PC-over-IP® to VMware View 4 Virtual Desktop Configuration and WAN Network Optimization Guide

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Issue 2

PCoIP CONNECTED

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Revision History

Version	Date	Description
2	October 2010	Configuration details for VMware View 4.5 and Windows 7 added
1	July 2010	Initial release

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Introduction

This document provides general guidelines for typical office users that are connecting PCoIP zero clients and software clients to VMware View 4 virtual desktops over remote access WAN networks. The PCoIP protocol enables the broadest range of network support to handle any enterprise user demands. Network requirements can vary greatly depending on the network parameters, application graphical requirements and user demands. As such, this document is not intended to replace more detailed documentation provided by VMware and Teradici.

There are a number of tuning options for optimizing performance on a WAN including:

- Adjust the Windows Experience (Section 2)
- Ensure sufficient minimum bandwidth for PCoIP packets (Section 3.2.1)
- Minimize packet buffering for PCoIP packets through the network (Section 3.2.2)
- Ensure an appropriate queuing/priority configuration in the switch/router (Section 3.2.2)
- Adjust the VMware View settings per user:
  - Image quality (Section 4.1)
  - Maximum display frame rate (Section 4.1)
  - Maximum bandwidth (Section 4.2)
- Follow key WAN testing guidelines (Section 5)

Detailed information on configuring VMware View or PCoIP zero clients and software clients can be found in the following documents:

- Using PCoIP Zero Clients with VMware View 4 (TERA0904005). To get this document, contact your Teradici Sales Director.
- Getting Started with VMware View (EN-000276-00)
- VMware View PCoIP Network Sizing Guide
- Additional VMware View documents

1 System Requirements

To connect a PCoIP client to VMware View 4 you must have:

- A functional VMware View environment using the latest VMware View release 4.0.2, 4.5, or newer.
- Virtual desktops with Microsoft Windows XP, Vista, or Windows 7 installed.
- A PCoIP zero client with the latest 3.x firmware installed. For a list of VMware Ready PCoIP zero clients, see http://www.teradici.com/pcoip/pcoip-products/vmware-view-clients.php
- A functional remote access network environment between the datacenter office and remote sites.

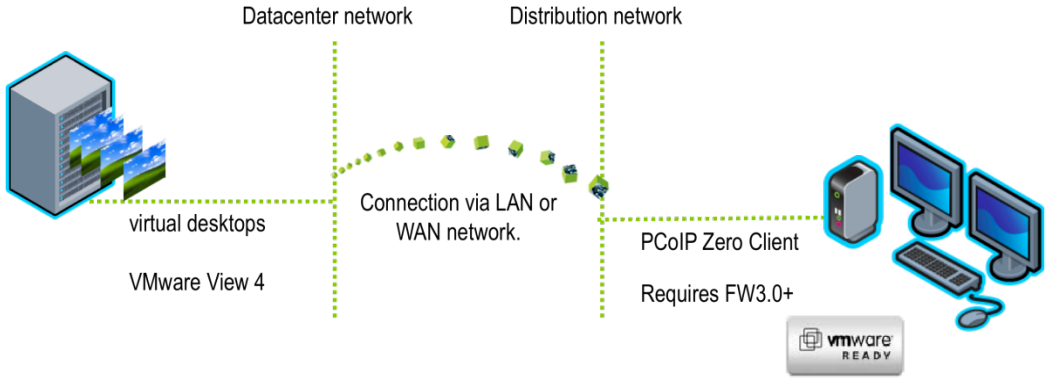

Figure 1-1 PCoIP Network Environment

2 Optimizing Windows Experience Settings

There are a number of visual settings in Windows that require additional bandwidth to deliver. An initial step in optimizing for WAN networks is to consider turning these features off to significantly reduce in the average and peak network bandwidth required.

2.1 Windows 7 Visual Settings Optimization

Warning: This batch file should be run by an experience administrator to understand the change made by using the script.

See the VMware View Optimization Guide for Windows 7.

To optimize the Visual Settings:

1. Save the Commands.txt as Commands.bat.
2. Right-click and then select **run as administrator**.

2.2 Windows XP Visual Settings Optimization

- **Set Visual affects to best performance:**
  1. Right-click on **My Computer**, and then select **Properties**.
  2. From the **Advanced** tab, click **Settings**.
  3. Select the **Adjust for best performance** option.
- **Remove Desktop wall paper:**
  1. From the **Start** menu, click **Run**.
  2. Enter *gpedit.msc* to display the **Group Policy** window.
  3. From the **Computer Configuration** folder, select **Administrative Templates** >> **Windows Components** >> **Terminal Services** >> **Enforce Removal of Remote Desktop Wallpaper**.
  4. Ensure this is set to **Enabled**, and then click **OK**.
- **Enable Blank Screensaver:**
  1. From the **Start** menu, click **Run**.
  2. Enter *gpedit.msc* to display the **Group Policy** window.
  3. From the **User Configuration** folder, select **Administrative Templates** >> **Control Panel** >> **Display** >> **Screen Saver**.

     The **Screen Saver** dialog appears.
  4. Ensure this is set to **Enabled**.
  5. Click **Next Setting** to display the **Screen Save executable name Properties** dialog. Set the **Screen Saver executable name** to *scrnsave.scr*

- **Enable Classic Start Menu:**
  1. Right-click on the **Taskbar** and then select **Properties**.
  2. From the **Start Menu** tab, select the **Classic Start Menu**.
  3. Click **Apply**, and then click **Customize**.
  4. Scroll to the bottom of the **Advanced Start menu options**, and then check the box for **Show Small Icons in Start menu**.
  5. Uncheck the **Use Personalized Menus** box, click **OK**, and then click **OK**.
- **Disable additional fading:**
  1. Right-click on the Desktop, and then select **properties**.
  2. From the **Appearance** tab, click **Effects**.
  3. Uncheck the boxes, click **OK**, and then click **OK**.
- **Change System Icon and Text Settings:**
  1. From the **Control Panel**, select the **View** menu.
  2. Select **Toolbars** >> **Customize**, and then set the **Text options** to **No text labels** and set **Icon options** to **Small icons**.
  3. Click **Close**.
  4. From the Control Panel, select the **Tools** menu.
  5. Select **Folder Options**, and then select the **View** tab.
  6. Check or uncheck the boxes as shown in the following two screenshots.

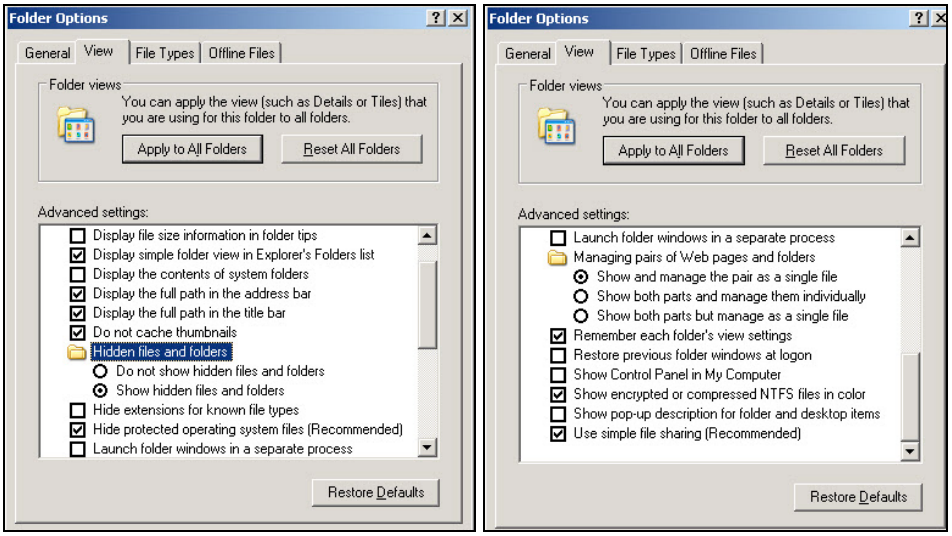

Figure 2-1System Icon and Text Changes

7. Click **Apply**.

3 Network Planning Considerations

The PCoIP protocol provides a real-time delivery of a rich user desktop experience using UDP. To ensure a responsive desktop, PCoIP protocol must be deployed across a properly architected network infrastructure that meets bandwidth, latency, jitter, and packet loss requirements. Since every customer/end user perception is different, when you plan your network consider:

- Graphically intensity of the typical user (e.g., forms pages or 3D viewer).
- Importance of image quality to user (e.g., administration or artist).
- Amount of interactivity vs. static viewing.
- Increased bandwidth may be required to satisfy more demanding users.

3.1 Network Bandwidth Planning – Basic Office Productivity Desktops

Determine minimum bandwidth required for simultaneous access for typical office productivity users.

When you consider your network bandwith, plan for:

- 200 to 250 kbps average bandwidth for a basic office productivity desktop: typical office, applications with no video, no 3D graphics, and the default Windows and VMware View settings.
- 80 to 150 kbps average bandwidth for a basic office productivity desktop: typical office, applications with no video, no 3D graphics, with Windows experience (Section 2) and VMware View session variable optimization (Section 4)
- 500 kbps to 1 Mbps minimum peak bandwidth to provide headroom for bursts of display changes. In general, size you network using the average bandwidth, but consider peak bandwidth to accommodate bursts of imaging traffic associated with large screen changes.
- 1 Mbps per simultaneous user running 480p video.
- Less than 80% network utilization.

Note: 80 to 250 kbps per user is based on the assumption that all users are operating continuously and performing similar tasks over an 8 to 10 hour day. Situations may vary in that some users may be fairly inactive and consuming almost no bandwidth allowing more users per link. As such, these guidelines are intended to provide a starting point for more detailed bandwidth planning and testing.

3.1.1 1.5 Mbps T1 Example for a Basic Microsoft Office Desktop

- Basic office productivity applications, no video, no 3D graphics, and keyboard/mouse USB traffic.
- Bandwidth required - (250Kbps/0.80) * 5 = 1.5Mbps.
- Result: Between 3 to 5 concurrent users per T1 line.

Note: You may require VMware View and Windows optimization to achieve this user density.

3.1.2 10 Mbps Example for a Microsoft Office Desktop with Occasional Multimedia

Scenario 1

- Basic office productivity applications, up to a single user watching occasional 480p video, no 3D graphics and keyboard/mouse USB traffic. Desktop optimizations including:
  - Windows experience settings optimized
  - Maximum bandwidth PCoIPMaxLinkRate GPO set to 5 Mbps
  - Maximum initial image quality PCoIPImagingMaximumInitialImageQuality GPO set to 70
  - Frame rate limit registry key set to 12 fps
- Bandwidth required - (250 Kbps/0.80) * 28 = 8.75 Mbps.
- Bandwidth required - (1 Mbps/0.80) * 1 = 1.25 Mbps (for a single user watching video at any given time)

Result: Up to 28 concurrent users per 10 Mbps line.

Scenario 2

- Basic office productivity applications, up to a single user watching occasional 480p video, no 3D graphics and keyboard/mouse USB traffic. Desktop optimizations including:
  - Windows experience settings optimized
  - Maximum bandwidth PCoIPMaxLinkRate GPO set to 3 Mbps
  - Maximum initial image quality PCoIPImagingMaximumInitialImageQuality GPO set to 70
  - Frame rate limit registry key set to 8 fps
- Bandwidth required - (150 Kbps/0.80) * 46 = 7.5 Mbps.
- Bandwidth required - (1 Mbps/0.80) * 1 = 1.25 Mbps (for a single user watching video at any given time)

Result: Up to 46 concurrent users per 10 Mbps line.

Note: You may need additional VMware View and Windows optimization to achieve this user density.

3.2 Network Configuration Considerations

To ensure a successful VMware View deployment, perform a network assessment to determine proper configuration to support the necessary bandwidth while meeting latency, jitter and packet loss requirements.

3.2.1 Network Bandwidth

- Ensure a full-duplex end-to-end network link is used.

Note: Older switches may incorrectly default to half duplex when connected to a link with auto-negotiation. In this case, you must explicitly set the switch link to full duplex.

- Confirm network connectivity and that sufficient bandwidth is available between the VMware View server, VMware View manager, and the PCoIP client.
- Ensure that PCoIP packets are not fragmented at any point in the network path.
    - Check that the MTU in the switches/routers in the network path is not below the PCoIP packet MTU size. Consider increasing the switch/router MTU or reduce the PCoIP packet MTU via the PCoIPMtuSize GPO – set to a value between 500-1500 bytes (default is 1400).

Note: Consider increasing the switch/router MTU before reducing the PCoIP packet MTU as a lower MTU size can impact desktop performance.

- Consider segmenting PCoIP traffic via IP QoS DSCP or a layer 2 CoS or virtual LAN (VLAN).
- If a VPN is used, confirm that UDP traffic is supported.
    - Do not route PCoIP traffic through TCP-based SSL tunnels.
    - Use a VPN-less solution such as a security gateway, or use IPSEC or DTLS-enabled SSL solutions.
    - See Knowledge Base item #312 on the techsupport.teradici.com for information on the Security Gateway development.

3.2.2 Network Latency and Jitter

- Ensure that the round trip network latency is less than 250 ms for VMware View 4.x.
- Perform a thorough assessment of active application traffic across the end-to-end network to ensure that there is sufficient minimum bandwidth available for PCoIP traffic even with network congestion.

  Network congestion and traffic shaping with deep packet buffers can cause high packet latency, which can be considered as lost packets to PCoIP protocol.
- Ensure that the buffers in routers/switches are set to minimize latency (e.g., to absorb 50 ms to 100 ms of PCoIP packet traffic).
    - If a service provider cannot reduce the buffer depths in all routers in the network path, consider applying traffic shaping policies in the Customer Edge (CE) router, or Service provider Edge (PE) router.
- Allow PCoIP traffic to burst when network bandwidth is available (e.g., do not set a hard limit on PCoIP traffic as a % of the link rate).
- Ensure sufficient priority for PCoIP traffic while considering the real-time nature of the protocol. Consider options such as Class-based Weighted Fair Queuing (CBWFQ).
    - Assign a priority to PCoIP traffic that is above standard TCP traffic, but below Voice-over-IP (VOIP) protocol.

  - Ensure guaranteed network bandwidth for PCoIP traffic during congestion. In general, set PCoIP traffic to have 80% of the remaining bandwidth after the higher priority traffic is allocated. For example, consider a network that guarantees 20% of a link bandwidth for critical traffic such as VoIP, PCoIP should be set to receive 80% of the remaining bandwidth, or 64%. This lets other protocols, such as file transfers or web traffic, transfer some traffic without starving the PCoIP sessions.
  - If traffic shapers are being used, use them in conjunction with a scheduling queue, and assign high priority to this queue based on the CoS value set for PCoIP traffic. This is CBWFQ.
- To reduce packet latency further, configure priority-queuing for low-latency traffic also called low-latency queuing. It can be configured with class of service to match and mark the high-priority traffic and then send it to a low-latency queue, On Cisco devices, network managers should try different queue-limits to ensure there are no tail-drops on PCoIP packets. This gives high priority to low-latency traffic. This is a version of policy-based routing available on most routers.
- Configure congestion avoidance policies to use weighted random early detection (WRED) for PCoIP traffic.
- Ensure that the ESX virtual switch traffic shaper is turned off.

Note: Periodic excessive latency is an indication that traffic shaping with deep packet buffers is impacting PCoIP packet delivery during periods of congestion.

3.2.3 Network Packet Loss

- PCoIP protocol is tolerant to a reasonable amount of packet loss. Since PCoIP traffic is a real-time delivery of a rich user desktop experience, packet loss should be minimized where possible.
- There are multiple potential sources of packet loss in a VMware View environment including:
  - Network congestion triggering congestion avoidance algorithms. While this is expected behavior when congestion avoidance policies are configured, excessive packet loss due to congestion is an indication that additional optimization is required to increase bandwidth available or to reduce PCoIP traffic.
  - PCoIP packets that arrive with a high latency due to network congestion may be considered as lost packets by VMware View.
  - PCoIP packets that arrive sufficiently out of order may be considered as lost packets by VMware View. Be sure to minimize packet re-ordering in the network.

Note: If network logs show no packet loss but VMware View and/or PCoIP zero client logs show packet loss, this indicates packets with high latency, or sufficiently out-of-order packets being considered as lost.

Description	Resolution Options to Consider						
	Optimize the Windows Experience Settings (section	Optimize VMware View settings for bandwidth limits, image quality and frame rate	Minimize the packet buffer depth in all switches/routers	Increase priority of PCoIP traffic	Increase the amount of bandwidth assigned to PCoIP traffic	Increase the link bandwidth	Minimize packet re-ordering in the network
Significant packet loss due to congestion (e.g. WRED being triggered)	✔	✔		✔	✔	✔	
Packets considered lost by VMware View due to high latency packet delivery	✔	✔	✔	✔	✔	✔	
Packets considered lost by VMware View due to sufficiently out-of-order packets	✔	✔					✔

Table 3-1 Resolution Options when Experiencing Significant Packet Loss for a VMware View Session

4 VMware View Manager Settings for the Desktop

Administrative templates can be used to customize virtual desktop settings via PCoIP session variables. This is done using the PCoIP.ADM template with the Microsoft GPO editor.

- **PCoIP.ADM file location:** The PCoIP.ADM file is found on the VMware View Connection Server in C:\Program Files\VMware\VMware View\Server\Extras\GroupPolicyFiles\pcoip.adm. For isolated changes to a specific VM, copy this file to C:\windows\inf within the Windows VM and implement using a group policy editor. For larger environments, apply the pcoip.adm to an OU or apply the setting to the template prior to deployment.
- **Importing the ADM file:**

  1. Copy the PCoIP.ADM to the Windows VM.
  2. From the **Start** menu, click **Run**, and then enter *gpedit.msc*. The **Group Policy** window appears.
  3. Right-click on **Administrative Templates**, and then select **Add/Remove Templates**.

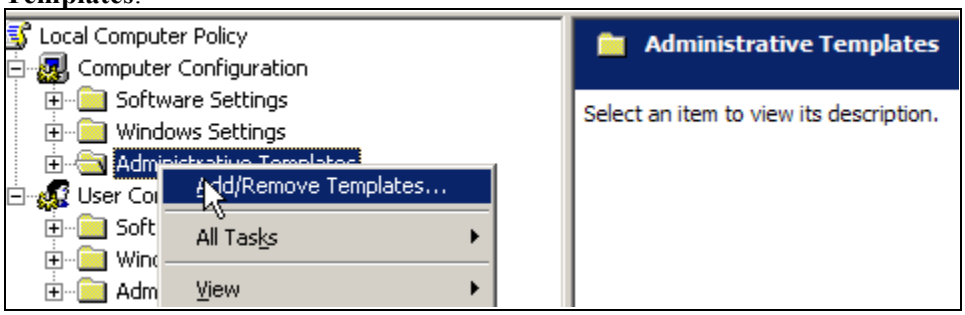

Figure 4-1 Importing the PCoIP.ADM file

  4. Select **Add** and choose the **PCoIP.ADM in C:\window\inf**.
  5. Click **Close**.

     GPO options for PCoIP session variables appear.

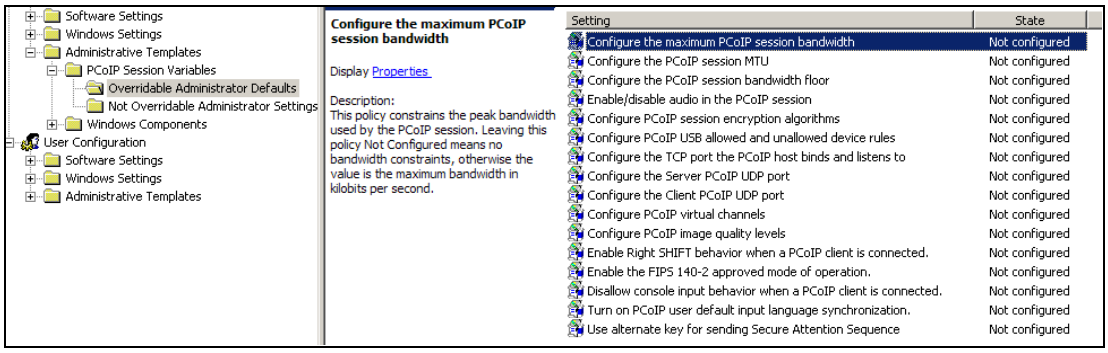

Figure 4-2 Setting PCoIP Session Variables via Microsoft GPO Editor

4.1 Display / Imaging

Warning: Teradici has carefully selected the default values and recommends that you do not change these settings unless you have carefully determined the overall effect to be beneficial.

For optional optimization, adjust the image quality settings:

- PCoIPImagingMinimumImageQuality GPO: Set to a value between 30 and 100 (default is 50). In a limited bandwidth scenario this setting allows configuring the preference between:
  - A higher frame rate (lower value) for smooth motion, with lower image quality.
  - A higher image quality (higher value) for crisp imaging, with less smooth image motion.
- PCoIPImagingMaximumInitialImageQuality GPO: Set to a value between 30 and 100 (default is 90). In a limited bandwidth scenario, this setting lets you configure the preference between:
  - A higher initial image quality, with larger peaks in bandwidth during large screen changes.
  - A lower initial image quality, with smaller peaks in bandwidth during large screen changes.

Note: If used, consider adjusting the maximum imaging quality before applying a bandwidth limit or adjusting the minimum image quality.

Note: The "Minimum Image Quality" must be set to a value below the "Maximum Initial Quality".

- PCoIP.maximum_frame_rate: The default is 30 frames per second (fps). In a limited bandwidth scenario, this setting allows configuring the preference between:
  - A higher frame rate for smooth display imaging motion, with possible increased average network bandwidth.
  - A lower frame rate for a lower average network bandwidth, with less smooth image motion.
  - If used, create a DWORD value in decimal under this registry key: HKEY_LOCAL_MACHINE\SOFTWARE\Policies\Teradici\PCoIP\pcoip_admin_defaults\pcoip.maximum_frame_rate setting up to 30 in Hz (default is 30). A limit of 8 to 12 fps should be acceptable for basic office users.

4.1.1 Example: Network Congestion Causes Occasional Degraded User Experience

Scenario:

- Basic office productivity applications, no video, no 3D graphics.
- T1 line with four active users.
- An analysis of the link shows periodic spikes in bandwidth that consume the available link bandwidth, or the bandwidth assigned to PCoIP traffic. Further analysis shows that the network traffic during these spikes is roughly distributed across all active users.
- Users notice a momentary degradation in their desktop experience.

Resolution:

- Set the Windows XP Visual settings for best performance as described in Section 2.
- Reduce the maximum initial image quality
  PCoIPImagingMaximumInitialImageQuality = 70

Result:

- Users maintain an acceptable desktop experience even during spikes in bandwidth.

4.2 Network

Warning: PCoIP protocol is architected to take advantage of available network bandwidth and fairly share bandwidth across active users on a link. As such, Teradici recommends that you do not change this setting unless you have carefully determined the overall effect to be beneficial.

Optional optimization:

- Set the ceiling on the bandwidth an individual user session can consume (in Kbps)
- Be careful not to set a maximum bandwidth limit too low such that individual sessions cannot take advantage of additional link bandwidth when available. In this case, consider increasing link bandwidth at network congestion point(s).
- PCoIPMaxLinkRate GPO: Set to the desired maximum PCoIP session bandwidth in kilobits per second (e.g., 1000 = 1000 Kbps = 1 Mbps). Default is 1 Gbps, 0 = no bandwidth constraints.

Note: If used, this setting must be configured for users that share a particular network link.

Optional optimization:

- Set a floor on the bandwidth an individual user session will try to consume under load (in Kbps). This GPO is available in VMware View 4.5 or newer.

Warning: PCoIP protocol is architected to take advantage of available network bandwidth and fairly share bandwidth across active users on a link. As such, Teradici recommends that you do not change this setting unless you have carefully determined the overall effect to be beneficial.

- Be careful to ensure that there is sufficient network bandwidth across the network patch to support all users on that network simultaneously transmitting at the bandwidth floor.
- **PCoIPBandwidthFloor GPO:** Set to the desired target PCoIP session floor bandwidth in kilobits per second (e.g., 350 = 350kbps). The value range is from 0 to 100,000 kbps (0-100 Mbps). Default is 0 = no bandwidth constraints.

Note: The actual bandwidth is below the configured bandwidth floor target if the user session does not require the additional bandwidth.

4.2.1 Example: Network Congestion from a Small Number of Users Cause Degraded User Experience

Scenario:

- Basic office productivity applications, no video, no 3D graphics.
- 6 Mbps link with 20 active users.
- An analysis of the link shows periodic spikes in bandwidth that consume the available link bandwidth or the bandwidth assigned to PCoIP traffic. Further analysis shows that one or two users are consuming 3 to 4 Mbps during the degradation (possible the users are watching video even though that was not planned for).
- The remaining users notice degradation in their desktop experience.

Resolution Options:

- Set the Windows XP Visual settings for best performance as described in Section 2.
- Set the maximum PCoIP bandwidth per user via the PCOIPMaxLinkRate. Since only one or two users spike at a given time, the bandwidth is set at 1000 kbps. This must be set for all users on the link.
- Set the PCoIP bandwidth floor per user via the PCoIPBandwidthFloor GPO. A floor of 240 kbps is set to ensure a baseline performance for the users during a congestion event.
- If after making this setting the users still notice a momentary degradation in their desktop experience, consider adjusting the image quality settings – reduce the maximum initial image quality PCoIPImagingMaximumInitialImageQuality = 70 increasing the minimum image quality PCoIPImagingMinimumImageQuality = 60.

Result:

Users maintain an acceptable desktop experience even when a few users spike in bandwidth.

4.2.2 Example: Optimizing for Increased User Density on WAN Network Links

Scenario:

- Basic task worker/call center applications, no video, no 3D graphics. Low average bandwidth is a higher priority than user experience.
- 1.5 Mbps link with >5 active users.

Resolution Options:

- Set the Windows XP Visual settings for best performance as described in Section 2.
- Set the maximum PCoIP bandwidth per user using the PCOIPMaxLinkRate. The actual setting depends on the number of users targeted for the link. This must be set for all users on the link.
- Reduce the maximum initial image quality PCoIPImagingMaximumInitialImageQuality = 70, and the minimum image quality PCoIPImagingMinimumImageQuality = 40.

- Reduce the PCoIP.maximum_frame_rate = 8 fps.
- If the average bandwidth is not sufficiently reduced, you can use even lower settings for the bandwidth limit and image quality.

Result:

More than five users can be active simultaneously on a T1 WAN link.

5 WAN Connected Virtual Desktop Testing Guidelines

Test real workloads with multiple users actively sharing the link. Key considerations include:

- Single user bandwidth tests are invalid since PCoIP protocol will take as much bandwidth as possible unless constrained by the network, or by configuration. When constrained, the PCoIP protocol fairly shares bandwidth with other PCoIP protocol users.
- Do not try to simulate desktop performance by limiting a single session. This is also an invalid test.
- Do not rely on video playback to be representative of real-application user performance
- Test real web sites that users go to, not just sites that support windows media since MMR improves video in just that case.

Note: Do not use random packet loss to emulate network loss. Random packet loss is not representative of real network loss and results in PCoIP protocol using the minimum quality and performance.

Free WAN emulation tools can randomly drop packets to emulate network packet loss. However, in real networks random packet loss is rare and due to poor network link quality which is typically repaired by Service Providers when it occurs. PCoIP protocol adapts to the packet loss to reduce the network load, however the random loss algorithm causes PCoIP protocol to continually lower the display quality and frame rates until the minimum quality floor is hit.

A common cause of packet loss is network congestion (or the result of congestion avoidance algorithms being triggered) which results in periodic and sequential packets lost. This loss goes away when the congestion is alleviated. More sophisticated WAN emulation tools incorporate more intelligent packet loss algorithms. PCoIP protocol adapts to the packet loss to reduce the network load to help alleviate the network congestion causing the loss.

5.1 X86 and/or Thin Client Considerations

- Multi-media redirection can make certain video's look better on an appropriately powerful client, but the same performance improvement is not realized when using Office applications or scrolling PDF's etc. Turn off MMR to see how the client appears with new media that is not supported by redirection (e.g., HTML5, Google WebM).
- Test with the client devices you plan to purchase.

For more detailed information on VMware View 4 to PCoIP zero client operation, see the online knowledge base or submit a support request at techsupport.teradici.com.