Research on Digital Operation and Maintenance of Information System in Distributed Environment

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Abstract. In recent years, the idea of information system construction has been continuously innovated due to the microservice architecture and domain driven design. Enterprises also have a new understanding of the importance of their own information security and data assets. But unfortunately, if we continue to use the original operation and maintenance environment and mechanism for waterfall development, the new information system under the microservice mode will not be applicable. For example, due to the lack of operation and maintenance positioning standards brought by the new development framework, the data source is not clear due to the microservice in hundreds of virtual machine environments, and the operation and maintenance quality lacks effective supervision. This requires a set of operation and maintenance standards and system quality assurance applicable to the new microservice design ideas. This research is based on this theory. This system is a collection of activities that give corresponding power and control to the software and hardware management of information. It includes four elements: organization, system, process and tool. The application results in this study show that the construction of this system greatly improves the management efficiency of operation and maintenance at all levels, improves the intelligent level of operation and maintenance, and plays a positive role in promoting the stable operation of the entire information system.

1. Introduction
In the era of transition from traditional industry to digitization, and gradually from upstream to downstream industry. [1]. Nowadays, the information system has been fully penetrated into the daily work of all levels of personnel, and the daily office management and business management of all departments are increasingly relying on the stable operation of the information system. At the same time, this factor brings about a huge number of users and systems of business scenarios, and in order to meet this phenomenon, the software and hardware industry is also constantly upgrading its own technical types and means [2]. Therefore, the operation and maintenance team also put forward higher requirements and difficulties. If we continue to use the old generation of operation and maintenance system, it will inevitably lead to operation and maintenance dead angle and monitoring failure. In particular, in the past decade, we have built large and small tools focusing on network equipment and application service monitoring [3]. However, due to the different application scenarios, those operation and maintenance tools are relatively single and scattered, which is not conducive to upgrade and maintenance. Moreover, for the operation and maintenance personnel, they lack intelligent auxiliary analysis ability and cannot adapt to the application of new technologies such as cloud computing, big data and large-scale distributed cluster [4]. Thus, the original intention of building an intelligent operation and maintenance system for microservices is derived. From the perspective of the
upper level, how to plan the operation and maintenance scheme from single system sector to platform level, in order to achieve the ultimate goal of active monitoring, centralized management and automatic operation and maintenance. This research designs and implements this operation and maintenance system, from the definition of basic elements of operation and maintenance to how to recover data in disaster environment. Finally, with the support of big data services, the research work of the whole operation and maintenance management system is completed. It provides a set of clear operation and maintenance standards and operation and maintenance reference scheme for the future system construction.

2. Definition of Basic Elements of Operation and Maintenance

2.1. Definition of Operation Management Framework

System operation management refers to the stable operation of the system in the "production environment" according to the designed function and performance after the system is completed and put into operation, so that users can smoothly use the functions provided by the system. At the same time, for hundreds of interface services or module microservices behind the user interaction page, it needs more stable operation and daily maintenance.

From an economic perspective, according to industry analysts, 50% (or more) of all it budgets are spent on running it systems, but 80% of the unexpected system failure time is caused by personnel and process errors [5]. For the technology of business expansion, it is very important to have skilled IT personnel, and to divide them into clear roles and responsibilities, and to use effective IT operation process and management skills at the same time. This also shows that the quality of operation and maintenance personnel plays a very critical role in the final delivery of the system.

The framework design is discussed from the perspective of time management, and the operation management framework acts on the longest period of the whole life cycle of the system [6]. The operation and maintenance stage, combined with the management framework of business requirements analysis, system design, system development and testing stages of the system, constitutes a complete management framework. In this framework, a relatively independent management process is called management module.

After the system enters the operation and management stage, there are great differences in objectives, guiding ideology, basic methods, problem-solving process and other aspects compared with the development stage [7]. First of all, the goal of operation management is to ensure that the system achieves the predetermined function and performance indicators, which have been given after the completion of design and development. Secondly, the operation management is facing the "production environment", which has the most direct impact on the smooth operation of the business. The guiding ideology of management is to comprehensively control risks. Thirdly, operation management emphasizes that the executors should deal with various tasks according to strict norms and systems, and the basic method of management is standardization. Fourthly, to solve the emergency, the operation management first requires to return to normal, that is to find a "satisfactory solution" as soon as possible, and then carry out system optimization after the emergency is relieved, that is to find the "optimal solution".

Operation management and development management work also influence each other. The quality of development directly determines the heavy degree of operation management tasks; while the operation management ensures the realization of design functions and performance, it also provides the first-hand information and basis for the development management feedback system and the next step of system optimization.

2.2. Service Center Design

Consider from the overall operation management framework construction scheme. In order to solve the problems of large-scale data statistics and analysis, as well as hundreds of interfaces tracking in micro service environment. This research designs a service desk which plays an important role in
service support. A complete service desk can be understood as the "front desk" of other IT departments and service processes, which can handle a large number of user requests without contacting specific technical personnel. For users, the service desk is their only point of connection with the IT department to ensure that they find the relevant personnel to help them solve problems and requests.

The service desk not only handles events, problems and user queries, but also provides interfaces for other activities and processes. These activities and processes include user change requests, configuration management, availability management, and continuity management.

As the "front desk" to contact with users, the service desk first processes the service requests from users. When it expects that it cannot effectively process these requests on the premise of meeting the service level, or when the requests themselves are unsolvable, it will transfer these requests to the second-line support or the third-line support for processing.

The main work of the service desk is to ensure that the user's request is handled effectively, and the relevant information of the IT department can be quickly fed back to the user, so as to promote the coordination and communication between the two sides. If you have any questions or need any support, please contact the service desk directly.

3. Planning and Design of Operation and Maintenance Framework

3.1. Risk Identification and Control

In the operation and maintenance management, it is necessary to identify and model all risks of the information system. So that the operation and maintenance team can quickly query the corresponding solutions according to the corresponding risk level and risk definition. For example, risk management caused by human factors and information security management system construction based on risk assessment and level protection are analysed. Information system risk management must be based on the actual situation of the enterprise to carry out risk assessment and risk prevention. Ensure the security of information system, and then provide the basic guarantee for the safe operation of enterprises. In this study, the risk level is defined as four levels. First level: when the fault occurs, it seriously affects the business operation of multiple sites of the company. Level two: when the fault occurs, it affects the operation of a sensitive department or a large business department on site. Level three: when the fault occurs, it affects the operation efficiency of the information system and slows down, but it does not affect the business site. Level four: when the fault occurs, emergency treatment can be carried out at any time, which will not affect the operation of the system outside the center, but it is a hidden danger. As shown in Table 1, Table 2 and Table 3, they are divided into three categories.

| Risk name                          | Level | Risk solutions                             | Resolution Time |
|-----------------------------------|-------|--------------------------------------------|-----------------|
| Damaged server components, mainboard, memory, etc | 2     | 1. Replace similar products                | 4 hours         |
|                                   |       | 2. On-site service of service provider     |                 |
| Hard disk is damaged, there may be multiple damages | 2     | 1. Whether the service provider can repair the door-to-door service | 4 hours         |
|                                   |       | 2. Restore the last backup data            |                 |

| Risk name                 | Level | Risk solutions           | Resolution time |
|---------------------------|-------|--------------------------|-----------------|
| Operating system failed to start | 1     | Restore system, restore system, backup operating system | 4 hours         |
Serious error reported by operating system 1  If it does not affect the application system, on the contrary, we have to find a way to solve it, and we can prepare or repair the restore 2 hours

General error reporting of operating system 2 Do not affect the normal operation of the application system, normal solutions 4 hours

Database is corrupted 1 Unable to start the application, using the backup database 2 hours

In the application database, one of them is damaged 1 Only restore, do a good job of data backup Depending on the size of the database, 10G 1h, 20G 2h, 80G 4h. Due to database comparison, the time is relatively long

| Risk name | Level | Risk solutions | Resolution time |
|-----------|-------|----------------|-----------------|
| Natural environment factors include fire and earthquake | 1 | Do a good job of data backup in different places | unknown |
| Environmental factors of computer room | 1 | Do a good job in computer room management | ASAP |
| Network factors | 1 | Transfer to portal group of network department for handling | ASAP |
| Service provided by the third-party provider is not in place | 2 | | ASAP |

3.2. Event Management

"Event management" refers to the management of abnormal conditions in the operation of the system. Exceptions include both end-user issues and requirements. It also includes the problems and hidden dangers found by various maintenance personnel (system, network, program, parameter, operation management and other maintenance personnel) in daily monitoring. Perfect event management can greatly improve the availability of the system, and constantly improve the satisfaction of users at all levels.

In principle, the user will turn to the event handling department of the same level. If there is a part-time event handler on the site, the application personnel of each business site may directly consult with him. However, it is also possible to directly report to the higher-level event handling organization (such as the event handling group of the regional company). In case of some special problems, relevant personnel may also report directly to the headquarters event handling agency across levels, and all these event reporting channels should be considered normal.

When a problem management department encounters an unsolvable problem, it can report it as a new event to the higher-level event management department, which is considered as another source of the event.

Events that cannot be solved shall be reported as "problems" to the problem management department at the same level or higher level for filing. See Figure 1 for details.
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3.3. Backup management
The database administrator, operator and technical director who implements data backup and recovery management shall be responsible for the application project of operation and maintenance. They will do the backup and recovery management of the host and storage system of the platform and technical support according to the actual needs. Backup focuses on the business data on the storage device. Data backup is the final recovery method when the application system is damaged. The goal is to recover the backup data required by the design in a timely and reliable manner and minimize the loss.

No matter whether the application is developed based on microservice architecture or not, all modules in the underlying design need frequent communication, cooperation and data sharing to achieve the overall value of the system. The difference between the independent framework and the integrated framework is that the single application is completed through local method calls, and in the microservice, it is completed through remote API calls. The simplest way to back up data is to use the shared database mode, which is the most commonly used mode in single application. Generally, there is only one database, such as the mode of "one database, multiple servers" and "one database, one server". As can be seen from the above figure. First, if there is a single point of failure and a database is hung up, the whole batch of services will be stopped. Secondly, the high coupling of data will produce many programs or tools that are highly dependent on each other. Finally, it is impossible to precisely optimize or expand a service. The service can be roughly divided into two parts: read more, write less, write more, read less. Database optimization is based on the service.

In order to avoid the above problems, this study uses a read-write separation as the core, and takes the domain driven design database group as the implementation mode to customize the common data backup and storage service according to different needs \[8\]. According to the actual access and storage size, the backup storage cycle and daily average backup frequency are allocated as required. The data in the same domain is stored in the same area, using read-write separation rules and load balancing control, so that it can automatically migrate to the safe backup environment for automatic operation after node failure. For example, a good backup includes full database backup, differential backup and transaction log backup. First, make a full database backup, and then make a regular differential backup and transaction log backup. The database should be backed up once a week, once a day, and then every other hour.

4. Operation and maintenance monitoring supported by big data
In addition to the organization, system and process of operation and maintenance management, operation and maintenance tools are also needed to implement and service the operation and maintenance management system. As a monitoring tool for microservice environment, it must have
reasonable resource utilization, flexible monitoring range, intelligent analysis and automatic operation and maintenance [9]. Then, based on the above objectives, this research plans and designs a set of information integrated operation and maintenance management platform suitable for the current enterprise needs, which is used to serve the whole operation and maintenance team members.

The system adopts the distributed deployment strategy, so that the functions of monitoring equipment operation monitoring and automatic operation and maintenance are deployed on the corresponding service nodes in the form of modular small programs. Each function includes a number of data monitoring collectors, as well as the backstage sub service. Each module communicates with each other in the form of asynchronous message queue, which is finally summarized into the main program. This method can greatly reduce the throughput of the total I/O flow of the system, and can also realize the function expansion and monitoring alternative scheme as required. At the same time, it improves the flexibility of the whole monitoring system. Compared with the traditional independent monitoring tools, this method is undoubtedly more suitable for the strict requirements of the scalability and computing power of the microservice architecture in the current software projects.

This distributed monitoring component deployment is shown in the figure, including the monitoring of a server's web application, database, directional URL, API provider, DNS and other directions. At the same time, it also regularly monitors the CPU, GPU, hard disk and memory of the service node. The operation and maintenance personnel can set all the above monitoring directories and monitoring abnormal fluctuation range thresholds. For example, in a certain period of time, the server will automatically back up the data, or restart the server and other fixed operations on the weekend evening. At this time, the system will ignore the abnormal state of this period of time and link again after processing.

As shown in Figure 2, after all data are collected and fed back to the system analyser, the module uses the big data intelligent decision analysis mode. Through the generated data including log and real-time monitoring data, in the form of auxiliary human intervention judgment, machine learning method is used to realize the functions of log analysis, monitoring analysis, exception troubleshooting, capacity planning, load migration, etc. In this mode, a learning model is introduced to learn the faults that have occurred before, analyse the processing results made by the operation and maintenance personnel under which conditions and data indicators, and input them into each module. In this way, the experience of the whole operation and maintenance team can be effectively accumulated to help the team realize knowledge sharing.
5. Data Analysis and Results
After three months of practice and application, the operation and maintenance management system is also applied to the digital office management platform of a large energy enterprise in this study. Locate the operation and maintenance boundary and the scope of the operation and maintenance subject, plan the operation and maintenance process, and conduct on-demand monitoring on various indicators, logs, services and machines. Collect sample data and abnormal frequent occurrence points, help operation and maintenance personnel quickly locate, provide user feedback and communication channels, establish big data analysis map and various indicators to try to monitor visualization page, abnormal alarm service, etc. See the figures below for details:

Fig. 3. The main dashboard of Operation and maintenance

Fig. 4. Service node data analysis diagram
6. Conclusion

The operation and maintenance management of information system is a process of continuous improvement and evolution in the current environment of rapid transformation of enterprises. With the help of today's project experience and big data analysis, the construction of operation and maintenance system suitable for the enterprise itself can solve most of the difficult problems. This study is also a new attempt to explore the overall monitoring and management of the information system, which gives the operation and maintenance team the corresponding power and control of the activity set. Finally, an operation and maintenance management system suitable for micro service environment will be formed, which is mainly composed of four elements: organization, system, process and tools, and a set of comprehensive and functional operation and maintenance management mode will be constructed. The system improves the efficiency of information operation and maintenance, and also brings a certain basis for the subsequent transformation of information management. In the future, we will continue to explore the automation and intelligence of operation and maintenance in order to reduce the cost of information construction and create economic benefits for enterprises.

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