GPG-001 | **MARCH 2012**

WIRELESS SENSOR NETWORKS

Wireless Sensors Help Decrease Data Center Energy Consumption

Data centers consume roughly two percent of all energy used in the United States, and their carbon footprint is projected to exceed that of the airline industry by 2020[1]. Nearly 50 percent of data center energy typically goes to non-IT loads, such as cooling and power conditioning. In the federal sector, agencies currently lease space from GSA to operate more than 1400 data centers[2]. In an effort to help client agencies increase energy efficiency in building operations, GSA's GPG program recently assessed the potential of wireless sensor technology to provide a cost-effective and facilities-friendly way of helping data center operators visualize and implement system changes that reduce overall energy consumption. Findings include significant cost savings, as well as a substantial reduction in cooling load and CO_2 emissions.

The GPG program enables GSA to make sound investment decisions in next generation building technologies based on their real world performance.

INTRODUCTION

What We Did
EXPERTS ASSESSED REAL-WORLD EFFECTIVENESS

A GSA's GPG program 2011 assessment of wireless sensor technology suggested that providing real-time, floor-to-ceiling information on humidity, air pressure and temperature conditions could enable data center operators to improve the energy efficiency of even well-managed data centers significantly.

To evaluate the real-world effectiveness of this technology, the GPG Program worked with the Department of Energy's Lawrence Berkeley National Laboratory (LBNL), industry recognized experts in state-of-the-art data center analytics. LBNL selected the U.S. Department of Agriculture (USDA) National Information Technology Center facility in Saint Louis, Missouri, as a demonstration project location because its baseline conditions were representative of a well-designed, well-managed data center operated by an engaged facility staff. Sensors utilizing a wireless mesh network and data management software to capture and graphically display real time conditions for energy optimization were then installed.

What We Measured
NETWORK PROVIDES COMPREHENSIVE PERFORMANCE MEASURES

After installation, the network began providing comprehensive, easily understood measures of recirculation and by-pass air mixing, underfloor air pressure, cooling system efficiency, adherence to thermal-operational ranges recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) for IT equipment, and other critical gauges of facility performance. Based on this information, data center operators, with the support of the wireless sensor technology vendor, were able to identify and implement specific no-cost air-flow-management and cooling-efficiency changes to optimize data center operations and track the cumulative energy savings benefit of these measures.

FINDINGS

LARGE REDUCTION IN COOLING LOAD Efficiency measures implemented as a result of information provided by the wireless sensor network reduced the demonstration facility's cooling load by 48 percent, reducing total data center power usage by 17 percent. This represented an annual savings of 657 megawatt-hours, and an improvement in the data center's Power Usage Effectiveness (PUE) from 1.83 to 1.51.

SIGNIFICANT SAVINGS Energy cost savings at the demonstration facility were calculated at $30,000 per year, even though current local utility rates were among the lowest in GSA's portfolio. Simple payback was calculated at 3.4 years. The annual greenhouse gas emissions associated with the operation of the data center were reduced by 542 metric tons of CO_2.
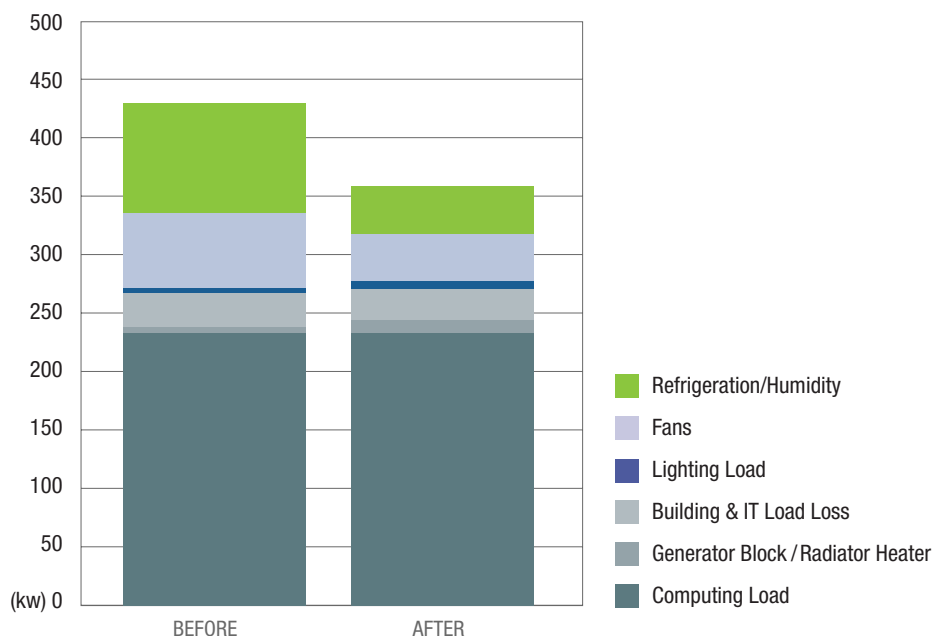
SIMPLIFIED ASSESSEMENT TOOLS Permanent installation of the sensor network requires multiple interruptions of facility power. A portable wireless sensor assessment kit developed during the study provides many of the full network's benefits while reducing deployment time and power interruptions during installation.

DEPLOY BROADLY Broad deployment represents a best practice that can help agencies meet mandated energy-use-reduction targets. Deployment of the wireless sensor network enabled the USDA's data center operator to make adjustments that resulted in the above savings using only parts on hand, without any investment beyond the cost of installing the network and its associated software.

Data Center Power Usage Distribution

48% Cooling Load Reduction, 17% Overall Data Center Energy Reduction

Legend:
- Refrigeration/Humidity
- Fans
- Lighting Load
- Building & IT Load Loss
- Generator Block / Radiator Heater
- Computing Load

CONCLUSIONS

Footnotes

[1]McKinsey & Company, "Revolutionizing Data Center Efficiency", 2008

[2]For the purposes of this report, data centers are characterized as a space 500 square feet or larger dedicated to "Automatic Data Processing" as of September 2011.

*Subject to evaluation and approval by GSA-IT and Security.

Technology for test-bed measurement and verification provided by Synapsense.

What We Concluded
ASSESSMENT ARGUES IN FAVOR OF BROAD DEPLOYMENT

To address the federal share of data center energy usage, the Office of Management and Budget is requiring agencies to consolidate data centers and, in some cases, move to cloud-based solutions. Remaining facilities must achieve significant energy savings. The wireless sensor network evaluated in this GPG demonstration project showed that comprehensive gauges of real-time data center conditions can deliver on this goal.

Will it work more broadly? Yes, according to LBNL, which projected that both the deployment costs and energy savings achieved at the GPG demonstration facility were representative of average costs and savings that could be achieved if wireless sensor technology were implemented by tenant agencies throughout the GSA portfolio. The LBNL evaluation team concluded that broad deployment represents a best practice that could help agencies meet mandated targets cost effectively. They forecast a potential $61 million in annual savings and an annual decrease of 532,000 metric tons of CO_2, an amount equal to the annual greenhouse gas emissions of approximately 104,000 passenger vehicles.

Lessons Learned
SIMPLIFIED ASSESSMENT TOOLS LIMIT POWER INTERRUPTION

The data center operator at the demonstration facility found that full deployment of the permanently installed wireless sensor network provides valuable real-time information needed for the on-going optimization of data center performance. However, permanent installation of the sensor network required multiple interruptions of facility power. Recognizing this as a potentially significant barrier for some tenants, as well as a source of additional time and vendor expense, LBNL, in association with the technology vendor, developed a portable wireless sensor assessment kit. LBNL has separately piloted this assessment kit at four federally operated data centers, and found that the snapshot of real-time information it provides holds many of the full network's benefits, reduces deployment time and power interruptions, reveals critical data center metrics, and allows operators to assess the utility of a permanent wireless sensor installation.

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