2022 IEEE 7th International Conference on Smart Cloud (SmartCloud) | 978-1-6654-5179-6/22/$31.00 ©2022 IEEE | DOI: 10.1109/SmartCloud55982.2022.00034

SmartCMP: A Cloud Cost Optimization Governance Practice of Smart Cloud Management Platform

1st Fang Li
Shanghai qianyun Information Technology Co., Ltd
Shanghai, China
li.fang@cloudchef.io

2nd Gang Wu
Shanghai qianyun Information Technology Co., Ltd
Shanghai, China
gang.wu@cloudchef.io

3rd Jianhua Lu
Shanghai qianyun Information Technology Co., Ltd
Shanghai, China
jianhua.lu@cloudchef.io

4th Mingye Jin
Shanghai qianyun Information Technology Co., Ltd
Shanghai, China
mingye.jin@cloudchef.io

5th Haitao An*
Electronic Information Vocational Technical College
School of Computer Science
Inner Mongolia, China
anhaitao@imeic.edu.cn

6th Junxiong Lin
School of Computer Science
Fudan University
Shanghai, China
jxlin18@fudan.edu.cn

***Abstract*—Cloud computing, as a new format of the information industry, is the key technology and means to lead the innovation and development of the information industry in the future. As the global economy continues to decline, enterprises pay more attention to refined operations and cost reduction and efficiency enhancement than before, and cloud computing is no exception. Does cloud computing ultimately increase the cost of business or is it worth the money? In the situation of business homogeneity competition, the cost, investment and operation of cloud infrastructure have also become the key to affecting the market competitiveness of enterprise cloud business. To achieve these issues, we design the platform named SmartCMP, which provides the value of cloud cost analysis and optimization. Firstly, from the perspective of financial, multi-dimensional display and analysis of cloud costs are carried out to find ways to reduce costs. Then, users can customize strategies for daily operation, speed up decision-making and reduce risks. Lastly, our platform will actively monitor, detect and repair risks in real time in accordance with policies to strengthen security. The effectiveness of our platform can be verified by comparing to other strategies.**

***Index Terms*—Smart cloud management platform, Big data, Enterprise-level, Service-oriented architecture**

I. Introduction

In recent years, the State Council, the Ministry of Industry and Information Technology and other departments have issued a series of regulations, standards and related policies to promote the development of the cloud computing industry [1]–[3]. Since 2021, our country has successively issued a series of policy documents such as "14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of Vision 2035", "14th Five-Year Plan for Software and Information Technology Service Industry Development" and "14th Five-Year Plan for Digital Economy Development". These documents all list cloud computing as a key industry in the digital economy, and implement the cloud-based action to promote the deep integration of digital technology and the real economy, and enable the transformation and upgrading of traditional industries [22]. As a concentrated expression of digital technology development and service model innovation, cloud computing will still be in a golden period of vigorous development in the next few years, and provide a strong foundation for the development of the digital economy.

As the global economy continues to decline, enterprises pay more attention to refined operations and cost reduction and efficiency enhancement than before, and cloud computing is no exception. Does cloud computing ultimately increase the cost of business or is it worth the money? In the situation of business homogeneity competition, the cost, investment and operation of cloud infrastructure have also become the key to affecting the market competitiveness of enterprise cloud business.

In the early days, cloud computing was regarded as an important way for enterprises to reduce IT management costs and improve business agility [4], [5]. The industry's publicity for cloud computing also focused on amplifying its advantages. Therefore, lots of CIOs migrated their businesses to the cloud. But now, the cost disadvantage of cloud computing has begun to appear, and cloud computing does not seem to be as good as it seemed at first, because the investment in cloud resources by enterprises may far exceed the expectations at the time, and it also brings a series of problems [8]. Cloud costs do not necessarily mean only IT costs, but also certain operational and administrative costs [6], [7]. So, how can enterprises optimize the cost of moving to the cloud? This requires the introduction of the concept of FinOps (cloud cost optimization).

According to the definition of FinOps by the FinOps Foundation [9]–[12]: FinOps is a change that integrates DevOps, finance and business, and its goal is to optimize the financial specifications and technical solutions of an organization's spending on cloud computing, that is, based on the historical record of expenditure and information from expected loads,

An Haitao is corresponding author.

978-1-6654-5179-6/22/$31.00 ©2022 IEEE
DOI 10.1109/SmartCloud55982.2022.00034

FinOps can pre-allocate resources or estimate costs when needed. As such, FinOps can be called ”financial operations,” or more bluntly, ”cost optimization,” bringing financial accountability to the IT enablement of cloud computing, making adjustments to optimize quality and cost.

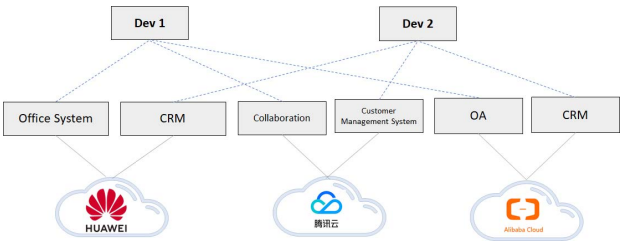

Fig. 1. The ownership of expenses can be defined and allocated to the corresponding personnel, organizational structure and cost center

The waste of cloud resources has become a common phenomenon in enterprise cloud use. On the one hand, the cloud adoption of enterprises is in full swing. The rapid development of cloud computing business has created a huge demand for cloud resources, which often leads to blind procurement and excessive application of enterprise cloud resources, and lack of reasonable and effective planning for cloud resource capacity [13]. On the other hand, enterprises lack constraints and norms in the process of allocation, use and management of cloud resources, resulting in increasingly serious waste of cloud resources. According to Flexera 2022 survey data, an average of 32% of enterprise cloud spending is wasted. The pay-as-you-go charging model for cloud resources has led enterprises to change from short-term expenditures of traditional data center costs to long-term operation of cloud resource costs. With the massive waste of cloud resources, enterprise cloud cost control faces huge challenges.

As shown in Fig. 1, enterprise cloud cost optimization and governance faces many challenges. Cloud computing reshapes the enterprise IT consumption model, the infrastructure procurement method has changed from the original centralized to distributed, the decision-making model has changed from the original short-term decision-making to long-term operation, the cost type has changed from the original fixed cost to the variable cost, and the cost management has changed from the original pre-assessment to the post-monitoring, and the cost responsibility has changed from the original centralized management to decentralized [14]–[16]. These changes have led to many difficulties in the governance of enterprise cloud cost optimization:

- Resource waste is difficult to identify, and effective resource optimization methods are lacking.
- Cloud billing data is huge and complex, and lacks professional tool support.
- In a hybrid cloud environment, it is difficult for multiple cloud products to be metered and billed uniformly.
- The organizational structure process management is not sound, and the cloud resource management lacks measurement standards.

The existence of these issues reflects the importance of FinOps practice. As one of the members of the first domestic cloud cost optimization (FinOps) industry standard ecological alliance, CloudChef Technology believes that in order to implement FinOps, enterprises need three aspects of support: business organization structure, data analysis and the cloud automation ability. In this paper, CloudChef SmartCMP platform provides the value of cloud cost analysis and optimization.

In summary, the main advantages of this platform are summarized as follows:

- From the perspective of financial, multi-dimensional display and analysis of cloud costs are carried out to find ways to reduce costs.
- From the perspective of operational governance, users can customize strategies for daily operation, speed up decision-making and reduce risks.
- From the perspective of security compliance, the platform will actively monitor, detect and repair risks in real time in accordance with policies to strengthen security.

The rest of the paper will be organized as follows. In addition to presenting some of the related work in the second section, we will introduce FinOps' five core products, which are important components of SmartCMP, in the third section, the other components that make up SmartCMP, in the fourth section, the specific performance benefits in the fifth section, and in the sixth section we conclude this paper.

II. Related Work

Enterprises have insufficient understanding of the use of purchased resources, lack of measurement system for the efficiency of cloud resource use, and imperfect evaluation basis and evaluation standards for resource use indicators, making it difficult to identify idle resources [8]. At the same time, there are too many applications for cloud resources for new businesses and there is no standard and control means while enterprises lack optimization methods such as closing unused resources, downgrading resources, and adjusting product types [17], [18].

Faced with the fact that the cloud platform provides aggregated data with product and month as the dimension and detailed data with resource as the dimension, enterprises lack professional tools to complete data visualization, data mining and analysis, etc. In a hybrid cloud environment [20], unified cost analysis cannot be performed, private cloud resources have no bills, managers cannot effectively grasp the usage of various departments, projects, and cloud products, and it is difficult to manage and control them reasonably [21].

With the continuous popularization of hybrid cloud, the use of multi-cloud platforms leads to an increase in the complexity and workload of enterprise cost management, and it becomes more difficult to optimize enterprise cloud costs. At the same time, product selection and payment models all require enterprises to evaluate and measure multi-platform, multi-product and multi-mode [19].

At present, most enterprise cloud cost optimization members are scattered in multiple departments such as the technical

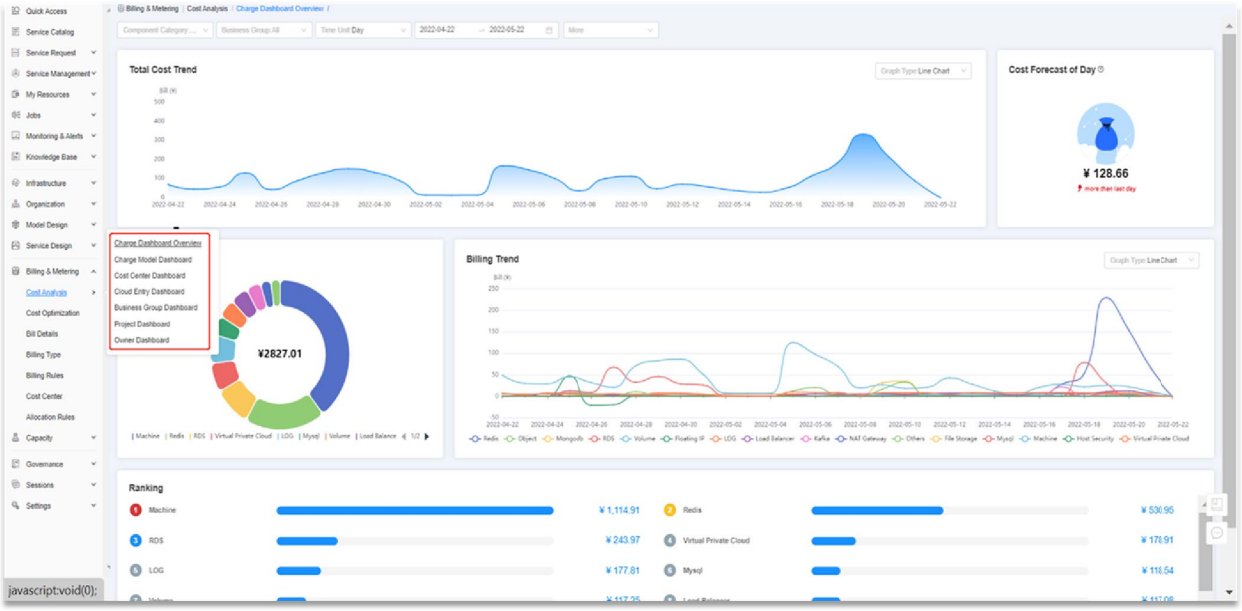

Fig. 2. The system exhibition of SmartCMP

group, financial group, and business group, and no unified cloud cost supervision organization has been established to conduct detailed monitoring and reasonable cost planning [22]. Business departments have no cost awareness, cloud resource management lacks mechanisms and data support, so it is difficult for operations departments to track each expense and resource usage throughout the entire process [23].

In summary, the existence of these issues reflects the importance of FinOps practice. As one of the members of the first domestic cloud cost optimization (FinOps) industry standard ecological alliance, CloudChef Technology believes that in order to implement FinOps, enterprises need three aspects of support: business organization structure, data analysis and the cloud automation ability.

III. FinOps Practice of CloudChef SmartCMP Platform

The overall framework of cloud cost analysis and governance of CloudChef Technology's SmartCMP platform is divided into several steps: 1. Access multiple clouds (including public cloud + private cloud), attribute resources on each cloud to different projects and departments, and complete sorting out cloud resources. 2. Collect the billing data of each cloud, except for collecting the public cloud cost data, for the private cloud and non-cloud resources, the cost data is generated by the billing rules of our platform. 3. For the above costs data, conduct unified data analysis. 4. Visualize data analysis results from different perspectives and different permissions. 5. Achieve continuous optimization through platform automation to save cloud costs.

According to the concept of FinOps, one of the key links is to build an organizational structure and implement the rights and responsibilities of expenses. The organizational structure can be subsidiaries, departments, or project groups. SmartCMP cloud cost analysis platform supports enterprises to define different roles, permissions, processes, etc. on each level of business group. Also supports customizing billing rules for any cloud resources, including public cloud, private cloud, software, database, application, SaaS and other resources to generate bills. You can even add cost information to non-cloud resource products such as electricity, rental, and labor costs to facilitate unified accounting.

With the cost data of the above various resources, the platform supports allocation by subsidiaries, departments, projects and owners. For cloud resources shared by multiple departments, we support proportional apportionment to make cloud costs more compatible with actual conditions.

After the cost allocation is completed, the platform can analyze and predict the display cost through different department permissions. For example, department managers and project administrators can view the expenses of their respective organizations, and the finance department can view all expenses calculated by cost center. Through the platform visualization dashboard, the multi-dimensional cost situation and analysis results are clearly and dynamically displayed, and managers can accurately track each cost expenditure.

It is not enough to collect and display fees only, we also need to continuously optimize cloud costs. Cost and compliance optimization can be done through the platform's built-in policies. The unique cost optimization engine of CloudChef SmartCMP platform comes with dozens of cost and compliance policies. Based on policy rules, it can analyze and discover various situations that do not conform to cost

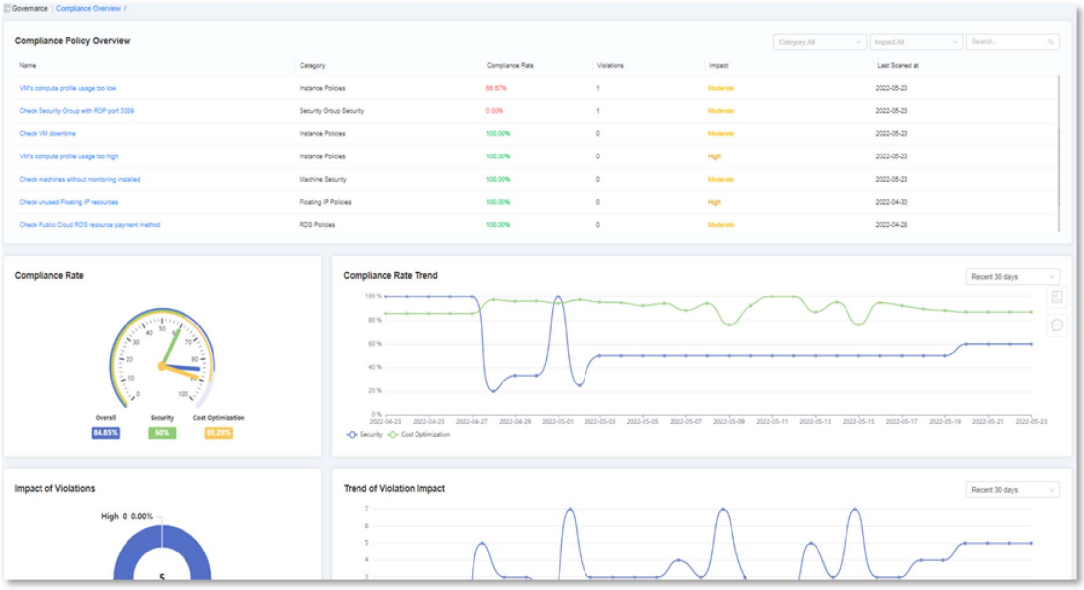

Fig. 3. Visually display the results of policy execution.

optimization policies and security specifications, and display policy execution intuitively and visually. As a result, if violations are found, they can be processed quickly with one click.

- Through the cost optimization strategy, the platform can discover idle resources and unreasonably allocated resources and implement the optimization strategy in time (automatic start and stop, automatic scaling, and scale adjustment).
- Through the compliance optimization strategy, the platform can check the illegal configuration of cloud resources and whether dangerous ports are exposed.
- Define automatic processing after the policy is triggered, such as setting notifications, optimization suggestions, and even automatic repair operations.

The platform has a powerful distributed policy execution engine that can execute millions of policy matches every night. The policy execution results can be displayed visually on the Compliance Overview, showing details of violations, compliance rates, and compliance trends.

IV. Important Components of CloudChef SmartCMP Platform

CloudChef SmartCMP platform provides the value of cloud cost analysis and optimization, which can be summarized into three aspects:

A. Arbitrary cloud resource encapsulation capability

Built-in hundreds of cloud resource models in the SmartCMP platform. A large FMCG company uses multiple cloud platforms, mainly mainstream public clouds (AWS, Azure, Alibaba Cloud, etc.), and domestic and foreign

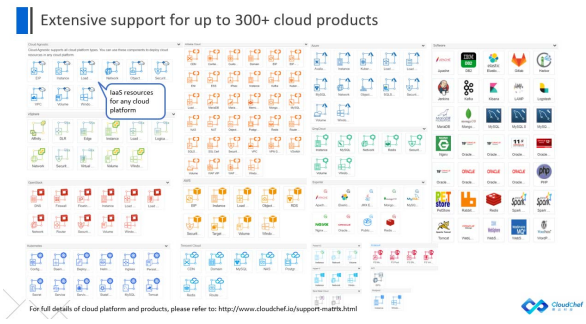

Fig. 4. Built-in hundreds of cloud resource models.

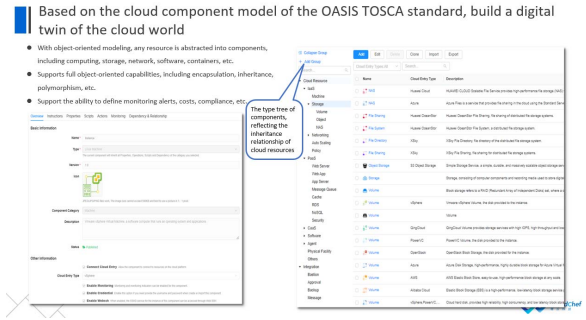

Fig. 5. Provide low-code (IaC) expansion capabilities, which can connect to any cloud and any resources.

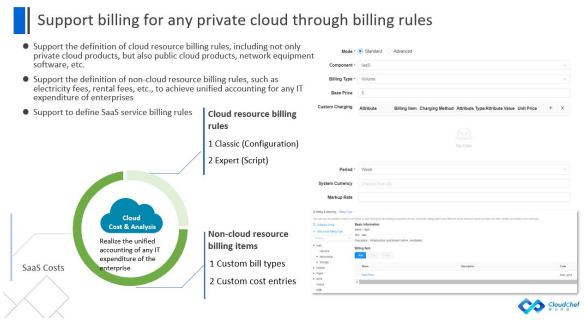

Fig. 6. Provide flexible billing model, support metering and billing of arbitrary resources (IaaS, PaaS, SaaS, etc.)

branches share some cloud resources. Due to the high complexity of organizational structure and cloud resources, there are some challenges in the process of cloud operation:

- In the multi-cloud scenario, there is a problem of scattered bills and no overall cost analysis. Basically, each cloud is displayed as an independent report.
- There is no overall cost optimization suggestion, only the cost allocation generated by a certain logic.
- The dimension of cost allocation is rigid. There is only a list of costs for each sub-account of the public cloud, and it is impossible to allocate and analyze from various aspects such as departments, projects, personnel, resource types, and factories.
- The statistics are only based on the costs on the cloud, and other costs such as management costs, labor costs, etc., cannot be billed.
- There is no unified management of overall resources, and resource statistics are completely dependent on manual processing of Excel for statistics. However, public cloud billing rules are often changed and difficult to maintain, and there are a large number of manual account adjustments.

B. Arbitrary resource billing capability

The common resource billing capability model consists of self-service capability for any user, flexible billing processing capability to meet the allocation logic of any scenario, unified operation management based on resource usage analysis, adaptive capacity evaluation rules based on system characteristics, and establish a continuous optimization process system for enterprises to go to the cloud and use the cloud.

- The flexible billing processing capability to meet the allocation logic of any scenario, which based on cloud platform, cloud resources, business group, project and owner, cloud resource tags, and resource set. According to actual needs, self-help to realize resource changes within the scope of authority to make self-request resources and automate delivery.
- The platform support multi-dimensional bill analysis, support layer-by-layer drill-down, data analysis, and intuitively grasp the whereabouts of resources and expenses. There are multi-dimensional resource, cost report export,and customized resource usage analysis dashboard.
- The platform support user-defined compliance optimization model, and dozens of built-in resource compliance optimization models. Dynamic and accurate identification of online idle resources based on the defined model, and linkage to alert devices and event centers to track the resolution of idle resources.
- The platform support organizational structure budget or project budget formulation, change and control. Support cost forecasting, cost accounting and allocation according to the project or application dimension, the whole process mechanism of cost assessment, comprehensively improve the cost awareness of all employees, and comprehensively control the cost.

C. Cost optimization measures

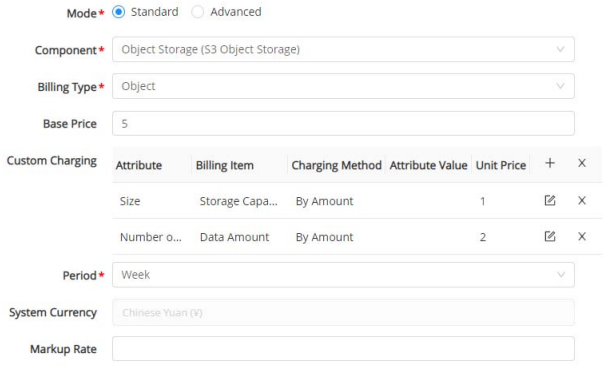

Fig. 7. Definition of any cost type (site fee, personnel fee, electricity fee, water fee, etc.)

According to the current situation and needs of the enterprise, CloudChef Technology has formulated a plan for unified management and control of cloud resources + intelligent cost optimization. First, through SmartCMP's multi-cloud management platform + cost analysis and governance platform, the enterprise builds a cloud cost management platform for all users (IT, business department, financial department), manages all types of cloud resources in a unified way, and views multi-dimensional cost analysis and allocation through one platform. The cloud cost visualization dashboard provided by the platform can clearly analyze and display data for each bill of all cloud platforms. In order to meet the needs of enterprises to customize costs, the platform can allocate all public cloud costs to specific personnel, projects, departments, and factories in the organization. In addition, cloud resources can be continuously optimized and automatically repaired according to resource usage.

D. The effectiveness of SmartCMP

Through CloudChef SmartCMP intelligent operation management platform, the enterprise has obtained the following benefits in multi-cloud cost operation:

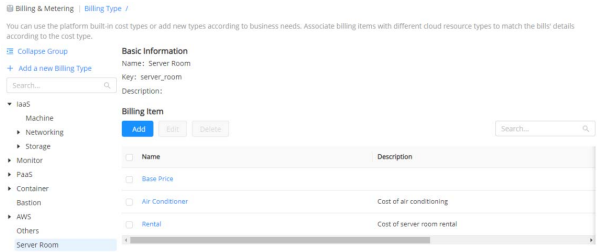

Fig. 8. Definition of any cost type (site fee, personnel fee, electricity fee, water fee, etc.)

- Unified management of the three resource islands of AWS, Ali, and Azure through billing and usage and automated deployment to achieve unified cost collection and allocation and provide visual and completed cost analysis chart display of the overall resources of the enterprise according to the dimensions of cost center, organizational structure, and resource type.
- The platform completely replaces the third-party team, handles more than 2 million bills and 1 million+ costs per month, allocates the costs in a more refined manner, and assigns each cost to each person.
- Provide a visual page to replace the original cost analysis in the form of Excel, and delegate the cost authority to each project, so that the financial personnel of each project can intuitively see the overall cost usage on the page.
- Realize cost optimization and compliance inspection of overall resources, prompt and alert idle and illegal resources, and display them uniformly to administrators for recycling or processing, and can also automate resource optimization actions.
- Realize the unified automatic delivery of resources and baseline configuration of multiple cloud platforms.

V. CONCLUSION

Under the mega trend of multi-cloud, ensuring business efficiency through cloud cost management is critical for enterprises. How to solve the complexity of expense management, improve cost security, reasonably control costs, and improve expense analysis and optimization has become an urgent problem to solve. This article introduced in detail how highly standardized SaaS platform SmartCMP can continuously and automatically optimize cloud resources, saving enterprise cloud costs and increase efficiency, as well as the technology advantages of SmartCMP, and shows why this platform is widely welcomed by many large enterprises. We believe that as the application of multi-cloud strategy, SmartCMP can provide more valuable improvements and IT management tools for enterprises in the future.

REFERENCES

[1] X. Zhou, X. Yang, J. Ma, and K. Wang, "Energy Efficient Smart Routing Based on Link Correlation Mining for Wireless Edge Computing in IoT," IEEE Internet of Things Journal, May 2021. DOI: 10.1109/JIOT.2021.3077937.

[2] K. Shvachko, H. Kuang, S. Radia, and R. Chansler, "The hadoop distributed file system." 2010 IEEE 26th symposium on mass storage systems and technologies (MSST), pp:1-10,2010.

[3] I. Polato, R. Ré, A. Goldman, F. Kon,"A comprehensive view of Hadoop research—A systematic literature review." Journal of Network and Computer Applications,pp:1-25,2014.

[4] R. Ramakrishnan, B. Sridharan, et al, "Azure data lake store: a hyperscale distributed file service for big data analytics." Proceedings of the 2017 ACM International Conference on Management of Data,pp:51-63,2017.

[5] X. Du, S. Tang, Z. Lu, K. Gai, J. Wu, and P. C. K. Hung. Scientific Workflows in IoT Environments: A Data Placement Strategy Based on Heterogeneous Edge-Cloud Computing. ACM Trans. Manage. Inf. Syst. Just Accepted (April 2022). https://doi.org/10.1145/3531327.

[6] C. Mathis, Data lakes, Datenbank Spektrum 17 (3) (2017) 289–293. [Online]. Available: https://dx.doi/10.1007/s13222-017-0272-7.

[7] Bauer, Daniel, et al. "Building and operating a large-scale enterprise data analytics platform," Big Data Research,vol.23,pp: 100181,2021.

[8] X. Du et al., "A Low-Latency Communication Design for Brain Simulations," in IEEE Network, vol. 36, no. 2, pp. 8-15, March/April 2022, doi: 10.1109/MNET.008.2100447.

[9] M. Kornacker, A. Behm, et al, "Impala: A Modern, Open-Source SQL Engine for Hadoop," Cidr, Vol. 1, 2015.

[10] S.Harris, and N. Bissoon, "Big SQL vs Spark SQL at 100TB: How do they stack up?." IBM, Tech. Rep,February 2017. [Online]. Available: https://developer.ibm.com/hadoop/2017/02/07/experiences-comparing-big-sql-and-spark-sql-at-100tb/.

[11] K. He, E. Rozner, K. Agarwal, W. Felter, J. Carter, A. Akella, "Presto: Edge-based load balancing for fast datacenter networks," ACM SIGCOMM Computer Communication Review,pp:465-478,2015.

[12] Thusoo, Ashish, et al. "Hive: a warehousing solution over a map-reduce framework," Proceedings of the VLDB Endowment,pp:1626-1629,2009.

[13] Y. Wang, X. Du, Z. Lu, Q. Duan and J. Wu, "Improved LSTM-based Time-Series Anomaly Detection in Rail Transit Operation Environments," in IEEE Transactions on Industrial Informatics, doi: 10.1109/TII.2022.3164087.

[14] Mazumder, Sourav, and Subhankar Dhar,"Hadoop ecosystem as enterprise big data platform: perspectives and practices," International Journal of Information Technology and Management,vol.17.4 ,pp: 334-348,2018.

[15] S.Dhar,and S.Mazumder,"Challenges and best practices for enterprise adoption of big data technologies," Journal of Information Technology Management,December 2014, Vol.25, No.4, pp:44-48,2014.

[16] Chen P, Du X, Lu Z, et al. EVFL: An explainable vertical federated learning for data-oriented Artificial Intelligence systems[J]. Journal of Systems Architecture, 2022, 126: 102474.

[17] Tang S, Du X, Lu Z, et al. Coordinate-based efficient indexing mechanism for intelligent IoT systems in heterogeneous edge computing[J]. Journal of Parallel and Distributed Computing, 2022, 166: 45-56.

[18] Prabhjot Kaur Chahal, and Shreelekha Pandey,"An efficient Hadoop-based brain tumor detection framework using big data analytic," Software: Practice and Experience,vol.52.3,pp: 805-818,2022.

[19] X. Du, S. Tang, Z. Lu, J. Wet, K. Gai and P. C. K. Hung, "A Novel Data Placement Strategy for Data-Sharing Scientific Workflows in Heterogeneous Edge-Cloud Computing Environments," 2020 IEEE International Conference on Web Services (ICWS), 2020, pp. 498-507, doi: 10.1109/ICWS49710.2020.00073.

[20] Otmane Azeroual, and Renaud Fabre,"Processing big data with apache hadoop in the current challenging era of COVID-19," Big Data and Cognitive Computing,vol.5.1, pp: 12,2021.

[21] Jorgi Luiz Bolonhezi Dias, Leandro Batista De Almeida, and Luiz Carlos Pessoa Albini,"Reducing Hadoop 3. x energy consumption through Energy Efficient Ethernet," 2022 IEEE International Conference on Big Data and Smart Computing (BigComp). IEEE, 2022.

[22] X. Zhou, Y. Hu, J. Wu, W. Liang, J. Ma, and Q. Jin, "Distribution Bias Aware Collaborative Generative Adversarial Network for Imbalanced Deep Learning in Industrial IoT," IEEE Transactions on Industrial Informatics, Apr. 2022. DOI: 10.1109/TII.2022.3170149.

[23] Yucong Duan: Towards a Periodic Table of conceptualization and formalization on State, Style, Structure, Pattern, Framework, Architecture, Service and so on. SNPD 2019: 133-138.