The Impact of Virtualization on Application Delivery

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Introduction

The IT function has historically been planned and managed with a focus on individual technology domains; e.g., LAN, WAN, mainframe, servers, operating systems, databases, security, etc. An example of this is that many IT organizations manage WAN performance by setting arbitrary thresholds for WAN utilization. By arbitrary thresholds is meant that the IT organization sets a WAN utilization threshold (e.g., 75% maximum utilization) independent of the applications that traverse the WAN.

Companies that use this approach implicitly make two assumptions:

- If the network is heavily utilized, the applications are performing poorly.
- If the network is lightly utilized, the applications are performing well.

The first assumption is often true, but not always. For example, if the company is primarily supporting email or bulk file transfer applications, heavy network utilization is unlikely to cause unacceptable application performance.

The second assumption is often false. It is quite possible to have the network operating at relatively low utilization levels and still have the application perform poorly. An example of this is any application that uses a chatty protocol over the WAN. In this case, the application can perform badly because of the large number of application turns, even though the network is exhibiting low levels of delay, jitter and packet loss.

Realizing both the limits of focusing on technology domains, as well as the strong interest that a company's business managers have in the applications that they use to run their business units, most IT organizations have begun to place greater emphasis on application delivery. Throughout this brief, the phrase *application delivery* will refer to the task of ensuring that the applications that an enterprise uses:

- Exhibit acceptable performance
- Can be effectively managed
- Incorporate appropriate levels of security
- Are cost effective

While it is undeniable that application delivery is critical to the success of the business, it is also undeniable that it is complex and difficult. In order to help IT organizations get better at application delivery, the 2009 Application Delivery Handbook[1] created and analyzed a framework that IT organizations can customize for use in their environment. The four primary components of the framework are:

- Planning
- Optimization
- Management
- Control

This brief will discuss some of the application delivery challenges associated with virtualization and will describe some optimization, control and management functionality that must be present in order to respond to these challenges.

Virtualization

Although virtualization has received a lot of attention in the trade publications over the last couple of years, it is not a new concept. IT organizations have been implementing virtualized technologies such as virtual LANs (VLANs) and virtual private networks (VPNs) for at least twenty years.

Most of the recent interest in virtualization has centered around server and desktop virtualization. In a survey that was completed in August 2008, 205 IT professionals were asked to indicate by the end of 2009 how much deployment their organization will have made of these forms of virtualization. As shown in **Table 1**, IT organizations have a significant interest in deploying both server and desktop virtualization.

Table 1: Anticipated Deployment of Virtualization

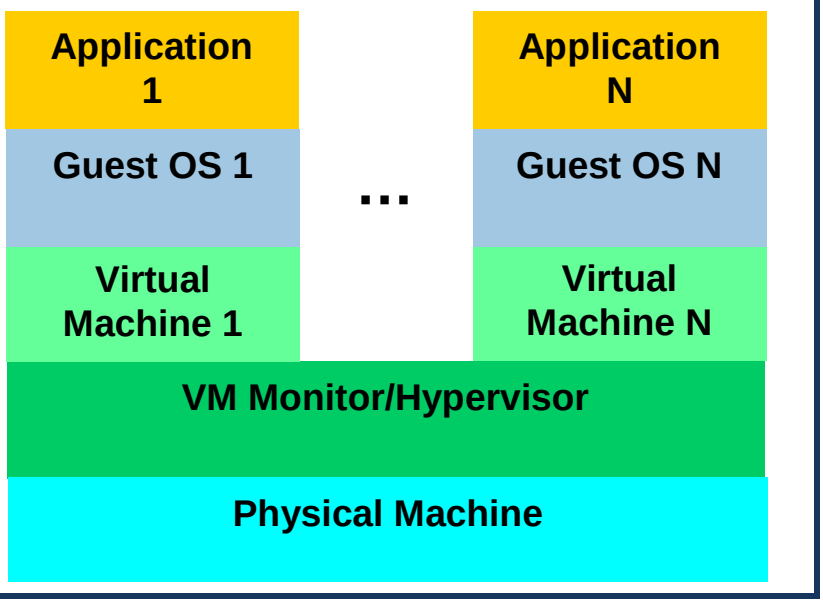
	None	Some	Moderate Amount	Significant Amount	Very Significant Amount
Server Virtualization	7.0%	27.6%	24.4%	22.4%	18.6%
Desktop Virtualization	34.7%	27.2%	21.8%	12.2%	4.1%

[1] http://webtorials.com/abstracts/2009-Application-Delivery-Handbook.htm

Server Virtualization

As shown in **Figure 1**, server virtualization refers to the ability of a single physical server to be partitioned to appear as multiple independent virtual machines (VMs).

Figure 1: A Virtualized Server



Server virtualization typically results in a reduction in the number of servers in the corporate data center, which leads to significant savings in both capital and operating expenses. As such, server virtualization helps IT organizations realize one of the goals of application delivery: ensuring that application usage is cost effective. Server virtualization does, however, create some management challenges. One of these challenges is that IT organizations typically loose visibility into the traffic that goes between VMs on a single physical server.

Unto itself, server virtualization does not put additional traffic on the enterprise WAN. However, many IT organizations implement server virtualization in conjunction with initiatives to remove servers from branch offices and place them into centralized data centers. Server consolidation does put additional traffic on the enterprise WAN. The application delivery challenges associated with server consolidation are described in the 2009 Application Delivery Handbook. In addition to these performance challenges, the combination of server consolidation and server virtualization creates an "all your eggs in one basket" situation whereby the corporate data center becomes even more critical to the business. This results in the need to increase the reliability of the enterprise WAN to ensure access to the corporate data center.

Virtual Desktop Infrastructure (VDI)

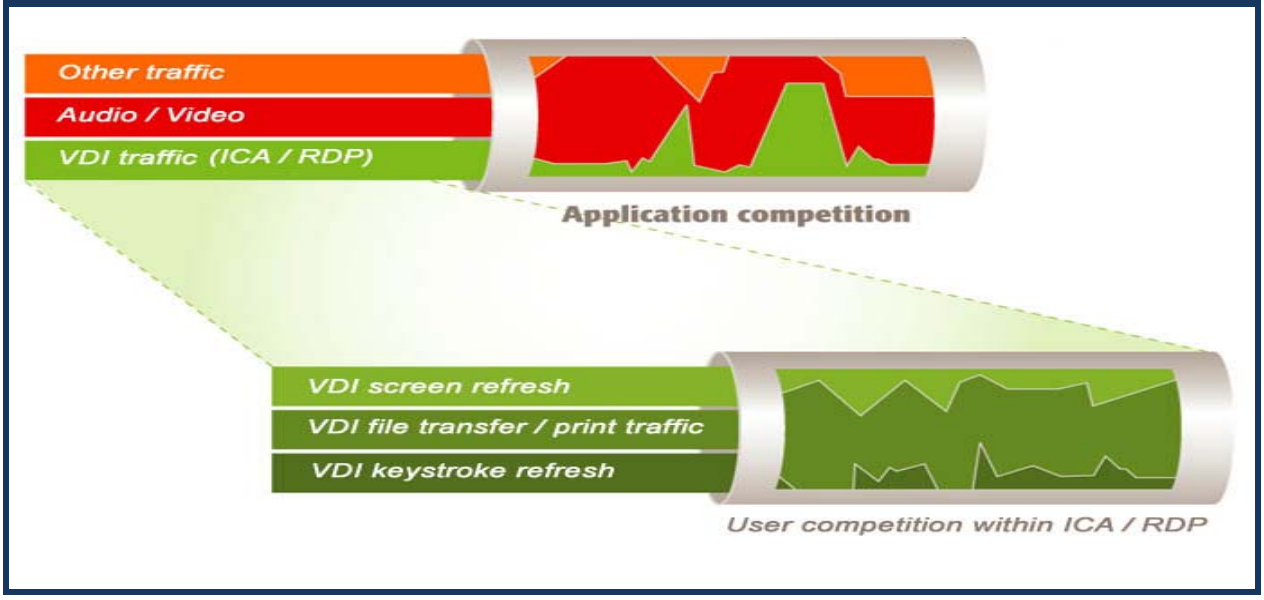
As part of VDI, a VM on a data center server hosts a complete user desktop including all its applications, configurations, and privileges. The client then accesses the applications via the network with the desktop and application objects delivered on demand over the network from the virtual desktop servers via a remote display protocol, such as Microsoft Remote Desktop Protocol (RDP) and/or Citrix's ICA protocol. In some instances, the user's desktop will contain two isolated environments. One environment is controlled by the IT organization and allows the user access to the corporate applications. The other environment contains whatever applications, data, music, photos the user has loaded onto their desktop.

Some of the primary benefits of virtualized desktops include simplified management, improved security, and increased reliability of desktop services. However, delivering acceptable application performance to a virtual desktop over the WAN can present challenges. Because of these challenges, many of the initial

deployments of desktop virtualization have been at a company's central sites based on the ability to leverage the existence of a high-speed LAN. IT organizations, however, can successfully implement VDI at remote sites if they implement the optimization, control and management functionality that enables them to overcome the challenges that are associated with VDI.

One of the primary challenges associated with VDI is the contention on the WAN link that connects the remote user with the VM in the data center. As shown in **Figure 2**, there is contention on this WAN link both among the various types of traffic (e.g., ICA/RDP, audio/video, other) that transit the WAN link as well as among the various types of VDI traffic; e.g., screen refresh, file transfer/print, and keystrokes.

Figure 2: Application Contention



Optimization

There are standard techniques that IT organizations can potentially implement to optimize the performance of VDI traffic. These include:

- **TCP Optimization**

ICA and RDP are highly optimized protocols. For example, ICA has the ability to tune the TCP window size in order to improve performance. As such, optimizing TCP will have little impact on the VDI traffic stream. Also, since isochronous applications such as video typically run over User Datagram Protocol (UDP), TCP optimization is meaningless for these applications. TCP optimization could improve the performance of applications such as file transfers if they were part of what is referred to in Figure 2 as *other traffic*.

- **Compression and Caching**

ICA and RDP incorporate a number of compression techniques including bitmap image compression, screen refresh compression, and general data compression. As a result, compression and caching will have little impact on the VDI traffic stream. Since video traffic is already compressed, additional compression will not improve the performance of video and could actually cause the performance to

degrade. Compression and caching could, however, improve the performance of large file transfers and/or print jobs if they are outside of the VDI traffic stream.

- **QoS and Bandwidth Management**

Unlike the case with TCP optimization and compression and caching, QoS and bandwidth management can play a significant role in mitigating the contention issues highlighted in Figure 2. Screen refresh, for example, is highly interactive and very sensitive to congestion. Video traffic is also very sensitive to congestion. While file transfer and print jobs are not very sensitive to congestion, they can induce congestion on the WAN and hence impact the other types of applications.

Control

The composition of VDI flows changes dynamically over time. The typical VDI flow alternates between keyboard strokes (highly interactive), screen refreshes (interactive and sometimes requiring a high data rate), and printing or file-copying. In order to guarantee the best possible user experience, it is important to automatically protect keyboard strokes and screen refreshes from other traffic types and to also ensure sufficient capacity to effectively support audio and video traffic.

At one time it was possible to implement this type of control by utilizing the ICA priority packet tag. Unfortunately CGP (Session Reliability Protocol) is enabled by default and the ICA traffic is tunneled inside of CGP which results in the priority packet being lost.[2] Both the use of CGP and the use of session sharing mode[3] also makes it impossible to prioritize flows based on the published application.

This leaves prioritizing flows automatically according to their behavior as the best option. Within this type of solution, each session is managed individually and gets by default a fair amount of bandwidth. Whenever a session is in an interactive phase, it is automatically prioritized. The solution must also preserve bandwidth for audio and video traffic.

Management

Even with a traditional IT infrastructure, one of the primary impediments to application delivery is the fact that in virtually all cases, it is the end user and not the IT organization that first notices application degradation. In addition to elongating the time it takes to resolve an application performance issue, this lack of visibility tends to tarnish the reputation of the IT organization.

A virtualized IT infrastructure is more complex than in a non-virtualized environment. As such, there are more sources of delay that can lead to unacceptable application performance. To compensate for this added complexity, IT organizations must implement solutions that give them the management visibility to be able to answer questions such as:

- What is the user experience right now?
- How many VDI sessions do my network handle per branch office?
- Which branch offices suffered from the poorest performance last week?
- Are bad response time related to server or to network issues?

[2] Packet prioritization on ICA priority packet tag, http://support.citrix.com/article/CTX105036
[3] Terminal Server Session Sharing Explained, www.msterminalservices.org/articles/Terminal-Server-Session-Sharing- Explained.html

Summary

Desktop virtualization is a classic good news/bad news situation. The good news is that because it simplifies some management tasks, improves security, and increases the reliability of desktop services, desktop virtualization helps IT organizations achieve some of the goals of application delivery. The bad news is that if IT organizations don't implement the appropriate optimization, control and management functionality, the deployment of virtualized desktops will result in unacceptable application performance.

Relative to optimization functionality, techniques such as TCP optimization as well as compression and caching can provide some performance improvement, primarily for applications that are not part of the VDI traffic stream. The real performance gains come from deploying QoS and bandwidth management in order to ensure that screens refresh in a reasonable amount of time as well as to ensure the acceptable performance of applications video.

Control functionality is needed in order to automatically protect keyboard strokes and screen refreshes from other traffic types and to also ensure sufficient capacity to effectively support audio and video traffic. Because of the complications created by both CGP and session sharing mode, it is not possible to implement this type of control by utilizing the ICA priority packet tag or by prioritizing flows based on the published application. This leaves prioritizing flows automatically according to their behavior as the most viable option.

The lack of management visibility is a barrier to application delivery independent of the IT infrastructure. However, a virtualized IT infrastructure is more complex than in a non-virtualized environment. This results in more sources of delay that can lead to unacceptable application performance. To compensate for this, IT organizations must implement solutions that give them the visibility to understand the user's experience in real time. This type of visibility is necessary in order for IT organizations to focus on the company's key applications and not just on the technology domains that support those applications.

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Webtorials Briefs
Vol 3, Number 4

Published by Webtorials Editorial/Analyst Division
www.Webtorials.com

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