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Intelligent Data Center Operations Management

The need for holistic management capabilities of IT infrastructures

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Abstract: IT service problems are difficult to prioritize without understanding the impact they may have on business operations. Standard alerts generated from system management tools simply may not provide enough information for better decision-making, timely response, or accurate analysis of problem cases. Our efforts to improve IT service response to these issues include (1) quick determination of all incoming alerts and IT problems' impact on business services, (2) identification and troubleshooting of issues prior to users' identification of problems. By combining a rule engine with data collection and analysis, we developed a dashboard making it possible to accurately understand actual states of performance problems. Troubleshooting, root cause analysis, and change planning all have a 70% success for affected IT services. Thus, we have the capacity to define rules which generate error notifications enabling us to diagnose the root cause of a problem and automate the discovery of other resources that are affected by the same error, across the entire platform.

Keywords: performance monitoring, automatic problem diagnostics, proactive problem analysis

1. Preface

At the Fujitsu Technology Solutions Company, we are carrying out a large ICT project for the Turkish Public Procurement Authority. The project aims to ensure continuous execution of public procurement from needs definition to contract in a completely electronic environment. This electronic procurement project is one of the eleven components of E-Government Projects in Turkey.

Studies have shown that the reasons for deficiencies in service provision are mostly due to human error, rather than technology. 80% of problems that adversely affect IT services are caused by human error. In addition 70% of IT spending is not for new technology, but rather for inefficient IT operations.

Continuous performance monitoring of applications with complex system components is, in our opinion, the most important activity for this work. Compliance with international standards in management of IT services requires real-time performance monitoring and preventive measures to stop problems before they occur.

We have been working on improving the efficiency of IT service management through a holistic approach by considering the criticality of interdependencies between both logical and physical layers. Our perspective on managing critical services is one of continuous achievement of daily activities to maintain service, consistency, and recoverability.

Our point of departure is in the provision of scalable access to computing resources and IT services, creating a fully automated data center. This fully automated data center has several distinguishing characteristics: real-time performance monitoring, problem and root-cause analysis implementation, and service-oriented computing.

We focus on challenges of real-world problem situations and discuss the use of technology to integrate heterogeneous information sources. Integration of these sources gives us a complete picture across the entire data center. In particular, we address the requirements of efficient management of data centers necessary to make intelligent, timely and precise decisions.

We cover the requirements of utilization of data center resources over time and visualization of key performance metrics in dashboards. Collecting this information requires multi-dimensional queries that span across IT-related and business operations, and therefore cannot be achieved through a single data source alone.

Through end-to-end integration and automation, which involves intelligent information access and analytics, we have achieved root cause analysis, error handling, resource management, self-service application deployment, service SLA calculation, and metering.

As a result of all these efforts, we have developed a dashboard that is capable of providing information for real-time monitoring and control of system resources and networking equipment. The dashboard visualizes these processes with symbols and values with 1.000 pre-defined critical components and a large quantity of data from about 12.000 sensors.

Therefore, we have made progress on the following issues:

- Availability: real-time monitoring of key performance metrics, including whether the system is working properly;
- Proactive: detection of performance issues of in transactions (web, db etc.) to resolve problems before end-users are impacted,
- Reactivity: quick analysis of problems when critical thresholds are exceeded;
- Metrics: development of a “performance” perspective that simultaneously monitors pre-defined capacity values of multiple components;
- Rapid check of components’ health status and the correlations between them;
- Rapid tracing of transaction details.

This paper discusses challenges to efficient data center management. First, we address considerations related to migration to a private cloud model as it relates to business continuity. As shown in Figure 1, and in accordance with our performance and problem analytic perspective, we include best practices for business impact analysis and dashboard development for performance management.

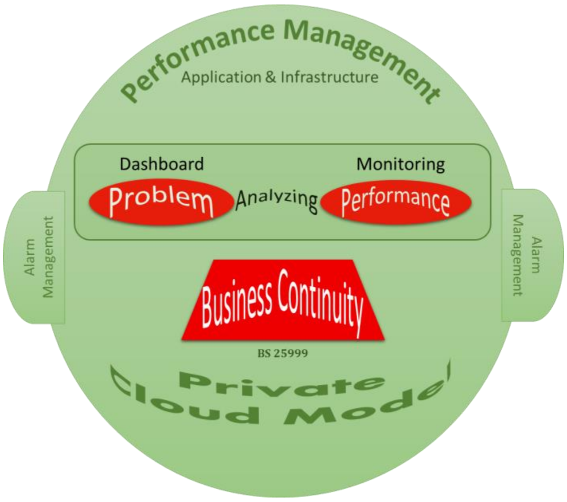

Fig.1 Cloud Model Approach

2. Cloud Model

The new paradigm of Cloud Computing is a more holistic, qualitative, and mature approach for new technological processes and platforms to enable change in business-oriented organizations.

We have established more effective private cloud environment to deploy, use, and manage VMs, applications, and other IT resources on hardware. Our scalable approach guides system evolution toward highly virtualized infrastructures.

Mission-critical operations have high requirements for security, availability, and greater degree of control over data. In our strategic analysis, we realized the importance of private cloud model. Using Microsoft System Center Suite and Hyper-V, we have capabilities for virtualization and end-to-end service management.

In this context, we prepared a business continuity architecture and strategy using a private cloud model as part of our infrastructure to transform the way we deliver services to the business.

2.1 Business Continuity

Business continuity is one of the most important issues we address in our mission-critical business activities. We developed disaster prevention and emergency response plans. Effective business continuity and disaster recovery management require not only technical expertise, but also detailed understanding of business requirements.

Our goal is to ensure that our business-critical IT system infrastructure is ready for any kind of threat to our business operations and services – from simple failures like unplugged cables or hard drive crashes, to more catastrophic events like earthquakes, hurricanes, and other natural disasters, as well as hacker attacks.

In this vein, we put together an appropriate strategy for disaster readiness or resilience of critical business processes. We focused on getting to the core of ensuring continuity of critical business activities with minimal resources.

Our Business Continuity Plan is based on visualization and standardization of entire business processes in compliance with the business standards of BS 25999. Our methodology is comprised of four components: defining Program Scope, Threat Assessment, Business Impact Analysis, Recovery Strategy issues. Our plan, therefore, approaches business continuity in terms of application, as well as infrastructure performance management.

3. Key Challenges

As we began the implementation of Private Cloud infrastructure by using Microsoft System Center Suite and adapting ITIL processes, we encountered many problems and performance issues produced by the operation manager tool (SCOM). Second, we observed many problem and performance issues by Tier1.

Our system, under considerable burden, had about 400,000 registered users, and, about 440 database transactions per second. Each day, our system responds to about 1.5 million requests, and our page is viewed about 100.000 times.

We recognized the necessity of approaching our IT systems as a collection of services, rather than discrete components of technology. Hence, we first began to use ITIL and created a Service Catalogue and a Service Map.

We are aware service maps can be especially useful in assessing and communicating the upstream impacts of changes. They are also helpful diagnostic tools.

Achieving high levels of application availability and performance are important service level objectives. Incidents must be resolved quickly to reduce downtime and ensure maximum availability. Quick resolution involves diagnosing and determining root-causes of application problems, prioritizing responses to problems that affect more critical applications and, automating future actions to avoid human intervention.

Problems are difficult to prioritize without understanding the impact they may have on business level. Standard alerts coming from traditional tools (like SCOM) simply do not provide enough information about context to improve decision-making, nor do they provide sufficient information to respond quickly and accurately. Therefore, we propose troubleshooting, root cause analysis, and change planning for the affected IT services.

We seek to reduce time in troubleshooting and the average time to repair performance problems; however, more importantly, we want to prevent issues with the quality of the end-user experience before users are impacted.

4. Performance Management

Performance issues are a major issue in complex systems. Bottlenecks can be caused network, application layer, system hardware, or system software components.

We need to monitor infrastructure performance from both the perspective of IT services and business. This goal can only be achieved if the quality of IT service delivery is measured from the perspective of users.

Monitoring performance of business-critical services is important in order to prevent performance problems before they disrupt business processes. Our IT infrastructure needs to make problems visible and identify potential problems before end-users start calling the help-desk.

We aim to deliver business applications that meet customer satisfaction through deep monitoring, quick troubleshooting and tracking end user experience. We intend to identify application faults and resolve those faults before the end user is affected.

When dealing with end-user complaints about application performance issues, it is essential to know what parts of the infrastructure are the causes of these problems. Having this information allows us to identify the root causes of performance issues and improve decision-making about actions required to resolve performance problems in a timely manner.

We introduce nine performance management implementation stages:

- Service catalog creation;
- Service mapping design and definition;
- Definition of service dependencies;
- Determining the scope of monitoring (servers, storages, network and security appliances etc.) and depth of tracking (CPU, RAM, DISK I/O, Performance counters etc.);
- Definition of system availability and outages for reporting;
- Determining which tools and methods (SNMP, WMI, ICMP, HTTP/S etc.) are to be monitored;
- Definition of system threshold values and monitoring intervals;
- Determination of the alarm mechanism (who will be informed by which method is using); and
- Visual design and development of dashboard including rule engine scripts for error-tracking and handling.

4.1 Business Impact Analysis

Despite the many alerts we receive from our operations management tool, every day we are confronted with uncontrollable and unknown situations. If the problem is faulty hardware or failure of monitoring processes to signal critical alerts, we cannot have a clear idea about system availability.

Our tool monitors .NET applications and provides real-time health alerts when those applications code failures or performance bottlenecks. In addition, the tool provides a dynamic baseline, and real-time monitoring automatically generates trend analysis of application performance data. The tool then correlates the trend analysis to CPU, I/O and memory utilization.

We optimized the application environment and prioritized troubleshooting efforts by monitoring top performance issues, failures, connectivity and security problems. We also took measures to prevent bottlenecks enabling faster resolution. Improved data accessibility also allows us to better understand and more quickly resolve resource utilization problems, as well as root causes.

By leveraging performance metrics we can see response time, throughput, and resource utilization, as well as how much CPU, memory, disk I/O, and network bandwidth our application consumes while performing its tasks. We concluded that long SQL calls, uploaded and downloaded file's I/O times, and long internal execution times resulted from complex code. Remote Web Services calls caused performance issues.

The root causes of performance problems widely occur in the virtual environments that are part of the infrastructure underlying our private cloud model. A rule engine that performs overall analysis by collecting information from the distributed sources is required for quick and accurate analysis of performance characteristics from the hypervisor level to the operating system and applications.

4.2 Dashboard Development

We have developed a dashboard that aims to provide a unified display of critical metrics for a particular situation. Thus we can monitor web applications and web services from the server and client-side perspectives for details about application availability and performance, helping to more quickly pinpoint problems.

Detailed, critical alarms in our environment, the dashboard provides real-time visibility into applications, thereby enabling easy identification of transaction bottlenecks and performance setbacks. This saves time spent on analyzing the problems.

For example, Root Cause Analysis for Web Monitoring is completed for a number of attributes such as servlet execution time, execute thread current idle count, active connections current count, leaked connection count, connection delay time, and more. All these analyses are presented as problem statements, such as servlet execution time for a web application on a particular host that exceeds a certain limit.

Therefore, we are developing a rule engine by using (VB) scripts collecting SCOM monitors and rules simply by combining data sampling and analysis. This makes it possible to accurately grasp the actual states of performance problems. The scripts generate symbols by converting the data collected on the dashboard, also making it possible to analyze the performance of the "black box" without having to modify the monitors and rules in each management pack.

Using the rule engine integrated in the platform, we are able to define and customize rules that generate error notifications whenever certain thresholds are reached and when SLAs are close to being breached. The integration of data from different sources allows us to automatically discover which other resources in the data center are affected by the same error.

Our dashboard allows us to monitor the general status, performance and availability of our infrastructure. Root cause analysis and error handling processes are sped up by enabling the definition of policies and alerts (via email) which inform the operation team whenever errors occur.

Through integration of the complete set of data center resources, an error propagated across the entire IT stack allows the administrator to easily determine which other resources are affected.

The dashboard and its reports also allow us to monitor different parts of our infrastructure through a single platform, making it easier to identify the root causes of application performance issues and prevent problems before they impact business users.

Trend analysis of system components is carried out on the necessary preventive and regulatory actions for values that exceed predefined metric values.

Therefore, as shown below in Figure 3, average request time on application servers is significantly reduced through performance improvement efforts by using the dashboard and its data-driven information reports.

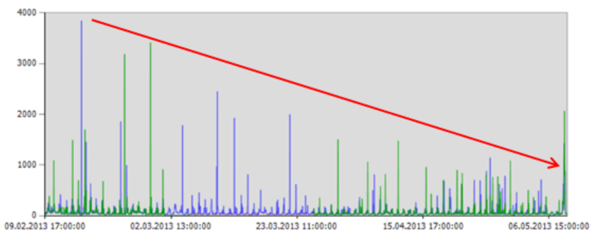

Fig.3 Application Avg. Request Times

5. Conclusion

Our vision for a fully automated data center is in its identification and communication of how issues affect services. In this sense, it performs root-cause analysis, identifies the right course for remediation, implements online performance monitoring and scaled capacity planning, and therefore, can forecast IT investment.

To achieve these goals, the dashboard requires the proper integration of data received from infrastructure components (agents) and cross-references information collected from the monitors. It then extends this data by documenting and annotating the respective items, making intelligent information and analytics accessible.

From the intelligence solution, the most important issue, is a rule engine integrated in the platform for root cause analysis and error handling processes. This integration allows us to define and customize rules which generate error notifications.

Our future intelligent data center solution will be assessed through the impact of a hardware component change within the service. This will be especially useful in assessing and communicating the impacts of changes to identify the relevant upstream and downstream components.

Further, we are working on a solution to improve internal knowledge management processes, and workflows, through integration of the complete set of data center resources. This will predict future probabilities and trends by providing analytics and data mining capabilities.

Finally, we seek to get the context right to make intelligent, timely and precise decisions. This capacity is improved through the integration of monitoring data, providing intelligent management of data center.

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