How Route Analytics Enables Virtualization and Cloud Computing

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Introduction

The typical IT infrastructure is characterized by a combination of rapid change and continually growing complexity. For example, roughly a decade ago most IT organizations began to implement distributed applications. This trend started with the adoption of client server applications and evolved to where IT organizations implemented n-tier applications. In the term *n-tier*, 'n' implies any number -- like 2-tier, 3-tier or 4-tier; basically, any number of distinct tiers used in an application architecture. The complexity that is associated with n-tier application has traditionally stemmed from the fact that each tier of the application is typically implemented on a separate system from which management data must be gathered.

The factor that is currently driving the most change in terms of how IT infrastructures are implemented and managed is the widespread adoption of virtualization and cloud computing. This adoption is driven by the promise of a significant improvement in cost and agility. The improvement in agility is a result of the fact that one of the key characteristics of virtualization and cloud computing is a new capability - the dynamic creation and movement of virtual machines (VMs). While this new capability adds great value, it also adds significant complexity to the management of the IT infrastructure.

The goal of this brief is to explain how the deployment of virtualization and cloud computing increases management complexity and to describe how IT organizations can use route analytics to reduce that complexity. To help achieve that goal, two IT professionals were interviewed. One was the IT manager for network automation and performance management for a Fortune 100 company. The other was the senior director of SaaS (Software-as-a-Service) delivery for a major IT provider. These two interviewees will be referred to in this brief respectively as The IT Manager and The Senior Director.

Virtualization

In the current environment, almost every component of IT can be virtualized. However, most of the current interest in virtualization revolves around the virtualization of servers. To quantify that interest, a recent survey asked three hundred and thirty nine IT professionals to indicate the percentage of their company's data center servers that have either already been virtualized or that they expected would be virtualized within the next year. Their responses are shown in Table 1.

	None	1% to 25%	26% to 50%	51% to 75%	76% to 100%
Have already been virtualized	21.6%	33.0%	18.9%	15.1%	11.3%
Expect to be virtualized within a year	12.4%	25.6%	21.9%	21.9%	18.2%

Table 1: Deployment of Virtualized Servers[1]

The data in Table 1 shows the ongoing interest that IT organizations have relative to deploying virtualized servers. Two observations that can be drawn from Table 1 are that within the next year:

- The number of IT organizations that have not implemented server virtualization will be cut almost in half.
- The number of IT organizations that have virtualized the majority of their servers will grow by sixty percent.

As previously noted, the adoption of virtualization and cloud computing is driven by the promise of a significant improvement in cost and agility. For example, once a server has been virtualized, a single physical server can support multiple VMs and as a result, applications that would normally require a dedicated server can now share a single physical server. This enables IT organizations to reduce the number of servers in their data centers, which yields a significant savings in both CAPEX and OPEX. In addition, a production VM can be transferred without service interruption from a given physical server to a different physical server, either within the same data center or between different data centers. This capability enables workload management and optimization across an IT organization's virtualized data center(s). This capability also helps to:

- Streamline the provisioning of new applications.
- Improve backup and restoration operations.
- Enable zero-downtime maintenance.

Cloud Computing

There are three general classes of cloud computing: public, private and hybrid. The phrase public cloud refers to IT organizations obtaining services from a cloud computing service provider (CCSP) such as Salesforce.com or Amazon. There are three categories of public cloud computing solutions.

[1] http://www.webtorials.com/content/2009/12/cloud-computing-a-reality-check-guide-to-risk-mitigation.html

They are:

- Software as a Service (SaaS)

  In one form of SaaS, an independent software vendor (ISV) such as Salesforce.com hosts an application in one or more of their own data centers.

- Infrastructure as a Service (IaaS)

  The two primary forms of IaaS are compute and storage. Providers of IaaS solutions, such as Amazon, typically implement their solutions on a virtualized infrastructure.

- Platform as a Service (PaaS).

  PaaS is the delivery of a computing platform and solution stack as a service from companies such as Force.com.

IT organizations have begun to show great interest in public cloud computing solutions, most notably in SaaS. For example, a recent market research report[2] indicated that SaaS revenues hit US$9 billion in 2009 and are growing at a rate of over 17% per year.

Because of concerns about the security and privacy of their data, many IT organizations are hesitant to either use a public cloud solution or to make a significant use of such solutions. However, in order to realize the cost and agility benefits that are associated with cloud computing, most of these IT organizations have decided to implement within their own organization the same techniques that are used by CCSPs. This approach is referred to as private cloud computing. Few IT organizations, however, will rely exclusively on an approach to cloud computing that is entirely public or entirely private. The IT Manager, for example, stated that his organization has just begun to implement a private cloud and that at the same time his organization is also acquiring some IT services from CCSPs.

There is not, however, a litmus test to determine the precise set of techniques that determine whether or not a given solution qualifies as being a cloud computing solution. That said, most cloud computing solutions include the virtualization of servers as well as other components of IT; e.g., desktops and/or storage. As described in a document entitled *A Guide for Understanding Cloud Computing*[3], some of the other techniques that are usually associated with cloud computing solutions include the:

- **Centralization** of server and storage resources.

- **Automation** of as many tasks as possible; e.g., provisioning, troubleshooting, change and configuration management.

- **Dynamic movement of resources** such as virtual machines and the associated storage.

- Heavy reliance on the enterprise **WAN and the Internet**.

[2] http://www.saasnewswire.com/?p=676
[3] http://www.webtorials.com/content/2009/11/a-guide-for-understanding-cloud-computing.html

- Use of **Self-service** to allow end users to select and modify their use of IT resources without the IT organization being an intermediary.

- **Simplification** of the applications and services provided by IT.

- Development of **standards** to enable, among other things, the federation of disparate cloud computing infrastructures with one another.

- **Federation** of disparate cloud computing infrastructures with one another.

A hybrid cloud computing solution involves a combination of services provided by the IT organization itself as well as by one or more CCSPs. For example, an IT organization may either already have, or be in the process of acquiring a 4-tier application. The IT organization may decide that for security reasons that it wants to host the application and database servers itself. However, in order to improve the interaction with the users of the application, the IT organization may also decide to let a CCSP host the web tier in numerous data centers around the globe.

Management Challenges

One of the factors that complicate management in a traditional IT environment is that due to the way that IP (Internet Protocol) was designed [4], there is not a single repository of routing information. This is an issue because routing tables are automatically updated and the path that traffic takes to go from point A to point B may change on a regular basis. These changes may be precipitated by a manual process such as adding a router to the network, the mis-configuration of a router or by an automated process such as automatically routing around a failure. In this latter case, the rate of change might be particularly difficult to diagnose if there is an intermittent problem causing a flurry of routing changes typically referred to as route flapping.

Issues such as route flapping can be classified as logical as compared to a device specific issue such as a link outage. The IT Manager said that in his forty years of experience that it is “very common” to have logical issues cause availability and performance problems. The Senior Director agreed with The IT Manager and stated that in his organization logical issues cause between ten and fifteen percent of availability and performance problems and that most of the logical issues are routing issues. He added that ninety percent of the time the logical issue doesn’t take them offline but that whether or not it takes them offline that “Finding the cause can be a challenging endeavor. It is not as easy as troubleshooting a failed WAN link.”

As previously discussed, once an IT organization has implemented server virtualization, or a private cloud computing solution that includes server virtualization, VMs can be transferred without service interruption from a given physical server to a different physical server. The IT Manager identified one of the management challenges associated with virtualization and cloud computing when he stated that one of the factors that keeps his organization from implementing the dynamic movement of VMs is the lack of a tool that tells them “Where is my application right now.”

To exemplify a related management challenge, assume that an IT organization has implemented the type of hybrid cloud computing solution that was previously discussed. In particular, assume that the IT organization hosts the application and data base tiers in one of their data centers and that the relevant

[4] The Logical Causes of Application Degradation, Jim Metzler, http://www.webtorials.com/abstracts/PacketDesign10.htm

servers have been virtualized. Further assume that a CCSP hosts the application's web tier, that all of their physical servers have been virtualized. All of the users access the application over the Internet and the connectivity between the web server layer and the application server layer is provided by an MPLS service.

Since the web, application and database tiers can be moved, either dynamically or manually, it is extremely difficult at any point in time for the IT operations organization to know the exact routing between the user and the web tier, between the Web tier and the application tier or between the application tier and the database tier. This difficulty is compounded by that fact that as previously discussed, not only does the location of the tiers of the application change, but the path that traffic takes to go from point A to point B also changes regularly.

The dynamic movement of VMs will increase over the next few years in part because organizations will increase their use of virtualization and cloud computing and in part because organizations will begin to deploy techniques such as cloud bursting. Cloud bursting refers to taking an application that currently runs in a data center controlled by an IT organization and dynamically deploying that application and the subtending storage in a data center controlled by a CCSP. Techniques such as cloud bursting will enable organizations to support peak demands while only deploying enough IT infrastructure internally to support the average demand. These techniques, however, will further complicate the task of understanding how traffic is routed end-to-end through a complex, meshed network.

One of the technologies that can be used to respond to the management challenges that are associated with the dynamic movement of VMs is route analytics. The goal of route analytics is to provide visibility, analysis and diagnosis of the issues that occur at the routing layer. A route analytics solution achieves this goal by providing an understanding of precisely how IP networks deliver application traffic. This requires the creation and maintenance of a map of network-wide routes and of all of the IP traffic flows that traverse these routes. This in turn means that a route analytics solution must be able to record every change in the traffic paths as controlled and notified by IP routing protocols.

Route analytics is gaining in popularity in part due to the increasingly dynamic nature of the IT infrastructure and in part because the only alternative for resolving logical issues involves a very time-consuming investigation of the configuration and log files of numerous individual devices. From an application delivery perspective, route analytics allows the path that application traffic takes through the network to be predetermined before changes such as moving a VM are implemented and then allows the application traffic to be tracked in real-time after the change has been made.

The IT Manager said that when something goes wrong and a business critical application slows down that "It gets very hectic around here and everyone points to the network." He added that troubleshooting a routing issue had been an intense manual process that required them to go "router to router", but that by using route analytics they can monitor the network end-to-end and see when changes occur.

The Senior Director stated that route analytics provides value to his organization in two different ways. One of those ways is that similar to the situation with The IT Manager, route analytics helps his organization to troubleshoot problems faster. While that is always important, it is particularly important to The Senior Director because his company has to pay penalties if the SLAs they provide are not met. The second way that route analytics adds value to The Senior Director is that it is one of the "industry leading tools" that his company makes their potential customers aware of in an effort to convince those customers that the company has the expertise required to meet the SLAs.

Summary

Over the last several years the typical IT environment has been getting continually more complex. That complexity comes in part from distributed applications being implemented over large complex networks that have multiple potential paths between any two end points. This type of environment is difficult to manage for two reasons. One reason is that because of the way that IP was designed, there is not a single repository of routing information. The second reason is that routing tables are automatically updated and the path that traffic takes to go from point A to point B may change on a regular basis. As a result of these factors, finding the source of routing issues is a time-consuming, labor-intensive process.

While virtualization and cloud computing add significant value to an IT organization, these techniques also increase management complexity because these techniques enable the dynamic creation and movement of VMs. Because the IT operations team may not even be aware of the fact that a VM was created or moved, the dynamic creation and movement of VMs further complicates the challenge of understanding how traffic is routed end-to-end through a complex, meshed network. This challenge will grow in importance over the next few years as the dynamic creation and movement of VMs increases in frequency.

One of the technologies that can be used to respond to the management challenges that are associated with the dynamic creation and movement of VMs is route analytics. A route analytics solution helps IT organizations respond to these challenges because it provides an understanding of precisely how IP networks deliver application traffic. Route analytics' insight into the logical operation and behavior of IP networks complements and increases the efficacy of both higher layer tools, such as those that focus on application performance management, as well as lower layer tools such as those that focus on gathering and processing SNMP data. As a result, route analytics plays a very valuable role in managing the increasingly dynamic nature of virtualized and cloud-based IT infrastructures.

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