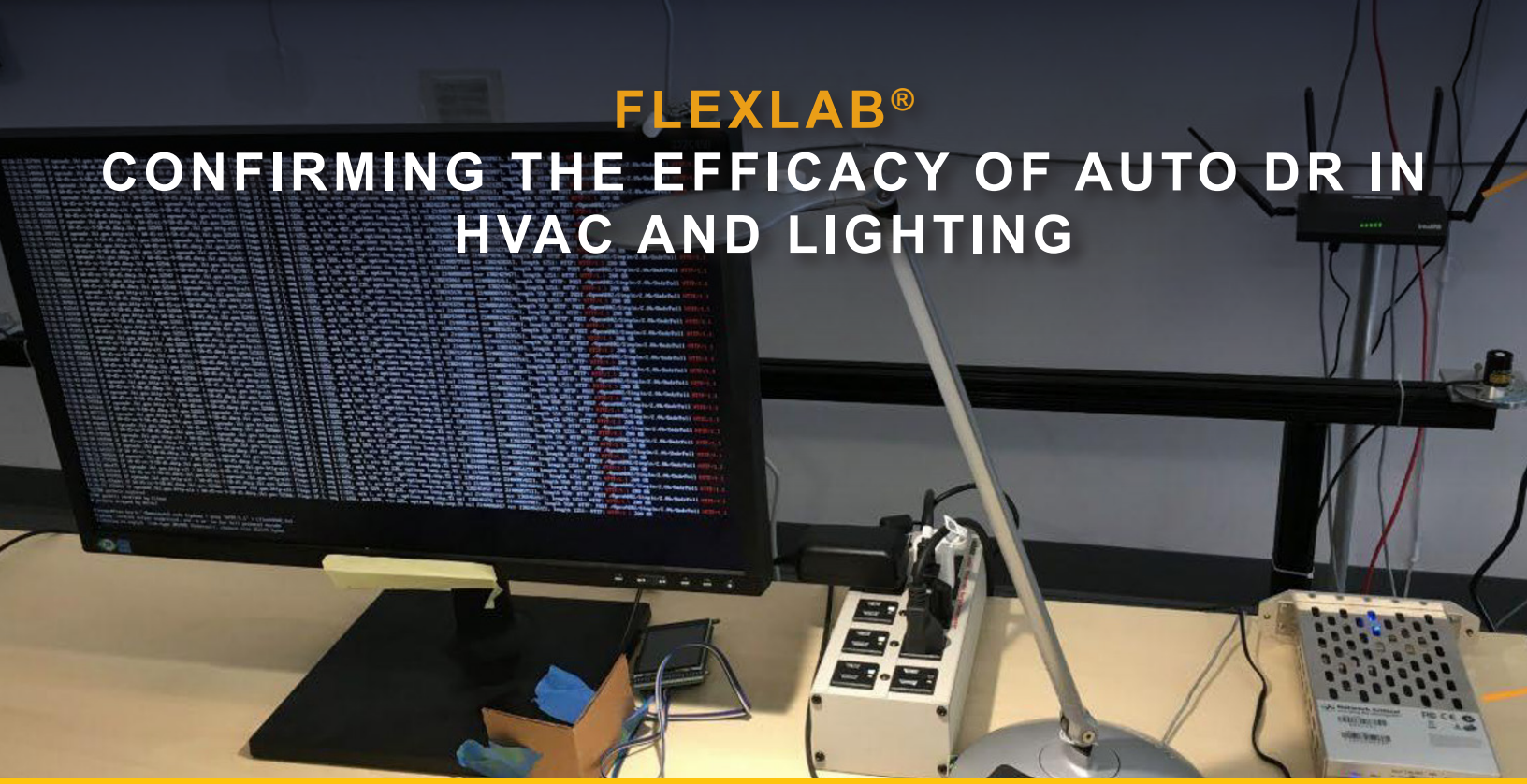


FLEXLAB®
CONFIRMING THE EFFICACY OF AUTO DR IN HVAC AND LIGHTING

FLEXLAB tests help to demonstrate the capability of automated demand response (AutoDR) control of flexible loads in supporting grid responsiveness.

THE CHALLENGE

Using AutoDR to rapidly respond to dynamic grid needs.

AutoDR speeds the responsiveness of customer electricity demand without human involvement, thus enabling the electricity grid to react more flexibly to evolving supply and demand conditions such as variable renewable generation. However, it is challenging to harmonize interconnection and interoperability standards for these services, while ensuring that devices can reliably provide grid service. The increasing penetration of smart devices and behind-the-meter distributed energy resources further complicates the communication and control. A standardized end-to-end testing procedure is needed to evaluate the performance of capable building end uses in meeting various grid service requirements.

THE SOLUTION

The U.S. Department of Energy's FLEXLAB® facility at Lawrence Berkeley National Laboratory developed and conducted tests to evaluate the capability of various end uses in providing fast demand response (DR). FLEXLAB offers the granular control and measurement necessary to conduct such exacting testing, including the ability to customize spaces to match the necessary test parameters.

> **From the very beginning of automated demand response, LBNL has been the thought leader for innovation in this field. The FLEXLAB® facility provides a simple test bed for complex scenarios and new use cases. The OpenADR Alliance is very happy to support this effort now and in the future.**

Rolf Bienert, Managing & Technical Director OpenADR Alliance

THE BOTTOM LINE

AutoDR satisfies the rapid-response needs of a modern grid system.

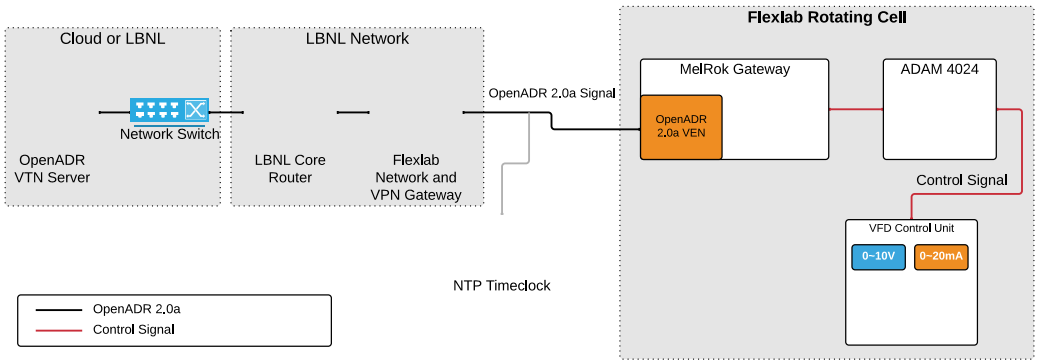
Testing with a variable-speed air handler fan showed response to the grid signal in less than one minute, while fully reaching the new speed within two minutes. Testing of a dimmable lighting system demonstrated fast response to the control signal within a second, with average power response accuracy of 93%. These results highlight the value of common testing methods for end-to-end automation and the importance of industry engagement in interoperability connections to customer devices for grid services participation.

THE EXPERIMENT

- The tests included (1) end-to-end AutoDR testing with commercial air handling units for retail DR, (2) testing of energy and capacity products, and (3) testing of dimmable lights for regulation service.
- Two end-to-end AutoDR tests (OpenADR 2.0a/b protocols) were conducted on common building systems in FLEXLAB's® laboratory environment. Three pathways were tested for connecting controllable loads to the grid: (1) device to grid through vendor cloud, (2) smart device with an embedded standard protocol, and (3) device to grid through a building energy management system. Standard internal load schedules were used, with weather being the only variable.
- The tests sought to: (1) ensure integration of the AutoDR system with controllable loads using relevant industry standards and protocols for DR communication; and (2) quantify the performance of DR control strategies.
- FLEXLAB's building automation system was customized to achieve more flexibility with new control sequences. For the variable frequency drive (VFD) control, a smart energy gateway was pre-programmed with demand management control sequences. Two types of DR signals were used, both a one-hour and five-minute duration.
- The lighting test used OpenADR 2.0b and common automated lighting systems to test: (1) communication infrastructure between the grid service providers and the customers (client), and (2) performance metrics (i.e., communication latency).

THE RESULTS

- Regarding direct load control, the VFD fan responded to the DR signal in less than a minute and reached its new speed in under two minutes. The VFD fan was able to provide nearly 80% of its full power capacity within one minute. Power change exhibited a quadratic trend over time.
- The tests evaluating global temperature adjustment through a smart thermostat showed that the thermostat responded to the DR signals successfully and resulted in significant demand savings from HVAC systems during the event hours. The control strategy of "raising thermostat setpoints by 6°F" has almost the same effect as cycling off the chiller plant under cool weather conditions.
- The LED dimmable lighting system can respond to the control signal within a second and the average power response accuracy was 93%, which indicates that latency was acceptable for both the response speed and accuracy in providing all grid services.
- In the end-to-end OpenADR communication latency test of the LED dimmable lighting system, the communication delay between the OpenADR server to the gateway client was less than 100 milliseconds on average. In the gateway, it took less than 200 milliseconds to translate the OpenADR price signal to the Zigbee price control signal. In total, it took less than two seconds from the timestamp of sending the OpenADR signal to the timestamp of the lighting power response.



Energy Technologies Area
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