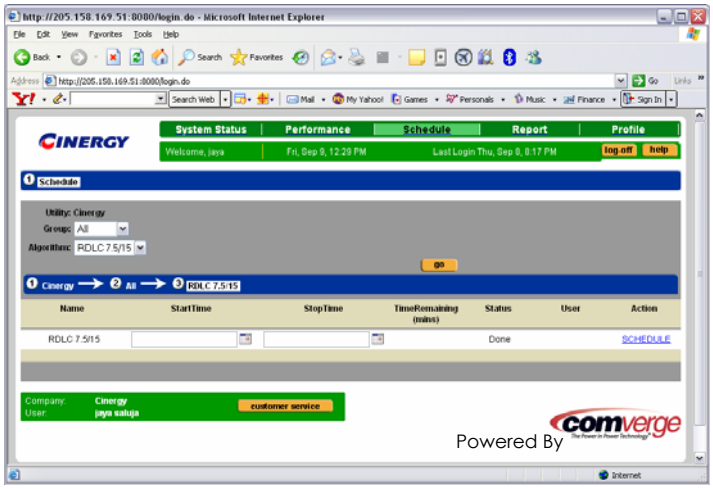

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AIR CONDITIONING LOAD CONTROL PILOT USING BPL

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I Pilot Overview

Two way Direct Load Control (DLC) communications over the BPL network is one of the most attractive EPDS business cases. Contemporary DLC communications systems consisting of simple one-way paging controls cannot support future price response controls. Additionally, two way BPL communications will support measurement and verification of load reduction, switch tampering alarms and integration of DLC with metering.

To prove this concept, CURRENT and Comverge have conducted a 9 unit Direct Load Control (DLC) Pilot using BPL communications on Cincinnati Gas & Electric's service territory during the month of September, 2005.

II Pilot Objectives

The objectives of the pilot were:

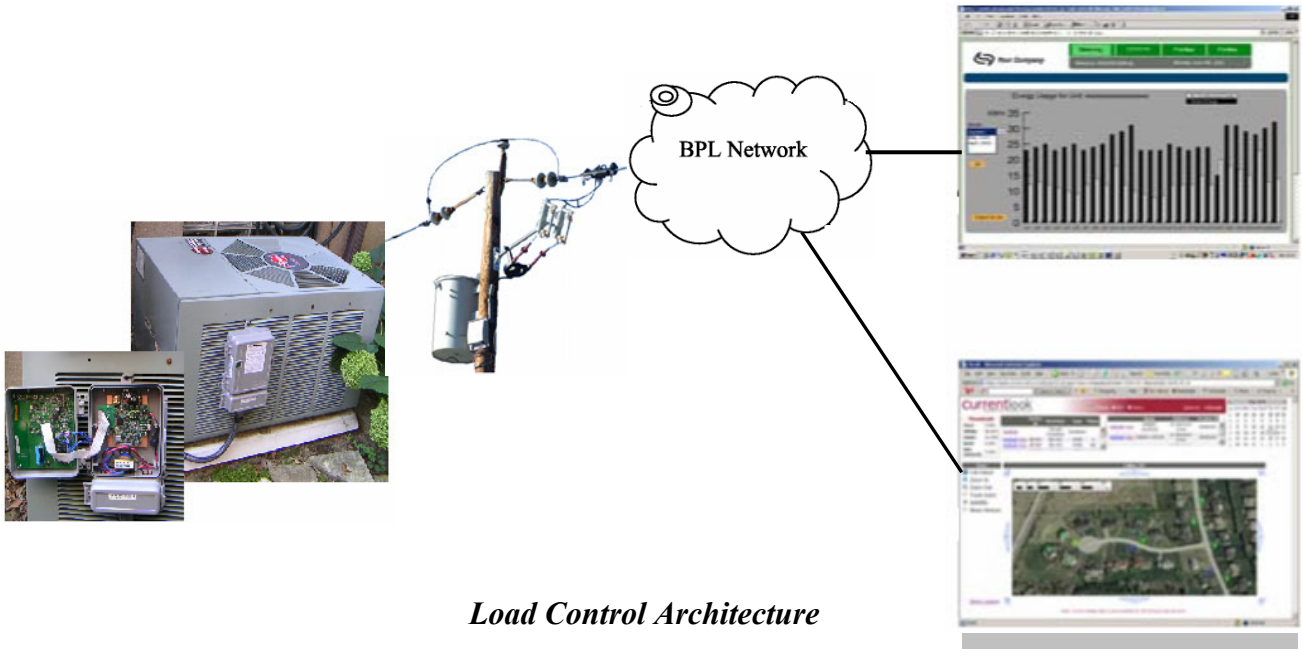
- Demonstrate Integration of Comverge's Digital Control Unit (DCU) on Current's BPL Network
- Demonstrate Integration of Comverge's Head-End Software with Current's BPL network
- Provide insight into the value proposition of two-way BPL communications for DLC including:
    - Real-Time Verification
    - Diagnostic / Tamper Alarms
    - Customer Load Behavior
    - Demonstrate analysis capabilities of having BPL enabled DLC and AMR on the same customers.

III Development Process

This pilot was accomplished by the integration of Comverge's Digital Control Unit (hereafter referred to as DCU) with CURRENT's BPL network using a modified version of the board that CURRENT has developed to integrate AMR meters with the BPL network (hereafter known as BPL Board).

The CURRENT BPL Board was physically modified as well as the internal firmware.

Comverge modified their head-end software (PowerCAMP™) to send and receive SNMP messages through Current's BPL network to the individual DCU units.



Load Control Architecture

Shadow metering was also installed. CURRENT Communications modified their CurrentLook™ software to provide on demand KWh load data for pilot premises that were also equipped with AMR metering.

BPL Shadow Metering Installation

IV Development & Pilot Teams

Development Team

The product development process was completed between June 27, 2005 (Development Kick-off) and September 2, 2005 (delivery of units to Cincinnati).

Pilot Team

The pilot team met through August to develop the Pilot Test Plan, and subsequently met on Monday mornings to discuss results and plan the next week's testing activities. The pilot phase started with installations on September 7th and ended with removals of equipment on October 12, 2005. The team consisted of CURRENT, Cinergy and Comverge personnel.

V Pilot Participant Selection

Cinergy's BPL Team initiated an e-mail letter to solicit pilot participants from a list of 22 Cinergy employees who were existing CURRENT BPL customers. The letter was sent on Friday August 5, 2005. Of these 22 candidates, eight agreed to the terms of the pilot (which included a $100 cash incentive, paid by CURRENT). Of these eight, five also agreed to allow an AMR meter to be installed for the duration of the pilot.

Once the pilot participants were identified, an agreement was drafted between the pilot participants and Cincinnati Gas & Electric. This agreement was signed by each pilot participant on September 2, 2005.

In addition to the 8 volunteers, noted above, CURRENT's demo-house was also added to the pilot installation list as a 9th site.

Contractor Performing DCU Installation

VI Pilot Installation

A specific installation plan was developed to detail the roles, responsibilities and estimated time required to complete the installation steps.

DLC Pilot
Installation Activities, Resources and Times

Task	Description	Time to complete
Conduct pre-installation tests for each participant	Collect information at each Current customer participating in pilot. Establish baseline information and service level prior to installing meter. Develop minimum acceptable level of service before abort	Completed prior to install date
Travel to Site		5 minutes
Install DCU	Install DCU	30 minutes
Install meter	Install serial meter socket and AMR meter	15 minutes
Provision DCU	Establish that DCU has been recognized by the CC NOC; verify that Comverge's LMS software can send commands to the DCU	15 minutes
Provision meter	Establish that meter has been recognized by the CC NOC; verify that Current Look AMR can access meter and collect data	15 minutes
Conduct post-installation tests for each participant	Collect information for each Current customer participating in pilot once the meter has been installed. Complete comparison of post-install data with baseline data. Determine if there has been significant loss of service level	15 minutes (only for Current BPL customers)
Collect field data	Collect installation data, meter reads	5 minutes
	Range of Potential Installation Times	**60 - 75 minutes**

Pilot Installation Plan

Originally, two days, September 7 and September 8, were planned for installations. During the installation process on September 7, it became apparent that all 9 installations could be accomplished in a single day. Contacts were made with the customers planned for September 8th and these were all moved to September 7th.

VII Test Plan Documentation

This section documents the test plan that was developed and accepted by each of the parties prior to the start of the pilot:

A. System Configuration:

Comverge and Current technologies have deployed a BPL enabled DCU for Air Compressor (A/C) cycling control. The following configuration was established:

- Deployments exist on 8 residences in the CG&E service territory
- A data communications network provided by Current Communications
- A hosted load-management software (PowerCAMP) suite operated by Comverge from it's Newark, CA offices.
    - The PowerCAMP Software is configured with 2 control groups - Group A and Group B and a Total Group (for all switches) accessible by the operators.
    - Each group has 4 control operations accessible by the operators - each control operation is initiated by a Start Time and stopped with a Stop Time entry by the user.
        - A 7.5/15 (min) duty cycling strategy that allows A/C operation for 7.5 min out of every 15 min of time.
        - A 100% shed operation that instantly stops A/C operation and returns it to normal after the stop time.
        - A 50% ADI shed operation that regulates the A/C operation to 50% of it's previous operating hour runtime.
    - Every 5 min, a Test LED Off and Test LED On command is sent to all DCU's in the field for installation verification purposes. This command controls an externally visible LED to an Off position. Installers will locally initiate a LED on function after installation. Thus, this command verifies proper installation and communication.
    - An API has been exposed for Comverge to collect AMR meter data from select homes and correlate it to load control operations. This load profile will be consumed by Comverge for display purposes with load control information.

- Comverge will collect operational data from the remote DCU's in a nightly fashion.:
    - A Cycle times -this counter increments each time the DCU opens a relay contact for control.
    - A Runtime - this counter records the A/C compressor runtime for every hour of the daylight day.

B. Testing Process

Using the deployment system, Comverge, Current and CG&E, under CG&E's direction, will conduct tests. The specific content and schedule of these tests will be determined by

weekly pilot management meetings (held on Mondays). These meetings will include representatives from CG&E, Current and Comverge. Consideration will be given to the predicted weather and the specific test requirements when determining weekly plans.

C. Installation/Communications Tests:

1. Each DCU will be installed and verified using the Test LED. This procedure requires the installation tech. to issue a LED on command and observe it's "off" state change within a 5 min. period of time.
2. Current will monitor the quality of communications to the DCU to ensure that acceptable levels are achieved.
3. Current will monitor communications traffic during operations to and from the IP addresses of the DCUs to ensure no spurious traffic.

D. Basic Cycling Tests:

1. Operators will control a group of DCU's with a standard duty cycling algorithm (7.5/15) and will observe a cycling count increase. Additionally, the user will observe a decrease in the compressor runtime and energy consumption values.
2. This may be repeated with additional algorithms and control groups as needed.

E. Advanced Cycling Tests:

1. A 2-way network provides the ability to compare cycling strategies for performance characteristics. For example, certain algorithms provide a "quick" response time, while others provide a more stable kW demand reduction across the control period, This test provides the basis for this understanding:
    a. The user will submit control schedules with each group with the same start times and stop times. Group A will use a 7.5/15 algorithm while Group B will use a 50% ADI algorithm.
    b. Compare the results with the AMR and cycle time data.

2. Response time test: Using a 100% control command in a 15 min amount of time will demonstrate the response time of the load management solution. AMR data from CurrentLook is recorded every 15 minutes and will be used to validate load reduction.

F. Advanced Functionality Tests:

These are tests that will allow CG&E to receive incrementally more value from their DLC program than what was originally received. Below are examples of tests and information that will be collected during pilot.

- Verify specifically the amount of load reduced with a control event (using AMR meter)
- Correlate device location on specific circuit in Current Look
- Develop average kW load data (using AMR meter)
- Track results of DLC action "real time" by measuring load reduction (using AMR meter)
- Monitor and collect data from DLC switch
  Cycling characteristics - Compressor Run Time (minutes per hour)
- Create algorithms that would predict the amount of kW shed based on usage history

VII Test Results

Good fortune allowed for the weather to be remarkably hot for the first 2 weeks of the pilot allowing for excellent testing conditions. As a result, four "shed events" were conducted by Cinergy. The results of these events are summarized below:

9/11/05 Event

The first test was conducted on Sunday, September 11, 2005. Prior to the first test, the During this test each of the control algorithms was deployed as detailed in the summary table below:

Event Data	9-11-2005 Event								
	Group C	Group A				Group B			
Comverge Site #	1	2	3	4	5	6	7	8	9
Site Name	Demo House	Marburg	Grand Vista	Elywnne	Palisades	Meriweather	Oak Crest	Paxton	Sherel
Algorithim Used	100% ADI	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	15/30 DI	15/30 DI	15/30 DI	15/30 DI
Event Start Time	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00	12:00
Event Stop Time	3:00 PM	3:00 PM	3:00 PM	3:00 PM	3:00 PM	3:00 PM	3:00 PM	3:00 PM	3:00 PM
Counter Before Event	20	10	37	not tested	11	10	32	11	9
Counter After Event	21	22	49	not tested	23	16	38	17	15
# of Cycles	*1*	*12*	*12*	*not tested*	*12*	*6*	*6*	*6*	*6*

The 9/11 Event was judged to be a complete success.

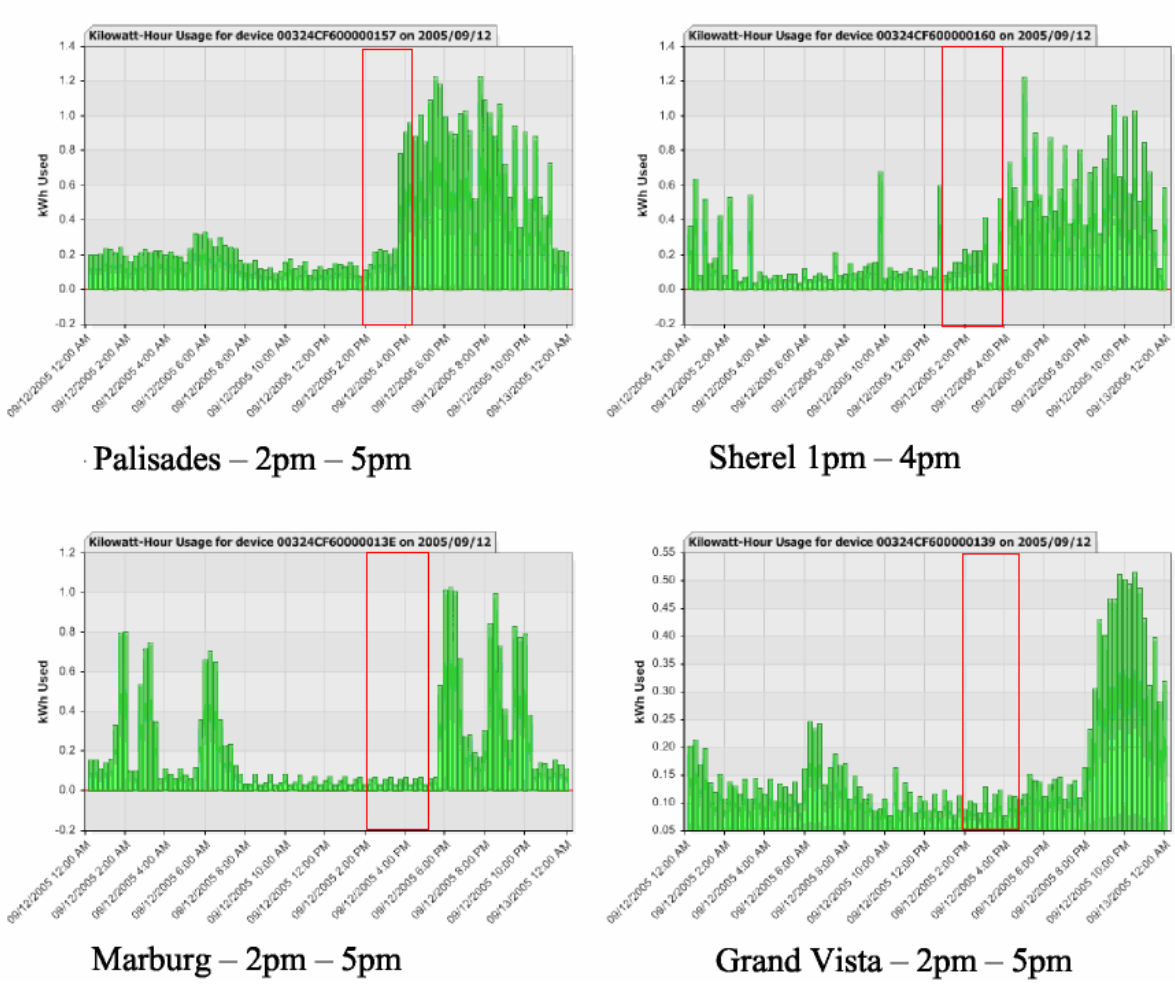
9/12/05 Event

The second test was conducted on Monday, September 12, 2005. This test was moved later in the day to attempt to be in the middle of the daily cooling cycle. Each premise was subjected to the 7.5/15 RDLC algorithm:

Event Data — 9-12-2005 Event

	Group C	Group A				Group B			
Comverge Site #	1	2	3	4	5	6	7	8	9
Site Name	Demo House	Marburg	Grand Vista	Elywnne	Palisades	Meriweather	Oak Crest	Paxton	Sherel
Algorithim Used	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC
Event Start Time	1:30	2:00	2:00	2:00	2:00	1:00	1:00	1:00	1:00
Event Stop Time	4:30 AM	5:00 AM	5:00 AM	5:00 AM	5:00 AM	4:00 AM	4:00 AM	4:00 AM	4:00 AM
Counter Before Event	21	22	48	not tested	23	16	38	17	15
Counter After Event	33	34	60	not tested	35	28	50	29	27
# of Cycles	*12*	*12*	*12*	*not tested*	*12*	*12*	*12*	*12*	*12*

To better understand the relationship between DLC operation and loading, AMR meters were installed on four of the pilot premises. The following diagrams show 24 hours of 15 minute KWh readings for these four premises on September 12th.



From these diagrams, it can be easily observed that the KWh loading was suppressed during the period of the shedding event. These results are consistent for all of the tests. The 9/12 Event was judged to be a complete success.

9/13/05 Event

The third test was conducted on Tuesday, September 14, 2005. Each premise was subjected to the 7.5/15 RDLC algorithm:

Event Data	9-13-2005 Event								
	Group C	Group A				Group B			
Comverge Site #	1	2	3	4	5	6	7	8	9
Site Name	Demo House	Marburg	Grand Vista	Elywnne	Palisades	Meriweather	Oak Crest	Paxton	Sherel
Algorithim Used	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC
Event Start Time	2:30	1:00	1:00	1:00	1:00	2:00	2:00	2:00	2:00
Event Stop Time	5:30 PM	4:00 PM	4:00 PM	4:00 PM	4:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM
Counter Before Event	33	34	60	not tested	35	28	50	29	27
Counter After Event	45	46	72	not tested	47	40	62	41	39
# of Cycles	***12***	***12***	***12***	***not tested***	***12***	***12***	***12***	***12***	***12***

The 9/13 Event was judged to be a complete success.

9/22/05 Event

The forth and final test was conducted on Thursday, September 22, 2005. Each premise was subjected to the 7.5/15 RDLC algorithm:

Event Data	9-13-2005 Event								
	Group C	Group A				Group B			
Comverge Site #	1	2	3	4	5	6	7	8	9
Site Name	Demo House	Marburg	Grand Vista	Elywnne	Palisades	Meriweather	Oak Crest	Paxton	Sherel
Algorithim Used	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC	7.5/15 RDLC
Event Start Time	2:30	1:00	1:00	1:00	1:00	2:00	2:00	2:00	2:00
Event Stop Time	5:30 PM	4:00 PM	4:00 PM	4:00 PM	4:00 PM	5:00 PM	5:00 PM	5:00 PM	5:00 PM
Counter Before Event	33	34	60	not tested	35	28	50	29	27
Counter After Event	45	46	72	not tested	47	40	62	41	39
# of Cycles	***12***	***12***	***12***	***not tested***	***12***	***12***	***12***	***12***	***12***

The 9/22 Event was judged to be a complete success.

IX Results & Conclusions

RESULTS

All of the objectives of the DLC over BPL pilot were met.

Provide insight into the value proposition of two-way BPL communications for DLC including:

- **Real-Time Verification**
- **Diagnostic / Tamper Alarms**
- **Customer Load Behavior**
- **Demonstrate analysis capabilities of having BPL enabled DLC and AMR on the same customers.**

Significant insight was gained from this pilot. Real time two-way communications were used to determine that the switch was present, functional, and that the requested shedding operations were completed successfully. Utilization of BPL enabled DCL and AMR on the same customer was proven to provide a sound mechanism for verification of customer load reduction.

About the author:

Dave Hyland oversees the sales function, planning, and staffing for Comverge's northern territory. Comverge is a Premier provider of solutions for Load Control, AMR and Distributed Automation to energy generators, providers and end users.

Mr. Hyland has over 25 years of sales and management experience spanning the energy, software, long distance telecommunications and chemical industries. His expertise involves both regulated and un-regulated industries.

Prior to Comverge Mr. Hyland held Senior management positions with Lumenor, Energy.com, American Electric Power and Enron. Additional responsibilities include customer service, collections, contract administration, as well as bottom-line profitability.

Mr. Hyland holds memberships in the following organizations:

Peak Load Management Alliance (Board Member)
Association of Energy Engineers (AEE)
National Energy Marketers Association (NEMA)
Association of Energy Service Professionals (AESP)
PJM Demand Response Working Group
ISO-NE Demand Response Working Group

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