Data Center Operation for Cloud Computing Age Implemented with MasterScope Ver. 8

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Abstract

Optimization of IT costs and the "cloud computing service" that is expected to deal quickly and flexibly with changes in future business procedures are currently attracting attention. This paper introduces the requirements of the data center operations management methods that form the foundation for the use by enterprises of cloud services. It also introduces a method of data center implementation using "MasterScope," integrated operations management software provided by NEC. This method is particularly helpful for providing a performance analysis technique that is a key point in supporting the stable provision of services by minimizing system downtime. This paper also introduces the latest technologies for solving issues resulting from "silent faults" that are difficult to solve using traditional technologies.

Keywords

cloud computing, operations management, MasterScope, silent fault, invariant analysis technology, data center

1. Introduction

Deterioration of the environment surrounding enterprises has made it more necessary than ever to enable optimization of costs and to provide a flexible approach to change in business environments. This trend has led to an increase in attention to the "cloud service," that can optimize IT costs by utilizing the required amount of resources at the required timings and can also deal quickly and flexibly with changes in business conditions. As the effectiveness of the cloud service is recognized more, it is expected that the opportunities for it to assume the core role in business activities will increase in the future. Foreseeing such a future, NEC has announced "REAL IT PLATFORM Generation 2" as the platform vision for the cloud-oriented data center (CODC) that is a foundation for the provision of the cloud services. We expect that the role of the operations management required for maintaining stable service provision using the CODC will increase following the growth in importance of the cloud service. In this paper, we summarize requirements for the operations management of the CODC and introduce "MasterScope [*1]," the integrated operations management software for the CODC. We will also focus particularly on the solution of the "silent fault" that is not detectable with the previously used system monitoring software.

2. CODC Operations Management

2.1 Issues for CODC

In order to provide stable services via CODC, it is necessary to recognize operations management issues that are caused by convergence of the IT resources. Convergence of resources leads to an increase in the scale of management and the labor used in achieving it. Diverse knowledge and technical expertise are required to integrate the previously dispersed multi-vendor/multi-platform resources and to run an environment in which the physical and logical device relationships vary flexibly due to virtualization. It is thereby expected that the management procedures are going to be more complicated than ever and that the power cost is expected to increase due to the convergence of the servers.

2.2 Effects of MasterScope Ver. 8

Integrated operations management software "MasterScope" has been handling the issues caused by increased scale and complexity [1]. Its latest version, MasterScope Ver. 8 inherits the same concept but is enhanced for total optimization by expanding the management scope from enterprise systems to CODC.

*1 MasterScope is originally sold under the name of WebSAM in Japan.

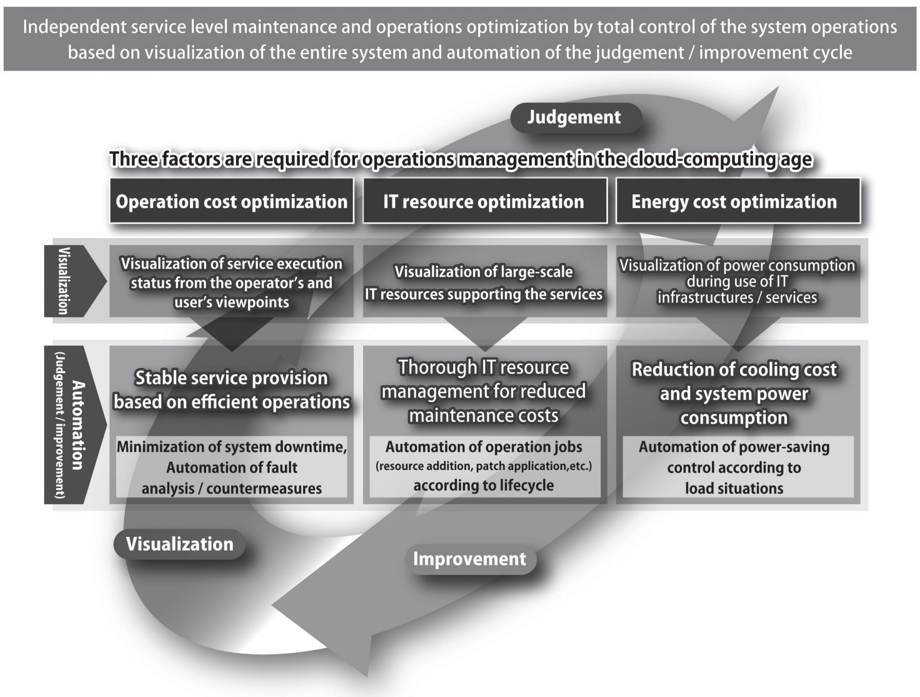

Fig. 1 MasterScope Ver. 8.

MasterScope Ver. 8 offers an operations management platform that can maintain a higher service quality with fewer administrators and lower cost, even in an environment that features increased scale and complexity. This is made possible by supporting "monitoring" of the system situations of the entire CODC and of automating the "judgments" and "improvements" in operations.

MasterScope Ver. 8 solves the issues of the CODC from the three viewpoints of "optimization of operations cost," "optimization of IT resources" and "optimization of energy cost" (**Fig. 1**).

For the "optimization of operation cost," it is required to predict faults and to solve their cause early in order to maintain and manage stable service provision. Nevertheless, in a cloud environment in which many resources are converged, workload exceed processing limit of the methods based on human labor or management tools, so that increased operational costs and degradation of the service quality could be a possible outcome. Therefore, MasterScope Ver. 8 monitors the potential fault by means of "auto discovery/mapping of physical/logical configurations of IT resources" without requiring a management function. In addition, it employs a performance analysis engine (to be described below) and thereby taking a different approach from conventional products in order to detect faults before they occur and analyze causes of faults quickly. It contributes thus to reductions in the administrator's workload and cost.

Next, for the "optimization of IT resources," to provide stable services, it is required to maintain the resources that form the basis of the services in a readily available and safe condition. MasterScope Ver. 8 pools the physical and virtual resources for centralized management and automates maintenance work such as patch management to support reducing the workload and costs for management .

Finally, for the "optimization of energy cost," the data center necessitates thoroughgoing energy saving measures. MasterScope Ver. 8 monitors the power consumption and reduces the power cost by improving the cooling efficiency and applying power-saving controls.

3. "Uncertainty of Fault Detection" in the Use of Cloud Computing

3.1 "Silent Faults" Reducing the Service Quality

As described for the "optimization of operation cost" in the above, the quick identification of a fault is important for minimizing the downtime in the cloud environment. However, there exist faults that cannot be detected by existing system monitoring software.

In the operation of the conventional data centers, faults are detected with error messages so that the identification of their cause don't occupy much time. However, some faults cannot be dealt with because they are not indicated by error messages and they become a source of degradation of the service quality. Such faults include, for example, "slowdown of the processing speed of the overall system while no problem is found in monitoring of individual servers." Because of their characteristics, such faults are called "silent faults."

The problem with silent faults is the delays in applying countermeasures as they are not detectable by monitoring and are not noticed until users make inquiries and there is a long period until recovery because even experienced administrators take time to identify the cause. As the cause of the fault is not noticed in the form of the error message, the administrators/experts of the server, network, business application, etc. need to acquire a huge amount of performance data and analyze the problematic point by taking a long time. Furthermore, if the system has a large number of components, workload exceeds the processing limit of human analysis, even when techniques such as graphs are utilized extensively for the identification of the cause. As a result, the only effective way that can be taken for the causal identification of such faults is to resort to the expertise of highly skilled engineers who extract the doubtful points based on their "experience and deductions."

3.2 Toward Solution of Silent Fault–related Issues

With the CODC, the traditional "silo type" system configuration (in which the components from hardware to applications (AP) are independent as a system) is replaced by configurations using shared platforms. This leads to separation of the business AP administrator at the higher level and the platform administrator at the lower level. This results in the inappropriateness of the traditional method in which the system administrator analyzes the performance by monitoring the entire system. This means that the operations management of the CODC system would necessitate more time, labor and advanced skill than previously.

Under these circumstances, the hard-to-detect silent faults pose an important issue for guaranteeing stable service provision because the service quality drops as the fault detection is delayed. To prevent this problem, it is necessary to use techniques for "silent fault" detection/analysis that are impossible to existing system monitoring software.

4. Resolution of Silent Faults

4.1 Invariant Analysis Technology

At NEC, we have developed the "invariant analysis technology" aiming at creating a solution to the silent fault issue. This technology is a system performance analysis technology that is original from the global viewpoint and was actually developed and patented by NEC Laboratories America.

"Invariant" means an unvarying relationship that exists for example between the quantity of traffic input to web servers and the CPU load of the servers executing processing accordingly (AP servers). In this relationship, an increase in traffic leads to an increase in the CPU load of the AP servers and a decrease in traffic leads to a decrease in the CPU load. Such relationships exist "invariantly" regardless of daily changes in the amount of business. The invariant analysis technology is a new technology that is capable of dealing with the strong correlation that exists in the relationship between two pieces of performance data (invariant relationship) such as in the above example.

The invariant analysis acquires the performance data over a certain period from an actual operational system and exhaustively investigates the existence of invariant relationships. Invariant relationships are obtained as mathematical expressions in the form "$y = f(x)$" and are modeled as behaviors in normal operations. These models are contrasted with the actual performance data in order to define behaviors that are different from those of normal operations.

4.2 MasterScope Invariant Analyzer

The MasterScope Invariant Analyzer is a system performance analysis software for applying the invariant analysis technology [2] .

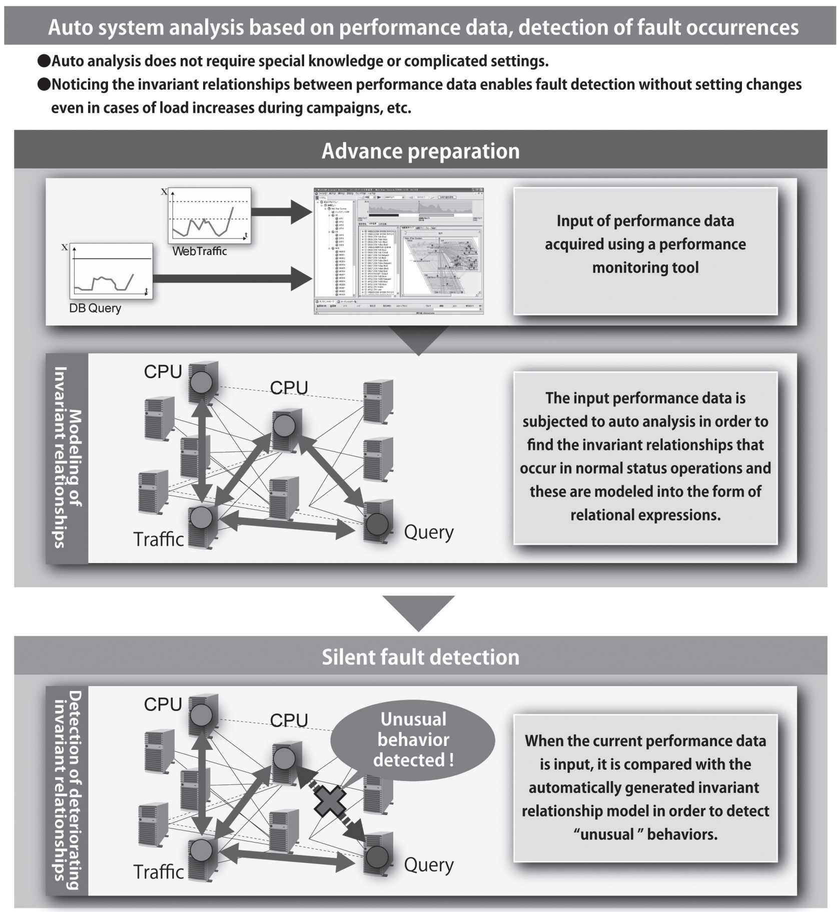

Fig. 2 Invariant analysis technology.

This product first generates models from the performance data in normal operation. It then detects the differences between the models and current data as abnormalities and judges that the system is normal if the correlations of the models in normal operation are maintained. If the relationships of any models are lost, it analyzes whether or not the behavior is "unusual" and judges if there is a possibility of a fault occurrence (**Fig. 2**).

The analysis results show how many "unusual" behaviors exist in the overall system and specifically which performance data is "unusual." From these results, the user can ascertain "when" faults occur, "how severe" the faults are, and "which" components cause fault. In addition, this product automatically compares the ratio of the "unusual" behavior in the system with the past fault cases. If the current fault pattern resembles that of past cases, it identifies similar faults so that the countermeasures taken in past cases may be referenced.

4.3 Effects of Invariant Analysis Technology

Since the invariant analysis technology does not depend on the "experience and deductions" of individuals, it can detect abnormalities exhaustively and accurately and discover "unusual" behaviors within a practical computation time even when the system is of a large scale. This abnormality detection method based on a different approach to threshold monitoring makes it possible to find silent faults that are not notified by error messages. For instance, there has even been a case in which MasterScope Invariant Analyzer succeeded in analyzing and solving in half a day a silent fault that used to take about two weeks from occurrence to cause identification.

Furthermore, invariant analysis technology is also capable of extracting invariant relationships from any kinds of data and of discovering "unusual" elements provided that the data consists of time-series digitized sequences. There is no restriction in the devices and performance data that can be supported. One of its appealing features is that it can compile data at different levels and perform cross-domain analysis of the entire system uniformly in order to increase analysis accuracy.

5. Application of Invariant Analysis Technology

5.1 Real–time Performance Analysis

Analysis by MasterScope Invariant Analyzer makes it possible to find silent faults of the system and specifically identify them as needed. We incorporated the same technology in the integrated management software "MasterScope MISSION CRITICAL OPERATIONS" in order to monitor silent faults permanently by analyzing the collected performance data in real time. This procedure has led to the capability of optimally monitoring and treating both the ordinary faults accompanied with error messages and the silent faults.

5.2 Application to Capacity Management

At present, we are also studying the application of the invariant analysis technology to capacity management. As described above, the invariant analysis technology generates accurate models from an actually running system in the form of mathematical functions. When values are substituted in these models, it is also possible to simulate the effect of the change of an item of performance data on other performance data related to it (**Fig. 3**).

When a system input value, for example the number of HTTP requests/sec., is increased sequentially, the performance data of one of the related constituent elements reaches the

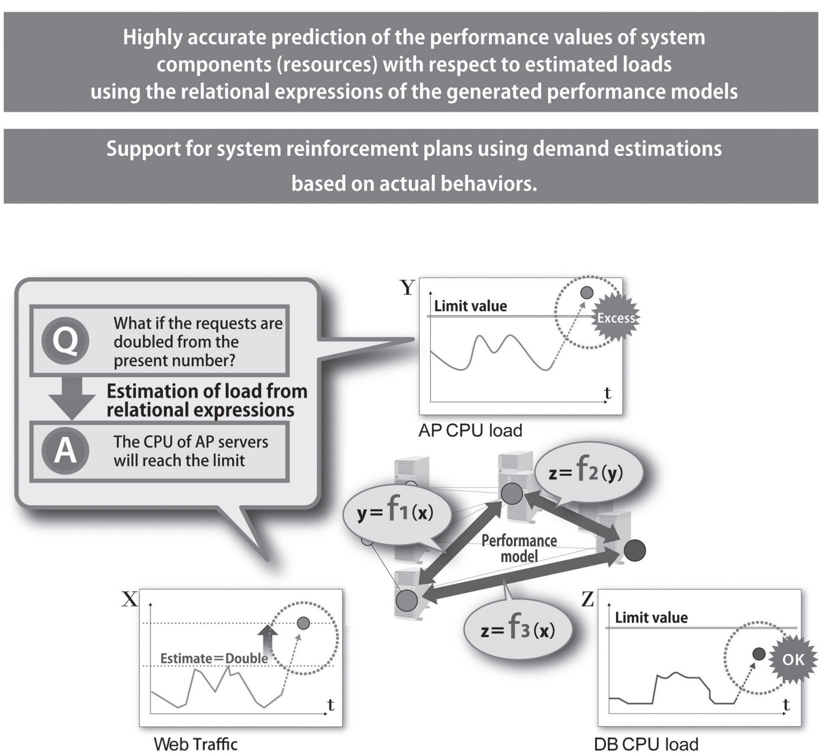

Fig. 3 Capacity planning.

limit value (e.g. 100% in the case of the CPU usage rate) at a certain moment. In this case the input value at that moment is the maximum tolerance of the system and the constituent elements reaching the limiting value becomes the bottleneck. In this way, it is possible to exhaustively and accurately identify the elements needing to be reinforced in the future.

6. Conclusion

As data centers are increasing their scale and complexity with regard to the implementation of cloud services, improvements in their operational efficiency are expected to become an important issue for the future. The invariant analysis technology introduced here is capable of automating the performance analysis work that used to be a heavy workload for the operations managers. In addition, when it cooperates properly with a MasterScope operations management product, the workload and cost of operations can be reduced even further. In the future age of cloud computing, we will continue to contribute to the improvement of data center operations efficiency by continuing to accommodate the new technologies.

References

1) “MasterScope”,
http://www.nec.com/global/prod/software/
2) “Invariant Analyzer”,
http://www.nec.com/global/prod/invariantanalyzer/

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