Citrix Systems, Inc.

Citrix Presentation Server™ 4.5 Platinum Edition

Bandwidth Consumption and Usability Study in Graphics-Rich Scenarios

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Test Summary

Premise: The need to virtualize and deliver mission-critical graphics applications over different networks while simultaneously, providing beneficial usability to distant users has been a challenge in remote environments. Citrix Systems provides the solution for on-demand, high-performance graphics applications with its new Citrix Presentation Server™ 4.5.

Citrix Systems, Inc. commissioned The Tolly Group to evaluate the bandwidth and graphics display benefits of its SpeedScreen Progressive Display feature available in the latest release of Presentation Server over a variety of network types in a simulated healthcare Picture Archiving and Communication Systems (PACS) application.

Tolly Group engineers evaluated the bandwidth usage benefits that the new SpeedScreen Progressive Display compression feature offers to enterprise end-users on multiple network links as compared to the SpeedScreen compression feature offered on Presentation Server 4.0. Engineers also objectively evaluated user experience improvements even in high latency networks.

Testing was conducted in April 2007.

Test Highlights

▶ Reduces bandwidth consumption by up to 15X when displaying animated pictures in a PACS application with the highest compression enabled

▶ Introduces SpeedScreen Progressive Display to compress graphics images for smooth playback and manipulation

▶ Improves user responsiveness in a PACS application for scrolling, zooming and moving images compared to Presentation Server 4.0

Bandwidth Usage to View a PACS MRI Brain Animation Over Simulated Network Types with Highest Compression Levels Enabled
As Reported by Wireshark 0.99.0
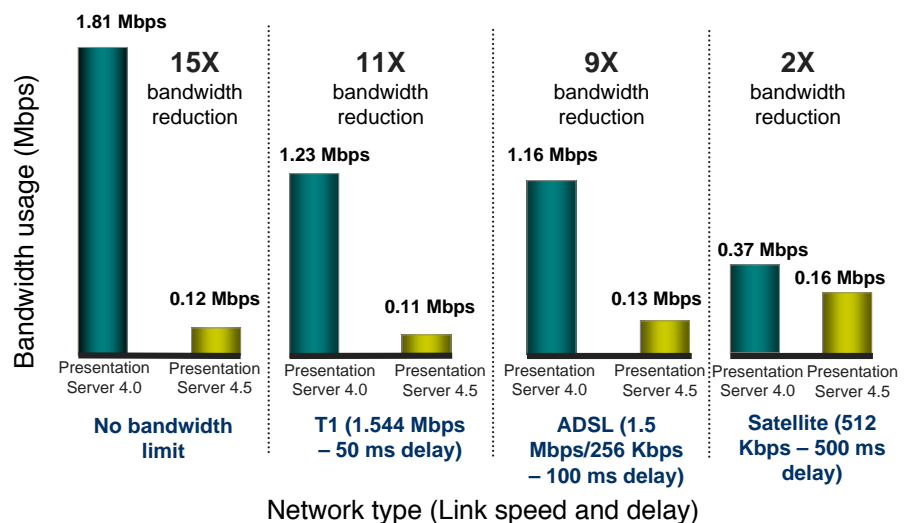
Source: The Tolly Group, April 2007

Figure 1

Executive Summary

Presentation Server 4.5 reduces bandwidth consumption by up to 15X when displaying animated images from a PACS application.

Enterprise IT administrators face a variety of challenges when delivering graphics-intensive applications to remote locations on the network, due to the large amount of bandwidth needed to display application graphics and the limited end-user experience remote users can obtain.

Citrix Systems incorporated its new SpeedScreen Progressive Display feature in the recent release of Presentation Server 4.5. SpeedScreen Progressive Display reduces the bandwidth usage of graphics-intensive applications over the network and improves the usability and responsiveness of such applications to remote users.

Tolly Group engineers verified that Presentation Server 4.5 with its Speed-Screen Progressive Display feature, reduced bandwidth consumption over a Fast Ethernet network up to 15 times for healthcare applications, such as PACS. (See Figure 1.)

The SpeedScreen Progressive Display feature incorporates logic to best determine bandwidth utili-

Comparison of Bytes Transmitted when Viewing a PACS MRI Brain Animation over Simulated Network Types with Highest Compression Levels Enabled

As Reported by Wireshark 0.99.0
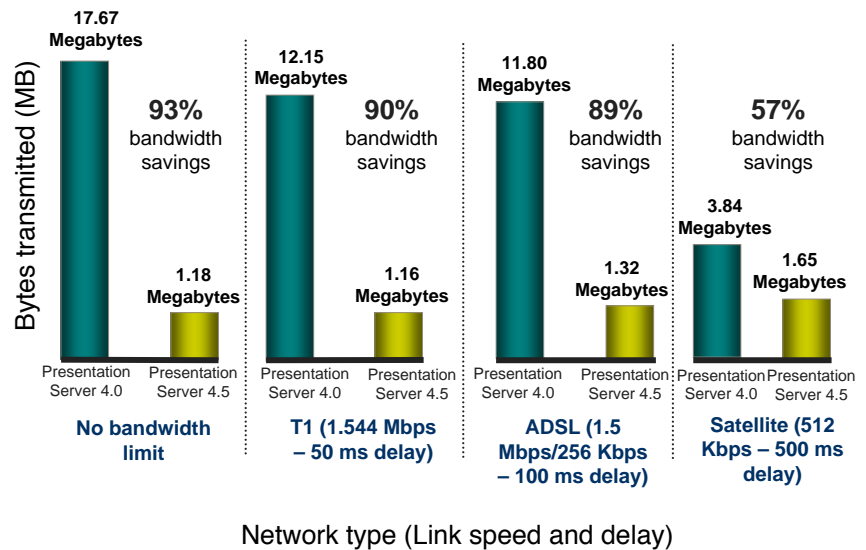
Source: The Tolly Group, April 2007   *Figure 2*

zation that helps provide the significant differences versus Presentation Server 4.0 seen during PACS testing.

As a result of these bandwidth savings, the remote client experienced improved graphics responsiveness and usability with the PACS application when trying to move, scroll or zoom on an image. (See Figure 2).

Results & Analysis

Bandwidth Consumption & Usability

To measure and verify the bandwidth consumption and application usability of the PACS application, engineers measured the bandwidth consumption over four network types with their respective delays, while simultaneously,

engineers commented on the application usability. On the usability verification, engineers performed tasks such as zooming, scrolling and moving 2D animated MRI brain images from the PACS application.

(Note: Testing focused on the bandwidth savings and user experience over the different network types. Engineers did not analyze the quality of the picture transmitted from Presentation Server to the client.)

For the "no bandwidth limit" network scenario, results showed 93% bandwidth savings for Presentation Server 4.5 when displaying an animated image over the network using 1.18 MB of data, versus 17.67 MB for Presentation Server 4.0. (See Figure 2.)

During the test, engineers experienced rapid responsiveness when

performing tasks such as zooming, scrolling and moving the animated images displayed to a remote client connected to Presentation Server 4.5. For Presentation Server 4.0, engineers experienced a "lag" or delay of 1 second when starting to play the animated MRI brain images and also, when zooming or moving the images. Engineers also noted the presence of skipped frames with Presentation Server 4.0, when displaying the animated images from the back-end server to the downstream client. Skipped frames are data frames lost during transmission to an end-point which becomes noticeable when an image jumps into another section of the animation or clip. Engineers did not witness any skipped frames with Presentation Server 4.5.

Over a simulated T1 scenario, results show that Presentation Server 4.5 delivered 2D graphics in fewer bytes — 1.16 MB — compared to 12.15 MB delivered by Presentation Server 4.0. Presentation Server 4.5 also used up to 90% less bandwidth.

Again, with Presentation Server 4.5, engineers experienced a smooth motion when playing the animated images and also, when moving or zooming the pictures. However, with Presentation Server 4.0, the delay of starting the image was higher (2 seconds) than the previous scenario when playing or

trying to perform any task on the images. Fewer skipped frames were noticeable when playing the images on Presentation Server 4.5 in comparison with Presentation Server 4.0.

In the Asymmetric DSL (ADSL) scenario, Presentation Server 4.5 sent fewer bytes — 1.32 MB — versus Presentation Server 4.0 with 11.8 MB, reducing bandwidth usage by 89%.

In terms of usability, Presentation Server 4.5 did not exhibit any degradation during the animation playback, nor when performing image manipulation such as zooming, moving or scrolling images. For Presentation Server 4.0, the delay of playing and performing any task on the images was similar to the T1 scenario. The skipped-frames issue was noticeable on both products however, on Presentation Server 4.5 the animated images were shown smoothly compared to Presentation Server 4.0.

Lastly in the high-latency simulated satellite scenario, engineers played and performed tasks on the 2D animated images from both Presentation Server 4.0 and Presentation Server 4.5, with the latter achieving bandwidth savings of 57%. Presentation Server 4.5 delivered 1.65 MB of data to the remote client; Presentation Server 4.0 sent 3.84 MB.

From a usability perspective, Presentation Server 4.5 did experience a small delay of 1 second when playing animated images as well as performing control tasks such as zooming, moving and scrolling over the images. With Presentation Server 4.0, engineers experienced a larger delay of 5 seconds approximately when playing the animated images over the session and also, when trying

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Citrix Systems, Inc.

Citrix Presentation Server 4.5

Graphics Performance

Product Specifications

* Vendor-supplied information not necessarily verified by The Tolly Group

Citrix Systems, Inc.
Citrix Presentation Server 4.5
Product Specifications*

Key Functionality:

- Application Virtualization
- Application Streaming
- Application Performance Monitoring
- Single Sign-On
- SmartAccess
- SpeedScreen Progressive Display
- Health Assistant
- 64-bit platform support
- Windows Vista support
- Isolation 2.0
- Application Hub

Product URL:

- http://citrix.com/presentationserver

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URL: http://www.citrix.com

to perform any control task. Engineers also noted a greater amount of skipped frames with Pres-entation Server 4.0 compared to Presentation Server 4.5. Version 4.0 did not show clearly the animated images during the playback while the Presentation Server 4.5 image motion was unaffected.

**Presentation Server 4.5 Graphics Performance
Results Summary -- Running PACS MRI Brain Animation**
High Compression Level on Presentation Server 4.0/Ultra High Compression Level
with Heavyweight Compression on Presentation Server 4.5

Link Type	Presentation Server Version	Performance Measurement			
		Iteration	Throughput (Mbps)	No. of Packets	Bytes Captured
No bandwidth limit	4.0	Windows XP client			
		1	1.620	19,190	16,273,312
		2	1.838	22,235	18,961,309
		3	1.974	23,535	20,348,764
		Average	1.811	21,653	18,527,795
	4.5	Windows XP client			
		1	0.125	3,284	1,295,196
		2	0.107	3,059	1,096,093
		3	0.129	3,417	1,337,913
		Average	0.120	3,253	1,243,067
T1 (1.544 Mbps / 50 ms delay)	4.0	Windows XP client			
		1	1.158	14,347	12,229,136
		2	1.225	14,380	12,872,287
		3	1.295	15,059	13,125,693
		Average	1.226	14,595	12,742,372
	4.5	Windows XP client			
		1	0.096	3,128	1,102,522
		2	0.115	3,241	1,200,908
		3	0.126	3,340	1,347,892
		Average	0.112	3,236	1,217,107
ADSL (1.5 Mbps/ 256 Kbps - 100 ms delay)	4.0	Windows XP client			
		1	1.165	14,379	12,290,718
		2	1.168	14,412	12,193,831
		3	1.143	14,473	12,645,310
		Average	1.159	14,421	12,376,620
	4.5	Windows XP client			
		1	0.115	3,008	1,221,283
		2	0.153	3,502	1,592,519
		3	0.126	3,253	1,358,476
		Average	0.131	3,254	1,390,759
Satellite (512 Kbps / 500 ms delay)	4.0	Windows XP client			
		1	0.360	5,258	4,000,444
		2	0.368	5,273	3,945,964
		3	0.385	5,631	4,148,356
		Average	0.371	5,387	4,031,588
	4.5	Windows XP client			
		1	0.169	3,467	1,825,611
		2	0.122	3,120	1,315,487
		3	0.191	3,846	2,073,074
		Average	0.161	3,478	1,738,057

Source: The Tolly Group, April 2007

Figure 3

Test Setup & Methodology

Bandwidth Usage

Engineers evaluated Presentation Server 4.0 Enterprise Edition (Build 2198) – Service Pack 2005.4, and Presentation Server 4.5 Platinum Edition – Service Pack 2006.10. Both versions of Presentation Server were deployed and configured in two servers equipped with Intel Xeon (dual-core) processors running at 2.6 GHz and 2 GB of RAM. Both systems used Windows Server 2003 Enterprise Edition (SP1).

Engineers deployed and configured a PACS healthcare application developed by General Electric (GE) Medical Systems Information Technologies. This application consisted of two components: Centricity Enterprise Web and Centricity Radiology RA600. This system had the same hardware and software specifications as previously mentioned.

For the client workstation, engineers used a system with an Intel Pentium D

(dual-core) processor running at 2.8 GHz with 1 GB of RAM and Windows XP Professional Edition with Service Pack 2. Testers used Citrix Program Neighborhood ver. 10.0 to connect to Presentation Servers.

The main network utilized to interconnect all systems was a Fast Ethernet network using a standard Layer 2 switch.

Engineers simulated multiple wide-area network links to measure the graphics performance of both Presentation Server products. The network links simulated were T1 (1.544 Mbps) with 50 ms delay, ADSL (1.5 Mbps / 256 Kbps) with 100 ms delay, and satellite (512 Kbps) with 500 ms delay. Engineers used Spirent Communications IP Wave Network Impairment Emulator version 3.0.0.0 installed in a separate Windows Server 2003 Enterprise Edition (SP1) system. This server was equipped with an Intel Xeon (dual-core) processor running at 3.2 GHz, and was equipped with 2 GB of RAM. (See Figure 4.)

To compare the graphics display benefits between both Presentation Server products, engineers measured bandwidth utilization and user usability experience on viewing and manipulating MRI brain scan animations from the PACS application. Testing was

conducted over four network link scenarios: no bandwidth limit, T1, ADSL and satellite. Bandwidth measurements were taken using Wireshark version 0.99.0.

User Experience & Usability

For the user experience and usability evaluation, engineers examined each of the network type scenarios and assessed the degree of usability of the PACS application from the client machine. Engineers played the MRI brain animation, and then used image scrolling, zooming and moving to assess usability.

For all network types, tests were conducted using the highest compression features available on both Presentation Server products. For version 4.0, engineers enabled the "High Compression; lower image quality" feature; while for Presentation Server 4.5 the "High Compression; lower image quality" was enabled, plus under the new SpeedScreen Progressive Display option, the compression level was set to "Ultra High Compression; ultra low quality", and lastly, the "Use Heavyweight Compression" feature was enabled, too.
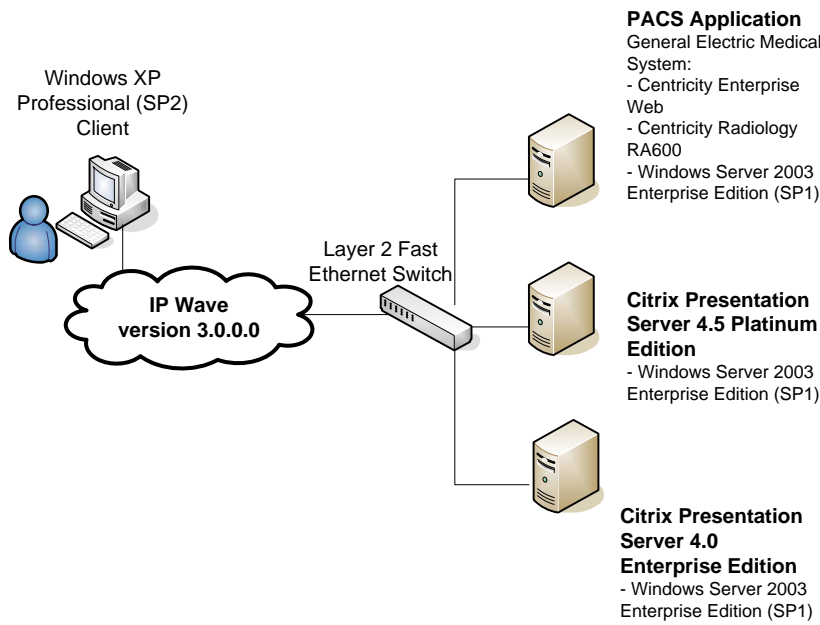
Tests were run three times for 90 seconds per each network type and the results were averaged.

🌐 **TOLLY INSIGHTS**

SpeedScreen Progressive Display

As testing demonstrated, SpeedScreen Progressive Display, the new graphics compression feature available on Citrix Presentation Server 4.5, dramatically improves the bandwidth performance and usability of graphics-intensive applications such as the PACS (Picture Archiving and Communication Systems) healthcare application. This image acceleration feature uses lossy compression to stream only a portion of the full image during manipulation, but enough to render a viewable image for end-users until motion stopped, at which point the loss-less image snapped into focus for detailed inspection. In Presentation Server 4.5, engineers witnessed throughout the testing that the SpeedScreen Progressive Display compressed significantly the PACS animated MRI brain images during playback, and also, engineers were able to manipulate the pictures with no radical problems with responsiveness.

Test Bed Diagram

Windows XP Professional (SP2) Client

IP Wave version 3.0.0.0

Layer 2 Fast Ethernet Switch

PACS Application
General Electric Medical System:
- Centricity Enterprise Web
- Centricity Radiology RA600
- Windows Server 2003 Enterprise Edition (SP1)

Citrix Presentation Server 4.5 Platinum Edition
- Windows Server 2003 Enterprise Edition (SP1)

Citrix Presentation Server 4.0 Enterprise Edition
- Windows Server 2003 Enterprise Edition (SP1)

Source: The Tolly Group, April 2007   *Figure 4*

The Tolly Group is a leading global provider of third-party validation services for vendors of IT products, components and services.

The company is based in Boca Raton, FL and can be reached by phone at (561) 391-5610, or via the Internet at http://www.tolly.com, sales@tolly.com

Test Equipment Summary

The Tolly Group gratefully acknowledges the providers of test equipment used in this project.

Vendor	Product	Web
Spirent Communications	IP Wave Network Impairment Emulator Ver 3.0.0.0	http://www.spirentcom.com

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