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Capitalizing on Two-Way Communications for Demand Response - Vendor Overview

Technical Report

Capitalizing on Two-Way Communications for Demand Response – Vendor Overview

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REPORT SUMMARY

This report is part of a two-volume study on communication technologies for demand response. Communications and controls technologies can automate much of the work in a utility's demand response program. This automation can make programs easier for customers to use, therefore making them more attractive and robust. This volume focuses on communication technologies currently available for automated demand response communications. The report also provides an overview of major technology vendors whose products might enable two-way communications. The second part of this report focuses on the communication needs of commercial, industrial, and institutional customers.

Results & Findings

Study results show there are a number of different technologies that can support demand response communication. However, some of these technologies are better suited for the real-time, two-way communication needs demand response programs may require. Likewise, there are a number of different vendors who offer products to meet communication needs. These products range from simple to highly complex.

Challenges & Objectives

This report is designed for demand response program managers, technology support personnel, and utility communications specialists. Information in this report can help these professionals better understand the various communication media available to their programs. Vendor information can be used to compare different communication products and develop successful programs based on various product attributes.

Applications, Values & Use

This two-volume report can help utilities design effective demand response programs with the right amount of automation to meet the needs of their business customers and the right amount of technology to meet their automation goals. Vendor information can be used to find companies that fit the automation profile developed by the utility for demand response.

EPRI Perspective

EPRI applied a unique approach to the issues of demand response communication, focusing on both the needs of the energy consumer and the products available in the marketplace. By combining these two pieces of information with the stated goals of a demand response program, utilities can design a successful program without over- or under-investing in automation.

Approach

The project team examined demand response communication issues within the context of how customers will interact successfully with demand response sponsors and the communications

architecture and technologies that can best serve these interactions. Together, the two volumes present a comprehensive overview of the demand response communication needs of business customers and the types of communication technologies and products available to utilities today.

Keywords
Demand response programs
Two-way communication
Communication automation technologies
Communication technology vendors

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1
EXECUTIVE SUMMARY

Utilities implementing demand response programs face a bewildering array of technologies, vendors and products that can improve communications and automate processes. Sorting through these choices can be daunting and the risks of making an incorrect decision can be high both in terms of fiscal costs as well as lowered customer participation.

This report helps utilities in better understanding their communication options by providing an overview of available communication technologies as well as major vendors and their products. The report is based on a review of secondary source literature and primary interviews to better understand the strengths and weaknesses of the various communication media. In addition, interviews were conducted with approximately 40 major communication vendors to identify 28 companies who provide communication products that can automate demand response programs.

The research uncovered a number of important findings, including:

- *Vendors come in a variety of guises*: The companies interviewed for this study run the gamut from meter manufacturers to software platform companies to service companies. Many of these companies are niche players targeting specific areas of the communication data chain. Many of the vendors interviewed target their products directly to the consumer marketplace and have either never considered selling to utilities or view such as a sales effort as not worth the effort.
- *Demand response automation could leverage existing technology solutions*: Solutions offered by vendors are engineered to configure or integrate with available technologies rather than creating new technologies. These technologies could support a broader range of connectivity applications than is now in common practice. That is, existing technologies and products can be integrated with little technology risk to significantly expand C&I customer participation in utility programs such as demand response. The challenge is for utilities to be aware of the capabilities (speed, throughput, ubiquity, low cost, etc.) of many modern connectivity options, and their ability to support many more creative and technically challenging applications than is now the case.

  In addition, many vendors expressed a willingness to integrate communication media, control devices and interfaces into “open architecture” end-to-end solutions. This could allow utilities to leverage their major customers’ previous investments in equipment. The readiness of utilities to provide convenient interfaces to *existing* customer-side demand response applications is important, and is far more palatable to customers than applications that require purchases of new equipment, complex interfacing or protracted commissioning processes.

- *Automation solutions can create more robust demand response programs*: The connectivity solutions reviewed in this survey show that automation can help increase the sophistication of demand response programs. Multi-site C&I customers have applied connectivity solutions in ways that suggest it would be relatively simple to integrate the utility into decision-making and operations. C&I energy users now operate software platforms that enable demand response in multiple, remote locations. Automation can allow for greater utility involvement and appropriate rate signals or demand response incentives. Involvement of the utility in connectivity solutions may also enable more sophisticated leveraging of assets on the customer side of the meter. In particular, more emphasis may be placed on "load sharing" or "peak sharing" programs that optimize the joint dispatch of demand reduction and dispatch of distributed generation.

Suitability Matrix

The analysis of the various communication technologies allows for a valuable comparison of the capabilities of each medium. This table indicates the suitability of technologies for utility connectivity programs for large electric users. Each entry reflects the suitability of the technology to serve at least part of the communication needs of the application. "Suitability" here includes both technical and economic characteristics of products embodying the technology. Solid black circles indicate preferred technologies.

Table 1-1
Suitability Matrix

	Connectivity Applications						
Technologies	**Critical Pk/Real Time Pricing**	**Utility Direct Load Control**	**Auto Bldg. Control**	**Customer Generation Dispatch & Control**	**Demand Side Bidding**	**Outage Detection/ Customer Notification**	**Interactive Energy Information Kiosk**
Paging	●	●	●	●	●	●	
VHF SCA	●	●	●	●	●	●	
WiFi	○	○	●	●			
Licensed VHF	●	●	●	●	●	●	
Licensed UHF	●	●	●	●	◎	◎	◎
Unlicensed UHF	○	○	○	○		◎	
Broadband PLC	○	○	○	○	○	○	○
Low Band FM PLC	◎	●	◎	◎	◎		
Power Frequency Signaling	◎	●	◎	◎	◎		
Ultra-Narrow Band PLC	◎	●	◎	○	◎		
Local PLC	○	◎	◎	◎			
Telephone (Wired)	●	○	●	●	●	●	●
Telephone (Cellular)	●	●	●	●	●	●	●
Coaxial Cable	◎	◎	◎	◎	◎		◎
Optical Fiber	◎	◎	◎	◎	◎	◎	◎
Free-Space Optical	○	○	○	○	○	○	○
Internet & Combined Media	●	◎	●	●	●	○	●

Legend

● Technology is entirely suitable, economical and capable of meeting one or more important application requirements.

⭘ Technology is capable, but others are generally better in performance or cost for meeting one or more application requirements. This technology will be effective if the preferred technologies are inappropriate for some reason.

○ Technology is a poor choice for economic or technical reasons, but can perform the function.

Blank – Technology is functionally unsuitable for the application and can make no contribution, at any price.

Notes

Paging and VHF SCA are both excellent choices for outbound signaling of load control or other demand management events.

WiFi is a capable and low cost local area network suitable for short-distance communication only.

If the utility has the licenses and has infrastructure installed, licensed VHF and UHF are very effective for outbound signaling. Some systems also provide inbound capability, but products may not be available specifically supporting the application.

Unlicensed UHF is a capable and low cost local area network, but few products are available to support customer connectivity applications. This technology is suitable for short-distance communication only.

The low-capacity PLC technologies (Low Band FM, Power Frequency and Ultra-Narrow Band) are very effective for outbound signaling, such as load control or customer notification. But products do not now exist to support general-purpose customer notification or interface to building control or customer generation.

Coaxial cable is a capable medium, but products supporting these applications are not generally available. Further, cable service generally is not available at commercial and industrial sites.

A fiber optic network can serve as part of the path in any utility-customer data exchange. Fiber is not specifically suitable to the customer connectivity applications addressed in this work.

Free Space Optical communication is best suited to point-to-point data transfers and therefore is not well suited to reaching many customers. It can be an economical and effective way to carry data in a segment(s) of a larger multi-point network.

2
OBJECTIVES AND METHODOLOGY

A successful demand response program requires the communication of time sensitive information from load serving entities (LSE) and/or independent system operators (ISO) to power consumers including event notices, pricing data, confirmation notices and reporting information. In return, LSEs and ISOs may require information from their demand response program participants: e.g. notice receipt, intent to curtail and participation verification. There are many methods, both manual and automated, to accomplish this two-way communication.

However, as demand response programs grow in complexity and scale to provide the maximum benefit to the most consumers, manual processes give way to automated options. Demand response program sponsors face a bewildering array of choices in vendors and technological solutions when deciding how to automate their programs. Deciding which technology best meets the needs of program participants is a critical factor in building a robust demand response program. Selecting the correct product and vendor is important to ensure reliable support and service.

This report provides an overview of the technologies and vendor offerings available to demand response program sponsors today. It provides general information on the state of the market as well as an in-depth overview of the different communication technologies and summary of major product vendors.

Objectives

The overall effort resulted in a two-part study of the two-way communications market for demand response. The first part consisted of a survey of 700 commercial and industrial establishments throughout the United States. The objective of that study was to develop a better understanding of consumers' interest in receiving energy information from the utility and their preferred communication methods for demand response.[1]

The second part of the study consisted of a survey of technology vendors and analysis of communication technologies. The objectives of the vendor research were:

- Describe the communication options currently available for automated demand response programs.
- Identify which technologies would be best suited for automating demand response communications. In addition, the research would highlight what other LSE/ISO applications might be enabled by the various technologies.

[1] The results of the survey are contained in a separate report: *Capitalizing on Two-Way Communications for Demand Response – Enduser Survey,* EPRI, Palo Alto, CA: 2003. Product ID 1008399.

- Profile the major two-way communication vendors and products to show the capabilities and limitations of each product for demand response applications.

Methodology

These objectives were accomplished by employing a combination of primary and secondary research. A number of possible two-way communication technologies that could be used for automated demand response programs were identified. Interviews were conducted with technology users and research performed using secondary sources to develop in-depth profiles of each of the technologies. The project also developed a suitability matrix showing the ability of each technology to serve the communication requirements for demand response programs. The matrix also highlights other applications each technology might be able to serve.

Simultaneous to the technology review, qualitative interviews were conducted with selected two-way communication technology vendors. Each vendor using a "script" to guide discussions. (A copy of the script can be found in Appendix A). Personnel familiar with communication technologies conducted each interview via telephone. Interviewing began in August 2003 with all interviews completed by October 2003. Interview results were summarized in a vendor/product description profile. Additional vendors were identified during the course of the project resulting in a total of 40 companies being surveyed. Of the 40 companies interviewed, 28 provide products that would enable automation of demand response programs.

Report Organization

The remainder of this report is divided into the following sections:

- *General Observations*: This section provides general analysis of the two-way communications market including implications for demand response programs.
- *Communication Technology Profiles*: This section provides an overview of each of the different communication technologies included in this study including how they work and suitability for two-way utility-to-consumer communications.
- *Vendor Profiles*: This section contains the summary profile of the 40 vendors surveyed by Plexus for this project.

3
GENERAL OBSERVATIONS

The objective of the vendor research was to identify the major demand response automation companies and compare various product attributes. During the interview process, the researchers gained considerable insight into the overall state of the vendor companies and the market for demand response technologies. As a result, several major themes were identified.

State of Vendor Market

Vendors that offer solutions aimed at automating demand response communications run the gamut from meter manufacturers to software platform companies to service companies. Some vendors only offer software integration platforms and do not sell any hardware. Typical capabilities of these providers include detailed customer information presentment and decision tools. Other companies provide robust hardware products for data collection and transmission.

The market continues to be filled with many niche players targeting specific areas of the communication data chain. Few technology vendors offer end-to-end solutions for the full range of connectivity applications surveyed. Only one company was a prominent across-the-market player, as a result of a series of strategic acquisitions in recent years.

Niches also appear in the markets that vendors target. A number of well-established connectivity solution providers have great depth of experience in the residential segment but relatively little in non-residential. Use of these technology solutions in *single phase commercial applications* may be feasible and highly attractive under certain circumstances.

Vendors as Utility Partners

A number of the vendors interviewed sell their connectivity solutions exclusively to C&I energy users *with no meaningful utility involvement*. In many cases this represents a lost opportunity for the vendor, the utility and the customer.

Vendors miss the opportunity to leverage sales using the utility as a sales channel. Utilities miss the opportunity to enhance their relationships with key accounts by offering programs that have already been proven to provide value. Customers miss the added value of utility involvement, such as a further energy coat reduction as a result of coordinating their energy management activities with utility demand response programs.

However, it is worth noting that, in some cases, there may be very little value added by the utility from the customer's or the vendor's viewpoint, apart from the promulgation of peak sensitive rate structures. In that sense, the market seems well served by the existing market dynamics. This appears to be true, for example, in the viewpoint of several prominent vendors of building automation systems.

The lack of involvement with utilities by some vendors, and the apparent lack of interest in selling to or in conjunction with load serving entities, manifested itself in a distinct unwillingness or lack of interest on the part of several major connectivity solution providers to participate in the survey. Several companies did not see the value in being represented in a study whose results would be shared with utilities and ISOs. This reflects skepticism about the role of utilities in the business development equation.

However, some connectivity solution providers are ready, willing and able to structure turnkey arrangements with utilities. These suppliers are now eager to structure "pay for performance" contracts, as exemplified by operation of outsourced load control projects. In fact, some connectivity providers express the view that their desired sales "sweet spot" is demand response programs that communicate with the customer's metering information management software package. Others create a network layer on top of the customer's existing energy management and information system.

Opportunities to Leverage Existing Technology Solutions

The connectivity solutions being delivered by the vendors interviewed have low technical risk. Components are generally available off-the-shelf and have wide application experience. Solutions are custom engineered for individual C&I energy users, but the engineering configures or integrates available technologies rather than creating new technologies with the associated risks. However, available technologies could support a broader range of connectivity applications than is now in common practice. That is, existing technologies and products can be integrated with little technology risk to significantly expand C&I customer participation in utility programs such as demand response. The challenge is for utilities to be aware of the capabilities (speed, throughput, ubiquity, low cost, etc.) of many modern connectivity options, and their ability to support many more creative and technically challenging applications than is now the case.

There are also opportunities to expand the use of existing connectivity systems to encourage more robust participation in programs. For example, connectivity applications currently marketed to owners of distributed generation for customer demand response can be applied more broadly. Though there are some technical hurdles, utilities are equipped to solve them and to influence wider adoption of these applications.

Willingness of some solution providers to integrate communication media, control devices and interfaces into "open architecture" end-to-end solutions may enable utilities to leverage their major customers' previous investment in a substantial base of equipment. The readiness of utilities to provide convenient interfaces to *existing* customer-side demand response applications is important, and is far more palatable to customers than applications that require purchases of new equipment, complex interfacing or protracted commissioning processes.

Due to the fact that many connectivity solution providers use *any* communication path that is provided, the utility may be in a position to leverage its existing communications infrastructure or that of its multi-site customers. For example, many connectivity solutions covered in the interviews utilize web-based monitoring to track energy usage at multiple, remote sites, integrating via local Ethernet gateways.

Opportunities to Increase Demand Response Sophistication

The connectivity solutions reviewed in this survey show that automation can help increase not only customer participation in demand response programs but also the sophistication of those programs. Multi-site C&I customers have applied connectivity solutions in ways that suggest it would be relatively simple to integrate the utility into decision-making and operations. C&I energy users now operate software platforms that enable demand response in multiple, remote locations. The utility could become directly involved if it could contribute value to the customer and if an additional master station or equivalent direct dispatch capability were installed at a utility location.

Deployment of the solutions without utility involvement generally results in customers reducing billing demands without regard for whether that demand is coincident with the utility's peak. The utility customer responds to simple economics more than any other impetus, as it should. With more enlightened utility involvement and appropriate rate signals or demand response incentives, impacts could more closely focus on coincident system peak demands.

Involvement of the utility in connectivity solutions may enable more sophisticated leveraging of assets on the customer side of the meter. In particular, more emphasis may be placed on "load sharing" or "peak sharing" programs that optimize the joint dispatch of demand reduction and dispatch of distributed generation. Some vendors' solutions enable major customers to operate demand controls and on-site generation as a physical hedge against wholesale market price volatility. This capability may be even more valuable to utilities under certain power supply situations.

Most of the end-to-end connectivity solutions covered by the interviews enable data logging down to 1-minute intervals and data streaming (polling of registers) in near real-time. These capabilities can enable increasingly sophisticated demand response programs. Some vendors' solutions are, in fact, special purpose variants of SCADA systems. At the moment these capabilities seem to be capable of absorbing considerably more challenging demand response applications that are now the case.

Data streaming capabilities of some solutions offer utilities increased assurance that demand reductions can be accurately measured and reported in a timely manner, as opposed to being estimated after the fact. This capability can help make demand response a more direct substitute for generation in energy scheduling and settlement calculations.

Multiple control strategy options are available—priority, rotating, variable duty cycle—and these can enable demand response programs of increased sophistication, able to respond to unique customer needs.

4
COMMUNICATION TECHNOLOGY PROFILES

The following pages present profiles of communication technologies suitable for utility communication with customers and customer-site devices. Most utility-customer connectivity programs will use combinations of these technologies. Low capacity technologies such as power line or shared wired phone are suitable for tasks with small amounts of data, such as meter reading. High capacity technologies like Internet are suitable for more demanding uses like visiting the utility's Web site to review load data. In combination, these technologies can support a very wide range of new customer programs.

Some of the technologies described here are used extensively by utilities and others are not but may be in the future. Figure 4-1 illustrates how they are used. It shows the possible communication paths among the elements of a customer connectivity program. In some cases the utility communicates directly with customer site devices. In other cases, the utility will use a communication service provider. Paths at the right side show data exchanges among devices within the customer site.

The gray behind the text in the bottom half of Figure 4-1 shows the preferred technologies for each path. This is based on technical suitability, product availability, and current economic and business factors. Technologies with a white background are technically capable, but not presently practical for any or all of these same reasons.

It will quickly be evident that no technology currently supports all the communication paths, but combinations of these technologies can provide comprehensive capability to exchange data with customers.

Readers interested in further technical information about allocation of the radio spectrum are encouraged to visit the Web sites of the Federal Communications Commission (FCC) at http://www.fcc.gov and the http://www.fcc.gov National Telecommunications & Information Administration (NTIA) at http://www.ntia.doc.gov/ and http://www.ntia.doc.gov/osmhome/allochrt.html .

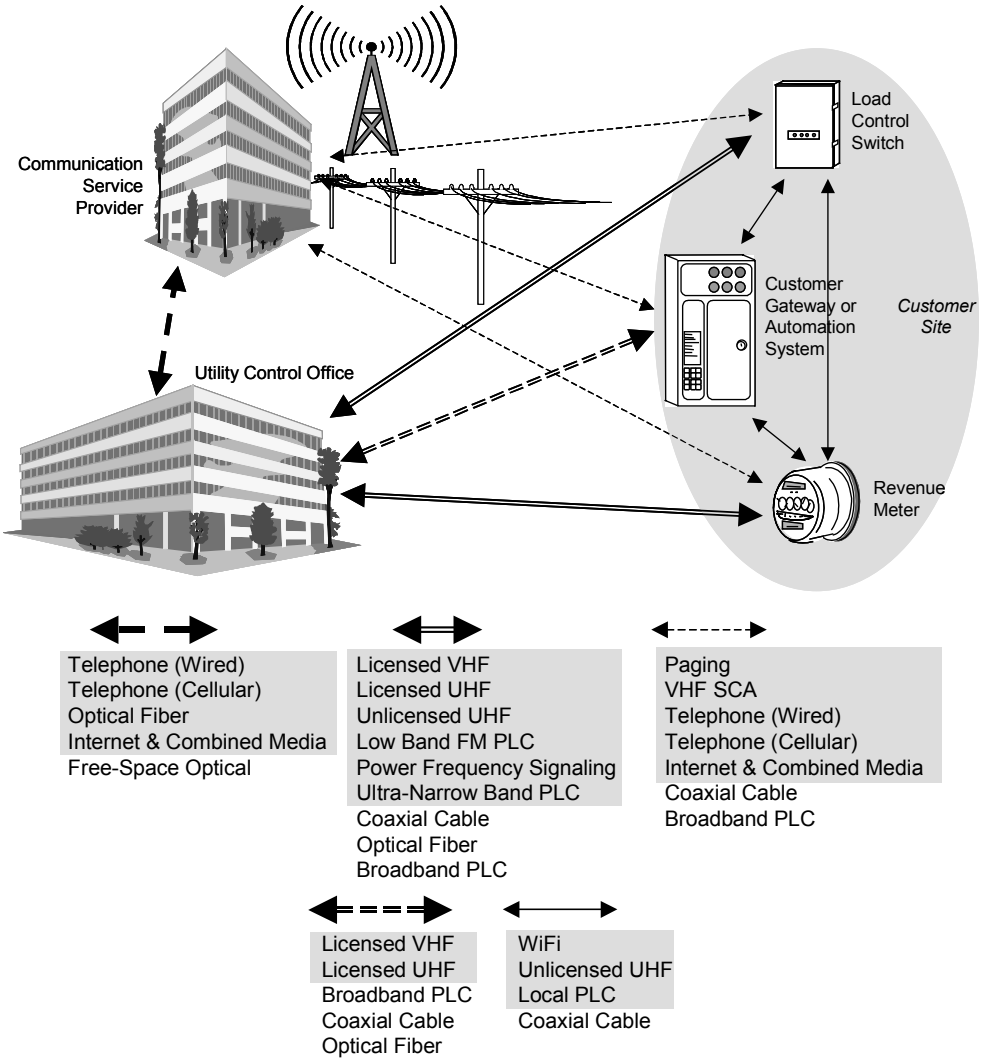

Figure 4-1
Utility-Customer Communication Paths

Technology Profiles

Public Radio

Paging

Brief History

The first commercial paging service was offered in the 1950s as a notification service for doctors within St. Thomas Hospital in London, England. Wide area paging—beyond a single building or building campus—was first offered in the U.S. in the late 1960s. Early paging receivers simply beeped to notify the recipient to call the paging company or some other prearranged party.

Digital display paging was introduced in the early 1980s. This allows the pager to show the phone number of the person initiating the page. It also allows paging to be used for signaling digital devices other than a person's paging receiver. For example, digital paging can be used for load control. Alphanumeric paging expanded the service to show text messages on the user's paging receiver.

Two-way paging was introduced in the late 1990s, following the U.S. FCC's auction of spectrum in the 1.8 to 2 GHz band.

Current Status

Utilities (as well as many other businesses) continue to use paging as an inexpensive way to signal individuals. And its use for utility signaling such as direct load control continues to grow. In the last two years, multi-function cellular phones have started to perform similar functions, cutting into the demand for paging services.

One-way paging service covers most of the U.S. population. Two-way paging is operative only in urban areas.

How it Works

Some paging systems are private, local to the facility that owns and operates them, such as a hospital. This discussion addresses only commercial paging services available to utilities (and all others), covering large areas and operated as a service to all. Agreements among paging companies allow them to offer regional and nationwide coverage to their subscribers. For example, if your paging service doesn't own a broadcast tower in Reno, it probably has a deal with another provider that does, and any page for you will be broadcast from there (or anywhere else) if you have subscribed to that level of service.

A commercial paging service provider operates a network of towers and broadcast facilities. Broadcast power is up to 500 watts at each antenna and coverage is measured in tens of miles. Some paging services relay messages from one region to another via geostationary satellite.

The "inbound" signal from the user's paging device to the paging service provider is much weaker than the high-powered outbound signal for two reasons: It must be powered from the user's battery. And it issues from the tiny antenna in the paging receiver. Therefore inbound paging signals succeed only when the user is within a few hundred feet of a two-way paging antenna site.

Paging messages are short, always less than a few hundred characters and usually much less. Typical utility uses for paging are direct load control, signaling field workers to call the office, or control of distribution devices such as capacitor banks.

The most important characteristics of paging are:

- It covers a large area. Outbound paging services now cover most of the land area of North America.
- It can signal many end points simultaneously with a single broadcast message.

- Message cost is low, typically less than 20 cents per broadcast message.
- Users pay a monthly fee for the service, which normally includes some number of page messages up to a preset threshold (such as 100 messages). Users pay a few cents per message if the monthly activity exceeds the subscription threshold. Monthly fees are typically $25 to $50.

Paging uses numerous frequencies, all licensed to the paging service provider. No license is required of the user. These include 35-36 MHz, 43-44 MHz, 138 to 174 MHz, 152-159 MHz, 450-470 MHz, 929 MHz and 931 MHz.

Suitability for Utility Customer Connectivity

Paging is a very economical way to send outbound signals to many devices and to reach individual or multiple (point to multipoint) mobile or stationary devices. Examples include load control, and price signaling, as in TOU or real time pricing.

Two-way paging is more expensive and is well suited to small message transfer in the urban areas where it is available. Examples include meter reading and power quality reporting for high-value sites such as substations and polyphase meters.

Some rural paging companies have exited the business in the last five years as paging has suffered business losses to cellular phones. A utility considering paging may wish to consider this possibility before relying on paging for critical communications.

VHF SCA

Brief History

Commercial broadcast FM stations and TV stations use their authorized frequencies to broadcast their normal programming. Within these frequency authorizations lies some often-unused "bandwidth." This resource permits the broadcaster to disseminate special interest programming that is audible only on special purpose receivers. Conventional consumer receivers do not respond to these broadcasts.

The FCC issued the Subsidiary Communications Authorization (or SCA) in 1955 to allow commercial use of this analog (normally audio) broadcast bandwidth for special interest programming. Thus, SCA transmissions carry the signal on subaudible portions of the FM radio or TV signals. This technique has been widely used for "Muzak" music subscription services, stock and commodity quote services, talking books for the blind, the Physicians Radio Network and other information services.

In the early 1980s the FCC rules were changed to allow SCA broadcasts to be used "for non-broadcast purposes", including dissemination of utility load control signals. This opened the use of these techniques to utilities through contractual arrangement between the utility and the broadcast station. The obvious advantage is that the utility now has access to the solid wide area coverage afforded by very high-powered transmitters and antennas without having to build or maintain them.

Current Status

Utility applications for broadcast FM-SCA are extensive and are similar to those for paging. In the early 1980s SCA techniques were refined for the electric utility industry by Vedette Energy Research. These technologies were subsequently acquired by ABB, which deployed many thousands of utility load control receivers using FM SCA signaling. These technologies were subsequently licensed to Cannon Technologies, which continues to offer and support FM SCA systems.

How it Works

FM SCA is a means of sending messages by radio one-way, outbound from the utility to customer sites (point to multipoint). Functionally, it is similar to one-way paging. The utility contracts with a broadcast service provider, usually a commercial FM radio station or a VHF TV station, to broadcast the utility's messages on demand. When the utility has a message to send, such as a load control command, it sends the message to the broadcaster, which then modulates the messages onto a subcarrier of its main broadcast signal. Coverage is excellent within the service area of the TV or radio station. Messages can be addressed to individual devices, all devices, or pre-defined groups of devices.

FM SCA has no inbound path. It is for one-way outbound signaling only.

The U.S. FCC defines the band from 30 MHz to 300 MHz as "very high frequency" (VHF). The SCA allows FM radio and TV stations in this band to broadcast multiple channels of audio or digital information on inaudible portions of the broadcast signal. The information capacity of the SCA channels is relatively low, so audio quality is not high fidelity and digital messages must be short.

Some SCA receivers have a uniquely useful feature. The receivers will automatically search the FM band seeking a recognizable and suitably coded signal. If a utility signs a service contract with, for example, an FM radio station for load control signaling, and if the station later—perhaps upon contract renewal—demands unfavorable terms, the utility can change to a service provider at a different frequency. The receivers will find the new frequency and operate normally with the new service provider. This avoids the onerous and costly possibility of having to change or adjust the receivers in all load control devices due to a change in broadcast service.

Suitability for Utility Customer Connectivity

FM SCA is very well suited to utility-customer connectivity when messages are short, for example not involving file transfer. Receivers typically cost less than $100 depending on quantity, as always. Geographic coverage is very good in almost all populated areas. The principal current utility use of FM SCA is direct load control. It is technically very well suited for dispatch signaling of any kind—including price signaling, short messaging, generator control, and energy event notification—but products for these applications are not generally available using FM SCA.

WiFi

Brief History

WiFi (a popular notation for wireless fidelity) is a short-range wireless method using spread-spectrum techniques, described by IEEE Standard 802.11b. The U.S. military first started using spread-spectrum radio transmission in the 1940s. The sophistication of this approach made it too complex and costly for commercial applications until semiconductors lowered the cost of the necessary processing. The FCC assigned frequency for commercial and civilian spread-spectrum use in 1989.

Numerous wireless networking products emerged during the early 1990s and established niche markets such as retail inventory and warehouse management. The IEEE began working on a standard in the mid 1990s and in 1997 introduced standard 802.11, later to be called WiFi. It governs wireless data communication among devices within a few hundred feet—more typically about 100 feet or less—of each other. WiFi products first appeared on the market in volume in 1999 and conformed to 802.11b.

Current Status

WiFi is now widespread and available for $20 to $50 for desktop and portable computers. Standard 802.11 is being revised more or less continuously. 802.11b describes communication at 900 MHz at up to 11 Mbps. Devices conforming to the newer 802.11a operate at 5 GHz and transfer data at up to 54 Mbps. An even newer version is 802.11g, which will operate at 2.4 GHz while retaining the 54 Mbps transfer rate.

A new standard now in development, called IEEE 802.16a or “Wider-Fi”, aims to extend the range of WiFi from a few hundred feet to several miles, making it suitable for much larger networks in the future.

How it Works

A wireless network normally has a relatively small number of wired nodes that communicate with the more numerous wireless devices. These nodes are wired to other communication participants, such as central computers, email hosts, and so on. WiFi installations commonly use Ethernet at 10 Mbps or 100 Mbps to carry data from the wired nodes. The simplest such node is a router that simply routes data traffic to the correct party on the network, whether wired or not.

The name “WiFi” refers to several communication methods described by the parts of IEEE standard 802.11, as described above. The most common at this time is the oldest one, 802.11b, which also is the one for which parts are least expensive. It operates in the unlicensed 2.4 GHz band. The newer 802.11a and 802.11g offer advantages; principally in higher data transfer rates and tighter security.

Suitability for Utility Customer Connectivity

The advantages of WiFi are simplicity and low cost. Its principal disadvantage is short range. Its widespread use and "blister pack" availability make it easy for almost anyone to set up a wireless network among Windows computers. Using WiFi among other devices, such as meters or load management devices, will be considerably more challenging since products are not available specifically for these applications. But WiFi will still provide the benefit of low cost.

Private Radio

Licensed VHF

Brief History

VHF frequencies are those from 30 MHz to 300 MHz. FCC licensed operation by utilities in the VHF frequencies dates back more than 50 years and encompasses a wide variety of land mobile voice, data, distribution automation and demand response applications.

In the 1960 Motorola developed a low cost tone-coded VHF receiver for utility load control applications. This product was extensively deployed, with more than 200,000 units installed on controllable residential loads at Detroit Edison, as one of many examples. The applications for load control were, however, not without challenges. For example, the popular control of electric water heaters demanded adequate signal strength in areas of the country where the water heater is typically below grade in basements. Other challenges relate to the limitations in available control codes. Motorola later offered a "dual tone sequential" load control receiver. In the early 1970s Scientific Atlanta developed a digitally encoded load control receiver, one version of which provided the ability to address even single units or groups of any composition. In the '70s and '80s companies including Regency Electronics, GE and ABB entered the VHF load control switch business. Comverge later acquired the Scientific Atlanta product lines and is today deploying VHF load control switches in utility installations. Cannon Technologies and Regency also offer VHF load control products.

Current Status

Licensed VHF frequencies are a mainstay of utility communication in operations. Utilities routinely use them for voice and data purposes, including crew dispatch and load management.

How it Works

The utility owns and operates one or more radio towers covering its service territory. A single VHF tower covers a radius of 5 to 50 miles, depending on frequency, terrain, broadcast power and antenna characteristics, and receiver characteristics. The utility operations centers communicate with remote users and devices by sending signals to the tower(s), which radiate them over the territory. Some systems use "simulcast" technology to make multiple towers behave as a single huge tower covering a large area.

Users and devices receive the signals and respond. For example, a crewman in a truck may respond to a voice inquiry about location or activity. The truck can have a relatively expensive, powerful radio and an antenna measured in meters. These features make communication with trucks relatively easy. A load control receiver must be inexpensive and will have a small antenna, making VHF coverage more challenging for uses like load control than for voice dispatch.

Coverage with VHF, as with any radio signal, depends on terrain and radio system configuration. Utility VHF systems typically cover well over 75% of the territory, though it can be less in especially rugged areas.

Suitability for Utility Customer Connectivity

VHF radio has several factors in its favor for customer connectivity uses. One is that most utilities already have much of the required infrastructure, making it easier to construct a positive business case for the customer connectivity program. Another is that VHF coverage, while less than 100%, is typically very good.

VHF is especially attractive for one-way outbound signaling, such as disseminating price or control signals. Receivers are inexpensive (under $100) and coverage is good. Transmitters can be more expensive for licensed VHF than for other choices, so two-way communication may be less expensive by other methods.

Licensed UHF

Brief History

The ultra high frequency range (UHF) is from 300 MHz to 3,000 MHz.

In the 1970s and 1980s the FCC allocated spectrum for “Business and Industrial/Land Transportation” within what are still called the Private Land Mobile Radio (PLMR) bands between 800 MHz and 960 MHz. One FCC reason to choose this spectrum was to assign frequencies for regional purposes that do not propagate far enough to interfere with other distant users of the same frequencies. This had been a problem with early mobile telephone services in the 1960s.

As VHF channels became more crowded, utilities (and others) obtained licenses in the UHF bands to support basic operating needs. Voice dispatch and SCADA were common utility uses.

Current Status

“Trunking” (see below) has evolved into a sophisticated and effective technique that allows licensed UHF systems to share channels as needed for both voice and data.

Many utilities continue to use licensed UHF systems for voice dispatch and SCADA. It is not unusual for these systems to be fully utilized during regular operations, such that the demands of storm restoration and other emergencies cause them to be overloaded.

How it Works

Some early use of these PLMR bands was for voice communication, with every conversation occupying one channel. Radio "trunking", developed in the 1960s, became a common approach to getting more use of limited spectrum. Automated trunking re-assigns radio channels on-the-fly so that a single conversation may move from channel to channel in mid-conversation. This allows the radio system to use the "dead time" in human conversations to transport other conversations or data.

The power and antenna height rules result in coverage of up to 15 miles per tower site (typically less). A medium or large utility will have a dozen or more UHF towers to serve its territory.

Suitability for Utility Customer Connectivity

Technically, licensed UHF is amply capable of supporting a wide range of customer signaling, control and reporting programs. The data rate is too low to support Internet access, but easily meets meter reading, fast-response signaling, short messaging and other low data rate requirements.

Advantages of licensed UHF are that the system is in place at many utilities and the utility has complete control of it. A disadvantage is that end devices for the customer site will cost more than for some other technologies. But this may be a minor issue in view of the advantages.

Unlicensed UHF

Note: Strictly speaking, the title "Unlicensed UHF" includes both the 902-928 MHz authorization described below and the WiFi communication at 2.4 GHz. WiFi is described above, and we will not repeat that coverage here. These bands are called the ISM (Industrial, Scientific and Medical) bands. Unlicensed operations are permitted there that also allow operation of other products including microwave ovens, cordless telephones and many others.

Brief History

The U.S. military developed techniques for "spread spectrum" communication starting in the 1940s. The basic idea is that the signal is sent in bits and pieces on various carrier frequencies, rather than on a single frequency. The message is "reassembled" at the receiving end. The benefits include high security, high tolerance of other uses of the same spectrum, and low interference with such other uses.

The FCC authorized commercial use of spread spectrum techniques starting in the mid 1980s. Users were not granted a license. Instead, use was (and remains) unlicensed, but subject to strict FCC rules that require all signals to be either of extremely short duration and low power, or "spread" over the spectrum to enable multiple unlicensed users to share the spectrum.

Over the following decade many commercial uses emerged, among them cordless telephones, secure garage door openers, residential and commercial physical security sensors and systems, and several prominent utility meter-reading systems.

Current Status

Unlicensed UHF devices number in the tens (probably hundreds) of millions in North America, and utilities are vitally dependent on them to read meters. The high production volume of these devices has made the integrated circuits so low cost that unlicensed UHF has become a cheap way to do things in spite of the very complex processing involved.

How it Works

The FCC's low power and short duration constraints on unlicensed signals limit their range to a few hundred feet, often much less. The most widely used frequency band for utility purposes is from 902 MHz to 928 MHz, though other bands are available above 2 GHz and 5 GHz.

Signal "spreading" is very sophisticated and uses any of several methods. A relatively simple method is frequency hopping, wherein the wave carrying the signal jumps very quickly from one frequency to another in a pre-planned sequence. The receiver can follow the transmitter and receive the signal because it knows the sequence. The probability that other devices in the area are following the same hopping sequence at the same time is very low, so the signal gets through even if there are occasional interferences.

A more complex method is called direct sequence spread spectrum. In effect, the transmitter is like a single singer, singing a song that is series of chords, each with many notes. The receiver recognizes the chords even though there may be so much other noise in the room that it could not have recognized any single notes.

Suitability for Utility Customer Connectivity

Unlicensed UHF communication is suitable for utility purposes (and all others) for local communication only. Its short range makes it effective for local networking and for short distance "bucket brigade" networks that may pass data from node to node.

In addition to the distance limitation, unlicensed signaling has limited data capacity. In the 900 MHz band, the bandwidth limits throughput to less than 50 kbps, and usually much less than 10 kbps. In the 2.4 GHz band, data throughput can be much higher, as evidenced by WiFi's 11 Mbps capacity.

Devices for utility meter reading are available to read many existing single phase and polyphase meter types in the 900 MHz band.

Power Line

Broadband

Brief History

People have been interested in using the power lines to carry communication since power lines first became widespread in the early 1900s. Numerous methods have been developed, and some successful methods are in wide commercial use. All of these support relatively low information transfer only. Examples include devices for:

- Controlling electric loads (e.g. lights and appliances) within buildings.
- Carrying voice and data communication on electric transmission lines.
- Utility distribution management (load control, meter reading, capacitor control, etc.) on electric distribution lines.

Most familiar utility applications of power line communications do not require high bandwidths. Data throughput of 60 bps or less at the distribution circuit level is common. Overall throughput of a system may be much higher since there can be simultaneous operation by many circuits at the same time. Continuing advances in digital electronics, particularly digital signal processing (DSP) made communication on power lines at rates higher than 1 Mbps possible starting in about 1995. A dozen or more companies have poured millions of dollars of venture money into product developments. At this writing (October 2003) a half dozen or so companies have achieved impressive results with initial designs on utility power systems. Demonstrations typically include viewing full-motion video and high-speed access to Internet Web sites via distribution power line.

Current Status

Broadband power line (BPL) communication is just emerging, and it is not yet clear whether it will compete successfully with DSL and TV cable. Several technical issues remain unresolved, particularly including the potential for emissions radiated from the power line to interfere with existing users of licensed radio spectrum in the 2 MHz to 30 MHz range.

The technologies work well and potentially provide data transfer speeds higher than DSL and cable. In addition to the user modem, they require devices in the electric distribution system to support and extend signal transfer. The economics of providing a commercial service using these methods has not been fully and publicly explored or clarified. It remains to be seen whether broadband power line companies can make a clear business case for the widespread market for their products and services in the face of other technologies, including cable and DSL.

If broadband power line technologies do not succeed commercially for long distance applications, other broadband power line technologies have already proven to be cost effective for communication within buildings.

How it Works

BPL communication carries data on a "carrier" wave imposed on the power lines. The carrier is between 1 MHz and 80 MHz, with most below 30 MHz. All current leading developers are using spread spectrum techniques to maximize data transfer rates and minimize radiated power. In addition, sophisticated modulation and demodulation techniques called orthogonal frequency division multiplexing (OFDM) allow detection of the signal in the high-noise environment of the power line.

Most techniques use some kind of transformer bypass method to avoid signal attenuation going through the distribution transformer into the customer premise. But a small number rely only on complex OFDM processing to detect and amplify the signal within customer sites.

Such high frequency signals decay rapidly as they propagate on medium voltage lines. Periodic signal boosting devices are required to achieve long distance data transfer. The distance between signal boosters varies considerably with distribution configuration, but is typically a half-mile.

"Broadband" communication typically refers to data transfer at a rate higher than is required for high quality voice communication, that is, 64 kbps. Broadband service by methods such as digital subscriber line (DSL) telephone or coaxial (TV) cable is typically at least four times higher than that, or more than 250 kbps. Raw data rates higher than 20 Mbps have been demonstrated in BPL results to date, much higher than subscribers now get with either DSL or cable. But BPL is a shared medium—like cable and unlike DSL—and multiple users will experience throughput lower, possibly much lower, than the gross capacity of the shared power line.

Suitability for Utility Customer Connectivity

No products for utility applications using broadband power line communication are commercially deployed in significant quantities at this time. All deployments are small pilot or demonstration tests. Products may become available and more widely deployed in 2004 or 2005.

The data transfer capacity of broadband power line technologies is considerably higher than is needed for most utility-customer communications. It is well suited to highly interactive customer exchanges, such as Web site browsing or running energy analysis applications. If the technologies succeed commercially and if prices for the products fall below other alternatives—such as DSL, wireless or telephone, depending on the requirements of the application—then broadband power line could be suitable for other applications such as meter data transfer.

Low Band Frequency Modulation

Brief History

"Low Band" describes frequencies above audio frequencies and below 300 kHz.

In the 1970s companies including American Science & Engineering, GE, Westinghouse and Rockwell developed and demonstrated two-way power line communication for utility applications such as load control and automatic meter reading (AMR). Emerson Electric licensed a technology developed by Arthur D. Little for the New England Electric System. The GE and Rockwell systems never achieved significant market penetration. The Westinghouse "EMETCOM" system was deployed in more than 200 utilities and is still actively being sold by Cannon Technologies. More than 30 utilities acquired AS&E systems that together involved more than 500,000 points.

A competing system, the "TWACS" system formerly offered by Emerson, is described below under the Power Frequency heading. Distribution Control Systems Inc (DCSI), a unit of ESCO INC, now offers it commercially.

Current Status

Cannon has recently redesigned the two-way meter reading electronics of the EMETCON system and indicates that it will—if customers respond with orders—revitalize the rest of the product line with new designs. The system remains a strong candidate for utility applications where low customer densities or other factors argue against radio communication.

QEI still supports existing users of the former GE and Rockwell PLC product lines.

How it Works

The carrier signal is a fixed frequency voltage wave, in this case in the range of 5 kHz to 15 kHz, superimposed on the power line. The data are encoded onto the carrier when the carrier is "modulated". The modulations are slight changes in carrier's main frequency slightly above or below (or both) that main frequency. The changes represent ones and zeroes. Because the modulations are changes in carrier frequency, this is called frequency modulation, or FM.

This carrier is created by "injection" equipment in distribution substations. The injection equipment communicates with the utility operations center by conventional means, such as a dedicated phone line.

Once injected, the carrier propagates on distribution wires and is detected by meters, load control switches and distribution control devices. They can similarly impose a carrier on the power line to send responses and data back to the substation.

Suitability for Utility Customer Connectivity

Low band FM PLC is appropriate for the parts of utility-customer connectivity programs that involve exchange of data and commands at low rates. Examples are load control, price signaling and meter reading. It is not useful for file transfer or Internet access.

This technology requires substation injection equipment that costs from $10,000 to $30,000 per substation. This makes excellent business sense if a utility has multiple reasons to employ this equipment. It is unlikely that any single utility connectivity program will justify it for large customers.

Existing end devices using this technology do the functions mentioned (meter reading, etc.). If a new connectivity program needs to do something different—illuminate a light or make a noise when a high price period comes into effect—it will be necessary to make a new device to perform the new function. Depending on the effort to do this, low band FM PLC may be more expensive than other alternatives.

Power Frequency Signaling

Brief History

Only the TWACS™ product by Distribution Control Systems Inc. (DCSI) uses power frequency signaling. TWACS stands for two-way automatic control system. Consulting firm Arthur D. Little developed the TWACS technology in the mid 1970s supported by funding from New England Electric. Intended applications included meter reading, load management and distribution control. The technology emerged as a successful utility product in the late 1980s when Florida Power & Light bought a large two-way load control system. Since then DCSI has sold over four million end points to North American utilities. Most are for meter reading, but the system is also used for load control and distribution management.

Current Status

DCSI continues to improve its product designs, reducing size and cost. TWACS meter reading devices are now available integrated into all-solid-state electric revenue meters. The company currently enjoys an enviable position among the leading suppliers of automated meter reading systems.

How it Works

The TWACS technology works by imposing a small discrete distortion on the 60 Hz power wave. “Outbound” signals from the utility substation to distribution and customer end points are imposed on the voltage wave. Signals “inbound” from end points to the substation are imposed on the current wave. Equipment in the substations conducts the power line communication with end points, and exchanges data with the utility via conventional means, such as fiber or dedicated telephone line.

The “carrier” for the TWACS signal is the 60 Hz voltage or current wave, and the technique derives up to six “channels” on each power conductor. The TWACS data rate appears low relative to some other systems at about 30 bits per second on each channel.

It is appropriate to note that this figure is not directly comparable to similar-sounding figures for some other systems, particularly radio systems. The gross capacity to transfer data into and out of a substation is the sum of the capacities of every phase of every feeder. Further, data compression techniques increase the amount of information transferred with a fixed number of bits.

Suitability for Utility Customer Connectivity

The TWACS was specifically designed for utility applications and is highly suitable for meter reading, load management and distribution control. Many utilities now use it daily for these purposes.

The technology can also support many other control and signaling applications, such price signaling and simple control. Its limited data capacity makes it much less suitable for applications that require transfer of many data bytes. For example, customer-messaging can be supported only if the messages short, or are pre-numbered and stored at the customer site and the communication path carries only the message number.

Ultra-Narrow Band

Brief History

Hunt Technologies was founded to develop its late 1980s invention of ultra-narrow band (UNB) power line communication for utilities. In 1990 the National Rural Electric Cooperative Association funded Hunt's first product design and large-scale testing. The resulting one-way AMR system is called the Turtle™, recognizing its unusually low data transfer rate.

The Turtle became and remains a substantial commercial success, particularly with rural utilities, which require reliable communication on very long feeders with low customer densities. In 2002 Hunt Technologies announced a new 2-way communication technique, also UNB, for advanced meter reading (e.g. TOU), on-demand meter reads, load control, and other applications.

One important quality of the UNB technique is that its digital filtering is implemented in semiconductor circuits that can be produced in high volume at low cost.

Current Status

Many thousands of one-way Turtles are deployed in North America, concentrated at rural electric cooperatives. The company's new two-way technology has been well received, and is now available in meter devices; load control switches, voltage monitors and service disconnect devices. Hunt plans more products with the two-way technology.

How it Works

Hunt's UNB end devices (meters, load control switches, etc.) communicate continuously with the substation equipment, each using a separate data channel. More than 3,000 separate Turtle channels operate simultaneously on each feeder. Two-way products expand this capacity by a factor of about three. As with other power line systems, substations exchange data with the utility using whatever commercial method suits the utility, including dedicated phone line, MAS radio and fiber, as examples.

The data channels are “ultra narrow” and carry data very slowly. Turtles deliver one meter reading about every 18 hours. The newer two-way devices can have faster speeds, but many retain the low speed—and its economic benefit—because it is fast enough to meet practical utility requirements. Among the expanded capabilities of the two-way devices are ability to record and return TOU energy readings, daily peak demand, and on-demand meter readings recorded at the time of the request and returned to the utility the next day.

Suitability for Utility Customer Connectivity

Hunt Technologies developed the UNB technique specifically for utilities, and the products are very well suited to utility applications that do not require transfer of more than a few bytes of data. These include all those applications mentioned immediately above, as well as event signaling. Sending prices or messages to customers would require—as with the TWACS—that the prices or messages are numbered and pre-stored at the customer site so that the communication can be simply the message number, not the entire message or price.

Like the other low-capacity PLC technologies discussed above, UNB signaling is not suitable for broadband communication with customers.

Local PLC

“Local” power line communication is limited to data transfer on the secondary of a single distribution transformer. Communication is typically within a single building or small cluster of buildings and reaches only a few hundred feet.

Brief History

Communication on power lines for local data exchange was first commercially successful on a large scale with the introduction of the X-10 product line in 1979. These low cost devices are not fast enough for applications requiring file sharing, but effectively transmit command and status information. They found wide application in home automation and control systems and in commercial lighting controls. The X-10 system has been improved over the years and remains a mainstay of residential and small commercial automation signaling.

In the 1990s new technologies began to enable higher frequency signal management on power lines. Several systems were developed for local communication on power lines. Notable among them are the Echelon LonTalk™ system and a line of products by Adaptive Networks of Newton, Mass. Various others have found niche markets for local control, telephony and computer networking.

How it Works

Local PLC uses the same technical approach as low band frequency modulation: A carrier signal at a fixed frequency is modulated. The modulations are slight changes in carrier’s main frequency slightly above or below (or both) that main frequency. The changes represent ones and zeroes.

X-10 devices communicate with a relatively simple, low-speed protocol by putting data bits onto a 120 kHz carrier. The newer higher speed techniques use much higher carrier frequencies to carry the data, some as high as 30 MHz.

Most local PLC products use some kind of "spread spectrum" technique to improve noise immunity.

Current Status

Except for X-10, local PLC has not achieved the high volume deployment often predicted for it. The success of unlicensed UHF (and the associated very high volume production of integrated circuits) has made radio a major and frequently chosen alternative to PLC. Nonetheless PLC has succeeded in many applications including numerous home, business and industrial control and automation systems.

Suitability for Utility Customer Connectivity

Local PLC is very well suited to communication within customer premises. Large customer sites often have more complicated noise sources than residential and small commercial sites, posing some special challenges for PLC. But many local PLC products work well nonetheless, and provide the important benefit of minimizing installation cost.

The principal alternatives to PLC in local communication are hard wiring and unlicensed UHF radio. Hard wiring is relatively costly and is generally avoided. Unlicensed UHF devices can be quite inexpensive, but suffer from interference in some industrial environments, leaving PLC as a preferred technique.

Telephone (Wired)

Brief History

Data communication by telephone uses a "modem", a **mo**dulator/**dem**odulator that modulates a data signal onto the phone line and demodulates it at the other end to get it off the phone line. Modems were developed for military purposes in the 1950s. Modems were first commercially introduced by AT&T in 1962 and carried data at 300 bps. Performance increased rapidly. Modems were available to send 9.6 kbps over a single telephone line by 1984. Continuing improvements in echo management, error detection and correction, and frequency-shift keying led to even higher speeds. By 1994 modems were available for 28.8 kbps communication. Not long afterward, speed was increased further to 33.6 kbps, then 56 kbps. At that point the modems were capable of speeds higher than could be supported by many analog phone lines.

Current Status

Telephone modems are still used by many residential customers. Businesses that need Internet access have generally converted to higher speed services, such as digital subscriber line (DSL) phone service or coaxial (TV) cable service. In a few areas some wireless services also have supplanted phone modems.

The mainstay analog modem for individual users remains the 56 kbps modem, readily available at very low cost, built in to most new personal computers. Modems used in utility devices such as meters tend to be slower and even lower cost. Typical speed is 9600 bps. The low speed improves reliability and is otherwise inconsequential because the volume of data transferred is small.

How it Works

Think of the modem as humming a tune onto the phone line (that is, modulating the data onto the line). The presence or absence of a note, say, middle C, corresponds to a one or a zero bit. By humming many notes simultaneously, on and off, the modem can send many bits, all decoded and turned back into a serial string of bits (that is, demodulated) by the modem at the receiving end. This "humming" sounds like white noise because the notes go on and off at a high rate.

Telephone communication is fully two-way when the call is connected. But it is less than full two-way if the phone line is shared (see below).

Suitability for Utility Customer Connectivity

Telephone modems are very well suited for some utility applications. Two basic approaches make good sense and are widely used: dedicated line and shared line.

A dedicated line is one installed purely for the utility uses. Only utility devices use the line; no people use it and no customer devices are connected. This costs the utility about what traditional wired phone service costs for any business: typically $20 to $30 per month for the service charge. Other charges for the minutes used are very small because data transfer is relatively fast and the line is unused most of the time.

When the value of the communication justifies the cost of a dedicated phone line (for example, for large energy users), a modem is a very reliable method. This is partly because the modem is reliable, and also because the phone system is *very* reliable.

A shared line is more commonly used at smaller customer sites to minimize cost. The utility device, say, a meter, connects to the customer phone line and reports data by calling a toll-free number owned by the utility. The device is normally programmed to call in the middle of the night when the customer will not be using the phone. If the customer (or any customer device) does lift the handset, the utility device will "hang up" within a fraction of a second.

Conflicts sometimes occur when the utility application shares the customer's phone line. If the customer is a business, the customer may receive calls in the middle of the night from its own customers wanting to leave messages. Other customer devices, such as fax machines, or modem-equipped computers or copiers, may conflict with the utility device. And customer phone services such as call waiting or call forwarding can compromise utility access to its device.

Finally, the technical suitability of telephone is sometimes outweighed by business and practical problems. Some phone workers have disconnected utility devices without realizing it. Such events require the utility to coordinate its programs with the phone company. But electric utility territories often encompass multiple phone companies, requiring the utility interaction with numerous smaller phone companies. Even where phone companies have merged under one name, coordinating with the diverse service organizations can be daunting.

Telephone modems continue to serve very well in many utility applications, but for all the reasons mentioned are generally not used in programs involving large numbers of sites.

Telephone (Cellular)

Brief History

Before there was cellular phone service, there was "mobile" phone service. Early developments patched mobile radio users into the wired phone network in the 1940s and 1950s. In 1956 the first "automatic" system—one that most of us would recognize as similar to telephone—was introduced. It was still manually patched and required an operator to make a call. By 1964, users could do their own dialing. In the 1970s the demand for the service grew rapidly and the FCC allocated 666 channels in the 800 MHz and 900 MHz bands. In 1978 Illinois Bell was the first to receive authorization to use the frequencies.

Field trials of the Advanced Mobile Phone Service (AMPS) began that same year in Chicago, and by 1984 the AMPS system was being deployed on a large scale. Of course, we all know it grew rapidly and was a commercial success.

The AMPS is an analog phone service. It carries voice as an analog signal modulated onto radio channels. Digital data service for low-rate applications such as utility meter reading was offered by using the control channel (not one of the voice channels) of the AMPS network. This is called cellular digital packet data (CDPD).

In 1993 the U.S. Congress passed a telecom reform law requiring the FCC to authorize spectrum for "personal communications". The FCC auctioned spectrum to multiple national developers that then introduced "PCS" cellular service, which we now call digital cellular.

For equivalent physical and spectrum resources, digital cellular capacity is much greater than that of analog service. This translates into more service for the money. As a result, digital cellular service expanded more rapidly than even optimists had predicted, eclipsing other services such as Motorola's Iridium satellite phone and even terrestrial paging in some markets.

Utilities invested in CDPD on a large scale for meter reading and distribution monitoring, but its analog foundation has become obsolete. The service will cease in June 2004 after 7 years of operating, orphaning the extensive CDPD infrastructure of many utilities (and others).

Current Status

AMPS service has the largest coverage area, and its control channel has an even larger coverage area, reaching all of the U.S. except the most rugged areas. Digital service is available to 90% of the U.S. population, though significant land areas are not served.

Numerous manufacturers provide devices and systems for communicating data and control via the cellular networks to utility equipment and customers. Utilities now commonly use cellular phone as a way to connect with meters, substations, customers and other important resources when there is no phone line or existing phone lines are fully occupied.

How it Works

The cellular network consists of towers, dotted all over the area served, that are wired to the existing wired phone networks. The towers communicate with cellular phones by radio in the 800 and 900 MHz bands. The range of any single tower is about 3 to 5 miles under near-perfect conditions. Terrain, buildings and foliage can limit this to less than a mile, sometimes much less. (Over water, cell phones on boats off shore can operate out to the horizon in good conditions, that is, 15 miles or more.)

Cell phone towers now support digital and analog cell calls in every major city and town in the U.S. Not every provider has a tower in every town, so service for any one user sometimes depends on the "deals" among cell phone companies. Many rural areas do not have digital service yet, but it continues to expand rapidly.

Most of the signal transport for cellular phone calls is carried on wires. A cellular (that is, wireless) call goes to the nearest cell tower, and is wired from there to the recipient or, if the recipient is a cellular phone, to the tower nearest the recipient.

Suitability for Utility Customer Connectivity

Cellular telephone is an expedient and cost effective way to communicate with large customer sites for many purposes. It is easy to exchange data and commands, but most Internet access is currently too demanding for a cellular phone connection.

Several manufacturers provide systems for retrieving data, exercising control and sending general signals using cellular telephone networks. Those using the analog AMPS network have the largest coverage. The digital systems have more limited coverage, but offer lower costs and probably a longer useful life.

Coaxial Cable

Brief History

Cable television service originated in the late 1940s as a service to households in areas with poor reception of over-the-air broadcast television signals. Receiving antennas were erected on high places. The TV signals received by the antennas were amplified and fed to homes through a network of coaxial cable. This was called Community Antenna Television, or CATV.

By 1960 the focus of cable operators had expanded from simply relaying local programming to offering a selection of programs, some of which were received from great distances and were not locally available from any broadcast station. This was perceived as competition with broadcast TV, and the FCC imposed limits on cable operators that "froze" the cable business for a decade.

Cable restrictions were relaxed beginning in 1972, and later that year the first "pay TV" business began named Home Box Office or HBO. Following this, the cable industry pioneered satellite distribution of TV programming, enabling cable companies to offer programs they received by satellite that were not simply a replay of something already offered by broadcast TV stations. By 1980 more than 15 million U.S. households subscribed to cable TV.

Deregulation of the cable industry in 1984 enabled the cable industry to (raise rates and) invest $15 billion over the following decade to dramatically expand the U.S. cable infrastructure. By 1990 nearly 53 million households subscribed. This was more than half of all U.S. households at that time.

Current Status

TV cable now passes well over 90% of the residential population of the U.S. A large fraction of this is one-way cable, but the cable industry is pushing hard to expand its two-way digital infrastructure. The cable itself is being upgraded to improve signal propagation and expand capacity, and the various amplifiers and other electronics are made two-way. Many urban areas now have fully two-way digital cable service supporting Internet access service.

How it Works

Think of cable as a different kind of radio. It is radio that travels inside the "pipe" of coaxial cable instead of being broadcast into the air. The programs and data on the cable are carried on radio signals in the frequency range from 50 MHz to 750 MHz and higher. Some analog television signals are actually carried on the same frequencies on cable as they are when broadcast over the air. Others are modulated onto different frequencies.

Early CATV systems were limited to as little as 350 MHz. As the amount of programming expanded, the bandwidth was increased. For many years the standard upper limit of analog cable TV was 550 MHz. Further expansion began in the 1980s as interest grew in hundreds of channels of programming. New technical standards allocate spectrum up to 865 MHz for digital communication, and "inbound" communication from customers to the cable "head end" occurs in the range from 5 MHz to 50 MHz.

Suitability for Utility Customer Connectivity

If a customer connectivity program requires high data transfer rates, cable can be a good candidate. Cable is technically very well suited for broadband data communication. Availability of two-way cable is currently limited to urban and suburban areas, and often it does not serve commercial neighborhoods where larger electric customers are located. (In rural areas, even one-way cable is generally not available.) Cost is also an important issue. Depending on many details of application and hardware installation, it may be less expensive to use a wireless approach.

A number of municipalities operate cable systems for municipal purposes and also sell entertainment services to residents. In these cases, cable is a good choice for municipal utility customer programs.

Optical Fiber

Brief History

In the 1840s, French experimenters showed that light could be conducted along a stream of water, and the technique was used to make pretty fountains. In the 1920s, researchers in England and the U.S. patented the idea of using bundles of glass fibers to carry images. In effect, each strand in the bundle carried one "pixel". Still, the information carried on each strand was analog. Glass fiber development proceeded with this kind of application in mind. Medical imaging was a major focus.

Also in 1960 the laser was invented, and the possibility of data communication on glass fibers became obvious. The glass fiber bundles could show images from inside the body. But light losses were too high for communication over long distances.

Work in England and America resulted in the announcement by Corning Glass Works in 1970 that it had developed a low loss glass fiber. In the same year the first room-temperature continuous-wave semiconductor laser was invented, dramatically reducing the cost of laser light. By 1980, optical fiber could carry signals several kilometers without amplifiers, and communication systems were springing up in many intermediate-distance uses.

Deregulation of the U.S. telecom industry in the early 1980s stimulated further investment, and the telephone companies began building the present nation-wide infrastructure of optical communication fiber.

Current Status

Optical fiber is now the backbone communication technology for much of the industrialized world. A single optical fiber can carry millions of megabits per second—that is, gigabits per second—of data.

Right now, fiber optic cable and equipment are relatively expensive, attractive only for carrying high volumes of data at high speed. In these cases, the very high capacity of optical fiber cannot be matched at lower cost by alternatives. Between regional nodes and the homes and businesses they serve, other lower-capacity technologies are chosen because the data volumes are lower.

How it Works

Light will go through glass if it strikes perpendicular to the glass surface. But if it strikes the glass at a very low angle, almost parallel to the surface, virtually all the light will reflect. For this reason the light stays inside the very slender glass fibers.

Electronic devices process the data in a manner similar to other communication techniques. The signals are converted to light by semiconductor lasers and the light is carried by the fibers. The speed of the system is limited by the speed of the electronics.

Suitability for Utility Customer Connectivity

This is simply an economic choice. Fiber optic communication is well suited to utility-customer communications requiring high data rates or capacities. In some applications using lower rates, fiber may still be the best way to get the data near to the customer, where it can be conveniently converted to some other medium such as telephone wire, coaxial cable or power line.

Free-Space Optical

Free space optical (FSO) communication is included here for completeness, though no utility industry supplier currently offers this as an off-the-shelf approach to utility-customer communication.

Brief History

FOS communication could be said to be as old as mankind. Waving your hand at a friend across a parking lot is a FSO communication. The signal lights used on ships at sea are also FSO.

Major advancement of FSO communication occurred with invention of the laser. Availability of low cost commercial lasers starting in the 1970s made data networking possible. The inherent characteristics of FSO include:

- Highly secure
- Capacity comparable to fiber optic cable
- Low cost for point-to-point data exchange over short and moderate distances
- No spectrum licensing or interference issues
- Immune to interference from acoustic or electrical noise

Why is FSO not in wide use everywhere? A clear line of sight is required. Things in the air can interfere with FSO signaling. Rain and snow normally do not create problems, but FSO communication generally does not work in fog or heavy dust. And air temperature variations in the data path create a varying index of refraction that can deflect the data beam off its target.

Current Status

FSO is well established as a point-to-point method for broadband data transfer. For example, when installing a new underground-wired service (e.g. coaxial cable) that must cross a major highway, FSO can be the best way to avoid the high cost of “trenching” through the highway. It is often used for secure data transfer in corporate campuses, and for secure networking in large open spaces such as factories and warehouses.

How it Works

Current FSO technology uses a low cost laser in optical or infrared bands. The laser sends a narrow and highly focused beam from source to destination. The beam is modulated with data. The data rate is limited only by the speed of the electronics driving the modulation and performing the demodulation at the receiving end. Data rates of 100 Mbps and higher are common.

Suitability for Utility Customer Connectivity

The characteristics of an application that make FSO a good choice tend to be specific to individual situations. Examples include crossing a highway or a corporate campus without trees. FSO generally is not chosen for utility-customer connectivity programs because these characteristics do not commonly occur for all customers that will want to participate in the program, and the utility will want to use a single communication method to reach all customers.

Nonetheless, FSO can be the most economical and effective communication method in certain applications and is worth remembering as technology advances improve its suitability for broad use.

Combined Media & Internet

Many communication problems are best solved using multiple media. For example:

- The existing telephone system in the U.S. uses copper wire to connect homes and businesses with regional phone offices, and optical fiber to interconnect those offices. As users of the phone service, we generally are unaware of the phone companies' integration that makes it all work.
- Many people use office or home computer networks that connect the computers to a local wireless node by WiFi radio. The node is connected by wired Ethernet to a modem that communicates with an Internet Service Provider by coaxial cable or DSL telephone.

Utility-customer programs commonly use multiple communication methods, too. Consider two familiar examples:

- A very conventional utility load control practice is to use telephone to communicate a load control command from the utility office to a utility broadcast tower, and 154 MHz (that is, VHF) radio to send the signal to control devices at customer sites.
- Some newer utility systems similarly use telephone to communicate the command to a paging service, paging to send the command to a customer gateway at the site, and local power line communication to relay the command to a customer load control switch.

Internet communication presents perhaps the most complicated combination. Typically, the utility will work with an Internet Service Provider (ISP) that is fully equipped to support Internet services to users such as the utility's business customers. The ISP will have arranged communication between its users and the ISP's computers. This is almost always a broadband connection and usually employs DSL telephone lines, or other phone lines such as T1 dedicated lines, T3 etc. Communication on this line uses the Internet Protocol (IP).

A few manufacturers sell devices (e.g. meters) or gateways that are “IP enabled” and can be connected to the customer’s communication resources to make them directly accessible via the Internet. This allows the utility to interact with the device or gateway at any time and to freely exchange data, commands, files, etc.

Suitability Matrix

This table indicates the suitability of technologies for utility connectivity programs for large electric users. Each entry reflects the suitability of the technology to serve at least part of the communication needs of the application. “Suitability” here includes both technical and economic characteristics of products embodying the technology. Solid black circles indicate preferred technologies.

Table 4-1
Suitability Matrix

	Connectivity Applications						
Technologies	**Critical Pk /Real Time Pricing**	**Utility Direct Load Control**	**Auto Bldg. Control**	**Customer Generation Dispatch & Control**	**Demand Side Bidding**	**Outage Detection/ Customer Notification**	**Interactive Energy Information Kiosk**
Paging	●	●	●	●	●	●	
VHF SCA	●	●	●	●	●	●	
WiFi	○	○	●	●			
Licensed VHF	●	●	●	●	●	●	
Licensed UHF	●	●	●	●	◎	◎	◎
Unlicensed UHF	○	○	○	○		◎	
Broadband PLC	○	○	○	○	○	○	○
Low Band FM PLC	◎	●	◎	◎	◎		
Power Frequency Signaling	◎	●	◎	◎	◎		
Ultra-Narrow Band PLC	◎	●	◎	○	◎		
Local PLC	○	◎	◎	◎			
Telephone (Wired)	●	○	●	●	●	●	●
Telephone (Cellular)	●	●	●	●	●	●	●
Coaxial Cable	◎	◎	◎	◎	◎		◎
Optical Fiber	◎	◎	◎	◎	◎	◎	◎
Free-Space Optical	○	○	○	○	○	○	○
Internet & Combined Media	●	◎	●	●	●	○	●

Legend

● Technology is entirely suitable, economical and capable of meeting one or more important application requirements.

⭘ Technology is capable, but others are generally better in performance or cost for meeting one or more application requirements. This technology will be effective if the preferred technologies are inappropriate for some reason.

○ Technology is a poor choice for economic or technical reasons, but can perform the function.

Blank – Technology is functionally unsuitable for the application and can make no contribution, at any price.

Notes

Paging and VHF SCA are both excellent choices for outbound signaling of load control or other demand management events.

WiFi is a capable and low cost local area network suitable for short-distance communication only.

If the utility has the licenses and has infrastructure installed, licensed VHF and UHF are very effective for outbound signaling. Some systems also provide inbound capability, but products may not be available specifically supporting the application.

Unlicensed UHF is a capable and low cost local area network, but few products are available to support customer connectivity applications. This technology is suitable for short-distance communication only.

The low-capacity PLC technologies (Low Band FM, Power Frequency and Ultra-Narrow Band) are very effective for outbound signaling, such as load control or customer notification. But products do not now exist to support general-purpose customer notification or interface to building control or customer generation.

Coaxial cable is a capable medium, but products supporting these applications are not generally available. Further, cable service generally is not available at commercial and industrial sites.

A fiber optic network can serve as part of the path in any utility-customer data exchange. Fiber is not specifically suitable to the customer connectivity applications addressed in this work.

Free Space Optical communication is best suited to point-to-point data transfers and therefore is not well suited to reaching many customers. It can be an economical and effective way to carry data in a segment(s) of a larger multi-point network.

5
VENDOR INTERVIEW PROFILES

The following pages contain profiles of 28 companies that provide products related to two-way communications for utility-to-business applications.

Vendor: Ametek Power Instruments

Solution Brand Name: Scientific Columbus JemStar Meter

Description of how vendor's solution enables C&I connectivity applications

Scientific Columbus was acquired by Rochester Instruments, which was then acquired by Ametek. The Scientific Columbus product line is now a brand in the Power Instruments division of Ametek.

Major applications enabled

Customer demand response/automated bldg control: The JemStar meter has a contact output that can be preprogrammed to close under various conditions (e.g. high demand).

Customer-owned generation dispatch & control: The meter contact closure could be used to start the standby generator(s) when a demand threshold is exceeded. Or the utility could phone the meter and close the contact to start the generation. All control and monitoring (other than the meter) would have to be provided by others.

Outage detection with customer notification: The JemStar meter telephones up to 4 preprogrammed numbers upon outage to provide notification.

System architecture type

Internet-enabled: Using its hard-wired serial connection, the JemStar meter could communicate on the Internet via an intermediate box. Ametek does not provide this box.

Telephone: The standard communication method for the JemStar meter is a dedicated phone line.

System components offered by vendor

End-use equipment control devices: The JemStar meter includes a contact closure it can operate on occurrence of preprogrammed circumstances detected by the meter.

Software platform: The meter software allows the utility to preset the conditions under which the relay will operate. Of course, it can also set all other relevant metering parameters: TOU intervals, load profile interval, etc.

Communication devices: The JemStar meter includes an analog telephone modem.

Communication technologies supported (including access to Internet)

Paging: The meter cannot receive pages. It can initiate them through its telephone modem by calling the paging company.

Analog modem

Communication paths supported

One-way/outbound from utility/ISO: When the meter has a dedicated phone line, the utility/ISO can call it any time.

One-way/inbound to utility/ISO: Meter can initiate a call to the utility/ISO at any preprogrammed time and under certain preprogrammed circumstances.

Two-way/bi-directional: Once the phone connection is established, the communication is fully two-way.

Two-way/simultaneous

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

No transfer capability: The meter records consumption in preset time intervals, unrelated to price.

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling: The only way to signal the meter is by phone. This precludes any "broadcast" signaling.

5 minutes ahead signaling: This is possible, but would be problematic if it was necessary to signal more than a few meters.

Ability to verify start signal received at remote site

Ability to verify start signal received/near real-time: The phone communication is full 2-way and the meter will confirm that it has received the start command.

Ability to verify control activated at remote site

None

Ability to remotely control load/operate generation

Supported, no on-site automation: The meter simply operates its one contact closure. No other automation is provided in the meter.

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Limited load interval settings: JemStar meter records a load profile all the time.

Flexible interval load settings: Intervals are can be set via the phone connection to any value from 1 to 60 minutes.

Flexible interval settings/remotely reprogrammable: Retrieval is anytime by dedicated phone line.

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Infrequent retrieval capability: As a practical matter, it is difficult to retrieve data frequently by telephone unless there are very few meters.

Very frequent updates are possible if the cost of an always-on phone connection is acceptable.

Years product has been in commercial service

More than 5: The JemStar was introduced in 2001. The JemMeter line was introduced in 1977.

Approximate no. of endpoints in North America (meter points)

More than 1,000, less than 10,000

Utilities with pilot or large-scale programs through which product have been sold

Ametek prefers not to identify JemStar users without their express permission.

Comments

The JemStar is an industrial-quality meter providing detailed consumption and demand data. Typical use will retrieve the data daily. The contact closure is often used by the energy consumer to manage loads.

Vendor: Apogee Interactive

Solution Brand Name: Demand Exchange

Description of how vendor's solution enables C&I connectivity applications

Apogee Interactive Inc. is a full-service provider of online technology solutions and consulting services to the energy industry. The company's product and service suite includes: Internet-based load management platforms and data analysis; Web-based employee and customer training courseware; Website development and hosting; and other electronic, interactive business and training solutions. The company provides no hardware. Its software solutions rely on the utility and participating customers to provide the hardware. The Demand Exchange is its principal demand reduction offering. It is a software suite licensed to the utility that operates demand reduction programs. Demand Exchange runs on the Apogee server and is "private labeled" to the utility. Utility C&I customers see only the utility name.

Major applications enabled

Critical peak pricing/real-time pricing: Customers make their own hardware arrangements. Price communication is through the Apogee Web site (private labeled for the utility).

Utility direct load control: The Demand Exchange software communicates via the Web to directly control customer loads, operated by Web-enabled hardware.

Customer demand response/automated bldg control: This uses the same capabilities as load control and peak pricing, described above.

Customer-owned generation dispatch & control: Operates similarly to load control, but with the addition of control hardware at the generator (provided by the utility or C&I energy user) that provides information back to Demand Exchange.

Demand side bidding: the Demand Exchange manages Bidding. Meter data are collected via the Web.

Interactive customer energy information "kiosk": Apogee provides full utility Web site design & hosting services with password protected customer access to energy data. The AuditMation software suite provides comprehensive energy consumption analysis and predicts impacts of changes in equipment suite and usage.

Other: In all these applications, Apogee supplies to the utility a software suite that accepts utility and customer inputs, and provides outputs to the utility, the customer and, as appropriate, control signals for customer equipment.

System architecture type

Internet-enabled: Communication for all Apogee services is via the Internet.

System components offered by vendor

Software platform: Apogee Interactive provides no hardware. Its software solutions rely on the utility and participating customers to provide the hardware.

Communication technologies supported

Other: Apogee applications and services all are Web-based. All communication is via the Internet.

Communication paths supported

One-way/outbound from utility/ISO: Demand Exchange can communicate in both directions. When the customer equipment maintains and always-on connection, communication capability is comprehensive and near real time.

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal: Demand Exchange issues an email to the enduse customer instructing him to log in to the Exchange for price offer and interface for entering promised load reduction. Also, Demand Exchange can issue load control signals to a box (say, an IED) at the load site that is commandable by Internet.

Bi-directional signaling

Other: An Internet gateway device monitors the generator and confirms receipt of command and operation of the generator.

Price transfer (during billing cycle) “Transfer”=update pricing for demand control or peak period pricing purposes

Transfer simple pricing: In price responsive programs, prices are posted on the Demand Exchange and the customer logs in and reads them.

Transfer simple pricing/near real-time: Demand Exchange does not include any automated customer response to prices and price variations. Customers must read the prices on the screen with their eyes and execute their chosen responses.

Transfer complex pricing

Transfer complex pricing/near real-time

Control event start signal transfer

Day-ahead signaling: The amount of advance notice depends on the utility program. The Demand Exchange can support any frequency and latency supported by the Internet itself.

Hour-ahead signaling

5 minutes ahead signaling

Frequent/near real-time signaling

Ability to verify start signal received at remote site

Ability to verify start signal received/after event: Demand Exchange relies on equipment at the customer site to provide confirmation of command receipt and execution. If the customer (or the utility) provides this capability, Demand Exchange can support and receive it.

Ability to verify start signal received/near real-time.

Ability to verify control activated at remote site

Ability to verify control activated/after event: Demand Exchange relies on equipment at the customer site to provide confirmation of command receipt and execution. If the customer (or the utility) provides this capability, Demand Exchange can support and receive it.

Ability to verify control activated/near real-time.

Ability to remotely control load/operate generation

Supported, no on-site automation: Demand Exchange provides no customer automation. It is a utility (or ISO) software platform for program hosting, execution and management. If the customer-premise equipment includes automation, Demand Exchange can send it commands and receive information from it.

Supported with automatic switching when temperature, load or price reach threshold setting: If the customer-premise equipment includes local monitoring and automation and can communicate via the Internet, Demand Exchange can use the information to notify third parties and the control functions to take actions in response to customer-premise events and conditions.

Supported with alarm notification via automatically generated e-mail.

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

ISO could login and read total load. Also can have a "master" DX that tallies all for the ISO. The ISO enters its needs and the software notifies the utilities, which pass it on. Capability exists now, but is not in use anywhere yet.

Flexible interval load settings

Flexible interval settings/remotely reprogrammable

Monitors at sub-minute level

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

No report retrieval capability during event

Years product has been in commercial service

More than 1 less than 5: 1998

Approximate no. of endpoints in North America (meter points)

There are a few dozen Demand Exchanges in the U.S., each in a single utility service territory. There are a few in other countries.

More than 1,000, less than 10,000: 3,000 end points in North America.

Utilities with pilot or large-scale programs through which product has been sold

Bonneville Power

Georgia Power

Entergy

Sacramento Municipal Utility District

Meridian Energy NZ

Comments

"Apogee Interactive clients include every type of energy provider in the U.S.: electric and gas, investor-owned, cooperatives, municipals, marketers and associations. The Demand Exchange supports four demand response categories.

1. Noticed interruptible: Customer gets an energy price break all year (or all season) by agreeing to accept a supply interrupt on demand.
2. Real time pricing: Utility posts 24 hourly prices for tomorrow. Customer responds at will. Customer response is not pre-promised, and customer pays only for energy used.
3. Demand bidding: The C&I customer pledges a specific load reduction for specific hours at a specific price, then must deliver that reduction or pay a penalty.
4. Price responsive: Utility sends a notice citing a date, hours and a price, and the customer responds with a promised reduction. Then the utility decides whether to accept that promise or not.

The Demand Exchange currently is licensed to the utilities that operate the demand reduction programs. But Apogee is open to other arrangements, e.g. licensing to an ISO."

Vendor: Brayden Automation

Solution Brand Name: Energy Access

Description of how vendor's solution enables C&I connectivity applications

Brayden Automation Corp. is a leading manufacturer of demand-side management equipment for the electric utility industry. The company works with electric utilities to reduce end-user customers' electric costs and utility system peak demands. Clients include Black Hills Power and Light, Otter Tail Power, Midwest Energy, Hawaiian Electric Company in addition to Xcel Energy. Founded in 1978, the company's demand control products enable residential, commercial, industrial and agricultural energy users to lower their energy costs significantly by reducing peak demand charges. In addition, Brayden Automation also helps electric utilities to manage peak power costs and to meet energy demand more efficiently.

Major applications enabled

Critical peak pricing/real-time pricing: Note: none implemented to date; demand controllers have a contact closure that can enable demand control

Customer demand response/automated bldg control

Interactive customer energy information "kiosk"

System architecture type

Other: Demand controllers hard-wired/switch closure is interface to utility

System components offered by vendor

End-use Equipment control devices

Software platform

Communication technologies supported

Other: Up to utility to provide communication path

Communication paths supported

One-way/outbound from utility/ISO: switch closure

Event-enabled signaling

Utility/ISO event-> outbound signal

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing: Up to 4 prices per input lines; dependent on communication infrastructure

Control event start signal transfer

Other: Depends on communication infrastructure

Ability to verify start signal received at remote site

None: Contents of meter register are only means to verify

Ability to verify control activated at remote site

None: Contents of meter register are only means to verify

Ability to remotely control load/operate generation

Supported, no on-site automation: Supported with load-based controls only

Other: Utility can remotely override TOU pre-sets via switch closure

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Monitors at sub-minute level

Other: Performed remotely using Energy Access™

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Other: Data are real-time at the computer; not stored in meter or controller

Years product has been in commercial service

More than 5: Software platform 7 years

Approximate no. of endpoints in North America (meter points)

More than 100, less than 1,000: Approximately 1,000

Utilities with pilot or large-scale programs through which product has been sold

Xcel Energy

Black Hills Power & Light

Otter Tail Power

Midwest Energy

Hawaii Electric

Electric Cities (NC)

Customer installation sites

Approx. 1,000 sites; typically work with small stores and chains - individual franchisees

Comments

Brayden is on the "customer side of the meter."

Vendor: Cannon Technologies

Solution Brand Name: Cannon

Description of how vendor's solution enables C&I connectivity applications

Cannon offers an array of one-way and two-way communication devices that send and receive data and commands to and from C&I meters, generation sets, building automation systems, and enable real-time pricing, demand trading and other applications. Communications technologies supported include VHF radio, FM-SCA radio, paging, satellite, power line carrier and telephone.

Major applications enabled

Critical peak pricing/real-time pricing

Utility direct load control

Customer demand response/automated bldg control

Customer-owned generation dispatch & control

Demand side bidding: In conjunction with Power Exchange

Outage detection with customer notification: Via power line carrier

System architecture type

Fixed radio network

Power line

Internet-enabled

Other: Satellite

System components offered by vendor

End to end solution(s)

End-use Equipment control devices

Software platform

Communication devices

Communication technologies supported

RF

PLC

Cellular: Analog

Paging

Analog modem

Other: VHF, satellite

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing

Transfer simple pricing/near real-time

Transfer complex pricing

Transfer complex pricing/near real-time

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Frequent/near real-time signaling: < 60 second

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Limited load interval settings

Flexible interval load settings (down to 5 minutes.)

Flexible interval settings/remotely reprogrammable

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability

Sub-minute reporting capability: 3-5 seconds

Years product has been in commercial service

More than 5

Approximate no. of endpoints in North America (meter points)

C&I: More 1,000, less than 10,000

Cannon also has approximately 1.5 million residential endpoints in service.

Utilities with pilot or large-scale programs through which product has been sold

Xcel ~1500 (meter, price)

Duke ~400; controls 400 gen sets using PMI meters

CP&L/Progress ~250

Missouri River Energy Services ~25

Customer installation sites

N/A

Comments

"Sensors to software"; multi-technology; "Optimizing Energy Delivery with a Common Software Platform - Yukon"; Utility load control with curtailment monitoring; curtailment based on demand exchange. Controls 119 Staples locations in CA: Stage 1=30% A/C; Stage 2=50% A/C; Stage 3=50% lighting; 2.8 MW reduction.

Vendor: Chevron Energy Solutions (Viron)

Solution Brand Name: UtilityVision®

Description of how vendor's solution enables C&I connectivity applications

UtilityVision® is a web based utility monitoring system that allows customers to track energy usage on single or multi-building sites, particularly for monitoring electricity consumption in colleges, universities, commercial developments, schools manufacturing plants and housing projects - and it is conveniently accessible by computer. The system easily integrates with an existing Ethernet LAN. It consists of a TCP/IP network host (metering Platform) that receives usage data from meters, and presents it in tables or charts. Customers may view and print both historical and real-time reports from the UtilityVision® Web site. UtilityVision® is a turnkey installation that involves mounting the metering platform and meters, installing cabling and connections, and configuring the interface. The system's modular structure makes it easy to install, reconfigure and expand in response to additional customer requirements.

Major applications enabled

Critical peak pricing/real-time pricing: Currently limited to analytical software tools

Utility direct load control

Customer demand response/automated bldg control

Customer-owned generation dispatch & control

Interactive customer energy information "kiosk"

Other: Solar load controller: Sheds pre-designated loads and optimizes PV output at times of coincident peak

Other: Submetering of university campuses, manufacturing processes, housing projects, school districts, etc.

System architecture type

Internet-enabled: On-site Internet gateway interfaces with meters and customer's control system/building controls

System components offered by vendor

End to end solution(s)

Communication technologies supported

RF: Between buildings on customer site

Analog modem: Not preferred path

Other: Internet gateway

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous

Event-enabled signaling

On-site event-> inbound signal

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

No transfer capability

Control event start signal transfer

No signaling capability

Ability to verify start signal received at remote site

None

Ability to verify control activated at remote site

None

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting: No price setting currently

Supported, with alarm notification via automatically generated e-mail

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 1 min.)

Flexible interval settings/remotely reprogrammable

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability

Sub-minute reporting capability: Real-time

Years product has been in commercial service

More than 1, less than 5

Approximate no. of endpoints in North America (meter points)

More 100, less than 1,000

Utilities with pilot or large-scale programs through which product has been sold

N/A

Customer installation sites

Company does not release customer names.

Comments

Originally built as a tool to manage performance contracts; presents detailed information to energy manager.

Vendor: Comverge

Solution Brand Name: PowerCAMP™

Description of how vendor's solution enables C&I connectivity applications

Comverge provides end-to-end solutions for C&I connectivity – and is completely technology agnostic – with experience with all popular communications media including terrestrial RF, satellite, powerline communication, and telephone. Comverge's bi-directional Commercial & Industrial wireless AMR gateway solution is designed for single and multi-meter deployments to transport meter data from remote locations over a public network to a utility's operations center. Maingate™ C&I gateways are designed for various communication networks to best cover a service area, including: CDPD, CDMA, and GSM/GPRS. Comverge offers a complete stable of proven one-way and two-way end devices, and versatile head-end software. Comverge's PowerCAMP™ Server is scalable, highly flexible, and capable of using multiple network technologies to collect and transmit data, including power line, cable, radio, telephone, and cellular communication technologies, or hybrid combinations thereof.

Major applications enabled

Critical peak pricing/real-time pricing

Utility direct load control

Customer demand response/automated bldg control

Customer-owned generation dispatch & control

Outage detection with customer notification: Part of MainGate.

Interactive customer energy information "kiosk"

System architecture type

Fixed radio network: Public; private (with licensed frequency), paging

Power line: CEBus now but changing to other standards; high-rise and multi-level

Internet-enabled

System components offered by vendor

End to end solution(s): System design through management, all hardware and software, installation optional

End-use Equipment control devices

Software platform

Communication devices

Communication technologies supported

RF: Paging, RF-private, RF-public

PLC

Cellular: C&I using Verizon 1XRTT, CDMA, Control Channel, GSM

Paging

Analog modem

Point-to point

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional: Maingate™ C&I (separate from residential MainGate); half duplex only

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing: Plug-in box with visible/audible

Transfer simple pricing/near real-time: Plug-in box with visible/audible

Transfer complex pricing: Plug-in box with visible/audible

Transfer complex pricing/near real-time: Commercial thermostat, also Maingate™ Multi for multi-tenant transfer complex pricing/near real-time

Control event start signal transfer

Day-ahead signaling: Depends on how the technology is applied

Hour-ahead signaling: Depends on how the technology is applied

5 minutes ahead signaling: Depends on how the technology is applied

Frequent/near real-time signaling: Depends on how the technology is applied

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time

Ability to remotely control load/operate generation

Supported, with automatic switching when temperature, load or price reach threshold setting: Offer special software for these features

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Limited load interval settings

Flexible interval load settings (down to 5 minutes.)

Flexible interval settings/remotely reprogrammable: 5,10,15,30,60 minute options

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability

Sub-minute reporting capability: Could stream data with Maingate™. Latency less than 10 seconds.

Years product has been in commercial service

More than 1, less than 5

Approximate no. of endpoints in North America (meter points)

More 100, less than 1,000

Utilities with pilot or large-scale programs through which product has been sold

PJM

Pennsylvania Power and Light/ 3,800-4,000 C&I points, installation to reach 6,500

Building owners/Consolidated Edison/then reselling ~500 residential units

Customer installation sites

N/A

Comments

N/A

Vendor: DCSI

Solution Brand Name: TWACS

Description of how vendor's solution enables C&I connectivity applications

TWACS® is a fixed network utility communication system that uses patented technology to communicate over electric power lines, providing low-cost, highly-reliable, two-way communication between the utility and the consumers of electricity, water and gas. TWACS is a state-of-the-art, proven reliable, multi-functional, power line communication system with full two-way access to and from the meter. TWACS provides unique capabilities ideally suited for Automatic Meter Reading (AMR), Load Control, Demand Response, Interval Data, TOU/Real-Time Pricing, Line-Voltage Monitoring, Outage Management/Restoration Monitoring, Remote Service Connect/Disconnect, and Tamper/Theft Detection using open architecture interfaces. TWACS uses the existing power lines for data transmission, and since it modulates the waveform at the zero crossing point, it uses the utility's network at the frequency for which it was designed.

Major applications enabled

Critical peak pricing/real-time pricing: Key capability is hourly load profile, which TWACS can do. Outbound signal can be TWACS load control signal or paging or other.

Utility direct load control

Customer demand response/automated bldg control: TWACS can provide a signal (as in load control) and can collect hourly data.

Customer-owned generation dispatch & control: Can use TWACS load control switch for signal and local control (from others) to control the generator.

Demand side bidding: TWACS can provide the hourly metering delivered daily, but not the rest of the software integration.

System architecture type

Power line: Power line communication using 60 Hz as the "carrier" of the data.

System components offered by vendor

End to end solution(s)

End-use Equipment control devices

Software platform

Communication devices

Communication technologies supported

PLC

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional: TWACS can send/receive on different feeders, but not on the same one.

Event-enabled signaling

On-site event-> inbound signal: Not currently possible. Product in development for 15-minute notification.

Utility/ISO event-> outbound signal

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

No transfer capability: Can send a binary alert, but not price. The system is capable of this in principle if the outbound messages are pre-defined. Message payload limit is about 20 bytes.

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling: Broadcast messages such as price or load shed can reach all customers at once. TWACS has a limited capacity to address many customers individually in a short time.

5 minutes ahead signaling: One-way latency of the TWACS signal is typically about 5 seconds, but can be up to a minute.

Frequent/near real-time signaling: Latency also must include the time to send the signal from the utility to the substation. This interval will typically be just a few seconds.

Ability to verify start signal received at remote site

Ability to verify start signal received/after event: Round-trip latency of the TWACS signal is typically about 10 seconds, but may be up to a minute.

Ability to verify start signal received/near real-time: The system cannot receive such verification from many sites at once at any one substation, so this capability depends on how many sites per feeder are participating.

Ability to verify control activated at remote site

Ability to verify control activated/after event: The metered hourly load profile will reflect change in load. Also TWACS later reports the number of contact closures of the control relay for verification. Time of closure is not recorded.

Ability to remotely control load/operate generation

Supported, no on-site automation: TWACS can perform this using a simple direct load control switch.

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Limited load interval settings: Hourly load profile only, reported daily.
Can provide hourly profile hourly for a small number of sites, a few per substation.

Utility/ISO capability to remotely monitor load during control event (reporting frequency):

Infrequent retrieval capability: Retrieval every 8 hours only, except for small numbers of sites per substation.

Years product has been in commercial service

More than 5

Approximate no. of endpoints in North America (meter points)

More than 10,000: 6,500,000 installed or under contract. 5.6 M AMR + 0.9 million DLC. (mainly residential)

Utilities with pilot or large-scale programs through which product has been sold

FPL/850,000

Puerto Rico Power Authority/945,000

Ozarks Electric Co-op (Ark)/42,000

PPL/800,000

Wisconsin Public Service/250,000 electric + 50,000 gas

ATCO Electric (Alberta Power)/155,000

2.4 million installed or under contract to about 100 electric cooperatives.

Customer installation sites

N/A

Comments

Communication with control devices requiring few bytes is effective. The low data rate and cost of equipment may preclude applications requiring direct data communication with customer equipment.

Vendor: Dencor

Solution Brand Name: Energy Administration System (EAS)

Description of how vendor's solution enables C&I connectivity applications

The Energy Administration System provides a complete system including both the information gathering and the energy control needed to operate successfully in a deregulated environment. The system provides the tools needed for implementing programs to achieve energy control, cost reduction and load aggregation. The Customer gains the benefit of a control system that permits an effective response to standard or special rate incentives from a utility. The Utility gains an effective customer communication and control link. The 300C stores one-minute demand data that can be used to provide billing information. Any meter with a KYZ output can be used. Software is available to provide aggregated data for conjunctive billing. The Energy Manager gains a tool to effectively monitor and control a large number of facilities from a single location. The one-minute demand data and temperature records allow the energy manager to provide support for customers and generate a continuous revenue stream by providing monitoring services.

Major applications enabled

Critical peak pricing/real-time pricing: Controls building loads remotely for customers on TOU, full-time demand or coincident demand rates

Utility direct load control

Customer demand response/automated bldg control

Customer-owned generation dispatch & control

System architecture type

Other: Independent system that takes utility input and controls building loads and gen sets remotely

System components offered by vendor

End-use Equipment control devices: Including firmware

Software platform: With central station

Communication technologies supported

Other: Utility provides communication path; can be one-way or two-way

Communication paths supported

Other: Depends on communication system deployed by utility or customer

Event-enabled signaling

Utility/ISO event-> outbound signal

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

No transfer capability

Control event start signal transfer

5 minutes ahead signaling

Frequent/near real-time signaling

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Other: System can report anomalies if utility comm. System is two-way

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 1 min.)

Other: Assumes EAS is also located at utility or ISO site

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability

Other: Can also monitor temperature minute by minute

Years product has been in commercial service

More than 5: 9 years

Approximate no. of endpoints in North America (meter points)

40,000 endpoints, mostly residential

Utilities with pilot or large-scale programs through which product has been sold

Dakota Electric ~12 points commercial

Otter Tail Power ~ thousands of residential points

Customer installation sites

Hudderite religious colonies in Canada (aggregation)

Comments

Customer may override control via PC connection or modem; system capable of controlling load, kVA, power factor; sophisticated multiple load control strategies and load shedding rules available--timer, duty cycle, priority order; no remote disconnect or tamper detection; direct PC or modem connection for data transfer; supports multiple duty cycle/scheduling options for load shedding; signals on-site diesel to operate and transfers load; can be used for lighting control using controllable dimming ballasts; can control walk-in refrigerators/freezers. “We have a very reliable product that can be applied across a broad spectrum of applications by utilities for intelligent control and cycling of equipment that minimizes the impact on the customer and maximizes demand reduction for the utility.”

Vendor: Elster Electricity

Solution Brand Name: Alpha Product + EnergyAxis™ System

Description of how vendor's solution enables C&I connectivity applications

The EnergyAxis System is comprised of an I/T system, 900 MHz mesh network, and meters. The system has been designed to facilitate economic data collection as well as facilitate flexible pricing scenarios. Utilizing the mesh network, pricing signals can be dynamically sent to the residential meter to trigger data collection in critical peak times. Since the meter does the 'metering in the meter', the I/T application will have billing data that is auditable to the meter.

Major applications enabled

Critical peak pricing/real-time pricing: Alpha meter + REX meter in EnergyAxis™ system; requires separate customer notification.

Utility direct load control: Using the LC relays in the meters, external systems can be notified.

Customer demand response/automated bldg control: A load control relay can be utilized to signal a critical peak tier.

Outage detection with customer notification: EnergyAxis™ system receives call from A3 ALPHA meter when outage occurs; it also receives restoration calls.

Other: Power Quality monitoring

System architecture type

Fixed radio network: Utilizing 900 MHz, key differentiator is that it is a 'mesh network'

Internet-enabled: EnergyAxis™ system uses a standard Internet browser

Other: Elster currently offers an overall system architecture that enables C&I connectivity applications for single-phase meters using

System components offered by vendor

End-use Equipment control devices: Control relays from the ALPHA meters

Software platform: EnergyAxis™ System

Communication devices: Modems and 900 MHz radiometer modules, telephone, analog cellular, CDMA, GSM, RS232/485

Other: Electronic meters supporting information capture and two-way communications

Communication technologies supported

RF: Meter can receive and transmit radio control signals (900 MHz unlicensed)

Cellular: A3 ALPHA with ICM, A3 ALPHA with external CDMA, GSM

Paging: A3 ALPHA with REFLEX 50/25

Analog modem: Meter and EnergyAxis™ System support modem communications

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Other: Communicates to meter only; no provision for sending price or signal to consumer (today)

Control event start signal transfer

Day-ahead signaling: Can signal consumer meter

5 minutes ahead signaling: Communicates with meter only; no inherent load control capability from system application perspective. Load control relays in meter.

Ability to verify start signal received at remote site

Other: Limited to meter register contents

Ability to verify control activated at remote site

Ability to verify control activated/near real-time: By reading meter

Other: Limited to meter register contents

Ability to remotely control load/operate generation

Supported, no on-site automation: Alpha product

Supported, with automatic switching when temperature, load or price reach threshold setting: ALPHA load control relay can operate at a peak tier or even by a KW threshold

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 1 min.): 15 minutes for REX single-phase meter, 1 min for ALPHA meter

Flexible interval settings/remotely reprogrammable

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Infrequent retrieval capability: Meter readings may be retrieved at any time; higher data volume will slow data flow

Other: Depends on communication infrastructure implemented

Years product has been in commercial service

Less than 1 year: For REX meter

More than 1 less than 5: For EnergyAxis Software

More than 5: For Alpha meter only

Approximate no. of endpoints in North America (meter points)

More than 10,000

Utilities with pilot or large-scale programs through which product has been sold

Elster is unable to list customers without their approval

Customer installation sites

N/A

Comments

Energy Axis™ 900 MHz mesh network is currently limited to single phase meters; polyphase meters to be included in early 2004 per company announcement.

Vendor: eMeter

Solution Brand Name: Power Information Platform™

Description of how vendor's solution enables C&I connectivity applications

eMeter designs, builds, and operates advanced metering systems for electric and gas utilities. The systems may be run by eMeter on an outsourced basis or turned over to the utility after completion. eMeter executes its projects around its Power Information Platform™, an integrated data collection, data management, data warehouse, asset management, and program management system. eMeter works with a variety of meters and communications types, including wireless, telephone, and power line carrier. eMeter assists electric utilities as they convert obsolete, 50-year-old metering systems to modern, communications-based, real-time information systems.

Major applications enabled

Critical peak pricing/real-time pricing

Utility direct load control

Customer demand response/automated bldg control: Building control is "indirect" only

Outage detection with customer notification

Interactive customer energy information "kiosk"

Other: Customer program marketing and enrollment on behalf of utilities

System architecture type

Fixed radio network

Mobile

Power line

Internet-enabled

System components offered by vendor

End to end solution(s): except the meter

Communication technologies supported

RF

PLC

Cellular

Paging

Analog modem

Point-to-point

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous

Event-enabled signaling

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing

Transfer simple pricing/near real-time

Transfer complex pricing

Transfer complex pricing/near real-time: Via web, E-mail and wireless messaging

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Frequent/near real-time signaling

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time: Notification not issued directly from control device - meter linkage only

Ability to verify control activated at remote site

None

Ability to remotely control load/operate generation

Supported, no on-site automation

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 5 minutes.)

Flexible interval settings/remotely reprogrammable

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability: to interval setting

Years product has been in commercial service

More than 1, less than 5

Approximate no. of endpoints in North America (meter points)

More than 10,000

Utilities with pilot or large-scale programs through which product has been sold

PG&E ~8,000 C&I customers

National Grid ~12 customers in pilot program

Reliant (small pilot)

Customer installation sites

This information is considered confidential by eMeter.

Comments

eMeter is a consulting operation as well as a software developer; eMeter helps select and integrate communication technologies and metering under its Power Information Platform(TM); "sweet spot" is a demand response program that requires communication with the customer's metering information management package. Focus is on the utility's program. The PIP is used to support the selection, design, construction, and integration of the advanced metering infrastructure.

Vendor: Encorp

Solution Brand Name: Encorp

Description of how vendor's solution enables C&I connectivity applications

Encorp provides a broad spectrum of hardware and software controls specifically designed to support distributed generation operations. From the switchgear that starts a generator all the way up to the software that controls multi-site monitoring and the dispatch of units, Encorp has integrated the layers of DG control infrastructure. Encorp's products and services are neutral to generator technology and have been integrated with every major engine manufacturer in North America. The technologies are open architecture and have also been incorporated into every leading software platform.

Major applications enabled

Customer demand response/automated bldg control: Only when in conjunction with DG installations

Customer-owned generation dispatch & control

Interactive customer energy information "kiosk": Only when in conjunction with DG installations

Other: Joint load management/DG peak "sharing" programs

Other: Create physical interfaces with grid systems to load share, export power, etc.

System architecture type

Other: Open architecture

System components offered by vendor

Software platform

Communication devices: Intelligent devices around DG site; comm. Interface devices to 3rd party software platforms

Other: Engine and generator controls

Other: Meters/monitors for DG inputs/outputs

Communication technologies supported

RF

Cellular

Paging

Analog modem

Other: Neutral as to communication medium

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous

Other: Two-way real-time

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing

Transfer simple pricing/near real-time

Transfer complex pricing

Transfer complex pricing/near real-time: minute-by-minute

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Frequent/near real-time signaling: real-time

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time: real-time

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time: real-time

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail

Other: Intelligent on-site capability; sophisticated remote trending analysis, alarming and reporting

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings

Flexible interval settings/remotely reprogrammable

Monitors at sub-minute level

Other: Monitoring in milliseconds

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Sub-minute reporting capability

Other: can be real-time

Years product has been in commercial service

More than 5: 1996 - 1997

Approximate no. of endpoints in North America (meter points)

More than 100, less than 1,000: > 240 customer sites; 650 MW under control; 1400 power controls, i.e., engines

Utilities with pilot or large-scale programs through which product has been sold

Exelon/Commonwealth Edison ~12 sites

TVA ~12 sites

TXU ~12 sites

Midwestern municipals, especially Iowa

Customer installation sites

U.S. Army

Equity Office Properties

Stewart & Stevenson

Honeywell

JP Morgan Chase

Comments

All enabling is centered on distributed generation. Three main scenarios supported: (1) Operating generator in response to a utility load management program; (2) Peak shaving; and (3) Operating generator as a physical hedge against wholesale price volatility in a real-time, market pricing environment.

Vendor: EnerNOC

Solution Brand Name: EnerNOC

Description of how vendor's solution enables C&I connectivity applications

EnerNOC integrates demand response (DR) solutions, including customer generation to meet regional utility demand. The company provides no hardware of its own. It integrates hardware and software supplied by others. EnerNOC makes DR programs accessible by handling all regulatory, permitting, operational, and metering requirements that would otherwise make participation impractical.

Major applications enabled

Critical peak pricing/real-time pricing

Utility direct load control: Presently only sprinklers. In principle any load can be controlled.

Customer demand response/automated bldg control: The NOC has comprehensive monitoring and control capability.

Customer-owned generation dispatch & control

Demand side bidding: EnerNOC bids in NY & commits to deliver demand reduction. Revenue is shared with participating energy users.

Outage detection with customer notification: Yes, related to customer generation and also to any customer they're monitoring/submetering.

Interactive customer energy information "kiosk": Web page shows customers their energy use profiles. Metering is a private label "box" with EnerNOC software.

System architecture type

Fixed radio network: Paging is sometimes used for outbound signals, such as load control or generator startup.

Internet-enabled: EnerNOC's various boxes communicate by ModBus to other boxes that connect to the customer's Internet access.

System components offered by vendor

End to end solution(s): EnerNOC buys hardware from others and integrates demand response solutions using its proprietary software and NOC.

End-use Equipment control devices: Some devices are private-labeled for EnerNOC, e.g. submeters. Others are not, e.g. Caterpillar engine-generator.

Software platform: EnerNOC provides proprietary software for data management, communication, electric metering and control of many devices.

Communication devices

Communication technologies supported

RF: EnerNOC does not get involved in the utility's private radio system. EnerNOC sends communication on the corporate intranet and the utility's existing systems handle the radio interface.

Paging

Analog modem: Dedicated line is used in a few cases, if Internet unavailable.

Other: EnerNOC does TCP/IP and everything else is usually transparent, using the customer's Internet access.

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous: Using the Internet access, data flow is bi-directional and almost immediate.

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing

Transfer simple pricing/near real-time

Transfer complex pricing: EnerNOC expects to do this in the future, but no participant currently requires it

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Frequent/near real-time signaling

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time: Bidirectional communication confirms control signal received.

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time: EnerNOC installs a submeter or KYZ feed from the customer meter, which confirms control action.

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail: Notification to ISO and to generator owner.

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 5 minutes.)

Flexible interval settings/remotely reprogrammable

Monitors at sub-minute level: The NOC collects data at any selected rate and makes it available to all allowed parties via the EnerNOC Web site.

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability: Any retrieval interval is possible, programmable from the NOC on request from the customer.

Sub-minute reporting capability

Years product has been in commercial service

More than 1, less than 5: Many parts of the solutions have been in service for decades, e.g. engine generators.

Approximate no. of endpoints in North America (meter points)

More than 100, less than 1,000: 150 sites now under contract. Most are private companies.

Utilities with pilot or large-scale programs through which product has been sold

No deals are presently in place with utilities, other than Fairfield CT (below). EnerNOC is equipped to serve utilities and expects to develop such business as utilities' DR needs grow.

Customer installation sites

EnerNOC controls loads at several facilities of the Town of Fairfield CT. Other customers are private companies, not disclosed. See list below.

Comments

"EnerNOC currently works with a broad spectrum of clients, including:

- Retail & Grocery Chains
- Commercial Office Properties
- Colleges & Universities
- Health Care Facilities
- Municipalities
- Water & Wastewater Treatment Plants"

Vendor: EnFlex

Solution Brand Name: EnFlex Solutions

Description of how vendor's solution enables C&I connectivity applications

EnFlex® is a unique, low cost, completely networked information management, monitoring, and control gateway. EnFlex Controller provides direct monitoring and control of equipment such as RTUs, VAV boxes, chillers, air handlers, cooling towers, lighting systems, etc. The EnFlex Gateway resides at a remote facility and connects to a variety of intelligent devices within that facility. EnFlex can manage numerous devices and transport information over TCP/IP networks, the Internet, and corporate Intranets. Information from a large number of facilities with EnFlex gateways can be aggregated using standard TCP/IP networking techniques.

Major applications enabled

Critical peak pricing/real-time pricing

Utility direct load control

Customer demand response/automated bldg control

Customer-owned generation dispatch & control

Outage detection with customer notification

Other: Web-enabled building management; networking of building systems

Other: Submetering

System architecture type

Fixed radio network: wireless network

Internet-enabled

Other: Any communication infrastructure connectible through multiple communication interfaces

System components offered by vendor

End to end solution(s): Tailored solutions made up of third party components to meet unique customer needs

Software platform

Communication devices

Other: Site control sensors, network servers, interfaces

Other: Software/network drivers

Communication technologies supported

Other: Internet

Other: Any communications technology

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing

Transfer simple pricing/near real-time

Transfer complex pricing

Transfer complex pricing/near real-time

Control event start signal transfer

Frequent/near real-time signaling: 1-second increments (offer a localized SCADA device)

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time

Ability to remotely control load/operate generation

Signaling only, no operational control

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings

Flexible interval settings/remotely reprogrammable

Monitors at sub-minute level: milliseconds

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Sub-minute reporting capability

Years product has been in commercial service

More than 5:10 years

Approximate no. of endpoints in North America (meter points)

More than 10,000: 500K meter control points; 3,000 EnFlex boxes

Utilities with pilot or large-scale programs through which product has been sold

PG&E ~75 Burger Kings

California Energy Commission

NYSERDA ~100 sites in Manhattan

NIPSCO ~100 DG solutions

Chevron ~400-500 sites

Customer installation sites

CostCo ~382 sites networked

Comments

EnFlex does not sell direct to end-users; utilities and retailers primary; emphasis on "localization of network" - create independence of LAN/WAN; network sits on top on energy management system; EnFlex provides diagnostic solutions also.

Vendor: Engage Networks

Solution Brand Name: Active Energy Management (AEM)

Description of how vendor's solution enables C&I connectivity applications

Engage Networks, Inc. provides via its AEM® a complete solution for real-time, wide-area Internet-based energy information and distributed generation control technologies, monitoring tens of thousands of meters and generators alike. Engage provides the ability to pass data from power monitoring and control instruments to host databases in a multiple-vendor network environment. Engage brings order and structure to network strategies of both local area networks (point solutions) and wide-area networks (enterprise solutions) through the application of both custom and standard hardware and software products. Products interface multiple vendors and networks to existing plant computers, instrumentation or PLCs. DGen® is an advanced application that facilitates the automated use of distributed generation assets via the Internet. Through DGen® it is possible to configure, command and control multiple remotely located generators. DGen® can automatically switch on and off the generator when the need arises. Generators are controlled automatically from any alarmable event such as temperature, real-time energy price, energy demand and many other pre-defined conditions.

Major applications enabled

Utility direct load control: wide area load curtailment

Customer demand response/automated bldg control

Customer-owned generation dispatch & control: including group dispatch

Other: Monitoring and maintenance of distributed generation

System architecture type

Internet-enabled: Ethernet connectivity; real-time Internet-based architecture

System components offered by vendor

Software platform

Other: Modules connecting meters to AEM software; Ethernet pulse input module, global pulse input module, GE-IP card

Communication technologies supported

RF

Cellular

Analog modem

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous

Event-enabled signaling

On-site event-> inbound signal: alarming notification

Utility/ISO event-> outbound signal

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing

Transfer simple pricing/near real-time

Transfer complex pricing

Transfer complex pricing/near real-time: <5 minutes

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temp. load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 1 min.)

Flexible interval settings/remotely reprogrammable

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Sub-minute reporting capability

Years product has been in commercial service

More than 1 less than 5: for load control applications

More than 5: for distributed generation applications

Approximate no. of endpoints in North America (meter points)

More than 1,000, less than 10,000: approximately 6,000

Utilities with pilot or large-scale programs through which product has been sold

N/A

Customer installation sites

Unidentified large customer uses AEM with DGen to monitor real-time pricing in multiple utility service areas to dispatch on-site generation

Comments

Customer override enabled but not used; product intended for multi-site groups; remote service disconnect supported but not yet deployed; FirstEnergy Solutions, a competitive retailer, is a reseller; customers use AEM analytics to optimize their load patterns.

Vendor: GE Industrial Systems

Solution Brand Name: Power Management Control System (PMCS)

Description of how vendor's solution enables C&I connectivity applications

GE Power Management Control System (PMCS) is a software package that turns a desktop computer into a virtual window for tracking and controlling facility power. With just a few clicks of a mouse, users gain real-time access to the family of POWER LEADER™ devices and even to third party devices or systems. With PMCS's powerful analytical tools, users can perform advanced power quality analysis, monitor energy consumption, and even manage loads. The product includes sophisticated graphics and a highly intuitive interface. PMCS is both ModBus® and Ethernet compatible and is optimized for the Windows 2000 SP2 operating system. It offers a flexible, open-architecture, high-performance power management system.

Major applications enabled

Utility direct load control

Customer demand response/automated bldg control

Customer-owned generation dispatch & control

Outage detection with customer notification

Interactive customer energy information "kiosk"

Other: Load sharing between on-site assets

Other: Remote monitoring and diagnostics via the Internet

System architecture type

Fixed radio network

Mobile

Internet-enabled

System components offered by vendor

End to end solution(s)

End-use Equipment control devices

Software platform

Communication devices

Other: Meters and relays

Communication technologies supported

RF

Cellular

Paging

Analog modem

Point-to-point

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional: Uses programmable logic controllers (PLCs) as polling device

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing

Transfer simple pricing/near real-time: Subject to limitations of communication technology

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Frequent/near real-time signaling: Subject to limitations of communication technology

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail: Can also notify via pager, cell phone, other means.

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 5 minutes.)

Flexible interval settings/remotely reprogrammable

Monitors at sub-minute level

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability

Sub-minute reporting capability: Subject to limitations of communication technology

Years product has been in commercial service

More than 5

Approximate no. of endpoints in North America (meter points)

More than 10,000

Utilities with pilot or large-scale programs through which product has been sold

Consolidated Edison

Commonwealth Edison

Florida Power & Light

Customer installation sites

Gillette (PMCS)

AT&T (remote web hosting - data centers)

Petrochemicals industry

Comments

GE offers multiple, competing products within this technology area. Customer solutions represent individually customized configurations of these and third party products.

Vendor: Honeywell

Solution Brand Name: Enterprise Building Integrator™/Atrium™

Description of how vendor's solution enables C&I connectivity applications

Honeywell's Energy Building Integrator(tm) offers a scaleable system that pulls together all core building systems and integrates information from many different enterprise subsystems, from industrial manufacturing and process automation, to financial and personnel records, environmental controls and data warehouses. With the Honeywell Enterprise Buildings Integrator, customers have the information they need to make critical decisions quickly -

decisions that ultimately help to better manage the company's bottom line. Within Honeywell Enterprise Integrator are powerful software application modules such as Energy Manager, which enables several key connectivity applications. Honeywell Building Manager provides the ideal platform for open data integration between traditional building systems and key enterprise systems. Leading industry standards such as LonMark, BACnet and OLE for Process Control (OPC) are supported. Interfaces are also available to a range of building subsystem controllers, allowing Honeywell Building Manager to uniquely integrate all building systems including HVAC monitoring and control, lighting, power and energy management into a single building solution.

Major applications enabled

Critical peak pricing/real-time pricing: Energy Building Integrator (EBI) - Energy Manager Module

Utility direct load control: Honeywell DMC

Customer demand response/automated bldg control: Energy Building Integrator (EBI) - Energy Manager Module

Customer-owned generation dispatch & control: Energy Building Integrator (EBI) - Energy Manager Module

Demand side bidding: Energy Building Integrator (EBI) - Energy Manager Module

Interactive customer energy information "kiosk": Atrium

Other: Decision support for customers' demand side and power dispatch/purchasing, including building aggregation

Other: Alarm management when set-point thresholds exceeded; also involves decision support

System architecture type

Internet-enabled: Ethernet gateway to building network, supporting standard protocols, i.e., LONWORKS, MODBUS, etc.

Other: Client-server based architecture

System components offered by vendor

End to end solution(s)

End-use Equipment control devices

Software platform

Communication devices

Other: Open and integratable re: use of wide range of third party components

Communication technologies supported

RF: at device level

Cellular

Paging

Analog modem

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing: Atrium

Transfer simple pricing/near real-time: EBI

Transfer complex pricing: Atrium

Transfer complex pricing/near real-time: EBI

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Frequent/near real-time signaling: EBI platform includes forecasting module

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail

Other: Also enables notification by cellular and paging

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 1 min.)

Flexible interval settings/remotely reprogrammable

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability

Sub-minute reporting capability: near real-time

Years product has been in commercial service

More than 1, less than 5: for integration platform

Approximate no. of endpoints in North America (meter points)

More than 1,000, less than 10,000

Utilities with pilot or large-scale programs through which product has been sold

N/A

Customer installation sites

N/A

Comments

N/A

Vendor: Infotility

Solution Brand Name: InfoNow Platform

Description of how vendor's solution enables C&I connectivity applications

Infotility's software and services combine real-time streaming data with proprietary data analytics and business process tools to automate energy market opportunities such as load control, distributed generation, and economic demand response. Through its aggregation services, Infotility helps businesses save money by avoiding costs, leveraging market opportunities and optimizing energy asset utilization. Infotility's software products enable energy services aggregation, provide an integration and connection layer between end-users, energy suppliers, and service companies; provide business process and services management, all while leveraging XML messaging, processing, and standards creation.

Major applications enabled

Critical peak pricing/real-time pricing

Utility direct load control: In partnership with Cannon, other partners

Customer demand response/automated bldg control: Not involved in building control directly; only passes signal to building control system

Demand side bidding

Interactive customer energy information "kiosk"

Other: Enable business process management modification of business rules

Other: Real-time data streaming – meter or pricing detail - and publication; analytical SW applications for data transformation

System architecture type

Internet-enabled

System components offered by vendor

Software platform: Platform encompasses hosted services, Windows clients, Internet portal, web interface, Excel templates

Other: Hardware provided through gateway partners

Other: Middleware

Communication technologies supported

RF

PLC

Cellular

Paging

Analog modem

Point-to-point

Other: all of the above provided by third parties

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous: Asynchronous

Event-enabled signaling

On-site event-> inbound signal: Business rules sets process the information and redirect alerts, notifications, and messages to any point

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing

Transfer simple pricing/near real-time

Transfer complex pricing

Transfer complex pricing/near real-time: Typically 1 min.; however, most signaling does not require real-time; middleware capable of faster speeds

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Frequent/near real-time signaling

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail: Notification by pager, PDA, or E-mail

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 1 minutes.): Typical setting is 1 min.; no practical limit beyond network latency

Flexible interval settings/remotely reprogrammable

Monitors at sub-minute level

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability

Sub-minute reporting capability

Years product has been in commercial service

More than 1, less than 5

Approximate no. of endpoints in North America (meter points)

More than 100, less than 1,000

Utilities with pilot or large-scale programs through which product has been sold

Sempra Energy Services (retailer)

PG&E

First Energy

Customer installation sites

N/A

Comments

Infotility's software is architecturally well suited to integration.

Vendor: Invensys IMServ

Solution Brand Name: IMServ Meter Data Services

Description of how vendor's solution enables C&I connectivity applications

IMServ is a billing quality meter data service provider. The company provides no hardware. The energy service entity (typically a utility or energy retailer) engages IMServ to collect, validate, and edit (as needed) meter data, and provide it to authorized parties.

Major applications enabled

Critical peak pricing/real-time pricing: IMServ supports this application by collecting the data and ensuring accuracy essential for billing & settlement.

Customer demand response/automated bldg control: IMServ has no specific services for this application, but will provide the meter data needed to support the program.

Customer-owned generation dispatch & control: IMServ has no specific services for this application, but will provide the meter data needed to support the program.

Demand side bidding: IMServ has no specific services for this application, but will provide the meter data needed to support the program.

Outage detection with customer notification: If the meter supports this, IMServ will provide whatever notification is desired when the meter notifies IMServ.

Interactive customer energy information "kiosk": IMServ will post meter data to a secure Web site, private labeled for the utility or retailer, accessible to the customer.

System architecture type

Internet-enabled: IMServ typically provides the meter data to the data users (utility, ISO, customer, etc.) via the Internet.

System components offered by vendor

Other: Outsourced meter data services, supported by IMServ's proprietary software.

Communication technologies supported

Other: IMServ retrieves the meter data in whatever way the utility meter installation supports. Data distributed via the Internet. IMServ's service is independent of communication architecture. IMServ will use whatever communication technology the utility puts in place.

Communication paths supported

One-way/inbound to utility/ISO: Typically the utility will handle customer notification. IMServ gathers & processes the billing quality meter data and serves it via FTP site to the utility/ISO. IMServ does not deal directly with the end user customer.

Event-enabled signaling

None: IMServ will gather data whenever the users need or request it. No ability is provided to respond to event signals.

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

No transfer capability: IMServ does not signal prices. Its service is a collection service for billing quality meter data.

Control event start signal transfer

No signaling capability

Ability to verify start signal received at remote site

None

Ability to verify control activated at remote site

Ability to verify control activated/after event: IMServ will collect the meter data showing (or not) that control has occurred. But IMServ does not perform analysis that reaches this conclusion.

Ability to remotely control load/operate generation

Not supported

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings: IMServ will provide the data to the utility or ISO as needed, down to 1 minute interval or whatever is supported by the utility meter and comm. Typically this is done by posting the data to an FTP site on the Internet.

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability: Can tell the utility/ISO the customer profiles as often as the utility wants and telecomm supports. Transfers data to utility/ISO by posting it to a Web site or an FTP server for continuous update.

Years product has been in commercial service

More than 5: started in early 1998

Approximate no. of endpoints in North America (meter points)

More than 10,000

Utilities with pilot or large-scale programs through which product has been sold

N/A

Customer installation sites

N/A

Comments

IMServ also provides whatever rollups of the data are needed, such as for customer site aggregation or settlement.

Vendor: Itron, Inc.

Solution Brand Name: Distributed Energy Manager, Curtailment Manager, C&I AMR Network, others…

Description of how vendor's solution enables C&I connectivity applications

Itron Inc. is a major provider of utility solutions for acquiring and managing meter data, and for distribution design and management. Itron's original core business was meter reading for water, electric
and gas utilities. In the last few years Itron has acquired several companies that expand corporate capability in data handling and customer interaction. These companies include Silicon Energy, Utility Translation Systems Emobile Data, Linesoft and Regional Economic Research. Connectivity solutions relate to the products of Itron's original core business, UTS, Silicon Energy and RER. Also, Itron is the exclusive North American distributor of the SmartSynch polyphase meter communication solution. At the time of this data gathering, Itron has announced its acquisition of Schlumberger Metering, but the FTC has not yet approved the deal and it has not completed. Therefore the capabilities of Schlumberger Metering are not included in this tabulation.

Major applications enabled

Critical peak pricing/real-time pricing: Curtailment Manager monitors customer load and notifies customer & others of load, price and demand program compliance.

Utility direct load control: Silicon Energy more for small commercial & residential using the thermostat.

Customer demand response/automated bldg control: Curtailment Manager allows customers to participate via Web site: sign up, declare load shed, opt out, etc.

Customer-owned generation dispatch & control: Distributed Energy Manager manages and dispatches dozens to thousands of generation units up to 20 MW capacity.

Demand side bidding: Curtailment Manager

Outage detection with customer notification: MV-90 detects outage by receiving calls from meters, and it will notify customers by page, fax, email or automated voice phone.

Interactive customer energy information "kiosk": By Silicon Energy.

System architecture type

Fixed radio network: Itron's C&I network is a 2-way 1.4 GHz fixed radio network for C&I meter reading.

Mobile: Itron's most basic AMR uses one-way 900 MHz mobile for meter reading.

Internet-enabled: Demand Manager and Distributed Energy Manager, in their most capable configurations, communicate via Internet with IP-connected meters and customer-site load and generation control devices. MV-Web gives customers comprehensive Internet access to their meter data.

System components offered by vendor

End to end solution(s): Itron offers turnkey implementation of all the connectivity applications discussed here. To the extent that Itron does not provide any particular required item, Itron will procure it outside and integrate it.

Software platform: Silicon Energy provides software for utilities and large customers to manage numerous control, real-time pricing and demand management programs. These operate with Itron's C&I AMR network and SmartSynch C&I AMR, and also with many other communication methods.

Communication devices: Itron offers devices to record and communicate meter data for C&I meters as part of its C&I network.

Communication technologies supported

RF: Itron's C&I AMR network uses 1.4 GHz. Itron C&I connectivity products can use any of various frequencies.

Cellular: Used for C&I meter reading, and also for generation control and status monitoring.

Paging: 1-way & 2-way paging are used for C&I meter reading, generation and demand event dispatch.

Analog modem: MV-90 products receive meter data and outage notification via analog phone, among other methods.

Other: Distributed Energy Manager interfaces for generation control include ModBus and Capstone.

Communication paths supported

One-way/outbound from utility/ISO: Outbound paging is typical for distributed generation control and demand management event notification.

One-way/inbound to utility/ISO: The MV-90 product suite often uses inbound telephone from the meter to the utility.

Two-way/bi-directional: MV-90 also is fully IP enabled for full 2-way communication with IP meters and other devices.

Two-way/simultaneous: The Silicon Energy products all operate on IP networks of any kind.

Event-enabled signaling

On-site event-> inbound signal: MV-90 and other Itron products can receive inbound event (e.g. outage) via telephone or Internet.

Utility/ISO event-> outbound signal: Outbound signals are sent via paging, Internet or other utility-specific radio or other communication.

Bi-directional signaling: Demand response software interacts with the customer bidirectionally via Internet, issuing and receiving notifications both ways.

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing: Demand Manager can handle a wide range of price structures from simple to complex.

Transfer simple pricing/near real-time

Transfer complex pricing

Transfer complex pricing/near real-time: Demand response software communicates with C&I customers via Internet and transfers price signals in near-real time.

Control event start signal transfer

Day-ahead signaling: Price signal can be sent days ahead, hours ahead or in near-real time, depending on utility program and tariff.

Hour-ahead signaling: Signals are sent by paging, email, automated phone notification, or direct IP communication with control device.

5 minutes ahead signaling: Also can communicate with building energy management systems, via phone or Internet.

Frequent/near real-time signaling: Demand response software communicates with C&I customers via Internet and transfers price signals in near-real time.

Ability to verify start signal received at remote site

Ability to verify start signal received/after event: Email and phone notifications produce confirmation of receipt. Meter data retrieved from all participating customers confirm control activation.

Ability to verify start signal received/near real-time: Customers confirm signal receipt by logging in to program Web site, or email is sent manually or automatically.

Ability to verify control activated at remote site

Ability to verify control activated/after event: Can read the meter in 15 minutes to verify control action taken.

Ability to verify control activated/near real-time: Can talk to the building energy management system, if there is one, to verify control action taken.

Ability to remotely control load/operate generation

Supported, no on-site automation: Demand and generation manager programs issue control commands to on-site automation provided by others.

Supported, with automatic switching when temperature, load or price reach threshold setting: Use regional weather data for temperature. Receive customer meter data online for load data.

Supported, with alarm notification via automatically generated e-mail: Email, paging and automated phone notifications are generated by Demand Manager and Distributed Energy Manager.

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Limited load interval settings: Itron retrieves load data from conventional polyphase meters by MV-90 products and Silicon Energy products.

Flexible interval load settings: The load data interval can be any value, depending on which Itron product is used.

Flexible interval settings/remotely reprogrammable: MV-90 load data is normally 15-minute, but is programmable.

Monitors at sub-minute level: Demand Manager & Distributed Energy Manger gather data from IP-connected meters at any desired interval.

Other: Demand Manager & Distributed Energy Manger also can operate in “day after” mode if IP-connection not available.

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability: Demand Manager & Distributed Energy Manger gather data in near-real time from IP-connected meters at any desired interval.

Years product has been in commercial service

More than 1 less than 5: Itron’s most prominent C&I “connectivity” product line is the Silicon Energy line, which has been in commercial use for 4 years. Itron has been a major supplier to the utility industry since the 1980s.

Approximate no. of endpoints in North America (meter points)

More than 10,000: Itron products serve millions of AMR points. Silicon Energy C&I connectivity products serve over 100,000 points in California alone.

Utilities with pilot or large-scale programs through which product has been sold

Demand Manager serves over 100,000 customers over 200 kW demand at PG&E and SCE.

Customer installation sites

A large proportion of North American utilities and many in other countries use Itron products for meter reading and other customer interaction.

Comments

Itron's C&I AMR network at 1.4 GHz uses an External Meter Modem as the radio network interface. The EMM accepts pulses from induction meters or reads meter data through the serial communication ports of electronic meters. Each EMM can manage up to 30 meters. Data can make up to 7 hops from EMM to EMM to the Hub where a phone line connects to the utility. EMMs work with most solid-state polyphase meters.

Vendor: Landis+Gyr

Solution Brand Name: Envoy/Advanced Data Infrastructure™ (ADI)

Description of how vendor's solution enables C&I connectivity applications

For the critical C&I customer segment, Landis+Gyr offers Envoy. A simplified user interface, technologically advanced meters and two-way wireless communication protocols are integrated to simplify network installation and improve communication performance. Landis+Gyr's S4 meter communication options include SkyTel pager, GSM/GPRS, CDMA/1XRTT and public digital packet radio protocols. Communication modules self-initialize to contact the Envoy system, making it easier to deploy field devices. The system's communication modules are also interchangeable in the meter and can be retrofit to previous generations of the S4 meter family. For the mass-market, Landis+Gyr also offers the Advanced Data Infrastructure (TM) (ADI). The integration of 900 MHz mesh technology with Landis+Gyr's FOCUS™ meter provides utilities a wireless end-to-end solution for the acquisition, transportation, management and delivery of meter data and other two-way information-centric applications, such as load control and management.

Major applications enabled

Critical peak pricing/real-time pricing: Envoy

Utility direct load control: Commercial S4 meter has contact relays/closures

Customer demand response/automated bldg control: Commercial S4 meter has contact relays/closures; ADI incorporates discrete device control

Customer-owned generation dispatch & control: Supported by high-end meters

Outage detection with customer notification

Interactive customer energy information “kiosk”

System architecture type

Other: Wireless public paging network; wireless mesh technology; cell phone protocols

System components offered by vendor

End to end solution(s): Advanced Data Infrastructure (ADI) – mass market

End-use Equipment control devices: Advanced Data Infrastructure (ADI) – mass market

Software platform

Communication devices

Other: Advanced metering

Other: Communication protocols

Communication technologies supported

RF: Including Mesh network technology

Cellular

Paging

Analog modem

Point-to-point

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Event-enabled signaling

On-site event-> inbound signal: outage notifications

Price transfer (during billing cycle) “Transfer”=update pricing for demand control or peak period pricing purposes

No transfer capability

Control event start signal transfer

No signaling capability: Meters can receive signals initiated by the utility or ISO

Ability to verify start signal received at remote site

Ability to verify start signal received/after event: technology in meter can read contact closures

Ability to verify start signal received/near real-time: technology in meter can read contact closures

Ability to verify control activated at remote site

Ability to verify control activated/after event: technology in meter can read contact closures

Ability to verify control activated/near real-time: technology in meter can read contact closures

Ability to remotely control load/operate generation

Supported, no on-site automation

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 5 minutes.): for data logging purposes

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability: frequency is command driven

Years product has been in commercial service

More than 1 less than 5: Paging communications; mesh technology and cell phone protocols

More than 5: Advanced commercial metering

Approximate no. of endpoints in North America (meter points)

More than 10,000: More than 1 million S4 meters installed in U.S.

Utilities with pilot or large-scale programs through which product has been sold

Involved in California statewide demand response program. Other utility information considered confidential by Landis+Gyr

Customer installation sites

Customer names considered confidential by Landis+Gyr

Comments

N/A

Vendor: MeterSmart

Solution Brand Name: PowerPrice™

Description of how vendor's solution enables C&I connectivity applications

MeterSmart provides a flexible and scalable line of utility meters, submeters and interval data recorders to meet today's need for advanced utility metering, data collection, and real-time energy information. Customers have the ability to meter anything from an individual lighting circuit to an entire building load without power interruption. Interfacing with various communication platforms makes the meters one of the most flexible solutions in the metering industry. Meters are fully certified and installed in over 250,000 locations throughout the world. MeterSmart connects its hardware solutions to the utility and its customers with an easy-to-use web front end that is as scalable as the hardware is flexible. MeterSmart offers numerous software service solutions including: interval data collection, web presentment, real-time pricing, complex C&I billing, alarming and notification, on-demand meter reads and summary reporting by email.

Major applications enabled

Critical peak pricing/real-time pricing

Customer demand response/automated bldg control: provides inputs to control devices

Customer-owned generation dispatch & control

Outage detection with customer notification

Interactive customer energy information "kiosk"

Other: Submetering (utility uses data and posts to web site)

System architecture type

Other: Multiple types, including Internet

System components offered by vendor

End to end solution(s)

Software platform

Communication devices

Other: Submetering devices use current sensors (only MV-90 compatible submetering devices)

Communication technologies supported

RF: 900 MHz two-way

Cellular

Analog modem

Other: CDMA

Other: Internet/Ethernet

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Event-enabled signaling

On-site event-> inbound signal: Via dry contact relay in meter; can initiate E-mail

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Other: Post hourly or 15 minute prices on web portal as frequently as necessary

Control event start signal transfer

No signaling capability

Ability to verify start signal received at remote site

None

Ability to verify control activated at remote site

None

Ability to remotely control load/operate generation

Not supported

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 1 min.): typically down to 5 minutes

Flexible interval settings/remotely reprogrammable: via own system and MV-90

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability: Via CE-MON; typical refresh is 15 minutes

Years product has been in commercial service

More than 5: Software platform; more than 20 for metering

Approximate no. of endpoints in North America (meter points)

More 1,000, less than 10,000: Remotely polling 9,000 meters daily or hourly

More than 10,000: more than 250,000 E-MON meters installed

Utilities with pilot or large-scale programs through which product has been sold

KCP&L

Lower Colorado River Authority

Customer installation sites

N/A

Comments

MeterSmart is a subsidiary of Hunt Power and affiliated with E-MON; profiling metering hardware installed without interrupting power; meters capable of measuring non-kWh attributes; primary communication channel is through utility; ability to do "run-time" (look at how long A/C ran during 15 minute interval or how long contact closure was open)

Vendor: Power Measurement

Solution Brand Name: Ion/Enterprise Energy Management

Description of how vendor's solution enables C&I connectivity applications

Power Measurement (PMI) is a leading provider of enterprise energy management systems for energy suppliers and consumers worldwide. The company's ION® web-ready software and intelligent metering and control devices comprise a real-time information and control network that supports billing for complex energy contracts, helps reduce energy costs, and improves power quality and reliability. PMI's metering products and software provide the advanced measurement, analysis, and logging features needed to support billing for customer contracts that might include not only complex rate structures but also even power quality guarantees. PMI meters are completely Internet-enabled, offering innovative MeterMail® email messaging and WebMeter® onboard web server access, as well as supporting multiple industry-standard protocols including DNP and Modbus. These extensive options provide the necessary real-time communications and information sharing for programs such as demand response, distributed generation control, and a variety of value added services to key utility customers.

Major applications enabled

Critical peak pricing/real-time pricing

Utility direct load control

Customer demand response/automated bldg control

Customer-owned generation dispatch & control

Outage detection with customer notification: Via power line carrier

Interactive customer energy information “kiosk”

Other: Power quality monitoring

Other: Submetering of commercial properties and aggregation (not currently involving utilities)

System architecture type

Fixed radio network

Internet-enabled

System components offered by vendor

Software platform

Other: integration services

Communication technologies supported

RF

Cellular: limited

Analog modem

Other: all forms of Internet connection

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional: polling approach

Event-enabled signaling

On-site event-> inbound signal: includes power quality events

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing

Transfer simple pricing/near real-time

Transfer complex pricing

Transfer complex pricing/near real-time

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Frequent/near real-time signaling: broadband IP

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time

Ability to remotely control load/operate generation

Supported, no on-site automation

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings

Monitors at sub-minute level: customer sets interval level

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability: 5-minute frequency accumulated

Years product has been in commercial service:

More than 5

Approximate no. of endpoints in North America (meter points)

More 1,000, less than 10,000

Utilities with pilot or large-scale programs through which product has been sold

Salt River Project (power quality)

ISO-NE (customer demand response)

Ontario Hydro

Hydro Quebec

American Electric Power

Customer installation sites

University of Chicago (submetering by floor and departments))

Weyerhaeuser (distributed generation)

Alcoa

Intel

All four major auto manufacturers (incl. Honda)

Energy-intensive process industrials (steel, paper, chemicals - power quality)

Comments

Direct customer sales exceed utility indirect sales; PMI makes high end revenue meters for PQ applications; strong reliance on web-enablement of data presentation (E-mail port and firewall always active) in demand response programs.

Vendor: RETX

Solution Brand Name: ePath Product Suite

Description of how vendor's solution enables C&I connectivity applications

RETX works throughout North America with electric utilities, load serving entities, system operators, retail energy service providers, and consumers to provide fully integrated, customized and secure Web-based services, including load management, customer enrollment, meter information management, retail settlements, assisting with audit capability, and more. RETX provides Internet-applications and services for energy management and demand response opportunities to manage wholesale megawatts to achieve savings, reliability, and conservation. The ePath platform is built on Microsoft's latest .NET Framework to provide easier connectivity with outside systems. RETX ePath product suite provides enhanced energy analysis tools, expanded notification features, improved reporting tools and ease of use. RETX ePath product suite consists of Notification Manager, Energy Usage and Analysis, Load Management Dispatcher, Regional Negawatt Hub and Professional Services.

Major applications enabled

Critical peak pricing/real-time pricing

Utility direct load control

Customer demand response/automated bldg control: role in automated building control is limited to providing signal inputs

Customer-owned generation dispatch & control

Interactive customer energy information "kiosk"

System architecture type

Internet-enabled: preferred

Other: Any system-type, depends on utility supplied infrastructure

System components offered by vendor

End to end solution(s)

Software platform

Other: Help desk/outsourcing/fully managed service

Communication technologies supported

RF

PLC

Cellular

Paging

Analog modem

Point-to point

Other: Any of the above; whatever technology infrastructure is supplied by the utility

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous

Event-enabled signaling

On-site event-> inbound signal: Typically demand-based notification; also price threshold

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer simple pricing

Transfer simple pricing/near real-time

Transfer complex pricing

Transfer complex pricing/near real-time

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Ability to verify start signal received at remote site

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

None

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 1 min.)

Flexible interval settings/remotely reprogrammable

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability

Years product has been in commercial service

More than 1, less than 5

Approximate no. of endpoints in North America (meter points)

More 100, less than 1,000

Utilities with pilot or large-scale programs through which product has been sold

NY-ISO ~1,000

NE-ISO ~200-300

Allegheny Power (distribution system application)

Ontario utility - distributed generation control

Customer installation sites

N/A

Comments

RETX has assumed a leadership position in the development of an international demand response effort through the PLMA; ePath product suite includes the following discrete components: Notification Manager, Energy Usage and Analysis, Load Management Dispatcher, Regional Negawatt Hub and Professional Services.

Vendor: SmartSynch

Solution Brand Name: SmartMeter System(SM) (Licensed to Itron)

Description of how vendor's solution enables C&I connectivity applications

SmartSynch is a leading provider of smart metering solutions to the energy and utility industry. Its core product, the SmartMeter System(SM), enables energy and utility companies to communicate two-way with commercial and industrial electricity meters using public wireless networks and the Internet. The SmartMeter System manages the delivery of critical information to any application system, workstation, computer, or browser enabled personal communications device. The SmartMeter System is a power management tool that delivers real-time information and provides an immediate link to the utility customer. The end-to-end solution utilizes its robust software architecture and advanced communication networks to supply two-way communication, enabling outage identification and response, automation of billing, and real-time energy solutions. The SmartMeter System automatically exports data to MV-90, Outage Management System, Load Curtailment, web presentment (i.e. MV-Web, Silicon Energy, ABB EPO, etc.), and other utility IT applications, as events occur and as load data are generated at the customer site.

Major applications enabled

Critical peak pricing/real-time pricing

Customer demand response/automated bldg control

Outage detection with customer notification

System architecture type

Fixed radio network

Other: Public wireless network

System components offered by vendor

Communication devices: Modules, firmware under the meter glass

Other: Smart meters and head-end software

Communication technologies supported

Cellular

Paging

Analog modem: Wherever public wireless network coverage does not extend

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional: Packet switching data; non-simultaneous

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

Transfer complex pricing: Timing subject to packet switching limitations

Control event start signal transfer

5 minutes ahead signaling

Other: Not directly applicable since SmartSynch is the communications "pipe"

Ability to verify start signal received at remote site

Ability to verify start signal received/after event: As stored in meter register only

Ability to verify control activated at remote site

Other: SmartMeter contains relays and registers but the advanced application itself is outside the product suite offered

Ability to remotely control load/operate generation

Not supported: handled by other vendors in the end-to-end solution

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 5 minutes.)

Flexible interval settings/remotely reprogrammable

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Other: Flexible on-command retrieval schedule tailored to mature of control/pricing structure

Years product has been in commercial service

More than 1, less than 5

Approximate no. of endpoints in North America (meter points)

More than 10,000: 35,000 total customers

Utilities with pilot or large-scale programs through which product has been sold

NStar (load research/power billing)

Florida Power & Light (customer service/marketing/event notification)

Southern California Edison (real-time energy metering/critical peak pricing - 10,000+ customers)

Pacific Gas & Electric (real-time energy metering/critical peak pricing - 10,000+ customers)

Customer installation sites

N/A

Comments

SmartSynch is an infrastructure/gateway provider.

Vendor: Square D

Solution Brand Name: Square D/PowerLogic™

Description of how vendor's solution enables C&I connectivity applications

Square D's PowerLogic® power management system enables intelligent analysis of power data and utility energy data to save money, providing graphic interface status of the entire electrical

system, reducing utility bills by avoiding peaks, providing early detection of power quality problems, tracking and allocating energy usage, enabling facility capacity planning and maintenance, and logging, trending, and recording events for quick troubleshooting. Power monitoring devices are installed on key circuits and networked with web-enabled Ethernet gateways and software. Using a standard web-browser, users view real time information and reports to enable savings.

Major applications enabled

Critical peak pricing/real-time pricing

Utility direct load control

Customer demand response/automated bldg control

Customer-owned generation dispatch & control

Outage detection with customer notification

Interactive customer energy information “kiosk”

Other: Managing facilities around power quality issues; hierarchical design enables drill-down from facility to meter level when alarms initiated

Other: Submetering with PowerShare™ billing and cost allocation software

System architecture type

Internet-enabled: Internet used for information key in

Other: Multiple communication architectures used for reporting–cellular, paging, etc.

System components offered by vendor

End to end solution(s)

End-use Equipment control devices

Software platform

Communication devices

Other: Meters

Other: Engineering services for system configuration and data diagnosis

Communication technologies supported

Other: Inbound = Internet

Other: Outbound = FTP, paging, cellular, web, E-mail

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Event-enabled signaling

On-site event-> inbound signal

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

No transfer capability: planned in future versions

Control event start signal transfer

No signaling capability: planned in future versions

Ability to verify start signal received at remote site

None

Ability to verify control activated at remote site

None

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 1 min.): for data logging

Flexible interval settings/remotely reprogrammable

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Sub-minute reporting capability: for data streaming

Years product has been in commercial service

More than 1, less than 5: 1989

Approximate no. of endpoints in North America (meter points)

More than 10,000: approximately 40,000 points

Utilities with pilot or large-scale programs through which product has been sold

Information considered confidential

Customer installation sites

Fortune 500 companies-- approximately 90% use Square D meters

Comments

Industry strengths in pharmaceuticals, microelectronics, petrochemicals, hospitals, universities, and government installations. Square D has recently begun addressing utility program needs.

Vendor: Stonewater Controls

Solution Brand Name: Energy 1st

Description of how vendor's solution enables C&I connectivity applications

Stonewater Control Systems develops and hosts Internet-based remote communication systems to manage energy and control devices. Stonewater saves energy consumers money by providing a low-cost, turnkey energy management solution. Stonewater offers utilities a turnkey demand-side management solution for voluntary, mandatory or price-based programs. Stonewater enables customers to view any number of sites at any location worldwide in real time. Stonewater will manage data from a variety of manufacturers and equipment types, enabling quick and efficient implementation. In addition to electricity, Stonewater monitors critical systems, water, gas and environmental variables.

Major applications enabled

Critical peak pricing/real-time pricing

Utility direct load control

Customer demand response/automated bldg control

Customer-owned generation dispatch & control

Demand side bidding

Outage detection with customer notification

Interactive customer energy information “kiosk”

Other: Remotely control building ventilation for indoor air quality compliance

Other: “Embedded control technology” – provide overall views of what lighting is on, etc. for security purposes

System architecture type

Fixed radio network

Mobile

Power line

Internet-enabled

Other: Any medium can be used to access the Internet

System components offered by vendor

End to end solution(s)

Other: network operations center

Communication technologies supported

Cellular: CMDA

Other: Internet and CMDA access

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous

Other: Control/monitoring device at customer site is strictly one-way/inbound to utility

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) “Transfer”=update pricing for demand control or peak period pricing purposes

Transfer complex pricing/near real-time: hourly or more frequently

Control event start signal transfer

5 minutes ahead signaling

Frequent/near real-time signaling

Ability to verify start signal received at remote site

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

Ability to verify control activated/near real-time

Other: Can also verify receipt by utility of inbound notifications

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail: Also supports phone call, fax, and pager message.

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 1 min.)

Flexible interval settings/remotely reprogrammable

Monitors at sub-minute level: down to seconds

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability

Sub-minute reporting capability

Years product has been in commercial service

More than 1, less than 5: since 2000

Approximate no. of endpoints in North America (meter points)

More 100, less than 1,000: 1,000-2,000 end use monitoring points, i.e., temperature, air quality, controls, etc.

Utilities with pilot or large-scale programs through which product has been sold

Georgia Power

Sacramento Municipal Utility District

Commonwealth Edison

NYPA

Keyspan (gas) - does electric monitoring for LIPA

Customer installation sites

Toyota (Contract is with Jorgenson)

Comments

"A myriad of applications that haven't been discovered yet can be enabled by these technologies"

Kim Weaver, VP, Marketing

Vendor: Trane

Solution Brand Name: Tracer™ Summit

Description of how vendor's solution enables C&I connectivity applications

Tracer Summit controls a building's climate, lighting and other controllable devices, creating an Integrated Comfort™ system. The PC Workstation is the primary operator interface for the Tracer Summit system. Graphics show building status at a glance and allow the operator to move through the system just like walking through the building. The system can be used to change set points and override equipment operation. The Tracer Summit building control unit is an intelligent field panel that communicates with Trane factory mounted unit controllers, general application controllers, and application specific unit controllers. The Tracer Summit PC Workstation software communicates with the building control unit using the ASHRAE®/ANSI BACnet™ protocol over a high-speed network such as ARCNET® or Ethernet or over phone lines. Using the BACnet communications protocol allows the Tracer Summit workstation to read and write data from other suppliers' BACnet compatible devices, providing system interoperability.

Major applications enabled

Critical peak pricing/real-time pricing: Tracer Summit Energy Service

Utility direct load control

Customer demand response/automated bldg control

Customer-owned generation dispatch & control

Outage detection with customer notification

Interactive customer energy information “kiosk”: Tracer Summit energy service

Other: Remote tenant services-remote scheduling of after-hours building occupancy and reprogramming of HVAC systems

System architecture type

Internet-enabled

Other: Hard-wired, telephone

System components offered by vendor

End to end solution(s)

End-use Equipment control devices

Software platform

Communication devices

Other: Entire range of products from HVAC/lighting sensors to building management boxes

Communication technologies supported

Paging

Analog modem

Point-to-point

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal

Bi-directional signaling

Price transfer (during billing cycle) “Transfer”=update pricing for demand control or peak period pricing purposes

Transfer simple pricing

Transfer complex pricing

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Frequent/near real-time signaling

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Limited load interval settings: Set up by "special request" - requires custom programming

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Infrequent retrieval capability: requires permission of facility owner

Years product has been in commercial service

More than 5

Approximate no. of endpoints in North America (meter points)

More than 10,000: 30,000+ building management systems

Utilities with pilot or large-scale programs through which product has been sold

Information not readily available within Trane

Customer installation sites

New Mexico State office buildings

Graco

Sunset Station Hotel & Casino

Eddie Bauer Corporate Center

Comments

N/A

Vendor: Tridium

Solution Brand Name: Niagara Framework™/Vykon™ Applications Suite

Description of how vendor's solution enables C&I connectivity applications

Tridium Inc. develops and markets a universal software platform - known as the Niagara Framework - that allows companies to build software applications for accessing, automating and controlling smart devices over the Internet or intranets. This open, Java-based framework integrates diverse systems, devices and communications standards into an interoperable, Web-enabled application environment. In addition, Tridium offers Vykon, a software suite that is powered by the Niagara Framework and specifically designed for building automation and energy services applications.

Major applications enabled

Critical peak pricing/real-time pricing

Utility direct load control

Customer demand response/automated bldg control

Customer-owned generation dispatch & control

Outage detection with customer notification: enabled by alarming capabilities and software platform

Interactive customer energy information "kiosk": specifically, by Tridium's Vykon E2 Profiler™

Other: Measurement and verification of load shedding

System architecture type

Internet-enabled

Other: Multiple architectures including satellite and phone

System components offered by vendor

Software platform

Communication devices: JACE (Java Application Control Engine) enables reusability of program modules

Communication technologies supported

RF

PLC

Cellular

Paging

Analog modem

Point-to-point

Communication paths supported

One-way/outbound from utility/ISO

One-way/inbound to utility/ISO

Two-way/bi-directional

Two-way/simultaneous: real-time

Event-enabled signaling

On-site event-> inbound signal

Utility/ISO event-> outbound signal: Will initiate signals for commercial customer programs

Bi-directional signaling

Price transfer (during billing cycle) "Transfer"=update pricing for demand control or peak period pricing purposes

No transfer capability

Control event start signal transfer

Day-ahead signaling

Hour-ahead signaling

5 minutes ahead signaling

Frequent/near real-time signaling: Depends on Internet latency (generally measured in seconds)

Ability to verify start signal received at remote site

Ability to verify start signal received/after event

Ability to verify start signal received/near real-time

Ability to verify control activated at remote site

Ability to verify control activated/after event

Ability to verify control activated/near real-time

Ability to remotely control load/operate generation

Supported, no on-site automation

Supported, with automatic switching when temperature, load or price reach threshold setting

Supported, with alarm notification via automatically generated e-mail

Other: Can initiate fax, pager and other notifications to any IP address or telephone number

Utility/ISO capability to remotely monitor load during control or peak period event (interval setting)

Flexible interval load settings (down to 1 min.): logged and retained

Flexible interval settings/remotely reprogrammable

Monitors at sub-minute level: real-time for demand limiting and demand response programs but not logged

Utility/ISO capability to remotely monitor load during control event (reporting frequency)

Minute-by-minute retrieval capability

Sub-minute reporting capability: Can view live data streams (not saved as logged data in less than 1 min. cuts)

Years product has been in commercial service

More than 1, less than 5: 1999-Niagara Framework; 2002-Vykon Energy

Approximate no. of endpoints in North America (meter points)

More than 10,000: 14,000 JACE boxes sold worldwide; mostly in U.S.

Utilities with pilot or large-scale programs through which product has been sold

Duke Energy (numbering in "dozens")

Progress Energy

Customer installation sites

Customer: Roche Bioscience (1.5 MW load shed)

Customer: Boeing

Customer: Montana State University

Customer: Callaway Gardens

Customer: Broadwing Telecommunications

Comments

Tridium sells to energy service companies and system integrators, who apply the products at customer sites; Tridium creates reusable common object modules for new connectivity applications (minimizes customized software development); company indicates it has the most sophisticated and comprehensive connectivity to energy-consuming equipment and a real-time control engine.

A
VENDOR INTERVIEW SCRIPT

Vendor Script

Gather as much of the information using the vendor's website in advance as possible to target the right group within large organizations and identify solutions that appear to fit with the survey intent.

Introduce yourself and Plexus.

Ask to speak to the person in Sales or Marketing who is familiar with the entire range of the company's products for the electric utility market.

When that person comes on the line, confirm familiarity with product line and capture name, title, e-mail and telephone number in Contacts spreadsheet. Alert the contact that the entire interview may take as long as 45 minutes and ask whether this is a convenient time to conduct the interview. If not, schedule a call back.

Briefly explain who Plexus is, that we have been retained by Primen (mention Primen's affiliation with EPRI) to develop a database of major vendors of connectivity solutions to electric utilities, specifically in the commercial and industrial customer space. Emphasize that residential connectivity applications are out of scope. Note that the database will ***not*** include applications such as automated meter reading where the system's sole function is to retrieve meter readings remotely.

Ask the contact to list the major connectivity applications supported by his/her company's products. Prompt as necessary with our Applications list:

- Load control
- Innovative rate forms such as TOU/RTP
- Distributed generation dispatch and management
- Customer equipment monitoring and control
- Customer demand response (other than TOU rates)
- Outage detection/notification
- Customer energy information web portal
- Open-ender: Are there other applications we should be asking about, that your solution enables?

At this point, determine whether there is sufficient application coverage to warrant including the company in the database.

If the answer is “no,” gently terminate the interview and ask whether I can call the contact back at a later date for further information. Document the reason for excluding the company

If there is sufficient coverage, proceed with the detailed interview.

Using the appropriate Data Capture Form, capture the relevant features and capabilities information for the vendor’s solution set and individual products that enable specific connectivity applications.

After completing all applicable products, thank the contact and make sure we can call back if we need any clarifications. Send a follow-up E-mail thanking the contact for his/her participation and requesting a short quote that encapsulates and differentiates the product line.

Program:
Market-Driven Demand Response

About EPRI

EPRI creates science and technology solutions for the global energy and energy services industry. U.S. electric utilities established the Electric Power Research Institute in 1973 as a nonprofit research consortium for the benefit of utility members, their customers, and society. Now known simply as EPRI, the company provides a wide range of innovative products and services to more than 1000 energy-related organizations in 40 countries. EPRI's multidisciplinary team of scientists and engineers draws on a worldwide network of technical and business expertise to help solve today's toughest energy and environmental problems.

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