Honeywell

Solution Note

HC900 for Data Centers

Summary

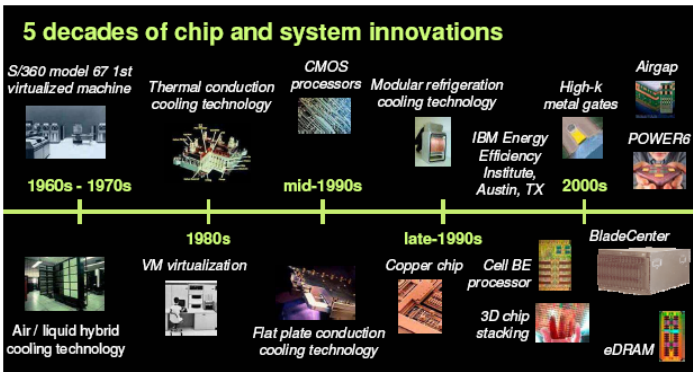
A typical data center consumes 10 to 100 times more energy per square foot than a normal office building. Aside from the huge energy cost involved, this leads to serious problems such as overheating, a high carbon footprint, and hot spots. All of these can affect the facility's reliability, which normally must be targeted at six-sigma levels. Data centers are therefore striving to reduce their energy consumption and sustain reliability greater than 99.999% of the server performance while lowering operating costs of HVAC energy usage.

Key to overcoming the specific challenges faced in a data center and ensuring the high reliability needed to maintain operation, is a control system with advanced control algorithms, smart field instruments to maintain optimum accuracy and performance, and wireless transmitters to detect overheating and hot spot problems. Honeywell offers an integrated control solution for data centers based around its HC900 Process Control System and smart field instruments including wireless transmitters.

This solution note describes the specific challenges faced by data centers, addresses the need to reduce Power Usage Effectiveness (PUE) values, summarizes the best practice guidelines outlined by the ASHRAE, and describes how Honeywell's integrated solution meets or exceeds these guidelines.

Introduction

The internet is on an unyielding curve of growth. Over 35% of the world's population connects to the internet today and the traffic is expected to quadruple by the year 2015. Behind all of these information sources is the "data center", the heart that beats to sustain this vast exchange. Even minor problems in the data center can "flat-line" a critical business, communication or social network.



Data Centers Technology

There are many challenges facing data centers today. One challenge is the tremendous pressure from the regulatory agencies that monitor carbon footprints to reduce energy usage and pollution. Many data centers use enough energy to light up a small city. Most data centers use an amount of energy to cool the servers that is equal or even greater than that used to power the servers themselves. The measurement of the energy efficiency of data centers has been normalized by the calculation of a metric known as Power Usage Effectiveness or PUE. PUE is the ratio of the total utility energy consumed by the data center (measured at the utility point of connection) to the energy portion used to power the IT equipment only.

Besides the cost of energy, data centers have to manage expectations from business-to-business, phone, communications, and social users, and ensure the highest level of reliability.

Depending on the size of the facility, the cost for downtime in a data center can range from thousands to millions of dollars. If the facility is a co-location and its reliability is the main factor driving sales, a downtime outage can lead to a rapid decline in customer service contracts. To avoid these losses, many data centers therefore run at 100% cooling capacity as a deterrent from hot spots and failing systems.

Conventional wisdom in the data center industry looks at IT equipment cooling like a “human comfort” cooling system. Facilities have therefore relied on standard commercial-grade HVAC equipment. However, the average data center (1000 m2) will use 10 to 100 times more energy per square foot than a typical office building. The cooling solution in a data center must also be managed and optimized to ensure that the temperature is consistent throughout the facility.

Key challenges

Energy consumption

In most data centers, 50% (or greater) of the energy cost is related to cooling the server area or server farm down to a manageable level. Cooling the center by every 1°F (0.56°C) consumes approximately 4% of the energy costs for the facility.

Overheating

Servers generate massive amounts of heat from their processors. The faster the processors are, the more heat they generate. If one server overheats, it can have a cascade effect on the other local servers and could possibly shut down an entire server farm or network. This crash can cost the data center owner millions of dollars in lost productivity and literally be catastrophic to the connecting businesses.

Carbon footprint

Associated with the high energy consumption is the related large carbon footprint, the resulting pollution, and the poor environmental image of data centers.

Humidity

Moisture is another issue facing data centers – the humidity in the server farm must be tightly controlled. Since cooling will dry out the air in the server room, data centers must manage static electricity and arcing in the servers. Conversely, if the humidity becomes too saturated, moisture build-up from condensate can damage electronic devices.

Hot spots

Hot spots always occur within a data center. Currently, they are discovered by using Infrared (IR) detecting cameras to map out the locations in the facility. However, not all hot spots are consistent, as server usage varies in a facility.

Water consumption

Water quality, usage, and control are also growing concerns. Due to the aggressive cooling processes, water quality must be maintained at a balanced level if it is used in a closed loop cooling system. Alternatively, monitoring for natural resource issues is necessary before the affluent is returned to the water source or city waste system.

Reliability

In a data center the cooling system controls must not fail. Control redundancy mitigates this risk but can be lacking in many data centers today. Some facilities will go to huge efforts and expense to build back-up cooling systems due to a control failure on their current system.

Inadequate HVAC system

Most HVAC systems, associated sensors, and control elements are designed commercially for human comfort levels. For example, HVAC sensors are generally designed for ‘ball parking’ the temperature to maintain simple control and comfort. These products are sold in a commodity market that requires very aggressive pricing. They are not designed to control an environment to less than 1°F (0.56°C) on a repeatable manner. They are not “smart” instruments characterized to compensate for ambient temperature changes or static pressure changes. Nor are they able to be ranged over a very broad span without jeopardizing accuracy or repeatability. A company in Dalles, Oregon randomly sampled their sensors after one year of operation and a crash, and discovered a 5°F (2.8°C) variable between sensors. Furthermore, HVAC control systems are not redundant and typically revolve around “On-Off” control. PID is almost non-existent.

Power Usage Effectiveness (PUE)

Power Usage Effectiveness (PUE) is a measure of how efficiently a computer data center uses its power. Specifically, it indicates how much of the power is actually used by the computing equipment, in contrast to cooling and other overheads.

$$\mathrm{PUE} = \frac{\text{Total facility power}}{\text{IT equipment power}}$$

An ideal PUE is 1.0. However, this is far from reality. For example, a facility with a total annual utility energy usage of 100,000 MWh, with 50,000 MWh to power the IT equipment, would have a PUE of 2.0.

Obviously, as the PUE increases, so does the cost. Assuming an electricity cost of $0.10 / kWh, the data center cited above has an annual operating cost of $10 million. If the facility’s PUE were

reduced from 2.0 to 1.5, the annual operating cost saving would be $2.5 million or 25%. Further reducing the data center's PUE to 1.2 would yield a total annual savings of $4 million or 40%.

PUE best practices

The Environmental Protection Agency (EPA) has identified a Best Practices goal of a PUE of 1.5 for data centers. The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) have declared the optimum PUE factor of 1.2 as the state-of-the-art goal. However, the vast majority of data center facilities throughout the world exceed 2.0 as the operating PUE. Many facilities continue to operate even far less efficiently and consequently there remains the potential for significant improvements.

ASHRAE guidelines

Several years ago ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers) established a series of recommendations based on known "Best Practices" in the data center market. The guidelines raised the bar on the type of control that one could use and still maintain reliability and repeatability. The guidelines regarding control established a number of challenges:

Reliability

The goal for a data center is 99.999% reliability. This is what is called the five 9's of reliability. In theory, the five 9's allow for approximately 6 seconds of downtime per week. The state-of-the-art goal is to achieve a design that meets 99.9999% reliability or six 9's. This would only allow for 0.6 seconds of downtime per week. This is a six-sigma level, meaning the probability the system would drop out is next to impossible.

Redundancy

Redundancy is established in a tier rating:

- Tier 1 – Non-redundant capacity components and single non-redundant path distribution paths serving the site's computer equipment.
- Tier 2 – Has redundant capacity components and single non-redundant distribution paths serving the site's computer equipment.
- Tier 3 – Has redundant capacity components and multiple distribution paths serving the site's computer equipment.
- Tier 4 – This is a fault tolerant data center with redundant capacity systems and multiple distribution paths simultaneously serving the site's computer equipment.

The critical factor here is that operating a data center that must have the five 9's of reliability must create a web of redundancy to achieve a fault tolerant system. Communication alone will not achieve that level of redundancy. The communication will just advise if it is working or not working; if a particular link is broken, operations will be flying blind.

The Honeywell solution

The Honeywell solution for data centers is based around three core components:

- The HC900 Process Controller for accurate process control
- Smart Field Instrumentation for temperature, pressure and flow
- XYR Series OneWireless™ Temperature Transmitters for accurate hot spot monitoring

HC900 Process Controller

The HC900 Process Controller is an advanced process and logic controller with a modular, scalable design that is built to work with a wide range of process equipment in a cost-effective way. It comes with a touch-screen operator interface which makes it very easy to operate. The HC900 possesses a flexible architecture that can accommodate the most demanding application, and with its advanced features and versatile connectivity, is capable of customized pinpoint control.

HC900 Process Control System

Specific benefits of HC900 - The robust control loops of the HC900 Controller support configurations from simple PID to interactive cascade, ratio, duplex, position proportioning and

three position step for motor positioning or custom control strategies. Standard for every control loop is auto-tuning using Honeywell's performance proven Accutune III tuning algorithm. A selectable "Fuzzy Logic" algorithm is also provided for each loop to suppress unwanted process setpoint overshoot. A soft start feature allows output rate limiting for protection of a process load on startup or after power failure.

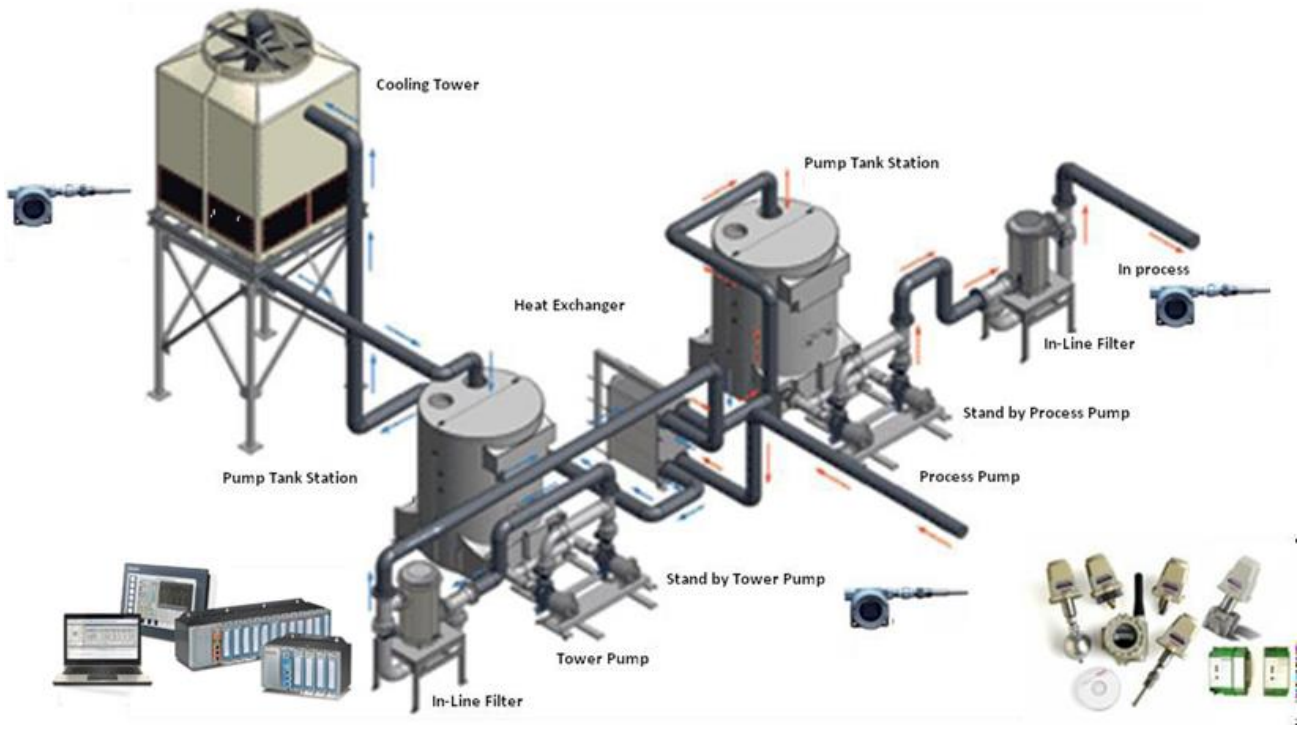
HC900 superiority over traditional PLCs (for data centers) - Accuracy is one of the most critical factors in determining the energy efficiency of a data center. The recommended ranges are from 64.4°F (18°C) to 80.6°F (27°C) based on current server technology. However, having the complete center balanced from chillers through cooling modules through to the server farm is critical to maintain the lowest possible energy use. Any spikes along the way could upset the entire process and jeopardize operations, or worse, cause an unplanned outage.

Accurate control of temperature and hot spot monitoring are key for data centers and HC900's advanced algorithms with accurate PID control make sure that we can provide energy efficiency and reduce the energy costs. In this latter area key differentiators of HC900 compared to traditional PLCs are accuracy, run mode editing, on-line monitoring, changes with limited process disturbance, and removal or insertion under power to keep the process running. These capabilities also help to protect the environment and reduce carbon footprint, which can be translated into better ROI.

HC900 superiority over HVAC systems - For data centers, the HC900 is particularly beneficial as it offers capabilities that most HVAC systems do not offer, such as:

- Redundant CPU's
- Redundant power supply
- Hot swappable boards
- Advanced PID algorithms
- Measurement accuracy 0.1% of configured range or 0.05% via field calibration
- OPC database capability: HVAC are typically proprietary
- Advanced control algorithms
- Open interface: HVAC are typically proprietary "only" HMI interfaces
- Flexible in terms of I/O: HVAC are typically rigid designs
- Accutune – The HC900 Accutune III is a powerful automatic self-tuning algorithm that can be used to calculate the optimum PID loop tuning parameters, simplifying furnace start-up and optimizing fuel usage. Accutune III can also tune the furnace control loops based on either a setpoint or process change.

Suppression – The HC900 Fuzzy Overshoot Suppression algorithm minimizes Process Variable (PV) overshoot following a setpoint (SP) change or a process disturbance. This is especially useful in processes that experience load changes or where even a small overshoot beyond the setpoint may result in damage or product loss.HC900 therefore offers key advantages over HVAC systems, which typically are not user-friendly.



Chillers – Central Control

HC900 and Honeywell Building Solutions - HC900 has been used on various projects by Honeywell Building Solutions. Here, HC900's features such as HC Historian and EBI History Backfill provide great differentiation to customers. Honeywell's Enterprise Building Integrator (EBI) is connected to HC900 using the Universal Modbus Driver (UMB). Pharmaceutical and other high-value customers had requested support to upload historical data into EBI should a network outage or a fault prevent the continuous collection of historical data. As a result, the HC900 Historian or Trend Backfill development was undertaken to secure this key customer need. In essence the HC900 Controller now collects a minimal set of plant history information, while EBI can now upload (or backfill) this historical data should the EBI History information have not been collected due to factors such as a network outage or EBI server failure. At all other times, the EBI History database remains the master. Backfills only occur when plant data is missing. This feature can be useful in data centers, as during a network outage it enables any sort of data to still be retrieved.

Smart Field Instrumentation

Honeywell's smart field temperature, pressure and flow transmitters offer accuracy, stability, and repeatability, with a Total Probable Error (TPE) of 0.34°F (STT-830) when calibrated with sensor. This contrasts with HVAC sensors which are typically +/- 0.5% of range by random samples at fixed conditions. This is an important differentiator as inaccurate feedback leads to lack of control. Furthermore, HVAC units are not "smart" so there is no possible characterization or diagnostics. Finally, Honeywell smart transmitters offer 0.01% stability over the life of the unit. HVAC offers nothing.

XYR Series OneWireless Temperature Transmitters

Wireless networking technology offers the ability to perform dynamic monitoring in the plant by moving and monitoring warm spots suspected in the farm. XYR Series OneWireless Temperature Transmitters are ideal to detect, measure and monitor hot spots, even in hazardous and remote areas. Since there are no wires to run, the transmitters can be installed and operational in minutes to quickly provide the desired process data. They offer the following benefits:

- Vision into the process that is both scalable and can offer a data collection system on a basic PC
- Excellent for troubleshooting hot spots
- Only take minutes to set up
- ROI can start from the first application
- No extensive training is required
- If location needs continuous monitoring the loop can be added in minutes and removed later at any time

Conclusion

Honeywell's control solutions are designed to protect and control data center processes that are worth millions of dollars and that cannot tolerate reliability issues. Whether your data center facility is 10,000 square feet to 750,000 square feet, Honeywell can provide a solution that will assure the five 9's of reliability related to cooling control. Honeywell has been providing this reliability to the oil & gas and refining industries since 1975 and we offer that same capability to keep data centers operating reliably and efficiently. Furthermore, Honeywell has enabled some data centers to achieve a PUE lower than ASHRAE's benchmarked best practice value of 1.2.

Furthermore, Honeywell control solutions offer quantitative benefits to OEMs and end users of data centers, including:

- Improved project efficiency leading to up to 15% cost savings
- Prevention of weeks of delay during late-stage design changes
- Improved production by up to 12-15%
- Lower total cost of ownership by up to 20-25%.

For More Information
Learn more about Honeywell's HC900 visit our website www.honeywellprocess.com or contact your Honeywell account manager.

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