



# Tapping into Remote Building Intelligence

By Todd Lash

**E**merging technologies and services are enabling engineers to tap intellectual property outside their organization, remotely and affordably, and add significant value to their processes and bottom lines. A new trend in remote facility monitoring and analysis is gaining wider acceptance among building owners, managers and engineers throughout the U.S. as they stretch their already-thin resources and budgets to new limits.<sup>1</sup>

A form of “remote intelligence” is garnering particular attention among facility professionals. Customized services provide continuous commissioning to HVAC equipment that can reduce energy consumption, and prioritize and track equipment maintenance issues. Some call it remote building solutions, or ongoing performance monitoring and improvement, while others give it such names as remote monitoring and analysis, networked building systems.

The Federal Energy Management Program (FEMP) calls it Continuous Commissioning<sup>SM</sup> (CC<sup>SM</sup>), defined as “a comprehensive and ongoing process to resolve operating problems, improve comfort, optimize energy use, and identify retrofits for existing commercial and institutional buildings and central plant facilities. According to FEMP, CC<sup>SM</sup> has produced typical savings of 20% with payback under three years (often one to two years) in more than 130 large buildings.”<sup>2</sup>

FEMP is clear about its process going beyond traditional operations and maintenance (O&M) programs by including a comprehensive engineering evaluation and an integrated approach that ensures local and global system optimization and the persistence of improved schedules.<sup>3</sup>

No matter what the service is called or how it is contracted, one common denominator exists: facility performance data are gathered or “mined” continuously from a building automation system (BAS) using open protocols and software algorithms, then downloaded to a large, remote database. The data are analyzed using a combination of artificial intelligence and advanced diagnostic methods managed by experienced, off-site energy and mechanical engineering professionals. The service uses proprietary applications, industry benchmark comparisons and recommended ASHRAE/National Institute of

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#### About the Author

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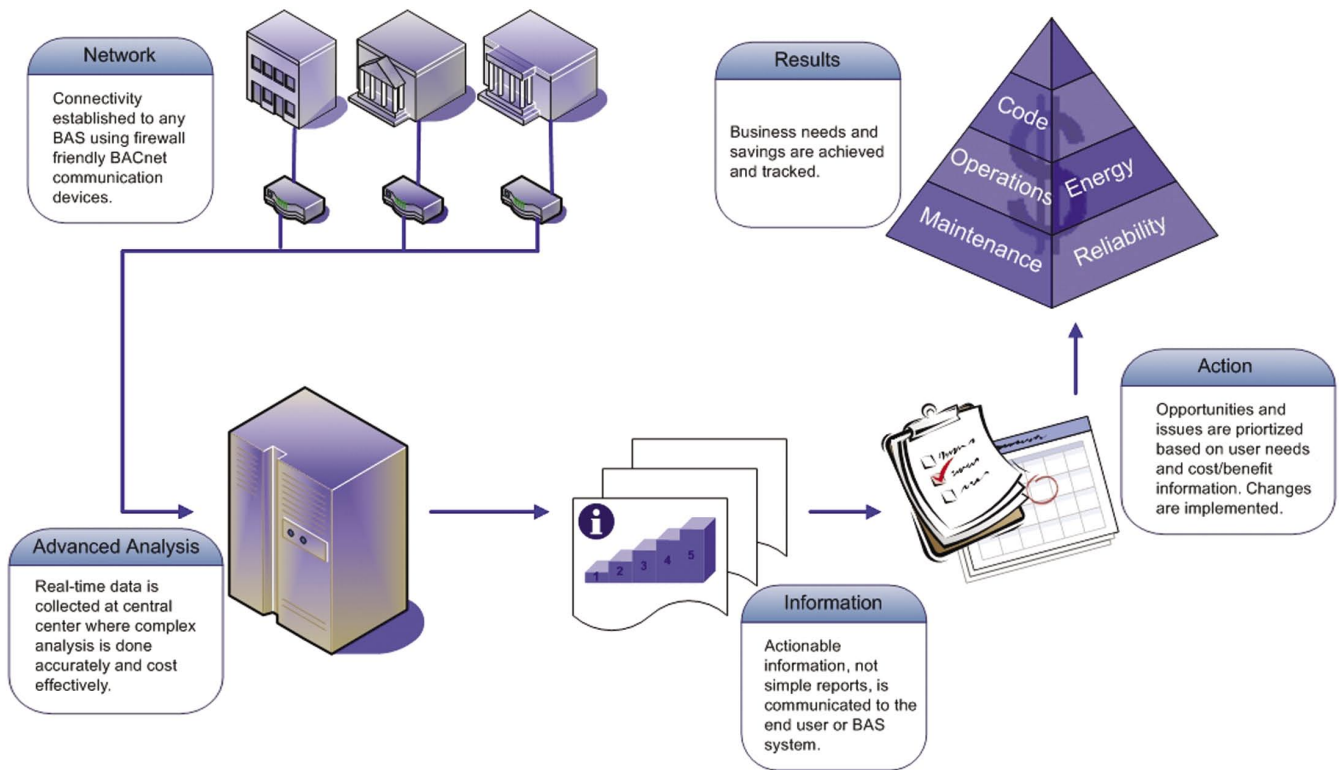


Figure 1: Typical delivery process of remote building analysis and optimization.

Standards and Technology (NIST) methods to expand the BAS capabilities for the end user.

As a generic description for this article, we will call it simply RBAO (remote building analysis and optimization).

A key component of RBAO is the intelligence gathered during a facility performance assessment. This comprises an initial site survey reinforced with ongoing analysis, tailored to the user's specific needs along with a quantifiable and tracked improvement plan.

### Remote Origins

The concept of RBAO was inspired by the shortcomings of packaged software products that tried to meet advanced application needs. While packaged products can collect data and provide reports, significant technical and cost barriers exist to a "shrink-wrapped" software solution that can combine user needs, custom facility operational and mechanical information, and data for meaningful and actionable improvement and diagnostics. Most packaged software still requires on-site expertise and time to interpret their outputs.

Over the past five years, the need for remote intelligence was further driven by the owners' desire to get more value

for the dollar from their systems by moving them into more customizable configurations that offer greater flexibility and opportunities for performance improvement.<sup>4</sup>

Over the next five years, advancements in networking, applications, interfacing and the Internet will be the primary drivers for change in the BAS industry. These changes will become enablers for significant new product developments in HVAC control. Engineers will be moving toward Web-based and networked solutions that can create new levels of efficiency in their automation systems and leverage their current infrastructure investments. Additionally, the next five years will most likely drive the BAS industry into a technological catch-up mode as demand intensifies.

RBAO promises to deliver a much-needed bridge between the value of data sufficiency and the resident, but usually untapped, capabilities of the BAS. Heretofore, the BAS has been used primarily to generate basic reports that have been interpreted by the user for problem diagnostics. Now, owners can better leverage their investments in their automation systems and their infrastructure by reducing energy and operating costs, boosting equipment and manpower efficiency, avoiding major costs and increasing asset values. Fault diagnostics de-

# Operations and Maintenance

tection, energy conservation, and continuous commissioning and improvement are the goals.

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Additionally, remote intelligence provides engineers with the “vision” to see the longer-term problems that set in from season to season and from year to year, as the facility goes through different cycles. They can see more clearly how the mechanical systems truly behave over time.

For example, the most common phenomena that the RBAO analysts look for are wasteful conditions or where equipment is not being used to optimum efficiency. But more importantly, they look for issues that relate more to the optimal design and operation of the building, not simply the control system.

Emerging remote services are moving well beyond alarm response and troubleshooting. They detect broader trends such as flaws within current operation, opportunities for more optimal operation and key information used to make better design decisions in the future.

One RBAO customer found an immediate cost savings of more than \$20,000 a year by correcting a leaking valve and some simultaneous heating and cooling. Midterm benefits for the same customer totaled \$44,000 a year—achieved by optimizing the staging of his plant to avoid repeating several costly design mistakes that were found in his air-handling units. Using the RBAO reports as a guide, the customer was able to plan future building projects on campus.

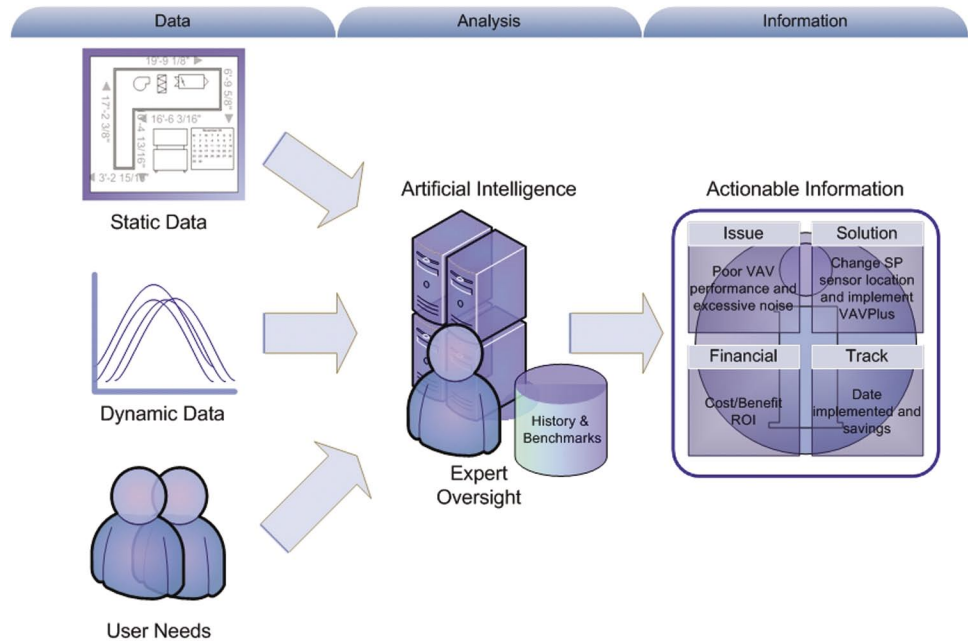


Figure 2: Key components of the advanced data analysis stage.

Once experts can assess performance and uncover problems and opportunities remotely, they can make specific recommendations for improvements and/or changes in operation.

## The Value of Intelligence

Applying sophisticated analytics to the mining and evaluation of facility performance data can pay significant dividends. Certainly, lower energy costs due to improved control and performance optimization top the list and attract the most attention from building owners and engineers. However, many other benefits exist of equal or greater value.

Most users will realize significantly lower operating and maintenance costs due to more efficient allocation and deployment—and shorter durations—of on-site manpower resources, which often results in the reduction of overtime expenses.

## Remote Intelligence in Action

Here is a partial list of examples of the types of problems and opportunities that the RBAO process can uncover and/or assess:

- Optimal Plant Staging,
- Global Plant/AHU Optimization,
- Plant Efficiency Declines/Predictive Maintenance,
- Optimal Plant Scheduling,
- Indoor Air Quality Issues,
- Optimal Mixed Air Control,
- Demand Control Ventilation,
- Ventilation Code Compliance,

- Optimal Setpoints and Setpoint Tracking,
- Optimal VAV Control, Including VAV Plus Variable Pressure,
- Energy Benchmarking,
- Peer Benchmarking,
- Enterprise Information Rollups and Analysis,
- Equipment Lifecycle Analysis,
- Optimal Scheduling and Tracking,
- Optimal Boiler Staging and Preheat,
- Degree Day Baselines,
- Comfort/Productivity,
- Valve Fault Detection,
- Loop Performance, and
- Optimal Start/Stop Analysis.

Because the goal of RBAO is to operate equipment as close to optimal conditions as possible, repair and replacement costs will be reduced and malfunctions can be diagnosed and remedied to preclude failure. Equally important, the longevity of most mechanical equipment can be extended substantially. Although RBAO-type services are relatively new on the HVAC scene and do not yet offer long-term operating data, extended life cycle estimates can be developed for budgeting and management approval purposes.

Further, since the collection of information and delivery of certain services can be managed effectively via the Internet and intranets, integration with existing information technology (IT) systems becomes simpler and more cost effective.

Finally, through improved control and a more consistently maintained environment, users also should realize increased levels of indoor occupant comfort and satisfaction, with reduced risk of air quality problems.

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Most RBAO programs provide engineers and building managers with a consolidated (usually monthly) report that serves as an important management tool for tracking results. Typically, details on energy consumption, use patterns, trends, and comparisons of actual vs. budget vs. baseline are included. The larger role of the report, however, is to provide data interpretation and action plans, not simply depict performance charts and graphs.

### How the Process Works

*Figure 1* provides a diagram of the steps involved in a typical RBAO process and illustrates how survey, static, dynamic data are integrated into the analysis.

The first step is site assessment and qualification of the facility to ensure that remote intelligence makes sense. This phase involves a thorough needs analysis and a comprehensive assessment of all facilities, including gathering all relevant, existing performance data and site histories. In addition, the assessment must ensure that the BAS at the facility has the resident tools and the advanced capabilities to facilitate the complex tasks of mining, compiling, transmitting and monitoring large amounts of real-time data.

This survey differs from traditional models, in that standard energy audits and retro-commissioning surveys usually take a short-term, static view of a building and recommend changes and modifications that should be pursued. Once the survey is complete, any changes to building operation (overrides, change in use/occupancy, etc.) and changes to equipment (failures, excessive cycling, suboptimal operation, etc.) will no longer be reflected.

Once the survey is complete, a road map or master plan can be crafted to pave the way for improvements and for continuous monitoring and commissioning. The plan must detail all of the

technical and procedural changes in the form of recommendations to optimize the value of the remote intelligence.

The next phase is establishing non-intrusive, secure BACnet connectivity between the user's BAS and the remote database to mine and transmit the facility's data on an ongoing basis. This step can be performed by the local BAS service office. The process involves installation and configuration of BACnet routing devices as gateways (when the BAS platform is non-native) that will provide the communications interface for continuous, real-time data. Security and firewall issues with the organization's corporate network usually can be addressed by using a firewall-friendly remote communications device.

BACnet technology has grown in appeal for this type of application because it enables remote systems to connect to a variety of different control systems that often vary in technology, capability, age and configuration.

Although each building is unique, the functions that are commonly targeted for monitoring include chiller and boiler plants, chilled and hot water distribution, air handlers, exhaust fans, VAV boxes, and flow and utility meters. (See sidebar, "Remote Intelligence in Action.")

Once connectivity is established, information is transmitted on an ongoing basis to a secure, off-site analytical lab where it is captured, stored and analyzed. This is the place where engineers avail themselves to the service's intellectual property. The goal of RBAO analysis is to uncover faults, diagnostics and value—through the eyes of expert, unbiased professionals—that cannot otherwise be reasonably detected or uncovered from a one-shot survey of a building or addressed with an off-the-shelf software product.

An RBAO analysis should provide users with a key benefit: a timely management report (usually monthly) with recommendations. Ongoing recommendations are based on analyses and observations made during the continuous monitoring and evaluative processes. An effective analysis must take both static and dynamic factors into account for continuously commissioned buildings. *Figure 2* illustrates the RBAO data analysis and reporting process.

Following implementation of the immediate recommendations, the monthly reports should indicate the facility's target energy consumption and operational characteristics. Variances from predicted results should be analyzed, problems identified and appropriate measures recommended as needed.

### Hospital Example

As an example of how an analysis might work, let's use a series of variable frequency drives (VFDs) in a hospital wing. The RBAO service has been monitoring 18 points to determine efficiency of both fan energy and cooling energy. The VFD signals were used to determine the fan energy loss based on

the affinity law where  $H_p$  is a cubic relation to speed. A 10% VFD loss is factored into the equation.

In this example, experts spot the potential for significant savings that can be derived from altering operation of a supply fan and a return fan, and from the reduction of excess cooling. One kW/ton is used to convert BTUs of cooling to kW. Using \$0.065/kWh, the analysis reveals that a total of approximately \$473 of excess air-handling unit (AHU) operations occurred during one summer month. Over an eight-month cooling period, that would amount to \$3,788. Additional savings would occur during the heating season.

Taking this example further, the experts also spot a potential problem in a different section of the hospital. Being monitored are the operating characteristics of one of the main AHUs. Experts notice that on some hot summer days, the discharge air temperature setpoint varies from 55°F up to 58°F (13°C to 14°C). This, in turn, causes the chilled water valve signal to experience wide swings to maintain the correct discharge air temperature. More revealing is that similar trends also appear on other AHUs in other hospital sections.

The report concludes that these wide swings in temperature setpoints (and corresponding actuator and valve oscillations)

can lead to premature equipment failure, system inefficiencies and comfort issues. In this case, the recommendations are to investigate each AHU control strategy to determine the source of the wide swings in the discharge temperature setpoints and to make the appropriate software or hardware adjustments.

A useful report should also prioritize all of the recommendations so the user understands which measures or changes require immediate attention, which issues should be addressed in the short or near term, and which issues require future attention.

In the hospital example earlier, the report identified one of the problems as a control issue that could be easily corrected, while the other problem uncovered a design flaw that required a change to the AHU. The staff was able to use this new intelligence in the design of a new hospital wing to direct future AHU mechanical designs and prevent such incidents from recurring. The two recommendations were given a priority rating of medium: action needed within the next 30 to 45 days (and continue to be monitored).

## Checklist for Success

Before embarking on a journey into RBAO services, the following considerations should be taken into account.

## D.C. University Taps New HVAC Intelligence Source

Statistics show that existing college buildings that are commissioned and stay commissioned consume an average of 15% less energy than non-commissioned buildings (according to the California Commissioning Market Characterization Study).

American University in Washington, D.C., was convinced of these statistics when it decided to try a new remote building analysis and optimization (RBAO) program for three of its buildings in early 2004. The service—a process of facility data acquisition, remote expert analysis and reporting—gives building operations personnel unbiased recommendations and management information that enables them to reduce energy and operational costs while enjoying the many benefits of continuously commissioned buildings.

The program assists systems' engineers with fault detection, troubleshooting and problem solving while prioritizing maintenance issues and reducing downtime. The overall goals, in addition to cost reduction, are to improve facility operation and efficiency, increase comfort and reduce risk of indoor air quality issues.

The university operates 50 buildings across its 84-acre campus in the nation's capital. A building automation system (BAS) monitors a total of 4,850 points on campus, with 3,000 of those points currently assigned to the RBAO service.

Director of physical plant operations, Willy Suter, admits he and his staff have their hands full with the number of operational and maintenance solutions that the service already has presented. But he is grateful to have an outside intelligence source that can spot troubles before they become failures.

"We're often so busy handling day-to-day symptoms," he explains, "that we don't have time to dig deeper into the root causes of many of the problems. The RBAO service enables us to see the larger picture of how our facilities really behave and what we really should be doing to address the larger issues."

Harry Thompson, assistant director of building maintenance operations, is responding to as many of the recommendations as possible in the monthly reports. "The service has enabled us to identify what our real maintenance backlog is (for the three buildings) and to understand how we can get more productivity out of our BAS. Unless we increase our staff by 24 people, we simply don't have the time to dig up all the information and perform the type of analysis that the remote intelligence service is able to provide in just a 30-day period."

Thompson says that the RBAO monthly reports have identified a range of HVAC issues involving software and hardware. "The reports let us know, for example, if CO<sub>2</sub> sensors are accurately sensing the conditions of occupied spaces and adjusting the outside air dampers appropriately to keep the CO<sub>2</sub> levels within the specifications. We know if the discharge temps at the AHUs are adequate to provide the needed setpoints for the spaces. The reports give us indications about energy consumption based on runtimes. The reports even evaluate the efficiency of the chillers in reference to such factors as water temperature, which gives us clues to other related issues."

Although it is too soon for quantitative results, the RBAO program estimates that the university will save more than \$70,000 per year in energy alone. However, Suter sees additional benefits: "We already have qualitative improvements in many spaces on campus where we previously had temperature problems that couldn't be resolved. The reports have enabled us to make relatively minor repairs in some cases, which has greatly reduced temperature-related complaint calls. As a result, we've experienced a net reduction in labor cost. At the same time, we've improved occupant satisfaction considerably. It's hard to put a number on that."

1. For new or retrofit facilities, be sure the building's design has adequate instrumentation to accommodate the latest technologies. Try not to cost-minimize when it comes to building control and monitoring; the downside could be greater—or worse, prohibitive—costs down the road.

2. Plan for open-system technology. Ensure that the BAS provider supports BACnet® technology at the top of their architecture. As the key access point for remote technologies, this will ensure that remote IP can be leveraged across all systems.

3. Ensure your facility has the best information technology (IT) infrastructure in place for your organization. For optimum information management, you will want the remote services and the BAS tied directly into your IT.

4. Thoroughly evaluate and assess the capabilities and robustness of your current BAS. Be sure the RBAO supplier's services are compatible with your system, and that your system can handle the increased complexities.

5. Be sure the BACnet routing devices and/or gateways to be used for gathering data and monitoring performance on a continuous basis are firewall friendly.

6. Ensure that your organization operates with a standard point-naming convention to minimize the cost of expanding the remote service to various parts of the facility.

These guidelines can help you and your organization better prepare for the future of intelligent buildings so that you can achieve the highest return from your BAS investment at the lowest cost.

#### Notes

1. Lee, J. and J. Griffith. 2003. "BACnet remote monitoring and the bottom line." *Today's Facility Manager* February. [www.facilitycity.com/tfm/tfm\\_03\\_02\\_news3.asp](http://www.facilitycity.com/tfm/tfm_03_02_news3.asp).

2. Federal Energy Management Program (FEMP). 2002. "Continuous Commissioning Guidebook for Federal Managers." [www.eere.energy.gov/femp/operations\\_maintenance/commissioning\\_guidebook.cfm](http://www.eere.energy.gov/femp/operations_maintenance/commissioning_guidebook.cfm).

3. "Continuous Commissioning Guidebook for Federal Managers." 2002. Introduction, p. 5.

4. From "Business Case Guidebook, Enhanced Automation," published by the California Energy Commission. [www.energy.ca.gov/reports/2002-06-20\\_400-02-005F.PDF](http://www.energy.ca.gov/reports/2002-06-20_400-02-005F.PDF). Covers a variety of strategies to increase the capabilities of existing building automation systems to control current, and plan for future, building energy costs while maintaining the comfort and productivity of all buildings. ●

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