White Paper

Advanced Load Management:
Challenges and Solutions

manage energy better

How does a multi-purpose network compare to load management alternatives?

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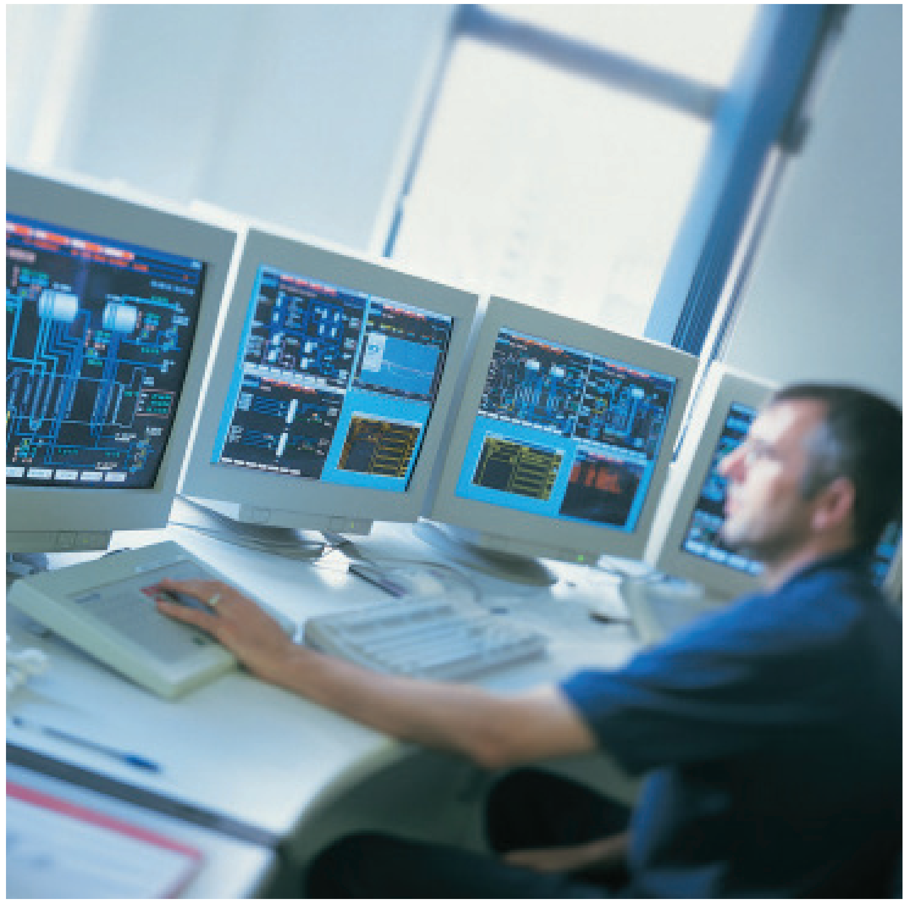
Advanced Load Management: How does a multi-purpose network compare?

U.S. utilities have made significant investments in demand response benefits programs and continue to value demand response



Demand response has been an energy-saving strategy used by utilities for decades. U.S. utilities have made significant investments in demand response programs and continue to value demand response both for monetary savings and energy conservation, as well as managing and balancing system loads. What's more, according to an Energy Research Council survey of middle-market companies, two thirds (66%) of survey respondents said they were extremely or very interested in services that reduce energy consumption and costs.[1]

First generation load management technology uses paging networks or powerline communications for direct load control of air conditioners and other high-energy appliances during peak conditions. While these technologies provide a means to reduce energy consumption, the limitations have always been evident. Because they are primarily one-way systems, there is no confirmation that the load control device received the signal and operated successfully. In this scenario, the utility must often analyze peak power demand changes by substation to confirm if load reduction targets are being met.

Many direct load control (DLC) systems put in place in the late 1970s remain in use. In fact, according to recent data from the Federal Energy Regulatory Commission (FERC), nearly all DLC programs in the U.S. providing more than 8 GW of peak capacity continue to run on one-way paging networks.[2]

New Requirements for Advanced Load Management

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While basic load management programs are designed to reduce peak power costs, maintain system reliability and prevent outages, recent advanced load management initiatives have evolved into strategic, real-time operational resources for a wide range of new commercial applications, circuit-level management and other advanced grid management functions requiring greater levels of data and feedback.

As a result, any enabling technology applied to effective load management programs must meet specific requirements:

- **Two-way communication.** Utilities need a robust two-way near-real-time communication with DLC devices to ensure program effectiveness.
- **Near-real-time visibility of available load.** Operators need near-real-time load information to verify how much load can be shed at any time. With some applications, such as virtual peaking and circuit-level load control, operators need earlier insight into whether or not the load shed event actually occurred.
- **Ability to communicate with multiple devices.** Beyond residential load switches, there is a need to communicate with a wide variety of devices on the network—including programmable thermostats and commercial switches.
- **Head-end integration with utility systems.** A future-ready load management platform must seamlessly integrate and share data with other enterprise applications and work with multiple technologies.
- **System availability.** An effective load management system must execute commands and receive confirmations quickly and reliably.
- **Reliability.** A demand response system must have the bandwidth capabilities needed to carry more information to more devices, and execute complex schedules in short time periods.
- **Use cases.** Any technology chosen for a load management system should be proven for a variety of use cases.

Advanced Load Management: How does a multi-purpose network compare?

Advanced Load Management Communication Options

A utility seeking to transition from a one-way load management system to two-way communications has a number of options:

- **Advanced metering infrastructure (AMI) —** architecture for automated, two-way RF communication between a smart meter with an IP address and the utility
- **Cellular —** networks designed for mobile data communications are adapted for load management
- **Broadband —** accessing an Internet connection at the premise for load management communications

As a solution to meet a utility's demand response needs, each technology has strengths and weaknesses. This table compares performance of each solution for the major functionalities required for a demand response system.

FUNCTION	AMI	PAGING	CELLULAR	Wi-Fi
Communication	2-way	1-way	2-way	2-way
Utility-owned communication network	YES	YES	NO	NO
Device price	$$	$	$$	$$
Operational costs	NONE	NONE	Cellular subscription	NONE
Network availability	Always on	Always on	Always on	Depends on customer
Near real-time view to available power	YES	NO	YES	YES
Reliability	Load control messages have predefined higher priority	No feedback loop (impossible to determine whether devices received message)	Data traffic always lower priority	No control over data packet priority (data traffic managed by ISP)
Bandwidth	Max 115 kb/s	Only couple kb/s	Depends on network (2G <50kb/s; 3G <1Mb/s)	Depends on customer subscription, typically several Mb/s
Typical command travel time	5-25 seconds	Up to 30 seconds	Depends on network (2G/3G/4G typically 5-20 seconds)	5-20 seconds
Data security/privacy	YES, end to end	NO	YES, cellular data is encrypted	YES, if turned on by customer
Message broadcast	YES	YES	NO	NO
Message prioritization for load management	YES	NO	NO	NO

Effectiveness of a Multi-purpose AMI Network

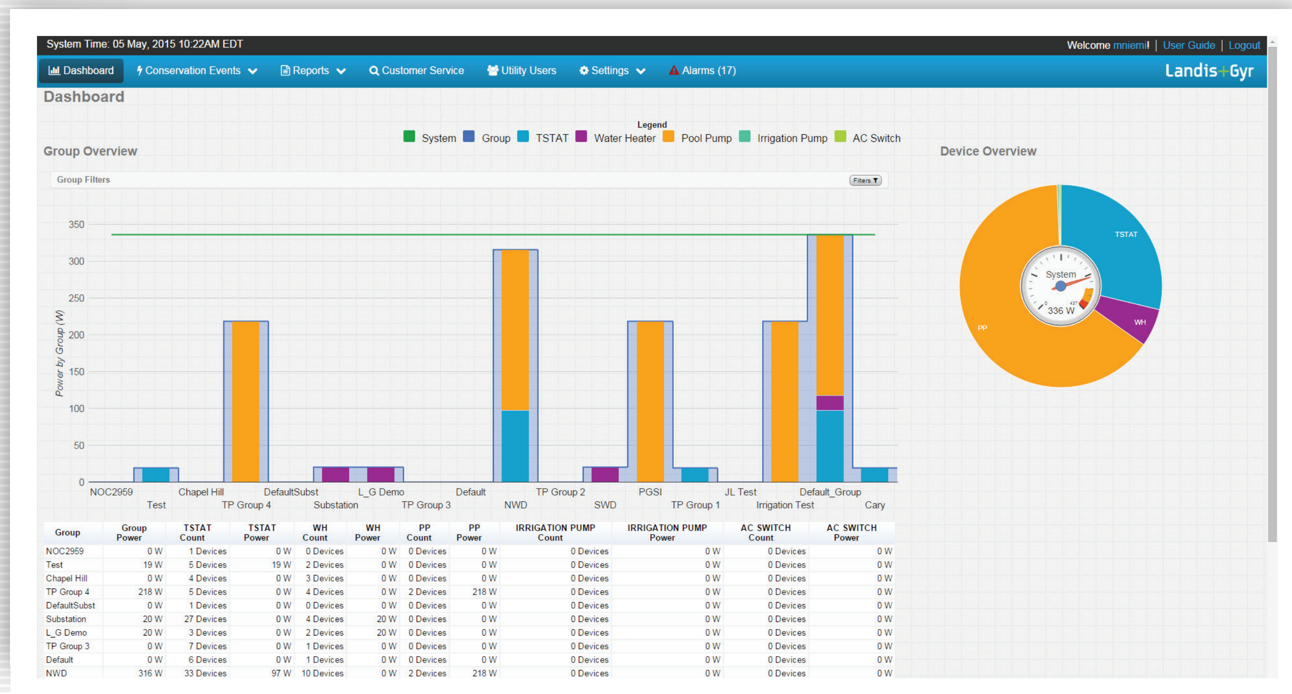
Since its introduction, AMI technology has offered two-way functionality for reading metering data, performing service connects and disconnects, and assisting with outage management—delivering significant operations savings for utilities. Today, utilities are leveraging AMI networks for an even wider range of uses, including distribution automation, voltage management and direct load control.

The two hurdles any load management technology must overcome to be viable are latency and bandwidth. It must communicate reliably and effectively in short time windows and transmit and receive data from a large-scale system while still performing other tasks. While some industry experts contend that an effective load management program demands a dedicated network, multi-purpose AMI networks meet and exceed the requirements for future-ready load management programs.

AMI networks provide the ability to prioritize load management messages over other traffic, which is not possible with cellular or broadband Internet.

In fact, as enabling technologies for demand response programs, next-generation multipurpose AMI networks offer more advantages than other load control technologies. For example, the ability to broadcast load control commands greatly reduces latency and differentiates an AMI network from cellular and broadband technologies. AMI networks provide the ability to prioritize load management messages over other traffic, which is not possible with cellular or broadband Internet. In fact, data traffic on cellular networks has the lowest priority. With broadband Internet, utility traffic is treated like any other packets in the network.

Modern AMI networks are used for many applications beyond load management, making them more cost-effective than the piecemeal communications approaches of the past. AMI networks communicate through a self-healing mesh architecture for built-in reliability. Additionally, the network can be enabled for advanced end-to-end security, meeting and exceeding even the strictest data privacy requirements. And unlike cellular, additional devices can be added without incurring new monthly data fees. Finally, utility staff are not faced with troubleshooting outside networks, as with consumer Wi-Fi connections.



Group	Group Power	TSTAT Count	TSTAT Power	WH Count	WH Power	PP Count	PP Power	IRRIGATION PUMP Count	IRRIGATION PUMP Power	AC SWITCH Count	AC SWITCH Power
NOC2959	0 W	1 Devices	0 W	0 Devices	0 W	0 Devices	0 W	0 Devices	0 W	0 Devices	0 W
Test	19 W	5 Devices	19 W	2 Devices	0 W	0 Devices	0 W	0 Devices	0 W	0 Devices	0 W
Chapel Hill	0 W	4 Devices	0 W	3 Devices	0 W	0 Devices	0 W	0 Devices	0 W	0 Devices	0 W
TP Group 4	218 W	5 Devices	0 W	4 Devices	0 W	2 Devices	218 W	0 Devices	0 W	0 Devices	0 W
DefaultSubst	0 W	1 Devices	0 W	0 Devices	0 W	0 Devices	0 W	0 Devices	0 W	0 Devices	0 W
Substation	20 W	27 Devices	0 W	4 Devices	20 W	0 Devices	0 W	0 Devices	0 W	0 Devices	0 W
L_G Demo	20 W	3 Devices	0 W	2 Devices	20 W	0 Devices	0 W	0 Devices	0 W	0 Devices	0 W
TP Group 3	0 W	7 Devices	0 W	1 Devices	0 W	0 Devices	0 W	0 Devices	0 W	0 Devices	0 W
Default	0 W	6 Devices	0 W	1 Devices	0 W	0 Devices	0 W	0 Devices	0 W	0 Devices	0 W
NWD	316 W	33 Devices	97 W	10 Devices	0 W	2 Devices	218 W	0 Devices	0 W	0 Devices	0 W

Load management dashboard provides continuously updated information on system performance.

AMI Use Cases

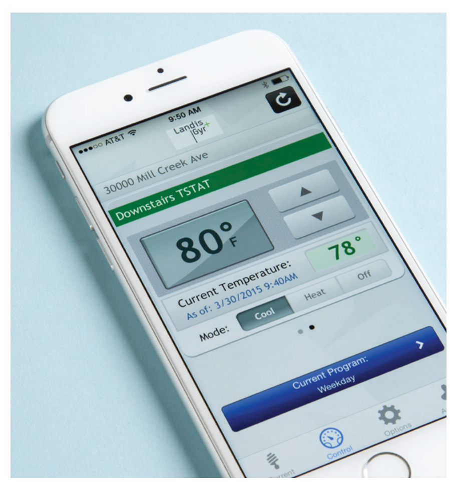
The Gridstream® network from Landis+Gyr is currently the primary communication method in a variety of load management scenarios. Following are a few examples of Gridstream network performance in a variety of applications.

1 USE CASE APPLICATION: CIRCUIT-LEVEL DEMAND RESPONSE

DEMAND RESPONSE REQUIREMENT: COMMUNICATE WITH MULTIPLE DEVICES

Every year, Colorado Springs Utilities, a community-owned utility in the Pikes Peak region of Colorado, identifies substations or circuits that are nearing or exceeding the design guide capacity of the utility's distribution system. In early 2014, the utility deployed 500 smart thermostats behind a substation with a history of overloading at peak times. These devices communicate via push methodology over the Gridstream RF AMI network, each one sending a read back to the system every five minutes, with a total of 228 reads per day. The system is designed so that each device is assigned a time slot for its message, with the entire device population randomized over a five-minute time window. This ensures messages are not all sent at the same time and the network is not flooded. In addition, the five-minute read and command from system to device fits into a single AMI network packet size so that the network can continue to process load management and other message transmission.

In the summer of 2014, Colorado Springs ran 14 conservation events, most of which used point-to-point messaging from the system to the thermostats. At the beginning of each event, a start command was sent to each participating device, ranging from a total of 150 to 520 devices spread over a specific geographic area. Broadcasting methodology used by the RF AMI network enables the utility to reduce command send time and ensure a high success rate. Throughout the test, there was no disruption to the performance of meters using the same network.



Mobile applications engage consumers in program.

2 USE CASE APPLICATION: MANAGING COMMERCIAL LOADS

DEMAND RESPONSE REQUIREMENT: IRRIGATION PUMP EFFICIENCY PROGRAM

Cornhusker PPD is a not-for profit electric distribution system serving rural areas in Nebraska. In these areas, irrigation pumps are the major contributors to system peaks. To ensure low-cost energy for customers and to avoid system peaks, the utility creates conservation events for irrigation pumps scheduled in groups each day; significant penalties are imposed on pumps that fail to keep their system load under an assigned threshold.

Because each irrigation pump is equal to as many as 40 residential homes, it is critical that the start command for each conservation event reach the device on a timely basis and the utility knows whether any controllers are nonresponsive. The two-way nature of the Gridstream AMI network makes these communications possible.

3 USE CASE APPLICATION: LATENCY TEST

DEMAND RESPONSE REQUIREMENT: SPEED/LATENCY

Baldwin EMC, a member-owned cooperative supplying electricity to more than 80,000 members in southwestern Alabama, recently conducted a test of its message success rate and latency as part of their advanced load management system assessment. The tests, which included more than 9,000 messages to 150 thermostats and load control switches operating over the Gridstream RF network resulted in a 99.85% command success rate. There were no RF interference-related or latency issues and messages were propagated to devices in 5 to 25 seconds.

When designed with utility requirements in mind, the RF AMI mesh network can see improved performance from the additional load management devices sharing the network. In areas with only a few endpoints, the additional radios can provide new paths for messages, thus strengthening the network. If an area becomes overly populated by load management devices, new network infrastructure can easily be added to increase the throughput.

Conclusion

Managing peak energy consumption has never been more critical. As consumption continues to outpace new generation resources, and new loads such as electric vehicles are introduced, load management has become an effective way to balance the needs of consumers and the costs associated with new generation. Furthermore, even generation-rich utilities can defer infrastructure resource investments by using load management to protect peaking assets.

To realize the full potential of two-way communications for their load management programs, it is important for utilities to work with experts who can implement a solution that meets specific objectives and solves issues related to territory, coverages and demographics.

Landis+Gyr's Gridstream RF self-healing mesh network technology delivers the interoperability and cross-functional capabilities necessary for today's smart grid networks. Gridstream enables demand response by delivering the information and automation necessary for cost-effective and reliable peak power adjustments and overall load management. With Gridstream, utilities are able to monitor and adjust system load from the substation to the consumer, and receive near real-time confirmation that adjustments have been made, ensuring energy savings and protecting power quality.

[1] "Best practices: demand response." *Energy Research Council*, April 2013. http://energyresearchcouncil.com/best-practices-demand-response.html

[2] "Not your grandfather's load control: helping utilities maximize demand response." *Electric Light and Power*, July 3, 2014. http://www.elp.com/articles/electric-light-and-power-newsletter/articles/2014/july/not-your-grandfather-s-load-control-helping-utilities-maximize-demand-response.html