

Cloud Computing Technology for the Petroleum Application

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Abstract — Recently cloud computing technology has gained its popularity on research and development for petroleum explorations. The advances of cloud computing offer flexibility of computing power and storage capacity, provides beneficial technology for this application domain. For instance, the cloud computing technology can effectively reduce the complexity of information collection and control time in the petroleum production process. This research encounters various methods in literature reviews, distant interviews, case studies, results analysis in information pattern and production system bottlenecks as research and evaluation for cloud computing technology implementation in petroleum exploration. Therefore it allows comprehensive analysis result in a specific recommendation for domestic petroleum companies to exploit cloud computing capability. In this research, 200 questionnaires were distributed to gather information and data analysis. 135 questionnaires are collected determines 67.5% sampling degree. This study is not only discussing about how to implement cloud computing for gas reserves exploration, but also comparing results and gaining understanding of unique methodology taken by different petroleum companies in each country. By leveraging cloud computing capabilities, this research technologically aims for gas layer exploration, gas manufacturing, cost calculation, data recording, real-time data update and hazard prediction. It is expected in the future that petroleum companies will create innovative management methods with the results of cloud computing implementation to achieve efficient and high quality gas reserves and exploration management.

Keywords— Cloud Computing, Petroleum Exploration, Knowledge Flow, Knowledge Management

I. INTRODUCTION

A. Cloud computing trends of development

A report from Gartner in 2010 suggested that when enterprises formulate technological strategic planning, the ten major trends should be included in consideration. Among the ten trends, cloud computing is the most concerned. Its importance ranking climbed from the third place in 2009 to the first place in 2010. Among the growth trends of emerging technologies, as proposed by Gartner in 2009, cloud computing is at the peak of technological development. As seen, cloud computing will be one of the key technologies for technological application and development after 2010 [1-2].

The National Institute of Standards and Technology (NIST) defined cloud computing as a convenient shared computing resource (e.g., network, server, storage, applications, and various types of services) through network access according to

user demand [3]. Users can interact with service providers with minimal system administration effort in order to quickly configure and publish information. The service model of cloud computing can be divided into three categories, as follows Software as a Service, Platform as a Service and Infrastructure as a Service [4].

B. Oil exploration and application trends of cloud computing

At present, most of the world's top ten oil companies have applied cloud computing on oil and gas exploration and management operations, which can effectively reduce the time spent on knowledge flow and sharing, thus achieving real-time knowledge control. Saudi Aramco, for example, has used cloud computing to conduct real-time information monitoring and instant feedback, in order to determine the best the drilling processes and oil well positioning, reduce production costs, enhance oil field output value, and improve reservoir management and production processes, and overall profitability. Saudi Aramco has applied real-time information integration to business management by introducing a variety of digital technologies into oil exploration and production processes, providing Saudi Aramco with the advantages of the development of the digital oil field, in terms of the integration of real-time information implementation methods and experience [5-7].

C. Application architecture of cloud computing in oil and gas exploration

In 2007, the Marathon Oil Company used services provided by iStore for cloud computing applications. The concept of architecture comprises the application, compilation, and presentation of information. The data layer includes a technical database, a real-time database, an enterprise resource planning database, and large data warehousing. These databases are used in reservoir management, reservoir engineering, and earth sciences, as well as third-party modules, and exploration site operations. They are also integrated into the business process management server and enterprise resource planning network services [8-11]. Finally, the three layers are summarized into digitized oil field workflow architecture.

The combination of appropriate cloud computing technology and an information management system is the key to Marathon's successful transformation and expansion. The cloud architecture established by Marathon plays a key role in decision-making and operation. With a common knowledge-sharing mode, and through virtualization of digitized fields, it can provide enterprises with more valuable business information, better decisions, optimized processes, and greater recovery of funds. In oil and gas exploration process, how to effectively reach the optimized effectiveness of oil and gas wells, oil and gas layers, and developing equipment and assets, are important issues of continued concern for oil companies of the future. This study found that integrating cloud computing technology into oil and gas exploration has been proven effective. In addition to the growing maturity of cloud computing applications and expanding digitized oil field technical aspects, for oil exploration and mining operations of the future, it can provide a rapid real-time data access platform and import new technologies to collaborative management of oil and gas production and development [12-14].

II. RESEARCH METHODS

Regarding cloud computing applications in oil and gas exploration, this study proposed feasibility analysis and specific recommendations. The operational research flowchart includes literature research, remote discuss and case analysis. According to the public information data of the global oil industry, this study conducted data collection and analysis, and summarized the current situation of cloud computing technology applied to oil and gas exploration. The main focuses of this study are as follows: (1) to collect the current situation of the global oil industry applying cloud computing in oil and gas exploration; (2) to collect the import reasons of oil companies for the application of cloud computing in oil and gas exploration; and (3) to summarize the current situation and effectiveness of applications in the oil industry.

This study used questionnaire, e-mail, and video conference interviews to collect data, in order to learn about the status quo of integrating cloud-based architecture in oil and gas exploration by oil companies. The main focuses of this study are as follows: (1) to investigate the application experience and knowledge of oil companies that have applied cloud computing in oil and gas exploration; (2) to explore the cloud computing architecture provided by the technology companies and consulting firms for oil companies to import cloud computing; and (3) the research and analysis of the current effectiveness and future planning of oil companies applying cloud computing in oil and gas exploration.

According to the application cases of oil companies, this study analysed the model and architecture of applying cloud computing technology in oil and gas exploration, and proposed the feasibility and recommendations of importing cloud computing into oil companies in the future. The main focuses of this study include: (1) to research and analyse one

or two international oil companies that have imported cloud computing technology; (2) to summarize the information compiled by oil companies, and propose the model or framework of applying the cloud computing technology in oil and gas exploration; and (3) based on the oil companies current situation, to assess the feasibility and specific proposals regarding the application of cloud computing technology in oil companies exploration and mining business.

At present, research on the application of cloud computing in oil and gas exploration remains in the initial stage in some oil companies. Research institutions, which some oil companies belong to, may have begun internal discussions. However, there is no specific information that is publicly available, and there are no related research projects available for reference. Applications of cloud computing technology in oil and gas exploration and drilling engineering are yet to be developed. By using the above methods, this study conducted research and analysis of the processes and impact of integrating cloud computing technologies by international oil companies. Based on the current situation of applying cloud computing technology in oil and gas exploration, as well as the current situation of oil companies applying the cloud architecture in oil and gas exploration.

The main focus of applying cloud computing in the oil and energy industry is to apply a smarter method to manage and control exploration and production procedures, and apply minimal changes and the best technology to users, processes, and organizations. Meanwhile, systematic technological implementation should be conducted in real-time drilling control centres to improve the efficiency of operations and the smooth flow of procedures through co-operations and long-distance remote control technology. Through cloud computing technology, knowledge management, collaboration, and enterprise community operations are integrated in order to achieve accelerated realization of digital oil field potential to reduce production time. The oil and energy industry is facing multiple challenges of cost and technology. How to combine the overall energy and use technology to enhance oil exploration technology is an important topic for oil companies.

III. RESULTS AND DISCUSSION

According to the results, a number of oil companies have combined the Internet of Things devices in the field of oil and gas exploration, providing a real-time data access platform to assist in oil exploration, as well as import of new technology for oil and gas production and development of collaborative management, in order to enhance the output value of enterprises, experimental platform and environment as shown in Figure 1.

This study will be a reference for petroleum companies to utilize cloud computing in gas reserve exploration and mining in the near future. This study has achieved two important contributions: (1) Current status and system analysis of cloud

computing technology on national petroleum companies. (2) Import cloud computing feasibility analysis and specific recommendations on domestic petroleum companies.

To obtain the maximum performance of cloud computing, oil industry information system developers must consider the conditions of the application in order that the system is able to make full use of the cloud computing architectural and deployment paradigms. In this way, it will be able to reduce computing and response time, minimize the risk of physical infrastructure configuration, lower the cost of entry, and increase the pace of innovation.

A. Reduce computing time and response time

Cloud computing applications adopt the batch processing job approach, where a cloud computing server can directly use 1,000 servers to accomplish tasks in 1/1000 of the time of using one server. Applications must provide customers with a rapid response mechanism, by using a virtual machine to achieve the best response time to meet customer demand.

B. Minimize risk of physical infrastructure deployment

IT organizations can reduce the inherent risk of purchasing a physical server by using cloud computing, and use the minimized risk of the cloud computing infrastructure. An enterprise data centres has increased peak workload processing capabilities by uploading the majority of the computing workload to the public cloud, and applying application lifecycle management to reduce the consumption of resources. This improved environment can meet real-time needs at a lower cost.

C. Reduce the cost of entry

By renting, instead of buying, infrastructure equipment, costs can be controlled. This norm of application development helps to reduce time-to-market, and allows the organizations to seize competitive opportunities through cloud computing environment deployment.

D. Increase the pace of innovation

Cloud computing can facilitate innovation, which allows newly established companies and organizations to rapidly deploy new products, reduce costs, and more efficiently compete with traditional organizations. Increasingly fierce competition also helps to increase the pace of innovation through the use of open source software; many innovations can be implemented to benefit the entire oil industry by promoting cloud computing.



Figure 1. Experimental Environment

IV. CONCLUSIONS

During the research period, the building of the cloud computing platform was completed. The accumulated experience will be the cornerstone of future research, developing new visions and opportunities for follow-up studies. In addition, through this study, it is expected to achieve improved and more effective allocation of resources, reduce excess fiscal spending, promote inter-industrial collaboration and cooperation, and attract industrial funds in the background of limited oil and gas energy. The import of cloud computing technology is expected to promote the development of oil and energy industries to facilitate an improved competitive edge.

ACKNOWLEDGMENT

Authors thank for financial support of the National Science Council, Taiwan under contract NSC 100-2623-E-011-004-ET and 101MG07-1.

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