct Requirements

- Time-based rates
 - Utilities:
 - Offer time-based rates to all customers, or
 - Demonstrate why compliance can not be achieved
 - State Regulators:
 - Determine appropriateness of requirement
- State Investigations
 - Conduct proceedings by August 2007
 - Determine pertinence to deploy advanced metering
 - Review business case for metering and demand response
- Metering
 - Time-based
 - Capable of supporting TOU, CPP and RTP
 - Have communications
 - Record usage at least hourly
 - Retrieve data at least daily

Who has Deployed AMI?

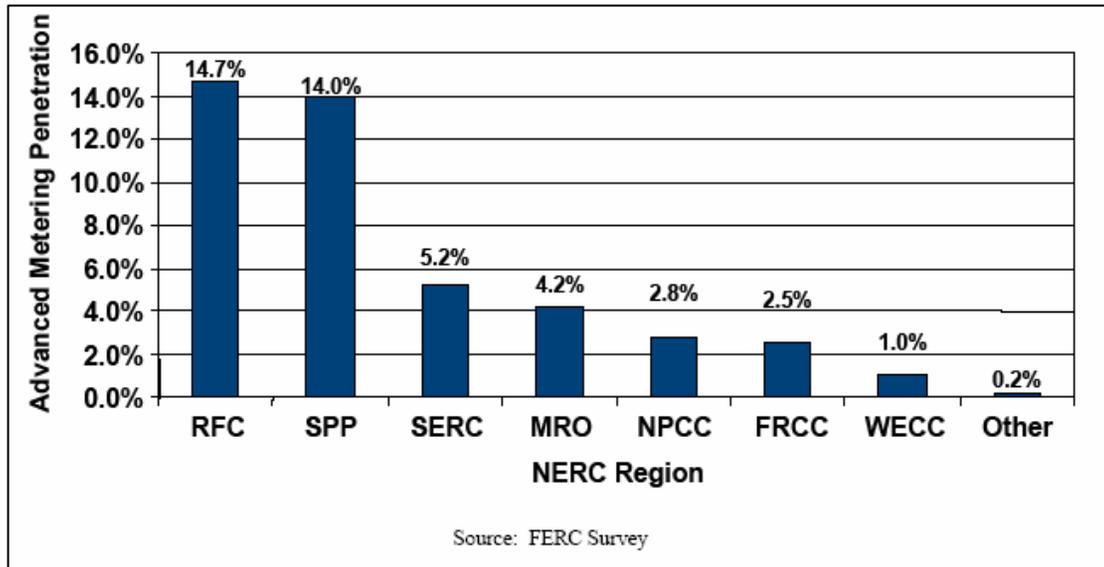


Where is AMI Deployed?



State	Advanced Metering Penetration
Pennsylvania	52.5%
Wisconsin	40.2%
Connecticut	21.4%
Kansas	20.0%
Idaho	16.2%
Maine	14.3%
Missouri	13.4%
Arkansas	12.9%
Oklahoma	7.2%
Nebraska	6.8%

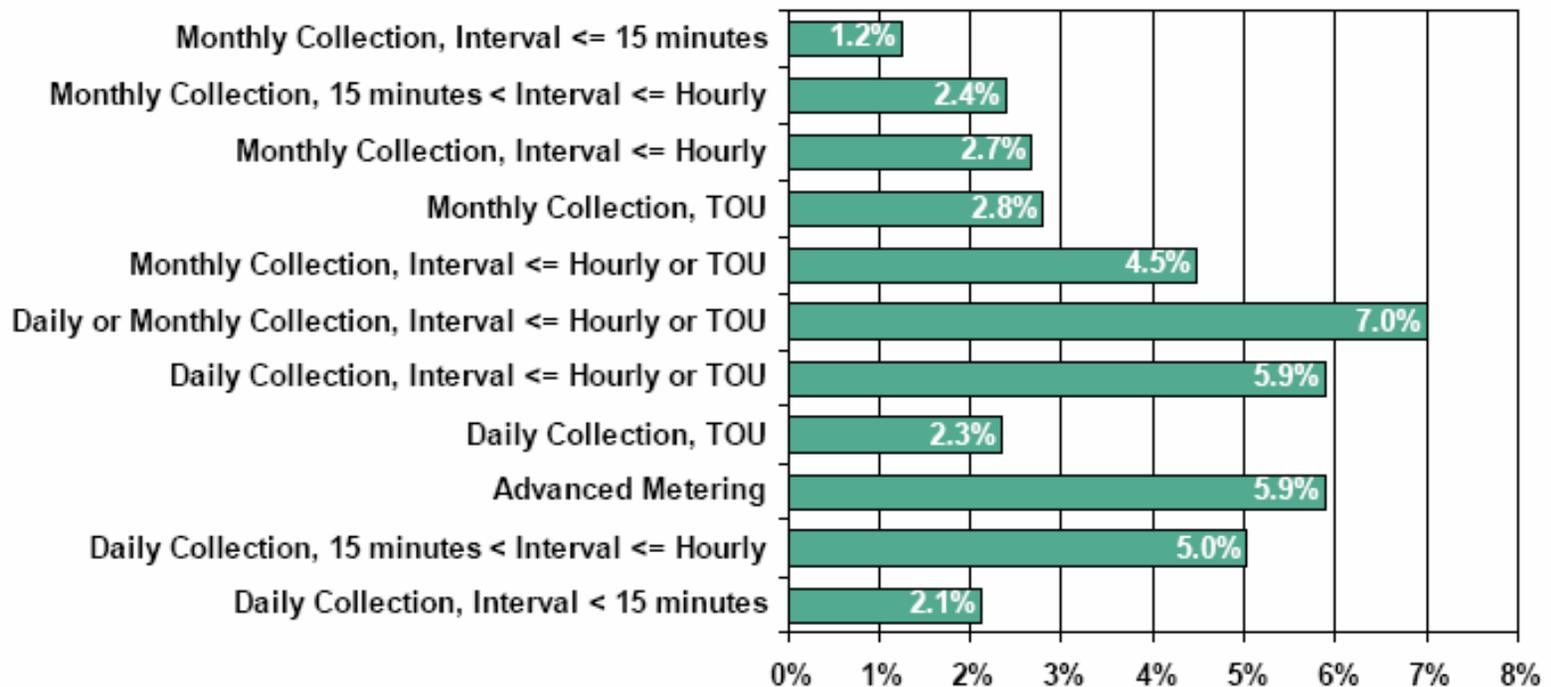
Source: FERC Survey



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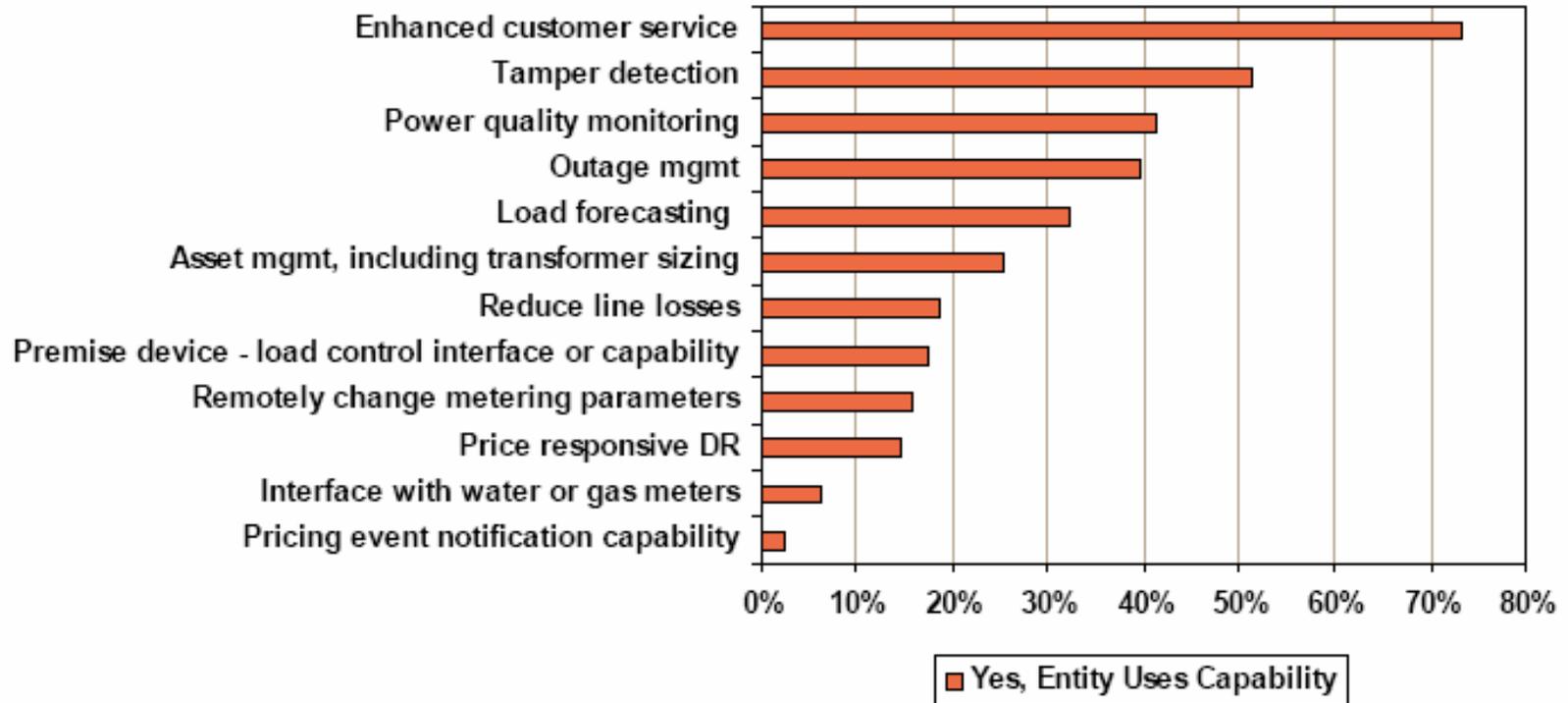
How Often is Data Collected?

Advanced Metering Data Interval and Collection Frequency Penetration



Source: FERC Survey

How is the AMI Data Used?



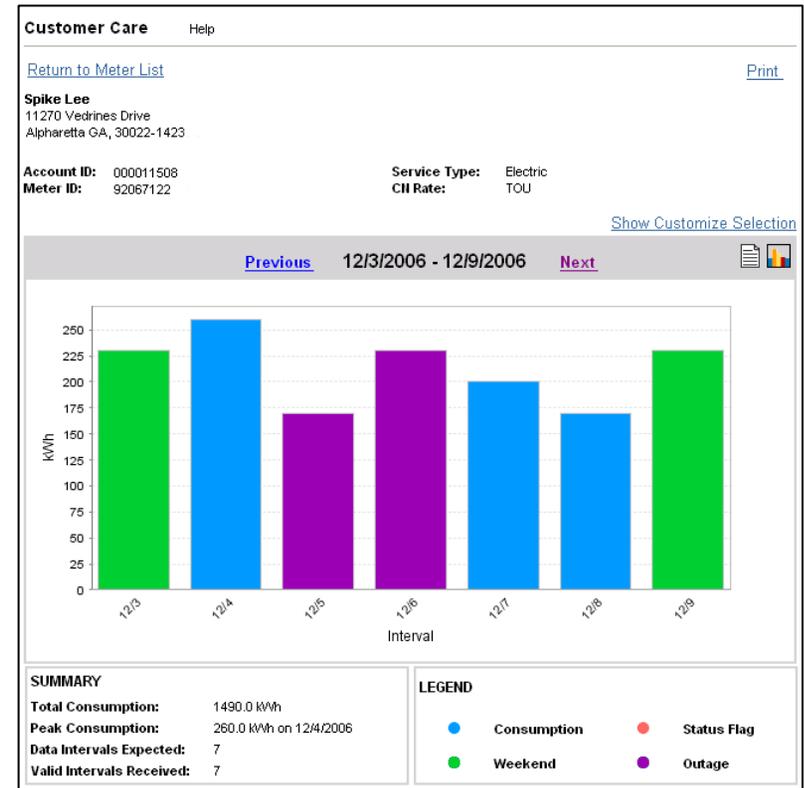
Source: FERC Survey

What does Advanced Metering Provide?

- Enhanced Customer Service
- Revenue Assurance Improvements
- Improving Load Forecasting
- Power Quality Monitoring
- Outage Management
- Supporting price-responsive Demand Response programs
- Service Disconnect/Reconnect

Enhanced Customer Service

- Improved Response to Customer Inquiries
- Real-time or near real-time on-request meter reads
- Remote Move-in / Move-out meter reads
- Historical daily usage information



Revenue Assurance Improvements

- Tamper detection
- Theft detection
- Faulty equipment detection
- Site installation status

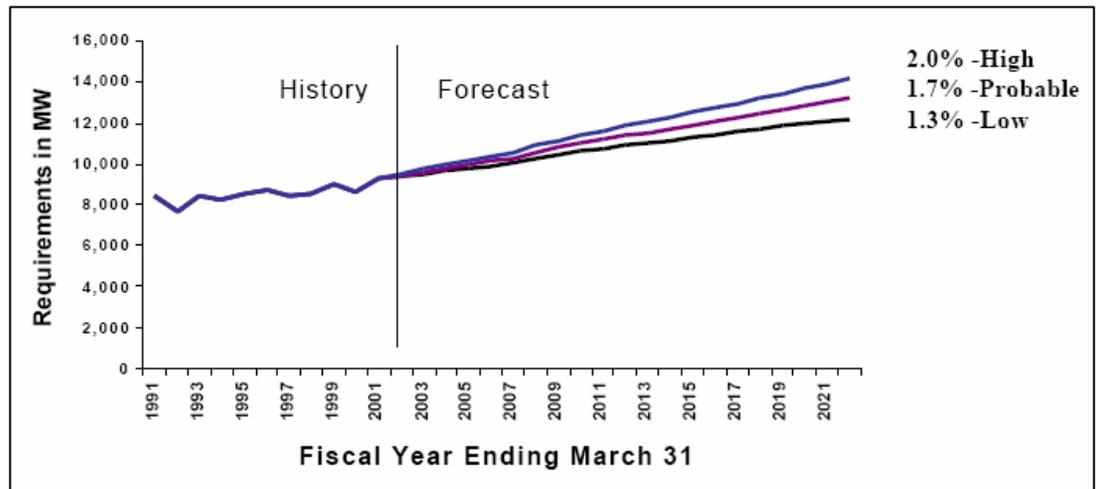
Meter Flag Detail
Report Generation: 08/16/06 09:36 AM
Number of Meters With Flags: 6

Meter ID	Module ID	Power Out	Cum Invalid	Data Corrupt	Magnet	Reverse Rotation	Static Chg	Sensor Fail	Watch Dog	Agent Error	Battery Low
002834077	1221221		Y					Y			
21300096	21300096							Y	Y		
44623772	14222211	Y								Y	
44623773	14222221	Y						Y		Y	
44623774	14222180	Y								Y	
C047B429700093597	1800790			Y		Y					Y

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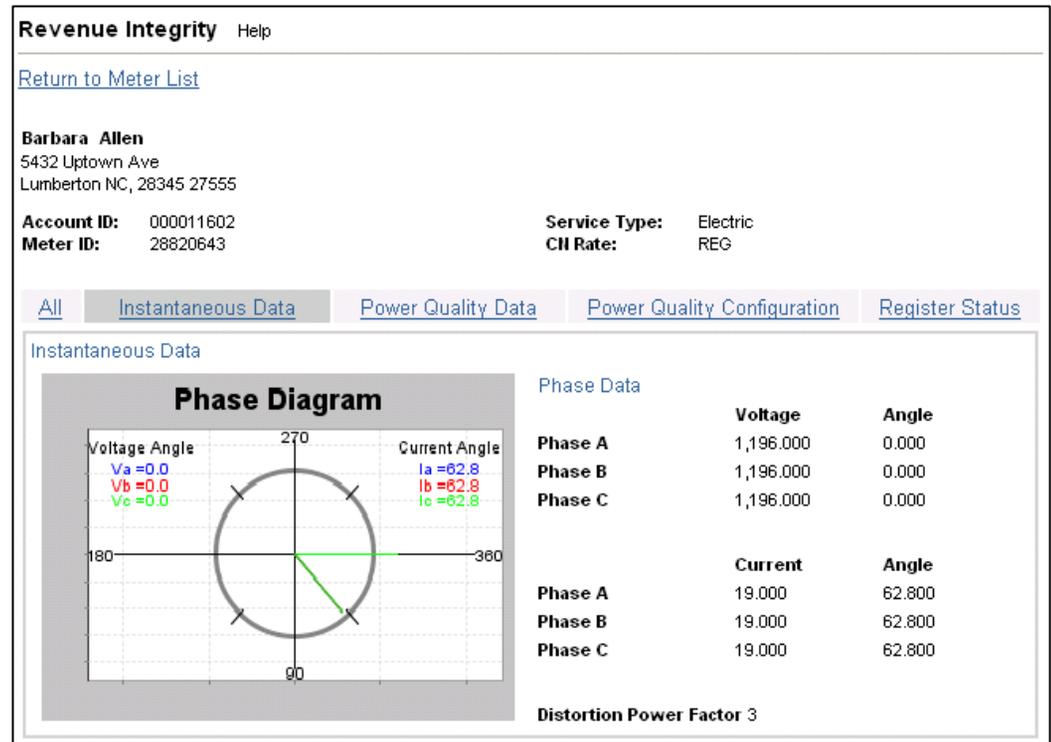
Improving Load Forecasting

- More frequent data – hourly meter reads
- Enhanced accuracy



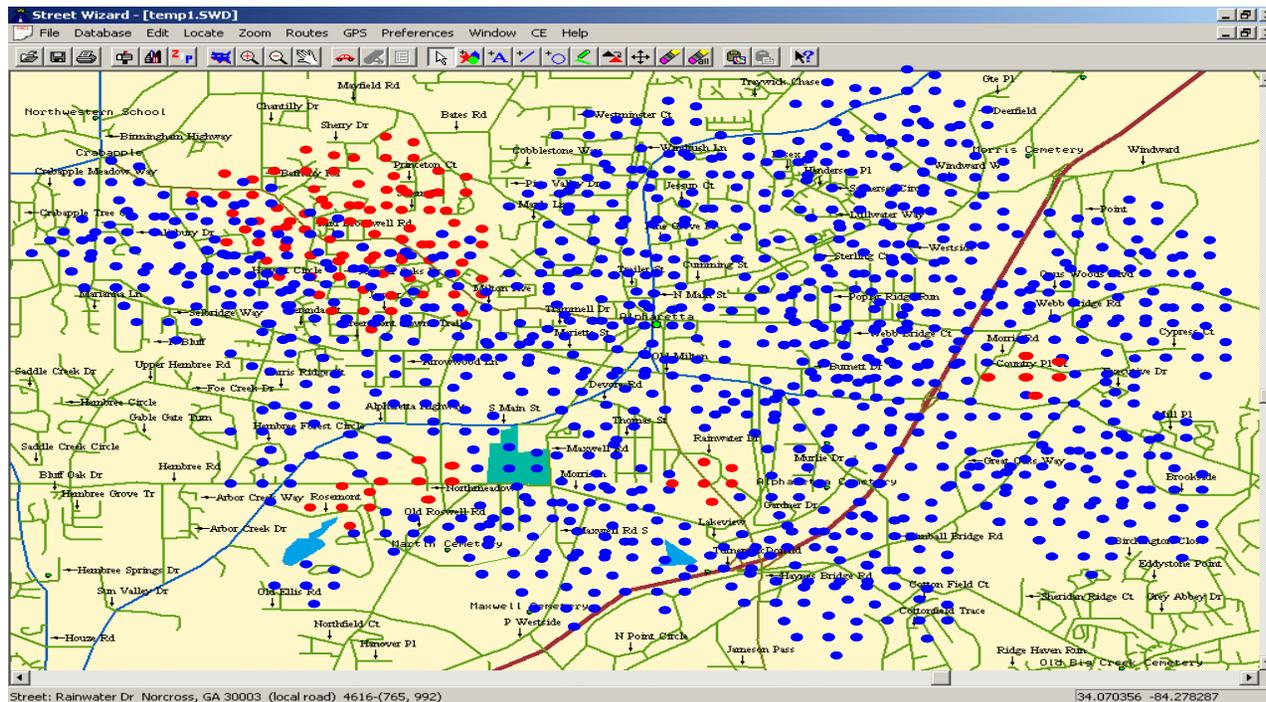
Power Quality Monitoring

- Site diagnostics
- Voltage quality data
- Device status



Outage Management

- Real-time access to outage events
- Faster response
- Request status capability
- More complete information to respond to customer inquiries



Demand Response Support

- Time-based rates
- Interval data availability
- Load control device support
- Customer notification device support



Service Disconnect/Reconnect

- Remote Operation
- Full 200 amp latched relay
- Load limiting
- Load side voltage sensing
- Remote Ready –
Customer Connect



Evolution of the Market



Monthly Data

- Mobile/walk-by
- Readings - 30 Days
- Tamper
- Limited Advanced Metering

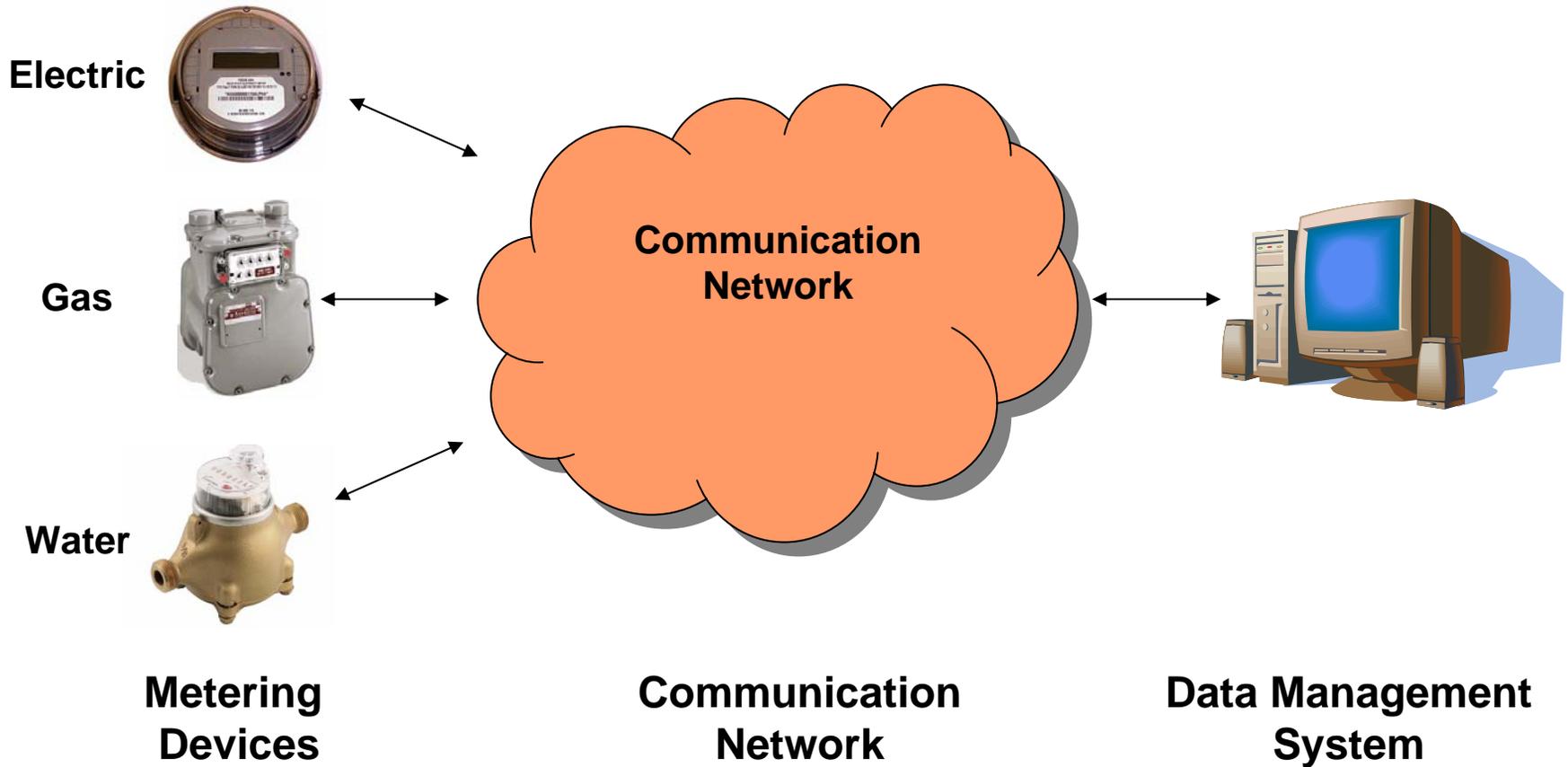
Daily Data

- Fixed Network
- Readings - Daily
- Billing 30 day Cycle
- Tamper
- Outage
- On-request Reads

Interval Data

- Fixed Network
- Readings hrly
- Data over 24 hrs
- Voltage, PQ
- Tamper
- Outage
- On-request Options
- Disconnect
- Future Expansion

Basic AMI Components



Metering Devices

- Electric metering: Transition from electromechanical to solid-state meter technology
- Transition from Manual reading, to AMR, now to AMI
- Communication technology “under-the-glass”
- Enhanced features provided by solid-state technology, as well as communication technology
- AMI purchase decisions “commoditizing” the meter

Residential Meter Trends

- 2-way communication
- Bi-directional measurement
- Voltage measurement
- Advanced Meter Register
- Advanced Logging
- Integrated Disconnect/Reconnect
- Home-Area-Network Interface

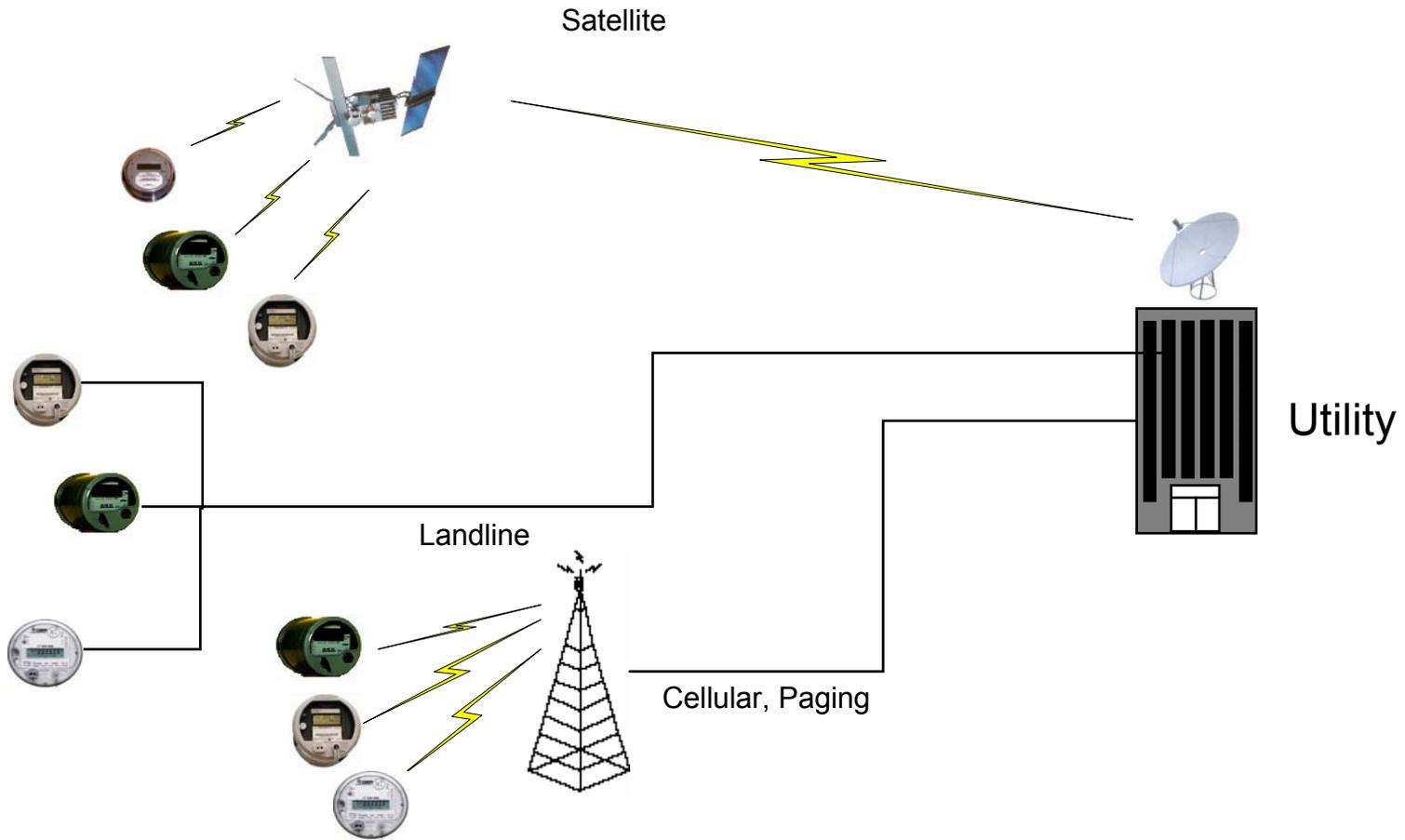
Communication Network

- Public Networks (landline, cellular, paging)
- Power line communications
- Broadband over power line
- Fixed Radio Frequency (RF) networks

Public Networks

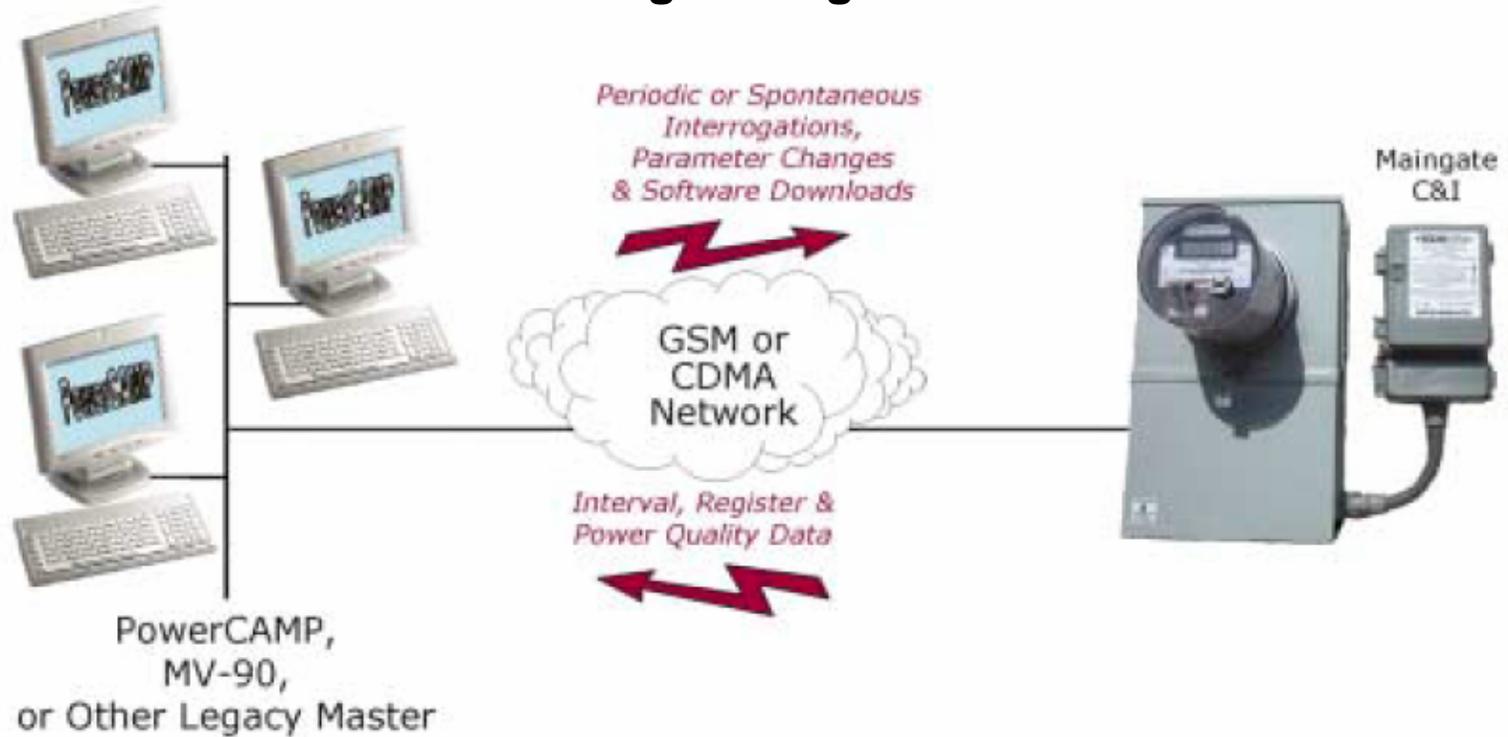
- Utilize public networks: Internet, paging, satellite, telephony (cellular or landline)
- Good technology for low density deployments
- Dependent on coverage by public providers, changing protocols
- Low installation costs, but typically higher operational costs
- Vendors include: SmartSynch, Trilliant, Comverge, Metrum

Public Network Examples



Courtesy of Landis+Gyr

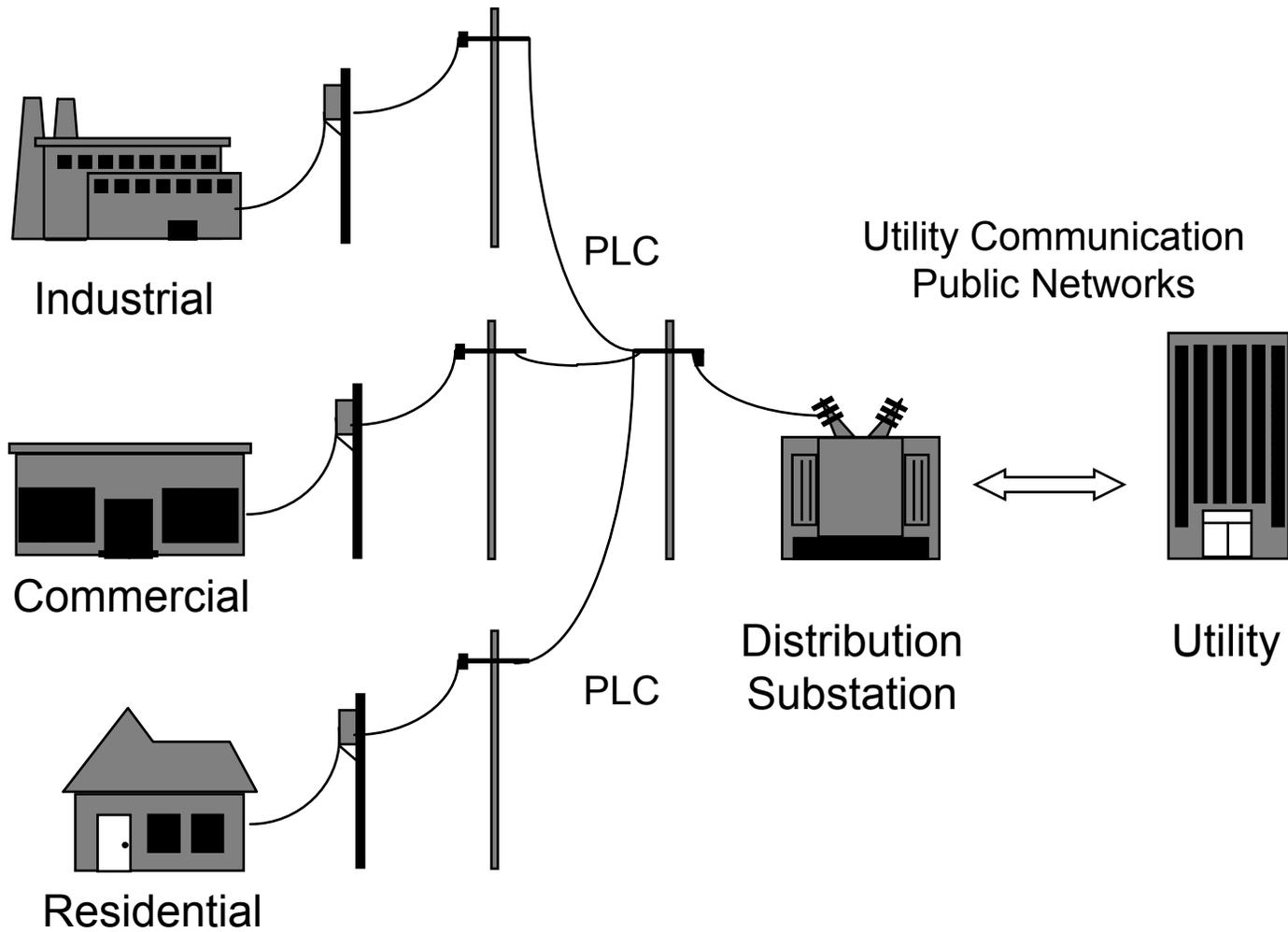
Comverge Maingate C&I



Power Line Communication (PLC)

- Perturbing the current or voltage signal at the zero crossing or adding a new signal onto the line
- Signals injected and received by equipment in substations
- Connectivity back to the data management system is typically Utility communications system or public networks
- Well suited for rural applications
- Vendors include: Hunt Technologies, Cannon Technologies, DCSI

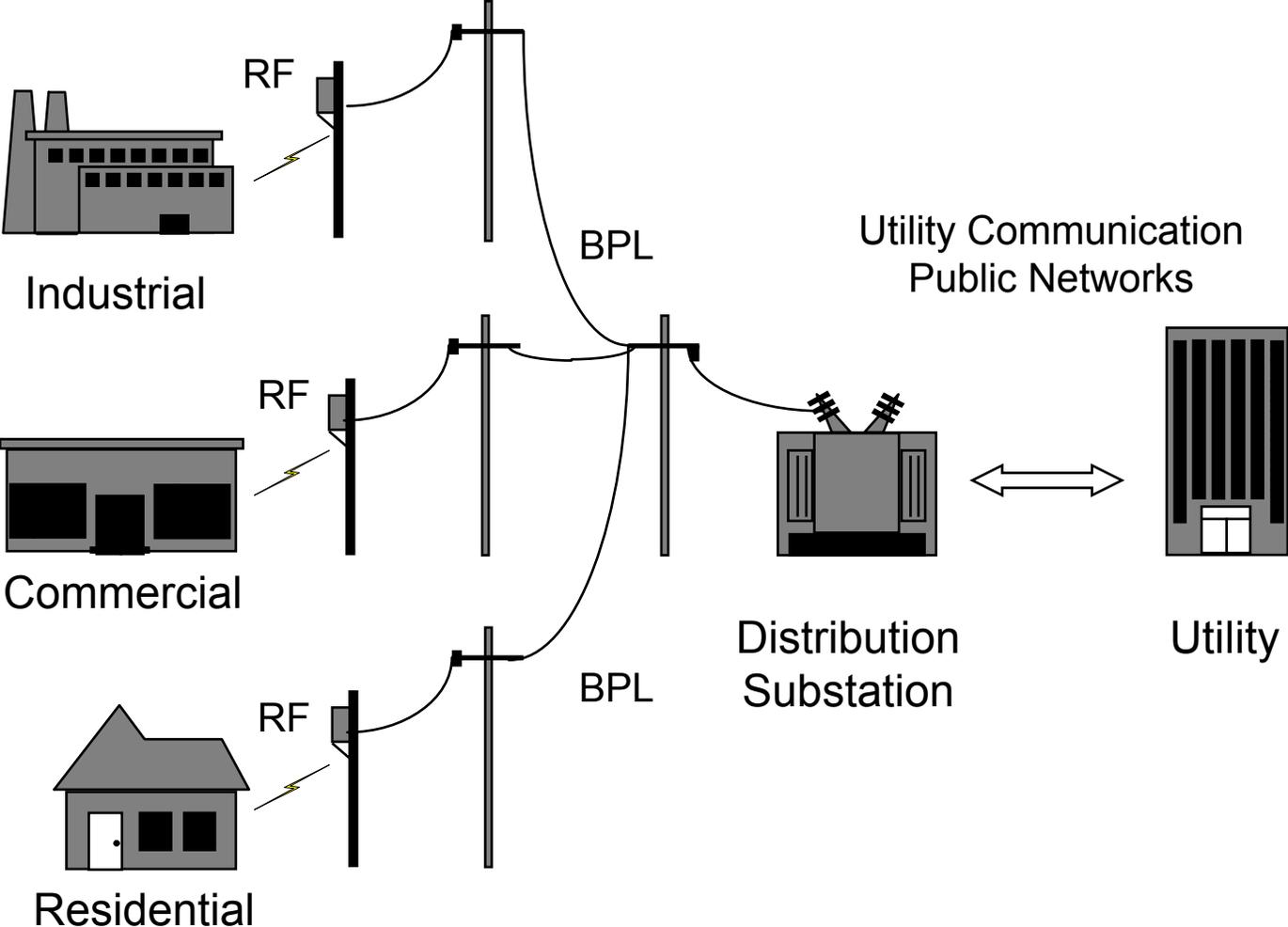
PLC Example



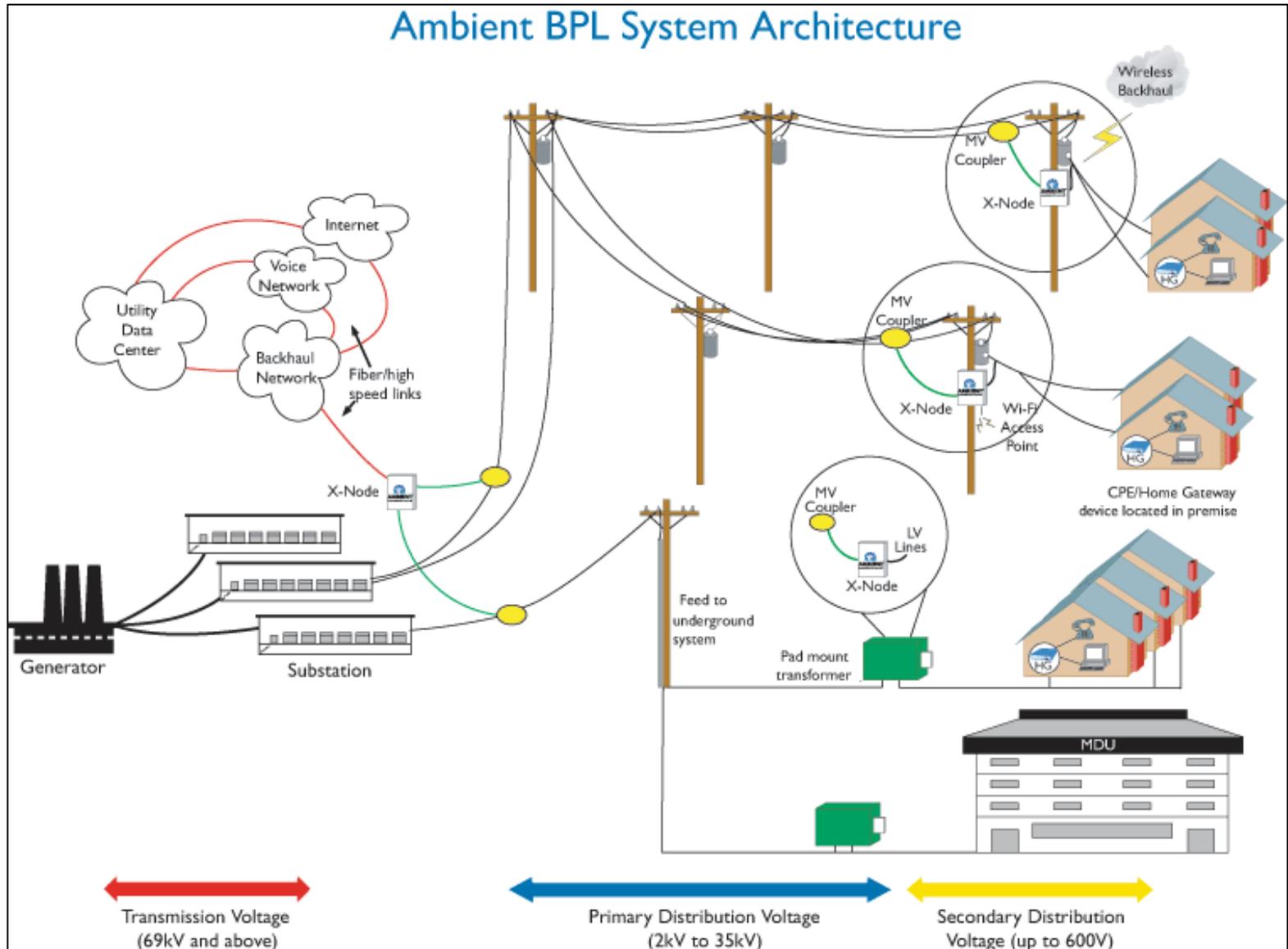
Broadband Over Power Line (BPL)

- Modulating high-frequency radio waves with digital signals from the Internet
- Fed into the grid at specific points, such as Substations
- Travel medium voltage circuits, and through or around transformers
- Sometimes connectivity to the customer meter is through other technology, such as WiFi
- Vendors include: Ambient, Amperion, Current Technologies, Main.net

BPL Example



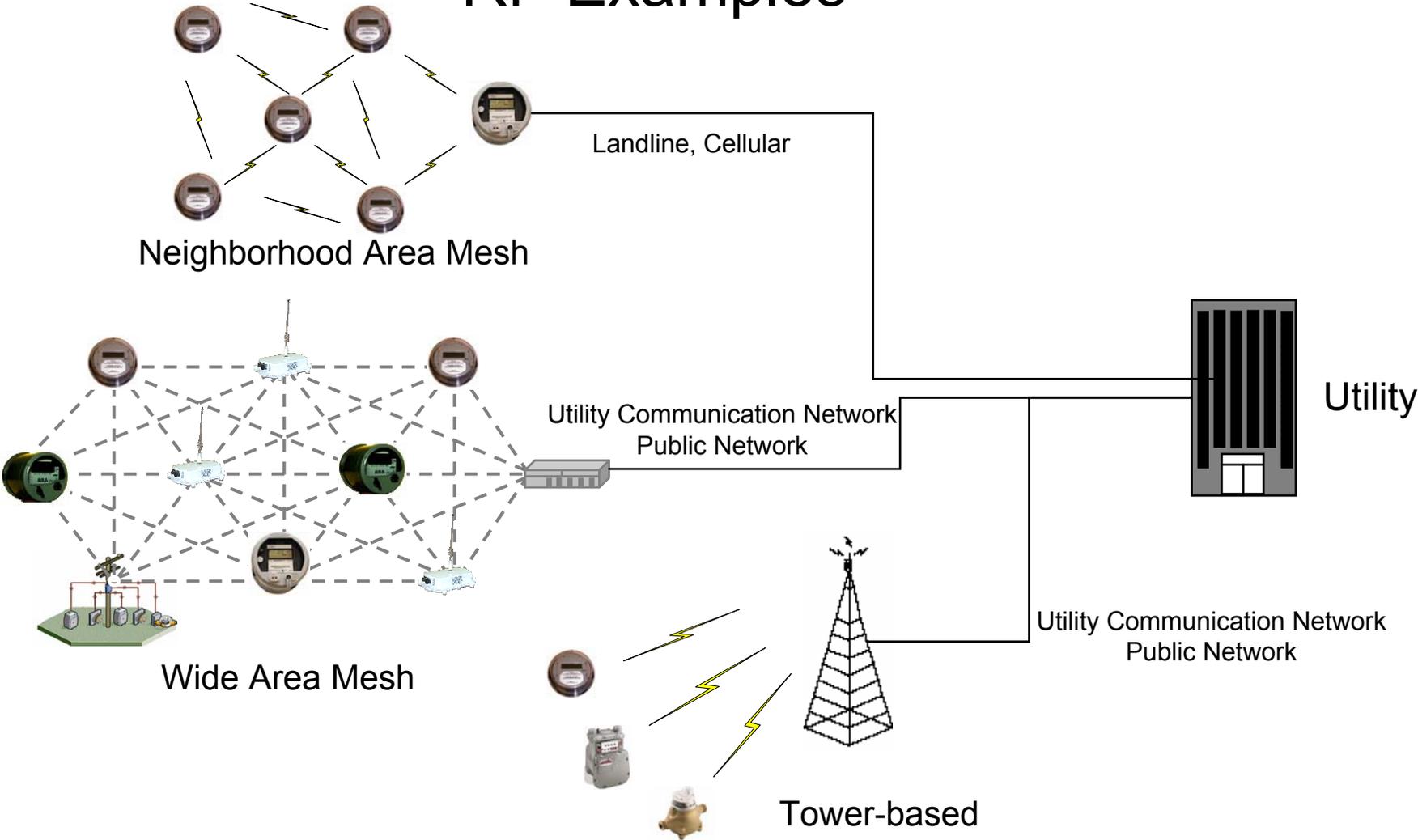
Courtesy of Ambient Corporation



Fixed RF Systems

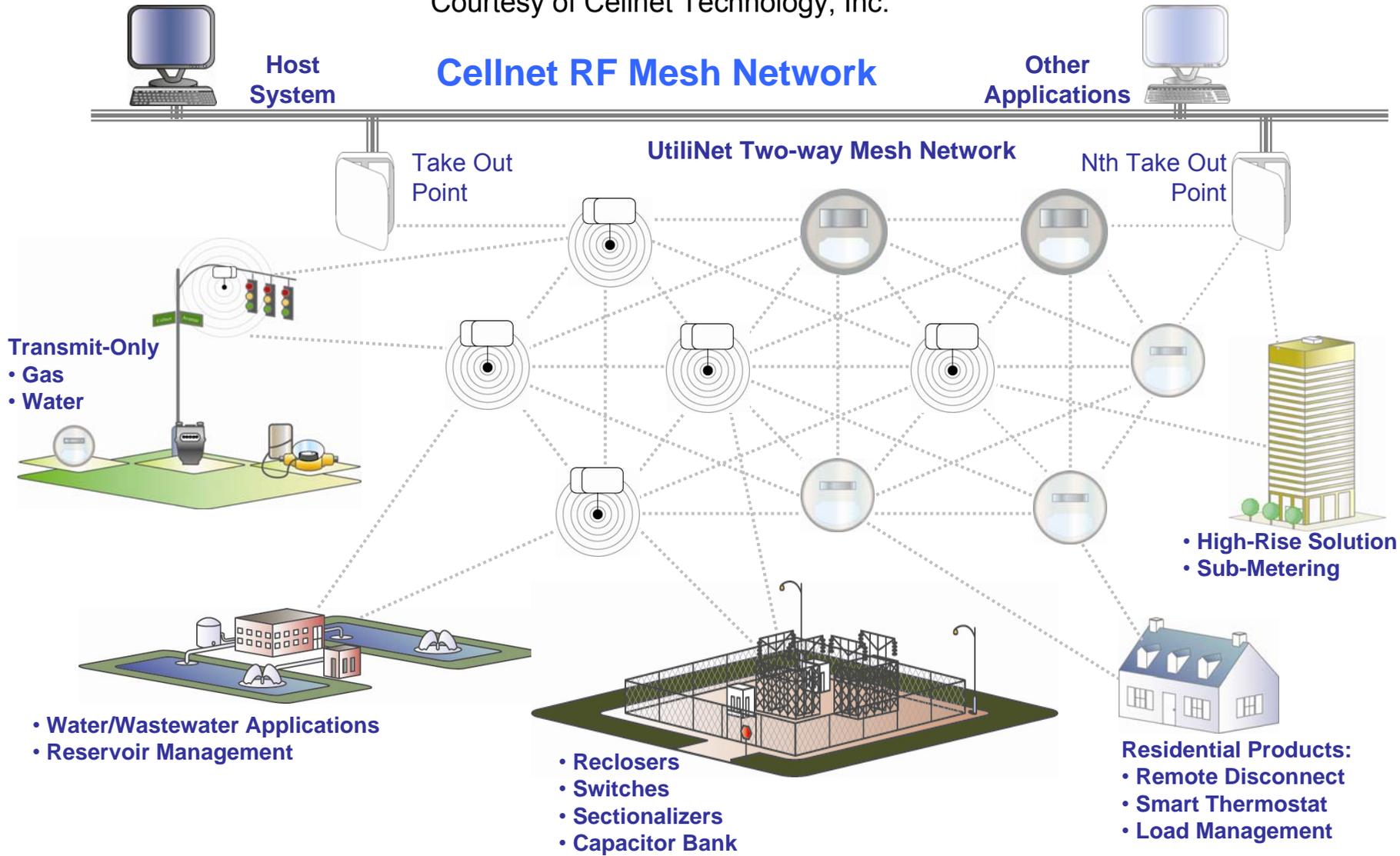
- Private RF network technology using either licensed or unlicensed frequencies
- Meters transmit to repeaters, data concentrators or each other, depending on the architecture
- Network entry/exit points typically at substation, radio tower or utility facility
- Connectivity back to the data management system is typically Utility communications system or public networks
- Self-healing capability, depending on the architecture
- Vendors include: Cellnet, Elster, Hexagram, Itron, Sensus/AMDS, Silver Spring Networks, StatSignal, Tantalus, Trilliant

RF Examples



Courtesy of Cellnet Technology, Inc.

Cellnet RF Mesh Network



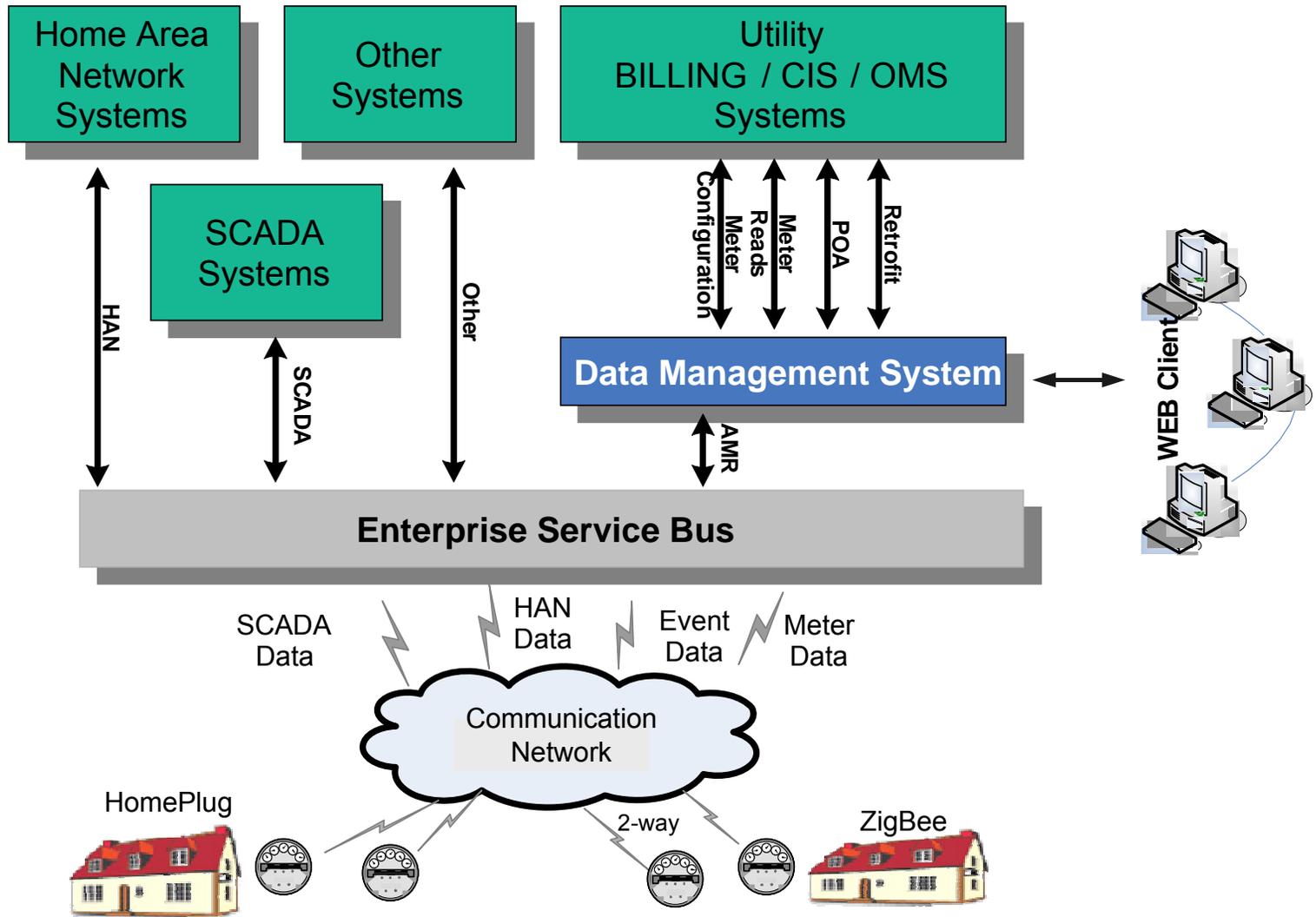
Data Management System (Basic)

- Data collection
- Network monitoring
- Network management
- Data storage
- Real-time meter reads
- Customer care data services
- Standard 3rd party system interfaces
 - MDM
 - OMS/GIS
 - CIS
 - Workforce Management

Data Management System (Advanced)

- Extended Data Storage
- Additional data post processing
- Full Disaster Recovery Mechanisms
- Enterprise Service Bus for data interfacing
- Real-time Web service for network interaction

Data Management



Interfaces to Consider

CIS	     <p>powering STRATEGIC ENTERPRISES</p>
OMS	     <p>powering STRATEGIC ENTERPRISES</p>
Work Order Management	    <p>An IBM Company</p> 
MDMS	   

Interoperability Considerations

- ANSI C12.19 – End Device Tables
- ANSI C12.22 – Data Communications Networks
- IEC-61968 (WG-14) / EPRI CIM Compliance
- MultiSpeak® Support

Security

- **Secure Communication Technology**
 - Denial of Service Attack
 - Spoofing
- **Data Security through Encryption**
 - Encryption keys for metering endpoints
 - Encryption key management
 - Periodic Rotation of encryption keys
 - Encryption support by all system endpoint devices, tools, and system components
- **Data Management System Security**
 - Secure application access
 - Authorization and Authentication
 - Hardening of accounts, passwords
 - Auditing of all activity
 - Intrusion detection

Benefits of AMI

- Meter Reading
- Customer Service and Satisfaction
- Asset Management
- Value Added Services
- Outage Management
- Financial

Benefits of AMI

- Meter Reading
 - Reduce meter reading expenses and capital expenditures
 - Increase accuracy and timeliness of meter reading and billing
 - Eliminate estimated bills
 - Synchronize meter reads
 - Improved employee safety
 - Reduce employee turnover and training

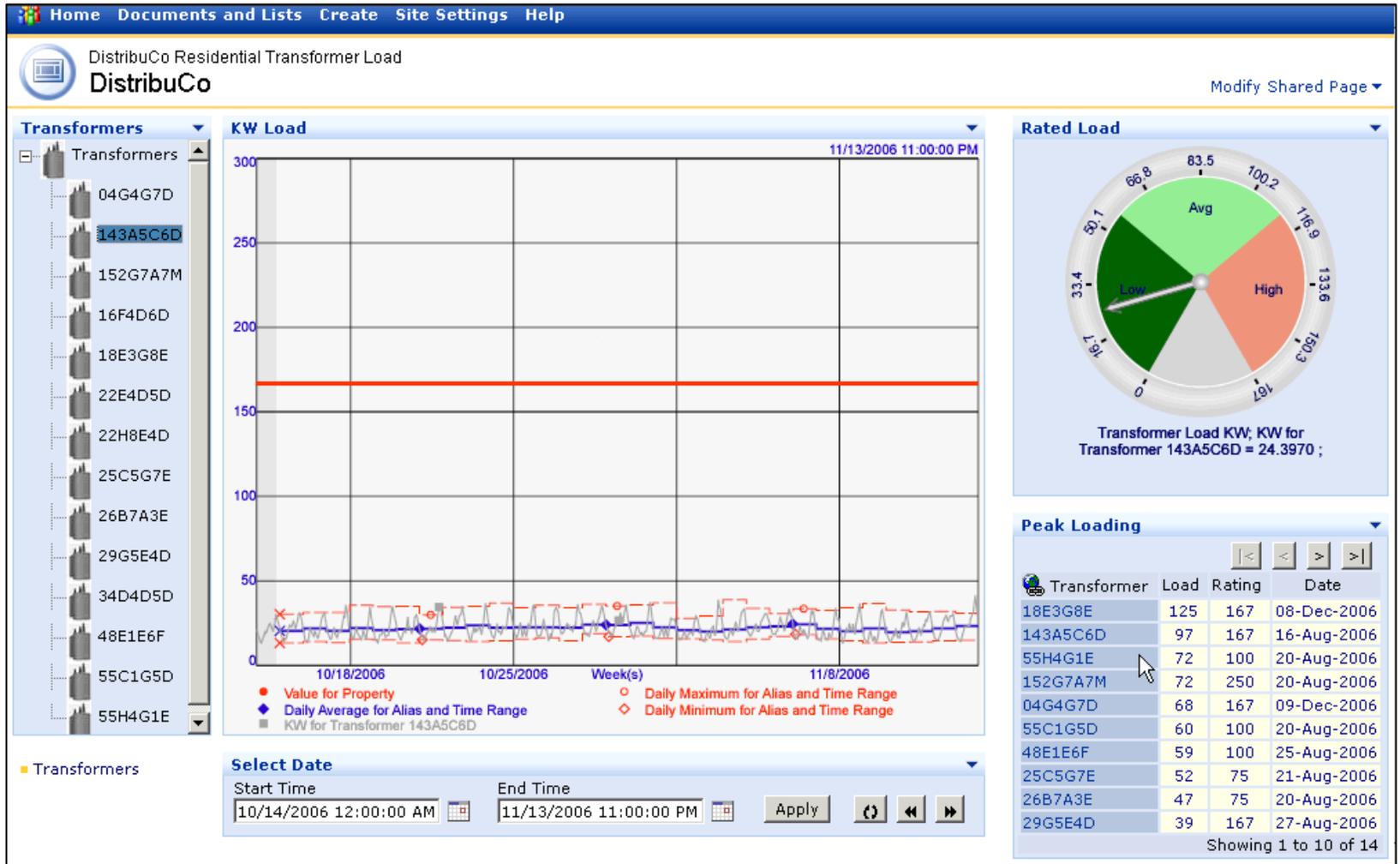
Benefits of AMI

- Customer Service and Satisfaction
 - Real-time reads for high bill complaints
 - Daily or even hourly historical Data (not only what, but when)
 - Flexible billing day
 - On-line customer bill presentment (customer access to historical and real time meter reads)
 - Progressive Usage Monitoring

Benefits of AMI

- Asset Management
 - Theft detection
 - Improve cost allocation across customer base
 - Deferring investment
 - Predictive maintenance of equipment
 - Vegetation management
 - Reduce manual testing due to self diagnostics
 - Proper sizing of distribution equipment

Transformer Sizing Analysis



Benefits of AMI

- Value Added Services
 - Additional rate options
 - Off-cycle meter reads
 - Benchmarking of energy usage
 - Aggregation/synchronization of accounts
 - Remote programmability
 - Bill prediction

Benefits of AMI

- Outage Management Benefits
 - Verify outage before assigning resources
 - Verify restoration before exiting an area
 - Improve response to small outages
 - Reduce call center volume
 - Provide better estimate for repair time

Benefits of AMI

- Financial Benefits
 - Better outage metrics
 - Improved cash flow due to reduced bill processing

Baseline Benefits for AMR Systems

Meter Operations	Meter Reading	Revenue Management	Customer Service & Billing
<ul style="list-style-type: none">• Reduction in labor force• Workers Comp issues• Trouble call reduction• Fewer estimated bills	<ul style="list-style-type: none">• Reduction in clerical staff	<ul style="list-style-type: none">• Compressing Read-to-Bill time• Database clean-up unbilled customers• More accurate metering devices	<ul style="list-style-type: none">• More accurate meter reads• Less estimated readings• Faster off-cycle reads

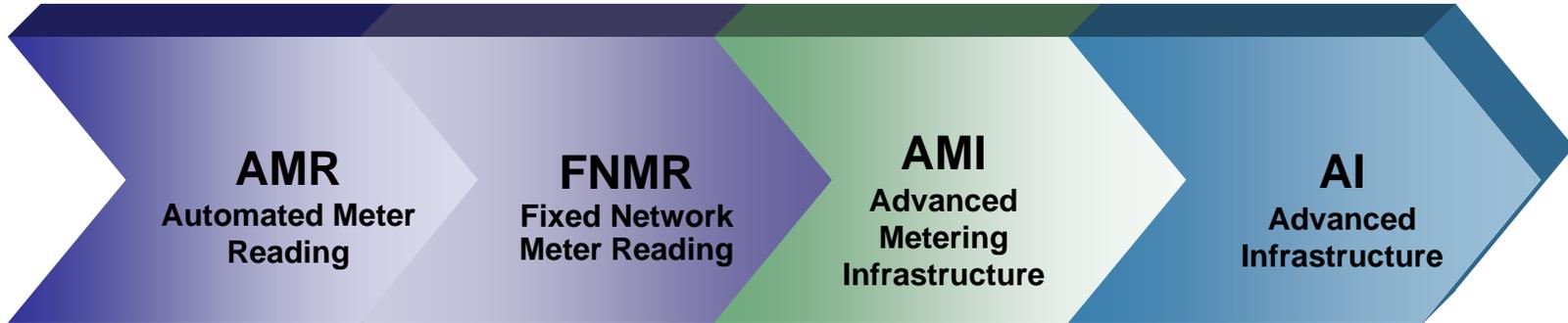
AMI Benefits – Fixed Network

Operational Improvements	Supply-Side Savings	New Revenue Opportunities	Customer Service Improvements
<ul style="list-style-type: none"> ● Outage Management Capabilities ● Leak Detection ● Theft Detection ● Decreased cost of tenant turnover and off-cycle reads ● Bill reconciliation (in deregulated market) 	<ul style="list-style-type: none"> ● Load balancing and forecasting ● Distribution / Transmission Planning ● Asset management and utilization ● Transformer Load Management 	<ul style="list-style-type: none"> ● Notification / monitoring services <ul style="list-style-type: none"> – Power outage / water and gas leakage – Threshold alerts ● Online customer profiles ● Consolidated Billing 	<ul style="list-style-type: none"> ● Billing dispute resolution ● Increased number of pricing plans ● Billing cycle flexibility

Advanced Benefits – Fixed Networks

Operational Improvements	Supply-Side Savings	New Revenue Opportunities	Customer Service Improvements
<ul style="list-style-type: none"> ● Distribution Automation Functionality ● SCADA Application <ul style="list-style-type: none"> ● Water ● Electric ● Capacitor Controls ● Control Automated Switches ● Grid Efficiency 	<ul style="list-style-type: none"> ● DR programs <ul style="list-style-type: none"> —Real-time pricing —Critical peak pricing ● Load control solutions ● Additional Asset management and utilization ● Spinning Reserves 	<ul style="list-style-type: none"> ● In-Home Displays 	<ul style="list-style-type: none"> ● Physical Remote connect / disconnect ● In-Home Displays ● Smart Thermostats ● Electronic Bill Payment and Presentment

The Next Phase



Monthly Data

- Mobile/walk-by
- Readings - 30 Days
- Tamper
- Limited Advanced Metering

Daily Data

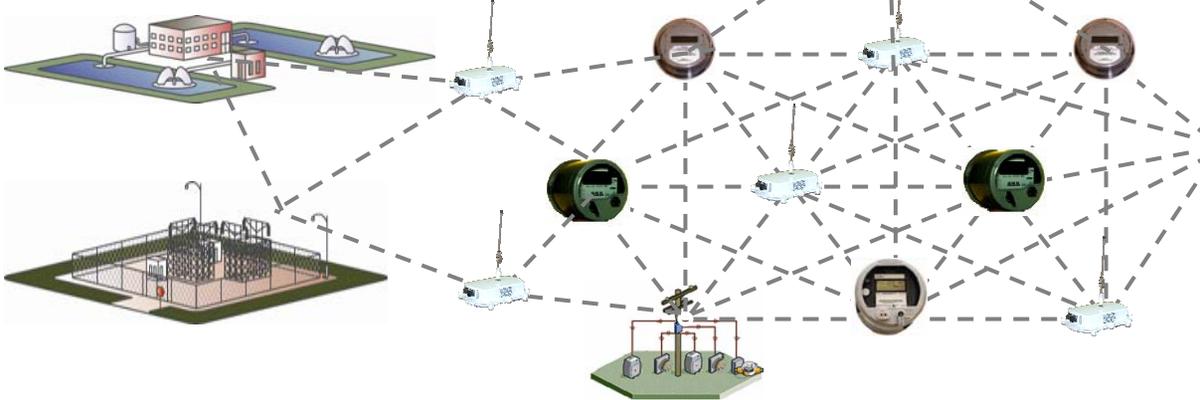
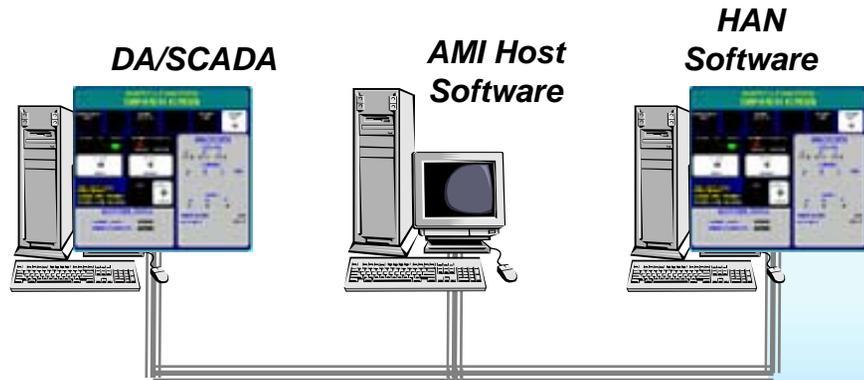
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Advanced Communication

- Communication Network
- Readings hrly
- CPP Event Processing
- Voltage, Power Quality
- Real time Alarms
- Disconnect
- Load Control
 - HAN, Thermostat, Displays
 - AC, Pools
 - Home Gateways
- Distribution Automation
- Prepay



AMI 101