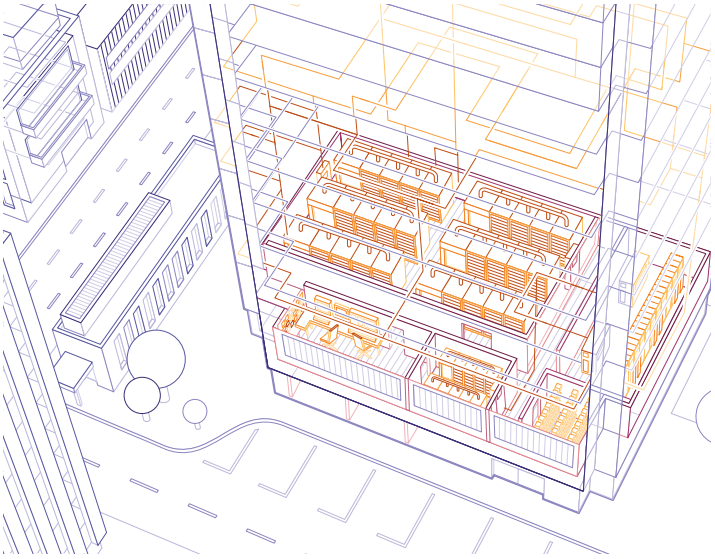
Whitepaper

Lessons learned from major data center outages

When US Airways, Research in Motion and Amazon.com experienced high-profile data center failures, the resulting service interruptions battered the companies' reputations and riled customers and shareholders alike.



The incidents also underscored the mission-critical nature of today's data centers. Entrusted with storing trillions of megabytes of information, data centers need to meet the needs of organizations that increasingly expect applications to run 24/7/365 and end-users worldwide who expect access to their applications and their data anytime.

As the failures can attest, outages—whether planned or unplanned—can exact a heavy toll on today's data center operators. Downtime has the potential to significantly impact the profitability, and indeed the very viability of an enterprise. At a cost of millions of dollars per hour, outages can take a big chunk out of the bottom line—and more.

With downtime not an option, data center operators must put in place high-quality maintenance programs to ensure 24/7 system availability.

The impact of data center outages

In a recent survey conducted by the Ponemon Institute, 95% of data center operators surveyed admitted to experiencing an unplanned outage in the last 24 months. Of those outages, respondents indicated that a full 80% could have been prevented.

Also noteworthy is the duration of the outages. Total outages averaged 107 minutes, while the average duration of a partial outage was 152 minutes. In addition to the tremendous financial cost of unplanned outages, other indirect—but no less important—impacts include:

- Business disruption.
- Lost revenue.
- Reduced end-user productivity.
- Cost to detect and remediate systems and core business processes.
- Legal and regulatory impact, including litigation costs.
- Lost confidence and trust among key customers and stakeholders.

Reasons for data center failures

Data centers fail for a multitude of reasons, including human error, equipment failure and environmental issues. However, the majority of data center outages fall within several discrete categories.

Leading causes of data center outages

Over the last five years, ABB has found that the main root cause of failures leading to data center outages included (ranked from most common to least common):

Rank	Root Cause
1	Human error
2	UPS & battery systems
3	Genset & transfer switch systems
4	Mechanical and moving parts, such as belts and pumps
5	Breaker coordination
6	Capacitors
7	Harmonic Filters
8	Water incursion

Lessons from major outages

All these root causes have a common thread: Operational and equipment issues which could generally have been avoided through appropriate maintenance systems and processes. Given the mission-critical nature of today's data centers and the enormous cost of outages—in terms of revenue, time, productivity and reputation—how can data center operators ensure that mere maintenance issues don't spiral into outages? Here are five ways.

1. It all begins with design.

As organizations become increasingly dependent on data center systems, a clear need exists for greater reliability in the critical infrastructure. The reliability of a system lasts only as long as the shortest component life in the unit. For instance, in the Amazon case, the failure was traced to a ground fault that caused a failure in a programmable logic controller (PLC), which resulted in insufficient power for all servers to continue operating.

Because even the smallest repair to a single component can cause a significant downtime, data centers are increasingly incorporating low-maintenance or maintenance-free parts into data center designs. These components are designed to save hours of maintenance each year and often allow for safe withdrawal of functional units while the gear is on line, which enables easy and cost-effective maintenance.

2. Practice condition-based maintenance.

Most data centers historically have employed one of two basic types of maintenance programs: a reactive response to faults or a preventive maintenance response in which a scheduled task is performed periodically based on vendor recommendations or historical failure data.

Because of the premium placed on 24/7/365 uptime, few of today's modern data centers solely employ a reactive posture to maintenance. Rather, many data center operators use a traditional, preventive maintenance regimen, through which equipment maintenance is performed according to a predefined schedule, regardless of the apparent health of the equipment.

Despite its popularity, this preventive-maintenance model has several drawbacks. By its very nature, preventive maintenance requires invasive procedures, which inject the risk of human error and the potential for unplanned downtime. The less frequently that invasive procedures are performed, the smaller the risk of human mistakes and accompanying downtime.

In addition, when it comes to maintenance, too much of a good thing can actually be a bad thing. Traditional preventive maintenance doesn't allow the data center operator to understand whether a piece of equipment truly requires the service it is nonetheless going to receive. As a result, the cost—in labor, parts and downtime—to replace a part that may not be near its failure state can be significant. Also, the process of repeatedly removing equipment from service for maintenance has the potential to cause unnecessary wear, eventually rendering the equipment less reliable over time.

Because of these limitations—and the need to ensure high levels of uptime, prolong equipment life and reduce total cost of ownership—many organizations are beginning to supplement schedule-based preventive maintenance with condition-based maintenance, or predictive maintenance. In this model, the data center operator decreases some of the maintenance that's based on a rigid schedule while increasing the ability to monitor key diagnostics that identify a need to perform maintenance on a piece of equipment.

Under condition-based maintenance the data center operator assesses failure and downtime risks and projects equipment condition over time. A condition-based maintenance approach helps identify particular equipment pieces that are most likely to experience defects that require repair or replacement. Conversely, it also helps identify which equipment components most likely will remain in acceptable condition without the need for maintenance. As a result, the data center operator can target maintenance to the areas where it provides maximum benefits while causing minimal disruption. Using condition-based maintenance, the data center operator can see, for example, the number of cycles a piece of switchgear has performed, the number of strokes a valve makes or the amount of hours a pump has run.

The primary enabler of condition-based maintenance is software that allows the data center to carefully monitor equipment condition. This software, which is often part of a Data Center Enterprise Management (DCEM) system, allows data center equipment to provide a virtually limitless amount of self-diagnostic, predictive and usage information. It broadcasts warnings when individual components are displaying abnormal readings and can even make recommendations for equipment maintenance or replacement.

To enable the level of predictive modeling to achieve condition-based maintenance, each piece of equipment in the data center is benchmarked against its peers and against historical norms for comparable products. From there, a typical performance profile is compiled and alarm triggers established. The software can combine input from multiple measurements and diagnostics and assess if there is a problem. This is important in situations where the individual pieces of information may seem valid on their own, but when considered in combination, are not. One example of this could be where a chiller is running on a cool night where it should be off since the air side economizer can cool the IT room on its own. Even though there is no process problem, it is inefficient and is probably due to someone leaving the unit running in manual mode. If the software detects equipment that is operating properly but has readings that are outside the established norm, an alert is issued and the data center operator is able to intervene.

Condition-based maintenance can be established and used for virtually all electrical and mechanical equipment in a data center, including switchgear, drives, pumps, coils, compressors and more.

3. Use the right monitoring systems.

In recent years data centers have experienced tremendous growth, both in size and complexity. Some of today's data centers are massive complexes that, size-for-size, consume approximately 30 times the power used to run the average office building. To manage this seemingly exponential growth, operators have increasingly turned to systems that allow them to optimize assets and monitor critical systems, as they would by employing a condition-based maintenance regime.

In many cases, however, data center operators find themselves burdened with too much raw data to process quickly and effectively. This avalanche of statistics is often overwhelming, forcing operators to dig through seemingly endless streams of data from multiple systems and struggle to make sense of what's been presented to them.

A Data Center Enterprise Management (DCEM) system provides the data center operator with an integrated view and unified, easy-to-comprehend information across the full spectrum of mission-critical processes and offers complete visibility into systems, energy use and resources across multiple sites.

In addition, by providing real-time equipment health status today's latest DCEMs enable highly advanced condition-based maintenance. Through continuous diagnostic monitoring and defined and stratified alarm levels, DCEMs can quickly diagnose equipment issues before they raise alarms, recommend service when equipment is not operating to its full potential and even issue maintenance tickets, work orders and followup reminders.

Example: Applying condition-based maintenance to data center batteries

Batteries lend themselves well to condition-based maintenance. Batteries are among the weakest links in a data center; a single bad cell among thousands of cells has the potential to take down an entire data center. Plus battery failures can be particularly insidious because batteries usually provide no outward indications of a problem until they're called upon and discovered to be unreliable.

The service life of a battery varies, and depends largely on several factors, including frequency of usage, ambient temperatures to which it is subjected and the quality of its connections and terminals.

Using condition-based maintenance procedures, data center operators can continuously monitor a wealth of performance data related to battery conditions. They can evaluate battery voltage over time and conduct discharge tests to determine precisely where each battery is in its lifespan. Using intelligent battery monitoring systems they can spot when individual cells within batteries become problematic. With that information available at a glance, batteries can easily be replaced before they cause a failure that could cascade throughout the system.

4. Get a single view of the facility.

A data center's mission-critical systems need to be watched closely to ensure maximum uptime. To do that, data centers frequently rely upon multiple monitoring systems, each addressing its own component or components. However, there's often little integration or commonality between these disparate systems. They frequently feature different displays, methods of navigation and on-screen behaviors. For instance, a particular color—say, red—in one system may indicate danger, while in another system it may indicate something entirely different.

As a result, monitoring the status of a complex facility from multiple workstations can be cumbersome and inefficient, often leading to errors or oversights. It can also increase costs because of the extensive training needed to master multiple systems.

Data centers are finding the solution to this issue in a single, integrated operator interface such as the one available in ABB's Decathlon™ DCEM solution. This interface, or dashboard, helps to automate maintenance processes and improve ease of operations by offering a single window into all corners of the data center—electrical, server, asset, building, power and network management. The dashboard alerts operators to all alarms or pending issues, automates data center maintenance with information directly from the DCEM and allows operators to quickly drill into problems associated with any electrical or facility asset.

The dashboard helps streamline operations by displaying consistent navigational behaviors across the system and displaying information in an easy-to-read manner that's relevant to the user. By right clicking on an indicated device, the console operator can drill down to obtain contextual information about what's shown on the display or even call up a service manual for the device indicated.

The dashboards also feature condition-based alarms that provide crisp, clear indications of system problems and severity and allow operators to view possible causes and suggested actions. Similarly, the interface also provides access to a complete system audit trail that provides data center operators with powerful data to look back in time to identify the root cause of a fault and take steps to ensure the issue is not repeated in the future.

5. Call in the experts.

As data centers become larger, more powerful and more complex, data center operators frequently lack the expertise and resources to keep pace with increasingly complex processes, procedures and equipment. In most cases, maintenance and support of the electrical and automation equipment integral to running the data center is not the core competency of data center personnel.

The solution for most data center operators is to enter into a service partnership in which an outside organization, such as ABB, commits to maintain and improve the production equipment. Under this type of agreement, the vendor assumes responsibility for engineering, planning, executing and managing an entire data center's maintenance activities. This allows the data center to improve reliability and availability and reduce costs through access to a wealth of knowledge and resources from an organization that features a committed, dedicated staff with vast experience in data center design, operations and maintenance.

A related option for overcoming maintenance and operational challenges is to take advantage of expert remote support service offerings. ABB and other organizations offer services in which remote experts carefully monitor a data center's critical systems and can quickly identify and diagnose potential problems before they escalate into an outage. ABB estimates that remote support may be able to prevent up to 95% of the problems that typically cause outages.

Conclusion

Today's data centers are increasingly mission critical and must meet the needs of organizations that expect applications to run 24/7/365 and end-users who expect unfettered access to their applications and data. The price of data center failures can be high, including business disruption, lost revenue, reduced end-user productivity, legal and regulatory costs and lost confidence among key customers and stakeholders.

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To guard against failures, data center operators must implement high-quality maintenance programs to ensure 24/7 system availability. Many organizations are supplementing traditional, schedule-based preventive maintenance with condition-based maintenance, or predictive maintenance. Under this model, the data center operator assesses failure and downtime risks and identifies the equipment that is most likely to experience defects that require repair or replacement. The data center operator can then target maintenance to areas of maximum benefit and minimal disruption.

Data center operators can take other actions to help ensure that maintenance challenges do not become major outages. These include incorporating low-maintenance or maintenance-free parts into the data center design and employing systems that provide an integrated view and complete visibility into systems, energy use and resources. In addition, organizations should also consider service partnerships with outside organizations, such as ABB, that commit to maintain and improve production equipment and take advantage of services in which remote experts carefully monitor the data center's critical systems and can quickly identify and diagnose potential problems before they escalate into an outage.

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