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Design and Implementation of a Business Middle Platform Microservice Operation Monitoring Platform

Li LI[1], Shu-Xian LI, Yang HONG, Jing MA, Wen-Juan SHI, Jia-Qi LI
Beijing China-Power Information Technology Co.,LTD., Beijing, China
ORCiD ID: Li LI https://orcid.org/0009-0006-9764-1470

Abstract. In the process of digital transformation in power enterprises, a number of new business systems based on microservices architecture have gradually been constructed. However, traditional passive monitoring methods lack the ability to face microservice architecture systems. At the same time, objective problems such as complexity of invocation logic, difficulty in fault localization, and lack of monitoring perspectives have become prominent. This article proposes a multidimensional monitoring method based on microservice architecture for business systems, extending the monitoring perspective to the business layer. So it could achieve comprehensive capture of the operation of the business system, and enabling timely detection of anomalies from the business layer. Meanwhile, it horizontally constructs invocation links at various levels of the system, vertically connects system resources at each level. Consequently breaking through the bottleneck of the disconnection between business and system, and improving the efficiency and accuracy of anomaly tracing greatly. Based on this design concept, it meets the different needs of various entities such as business, components, and management for system operation and maintenance, effectively improving the refinement and intelligence level of operation and maintenance monitoring. On this basis, relying on unified monitoring indicators, alarm systems, and visual large screen capabilities, it assists in locating key nodes where faults occur. Build an enterprise level operation monitoring platform, form a comprehensive and comprehensive monitoring mode, collaborate to ensure stable business operation, and improve the intelligence level of enterprise operation management.

Keywords. Digitization, Operational monitoring, Electricity marketing, Link construction

1. Introduction

Nowadays, the technology of network intelligence has developed at a rapid speed, and the demand for electricity consumption in society is increasing year by year. At the same time, the electricity customers put in higher requirements for the ability and quality of power grid service. Based on the background aforementioned, electric power enterprises are gradually strengthening the construction of informatization, and the scale of power grid informatization continues to expand [1-7], so as to better adapt to the rapid changes in the electricity marketing. In particular, in recent years, with the in-depth promotion of

[1] Corresponding author: Li LI, Beijing China-Power Information Technology Co.,LTD., Beijing, China, E-mail: supremeli0831@163.com.

the "middle platform and microservice" architecture model, a number of new flexible deployment and agile iteration marketing business systems have emerged, forming a high-response electricity marketing service mode [8], which can better meet the increasingly complex electricity marketing business needs and bring new opportunities for the digital transformation of power enterprises. However, at the same time, it poses challenges to the existing operation and maintenance monitoring capabilities of business systems. It is obvious that the traditional manual operation and maintenance mode of passive firefighting is difficult to trace the source of failure, and it is increasingly difficult to adapt to the needs of power information system operation and management [9]. It can no longer provide reliable guarantees for business development. At the same time, the complex and huge system architecture, rapidly changing business and systems, independent and decentralized monitoring tools, low tolerance for business interruptions, etc., have put forward higher requirements for effective monitoring of microservice architecture systems, and pose challenges to the smooth operation of electricity marketing business. It is urgent to deepen operation monitoring capabilities and take full advantages of big data technology [10-11], build a monitoring platform that fits the characteristics of microservice architecture systems, and improve intelligent operation and maintenance level.

To address the above issues, existing research explores new system operation and management modes from different perspectives. The researches [4-5,12] explored different methods for detecting system security status supported by big data technology, using algorithms to determine security factor associations, developing security situational awareness strategies based on reinforcement learning, and constructing security state detection models. The research [13] integrated artificial intelligence technology to analyze the health status of terminal devices, providing active operation and fault diagnosis capabilities. On this basis, the research [14] introduced algorithms to improve operational efficiency in three stages: equipment health status assessment, operational status prediction, and equipment fault diagnosis. The researches [15-16] focused more on user service experience by improving the automation level of inspection, maintenance, fault handling, operation monitoring, marketing planning and other processes, creating power operation support tools, and developing user-friendly client systems. The research [17] focused on the management of service interfaces, assisting in the formation of a lean control model by developing a unified interface and implementing standardized design. The above ideas have effectively improved operational monitoring and management capabilities, but have not adapted to the characteristics of microservice architecture systems, resulting in weak overall monitoring capabilities for complex microservices. The research [11] paid attention to the microservices system architecture, integrating advanced technologies such as big data, the Internet of Things, and mobile applications, focusing on improving operational monitoring, supervision, and panoramic display capabilities, and constructing a refined operational control system. The research [18] considered on the problem of microservices fault localization, designing and modeling fault impact maps from both time and space dimensions, effectively improving the comprehensiveness and accuracy of fault localization. The research [19] focused more on improving the level of monitoring related technologies, proposing a configurable wireless communication method to ensure that it is not affected by complex working environments and maintains good wireless signal propagation quality. However, the above methods are limited to the service and system themselves, or only focus on inproving the technical level, ignoring that the core of monitoring business systems lies in the business.

Therefore, this design is based on the problem of insufficient operation and monitoring capabilities for the current "middle platform and microservice" architecture. With microservices operation and monitoring as the core, resource monitoring at various levels of the system as the focus, indicators and alarm systems as the basis, and based on multiple dimensions such as business, components, and management, it forms a full level, multi-dimensional, and high-precision digital operation and monitoring full level and full process operation system. It improves the quality and efficiency of on-site operation and maintenance, ensures the stable and continuous availability of business systems effectively, and helps achieve the goals of online, automated, and intelligent enterprise operation and maintenance management.

2. Overall Architecture of Business Middle Platform Microservice Operation Monitoring Platform

The business center microservice operation monitoring platform follows the design principles of 3U, i.e. unified management and collection, unified planning and construction, and unified refinement support, and designed the overall architecture based on needs of operation and maintenance for various entities such as business, operation and management. It is abstracted into three architectural levels: data collection layer, platform layer, and application layer. The overall architecture of the business middle platform microservice operation monitoring platform is shown in Figure 1.

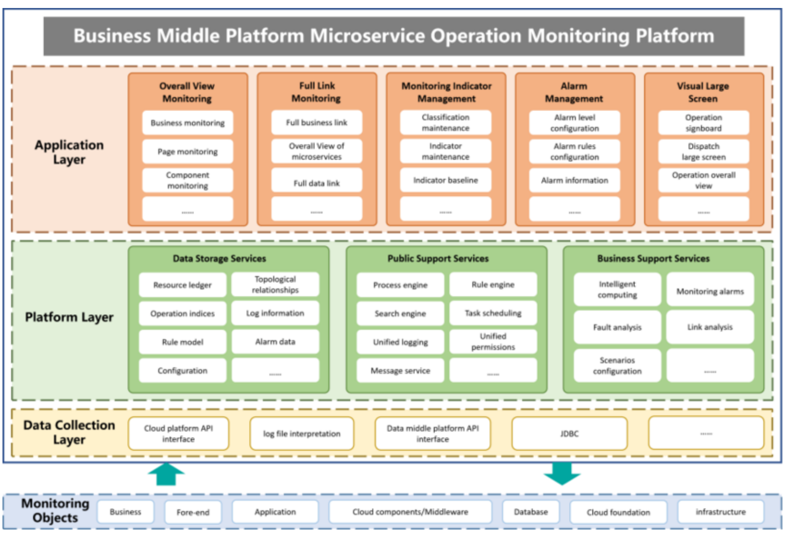

Figure 1. Overall framework diagram of the business middle platform microservice operation monitoring platform

The data collection layer serves as the foundation of the operation monitoring platform, and completes differentiated collection of monitoring object data, for instance, infrastructure, platform, service, and data resource through API interfaces, JDBC, and other channels. It creates a unified operation monitoring platform tool. The platform layer includes three parts: data storage services, public support services, and business support services. It realizes the unified aggregation and preprocessing analysis of full operation monitoring data, constructs the basic support and core service capabilities of the monitoring platform, and supports the efficient development of application layer business upwards; The application layer creates a management mode for the entire operation and monitoring lifecycle. It takes the stable operation of the system as the core, regards multi-dimensional perspective monitoring, intelligent operation and maintenance disposal, and auxiliary decision-making as the key segments, and looked upon unified configuration management as the support, and then divides into five modules: overall view monitoring, full link monitoring, monitoring indicator management, alarm management, and visual large screen. It collaborates to ensure the sustainability of digital infrastructure services.

3. Detailed Design of Core Modules for Business Middle Platform Microservice Operation Monitoring Platform

3.1. Overall View Monitoring Module

Overall overview of the business system, divided from top to bottom into levels such as business, front-end, application, cloud components, middleware, database, etc. By utilizing log analysis, API integration, link tracking and other means, various monitoring tools are gathered to integrate full volume operation and maintenance monitoring data, solve the problem of scattered and inconsistent monitoring tools. It creates a unified indicator monitoring system, provides full level monitoring services, and assists operation and maintenance personnel in comprehensively observing the operating status of business system.

For business, collect system logs in a non-invasive manner, and support flexible configuration of business monitoring indicators, complete the segmentation of log data, black and white list filtering, and achieve real-time monitoring and alarm of business indicators; For front-end and application, connect the call correlation between pages, Nginx, microservices, and interfaces. Based on above, it can monitor indicators such as response time and number of calls; For cloud component/middleware, monitoring components such as MQ, K8S, SLB, ECS, backend task scheduling and so on can be achieved through self-developed monitoring and calling cloud platform framework procurement component interfaces. It can monitor indicators such as average response time, heap count, total number of queries and so on. For database, it is possible to monitor databases such as RDS, Redis, and Oracle through self-developed monitoring and calling cloud platform framework acquisition component interfaces, which can monitor indicators such as CPU usage, memory usage, QPS, and connection count.

3.2. Full Link Monitoring Module

Considering the characteristics and actual requirements of microservice architecture business systems, a monitoring design concept of "horizontal full link, vertical full correlation" is formed, which is to build a complete business link based on business processes horizontally, and achieve full link tracking and monitoring of business operation processes; Vertically connecting the indicators of the business layer, application layer, component layer, platform layer, and hardware layer of the business system, supporting analysis operations such as association, fusion, and calculation, assisting in problem root cause localization, and forming two core capabilities: microservice panoramic monitoring and business full chain monitoring. Taking some key nodes involved in the volume cost scenario as an example, the design concept of the full link monitoring module is shown in Figure 2.

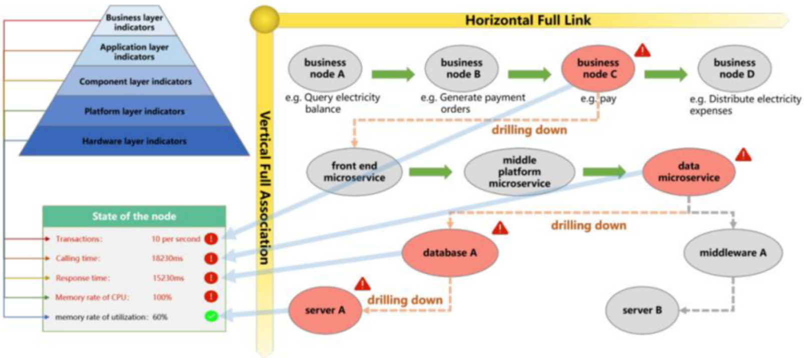

Figure 2. Design concept diagram for full link monitoring

3.2.1. Design Method for Microservice Panoramic Monitoring

As a core component supporting the operation of business systems, the normal operation of microservice call links is crucial for the stability of business system operation. By utilizing Huawei Cloud APM2.0 and Alibaba Cloud ARMS technology, we can track the call link from gateway microservices, front-end microservices, middle platform microservices to data microservices, display the application itself, its upstream and downstream information visually, and achieve the construction and monitoring of a panoramic full chain of microservices. Based on this, it depicts the health profile of a single microservice from the aspects of running status information, upstream and downstream call interfaces, service dependency components, etc., and display information in columns according to the basic resources, JVM, interfaces, pages, and other modules associated with the current service, intuitively presenting the current application exception points and the business scope affected.

3.2.2. Design Method for Business Full Chain Monitoring

Business data serves as an intuitive reflection of business development, and global monitoring at the business level is a key reference for evaluating business operation status and optimizing business logic. For business systems, there is a possibility of anomalies caused by unreasonable resource allocation, mismatched demand and available resource usage, leading to near or exceeding load. Therefore, it is necessary to establish the correlation between business and application, and complete the construction and monitoring of the entire business chain.

The design of business full chain monitoring takes business logs as the data source, builds business process links based on typical business scenarios, displays the health status of business nodes in real time, displays fault points from a business perspective, realizes real-time tracking and monitoring of business operation processes, and improves the timeliness of business operation risks and fault detection. At the same time, by drilling down into business failure scenarios, visually display the corresponding abnormal business indicators and associated abnormal microservices, and determine the scope of impact of abnormal applications. Finally, it focuses on a single application and display the health status at multiple levels comprehensively, including entry and exit interfaces, instance status, and dependent components, to achieve vertical link correlation from business to application internal, and then to associated cloud resources, assisting operation and maintenance personnel in locating the root cause of anomalies.

3.3. Monitoring Indicator Management Module

Monitoring indicators, as evaluation criteria for faults, performance, safety and other issues in monitoring events, are the core and foundation of monitoring systems. The systematic construction of monitoring indicators is of utmost importance. The process of constructing an indicator category framework includes four stages: summary of indicators, indicator model construction, profession layering, and theme classification, as shown in Figure 3.

By integrating internal and external monitoring tools and system data, a monitoring indicator pool is formed, and a unified monitoring indicator data model is constructed based on attributes such as source of indicators, indicator names, collection cycles, and statistical cycles. The monitoring indicators are sorted and layered according to professional lines, and the top-level layers are abstracted. Finally, based on business needs, multiple theme classifications are further refined to complete the construction of a unified indicator system.

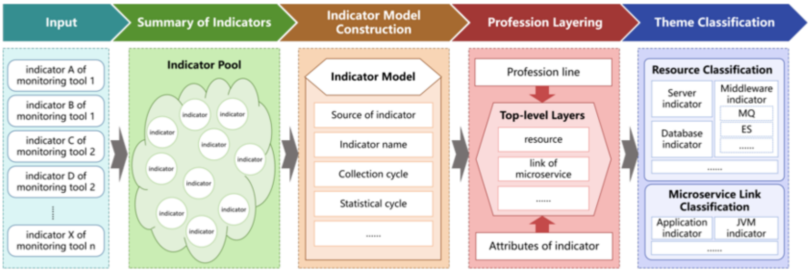

Figure 3. Flow chart for constructing indicator category framework

3.4. Alarm Management Module

The construction of the alarm system follows the design principles of "unified alarm exit, unified information push, unified event display, and unified work order management". Based on the construction results of the unified indicator system, it forms three major capabilities: alarm configuration, alarm information query, and alarm convergence and aggregation. By flexibly configuring alarm levels, alarm rules, and alarm message templates, when abnormal situations occur in the system, relevant responsible personnel are notified in a timely manner through SMS, email, on-site messaging, and other means according to the previous configuration, greatly reducing the time for anomaly detection and disposal. On the basis of collecting alarm information from multiple channels and levels across the entire platform, convergence algorithms such as alarm silence and aggregation are integrated to achieve redundant information filtering and effective key information extraction, avoid the risk of alarm information storms, further improve user processing efficiency, and assist in quickly understanding and locating problems.

On the basis of building a monitoring, unified indicator and alarm system, predict hidden dangers based on dependency relationships and historical alarms, it can reduce the occurrence rate of faults. Meanwhile, it timely alert and locate fault points when abnormal business systems occur. For typical faults, an experience base is formed through analysis and mining to improve the efficiency of problem handling.

3.5. Visual Large Screen Module

With the help of graphical means, based on different operation and maintenance monitoring needs, the original monitoring data is aggregated in different dimensions such as system hierarchy and resource categories to create personalized and configurable visual dashboards for system operation and maintenance personnel. The dashboards comprehensively and intuitively display the operation status of the system, including system operation status monitoring, microservice basic information monitoring, component basic information monitoring, cloud resource information monitoring, and other content.

4. Conclusion

This article designs an operation monitoring platform, whose core idea is to adapt to the business system of microservice architecture, make up for the shortcomings of traditional operation monitoring systems, and comprehensively optimize the intelligent management capabilities of business operations from multiple aspects, such as real-time monitoring, data collection, and fault location, to provide strong support for the stable operation of new business systems. Its monitoring perspective is no longer limited to the system itself, but extends to the business level. Starting from the business level, it connects the monitoring perspectives of the system's applications, components, platforms, hardware, and other resources at various levels layer by layer. Therefore, it forms a complete monitored entity, which is easy to trace and troubleshoot the root cause of anomalies. On this basis, a unified indicator, alarm system, and visual large screen auxiliary capabilities have effectively improved the operational management efficiency of operation and maintenance personnel, enhanced the real-time acquisition of abnormal information and the intuitive viewing of system operation related data, and improved the satisfaction of operation and maintenance personnel significantly.

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