



VMware View™ 5 with PCoIP

NETWORK OPTIMIZATION GUIDE

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Introduction to VMware View PCoIP

The PCoIP protocol provides real-time delivery of a rich user desktop experience using UDP. This document addresses the optimization of the PCoIP display protocol in VMware View.

Any successful virtual desktop deployment starts with a solid plan and design, from the endpoint device to the datacenter, to support the use cases and business objectives. As with any remote display protocol, the most important design consideration is a properly architected network. To ensure a responsive desktop, the PCoIP protocol must be deployed across a network infrastructure that meets bandwidth, latency, jitter, and packet loss requirements.

Network requirements can vary greatly depending on the network parameters, application graphical requirements, and user demands.

The sections of the paper are:

- PCoIP Bandwidth Optimization in View 5
- Using VMware View Planner to Optimize Your View Deployments
- Recommended Configurations for Optimal Bandwidth Utilization in View 5
- Windows Desktop Settings to Optimize Performance over a WAN
- Network Optimization
- Advanced Configurations in VMware View
- Using PCoIP Session Statistics to Monitor End-User Experience

PCoIP Bandwidth Optimization in View 5

In View 5 with PCoIP, VMware made significant performance optimizations to improve overall bandwidth utilization and CPU consumption. The bandwidth improvements permit higher session consolidation per network connection and increased WAN scalability. Combined with the CPU optimizations, you can achieve higher consolidation ratios per host and greater responsiveness.

The bandwidth reduction was achieved with a combination of these changes:

- Lossless codec improvements
- Client-side caching
- Ability to turn off Build to Lossless

The lossless codec and client-side caching changes are enabled by default in View PCoIP. Build to Lossless is enabled by default to provide the richest graphical experience, and now you can disable Build to Lossless. These three changes combined result in optimal bandwidth utilization. The bandwidth reduction occurs on both a LAN and a WAN, but you gain the most value on a WAN because of the smaller bandwidth available.

Updates to the Lossless Codec

In View 5, VMware and Teradici improved the lossless codec by changing the algorithm for compressing text. This improvement significantly reduced bandwidth usage, especially in cases where ClearType and anti-aliased fonts are used.

The updated lossless codec is enabled by default and does not require configuration.

Client-Side Image Caching

Client-side caching stores image content on the client to avoid retransmission. By default, client-side caching is set to On, which helps to reduce bandwidth usage.

Client-side caching is a feature in Windows View Clients, but not in zero clients or mobile clients. In addition, the Mac and Linux Clients do not yet have client-side caching.

The recommended memory for client-side caching is 1GB. Windows, Mac, and Linux clients usually have more than 1GB memory, as do thin clients, but a virtual machine could have less. Consult the client documentation or client provider for information on available memory. If the client memory is less than 512MB, reduce the client cache size for optimal performance of client-side caching. See [Client Cache Size Setting in View](#).

Build to Lossless

Building to lossless is a unique capability built into PCoIP to provide the highest quality of graphic image. VMware View with PCoIP uses a progressive build process for screen images so that users have the optimal experience, even under constrained network conditions. PCoIP builds to lossless in three incremental steps:

- Sends initial, highly compressed lossy (grainy) image to the client, with the image content cached on the client
- Builds image to perceptually lossless
- Builds image to fully lossless (full fidelity)

By default, PCoIP builds to fully lossless, the highest image quality. The final step between perceptually lossless and fully lossless by default takes thirty seconds. The process of building to lossless, when enabled, occurs in the background.

Building to lossless works best on a LAN or high-bandwidth WAN. To maintain desktop responsiveness on congested networks, PCoIP dynamically reduces image quality and screen update frequency. On networks with less than 1Mbps of bandwidth per session, PCoIP dynamically adapts to changing network conditions and adjusts by slowing down the build to lossless, with a visibly lossy image to the user, then a rapid build of the

image to a lossless state. When the network is no longer congested, PCoIP resumes maximum image quality and update frequency. This algorithm allows the desktop to remain responsive even under varying network conditions.

A fully lossless image is critical for use cases such as medical imaging and graphic design, where image quality is a more important consideration than bandwidth utilization.

Other use cases, such as office workers, task workers, and knowledge workers, do not require the same level of image perfection. In these cases, bandwidth utilization is usually more important than image quality. In View 5 with PCoIP, you have the ability to disable the build to lossless stage to lower bandwidth utilization. This provides standard users with a perceptually lossless rich user experience at the same time as you optimize network bandwidth utilization.

You configure the build-to-lossless capability with the Disable Build To Lossless group policy setting provided in VMware View. The default value of Disable Build To Lossless is Off; fully lossless is enabled, and images are built to the highest quality. In cases where bandwidth utilization is more critical than highest image quality, disable the build-to-lossless feature by setting Disable Build To Lossless to On. See [Recommended Configurations for Optimal Bandwidth Utilization in View 5](#).

The Disable-Build-to-Lossless feature extends beyond the standard View Clients to zero clients and mobile clients.

Using VMware View Planner to Optimize Your View Deployments

VMware View Planner is a workload generator and sizing tool that simulates a large-scale deployment of virtualized desktop systems. This virtual appliance enables you to study the effects of a View deployment on an entire virtualized infrastructure. The tool is scalable from a few virtual machines running on one VMware ESX host up to hundreds of virtual machines distributed across a cluster of ESX hosts.

View Planner assists in the setup and configuration of the testing infrastructure, runs a set of application operations selected to be representative of real-world user applications, and reports data on the latencies of those operations. View Planner is highly flexible and accommodates many testing and usage scenarios.

VMware used View Planner to test the performance of PCoIP in View 5. The View Planner tool is available to consultants from the VMware Professionals Services Organization and to VMware Partners via download from [Partner Central](#). For more information about evaluating your View deployment with this tool, contact a [VMware Partner](#) or the [VMware Professional Services Organization](#).

For an introduction to View Planner see the [VMware View Planner community forum](#) and the [View Planner Datasheet](#).

For complete instructions on using View Planner, see the [View Planner and Installation Guide](#) and [Using Custom Applications in View Planner](#).

Recommended Configurations for Optimal Bandwidth Utilization in View 5

View 5 is optimized to a new level of low bandwidth usage. Updates to the lossless codec and client-side caching are enabled by default in View 5. You can achieve the maximum bandwidth efficiency by:

- Turning off the Build to Lossless capability

You can gain further reduction by:

- Configuring audio compression

All configurable PCoIP settings are within the View `pcoip.adm` group policy administrative (ADM) template file. You can configure the group policies in one of the following:

- In Active Directory
- On an individual virtual machine that will be the parent or template for a desktop pool

Before you can configure the View PCoIP settings, you must import the PCoIP administrative template into the environment where you will configure the policies.

Choose to configure the PCoIP group policy settings on the Active Directory server when one of the following is true:

- You want to apply the policies to desktop pools
- You want to apply the policies to the entire View environment

Choose to configure the PCoIP group policy settings on an individual machine that will be the parent or template for a desktop pool when:

- You want to apply the policies to only one desktop pool

If you are applying the policies to only one desktop pool, you have the choice of configuring the policies either in Active Directory or on a master virtual machine. However, pay careful attention to the level at which you configure the PCoIP group policy settings:

- Plan your group policy settings for users and machines ahead of time. You can map View desktop pools to Active Directory organizational units.
- Active Directory domain-level settings override machine-level settings. For more centralized management, configure the settings in the Active Directory.

Importing the PCoIP Administrative Template

Importing the Template into the Active Directory Server

To configure the group policies in Active Directory, you must first import the `pcoip.adm` group policy template into the Active Directory server.

When you install View, this file is automatically installed in:

```
<install_directory>\VMware\VMware  
View\Server\extras\GroupPolicyFiles\pcoip.adm
```

on your View Connection Server, and you copy it to your Active Directory server.

Prior to copying the `pcoip.adm` template file to the Active Directory server, prepare your View environment for applying policies to organization units (OUs):

- Create organizational units for your View desktops so that you can isolate the configured group policies from other Windows computers in the same Active Directory domain. Add your View desktops to the OUs.

For details on creating OUs and adding desktops to the OUs, see *Create an OU for View Desktops* in the *Configuring Policies* chapter in the [VMware View Administration guide](#).

- Create GPOs to contain the View group policies and link them to the OUs for your desktops

Select **Start > All Programs > Administrative Tools > Active Directory Users and Computers**. Continue with the instructions in *Create GPOs for View Group Policies* in the *Configuring Policies* chapter in the [VMware View Administration guide](#).

- Add the template to your GPOs so you can apply the View group policy settings to your View desktops
 1. Copy the `pcoip.adm` template file from the Connection Server (<install_directory>\VMware\VMware View\Server\extras\GroupPolicyFiles) directory to your Active Directory.
 2. Continue with the instructions in *Add View ADM Templates to a GPO* in the *Configuring Policies* chapter of the [VMware View Administration guide](#).

You are now ready to configure the `pcoip.adm` group policy settings in Active Directory. See [Configuring Group Policies in Active Directory](#).

Importing the Template into an Individual Virtual Machine

To configure the group policies on an individual virtual machine that will be the parent or template for a desktop pool, you must first import the `pcoip.adm` group policy template into a virtual machine in your View deployment. You add the `pcoip.adm` template file to the Local Computer Policy configuration on this virtual machine.

When you install View, this file is automatically installed in:

```
<install_directory>\VMware\VMware  
View\Server\extras\GroupPolicyFiles\pcoip.adm
```

on the View Connection Server, and you copy it to the master virtual machine.

1. On the virtual machine you will use to create the desktop pool, click **Start > Run**.
2. Type `gpedit.msc`, and click **OK**.
This opens the Local Group Policy Editor console in Windows.
3. Make sure you can connect to the View Connection Server from this virtual machine.
4. Navigate to **Local Computer Policy > Computer Configuration**.
5. Right-click **Administrative Templates**.

Alert: Do not select **Administrative Templates** under **User Configuration**.

6. Click **Add/Remove Templates**.

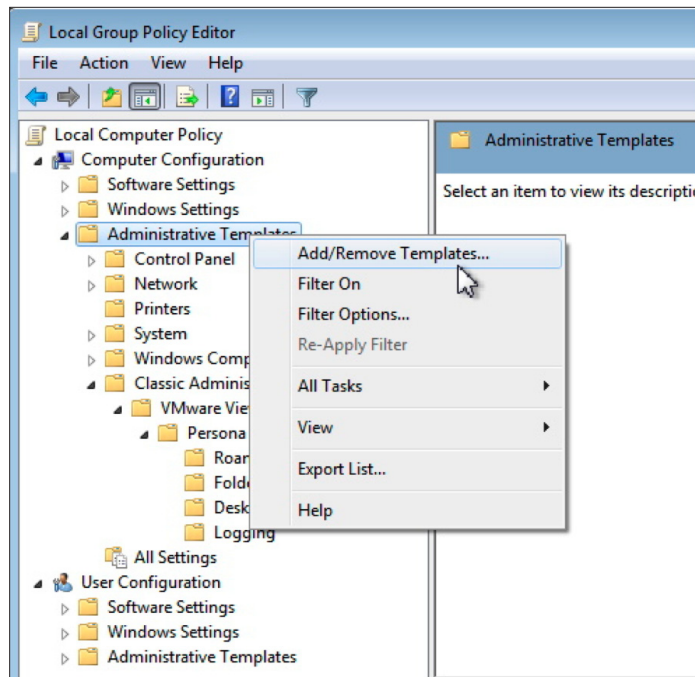


Figure 1: Local Group Policy Editor > Add/Remove Templates

7. Click **Add**.

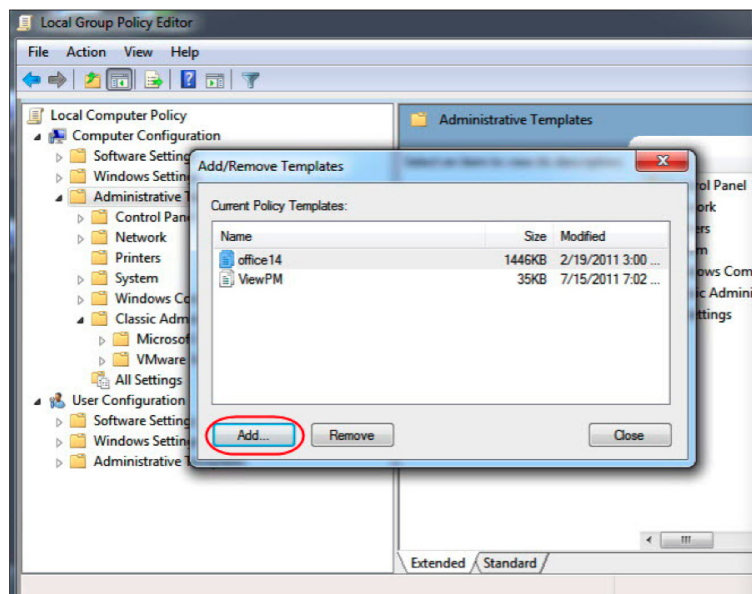


Figure 2: Add/Remove Templates

8. Navigate to `<install_directory>\VMware\VMware View\Server\extras\GroupPolicyFiles\pcoip.adm` on the View Connection Server.
9. Click **Open**.

10. Close the Add/Remove Templates window.

The PCoIP group policy settings are added to the Local Computer Policy environment on the desktop system and are available for configuration.

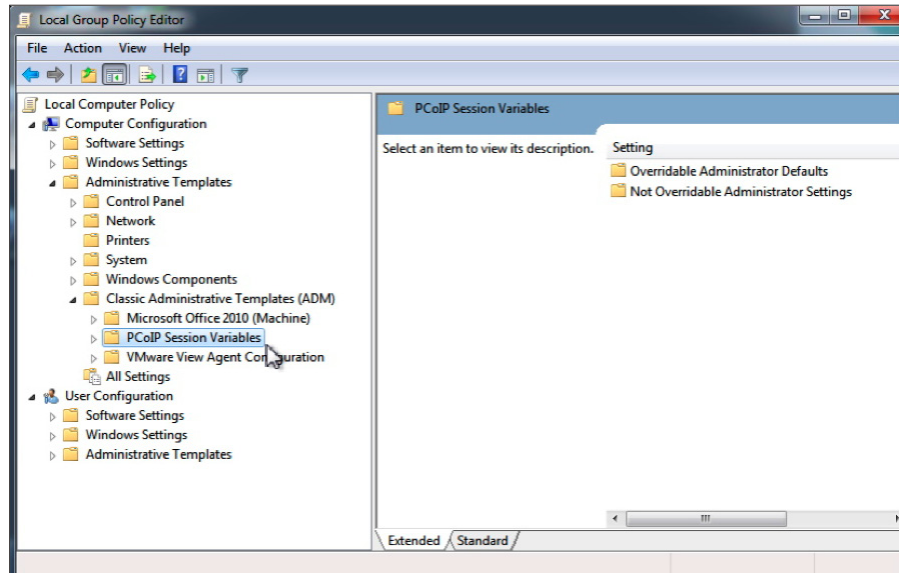


Figure 3: PCoIP Session Variables Added to Local Group Policy Editor

Now that the template is on the desktop system, you can configure the group policies. See [Configuring Group Policies in an Individual Virtual Machine](#).

Configuring Recommended View Settings

Now that you have imported the `pcoip.adm` template into either the Active Directory server or a View virtual machine, you configure the View PCoIP settings.

Configuring Group Policies in Active Directory

Configure group policies in Active Directory if:

- You want to apply the policies to desktop pools
- You want to apply the policies to the entire View environment

You must have first imported the `pcoip.adm` template into the Active Directory server. See [Importing the Template into the Active Directory Server](#).

To configure PCoIP policies in Active Directory:

1. On the Active Directory server, navigate to **Start > Administrative Tools > Group Policy Management**.

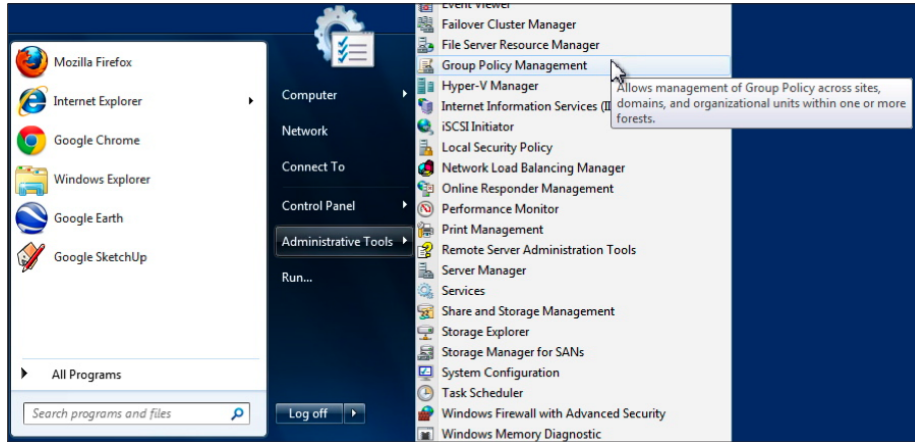


Figure 4: Administrative Tools > Group Policy Management

2. In the left pane, navigate to **Group Policy Management > your_forest > Domains > your_cloud > View Environments > View Desktops**.
3. Right-click **View Desktops** and select **Edit**.

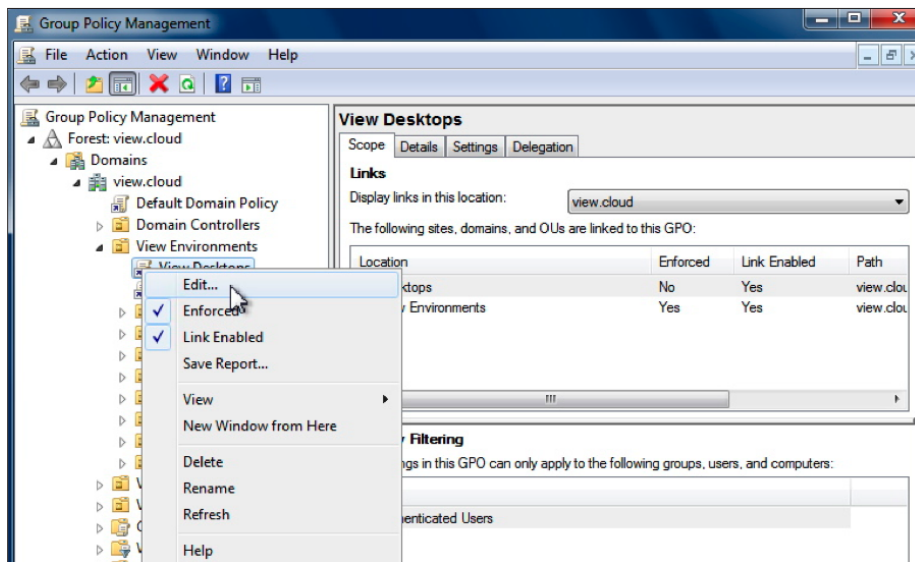


Figure 5: Group Policy Management > Edit

The Group Policy Management Editor opens with View Desktops in detail.

4. Navigate to **Computer Configuration > Policies > Administrative Templates... > Classic Administrative Templates (ADM) > PCoIP Session Variables**.

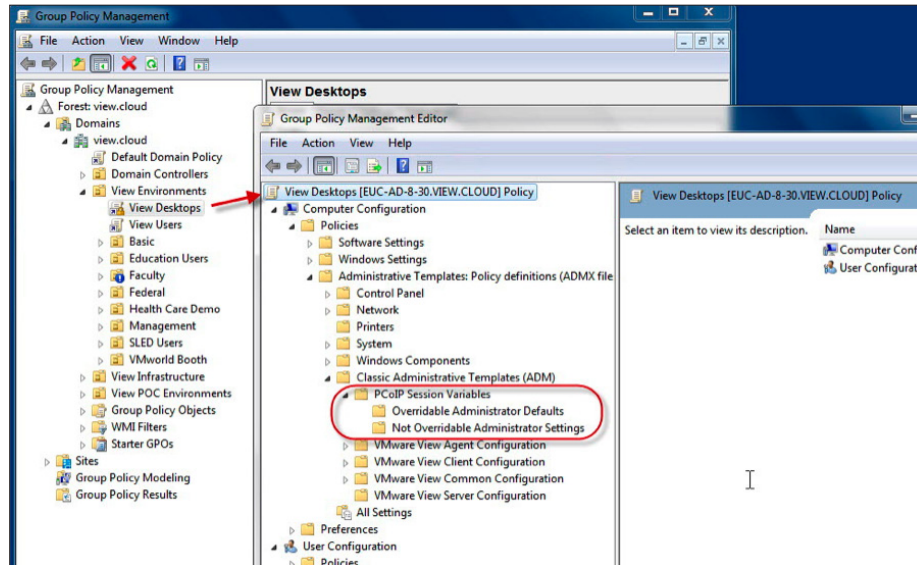


Figure 6: Group Policy Management > View Desktops > PCoIP Session Variables

From this point on, the configuration of PCoIP session variables is the same as in an individual virtual machine. See [Configuration of Individual PCoIP Session Variables](#).

Configuring Group Policies in an Individual Virtual Machine

Choose to configure the PCoIP group policy settings on an individual machine that will be the parent or template for a desktop pool when:

You want to apply the policies to only one desktop pool

You must have first imported the `pcoip.adm` template into the Local Computer Policy configuration of the master virtual machine. See [Importing the Template into an Individual Virtual Machine](#).

To configure PCoIP policies on an individual virtual machine:

1. Select **Start > Run** and type `gpedit.msc`.
The Local Group Policy Editor window opens.
2. Under **Local Computer Policy**, navigate to **Computer Configuration > Administrative Templates > Classic Administrative Templates (ADM) > PCoIP Session Variables**.
3. From this point on, the configuration of PCoIP session variables is the same as for an Active Directory server. See [Configuration of Individual PCoIP Session Variables](#).

Configuration of Individual PCoIP Session Variables

You have opened the group policy editor either in Active Directory or on a master virtual machine. The following steps are common to either group policy editor.

1. Decide whether you want to open **Overridable Administrator Defaults** or **Not Overridable Administrator Settings**. See *View PCoIP Session Variables ADM Template Settings* in the *Configuring Policies* chapter in the [VMware View Administration guide](#).

After you choose a type, the list of PCoIP session settings appears.

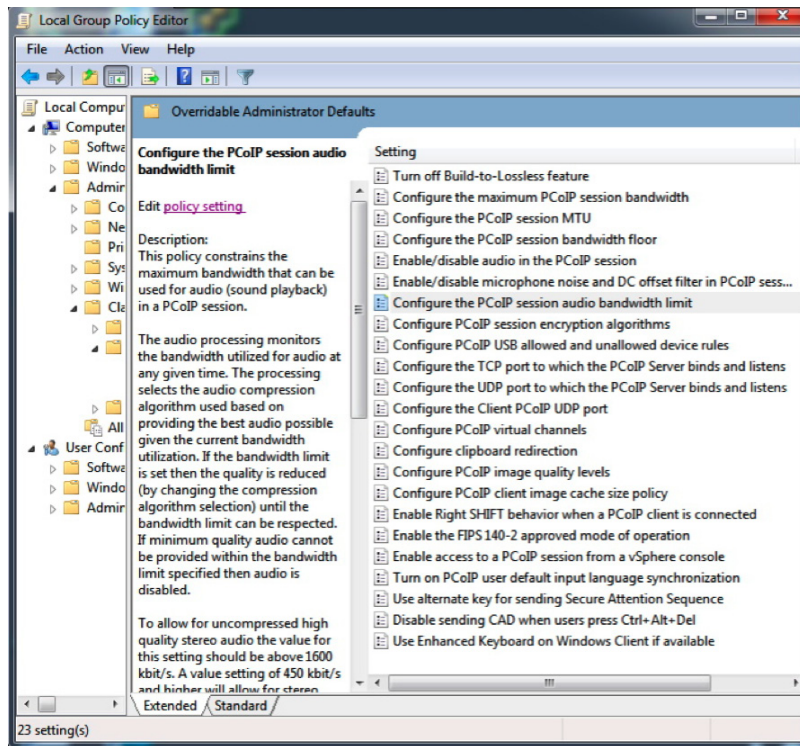


Figure 7: List of PCoIP Session Settings

For each setting, the procedure is the same:

1. Double-click the setting name, or highlight the setting name and select **Edit policy setting**.
The setting window opens.
2. Select a value at the top left and configure any details in the lower left of the window.
3. Click **OK**, or **Apply** and then **Next Setting** or **Previous Setting**.

Note: You are configuring the settings on the Windows desktop (sometimes called the soft host). You do not configure on the View Client (soft client), but the settings take effect when you connect to the desktop with the View Client.

Recommended Settings to Configure

View PCoIP is optimized to reduce bandwidth usage. To reach full optimization, VMware recommends that you disable the Build-to-Lossless feature with the PCoIP setting:

Turn off Build-to-Lossless feature

You can further reduce bandwidth by increasing audio compression with the PCoIP setting:

Configure the PCoIP session audio bandwidth limit

Disabling Build to Lossless

The Build to Lossless feature in PCoIP gives highest quality, precise images suitable for the medical imaging and artistic illustration professions. Images are built to lossless by default. Most users do not require this quality of image and cannot differentiate perceptually lossless from fully lossless. VMware recommends that you disable Build to Lossless for all users except those in these specialized professions.

You configure the Build to Lossless feature in the **Turn off Build-to-Lossless feature** setting in the `pcoip.adm` template. Disabling BTL gives you the full improvement in bandwidth optimization in View 5.

TURN OFF BUILD-TO-LOSSLESS FEATURE	
Brief definition	Disable the Build-to-Lossless feature so that bandwidth usage is reduced. Build to Lossless provides the highest quality of image rendering.
Default value	Disabled (Build to Lossless is enabled)
Possible values	Disabled, enabled. Disabled preserves highest-quality lossless images. Enabled builds images to perceptually lossless and reduces bandwidth usage in limited bandwidth network environments. Users who require great precision of images—medical technicians and illustrators—need this setting disabled. Most users are satisfied with perceptually lossless (enabled setting).
Use cases and details	Enable this setting to reduce bandwidth usage in limited bandwidth settings.

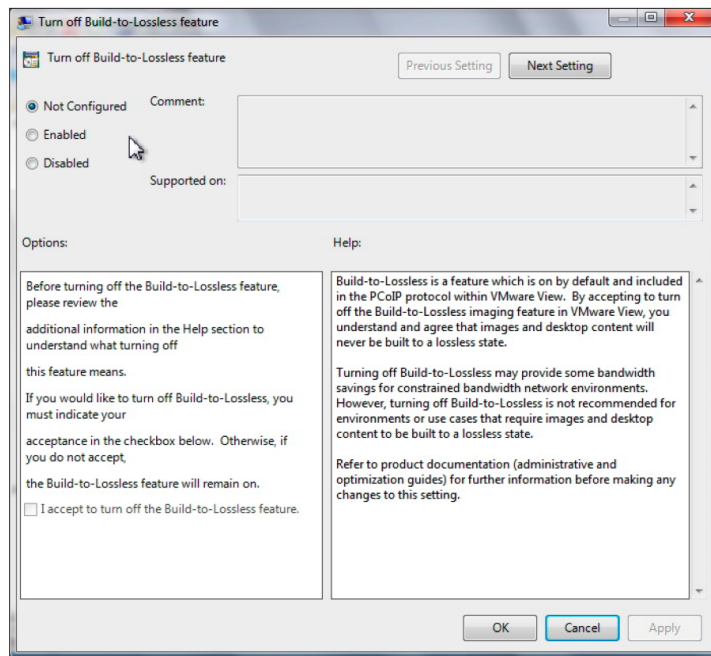


Figure 8: Turn off Build to Lossless

Configuring Audio Compression

Audio compression is controlled by the **Configure the PCoIP session audio bandwidth limit** setting in the `pcoip.adm` template. The lower the bandwidth assigned, the higher the compression, and the lower the quality. Audio compression is normally automatically controlled, with the best audio quality provided for the given network bandwidth available. If a limit is set in **Configure the PCoIP session audio bandwidth limit**, the audio quality is reduced to fit within the bandwidth limit.

CONFIGURE THE PCOIP SESSION AUDIO BANDWIDTH LIMIT	
Brief definition	Maximum bandwidth that can be used for sound playback in a PCoIP session. The lower the bandwidth assigned, the higher the compression, and the lower the quality. Audio is normally automatically compressed, depending upon the available network bandwidth. In a congested or constrained network, the audio compression is increased to reduce the network bandwidth. After the congestion is alleviated, the audio compression is reduced. Audio processing monitors the bandwidth available for audio at all times and selects the audio compression algorithm to use based on providing the best audio possible, given the current bandwidth utilization. If a limit is set, the quality is reduced (by changing the compression algorithm) until the bandwidth limit can be respected. If minimum quality audio cannot be provided within the bandwidth limit specified, then audio is disabled. The active bandwidth that PCoIP audio requires may fluctuate and may be temporarily above the limit. Does not apply to USB audio. Audio must be enabled on both endpoints before the setting takes effect.
Default value	500Kbps
Possible values	0–100,000Kbps. The higher the audio compression, the lower the quality, but the average bandwidth usage from desktop audio per user is reduced. Uncompressed high-quality stereo audio requires 1600Kbps or above. 450Kbps or higher allows for compressed high-quality stereo audio. 50–450Kbps provides audio quality between FM radio and phone calls. 50Kbps and below may result in no audio playback. 50–100Kbps is good with high network traffic and audio that does not require high quality.
Use cases and details	<p>Use cases:</p> <ul style="list-style-type: none"> Consider using this setting if the maximum bandwidth limit results in an automatic audio bandwidth setting that is higher than your target average bandwidth. For example, a law firm set a maximum session bandwidth limit of 5Mbps, which resulted in up to 400Kbps for users consistently listening to audio. However, this audio bandwidth was well above the law firm's total session average bandwidth target of 175Kbps. In this case, an audio bandwidth limit can be set. Email and instant messenger audio notifications cause a bandwidth spike for each notification. The default audio bandwidth of 500Kbps for 200 emails per user can result in more bandwidth usage than required. Email alerts do not need high-quality audio, so you can increase audio compression. You can safely limit audio bandwidth to 50–100Kbps if network traffic is high, and your users do not require high-quality audio for other reasons. Videos and radio transmission require less audio compression.

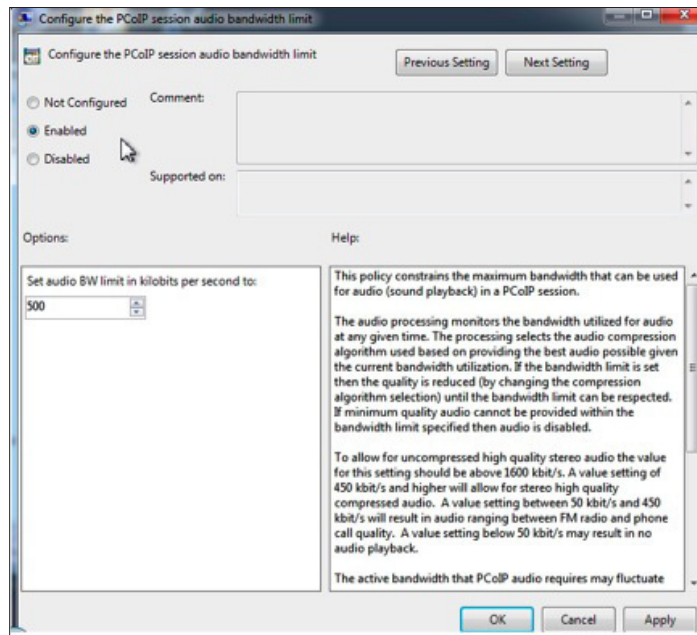


Figure 9: Audio Bandwidth Limit

The following table shows the default audio bandwidth and quality under various network bandwidth conditions. View PCoIP is constantly measuring the available network bandwidth for the session. The ranges for available network bandwidth are set within the View audio compression algorithm, or audio codec. For each range, audio uses a set amount of bandwidth, which results in a particular audio quality. Without a configured audio bandwidth limit, the audio compression algorithm sets audio bandwidth consumption at the default level indicated in the table according to available bandwidth.

IF THE AVAILABLE NETWORK BANDWIDTH IS:	THEN AUDIO WILL USE THIS AMOUNT OF BANDWIDTH:	AND THE RESULTING AUDIO QUALITY IS:
>= 8Mbps	1500Kbps	CD-quality stereo audio
2-8Mbps	400Kbps	Stereo audio
700Kbps-2Mbps	90Kbps	Mono
125-700Kbps	60Kbps	Compressed mono (like a phone call)

If you set an audio bandwidth limit, then PCoIP recognizes only that amount of available bandwidth, and the audio quality is reduced (by changing the compression algorithm) until the audio bandwidth limit can be respected. If minimum quality audio cannot be provided within the bandwidth limit specified, then audio is disabled for that PCoIP session.

Windows Desktop Settings to Optimize Performance over a WAN

Operating system tuning and optimization is extremely important. The effects of small reductions in bandwidth usage are greatly beneficial when scaled over hundreds and thousands of instances. Even a 10% reduction in CPU, I/O, or network consumption can be significant over a whole deployment.

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 the average and peak network bandwidth required.

These configurations are not required, but you may wish to test the effects of turning off certain visual settings that your users do not need.

These settings changes apply to both RDP and PCoIP, to reduce network bandwidth used.

For more information about Windows 7 and Windows XP settings for a View deployment, see:

- [VMware View Optimization Guide for Windows 7](#)
- [Windows XP Deployment Guide](#)

Windows 7 Visual Settings Optimization

To optimize Windows 7 visual settings, use the commands `commands.txt` file in the [VMware View Optimization Guide for Windows 7](#). This file should be run only by an experienced administrator who fully understands the changes made by the script. Review the section called *Optimization Aids Provided* and *Appendix B*.

Important: If you are implementing Persona Management, delete these three lines from the script for those desktops:

```
Powershell Set-Service 'VSS' -startuptype "disabled"  
...  
vssadmin delete shadows /All /Quiet  
Powershell disable-computerrestore -drive c:\
```

To optimize the visual settings:

1. Save `Commands.txt` as `Commands.bat`.
2. Right-click `Commands.bat` and select **Run as administrator**.

Windows XP Visual Settings Optimization

Set visual effects to best performance:

1. Right-click **My Computer**, and select **Properties**.
2. From the **Advanced** tab, click **Settings**.
3. Select the **Adjust for best performance** option.

Remove desktop wallpaper:

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. Select **Enabled**, and click **OK**.

Enable blank screensaver:

1. From the **Start** menu, click **Run**.
2. Type `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. Select **Enabled**.
5. Click **Next Setting** to display the Screen Saver executable name Properties dialog.
Type `scrnsave.scr` for **Screen Saver executable name**.

Enable the Classic Start menu:

1. Right-click the **Taskbar** and 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 select **Show Small Icons in Start menu**.
5. Deselect **Use Personalized Menus**, click **OK**, and then click **OK** again.

Disable additional fading:

1. Right-click the desktop, and select **Properties**.
2. From the **Appearance** tab, click **Effects**.
3. Deselect all options, click **OK**, and then click **OK** again.

Change system icon and text settings:

1. From the **Control Panel**, select the **View** menu.
2. Select **Toolbars > Customize**, and 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 select the **View** tab.

6. Select options as shown in the following two screenshots.

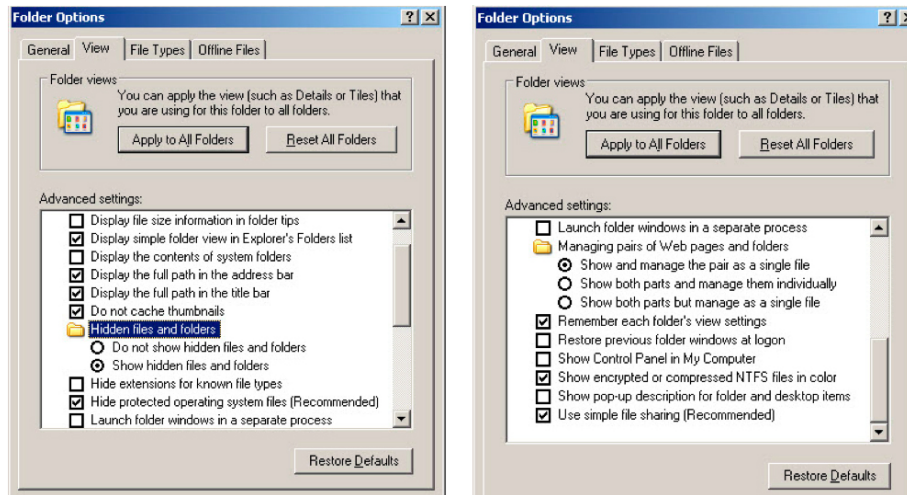


Figure 11: System Icon and Text Changes

7. Click **Apply**.

Network Optimization

If performance needs improvement in your View deployment, the first thing to check is the network configuration.

The needs of every organization are different. When you plan your network, consider:

- The kinds of computing tasks the end users will perform (typical office work; VoIP; heavy audio/video utilization)
- Graphical intensity of the work of the typical user (such as forms pages or 3D viewing)
- Importance of image quality to user (artists and medical technicians, as opposed to administrators and office workers)
- Amount of interactive or static viewing
- Physical or geographical location of all users (working from home; offshore)
- Required peripherals (printers, microphones, specialized keyboards, external CD or DVD)
- Whether Local Mode will be used
- Average bandwidth utilization of users performing the job requirements for each use case
- Increased bandwidth required to satisfy more demanding users

Note: VMware View is not designed to handle heavy 3D applications, such as CAD/CAM. View supports light 3D applications such as Office 2010 and Aero.

Strengths of the PCoIP Protocol

PCoIP is a real-time protocol based on the User Datagram Protocol (UDP). UDP provides no resiliency facilities at the network layer. Instead, PCoIP provides resiliency at the application layer. The real-time nature of the protocol means that PCoIP makes the decisions about which data is important, and which data can be discarded. The protocol is therefore very responsive, but anything that may induce packet loss or add latency must be eliminated for optimal performance.

PCoIP automatically reduces image or sound quality on congested networks, and resumes best quality when congestion is alleviated. PCoIP is adaptive and can detect available network bandwidth and network conditions, such as delayed or out-of-order packet delivery. When these conditions reach a particular threshold, PCoIP compensates by limiting how much bandwidth it uses or by increasing compression depth. You need to make sure the network is optimized so that PCoIP does not adjust itself down to a level with unsatisfactory quality. PCoIP requires minimal and consistent latency and high-priority queuing to perform well.

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

- Ensuring sufficient minimum network bandwidth for PCoIP packets
- Minimizing packet buffering for PCoIP packets through the network
- Ensuring an appropriate queuing or priority configuration in the switch or router
- Following key WAN testing guidelines

Network Bandwidth Planning for Basic Office Productivity Desktops

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

When you consider your network bandwidth, plan with the following estimates:

- 100 to 150Kbps 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
- 50 to 100Kbps average bandwidth for an optimized office productivity desktop: typical office applications with no video, no 3D graphics, with Windows desktop settings optimized and VMware View optimized
- 400 to 600Kbps average bandwidth for virtual desktops utilizing multiple monitors, 3D, Aero, and Office 2010
- 500Kbps to 1Mbps minimum peak bandwidth to provide headroom for bursts of display changes. In general, size your network using the average bandwidth, but consider peak bandwidth to accommodate bursts of imaging traffic associated with large screen changes.
- The percentage of users who will use 3D graphics. You might balance users who will use 3D with other users who will not use 3D graphics. Those using 3D will have higher bandwidth utilization. With the reduced bandwidth consumption in View 5, adding 3D users is satisfactory on a WAN with up to approximately 100ms latency.
- 2Mbps per simultaneous user running 480p video, depending upon the configured frame rate limit and the video type
- Less than 80% network utilization

Note: 50 to 150Kbps per typical user is based on the assumption that all users are operating continuously and performing similar tasks over an 8- to 10- hour day. The 50Kbps bandwidth usage figure is from View Planner testing on a LAN with the Build-to-Lossless feature disabled. Situations may vary in that some users may be fairly inactive and consuming almost no bandwidth, allowing more users per link. Therefore, these guidelines are intended to provide a starting point for more detailed bandwidth planning and testing. After you know the real bandwidth requirements of your typical users, substitute in those values.

1.5Mbps T1 Example for a Basic Microsoft Office Desktop

Scenario:

- Users with basic office productivity applications, no video, no 3D graphics, and keyboard/mouse USB traffic
- Bandwidth required per typical office user on VMware View is from 50-150Kbps
- T1 network capacity is 1.5Mbps
- 80% bandwidth utilization (.8 utilization factor)

Calculations:

In the worst case, users require 150Kbps:
 $(1.5\text{Mbps} \times .8) / 150\text{Kbps} = (1500 \times .8) / 150 = 8 \text{ users}$

In the best case, users require 50Kbps:
 $(1.5\text{Mbps} \times .8) / 50\text{Kbps} = (1500 \times .8) / 50 = 24 \text{ users}$

Result:

Between 8 and 24 concurrent users per T1 line with 1.5Mbps capacity

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

10Mbps Example for a Microsoft Office Desktop with Occasional Multimedia

In this example, one 480p video user is sharing the network link with typical office users. Such a video user requires approximately 2Mbps of bandwidth, depending upon the configured frame rate limit and the video type. Two scenarios are presented, one with a lower frame rate limit. With a lower frame rate limit, the bandwidth consumed by this one video user can be calculated at 1.5Mbps, rather than 2Mbps. With the lower frame rate limit, and therefore less bandwidth utilization for the video user, the number of office workers able to share the link increases.

Scenario 1:

- Users with basic office productivity applications, no 3D graphics, and keyboard/mouse USB traffic share the network link with a single user watching occasional 480p video
- Frame rate limit is set to 12 fps
- Bandwidth required for a single 480p video viewer is 2Mbps
- Bandwidth required per typical office user on VMware View is from 50–150Kbps
- Network capacity is 10Mbps
- 80% bandwidth utilization (.8 utilization factor)

Resolution:

Desktop optimizations including:

- Windows desktop settings optimized
- Maximum bandwidth limit set to 5Mbps
- Maximum initial image quality set to 70%

Note: A maximum bandwidth limit per session of 5Mbps has been set so that one user cannot consume all 10Mbps of bandwidth.

Calculations:

Because the bandwidth utilization factor is .8, you need to set aside more than 2Mbps for the one video user:

$$2\text{Mbps}/.8 \text{ utilization factor} = 2.5\text{Mbps}$$

Set aside 2.5Mbps for the video user. Divide the remaining bandwidth over the typical office users:

$$10\text{Mbps} - 2.5\text{Mbps} = 7.5\text{Mbps}$$

The worst case situation is if office users consume 150Kbps per user:

$$(7.5\text{Mbps} \times .8) / 150\text{Kbps} = (7500 \times .8) / 150 = 6000 / 150 = 40 \text{ users}$$

Best case is 50Kbps per user:

$$(7.5\text{Mbps} \times .8) / 50\text{Kbps} = (7500 \times .8) / 50 = 6000 / 50 = 120 \text{ users}$$

Result:

40 to 120 typical office users can share a 10Mbps network line with one video user if the frame rate is set at 12 fps so that the video user consumes 2Mbps bandwidth. (The frame rate of 12 fps is built into the estimated 2Mbps bandwidth utilization for the video user.)

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

Scenario 2:

- Users with basic office productivity applications, no 3D graphics, and keyboard/mouse USB traffic share the network link with a single user watching occasional 480p video
- Frame rate limit is set to 8 fps
- Bandwidth required for a single 480p video viewer is 1.5Mbps, because of the lower configured frame rate limit
- Bandwidth required per typical office user on VMware View is from 50–150Kbps
- Network capacity is 10Mbps
- 80% bandwidth utilization (.8 utilization factor)

Note: The only difference between Scenario 1 and Scenario 2 is the frame rate limit setting, which changes the figure for consumed bandwidth of the video user.

Resolution:

Desktop optimizations including:

- Windows desktop settings optimized
- Maximum bandwidth limit set to 5Mbps
- Maximum initial image quality set to 70%

Note: A maximum bandwidth limit per session of 5Mbps has been set so that one user cannot consume all 10Mbps of bandwidth.

Calculations:

Because the bandwidth utilization factor is .8, you need to set aside more than 1.5Mbps for the one video user:

$$1.5\text{Mbps}/.8 \text{ utilization factor} = 1.875\text{Mbps}$$

Set aside 1.875Mbps for the video user. Divide the remaining bandwidth over the typical office users:

$$10\text{Mbps} - 1.875\text{Mbps} = 8.125\text{Mbps}$$

The worst case situation is if office users consume 150Kbps per user:

$$(8.125\text{Mbps} * .8) / 150\text{Kbps} = (8125 * .8) / 150 = 6500 / 150 = 43 \text{ users}$$

Best case is 50Kbps per user:

$$(8.125\text{Mbps} * .8) / 50\text{Kbps} = (8125 * .8) / 50 = 6500 / 50 = 130 \text{ users}$$

Result:

43 to 130 typical office users can share a 10Mbps network line with one video user if the frame rate is set at 8 fps so that the video user consumes 1.5Mbps bandwidth. (The frame rate of 8 fps is built into the estimated 1.5Mbps bandwidth utilization for the video user.)

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

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.

WAN Accelerator Network Devices and PCoIP

PCoIP is already highly compressed and does not need and cannot make use of WAN accelerator network devices. Some WAN acceleration features are built into PCoIP:

- UDP protocol
- No resending of stale dropped packets
- Audio and HID are already the highest priority packets

Network Bandwidth

Following are recommendations for optimizing network bandwidth:

- Ensure that 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 autonegotiation. 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 Administrator, and the View Client.
- Ensure that PCoIP packets are not fragmented at any point in the network path.
- Check that the maximum transmission unit (MTU) in the switches or routers in the network path is not below the PCoIP packet MTU size. Consider increasing the switch or router MTU or reducing the PCoIP packet MTU via the PCoIPMTuSize GPO—set to a value between 500 and 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 Quality of Service (QoS) Differentiated Services Code Point (DSCP) or a layer 2 Class of Service (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 Internet Protocol Security (IPsec) or Datagram Transport Layer Security (DTLS)-enabled SSL solutions. See the VMware knowledge base article [VMware View PCoIP Security Gateway](#).

Network Latency and Jitter

Following are suggestions for handling network latency and jitter:

- Ensure that the round-trip network latency is less than 250 ms.
- 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 or switches are set to minimize latency (for example, to absorb 50 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 (for example, do not set a hard limit on PCoIP traffic as a percentage 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, to transfer some traffic without starving the PCoIP sessions.
- To ensure proper delivery of PCoIP, tag it in Quality of Service (QoS) so that it competes fairly across the network with other real-time protocols. Also prioritize PCoIP above other non-critical and latency-tolerant protocols (such as file transfers or print jobs). Failure to tag PCoIP properly in a congested network environment leads to PCoIP packet loss and a poor user experience, as PCoIP adapts down in response.
- Tag and classify PCoIP as interactive real-time traffic. Generally, you will classify PCoIP just below VoIP, but above all other TCP-based traffic. While this recommendation is likely to have a far larger impact in a WAN scenario, consider it a best practice for LAN environments as well.
- 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.
- Jitter or latency variance of + or – 30 ms may be too much for PCoIP to succeed.
- If your users make use of 3D graphics, network latency on a WAN should not exceed 100ms. If your network latency is higher, your users will probably not be satisfied with the rendering of 3D graphics.

Network Packet Loss

PCoIP protocol is tolerant of a reasonable amount of packet loss. Because PCoIP traffic is a real-time delivery of a rich user desktop experience, packet loss should be minimized wherever possible. PCoIP is sensitive to delays in packet delivery and packet loss caused by congestion-avoidance mechanisms.

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 or PCoIP zero client logs show packet loss, this indicates that packets with high latency, or sufficiently out-of-order packets, are 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/router	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 1: Resolution Options When Experiencing Significant Packet Loss for a VMware View Session

WAN Virtual Desktop Testing Guidelines

When you test View over a WAN, be sure to test real workloads with multiple users actively sharing the link. Key considerations include:

- Single-user bandwidth tests are invalid because 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, because MMR improves video in just that case.
- **Important:** 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 lost packets. 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.

VMware View Planner is highly recommended for testing typical workloads. See [Using VMware View Planner to Optimize Your View Deployments](#).

X86 and Thin Client Considerations

Multimedia redirection (MMR) adds value because it accelerates some media formats. MMR requires a more powerful client, but most clients are powerful enough. VMware View PCoIP works with multimedia redirection (MMR), but MMR does not work across all View Clients. For example, zero clients do not support MMR. If you need MMR in your environment, choose clients carefully and test them.

Advanced Configurations in VMware View

Because VMware has optimized View 5 PCoIP, you do not need to configure anything beyond disabling Build to Lossless and configuring audio compression. Configuring any other View PCoIP settings may have little effect on bandwidth usage, except in specialized cases.

This section specifies some advanced View PCoIP settings that may be beneficial in some use cases.

Note: The default values for the View PCoIP settings have been carefully selected to give maximum performance in most environments. VMware recommends that you do not change these settings unless you have carefully determined the overall effect to be beneficial.

Consider configuring the following settings for special use cases:

- Image quality levels
 - **Maximum Initial Image Quality**
 - **Minimum Image Quality**
 - **Maximum Frame Rate**
- Network settings
 - **Configure the maximum PCoIP session bandwidth**
 - **Configure the PCoIP session bandwidth floor**
- Client cache size (**Configure PCoIP client image cache size policy**)

Image Display Settings in View

For optional optimization, adjust the image quality settings in View. These settings are in the `pcoip.adm` administrative policy template. Refer to [Importing the PCoIP Administrative Template](#) for instructions on copying the administrative template and configuring settings.

The **Configure PCoIP image quality levels** setting in the `pcoip.adm` administrative template enables control over how PCoIP compresses images during periods of network congestion. Three variables within this one setting interoperate to allow fine control in network-bandwidth-constrained environments:

- **Maximum Initial Image Quality**
- **Minimum Image Quality**
- **Maximum Frame Rate**

MAXIMUM INITIAL IMAGE QUALITY	
Brief definition	Limits the initial image quality of changed regions of the display, which can reduce network bandwidth peaks. Most useful in limited bandwidth scenarios. (Note: The unchanged regions of the image progressively build to a lossless (perfect) quality, regardless of this setting.)
Default value	90 (percentage of fully lossless)
Possible values	30–100 (percentage of fully lossless). A lower value reduces the image quality of content changes and decreases peak bandwidth requirements. A higher value increases the image quality of content changes and increases peak bandwidth requirements. The recommended value of 90 or lower best utilizes the available network bandwidth. Must be set to a value greater than or equal to the Minimum Image Quality setting.
Use cases and details	<p>Use cases:</p> <ul style="list-style-type: none"> • When trying to achieve a low average bandwidth usage per user • Where a link is designed to be heavily utilized based on the average bandwidth used, and where congestion is expected along with limited headroom for peaks in individual session bandwidth • Environments where a small number of users spike in bandwidth and impact other users

MINIMUM IMAGE QUALITY	
Brief definition	Sets the lower limit of quality for images. Useful in a limited PCoIP bandwidth scenario, Note: When network bandwidth is not constrained, the PCoIP protocol maintains maximum image quality regardless of the Minimum Image Quality setting.
Default value	50 (percentage of fully lossless)
Possible values	30–100 (percentage of fully lossless). Must be set to a value less than or equal to the Maximum Initial Image Quality setting. Higher values of image quality use more bandwidth.
Use cases and details	In some medical or healthcare applications, you might not want to display below a certain quality of image

MAXIMUM FRAME RATE	
Brief definition	Limits the number of screen updates per second, which can reduce the average bandwidth consumed per user. Most useful in a low-bandwidth scenario. The higher the frame rate, the more frequently the screen is updated, and the more bandwidth used. This setting reduces average bandwidth only when the workloads have significant imaging motion. Desktop workloads without high imaging frame rate (below the maximum frame rate) are not affected by this setting.
Default value	30 fps
Possible values	1–120 fps. A higher setting may use more bandwidth, but provides less jitter, for smoother transitions in images that change, such as video. A lower setting uses less bandwidth, but results in more jitter. Depending upon network settings, 10–15 fps is recommended. When setting Maximum Frame Rate , consider the frame rate of an unconstrained desktop in your environment. Look at the maximum and average frame rates per second in the PCoIP session statistics . User testing in your environment will indicate the need for a higher or lower value.
Use cases and details	Configure for WAN environments with video playback and fast graphics operations.

In limited bandwidth scenarios, you may want to configure these image quality settings. You can balance **Minimum Image Quality** with **Maximum Frame Rate**. You can combine a lower minimum image quality (with possible blurred images) with a higher frame rate for smooth motion, or combine a higher minimum image quality for crisp imaging with a lower frame rate (and possible choppy motion).

Maximum Initial Image Quality allows you to reduce the network bandwidth peaks by limiting the initial image quality displayed. You can configure a lower initial image quality (with possible blur) with more frequent updates (higher frame rate, smoother motion) to decrease peak bandwidth requirements during large screen changes. Or you can configure a higher initial image quality (crisper image) with less frequent updates (lower frame rate, possible choppy motion), which increases peak bandwidth requirements during large screen changes.

PCoIP attempts to maximize the image quality within the following bandwidth constraints:

- Configured maximum session bandwidth
- Determined bandwidth limit (see the server/client logs)
- Configured maximum initial image quality

Tip: If you adjust **Maximum Initial Image Quality**, consider configuring it before applying a maximum session bandwidth limit or configuring the **Minimum Image Quality**.

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 desktop settings for best performance as described in [Windows Desktop Settings to Optimize Performance over a WAN](#)
- Reduce the **Maximum Initial Image Quality** (for example, to 70 percent)

Result:

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

Example: Screen Performance Is Inconsistent

If the user desktop experience is degraded, or the screen performance is inconsistent, the PCoIP protocol adjusts and is optimized. If issues arise, adjust the **Maximum Initial Image Quality**. Only change these image quality settings if you are confident about your understanding of them.

Network Settings in View

You can achieve the optimal bandwidth usage in View 5 with the default settings, plus by disabling Build to Lossless. The PCoIP protocol automatically takes advantage of available network bandwidth and fairly shares bandwidth across active users on a link. Change the network settings only if you have determined the overall effect to be beneficial.

Configuring some of the PCoIP network settings may be useful in special cases:

- Maximum PCoIP session bandwidth (maximum link rate) (**Configure the maximum PCoIP session bandwidth**)
- Session bandwidth floor (**Configure the PCoIP session bandwidth floor**)

These settings are in the `pcoip.adm` administrative policy template. Refer to [Importing the PCoIP Administrative Template](#) for instructions on copying the administrative template and configuring settings.

CONFIGURE THE MAXIMUM PCOIP SESSION BANDWIDTH	
Brief definition	Sets the maximum session bandwidth used <i>by any one PCoIP session</i> so that one user's bandwidth peaks do not interfere with others' productivity. Constrains the maximum link rate in a PCoIP session. Permits you to better estimate total bandwidth usage. Set this value to the overall capacity of the link to which your endpoint is connected. You do not want the server to try to transmit at a higher rate than this because you would have excessive packet loss and a poor user experience. This setting forces both the client and server to use the lowest bandwidth setting found on either side. Leaving this setting Not Configured imposes no bandwidth constraints from the endpoint side.
Default value	90,000Kbps
Possible values	104–90000Kbps. Do not set it too low because the ability to peak is key to desktop performance. You want individual sessions to take advantage of additional link bandwidth when available.
Use cases and details	If someone is overconsuming bandwidth, limit this setting. For a LAN, there is no need to configure this setting. Set per your WAN network conditions.

CONFIGURE THE PCOIP SESSION BANDWIDTH FLOOR	
Brief definition	Lower limit to the bandwidth reserved for each PCoIP session. Improves responsiveness: A user does not need to wait for bandwidth to become available because this minimum amount is waiting for them. Actual session bandwidth can be below the floor if the desktop does not need the minimum amount configured.
Default value	0Kbps (no minimum bandwidth is reserved, so users may wait for bandwidth to be available)
Possible values	0–100,000Kbps. For a given configuration, the sum of all floors for all connections cannot exceed the network capability (which would be oversubscribing).
Use cases and details	Use only in special cases; consumes bandwidth.

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

The PCoIP protocol automatically handles variation in user bandwidth requirements, and you generally do not need to configure network settings. In some situations, consider changing these PCoIP settings. For example, users may complain of network degradation. You investigate and notice that one or two users are consuming 3 or 4Mbps during this degradation. The users may be watching more videos than you anticipated. In this case, make sure the [Windows visual settings are optimized](#). In addition, you can adjust the maximum session bandwidth for all users on the network link to limit how much bandwidth the video watchers can consume. If you also set the PCoIP bandwidth floor, you can ensure a baseline performance for all users during a network congestion event.

If these settings are not sufficient, consider adjusting the image quality settings. Reduce the maximum initial image quality and increase the minimum image quality.

Example: Optimizing for Increased User Density on WAN Network Links**Scenario:**

- Users with basic task worker or call center applications, no video, no 3D graphics. Low average bandwidth is a higher priority than user experience.
- 1.5Mbps T1 WAN link
- More than 25 active users

Resolution options:

- Set the [Windows visual settings](#) for best performance.
- Set the maximum PCoIP session bandwidth per user. The actual setting depends on the number of users targeted for the link. This must be set for all users on the link.
- Adjust the minimum and maximum image quality. For example:

Maximum Initial Image Quality = 70

Minimum Image Quality = 40

- Reduce the **Maximum Frame Rate** to 8 fps.
- If the average bandwidth is not sufficiently reduced, you can use even lower settings for the maximum bandwidth and image quality.

Result:

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

Client Cache Size Setting in View

Client-side image caching is enabled by default in View to reduce bandwidth usage. The recommended memory for client-side caching is 1GB. If the View Client has less memory, you can reduce bandwidth usage by adjusting the View Client cache size. This setting is **Configure PCoIP client image cache size policy** in the `pcoip.adm` policy template.

CONFIGURE PCOIP CLIENT IMAGE CACHE SIZE POLICY	
Brief definition	Controls the size of the PCoIP View Client image cache. Client-side caching stores previously transmitted image content on the View Client to avoid retransmission, which reduces bandwidth usage. Takes effect only on Windows View Clients, not mobile or zero clients, and not yet on Mac or Linux View Clients.
Default value	250MB
Possible values	50–300MB. A larger cache size reduces bandwidth usage, but requires more memory on the client. A smaller cache size requires more bandwidth usage.
Use cases and details	A thin client with little memory requires a smaller cache size.

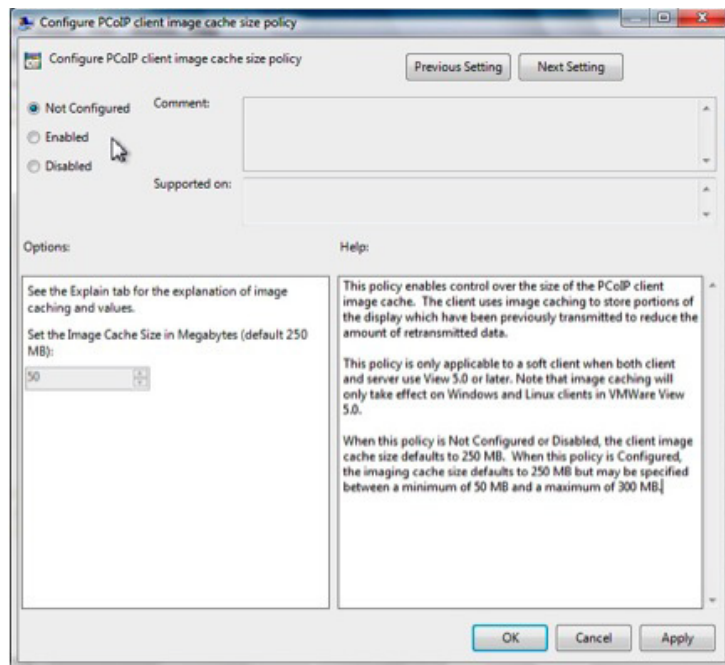


Figure 12: Image Cache Size

Using PCoIP Session Statistics to Monitor End-User Experience

VMware View 5 offers the administrator more than thirty PCoIP session statistics to monitor, obtain trending on, and troubleshoot end-user connections. Troubleshooting remote desktop connections is difficult, and traditional logs do not give enough information. These PCoIP counters give per-session feedback on PCoIP protocol performance. When latency arises, or users report a problem, administrators can examine these statistics. The ability to examine individual sessions is very helpful.

This performance monitoring runs from the Windows desktop. You can import the data into any standard Windows Management Instrumentation (WMI)-based tool or programming interface for further analysis. If you currently use a monitoring or management tool in the enterprise to collect WMI statistics, you can point the tool to the View virtual machines and set the counters to collect data. For example, you can use PerfMon (Windows Performance Monitor), which is simple and free, yet not very scalable. You can also do WMI scripting. Several VMware Partners have integrated these statistics into robust tools.

For more information on integrating PCoIP session counters into your performance monitoring environment, see the *Examining PCoIP Session Statistics* chapter in the [VMware View Integration guide](#).

View 5 measures and tracks sessions with individual session counters in five major categories:

- PCoIP Session General Statistics
- PCoIP Session Imaging Statistics
- PCoIP Session Network Statistics
- PCoIP Session USB Statistics
- PCoIP Session Audio Statistics

The most commonly used session statistics in View are in the following table.

PCOIP SESSION STATISTIC	DEFINITION
Audio RX BW kbit/sec (calculated from AudioBytesReceived)	Incoming audio packet bandwidth being used, in kilobits per second
Audio TX BW kbit/sec (calculated from AudioBytesSent)	Outgoing audio packet bandwidth being used, in kilobits per second
Session Duration Seconds (SessionDurationSeconds)	How long the PCoIP session has been connected, in seconds
Imaging Encoded Frames/sec (ImagingEncodedFramesPersec)	Imaging encoding frames per second that PCoIP is sending across the network
Round Trip Latency ms (RoundTripLatencys)	Network roundtrip latency between server and client, in milliseconds
RX BW kbit/sec (calculated from BytesReceived)	Receive bandwidth available for incoming PCoIP packets, in kilobits per second
TX BW kbit/sec (calculated from BytesSent)	Transmission bandwidth available for outgoing PCoIP packets, in kilobits per second
TX Packet Loss % (calculated from PacketsSent and TXPacketsLost)	Percentage of transmitted packets lost during the sampled period
RX Packet Loss % (calculated from PacketsReceived and RXPacketsLost)	Percentage of received packets lost during the sampled period (received packets have sequence IDs, so if some are missing, they are considered lost)

Table 2: Commonly Used PCoIP Session Statistics in View

For a complete listing of the PCoIP session counters, see the *Examining PCoIP Session Statistics* chapter in the [VMware View Integration guide](#).

Session statistics are sampled every second.

References for Further Information

For more information on VMware View:

- Visit the [VMware Community Forum](#) for View
- Query the [VMware Knowledge Base](#)
- Contact your local authorized [VMware partner](#)
- Delve into the [View Technical Resources](#) (technical whitepapers), including:
 - [Windows 7 Optimization Guide for VMware View](#)
 - [Using PCoIP Host Cards Brokered by VMware View 4](#)
 - [Using PCoIP Zero Clients with PCoIP Host Cards](#)
- Refer to the [VMware View documentation](#):
 - [VMware View Architecture Planning](#)
 - [VMware View Administration guide](#)
 - [VMware View Installation guide](#)
 - [VMware View Upgrades guide](#)
 - [VMware View Clients documentation](#)
 - [VMware View Integration guide](#)
- Consider [View Planner](#) for testing your network

About the Author and Contributors

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