Research and application on the digital mine platform

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ABSTRACT

This paper introduces a digital mine platform which integrates functions such as data storage, deep mining and intelligent management. The digital mine platform encapsulates the software and hardware resources, and uses resource virtual to respond the users quickly, solves the standardization problem of message transmission process through XML documents, integrates process calls of existing heterogeneous system, and collects massive signals resource. The digital mine platform lays the foundation for digital mines.

Keywords: Smart mine, smart manufacturing, smart service

1. INTRODUCTION

The rapid development of computer technology has deeply affected the traditional coal mining industry. The use of advanced information automation technology and the latest technological achievements such as the Internet, big data, cloud computing, and artificial intelligence can build smart mines and promote the transformation of coal production methods[1]. This paper establishes a digital mine platform, which is based on advanced cloud computing technology, big data analysis technology and sensor technology to achieve efficient mine production, occupational health and safety, technical and logistical support[2-3].

2. THE OVERALL FRAMEWORK OF THE DIGITAL MINE PLATFORM

The overall architecture of the digital mine platform as shown in Figure 1, which includes four aspects as follow:

(1) Open access. The digital mine platform provides an open access platform which can continuously expand resources, and the platform builds required services through custom processes to improve data access and information interaction in distributed information systems.

(2) Diversified visits. The digital mine platform identities the authentication of users who want to use the resources in the digital smart mine system.

(3) Heterogeneous resource coordination. The digital mine platform uses data warehouse, and it promotes the application of innovative functions in the equipment manufacture.

(4) Standardized construction. The information standardization mainly includes two parts, one part mainly services query standardization, which converts user to query content into identifiable statements in the system to facilitate the calling data; the other one part returns the query results from heterogeneous resources, which can be converted into a unified and standard result set.

3. CORE MODULE

The digital mine platform is a basic framework to collect sensor data by using the IoT technology[4]. The core module in the digital mine platform as shown in Figure 2, under the condition of heterogeneous and complex information resources, the coding identification of the basic information will be the basic units in the mine. The digital mine platform carries out standardized data collection for sensors, the Internet of Things realizes the deployment management between mining equipment and remote control[5-6].

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Third International Conference on Computer Science and Communication Technology (ICCSCT 2022)
edited by Yingfa Lu, Changbo Cheng, Proc. of SPIE Vol. 12506, 125064C
 · 0277-786X · doi: 10.1117/12.2662883

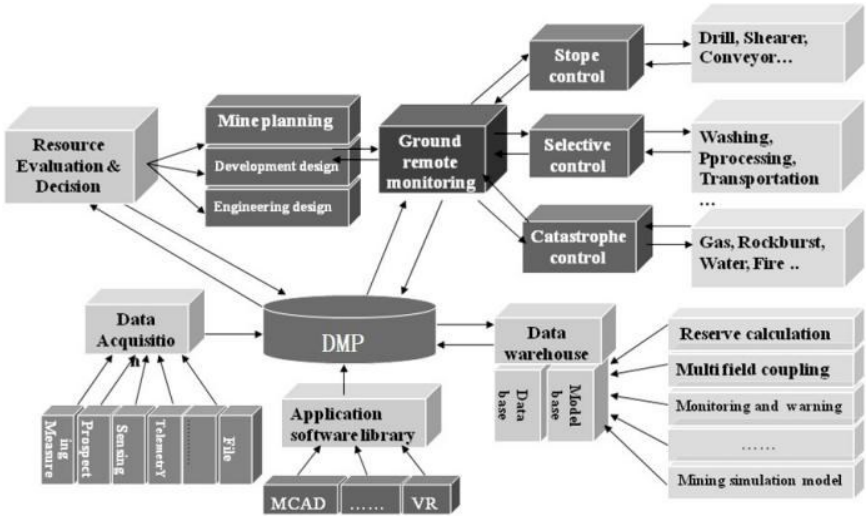

Figure 1. The overall architecture of DMP.

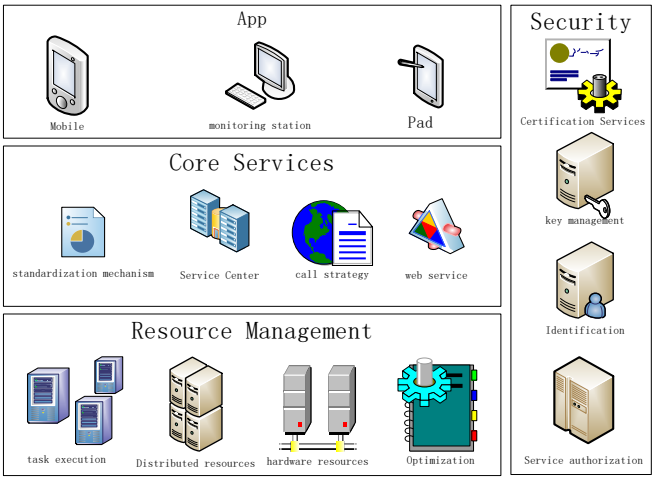

Figure 2. DMP architecture diagram.

The integration of heterogeneous resources and services invocation are the main goals in the digital mine platform. In order to form a broader industry integrated information service platform, the digital mine platform should be focus on solving the problem of system process heterogeneity and equipment interface inconsistency[7]. The core modules in digital mine platform as follow:

(1) Resource interpretation unification. There are inconsistent element descriptions in heterogeneous systems. The resource interpretation unification solves the problems of heterogeneous distributed data fusion, information unification and service matching, semantic transformation and core lexicon mapping are used to eliminate data redundancy and interpretation differences.

(2) Process virtual collaboration. The digital mine platform uses WSDL to describe the virtual resources and forms Web services services. The digital mine platform describes the resources according to categories and calling rules, and then stores them in the index center uniformly. The digital mine platform uses XML (Extensible Markup Language) documents to realize communication transmission, reduces resource retrieval matching and enhances resource collaboration efficiency.

(3) Process definition autonomy. The users will deploy the required services through the work-flow engine, and the registry finds the required resources and then uses WSDL to implement the call.

4. DMP TECHNOLOGY

4.1 Key technologies

The key technologies affecting the visual digital management of coal mines mainly include communication technology, sensor technology, spatial information technology and big data storage technology. In the basic data definition module, the communication protocol and standardized transmission format are used for definition to realize real-time reading and high-reliability transmission of data; sensor technology is used to analyze the methane, anchoring pressure, well bore stress and roof layered environment in the mining environment. The digital mine platform uses the spatial information technology to construct three-dimensional scene reproduction of mine geographical space; researches and establishes mine Internet big data storage technology to realize cross-platform and cross-system standardized mine data warehouse on the mine[8].

4.2 Work-flow of heterogeneous systems

The specific work-flow of the digital mine platform is shown in Figure 3. The system registers can access resources in the cloud server directory, and performs service encapsulation, and supports instructions (including syntax layer, semantic layer) and calls parameters. The service requests will send service requests to the cloud service center and retrieve related services according to the standard specifications. The service center executes the request information according to the WSDL description, the service requester can also find the required resources in the platform[9-10].

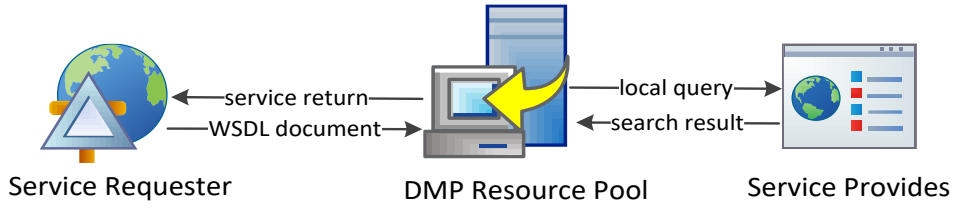

Figure 3. DMP work-flow.

5. APPLICATIONS

5.1. System platform construction and cloud-assisted decision-making

The digital mine platform detects multi-channel source data in real time through the network. The diagnosis model extracts relevant potential knowledge from the cleaned massive data, realizes real-time monitoring of mining in the mine, and early warning of fault diagnosis. The digital mine platform has the advantages of integrated control and distributed calling, which greatly reduces the capital investment in the intelligent construction of a single mine, and quickly completes the intelligent application layout based on the Internet big data.

5.2 Lean management synergy and productivity value enhancement

Due to the poor working environment and large workload of mining equipment operating in mines, it seriously affects production and even causes safety accidents. According to the statistics, equipment operation and maintenance services will supply account for 5% of the total procurement cost of the enterprise. The digital mine platform builds a closed-loop lean operation and maintenance intelligent service for users.

The digital mine platform predicts the degree of wear on the equipment connected to the mine, and sends out prompts to prepare or replace the relevant spare parts in advance, and provides the corresponding products and services in the cloud domain which according to the price and favorable rating. After the user confirms, the system automatically saves the priority of the selected supplier, and promotes the cooperative relationship between enterprises in each node in the supply chain, and meets the individuality to the greatest extent. The digital mine platform reduces the proportion of orders, improves the efficiency of collaboration between enterprises, reduces the urgency of production demand in the mine and the cost of idle inventory consumption, and realizes the coordinated development of intelligent enterprises with the mining industry chain as the core.

6. CONCLUSION

The digital mine platform mainly provides the users with an open access platform that can continuously expand resources and data. The resources in the access domain are used, and technologies such as data warehouse and mapping index are used to realize the coordination of heterogeneous resources and promote wisdom. The digital mine platform includes the IoT perception layer, the information transmission layer, the data storage layer, the intelligent deep learning layer, the intelligent analysis layer and the intelligent application layer. The digital mine platform uses the IoT technology to collect sensor data, establishes standardized information collection and formats analysis, and realizes different.

The resource pool in the digital mine platform covers all the resources available in the domain. The system service center executes the request information according to the WSDL description, and the users can call the service components in the resource pool, they can find the required resources in the digital mine platform.

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