I already have a building automation system in my building. Do I still need Real-Time Energy Management?

Harnessing the Power of Next-Generation Building Automation

The Internet of Things (IoT) is the future of building automation.

Real Time Energy Management (RTEM) is IoT applied to building automation. The application of big data and analytic resources residing in the cloud to deliver new capabilities is on the same logical path as moving from pneumatic control to distributed direct digital controls (DDCs). Adopting RTEM, howeverdoes not need to be as disruptive, costly, and complex as the previous migrations. The integration between RTEM and a modern DDC system is synergistic and makes engineering and business sense.

Recent advances in internet connectivity, encryption, and software integration are simplifying the transmission of real-time building data to the cloud, where they are stored indefinitely. Data sampled from seconds to minutes is recorded and analyzed. Moreover, a wide range of cloud resources—from accessing weather forecasts to reading spot-market energy prices—are adding to the intelligence of control decisions employed by the building automation system.

Building owners and operators should never buy or upgrade a Building Automation System (BAS) without including RTEM Capabilities.

Benefits of RTEM as a Strategic Management Tool

RTEM drives a building’s operation from a statically scheduled maintenance and chasing faults modus-operandi, to one that follows performance-optimized strategies by being proactive and applying predictive analytics to building automation. Prior investments in modernized control or automation systems need not be written off, but are synergistic and often an ideal stepping stone to incorporating RTEM.

RTEM has the potential to achieve 15–30% in energy savings[1] while improving occupants’ comfort and wellness,[2] safeguarding compliance to codes and regulations, and ensuring proper operation for millions of dollars’ worth of building assets.

Enhancing BAS with RTEM

[1] Methods for Fault Detection, Diagnostics, and Prognostics for Building Systems, International Journal of HVAC&R Research, Vol. 11, No. 2, April 2005. Srinivas Katipamula, senior research scientist, Michael R. Brambley, staff scientist at Pacific Northwest National Laboratory.

[2] Through integrating indoor air quality (IAQ) monitoring and optimization of the outdoor air exchange rate.

Many BAS, especially older systems, lack the capability to access data from the building's utility meter, sub-meters, electrical panels, and electrical risers. RTEM can readily incorporate real-time data from pulse and smart meters. Current transformer-based data acquisition devices provide additional fine-grain data about energy-consuming patterns. The availability of smart plugs and power strips with monitoring capabilities allows RTEM to incorporate the monitoring of significant plug loads.

RTEM's ability to integrate data from the internal electrical distribution network is especially useful to incorporate tenant spaces into the monitoring of the base building and consumption in the common spaces. RTEM expands the capability of BAS with new KPI capabilities, such as kW/ton for a chiller plant or EUI calculations updated in real time.

Additionally, RTEM also monitors all utility services for a building, not just electrically operated plants and equipment. Utilities such as water, gas or steam can all be readily integrated into the RTEM for a comprehensive view of a building's energy performance.

Following is a brief review of the superior analytic, fault detection, and fault diagnostic functionalities that RTEM offers compared to BAS in environments where detection requires years of historical trends and cloud-based data sources can play an enabling role. System and equipment performance issues are difficult to detect because buildings can be maintained at the desired conditions (temperature and humidity), and yet over time, drift out of the accuracy range, wasting tens of thousands of dollars in energy costs and compromise equipment health.

BAS System and Equipment Issues

- Sensors drift out of the required accuracy range over a long period
- Sticky or faulty actuator/linkage for valves and dampers
- Intermittent communication failures in the network connecting field devices and controller
- Sensors misplaced within the equipment/distribution loop, leading to poor equipment operations
- Set points left in default
- Alarm thresholds left in default
- Limited range of control of mechanical/pneumatic field devices
- Unoptimized control loop programming heating and cooling valves overshoot set points, cycling from close to 100% repeatedly to hit a set point

BAS Operational Issues

- Persistent manual mode operation
- Improper set points result from new staff’s interfering with or circumventing commissioned set points
- Improper alarm thresholds lead to staff’s ignoring repeated alarms
- Simultaneous heating and cooling to maintain set point
- Over-extended hours of operation

BAS End-of-Life Issues

- Management software outdated
- Lack of documentation for programmable controller software
- Lack of manuals for field devices
- Staff turn-over leads to loss of knowledge, data, expertise, and consistency

Evolution of Building Automation

Past

Manual adjustments were made by on-site operators to compensate for dynamic conditions in the building environment. Advancements in electrically controlled devices replaced pneumatically controlled components, improving comfort for occupants, and provide greater functionality for the operators.

Present

Continuous and dramatic improvements in microelectronic components and microprocessors led to today’s DDCs. Sophisticated controls are distributed throughout building systems. A giant leap was made from the pneumatic control system, replacing compressed air and hard-wired control with digital communication as the medium for dispatching control signals.

Future

Application of big data and analytic resources residing in the cloud will deliver new capabilities. Advances in internet connectivity, encryption, and software integration will simplify transmitting real-time building data to the cloud. Integration between RTEM and a modern DDC system will be synergistic. Substantial increases in energy savings will be realized.

Value of Historical Data

Historical building data delivered via the web is perpetually available and unaffected by physical limitations such as local bandwidth, database responsiveness, and hard drive space availability. This allows an entirely new category of analytics to be performed on data that was traditionally performed manually, and sporadically, if at all, due to the labor and resource intensiveness of the task. Consequently, historical data has been mostly unused in building automation.

As more intelligence is pushed to terminal and equipment controllers in an advanced DDC implementation, more historical data is collected and communicated to the BAS historian, further worsening the potential for lost opportunities.

While BAS often only uses a few seconds, minutes or hours of data, RTEM can incorporate years of normalized data. Incorporating historical data allows the continuous refinement of building performance, which eventually achieves and maintains optimization and energy efficiency benefits.

Value of Forecast Data

The progress in machine learning and artificial intelligence can be seen everywhere in our daily lives. There are also significant research, development and demonstration efforts focused on applying machine learning and artificial intelligence to building automation. High-quality historical data is critical in the training of the machine learning and artificial intelligence algorithms.

RTEM combines data mining, statistics, modeling, and forecasting intelligence to predict the building's future performance. With BAS, forecasting is primarily an engineering function. Integrating historical data with forecasted data enables the prediction and fine tuning of a building's reaction to dynamic conditions, with or without operator intervention, to maximize comfort, improve and maintain equipment health, and realize cost savings. For example, when unusually cold weather is forecasted, preheating building spaces will use the building's natural storage capability to ensure occupant comfort without overtaxing building systems. Adjusting the duration of the preconditioning to match the building's ability to store the conditioned environment in relation to the forecasted building occupancy schedule will ensure energy is not wasted. An accurate building model allows the storage capacity of the building to be evaluated, incorporating all of the dynamically changing parameters.

RTEM for the Decision Makers

RTEM is designed for a wide variety of users, with modern user management capability that tailors user access to a preconfigured set of permissions. User access does not require special software besides a web browser in most RTEM systems, which allows dash boards dedicated to management users to display concise key process indicators (KPIs) and financial metrics in a format that is useful to upper management.

For example, a finance executive may have access to a dashboard that presents immediate and long-term financial data, such as real-time costs relative to energy use versus budgets based on predictions that considered weather forecasts and fluctuations in energy spot-market prices. Comparatively, a corporate sustainability executive has access to benchmarking tools to identify whether a building is performing at a level that meets sustainability goals incorporating all utilities consumed by the building, not just the limited set that is monitored by BAS.

BAS is designed for building operators and is local within the building. The graphical screens showing schematics of equipment and processes provide building operators/engineers with a bird's-eye view of building operations. For BAS equipped with a historian (the specialty database used to store time-stamped historical values), trend charts and tables of numbers are often densely populated. Access to BAS by non-engineers and non-operators creates a liability where inadvertent user inputs could cause serious problems that are mostly avoidable. Many operators would not even allow remote access by consulting engineers outside of the building.

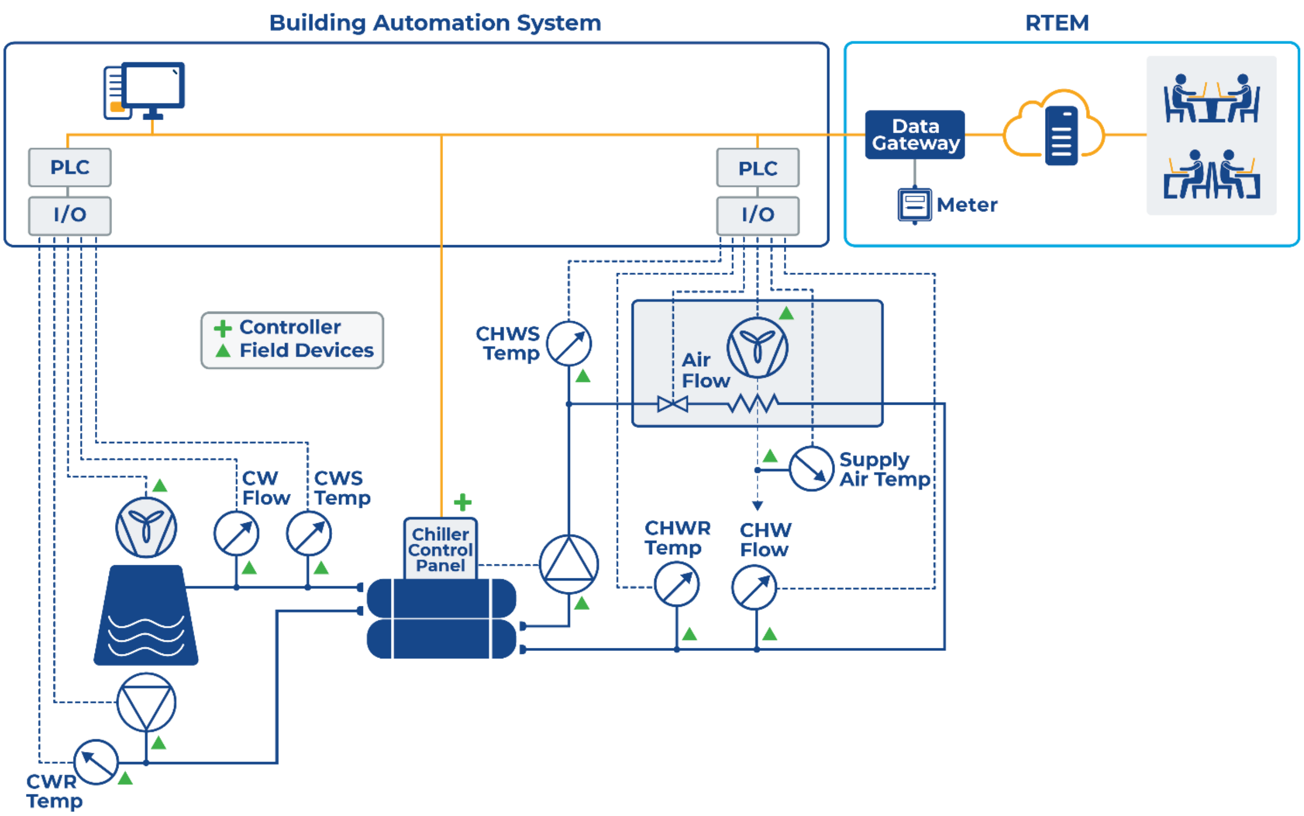
Allowing wide varieties of authorized users to have access to analyzed data tailored to the role of the executive elevates energy management to a strategic management function. Critical decisions such as the allocation of the capital budget become a data-driven exercise spanning historical, current, short-term and long-term futures.

BAS Integration with RTEM

Modern DCC supports industry-standard BACnet protocol, which streamlines integration to export data from the BAS and to allow control setting changes calculated by an RTEM system to be dispatched to the BAS. Many of the older BAS may be readily upgraded to support BACnet or can expand by using a data gateway device to bridge legacy BAS with RTEM system. Consequently, data from the BAS sourced by field devices and programmable controllers can be extracted by an RTEM system. This approach preserves the data sources from the BAS and maintains data integrity between the BAS and the RTEM system. BAS continues to perform local, sub-second types of control loop calculations, while RTEM, with access to a wide array of resources external to the building, provides optimization.

Figure 1 shows a BAS for a chilled water plant with multiple programmable controllers and field devices. The figure illustrates the use of the data gateway, whether a single device or panel consisting of multiple devices, to exchange data and commands with the BAS. The data from the BAS, supplemented with readings from electric meters, is transmitted to the cloud, where the RTEM software and database reside. Applications performing analytics, fault detection, and fault diagnostics are executed on a continuous, automated basis. Modifications to the BAS are either dispatched directly to the BAS or communicated to an operator. Additional engineering expertise can be used to optimize the building with the remote access that is intrinsic to applications residing in the cloud.

Figure 1. Integrating RTEM and BAS



RTEM for Building Portfolio Management

BAS is designed to reside within the four walls of a building. Each BAS, and its building, is a standalone entity. Using benchmarking to compare the performance of one building to the performance of other buildings identifies a larger number of optimization opportunities. Typically a one-time manual effort, manual benchmarking relies on tools such as EPA's Portfolio Manager. RTEM makes available a much wider and deeper set of KPIs to benchmark individual buildings or entire portfolios against the industry average as well as high-performing buildings. Going beyond EPA's Portfolio Manager, RTEM enables the comparison of a building's energy use intensity and individual building system performance, such as chiller efficiency in kW/ton, or boiler efficiency in fuel cost per 1,000 lbs of steam. The ability to enable portfolio-level management of buildings is perhaps one of the single largest differentiators of RTEM compared to BAS. Figure 2 illustrates how RTEM enables building portfolio management.

Figure 2. RTEM Enables Building Portfolio Management