ECHELON

NES LOAD PROFILE PERFORMANCE TEST IN KAISERSLAUTERN, GERMANY

The smart grid is the future of energy distribution — we all agree about that. But the devil is in the details: Which standards should be used? Which technology is best?

These questions leave many utilities uncertain and, therefore, reluctant to make a decision. The battle of standards and technologies also leads to many rumors, as well as false claims about technologies and their capabilities. One of these claims is that narrow-band power line systems don't have the necessary bandwidth to let utilities take advantage of the smart grid's features. Some are especially concerned that downloading load profile data from each end customer — to gather detailed information about energy use and maybe generation — can create bottlenecks in the narrow-band PLC systems, since this data must be transferred from the meter to the head-end enterprise system. To address these concerns, Echelon and its VAR partner EVB Energy Solutions conducted a performance test with the municipality of the southwest German city Kaiserslautern (TWK). During the study, Echelon's NES System demonstrated very high reliability and fast performance over a challenging set of field environments.

PURPOSE

The goal of the study was to test the reliability and speed of the NES System's load profile collection mechanism in a real-world installation under challenging conditions. While the number of meters per transformer varies from location (from less than 10 to several hundred), for the purpose of this study, three low-voltage grid sections were used. Each had a large number of meters per transformer and each had repeating in use, in order to put maximum load onto the network and provide the most difficult test possible. In order to put maximum load on the network and provide the most difficult test possible, each scenario used high numbers of meters per transformer, repeating was in use, and load profile information was collected all at once each day.

Scenario 1. High density - 188 meters under one transformer.
Scenario 2. Very high density - 303 meters under one transformer.
Scenario 3. Extreme density - 939 meters under one transformer.

In each scenario, the following case was tested:

Case A. Each meter was configured to deliver a daily load profile of two channels (forward active energy and reverse active energy) based on 15-minute intervals (192 values per meter each day). The test was performed for two consecutive weeks (May 14-27, 2010).

Case B. As a second step, the load profile channels in scenarios 1 and 2 were increased to four (forward active energy, reverse active energy, import reactive energy, and export reactive energy) and tested for three consecutive weeks (May 29-June 19, 2010). Again, this was based on 15-minute intervals, corresponding to 384 values per meter each day. Scenario 3 was left unchanged for this test period in order to eliminate any possible impact on the ongoing Intelliekon project (www.intelliekon.de/).

The values selected for the load profile were chosen because, based on feedback from many utilities, these channels are those that utilities will want to track in their load profiles in the future.

KEY FINDINGS

The NES System was proven to offer very high reliability and fast delivery of the load profile values to the data concentrator, as well as to the head-end enterprise system. In addition, no significant performance loss was observed when the number of channels was doubled.

Out of the 1,430 meters in the test, about 1,418 delivered successfully on a daily basis — a success rate of 99.16%. Looking at the distribution of signal margins, this is a very good result considering how many meters worked on a weak signal.

The non-delivering meters differed throughout the test period, so no data was lost, as these meters were able to be reached on some days.

BACKGROUND

Load profiles are a feature of NES smart meters that track customers' energy use in more detail than currently provided. The data can benefit end customers, as well as the power distribution and generation companies.

For end customers, more-detailed load profile data lets them review their energy use throughout the day and identify peak periods and, potentially, devices with excessive consumption. This can help them use less energy in general, and also help them shift their use of high-energy-consuming devices to off-peak periods to lower their overall costs.

For utilities, load profiles help them provide more accurate usage models to improve their power procurement activities. Profiles also help utilities design tariff models that better reflect their costs during on-peak and off-peak periods, achieving a more stable load throughout the day. Improved energy usage forecasting reduces costs for consumers and utilities by mitigating the need to buy energy on the expensive spot market. (Industry experts say that a mere 2 percent of peak energy usage can cause 20 percent of the costs for a utility, so the benefits of shifting or reducing the peak are huge). In addition, better forecasting positively affects the environment by letting more generation take place in cleaner, more efficient plants.

TECHNICAL BACKGROUND

Load profiles are a set of values configured to be recorded by a meter on a frequent interval (for example, the registers for forward and reverse active energy every 15 minutes). These values are then frequently collected by a data concentrator and routed to the head-end system for further processing.

The NES System's Continuous Delta Load Profile collects unread values from a meter throughout the day at a user-configurable rate (such as every three hours). Collecting data multiple times per day spreads the traffic over the network. It also lets head-end systems begin processing load profile data during the day instead of waiting until the end of the day, reducing the requirements for enterprise processing power. For our study, however, load profile information was collected all at once, every 24 hours, to put maximum stress on the power line network.

DETAILED RESULTS

The results for each day are shown on the following pages.*
The colors in the Hop Count Distribution and Signal Margin Distribution charts represent the amount of time needed to download data from the time it was ready on the meter, up to the NES head-end system.

- Green = Better than Average
- Yellow = Average
- Gray = Below Average

** During the last days of May and first days of June, hardware problems in the utility's data center caused wildly skewed data reads. Once corrected, results returned to expected ranges based on data collected until the event occurred. Data from these days have been removed from the charts, but are available in the downloadable version of the test data.*

SCENARIO 1/NUMBER OF METERS: 188

Hop Count Distribution

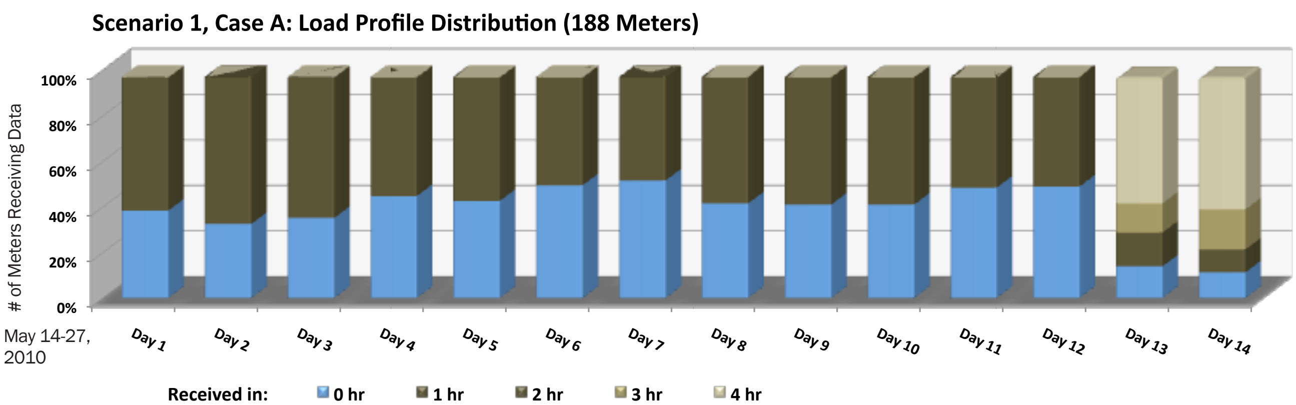
The hop counts show how many repeating steps were needed to get from the data concentrator to the meter.

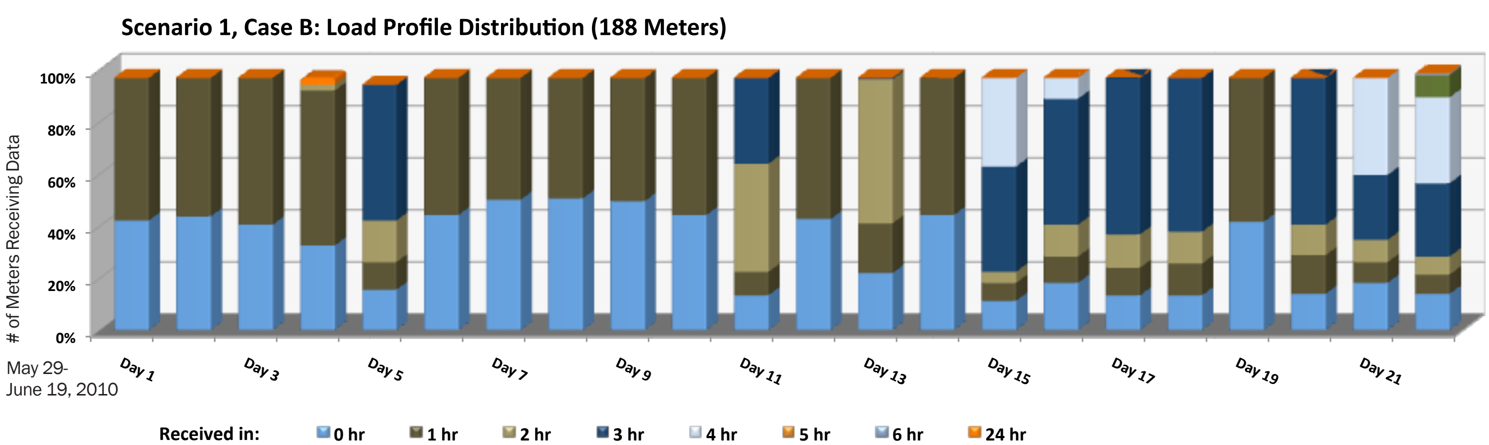
ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN	EIGHT
55	48	27	26	20	10	1	1

Signal Margin Distribution

The signal margin is defined as margin[dB re3.5Vpp] = signal strength [dB re3.5Vpp] - noise[dB re3.5Vpp] - 9dB. A margin of 0dB should lead to a packet error of ~5%.

-3 dB	0 dB	3 dB	6 dB	9 dB	12 dB	15 dB	18 dB	21 dB	24 dB	27 dB	30 dB	33 dB	36 dB	39 dB
1	1	10	15	14	21	47	46	48	35	17	10	5	4	29





SCENARIO 2/NUMBER OF METERS: 303

Hop Count Distribution

The hop counts show how many repeating steps were needed to get from the data concentrator to the meter.

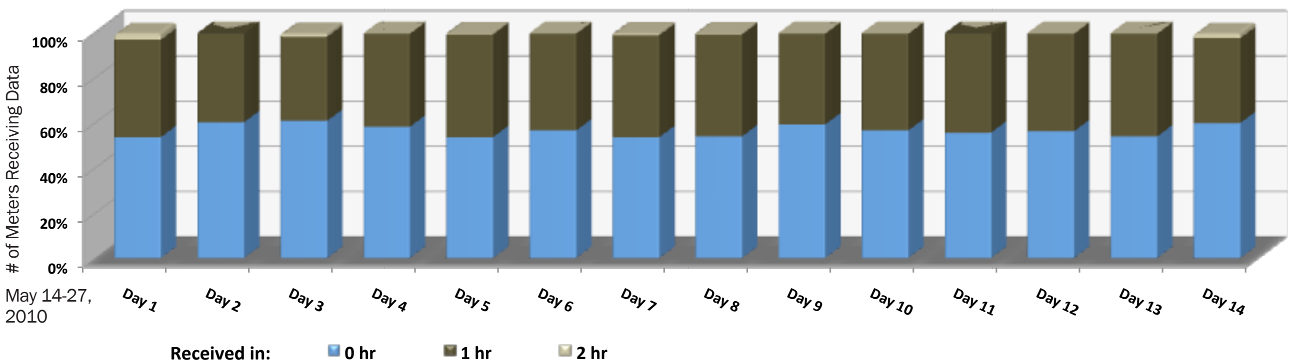
ONE	TWO	THREE	FOUR	FIVE
128	83	53	34	5

Signal Margin Distribution

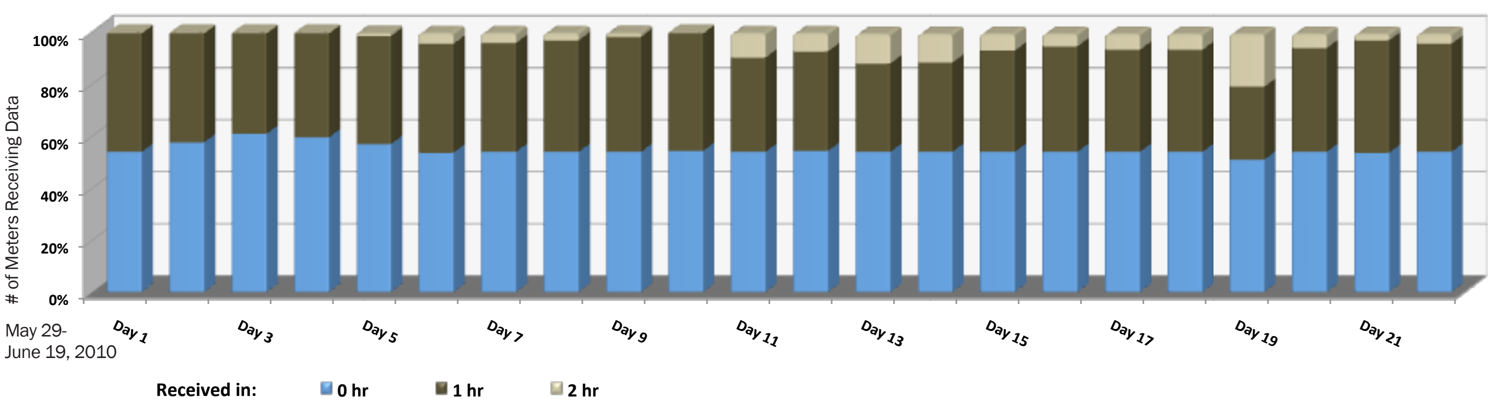
The signal margin is defined as margin[dB re3.5Vpp] = signal strength [dB re3.5Vpp] - noise[dB re3.5Vpp] - 9dB. A margin of 0dB should lead to a packet error of ~5%.

-6 dB	-3 dB	3 dB	6 dB	9 dB	12 dB	15 dB	18 dB	21 dB	24 dB	27 dB	30 dB	33 dB	36 dB	39 dB
2	2	5	16	15	15	24	19	37	20	6	2	4	4	17

Scenario 2, Case A: Load Profile Distribution (303 Meters)



Scenario 2, Case B: Load Profile Distribution (303 Meters)



SCENARIO 3/NUMBER OF METERS: 939

Hop Count Distribution

The hop counts show how many repeating steps were needed to get from the data concentrator to the meter.

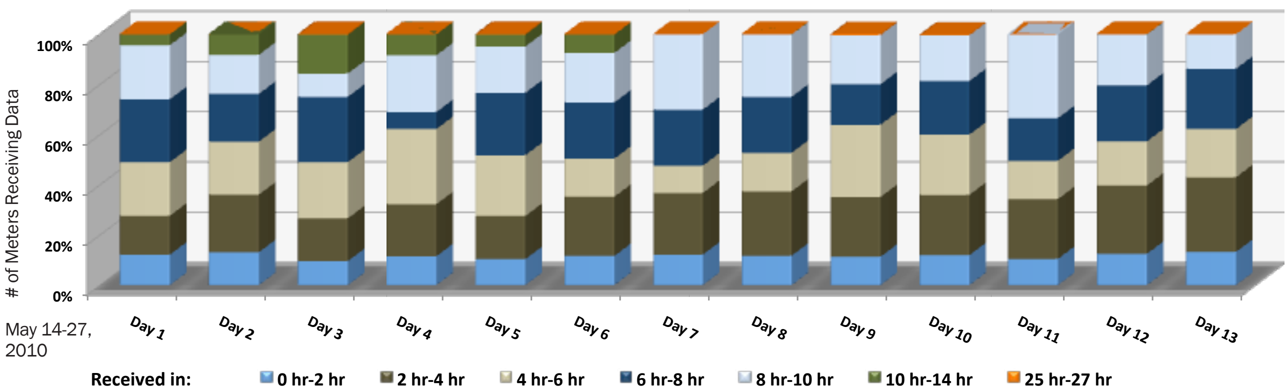
ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN
272	248	193	120	66	37	3

Signal Margin Distribution

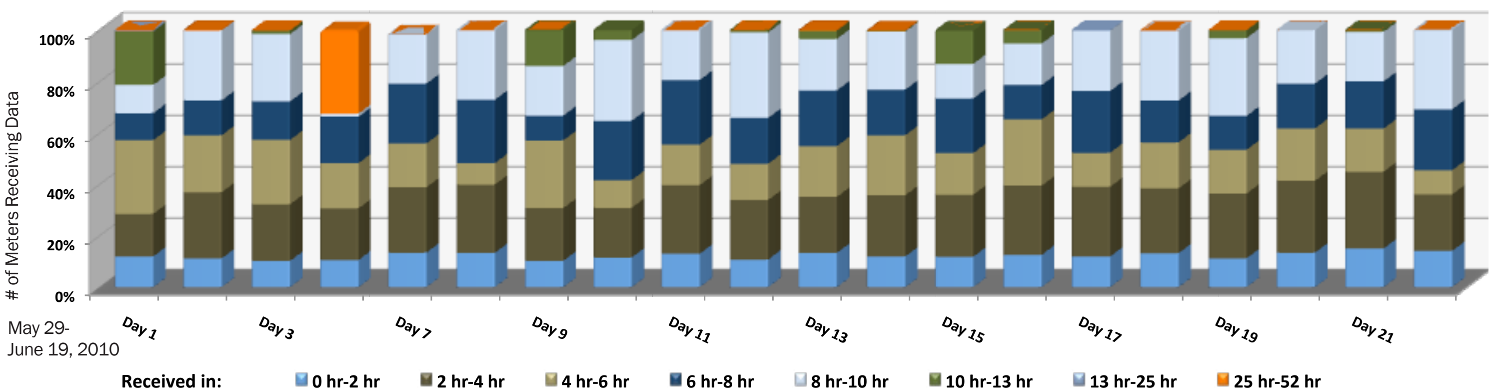
The signal margin is defined as margin[dB re3.5Vpp] = signal strength [dB re3.5Vpp] - noise[dB re3.5Vpp] - 9dB. A margin of 0dB should lead to a packet error of ~5%.

NO AGENT	-6 dB	-3 dB	0 dB	3 dB	6 dB	9 dB	12 dB	15 dB	18 dB	21 dB	24 dB	27 dB	30 dB	33 dB	36 dB	39 dB
2	21	21	38	33	44	68	92	97	84	88	83	50	42	56	47	73

Scenario 3, Case A: Load Profile Distribution (939 Meters)



Scenario 3, Case B: Load Profile Distribution (939 Meters)



ECHELON CORPORATION

Echelon Corporation is leading the worldwide transformation of the electricity grid into a smart, communicating energy network — one that connects utilities to their customers, enables networking of everyday devices, and provides customers with energy-aware homes and businesses that react to conditions on the grid.

Echelon's NES System — the backbone of the smart grid — is used by utilities to replace standalone electricity meters with a network infrastructure that's open, inexpensive, reliable, and proven. The NES System helps utilities compete more effectively, reduce operating costs, and provide expanded services, and helps energy users manage and reduce their overall energy use.

EVB ENERGY SOLUTIONS

EVB Energy Solutions GmbH implements smart metering solutions for worldwide energy utilities and network operators in the electricity, water, gas, and thermal energy segments. It is Germany's first technology-independent system vendor, the result of the merger of EVB Energie AG and DIEHL Energy Solutions in 2010.

As a full-service provider, EVB Energy Solutions offers the complete process chain, from meter to billing. The use of smart metering systems and a broad spectrum of services lets energy utilities optimize their processes and develop new sales products. EVB Energy Solutions creates the basis for economic operation and paves the way for home automation, smart grids, and E-mobility.

TWK KAISERSLAUTERN

The TWK Versorgungs-AG was founded in 1992 and belongs to the **TWK Technische Werke Kaiserslautern GmbH**. TWK, which was created in 1991 as a result of public utility restructuring, is fully owned and operated by the City of Kaiserslautern.

The TWK Versorgungs-AG supplies district heat, electrical power, and water. With environmental protection its highest priority, the company employs innovative technology to generate energy efficiently.