AMR – Automated Meter Reading Overview

21st Century Energy Plan Discussion Forum

June 29, 2006

DTE Energy®

Introduction

- The purpose of this document is to provide an overview of Automated Meter Reading (AMR) technologies for the 21st Century Energy Plan Committee.

- Sections 1, 2 and 3 describe the major types of AMR technologies, their capabilities, their benefits and the system architecture and requirements of those AMR systems.

- Sections 4 and 5 provide a brief summary of DTE's past pilots in AMR and from other utilities who have deployed AMR.

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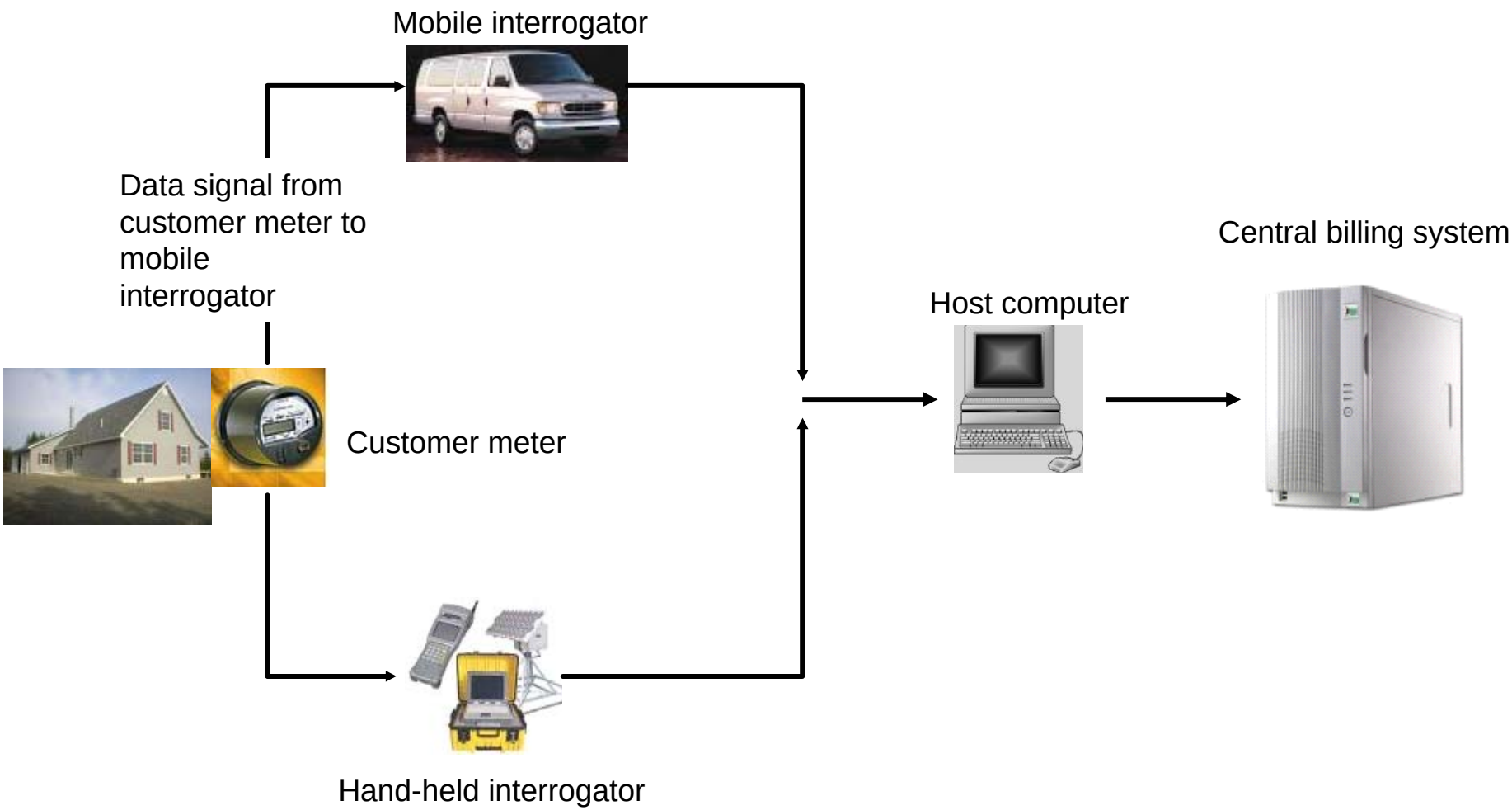
1. **Background: AMR technologies and infrastructure**
2. Benefits and organizational impacts of AMR options
3. Evolution of the AMR market
4. Previous DTE pilots and lessons learned
5. Lessons learned from utilities who have deployed AMR

Metering terminology relevant to AMR

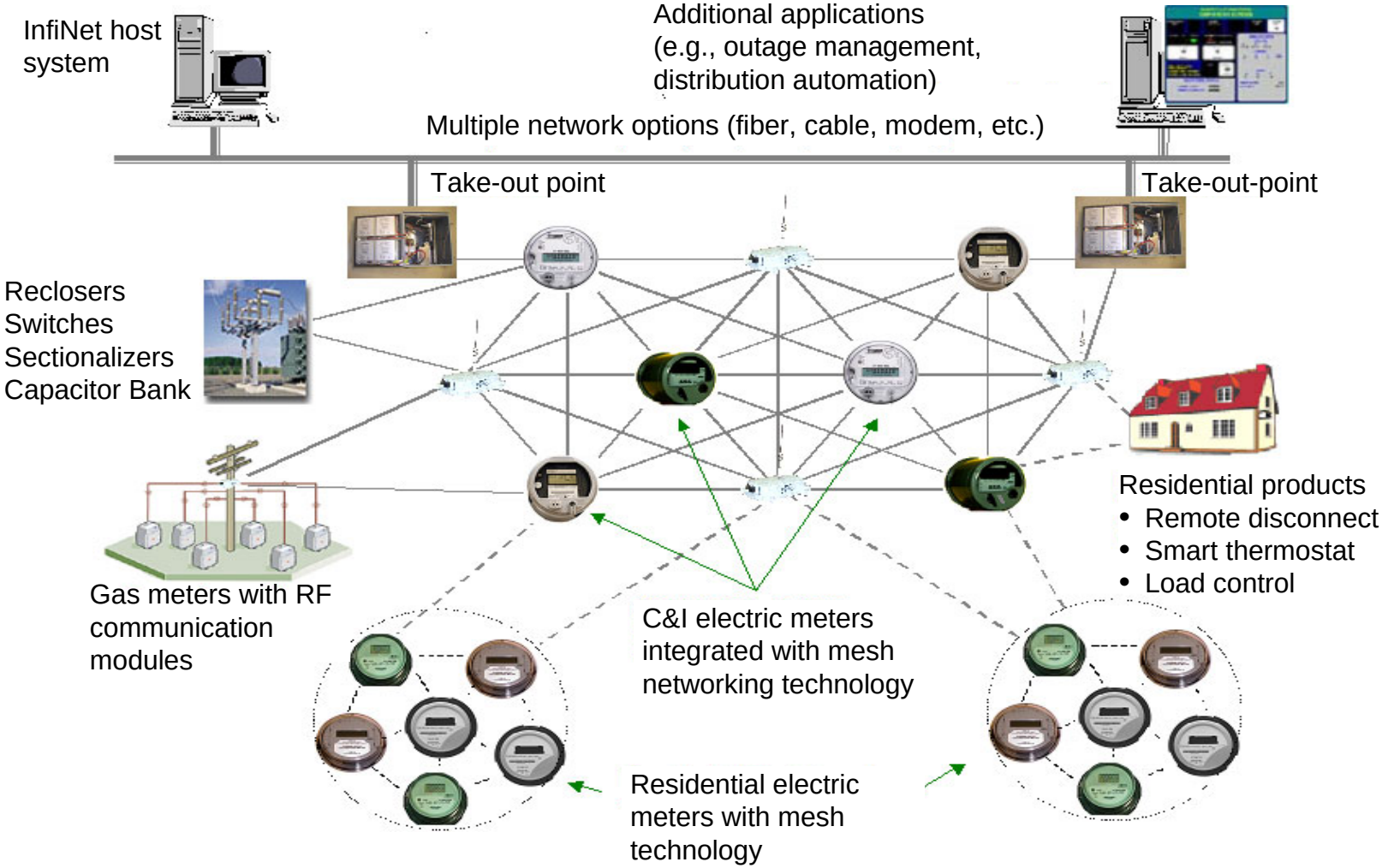
Term	Description
Automated/Automatic Meter Reading (AMR)	• A term broadly applied to any form of automation of the meter reading process using communication technology to collect energy consumption data used to support utility billing and operational processes.
Advanced Metering Infrastructure (AMI)	• A term used to describe automation of the meter reading process using various forms of fixed network technologies in which a permanent communication link is established with the meter.
Electromechanical meter (induction meter)	• Traditional induction meter used by utilities. It is essentially a motor whose speed is monitored by gear driven dials to derive customer electric energy usage.
Solid state meter	• A new technology meter that measures and records electric energy usage through advanced electronics without moving mechanical components. These meters are proven to have an improved lifetime and accuracy compared to electromechanical meters
Smart Metering	• A confusing term that represents a combination of meter technologies and systems. In the context of the Energy Policy Act of 2005, the term means a combination of metering-related technologies, configured in a system, to support complex rates.
Mobile radio frequency (RF) AMR	• A one-way radio frequency (RF) communication system where meters are read by walk-by handheld devices or a drive-by reader mounted in a vehicle.
Fixed RF Network AMR	• A one-way or two-way RF communication system where data is collected over a fixed network and transmitted to a central location.
Power Line Carrier (PLC);	• A one-way or two-way communication system that collects data using existing power lines and transmits to a central location.
Broadband-Over-Power Line (BPL)	• A high speed two-way communication system that communicates with the meter using existing power lines. The higher speed capability of BPL also facilitates other features such as Internet service to the customer.
“Real time” metering	• An automated metering system that can capture usage data in individual meters (in a pre-determined real-time period) and transmit the data to a central location
Time-of-use (TOU) data	• Time-specific data correlating usage patterns with different time intervals during the day
Demand-side management (DSM)	• Planning, implementing, and monitoring activities of energy utilities to encourage consumers to modify their level and pattern of electricity usage

Mobile RF AMR – system components



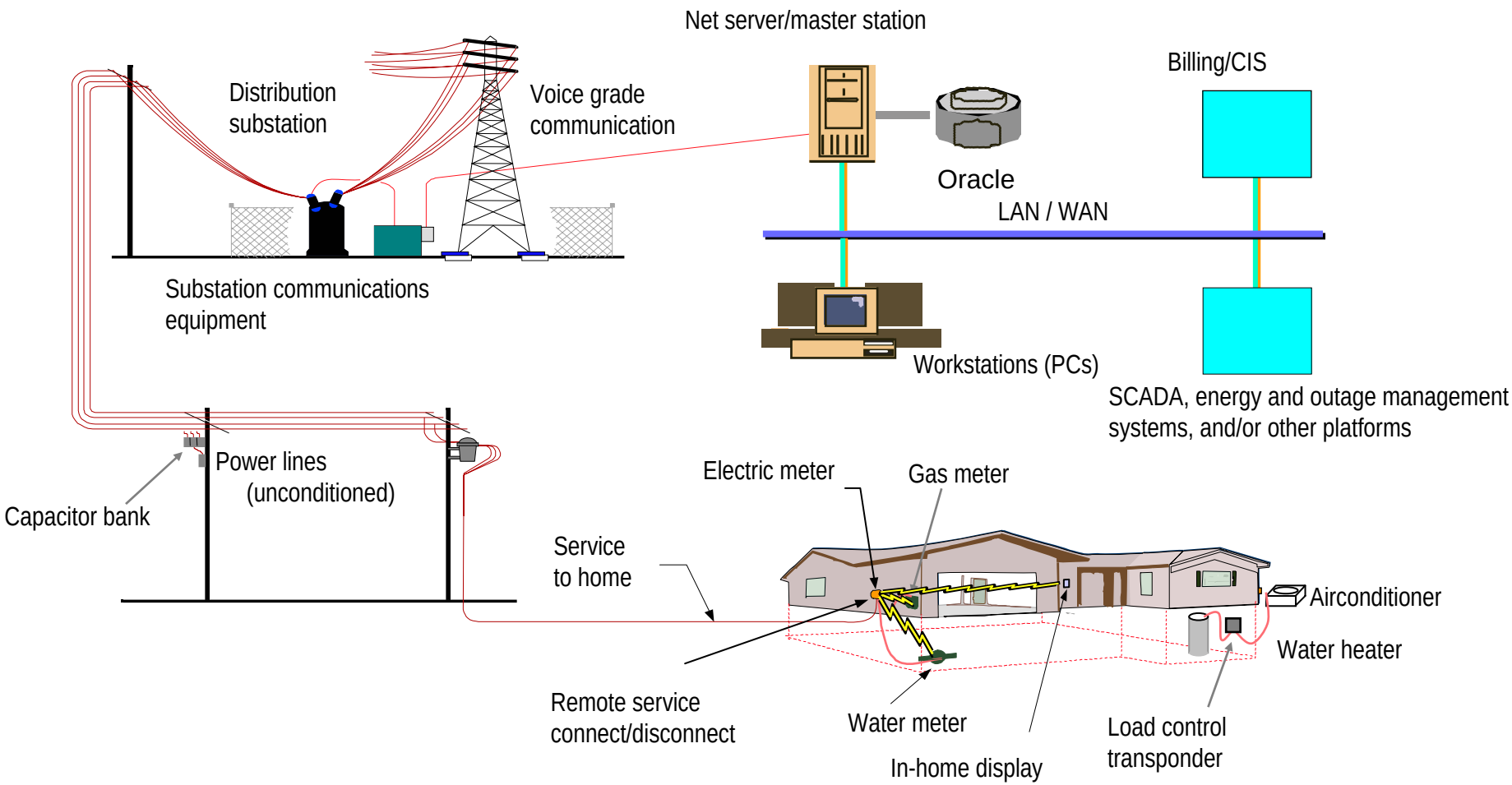
Source: Itron

Fixed RF AMR – system components



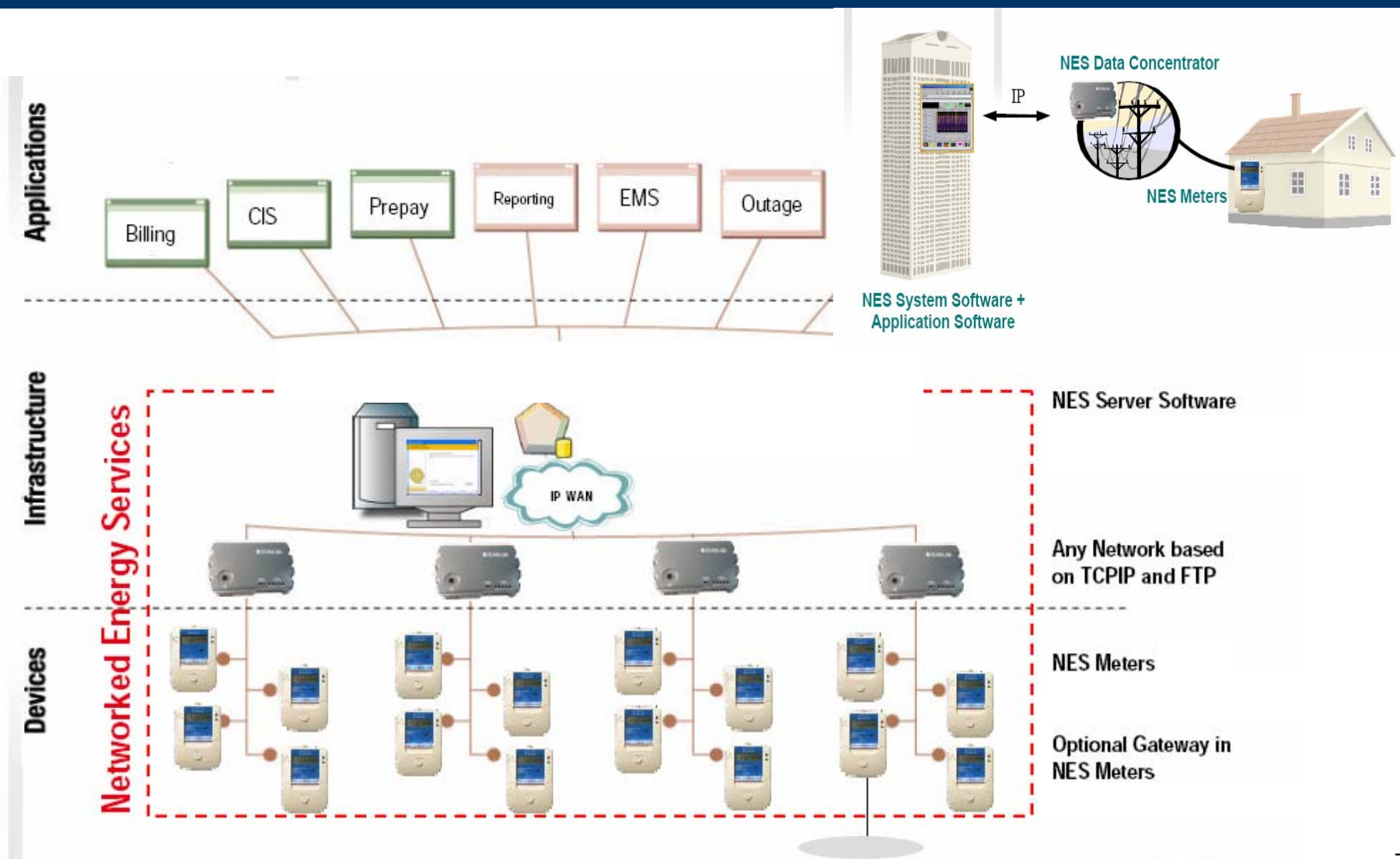
Source: Cellnet

PLC AMR – system components



Source: DCSI TWACS

Advanced Powerline Carrier system components (i.e. ECHELON NES AMR)



Source: Echelon

AMR applications range from pure remote meter reading to automated meter infrastructure (AMI)

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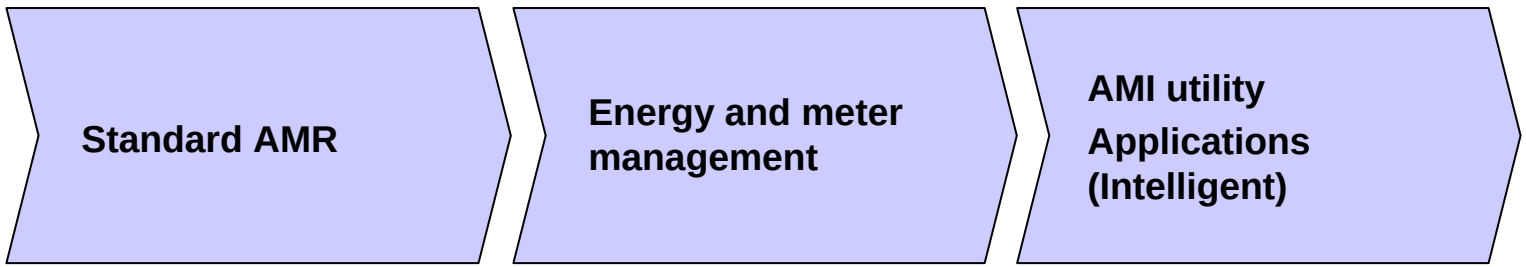

- Basic data collection
  - Mobile AMR
  - 1-way fixed RF network
  - 1-way narrowband PLC
- Unbilled revenue capture

- 1-way or 2-way communication
  - Fixed RF network
  - Narrowband PLC
- Demand side management
- Energy management
- Unbilled revenue capture

- Potential for full IP accessibility
- Broadband
- Network planning and operation
- Remote asset monitoring
- Advanced network analytics
- Unbilled revenue capture and new services/ revenues

AMR technologies differ widely on several key dimensions

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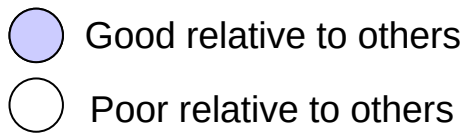

		Capital Cost	Capabilities	Maturity	Option Value
1	Mobile radio frequency (RF) AMR	●	○	●	○
2	Fixed RF network AMR	◔	◑	◔	◔
3	Fixed RF network AMR with remote turn-on/disconnect	◔	●	◔	◔
4	Basic powerline carrier (PLC)	◔	◑	◔	◑
5	Advanced powerline carrier (PLC)*	◑	●	○	●

* Also referred to as Echelon Networked Energy Systems

Brief summary of AMR options: pros and cons

	Technology	Description	Pros	Cons
1	**Mobile radio frequency (RF) AMR**	• Meter data emitted via RF and collected by computer-like devices in drive-by vehicles once a month	• Fast to install, easy to operate • Fast O&M reduction • Proven technology	• Only a metering solution • O&M savings limited to CS, no outage management benefits • Expansion to fixed RF network not proven and risk of vendor lock-in
2	**Fixed RF network AMR**	• Meter data emitted by RF and collected by a fixed proprietary network at predetermined intervals	• Daily/on-demand remote metering • Substantial additional O&M savings in DO (outage, storm and day-to-day trouble management) • Proven at large scale	• More costly than mobile • Scale of data unfamiliar to utilities • More complex network operations and data management
3	**Fixed RF network AMR with remote turn-on/disconnect**	• The same fixed RF network with additional capability of remote turn-on/disconnect (turn-on and disconnect for electric, just disconnect for gas)	• Additional benefit of remote turn-on/disconnect capability • Substantial improvement in collection efforts and arrears reduction	• High cost add-on modules or integrated into the meter at $95-$250 each • While electric technology is mature, gas technology is emerging
4	**Basic powerline carrier (PLC)**	• Meter data collected over low voltage powerline via narrow-band communication at pre-determined intervals	• Daily/on-demand remote data collection • Uses existing powerlines for communication • Gives better control of network	• Not proven at a comparable scale • Network reliability is an issue • Reduced distribution network benefits (e.g., outage, storm, day-to-day trouble) if low voltage lines are damaged
5	**Advanced powerline carrier (PLC)***	• Meter data collected by a combination of larger bandwidth PLC and IP addressable devices at predetermined intervals using a new integrated meter	• All benefits offered by fixed RF and basic PLC except gas disconnect • Built-in turn-on/disconnect switch • Integrated meter (meter and communication module on one board) • Bi-directional communication with the meter	• Unproven technology in U.S., though operational in EU • Higher cost than other fixed technologies • Does not provide gas remote disconnect capability

* Also referred to as Echelon Networked Energy Systems

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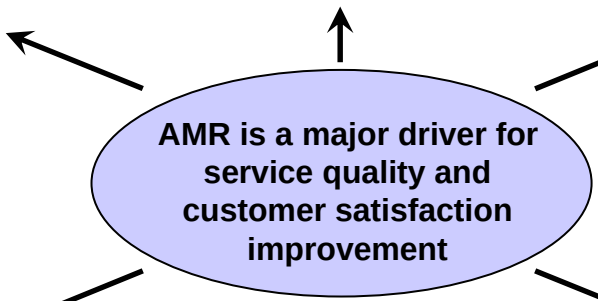
AMR provides wide-ranging operational and customer satisfaction benefits



1. Increased accuracy/ accessibility of meter reads

- AMR eliminates manual meter reading and all related accuracy and access issues including
  - Inaccurate and estimated bills
  - Property access difficulties
  - Electromechanical meter accuracy issues if SS meter deployed with AMR

2. Improved quality and reliability of energy delivery

- AMR provides remote monitoring of the distribution network and enables
  - Faster and more reliable outage detection and restoration
  - More efficient and informed planning of distribution assets
  - Enhanced transformer load management

3. Timely, accurate and effective customer care

- AMR improves relationships with the customer and PSC
  - Addresses customers' questions/ requests promptly and accurately
  - Improves customer service
  - Reduces customer complaints

4. Collection and theft process efficiency

- AMR enhances the collection and theft processes
  - Elimination of final estimated reads
  - Enhanced meter tampering detection
  - Remote disconnect/ reconnect capabilities

5. Accurate demand and consumption tracking

- AMR enables customers to track their consumption and demand over the web and assist them with
  - Adjusting their consumption according to their budgets
  - Choosing a more convenient billing cycle to meet their income

6. Support for regulatory environment

- AMR will support state and federal regulatory environment
  - Prepares possible Federal Energy Act changes
  - Reduces complaint level
  - Facilitates future demand side management initiatives
  - Eliminates need for separate load research samples

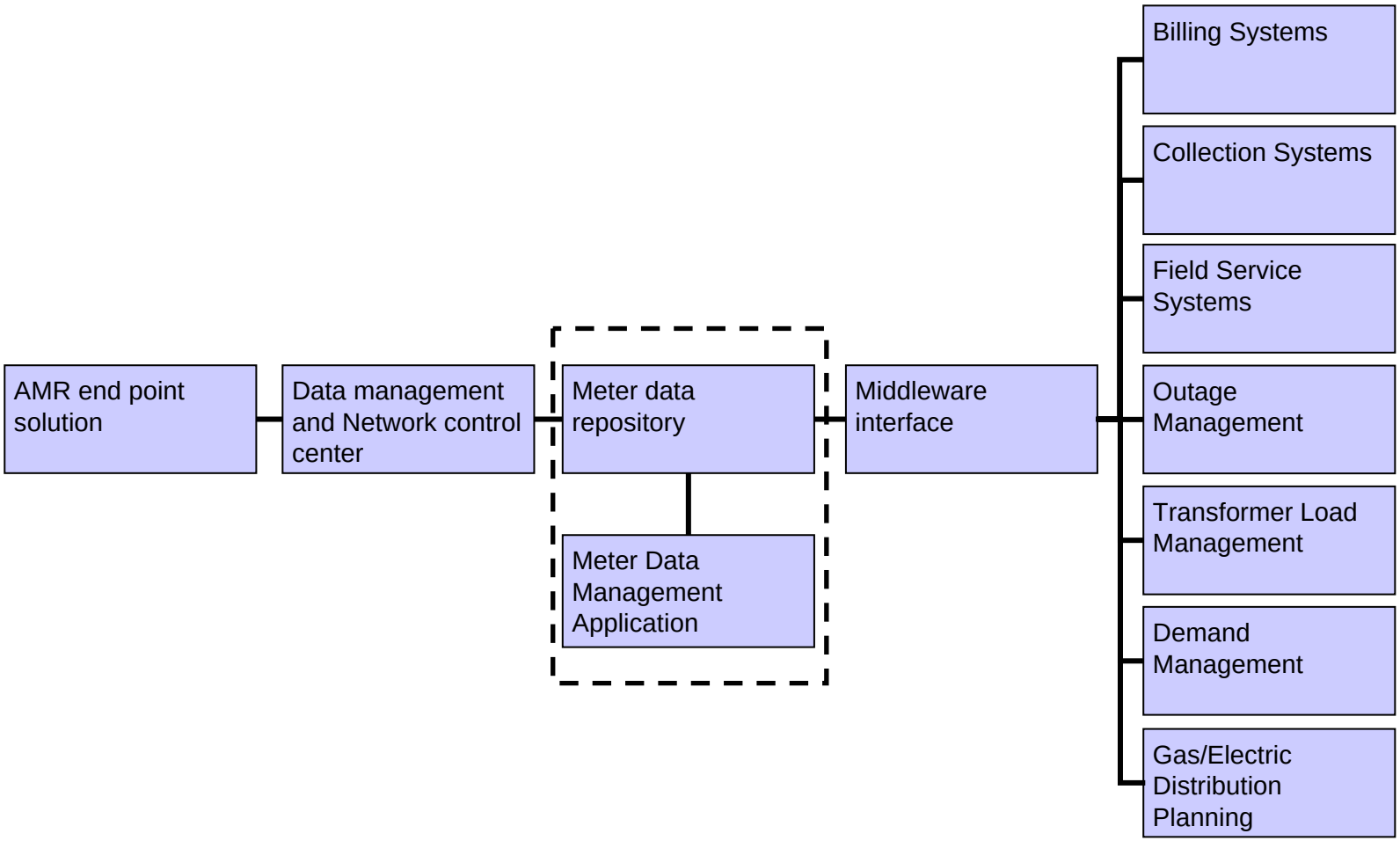
Mobile and fixed AMR technologies have different impacts on key utility business processes

	Mobile AMR	Fixed AMR*
Data collection & billing	• Significant reduction of meter reading workforce (>90%) • Increased reading (>99%) & billing accuracy leads to elimination of estimated bills • Reading and billing still on monthly basis	• Remote meter reading (without any meter readers) enables “real-time” meter reading every ~5-15 mins, reducing cost of special reads • Increased reading (>99%) & billing accuracy leads to elimination of estimated bills
Call center	• Reduction in calls related to estimated bills • Elimination of complaints about meter readers	• Reduction in calls related to estimated bills • Elimination of complaints about meter readers • Increased effectiveness of call center representative via on-the-spot meter reading
Credit & collection	• Elimination of estimated bill related collection problems • Minimal effect on tampering/theft detection	• Elimination of estimated bill related collection problems • Tampering/theft detection • Reduction in field collection workforce and arrears with remote disconnect capability**
Electric dist operations	• No direct impact on processes	• Significant improvement in day-to-day trouble and outage restoration during storms because of outage & power quality monitoring • Elimination of miscellaneous reads, turn-on/disconnects**, billing related service orders • Potential integration with demand management
Gas dist operations	• Increased workforce effectiveness due to elimination of hex replacement/repairs • Elimination of miscellaneous reads	• Increased workforce effectiveness due to elimination of hex replacement/repairs • Elimination of miscellaneous reads

* Includes Fixed RF and PLC type network solutions

** Not included in the standard technology packages. Available as an add-on

IT integration is key to the effective interfacing among all the business processes AMR will link



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Highlights from recent market trend survey

Points from 2004/2005 AMR market survey*	Notes
• In 2005, 33% of the utilities surveyed were considering advanced metering solutions, up from 18% in 2004	• 61 million installed as of 2004 of which 12 million has advanced applications; 150 million expected in 2007
• Mobile technology deployments are dominant in AMR	• Mobile AMR 56%; fixed RF network 29%; PLC 11% • Fixed RF technology and PLC showing solid growth
• Improved customer service and cost savings are the two major drivers for AMR	• Theft detection and daily reading requirement are other important drivers for AMR • Interest in AMR for energy conservation and peak shaving seems to be less significant
• Average cost of AMR differs significantly for residential and C&I customers	• $60-70/meter for residential mobile AMR • $140/meter for advanced residential AMR • $365/meter for C&I, including meter labor
• Market share of top AMR vendors stayed stable in 2005	• Itron – 54%; Cellnet – 22%; DCSI – 11%

* Out of 119 utilities surveyed by Chartwell in 2004, and 118 surveyed in 2005. Total estimated meter population in U.S. is 285 million in 2005

Many large U.S. utilities have already successfully deployed AMR technologies

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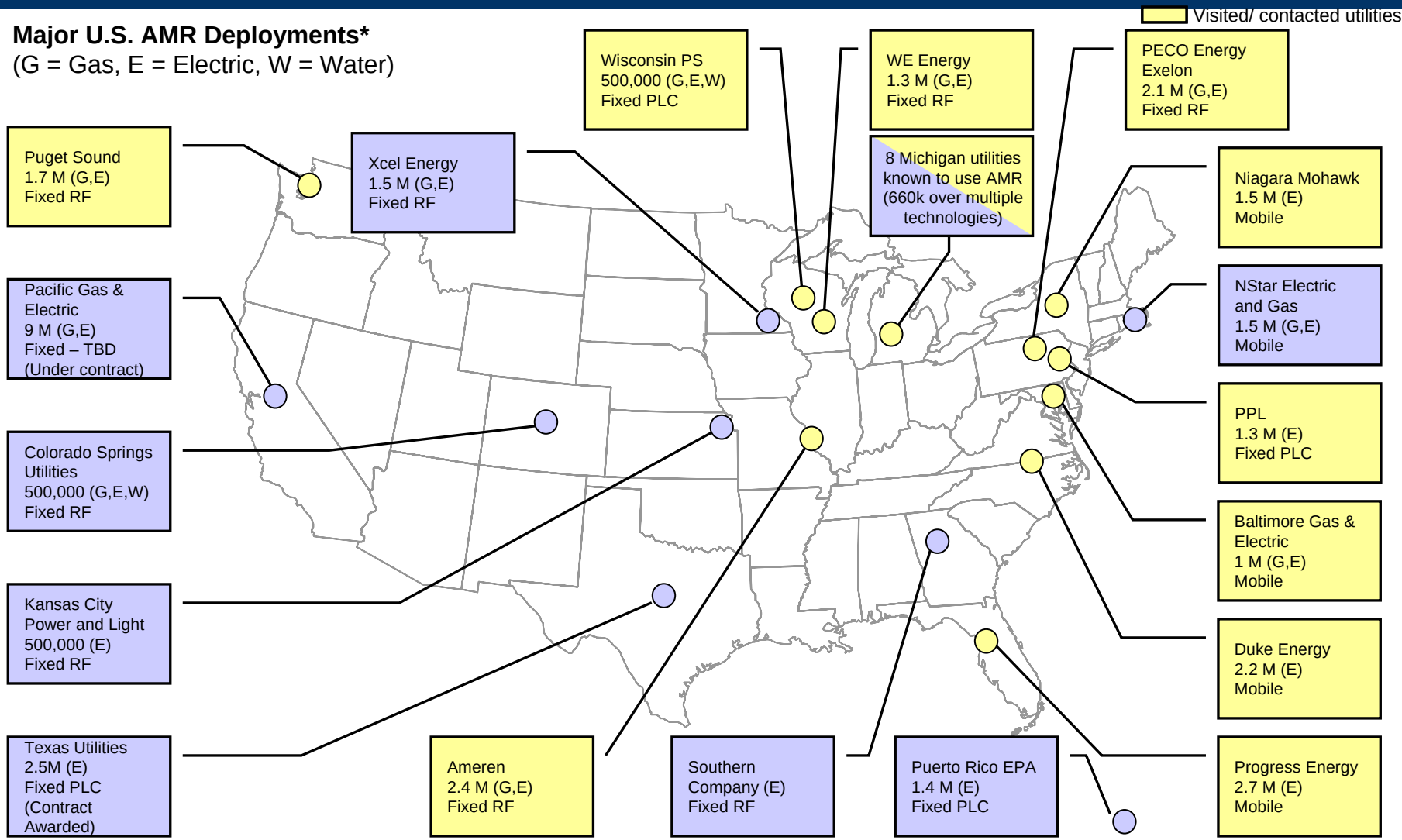
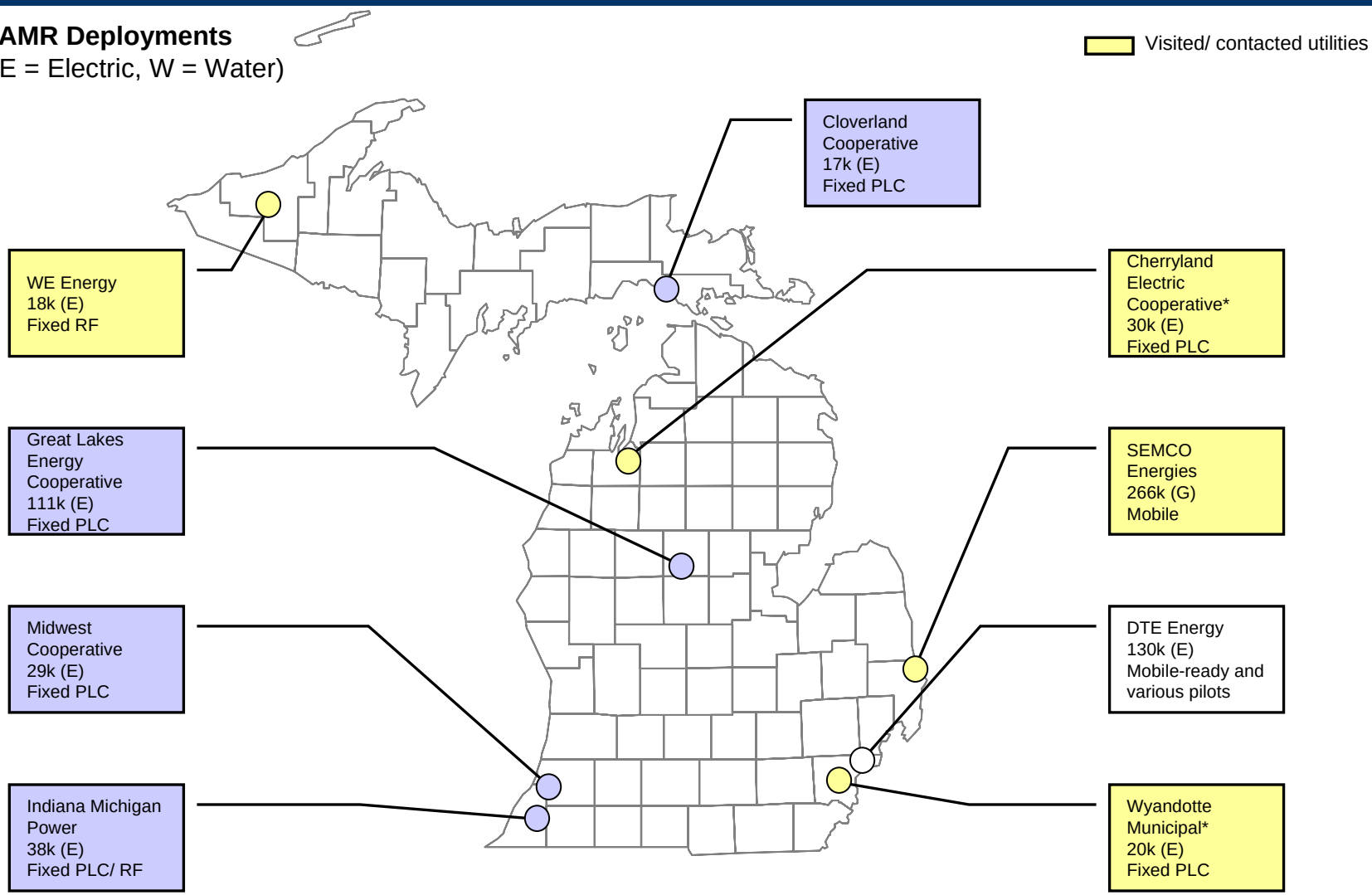
Major U.S. AMR Deployments*
(G = Gas, E = Electric, W = Water)



* Includes deployments over 500,000 meters throughout the U.S. RF = Radio Frequency, PLC = Power Line Carrier

Many utilities in Michigan are also using AMR

Michigan AMR Deployments
(G = Gas, E = Electric, W = Water)



* Implementation in progress

Benchmarking overview – recent mobile AMR installations

Utility	AMR scope	Vendor/ Project mgt./ Installation	Roll-out/ Prioritization	Cost justification/ Benefit Realization
Duke Power	• 2.2m (E) • 85% Retrofit • 15% Solid-State Meters	• Itron • Itron Project Mgt. • Contract meter installation (Scope Services)	• 5 yrs. • 2000-2005	• MR & Call Center Cost Reduction • Billing Improvements • Read Percentage
Niagara Mohawk	• 1.5m (E) • Solid-State Meters	• Itron	• 2 yr. Project • 2002-2004	• MR & Call Center Cost Reduction • Billing Improvements • Safety • Theft/System losses
NStar Electric & Gas	• 1.3m (E) • 45% Retrofit • 55% Solid-State Meters • 0.27m (G)	• Itron • NSTAR Project Mgt. • Contract meter installation	• In progress, 2003-2007 • 1.1m (E) & 0.27m (G) meters	• MR & Call Center Cost Reduction • Read Accuracy • Customer complaints • Safety
Avista Utilities	• 325k (E) • Solid-State Meters • 300k (G)	• Itron • Avista Project Mgt. • Contract meter installation (Truecheck)	• In progress, 4yr. project • 113k installed	• MR & Call Center Cost Reduction • Billing Improvements • Theft • System losses
BG&E	• 1.2m (E) • 0.6m (G)	• Itron • Itron Project Mgt. • Contract meter installation (VSI)	• In progress, 3 yrs. • 933k installed	• MR & Call Center Cost Reduction • Billing Improvements • Read Percentage

Benchmarking overview – recent fixed RF AMR installations

Utility	AMR scope	Vendor/ Project mgt./ Installation	Roll-out/ Prioritization	Cost justification/ Benefit Realization
PECO Energy	• 1.73m (E) • 0.47 (G)	• Cellnet	• 4 yrs	• Cost reduction • Efficiency improvements • Read percentage
Puget Sound	• 1.6m (E)	• Cellnet	• 5 yrs install • 15 yrs service	• Reading costs • Accuracy
Ameren	• 1.3m (E) • 139k (G) • Illinois expansion includes 550k (E) and 450k (G)	• Cellnet	• 5 yrs	• Cost reduction • Outage detection • Distribution operations • System losses
Xcel Energy	• 1.1m (E) • 360k (G)	• Cellnet	• 4 yrs	• Cost reduction • Meter read performance
WE Energies	• 762k (E) • 612k (G)	• Cellnet	• 4 yrs • 2002-2006	• Cost reduction • Efficiency improvements • Read percentage

Benchmarking overview – recent PLC AMR installations

Utility	AMR scope	Vendor/ Project mgt./ Installation	Roll-out/ Prioritization	Cost justification/ Benefit Realization
PPL	• 1.3m (E)	• DCSI • Joint Project Mgt	• 2002-2005	• Eliminated est. bills • Red. high-bill complaints • Red. complaints to regulators • Demand-side response programs • Post-storm restoration assessment
Puerto Rico EPA	• 1.4m (E)	• DCSI • Joint Project Mgt.	• 9 yrs • 1998-2007	• Lower estimated reads • Monthly reads • Theft detection • Voltage Monitoring • Reduce Energy Losses • Dist. Automation
Wisconsin PS	• 0.43m (E/G/W)	• DCSI	• 2001-2005	• Improved customer processes: – reduced high-bill complaints – improved service dispatching and outage management

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Previous and ongoing experience with AMR technologies

Year	Vendor/Party	Technology	Scope	Notes / Key Lessons Learned
Pre-2000	• Hexagram	• Pulse encoders – read by handhelds	• 600,000 inside gas meters currently in service	• Still in use • Some maintenance issues with batteries and access
	• Itron	• RF handheld radio technology	• 130,000 point solutions for company/ access issues	• In use today with very limited manpower
	• Echelon, Comcast, HP	• Custom 2 way technology	• 160 point solutions • Appliance Control • TOU Special Rates	• High Cost, Technology ahead of its time • Complex for customer
2001	• Hexagram	• STAR fixed network licensed 450 MHz	• 50 homes Hamtramck – electric gas & water – 2 data collectors • 1,000 gas meters, rural deployment – 8 data collectors • Hourly data downloads	• Deactivated – Never expanded due to cost • Retrofit electromechanical meters is expensive • Collectors on pole expensive to maintain (requires line crews/bucket trucks)
2002	• Itron	• Fixed network licensed 960 MHz & 1 GHz	• Pilot for 1127 residential electromechanical meters retrofitted with ERT-45 modules • 43 cell control units • 1 network control node • 3 servers • 15 minute interval data	• Software update issues created problems • Collectors on poles – some outages

Previous and ongoing experience with AMR technologies

Year	Vendor/Party	Technology	Scope	Notes / Key Lessons Learned
2001	• DTE Load Research	• Wireless analog	• 1,800 units retrofitted • Residential (single phase) and commercial interval meters for load research and hard-to-read meters	• Still in use • DTE owned technology, non-commercial • High maintenance and infrastructure costs
2001	• MUNET	• Cable/DSL broadband	• 12 locations (DTE volunteers)	• Multiple upgrades required at meter – hard on customers • Power supply issues force need to pull meters often
2001-2005	• Innovatec • Nertec • Smart Synch • Elster REX • Transdata • Comverge • Telenetics • Metrum	• Various technologies	• Small lab tests ranging from 1 to 20 meters for multiple technologies and vendors – primarily done in conjunction with MV-90 and choice meters, but technologies can be used in larger AMR deployments	• Lab testing only • Learning about technologies, but no technology accepted for larger pilot • General improvements over time especially in deployment (vs. technology)

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Key themes in AMR implementation from peer utilities

Technology choice

- Earlier technology choices were primarily based on cost savings considerations
- More utilities today justify their technology decision with recent or expected regulatory changes around energy management, e.g., PG&E, SCE
- Technology obsolescence concerns have arisen at utilities with mobile AMR, e.g., Duke Energy is considering a transition to fixed network AMR

Roll-out/ installation

- No major budgetary or contractual complications during roll out and installation
- Customer notification especially for hard-to-reach meters is key prior to installation

Operations

- Vendor is involved at different levels in operating the system, especially for the fixed network options, depending on the contract structure and specific technology choice
- A new 'Meter Technology Group' coordinates and designs sharing of AMR data with other business units. This unit also continuously looks for new ways of using the AMR data to improve savings and overall operations

Benefit realization

- The extent of benefit realization is strictly coupled with thorough understanding of technical capabilities, IT integration and continuous improvement
- Peer utilities are still finding new ways of utilizing the AMR data to increase savings

Source: Interviews with Duke Power, Avista, BG&E, Ameren, PECO Energy, PPL, Progress Energy and WE Energies

Key takeaways from peer utilities' experience with mobile RF AMR

Drivers for AMR technology choice	• The cheapest AMR solution that is easy to rollout without lag between the installation and benefit realization
Issues around roll-out and installation	• No major issues regarding vendor or the technology • Careful planning of the logistics and having accurate meter information is key for on-time completion of installation
Operational complications	• Meter data management and billing systems may not be able to adapt to the daily number of meters changed • Routing, capital vehicle replacements continue as daily activities in manual reading
Benefits realization	• The predicted O&M savings in customer service and meter reading labor were firm and realized • Savings in other areas of customer service thanks to accurate reads

Source: Phone interviews with Duke, Avista, and BG&E. Site visit to National Grid and Progress Energy

Key takeaways from peer utilities' experience with fixed RF AMR

Drivers for AMR technology choice	• Business cases were primarily based on hard savings in customer service including meter reading, reduced calls, reduced billing exceptions, etc. • Access to interval meter data (as frequent as every 5 minutes) • Executive sponsor was key for the final approval of the business case
Issues around roll-out and installation	• No major issues regarding vendor or the technology • Sourcing and logistics of roll-out can be challenging. Having an accurate meter database (meter ID #, type, location) greatly help with the installation
Operational complications	• No major complication • Meter data management and billing systems may not be able to adapt to the daily number of meters being replaced
Benefits realization	• Benefits in customer service fully realized, e.g., 95% reduction in meter readers, significantly reduced SAIFI instances, reduced call volume helped consolidate call centers from three to one • Theft benefits, usually excluded from business cases, are now being realized • Outage assessment, restore efficiency, reduction on OK on arrivals are being realized. Outage systems can handle 3,000 events per minute. CAIDI improved by 5% • Currently exploring how to use AMR data in engineering design, power quality and predictive maintenance

Source: Phone interviews with Ameren and PECO Energy, and site visit to PECO Energy

Key takeaways from peer utilities' experience with PLC AMR

Drivers for AMR technology choice	• Deregulation, cost cutting, and tamper detection drove the decision to implement an AMR solution • Executive sponsors (the President of Transmission and Distribution in partnership with the Vice President of Customer Service) were key for the final approval of the business case
Issues around roll-out and installation	• Suffered from meter shortage, which delayed the deployment • Sourcing and logistics of roll-out can be challenging. Having an accurate meter database (meter ID #, type, location) greatly help with the installation
Operational complications	• In order to monitor the deployment process, tracked quality, install rates, return rates, and installer productivity. The reporting tools were essential to identifying potential issues • The deployment schedule was based solely on meter route and ignored factors such as individual meter age and individual meter accuracy • Weak software support prevented collection of frequent data during the day • Scalability to larger meter populations seems to be a concern
Benefits realization	• CS benefits mostly realized. 25% reduction in billing exceptions. 82% reduction in billing complaints. Customer can know determine their billing cycle • Benefits from outage monitoring delayed due to lack of software/data management tools • Almost 50% reduction in formal PUC complaints. Informal PUC complaints decreased by 25%

Source: Phone interview followed by a site visit to PPL and Cherryland Electric

Conclusions

- A comprehensive enterprise-wide assessment of benefits must be performed to ensure the correct technologies are selected for advanced metering.
- Legislative and regulatory drivers play a key role in AMR decisions.
- AMR/AMI technologies continue to mature.
- Industry experience supports significant AMR/AMI return on investment.

Open Discussion & Questions