Next-generation Full-stack Data Center: Improve Efficiency and Reduce Costs with Intelligent Operation & Maintenance

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Data Center Upgrade Challenges Manual Operation and Maintenance

With the rapid development of digitization and network technology, more and more traditional industries embark on the digital transformation journey. This trend of the digitization across industries generates a range of data processing and storage requirements. Driven by this trend, large and super-large data centers have become a priority in construction of next-generation data center infrastructure. In the meantime, the business loads as well as the scale and complexity of data centers has grown rapidly. To ensure the stable operation of data centers for high-load business scenarios, onsite operation and maintenance (O&M) also faces tremendous pressure.

For large data centers of operators, apart from routine inspections, troubleshooting, software and hardware upgrades, etc., the alteration of business applications is often required to align with the changes of customers' business. At present, this type of O&M is dominated by human inspection, which is difficult to conduct, experience-dependent, highly instable, and expensive. Once equipment failure occurs, the traditional identification and troubleshooting is an obstacle to ensure stable operation of data centers for it takes a long time to locate the fault. With data centers become more complex, the demand for experienced O&M staff is increasing, which means it is necessary to expand the team and arrange training for O&M personnel. This further increases the labor cost of O&M, hindering the reduction of overall O&M costs.

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It's Time for Intelligent O&M

Data center O&M is now facing severe challenges, as the scale and complexity of data centers are growing yet the human resources are in shortage and the O&M costs are very high. The O&M of most data centers now rely heavily on the experience of O&M teams and individuals. This model may operate effectively in small or medium-sized and single-business data centers at present, but there exist potential instable factors. First, the reliance on human experience puts an upper limit on the effectiveness of O&M. The risk of losing technical staff also brings instability. Secondly, there is a difference between O&M standard process and actual human experience. In practical, the way to deal with this difference depends on O&M staff, which may result in the actual operation deviating from the standard process in the pursuit of efficiency. In addition, with the O&M become more difficult, the expertise of O&M staff and team size are required to improve, which will inevitably increase labor costs. This becomes a barrier to reduce the overall operating cost for data center.

These contradictions will become more prominent in the next-generation data centers with higher complexity. As the operator of a large number of data centers, players are pressed to rethink future O&M requirements, find and quickly implement more efficient O&M solutions, improve the efficiency and effectiveness of O&M in large-scale and complex environments, and reduce the O&M costs under these premises. To fundamentally resolve this problem, it is important to comprehensively improve the quality and efficiency of data center O&M and management and save O&M costs through intelligent digital technologies.

Basic O&M Inspection

More than half of the data center O&M effort is to carry out equipment inspections and routine maintenance on a regular basis, as well as implement major overhaul and drills on an annual basis, which requires a lot of manpower to check and record the status of the security, fire protection, air conditioning, power distribution systems of the computer room. The disadvantages of human inspections include frequency and route restrictions, blind spots in monitoring and management, difficulty in accurately identifying equipment problems for some O&M staff with less expertise and in consolidating and analyzing the running status based on human inspection records.

An intelligent O&M first needs to address various problems of human inspection by using less or even zero onsite personnel to meet inspection and maintenance needs, which requires automatic inspection equipment to replace inspectors, and various sensors throughout the computer room to replace human fault identification with the goal of achieving equipment-level granular monitoring. In the standard process of digital O&M, sensors collect equipment operating parameters such as temperature, load, and current and upload to a unified digital O&M platform, where these data will be automatically used to generate the O&M logs. For data centers requiring close inspection, robots could be deployed for onsite inspections to send the equipment image or noise when moving along the path to the cloud-based O&M platform in real time through image/sound sensors. The equipment status could be judged using cloud-based AI algorithm and then the parameters will be

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dynamically adjusted according to changes of IT and cloud requirements. This also enables O&M staff to control the operation of multiple data centers through large digital displays, monitoring maps, mobile apps, and other interfaces anytime and anywhere, and keep track on the operating status of equipment.

Furthermore, when the centralized operation inspection platform harvests sufficient historical operation data from various equipment in the data center, it will support the digital simulation of operating status and patterns of all equipment with AI algorithm, and the structural integration and record of various O&M parameters of all equipment, so that to proactively detect potential instable factors, automatically trigger risk management, and then perform preventive maintenance to a certain extent without human intervention. The closed-loop risk management is realized by this way.

Fault Identification and Response

The fault handling capability of data center is an important criterion to assess the effectiveness of O&M, which is crucial to the stability and performance of business applications. In a traditional data center, when a fault is detected through human inspections or equipment alarms, the O&M staff would locate the fault based on personal experience and O&M manual, identify the cause, and then address the problem. This process is not only time-consuming, but also heavily relies on the expertise and experience of O&M staff. For faults difficult to troubleshoot, it is not easy to respond effectively and in time, thus seriously affecting the stability of the data center.

In the larger and more complex next-generation data center, the potential causes of equipment failure will be more complicated, which means human experience is not enough for effective identification and troubleshooting. Therefore, an intelligent O&M management system enabled by AI is particularly important to fault handling. On top of the basic intelligent O&M, the O&M platform has realized centralized monitoring, unified management, and preventive maintenance of various equipment. For fault identification, an AI-driven fault training platform is required for fault diagnosis and prediction. AI training materials not only include equipment logs, diagnosis, operation records, etc., but also human experience and specific rules to accelerate the modelling.

Through this AI-powered fault detection model, O&M platform could automatically inspect each unit rapidly, narrow the scope of failure, and then accurately identify the specific type of the failure. For those faults with little impact and easy to handle, the platform can automatically deal with them through load adjustment, cooling adjustment, etc. and make records. For hardware such as cables, ports, equipment, etc., the O&M platform will show troubleshooting suggestions based on historical data through a visual interface. Apart from this, there is information provided to the O&M staff like detailed route, fault location, and operation steps for onsite handling, aiming at significantly lower the technical threshold for fault handling.

For difficult problems that cannot be accurately identified by AI-powered fault detection system, O&M technical experts are required to make a more careful diagnosis. To solve the problem of limited number of technical experts and unavailability for an onsite in-time troubleshoot, a remote online network should be established on the intelligent platform, sharing all parameters of the fault with experts at different locations. After online consultation, technical experts will send the diagnostic results and treatment suggestions to the onsite O&M staff through the platform. Thanks to the remote fault diagnostic platform, a team with a few technical experts is enough to guarantee

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the operation of multiple data centers, and the skills and experience requirements for onsite O&M staff can also be lowered.

O&M Costs

In traditional data centers with manual O&M as the mainstream solution, labor cost is an important part of operating expense. As the business requirements change, human resources for data center O&M are also facing high instability. Due to the need for a certain team size, O&M personnel often have short training periods and lack of professional experience. The control of labor costs also leads to a serious loss of O&M experts. For data centers where stability is everything, the instability of O&M human resources becomes one of the biggest obstacles to further development. It is hard to strike a balance between maintaining a highly professional team and controlling operating costs.

In the next-generation data center, an intelligent O&M system will mitigate this pain point. The significance of an intelligent solution is to reduce the dependence on manpower and human experience to some extent: with sensors and robots inspections replacing human inspections, AI-enabled fault detection model replacing human experience-based troubleshooting, and intelligent proactive prevention replacing passive fault response, the O&M process can be much less complicated, thereby reducing the size of onsite O&M team, lowering the technical and experience requirements for O&M staff, and bringing down the training and labor costs. The experience of technical experts can be cloud-based, i.e. provided through an online O&M platform. Compared with the traditional one-to-one onsite troubleshooting, the improved utilization efficiency of expert experience could greatly reduce the unit cost of an expert team. Thanks to the reduction of expert costs and onsite team costs, the next-generation data center powered by intelligent O&M could not only improve O&M effectiveness, but also slash the overall O&M labor costs by more than a third.

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Summary

As a carrier for cloud-based data computing and storage, data center has become an indispensable digital infrastructure in the information society with the booming mobile internet and cloud computing. For operators, stable, highly efficient, and low-cost data center operations are their key competitive advantages in the digital industry. In the next stage of information era, the continuous growth of business loads will make O&M more difficult and expensive. To further boost the competitiveness of data centers, it is urgent to renew the data center O&M with highly intelligent digital technologies.

Compared with the planning, design and other efforts around data center, O&M still relies heavily on human experience. The shift from manual O&M to intelligent solutions is inevitable. Apart from business stability, consideration of the labor costs is also driving this move. AI-based intelligent O&M system could continuously optimize the efficiency and effectiveness of O&M for a period of time in the future, enable closed-loop management in specific areas, replace some manual operations, and reduce the size of an O&M team.

In the long run, the degree of intelligent O&M will be further strengthened as the continuous AI model optimization will maximize the efficiency of basic O&M, and the platform will cover almost all O&M tasks across various fields. At the same time, for most potential faults, AI-based fault detection model can accurately identify them, provide feedbacks, and automatically make troubleshoots through O&M platform. With the manual work further reduced, the low-cost unmanned O&M could be ultimately realized.

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Appendix

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