Research on intelligent operation and maintenance management method of enterprise IT

Xiaoshuang Wang¹, Yaofeng Su¹, Qiang Li¹,* and Feng Han¹

¹ College of Information Communication, National University of Defence Technology, Wuhan, China

*Corresponding author e-mail: frank1188@163.com

Abstract. With the gradual deepening of the influence of artificial intelligence technology on all walks of life, enterprise IT operation and maintenance management is also undergoing changes in a more intelligent and advanced direction. In order to change the practical problems of enterprise IT operation and maintenance management, such as single method and lack of means, this paper analyzes and studies the overall framework of enterprise IT intelligent operation and maintenance management technology, and deeply analyzes the key intelligent methods in operation and maintenance management, such as fault prediction, fault analysis, operation and maintenance scheduling, so as to provide support for effectively improving the level of enterprise IT intelligent operation and maintenance and systematic support ability.

1. Introduction
The goal of modern enterprise operation and management is to maximize comprehensive income, which means that enterprises need to reform their management models and methods. Enterprise IT operation and maintenance management is one of the important research contents. As modern enterprise IT-related software and hardware systems become larger and more complex, this means that the main objects of operation and maintenance are huge, complex, and diverse, and the boundaries of operation and maintenance continue to expand. Operation and maintenance data has become increasingly quantified, and the traditional manual operation and maintenance management model has gradually been unable to adapt.

The problems arising from technological development must be solved by technology. Only by introducing new technologies and new ideas in the field of operation and maintenance management can the level of operation and maintenance be better improved. Therefore, enterprise operation and maintenance management work increasingly needs to keep up with the development trend of IT information technology and make changes in a smarter and more advanced direction.

This article aims to straighten out the status quo of the development of enterprise IT operation and maintenance management, explore the application evolution path of intelligent operation and maintenance technology and methods, so as to effectively enhance the effect of operation and maintenance management and improve the efficiency of operation and maintenance management.

2. Research status of intelligent operation and maintenance
With the development of information technology, the development of enterprise IT operation and maintenance management has roughly gone through four stages: manual stage, tool and automation stage, platform stage and intelligent operation and maintenance stage.
Gartner proposed the concept of Artificial Intelligence for IT Operations (AIOps) in 2016 and predicted that the global deployment rate of AIOps will increase from 10% in 2017 to 50% in 2020[1]. At present, many scientific research institutions (such as Tsinghua University NetMan Intelligent Operation and Maintenance Laboratory, etc.), Internet companies (such as Alibaba, Baidu, JD Finance, etc.), large financial institutions (such as Bank of Communications, Bank of China, etc.), technology manufacturers (such as Splunk, IBM, Huawei, etc.) are all at the forefront of intelligent operation and maintenance engineering applications, and have built practical applications such as operation and maintenance big data platforms, intelligent analysis and decision-making, automation tools, and achieved good operation and maintenance results.

In 2019, Professor Dan Pei of Tsinghua University predicted the ecological trend of the AIOps industry[2]. He pointed out: "All industries are trying to implement AIOps, which provides a good industrial foundation for the direction of AIOps. "Production, learning, research, and application." All parties are actively following up and forming an AIOps ecosystem."

3. The overall framework of operation and maintenance management intelligent technology

For enterprise IT, traditional IT tools still play a role to fully protect the initial investment of the enterprise. Intelligent operation and maintenance management is the integration of artificial intelligence technology into the operation and maintenance system, based on big data and machine learning, from a variety of data sources Collect massive data (including logs, business data, system data, etc.) for real-time or offline analysis and mining, automatically learn and summarize rules from the massive operation and maintenance data, and assist operation and maintenance personnel to make accurate decision-making and judgment, so as to achieve better and faster decision-making and task process automation.

Therefore, operation and maintenance management is essentially a looping iterative process of observation, judgment, decision-making, and implementation. It is expected that abnormalities can be quickly identified, faults can be accurately located, root causes can be identified in a timely manner, and prompt response and treatment can be achieved to achieve high-quality and efficient vision goals. From a technical perspective, intelligent operation and maintenance management directly perceives and collects various types of key operation and maintenance data based on multi-dimensional and massive time series KPIs, text logs, and alarm information[3]. After processing, it meets certain specifications and quality requirements; based on big data Above, use machine learning and other artificial intelligence algorithms for analysis and mining, analyze and determine the root cause and propagation relationship of operation and maintenance events according to specific operation and maintenance scenarios, give corresponding decision-making suggestions, and finally directly handle operation and maintenance operations with the help of automation tools. The overall framework of operation and maintenance management intelligent technology is shown in Figure 1.

In order to construct a knowledge graph in the operation and maintenance field, it is necessary to sort out the knowledge sources of operation and maintenance management. This knowledge is contained in structured (such as alarm events, monitoring data, etc.), semi-structured (such as configuration management information, logs, etc.), and unstructured (such as various specifications, manuals, and cases) data. The corresponding data, Acquisition of corpus for collection and extraction. And then carry out related knowledge storage, knowledge modeling and representation, knowledge complement and fusion, knowledge calculation, etc., to complete the construction of the knowledge map of the operation and maintenance domain. With the support of the knowledge map in the operation and maintenance field, by focusing on the collection of relevant historical data and real-time data in the operation and maintenance scenarios, research and implementation of intelligent failure prediction, intelligent failure analysis, intelligent operation and maintenance scheduling and other key landing scenarios technical methods.
4. Intelligent fault prediction method based on massive data

Fault prediction is the most basic activity in operation and maintenance management. Traditional operation and maintenance usually uses operation and maintenance methods to handle exceptions after they are found, and service quality and user experience are often affected to varying degrees. If the passive processing after the operation and maintenance is transformed into the active prediction beforehand, the user experience and operation and maintenance efficiency will be greatly improved[4].

4.1. The basic idea

The intelligent fault prediction method based on massive data relies on the machine learning and deep learning capabilities of artificial intelligence, through the actual collection of information system operation and maintenance data and simulation to generate part of the training data, and extract and analyze the invisible characteristics of the foreground business abnormality in the stage before the failure event[5]. Common features such as decline in network indicators, sudden changes in background service interruptions, and classification of major, major, general, and abnormal failure levels, and effective prediction of failures.

4.2. The main steps

The intelligent fault prediction method uses machine learning and deep learning to mine the deep correlation characteristics between faults and abnormalities, analyzes the application data carried by the system, and establishes a predictive model with the help of data analysis technology to objectively and accurately capture the pre-failure symptoms, and then predict the fault. The specific method steps are shown in Figure 2.
First, offline historical data analysis and mining system performance indicator trends and in-depth correlation characteristics of objective data, such as operating environment, business volume emergencies, major security tasks, etc. Then the performance indicators are monitored online in real time, and the trained feature rules are used for matching inferences, the performance trend is analyzed, and the system performance indicator trends are timely predicted. Intelligent fault prediction obtains the prediction model through the training of offline historical data. After online deployment, it conducts performance testing through regular data collection. At the same time, the trained model is used for fault prediction and reasoning. If there is an unpredictable fault, then Summarize the stage data before the failure time point as training input, retrain the prediction model, and continuously iterative optimization.

5. Intelligent failure analysis method based on business characteristics
Failure analysis is the most common activity in operation and maintenance management. Enterprise information system failures show diversity, such as performance alarms, KPI abnormalities or business failures[6,7]. A single failure alarm can no longer reflect accurate failure information, and it is difficult for operation and maintenance personnel. Rely on empirical judgment and rapid and accurate positioning.

5.1. The basic idea
The intelligent fault analysis method takes the characteristics of the system carried by the business as the entry point, comprehensively analyzes the operation and maintenance data of the enterprise information system network, hardware, software, data, cloud platform, etc., performs fault prediction and problem analysis, and makes up for the shortcomings of the traditional operation and maintenance methods. Through the use of intelligent fault tracing technology, common features can be extracted from diversified alarms, quickly leading to the point of failure, reducing the difficulty of operation and maintenance, and improving the efficiency of operation and maintenance.
5.2. The main steps

The intelligent fault analysis method is based on big data analysis and artificial intelligence feature mining, and comprehensive multi-dimensional historical data analysis based on the network and other software and hardware and business subordinate relationships in the system, such as: KPI, alarm, performance, configuration, log, fault resolution history, Operation and maintenance work order historical data, etc., mining potential features and rules that cannot be summarized by manual experience, and outputting a matching rule library for fault events and features. In the actual operation and maintenance process, the fault rules are automatically matched to diagnose according to the fault characteristics, and judgments and handling suggestions are given. At the same time, it can be combined with intelligent work order management technology to achieve precise fault location and trigger operation and maintenance resource scheduling. The specific method steps are shown in Figure 3.

![Figure 3. Schematic diagram of intelligent failure analysis method](image)

Intelligent fault diagnosis is a key step of fault analysis, which mainly includes the generation of diagnosis rule base and the operation of diagnosis rule[8]. Among them, the generation of a diagnostic rule library based on AI learning includes multi-dimensional historical data acquisition, and based on historical data, features and rules mining data realized by artificial intelligence model algorithms. The operation of diagnostic rules includes system monitoring, acquisition of real-time fault and alarm information, matching rule base, root cause analysis, intelligent fault diagnosis, and associated O&M system to issue O&M requirements[9]. After O&M, the effectiveness of O&M is reversed Revise and strengthen the existing rule system, conduct self-learning and self-optimization.

6. Task-driven intelligent operation and maintenance scheduling method

Operation and maintenance scheduling is the most critical activity in operation and maintenance management. After performing operation and maintenance tasks, especially locating faults, it is necessary to arrange operation and maintenance personnel for disposal as soon as possible, and dispatch various operation and maintenance forces to complete the operation and maintenance of the network, hardware, software, data, security and cloud platforms. The quality of the disposal effect directly determines the efficiency of operation and maintenance.

6.1. The basic idea

The intelligent operation and maintenance scheduling method quantifies the system operation and maintenance activities into the content of the work order by establishing a scientific and standardized work order system, circulation procedure and circulation mechanism, and effectively connects the operation and maintenance personnel and the operation and maintenance activities through the work order to form a task-based system. Driven intelligent operation and maintenance scheduling process, shorten processing time and improve response efficiency.
6.2. The main steps
Intelligent operation and maintenance scheduling technology includes fault work order early warning and real-time intelligent scheduling based on AI learning. The specific method steps are shown in Figure 4. Fault work order early warning extracts feature vectors related to the occurrence of faults from historical work order information, and generates fault models with the help of AI classic prediction algorithms such as polynomial fitting and neural networks. Through this model, the current feature is extracted to predict the possibility of failure, which provides strategic reference for active operation and maintenance. Real-time intelligent scheduling uses genetic algorithms to automatically plan the path that meets the global optimal scheduling based on work order types, requirements, priorities, spare parts, and fault locations, to achieve real-time scheduling.

![Figure 4. Schematic diagram of intelligent operation and maintenance scheduling method](image)

7. Conclusion
By studying intelligent fault prediction, analysis, and scheduling methods, a complete closed-loop solution for enterprise IT operation and maintenance management from anomaly detection, alarm convergence, correlation analysis, fault location to processing can be realized, which can effectively improve the level of enterprise IT operation and maintenance management and ease operation and maintenance Manage human resource contradictions, and deeply integrate intelligent operation and maintenance capabilities with operation and maintenance management processes, operation and maintenance organization structure, and operation and maintenance automation to form an integrated intelligent operation and maintenance capability.

References
[1] Gartner.https/blogs.gartner.com/andrew-learner/2017/08/09/aiops-platforms/Liu D, Zhao Y, Xu H, et al.Opprentice: Towards Practical and Automatic Anomaly Detection Through Machine Learning[C]//Proceedings of the 2015 Internet Measurement Conference. New York: ACM Press, 2015: 211-224.
[2] PEI Dan, ZHANG Shenglin, PEI Changhua. Intelligent Operation and Maintenance Based on Machine Learning[J]. Communications of CCF, 2017, 13(12): 67-73.
[3] ZHU Haiqi, JIANG Feng, Research and Analysis of Anomaly Detection Technology for Operation and Maintenance Data in the Era of Artificial Intelligence, NetInfo Security. 2019, Vol. 19 Issue (11), pp 24-35

[4] Song Hai-tao, Wei Da-wei, Tang Guang-ming, et al. Anomaly detection of single user behaviors based on pattern mining [J]. Journal of Chinese Computer Systems, 2016, 37(2): 221-226.

[5] Jiahao Bu, Ying Liu, Shenglin Zhang, Weibin Meng, Qitong Liu, Xiaotian Zhu, and Dan Pei. Rapid deployment of anomaly detection models for large number of emerging kpi streams. In IEEE IPCCC, 2018.

[6] Shenglin Zhang, Ying Liu, Weibin Meng, Zhiling Luo, Jiahao Bu, Sen Yang, Peixian Liang, Dan Pei, Jun Xu, Yuzhi Zhang, et al. Prefix: Switch failure prediction in datacenter networks. Proceedings of the ACM on Measurement and Analysis of Computing Systems, 2(1):2, 2018.

[7] ADEREMI O, ANDRONICUS A A. A Survey of Machine-learning and Nature-inspired Based Credit Card Fraud Detection Techniques[J]. International Journal of System Assurance Engineering and Management, 2017, 8(2): 937–953.

[8] KWON D, KIM H, KIM J, et al. A Survey of Deep Learning-based Network Anomaly Detection[J]. Cluster Computing, 2019, 22(1): 949-961.

[9] LITJENS G, KOOI T, BEJNORDI B E, et al. A Survey on Deep Learning in Medical Image Analysis[J]. Medical Image Analysis, 2017, 42: 60-88.

[12] MOHAMMADI M, ALA A F, SAMEH S, et al. Deep Learnin