Optimizing HDX Technologies for XenDesktop 4

Citrix XenDesktop
Best Practices
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Executive Overview

Citrix XenDesktop with HDX (High Definition User Experience) technology is the most complete solution for high definition desktop and application virtualization on any device over any network. Citrix HDX technology provides network and performance optimizations to deliver the best user experience over any network connection, even at low bandwidth and high latency. Citrix HDX technology simplifies secure access to computing resources and peripheral devices for end users while giving administrators fine-grained security and policy controls for different types of remote or LAN connections. Citrix HDX is the only viable solution on the market for providing high definition multimedia content and graphics-intensive applications over the WAN, allowing businesses to utilize employee talent in more geographies while protecting intellectual property within the datacenter.

HDX has been developed from proven application delivery technologies that Citrix has been perfecting for more than two decades. These technologies include software and hardware products, an advanced delivery protocol and intelligent algorithms used to optimize end-to-end system performance. Due to the diversity of components, IT professionals desire a clear understanding of their functionality and best practices for deployment. This document can be used to address a variety of common topics such as:

- Optimizing video playback over LAN and WAN connections
- Configuring HDX Plug-n-Play for added security with peripheral devices
- Delivering 3D professional graphics applications over WAN conditions
- Using VoIP applications with a multitude of users while retaining call quality

This best practices whitepaper provides a guide to interpreting the uses of each HDX technology as it applies to a XenDesktop environment and is meant to supply the best practices recommendations for implementing each.
Product Overview

Citrix provides a High Definition User Experience (HDX) to any end user utilizing a virtual desktop for any application, on any device or over any network. Citrix XenDesktop delivers end users virtual desktops that perform as well, if not better than local desktops and offers IT administrators a manageable, centralized virtual desktop solution. This section provides a high-level overview of the key XenDesktop products and features designed to accomplish this.

Citrix XenDesktop

Citrix XenDesktop is a desktop virtualization system that centralizes and delivers desktops as a service to users anywhere, reduces desktop TCO up to 40 percent and improves data security by centralizing desktop lifecycle management in the datacenter. It delivers a high definition user experience over any connection including high latency wide area networks. The open architecture of XenDesktop offers choice and flexibility of virtualization platform and end points. Citrix XenDesktop provides the flexibility to easily manage and deliver specific desktops to different types of users, whether they are task workers, knowledge workers or mobile workers. Unlike other desktop virtualization alternatives, it simplifies desktop management by using a single image to deliver personalized desktops to users anywhere and enables IT to manage service levels with built-in desktop performance monitoring.

Citrix XenApp with XenDesktop Enterprise or Platinum

Citrix XenApp is a Windows application delivery system that manages applications in the datacenter and delivers them as an on-demand service to users anywhere using any device. Citrix XenApp is used by 99 percent of the Fortune Global 500 companies and provides the core functionality for application virtualization and delivery. Citrix XenApp is based on the foundation of the ICA protocol which has been developed for more than 20 years to ensure the most efficient use of computing and network resources in delivering applications. XenApp for is now available as a feature of XenDesktop Enterprise and Platinum Editions.

Citrix Access Gateway with HDX SmartAccess

Citrix Access Gateway is a secure application access solution that provides administrators granular application-level policy and action controls to secure access to applications and data while allowing users to work from anywhere. It gives IT administrators a single point of control, and tools to help ensure compliance with regulations and the highest levels of information security across and outside the enterprise. With SmartAccess, it empowers users with a single point of access—optimized for roles, devices and networks—to reach the enterprise applications and data they need while allowing IT administrators the ability to control application and desktop delivery based on environment and user requirements. This unique combination of capabilities helps maximize the productivity of today’s mobile workforce. The licenses to secure XenDesktop traffic with Access Gateway are included with XenDesktop Standard, Advanced, Enterprise and Platinum, but an additional appliance purchase is required.
Citrix Branch Repeater

Citrix Branch Repeater, available as a physical or virtual appliance, is a WAN optimization solution that provides a high definition desktop and application experience to branch and mobile users while dramatically reducing WAN bandwidth costs and simplifying branch infrastructure. Branch Repeater accelerated desktop and application delivery decreases WAN bandwidth consumption and enables server consolidation. Branch Repeater can address the full range of WAN optimization scenarios and delivers unparalleled application acceleration benefits, especially for Citrix XenDesktop and Citrix XenApp. WAN optimization licenses are included with XenDesktop Platinum, but an additional appliance purchase is required.
Citrix HDX Technology Overview

High Definition User Experience (HDX) technology is a set of capabilities that deliver a “high definition” desktop virtualization user experience to end users for any application, device, or network. These user experience enhancements must balance performance over high and low bandwidth connections. HDX technology provides network and performance optimizations to deliver the best user experience over any network, including low bandwidth and high latency WAN connections.

Citrix has been providing and perfecting the high definition user experience for virtual application delivery and the application delivery protocol for over 20 years. Citrix XenDesktop is built upon the same proven application delivery technologies to virtualize and deliver desktops to the end user. These improvements ensure the best possible user experience for multimedia content, real-time communication, USB peripherals and 3D graphics, regardless of the network or the endpoint device.

HDX technology is composed of the following individual technologies that will be discussed in detail throughout this section:

- **HDX Broadcast**: Optimized delivery over any network
- **HDX Adaptive Orchestration**: Maximizes the use of the end point, network and server resources
- **HDX MediaStream**: Seamless multimedia experience
- **HDX RichGraphics**: High-performance graphics
- **HDX RealTime**: Voice and video for real-time collaboration
- **HDX Plug-n-Play**: Simple access to peripherals
- **HDX SmartAccess**: Simple secure access to users anywhere
- **HDX WAN Optimization**: Performance and bandwidth optimizations

**HDX Broadcast**

HDX Broadcast is a set of proven Citrix technologies that allow for the delivery of an exceptional user experience over any network. HDX Broadcast leverages the Citrix Independent Computing Architecture (ICA) remote display protocol to optimize the reliability and performance of hosted virtual desktops and applications over any network, enabling the high definition user experience when accessed on the corporate network or from outside the corporate network for remote desktop access. ICA is designed to intelligently scale and throttle session data for many users simultaneously and better coordinate server-endpoint communication depending on available bandwidth, latency and other network conditions.
The Citrix ICA protocol is a TCP-based protocol used to deliver screen updates, interactivity between the server and endpoint, multimedia content including audio and video, and other vital endpoint communications data such as printing, USB and more. This content is organized and prioritized for efficient delivery via the use of different ICA Virtual Channels. This concept is known as ICA priority packet tagging. The priorities of these Virtual Channels can be modified manually for even more granular control over content delivery and this process is described in subsequent sections of this document. The concept behind prioritizing ICA virtual channels is to allow more critical data, such as screen updates and audio, to have a higher priority for transmission and reassembly as compared to other data such as print requests.

![Image](image.png)

**Figure 1: Thinwire Virtual Display Adapter**

Figure 1 shows how a screen update within a XenDesktop virtual desktop is sent to the Citrix Receiver on the endpoint device using the ICA protocol. The following items should be noted:

- The Citrix Thinwire Virtual Display Adapter is a Windows Display Adapter embedded within the XenDesktop virtual desktop.

- When the user makes a change to the application running within the virtual desktop, XenDesktop utilized the Thinwire Virtual Display Adapter to capture the screen updates, also known as Graphics Device Interface (GDI) commands.

- The commands are then transported within the ICA protocol as prioritized within the relevant ICA Virtual Channels to the endpoint device where the Citrix Receiver is installed.

- The Citrix Receiver then utilizes the local physical Display Adapter of the endpoint device to render the screen updates/GDI commands.

Thinwire assists with HDX technologies like Progressive Display, SuperCache, and Image Acceleration.
• **Progressive Display** improves interactivity of user sessions by using lossy compression to render screen movement, and then improving the image quality for greater detail, once the motion has subsided.

• **SuperCache** is the way that Thinwire caches previously-rendered portions of the screen and re-uses them, rather than having them resent to the endpoint, thereby reducing network bandwidth and improving responsiveness for the user.

• **Image Acceleration** is a set of lossy compression policies that can be adjusted to provide varying display quality and reduced bandwidth consumption based on the client’s type of network connection.

HDX Broadcast and Thinwire take advantage of **SmartRendering** technology, which determines the most efficient manner of delivering and rendering graphics. With SmartRendering, there are two ways to display applications and full desktop images for users: (1) by rendering images on the server/desktop and sending compressed bitmaps over the network to the client, or (2) by sending the underlying Windows Display Adapter rendering commands, known as GDI commands, across the network to the client and instructing the Thinwire Virtual Display Adapter to render screen images on the client machine. Thinwire is designed to determine which of these methods is most efficient for utilizing existing bandwidth and hardware computing resources.

As mentioned previously, these Citrix technologies labeled as HDX Broadcast form the core foundation for Citrix’s virtual application and desktop delivery that have been developed and proven for more than two decades.

**HDX Adaptive Orchestration**

HDX Adaptive Orchestration is an overarching term used to describe the way that different HDX technologies coordinate with one another to provide the best user experience over any network, while optimally utilizing the system’s computing resources between the client and the server. The technology behind the HDX Adaptive Orchestration concept is SmartRendering, which allows for the intelligent toggling between server and client to select the proper rendering location for graphics and multimedia content based on a variety of factors.

**HDX MediaStream**

HDX MediaStream is a description of the additional ways that XenApp and XenDesktop have been improved and optimized for delivering multimedia content. HDX MediaStream utilizes SmartRendering to coordinate the optimal rendering location for Windows Media and Flash content, which are two of the most commonly-used formats for viewing video on the web and internally for organizations.
HDX MediaStream Flash Redirection

HDX MediaStream Flash Redirection obtains and displays Flash content within the virtual desktop through a combination of fetching and rendering techniques. Flash content can either be fetched by the server or by the client, if client access to the content, such as internet browsing, is enabled. For server-side fetching the Flash content is obtained by the server and then sent over ICA in its native format for rendering on the client as shown in Figure 2.

![Figure 2: Server-side Fetching](image)

For client-side fetching, the client must be able to access the content directly, and the client pulls the Flash content directly down to the client device and utilizes local resources in conjunction with ICA to render the Flash content within the virtual desktop as shown in Figure 3. Client-side fetching and rendering utilizes local desktop resources, thereby ensuring a high definition viewing experience, while freeing up computing resources in the datacenter and reducing overall bandwidth consumption.

![Figure 3: Client-side Fetching](image)
HDX MediaStream Flash Redirection can also be configured to instead use both server-side fetching and server-side rendering to deliver Flash content via Thinwire. Server-side fetching and rendering of content can be controlled with a pre-configured list of websites available in XenDesktop. This pre-configured list can be used for websites that require server-side resources.

**HDX MediaStream Windows Media Redirection**

HDX MediaStream Windows Media Redirection provides the ability to fetch Windows media content (inclusive of WMV, DivX, MPEG, etc) on the server and render the content on the client machine. Windows media content is sent to the client through an ICA Virtual Channel in its native, most compressed format for best performance and least bandwidth consumption. In the event that the client does not have the appropriate codec to display a video or does not support Windows Media Redirection, MediaStream automatically falls back to server-side rendering of media and delivers it via Thinwire.

**HDX MediaStream Network Conditions**

HDX MediaStream also intelligently detects adverse network conditions that may be detrimental to a user’s multimedia viewing experience and is capable of automatically falling back to server-side rendering and traditional delivery via Thinwire. In the case of Windows media content, HDX MediaStream continually measures the available bandwidth and determines the proper rendering location based on the calculation. For Flash content, the latency of the connection has a bigger impact on the Flash content rendering; therefore, the latency of the connection is calculated to determine the proper rendering location for Flash content. If the latency is greater than 30ms, Flash content is rendered on the server.

**HDX RichGraphics**

HDX RichGraphics is a series of extensions to HDX technologies that are intended for users with a need for graphics-intensive applications or desktops, ranging from 2D and “2.5D” graphics used in modern business applications to high-end 3D CAD applications and medical imaging software. HDX RichGraphics has the capability to leverage both software and hardware-based codecs to enable high compression, performance and network efficiency. HDX RichGraphics also utilizes Progressive Display technology, which intelligently alternates between lossy compression and high-quality imaging, depending on movement on the screen.

The 3D Pro Graphics feature of HDX RichGraphics is specifically designed to take advantage of the graphic processors (GPUs) for accelerated rendering. HDX 3D Pro Graphics also uses GPU-assisted image compression for even greater performance, when both the client and server, or physical desktop, are equipped with CUDA-enabled NVIDIA GPUs. This reduces bandwidth consumption while retaining top quality and thereby ensures a high definition user experience over the WAN for even the most graphics-intensive applications.
HDX RichGraphics with RemoteFX will leverage the Microsoft RemoteFX technology platform to extend the benefits of hardware-based acceleration to multiple users sharing a single Windows server or Hyper-V server. RemoteFX is a Microsoft product that is designed to deliver high quality graphics, including video and audio within a Windows Aero desktop environment, over the LAN, via the addition of graphics processing hardware in the data center.

**HDX RealTime**

HDX RealTime is a refinement of Citrix technologies that provide exceptional audio and video collaboration across any network. For XenDesktop, HDX RealTime describes the ability to use bi-directional audio and video capabilities for users connected with peripherals, such as microphones, dictation devices and webcams. Users interact with their virtual desktops in much the same way as with a local desktop and real-time media is highly compressed and optimized to enable performance and clarity over the network. Different audio compression codecs are built into HDX RealTime policies to allow for more granular performance options. HDX RealTime utilizes XenDesktop and XenApp’s built-in compression techniques to deliver this high-quality user experience, even over-the-WAN, when connecting to their desktops.

HDX RealTime provides administrators with the ability to control the bandwidth consumed by audio and video through the use of policies. The policies allow administrators greater security controls by restricting access to these network-intensive peripheral devices, depending on factors such as Active Directory user groups, pre-designated IP addresses, external WAN access and more.
HDX Plug-n-Play

HDX Plug-n-Play extends existing Citrix technologies for peripheral devices to a VDI environment and virtual application environment. HDX Plug-n-Play enables simple, reliable connectivity for USB, multi-monitor, printers and other peripheral devices. Local machine resources can also be utilized by the virtual desktop, just like with XenApp, and Smart Cards are fully supported for easy, seamless authentication to desktops and applications. The Citrix Universal Print Driver is built into the HDX Plug-n-Play technology. When a user connects a peripheral device to the endpoint, IT administrator can configure policies to limit or grant access based on security restrictions. HDX Plug-n-Play technology allows the users to utilize the same peripheral devices as a local desktop, but still provide administrators the ability to enhance security restrictions.

HDX WAN Optimization

Citrix WAN Optimization technology leverages the functionality of Citrix Branch Repeater. Branch Repeater can be deployed as physical or virtual appliance and functions as a symmetric solution, where a Branch Repeater is located at each end of a WAN connection. Branch Repeater achieves WAN Optimization through providing the following technologies:

- TCP Optimization: Branch Repeater is a symmetric solution, where a Branch Repeater is located at each end of the WAN connection (in the datacenter and in the branch office) recognize each other’s presence and employ RFC compliant TCP optimization techniques that ensure optimal utilization of the network bandwidth.

- Traffic Prioritization (QoS): Administrators can classify network bandwidth based on TCP port numbers and IP ranges to prioritize the delivery of TCP segments based on the classification. Furthermore, Branch Repeater recognizes the priorities of the various ICA virtual channels and can ensure preferential treatment of real-time critical data such as audio.

- Compression: Branch Repeater can detect repeating patterns in the transmitted data and utilize very small tokens across the WAN to identify such repeating data patterns and serve the data to the user out of the appliance memory; therefore, restricting the amount of data required to traverse the WAN and improving user experience.

- Protocol Optimization: Branch Repeater can optimize a variety of common application protocols. Citrix XenDesktop leverages the ICA protocol, which employs a variety of optimization and security features natively. In order to apply compression, a WAN optimizer must be able to decrypt the ICA workload, identify repeating patterns within the ICA virtual channels, apply the optimization, and re-encrypt the data stream. This is why Citrix Branch Repeater is the only WAN optimization product capable of directly optimizing the ICA payloads on the protocol level.
HDX SmartAccess

SmartAccess allows secure access to desktops and applications through the use of the Citrix Access Gateway product line. Citrix Access Gateway is offered as either a physical or virtual appliance located in the DMZ and allows remote users to access the corporate infrastructure through a secure SSL VPN tunnel. Access Gateway with SmartAccess allows IT administrators to offer various desktop and application access options based on the security criteria of a remote user’s endpoint device. When a remote user connects to Access Gateway with SmartAccess enabled, the remote user’s endpoint device is first scanned against a pre-configured list of security policies, such as anti-virus software version. The security information is passed to the Access Gateway and based on the conditions of the security policies access to desktops and applications are granted. For example, if a remote user connects to Access Gateway from a public kiosk, the user is only granted limited access to a virtual desktop without the ability to copy and paste outside of the virtual desktop. SmartAccess allows end users to work from any location and any device while still providing the IT administrators with the ability to ensure that corporate data remains secured.
Best Practices for Delivering XenDesktop with HDX Technologies

This section reviews various architectural and environmental concepts that should be considered when implementing HDX components for XenDesktop. Citrix HDX technologies are designed to deliver high definition desktop performance and quality over any network, and today’s IT professionals require a significant understanding of all factors that may impact the end-to-end delivery of rich desktops, 3D applications and powerful media content. Topics, such as network conditions, security requirements, system performance, monitoring and more, are discussed as they relate to implementing each HDX technology.

HDX Monitor for XenDesktop

The first topic that encompasses all of the available HDX technologies is the HDX Monitor. This standalone monitoring application was developed by Citrix to be used by administrators to display the wide-range of HDX settings currently implemented in an environment and to show the existing network conditions impacting the user experience on the endpoint. As shown below, the HDX Monitor provides information such as endpoint system compatibility with HDX features, audio codecs in use, multimedia redirection capabilities, HDX Flash AD Group Policy settings in place, WAN bandwidth and latency measurements, and much more.

![HDX Monitor for XenDesktop](image)

Figure 5: HDX Monitor for XenDesktop
The HDX Monitor is an exceptionally useful tool that can be used by administrators for planning an HDX environment setup and for troubleshooting HDX issues. The HDX Monitor should be installed on a virtual desktop that is representative of one that will be delivered to users. Administrators should then conduct testing with this virtual desktop in the same manner that users would use XenDesktop. The HDX Monitor can be downloaded directly from http://hdx.citrix.com/hdx-monitor. More information on using the HDX Monitor can be found at the following URL: http://support.citrix.com/article/CTX123058.

HDX Broadcast

The functionality of each HDX Broadcast component is described in the previous Technology overview section of this document. The considerations for deploying each component and any corresponding configurations that can be altered to provide an optimal user experience are described here.

ICA Virtual Channels

Citrix ICA Virtual Channels provide a structured way to deliver content and ensure interactivity of user sessions, as described previously. Each virtual channel for each user session is assigned a priority based on significance. For example, since Thinwire is responsible for providing user feedback and desktop control input to the virtual desktop, it is assigned the highest priority. USB and multimedia delivery, such as MediaStream for Flash, are assigned a high priority, as well. Data from printers and COM ports are assigned the lowest priorities.

These settings can be altered for troubleshooting and performance purposes. For example, some organizations rely on the use of peripheral audio devices for voice conferencing or voice dictation. Correspondingly, the Client Audio Mapping virtual channel can be set to highest priority to achieve best performance for audio over the WAN.

By default, the virtual channel priorities in XenDesktop are preset for an all-purpose configuration. The process for customizing the virtual channel priorities involves modifying an exported XML file on each Desktop Delivery Controller (DDC) to prioritize all the virtual channels appropriately to ensure the optimum user experience. These settings affect all users connecting through this particular Desktop Delivery Controller and adjustments to virtual channels in this manner are unrelated to Presentation Server Policies placed on the environment, such as audio and printing bandwidth limitations. The basic steps of this procedure are as follows.

1. On the DDC, navigate to the following directory: C:\Program Files\Citrix\Desktop Delivery Controller
2. Run the following command: PortICASetDefaults /o <Directory>:\<FileName.xml>
3. Modify the priorities of particular virtual channels, such as for Client Audio Mapping: <value>CTXCAM ,0</value>
For more information about the different virtual channels that can be modified and about the procedure for exporting, modifying and re-importing the XML file, please refer to the following Citrix knowledge article: http://support.citrix.com/article/ctx118836.

Thinwire Frame Rate

XenDesktop with HDX is pre-configured for a rich multimedia experience by rendering frames at a movie-theater quality rate of 24 frames-per-second. The frames are rendered on the virtual desktop and delivered via Thinwire to the client. This frame rate can be increased or decreased for different multimedia viewing scenarios. In one example, engineers or video editors may desire a frame rate up to 30 frames-per-second. And in a second example, an environment that supports mostly WAN users, does not require high definition multimedia viewing or has minimal local resources (thin client), may be better suited for a lower frame rate like 15 frames-per-second.

For users who may encounter a low bandwidth connection, XenDesktop offers Dynamic Frame Rate Capping. Dynamic Frame Rate Capping will automatically reduce the frames-per-second rate for server rendered content when the available bandwidth is less than the required 24 frames-per-second. XenDesktop dynamically monitors the environment to determine when to alter the frame rate. This setting does not require any configuration changes, but in other scenarios a custom lower frame rate could improve the hypervisor CPU performance.

It has been shown in some circumstances that the CPU load on the virtual desktop can be slightly reduced with a lower Thinwire display frame rate. It should be noted, however, that these CPU savings may not directly create CPU savings on the underlying hypervisor in the case of multimedia viewing, since in the case of multimedia redirection the desktop CPU is being utilized for decompressing audio and video of the particular multimedia format. A lower Thinwire frame rate only applies to the delivery of server-rendered video content.

The frame rate is set within the Thinwire properties specified in the Citrix registry hive on each virtual desktop. Changes to this frame rate can be made either via Group Policy, scripting or manually. The specific registry key is as follows:

[HKEY_LOCAL_MACHINE\Software\Citrix\PortICA\Thinwire MaxFramesPerSecond]

In summary, the default Thinwire frame rate of 24 frames-per-second provides a high quality viewing experience with only minimal CPU overhead and should be changed only in niche cases, such as for graphics designers, engineers and video artists. Citrix administrators should also make note of the design implications of potentially managing an environment with different frame rates for different virtual desktops and plan well-structured Active Directory Organizational Units for overseeing this added complexity.

Progressive Display, Image Acceleration and SuperCache

As mentioned in the Product and Technology Overview section of this document, Progressive Display, Image Acceleration and SuperCache work together to improve the visual experience for users by using caching and lossy compression to increase responsiveness and reduce network
consumption over the LAN and WAN. These features are configurable in XenDesktop via Citrix policies within the Presentation Server Console, also known as the XenApp Advanced Configuration console.

Administrators should carefully decide on the appropriate Progressive Display and Image Acceleration settings for their environment. Citrix policies to control image quality and compression levels should be created based on factors such as the type of media content, the applications being delivered, the access requirements for users and the networks in use.

An example commonly used for demonstrating the applicability of each of these settings is if the requirements are to deliver high-quality medical images to users remotely over low bandwidth WAN connections, such as when doctors require secure access to patient data while working remotely. In this case, the retention of the quality of these images is paramount, but the low bandwidth could cause excessive load times. To resolve this, Progressive Display compression (titled “SpeedScreen Progressive Display” within the Presentation Server Console) could be set to “High compression; low quality” and Image Acceleration (titled “Compression Level” within the Presentation Server Console) could be set to “Do not use lossy compression”. These settings are shown below.

![Image of Citrix Policies for Progressive Display and Image Acceleration](Image)

**Figure 6: Citrix Policies for Progressive Display and Image Acceleration**

In this way, images will use lossy compression for initial loading and movement across the screen, but will then quickly load with full image quality as time progresses. This example also demonstrates the use of the SuperCache, which will retain the image on the client during successive movements.
for an improved user experience. Administrators can adjust these options to account for various WAN conditions.

The Citrix policies configurable within the Presentation Server Console also allow for the ability to apply different policies to different types of connections to the XenDesktop environment. For example, LAN and WAN users can be separated based on either explicit IP address ranges, or by connections made through a particular Citrix Access Gateway farm. So for example, Image Acceleration and its corresponding lossy compression settings can be configured for connections over the WAN in order to improve usability and performance. However, a different Citrix policy with Image Acceleration disabled and full image quality can be applied for the same users, while connecting over the LAN.

![Citrix Policies Applied to LAN IP Addresses](image)

**Figure 7: Citrix Policies Applied to LAN IP Addresses**

More information on the Citrix Policies as configured in the Presentation Server Console, as well as more information about Progressive Display, Image Acceleration and SuperCache, are included in the References section of this document.

**TCP Window Size**

Optimizations can be made to the way that TCP packets are transmitted from the virtual desktop to the client in order to increase throughput for HDX. As mentioned earlier, ICA is a TCP-based protocol and therefore uses TCP packets for data transport over the network. The TCP protocol coordinates sending and receiving packets by using a TCP receive window, or “sliding window”, which is a segment of sequential packets in a data stream. The sender sends the packets within this window at the same time and the endpoint sends acknowledgements back to the sender for each
packet it receives. Once all packets are acknowledged as received, the sender moves the “sliding window” and simultaneously sends the next set of packets. In this manner, higher throughput can be achieved, because the sender can send multiple packets without waiting for an acknowledgement response.

It is recommended that the size of the TCP receive window be increased for optimal throughput for high latency network conditions. Different TCP window sizes should be used for different levels of latency. The TCP receive window size set within XenDesktop is optimized for LAN conditions by default. For higher latency conditions, such as 100 ms, 200 ms and 300 ms, this value can be recalculated and modified. Adjusting the TCP receive window involves changing several registry values on the client machine, which can be accomplished via Group Policy, scripting or manually. The two registry keys that are adjusted are as follows:

[HKEY_LOCAL_MACHINE\SOFTWARE\Citrix\ICA Client\Engine\Configuration\Advanced\Modules\TCP/IP]

"OutBufCountClient2"= Number of OutBufs (default is 44)

"OutBufCountHost2"= Number of OutBufs (default is 44)

The following chart is an excerpt from the Citrix knowledge article titled “HDX Bandwidth Optimizations over High Latency Connections” and shows the recommended value for both of the above registry settings, depending on the bandwidth and latency.

<table>
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<th>Latency (RTD)</th>
<th>Recommended Buffers to utilize all available bandwidth</th>
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<td>100ms</td>
<td>44</td>
</tr>
<tr>
<td>2 Mbps</td>
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<td>6 Mbps</td>
<td>300ms</td>
<td>176</td>
</tr>
</tbody>
</table>

Table 1: Recommended TCP Receive Windows Size for WAN Conditions

More information on how to calculate and modify the TCP receive window is contained within this Knowledge Center article How to Optimize HDX Bandwidth Over High Latency at http://support.citrix.com/article/ctx125027 and the References section of this document.
HDX MediaStream

HDX MediaStream Windows Media Redirection media and Flash is designed to significantly improve the user experience by providing the ability to render the most popular or most resource-intensive multimedia content locally on the client device. Bandwidth, latency and packet loss between the virtual desktop and the endpoint affect the delivery of content to the client device. Administrators should first measure such network conditions for planning LAN and WAN XenDesktop deployments so as to have this information available when making setup and configuration changes for HDX MediaStream Windows Media Redirection and Flash. Although the default settings prove sufficient for most customer environments, they can nevertheless be customized for more granular control.

As mentioned in the Product and Technology Overview section of this document, HDX MediaStream uses SmartRendering to continually monitor network conditions and toggle between client and server-side rendering for both Windows Media and Flash. Other types of media content, such as QuickTime and Silverlight videos, are rendered on the server and delivered via Thinwire. Generally, the audio and video quality of Windows Media and Flash videos correlates with the amount of data that must traverse the network; therefore administrators should evaluate the type, format and quality of multimedia content that will be delivered via XenDesktop. Low-bandwidth, high-latency and high-packet loss network conditions affect the viewing experience for users, as well, and should be measured and taken under consideration, before attempting to deliver high definition content over the WAN.

The SmartRendering network thresholds for HDX MediaStream Windows Media Redirection and Flash are available bandwidth and round-trip latency, respectively. The minimum network bandwidth threshold required to render Windows media content on the client is set to a low value by default (512 kbps in the first release of XenDesktop 4). This setting was introduced to ensure that the client had enough available bandwidth to adequately render the Windows media content at the intended data rate of the video. As an additional benefit, client-side rendering has been shown to produce the best user experience for video rendering. This is due to reduced network utilization, as described in the Technology Overview. Even more network savings are seen when combining client-side rendering for Windows media content with Citrix Branch Repeater, which is the key product behind HDX WAN Optimization technology, as described later on. Should server-side rendering be preferred when delivering videos with a bit rate above 512 Kbps, this bandwidth threshold value can be changed by modifying the following registry key on the virtual desktop. The following registry setting can be altered to modify the default minimum network bandwidth threshold:

- Set the bandwidth threshold (in kilobits per second) on the VDA in the following registry key: [HKLM\SOFTWARE\Citrix\HdxMediastream\MinimumBandwidth]

- [HKLM\SOFTWARE\Wow6432Node\Citrix\HdxMediastream\MinimumBandwidth] is the registry path for 64-bit platforms
For more information on configuring the minimum bandwidth threshold please see this article [http://support.citrix.com/article/ctx124777](http://support.citrix.com/article/ctx124777).

HDX MediaStream for Flash measures round-trip latency for a session to decide whether to use client-side or server-side rendering. The default value is set to 30 ms in the first release of XenDesktop 4. This setting was chosen to deliver the best user experience for general web surfing. If the roundtrip latency between the user and the data center is more than 30s, using Flash Redirection can result in a more sluggish user experience than using server-rendered multimedia delivery. However, administrators can experiment with increasing the threshold to see which HDX MediaStream technology delivers the best user experience for the Flash-based sites that users in the organization will visit. This setting is specified in the HDX Flash Active Directory Group Policy ADM templates provided with XenDesktop and can be applied to the server, as shown in the following two figures.

There are a number of requirements for client-side rendering of Windows Media and Flash for HDX MediaStream. The minimum version requirements are Windows Media Player 11 or 12 and Adobe Flash Player browser plug-in version 10. HDX MediaStream will not work for other standalone players or plug-ins, such as Adobe Shockwave Player. The proper codecs for viewing Windows media content must also be present on the client machine, otherwise MediaStream will fall back to server-side rendering.

The proper functioning of HDX MediaStream can be confirmed by administrators for both Windows Media and Flash content by either observing minute, visual indicators at the start of video playback or by monitoring particular Windows processes on the endpoint. To determine if HDX MediaStream Windows Media Redirection is functioning and content is being rendered properly on the client device, an observer will notice a black rectangle quickly flash by as the video begins to play. This black rectangle indicator is not seen when server-side rendering is in use and HDX MediaStream Windows Media Redirection is inactive. To determine if HDX MediaStream for Flash
is in use and content is being rendered properly on the client, the user will notice a process called “pseudocontainer.exe” running on the Windows operating system, which is viewable via Windows Task Manager. This process is not seen when HDX MediaStream for Flash is inactive and server-side rendering is in use.

For HDX MediaStream for Flash, administrators are able to set up a “Server-side content fetching list” in the AD Group Policy ADM template to isolate content for fetching and rendering on the server, rather than on the client. This allows for users to have the ability to remotely access Flash content that may be inaccessible outside of the corporate network. As an example, an organization might use internal-only Flash videos for delivering training content.

As mentioned previously, HDX MediaStream for Flash Group Policy ADM templates are included with XenDesktop. These settings provide administrators the ability to better control the fetching and rendering settings for clients and servers. These settings also include the ability to synchronize server and client HTTP cookies for content fetching. Administrators should use AD policies as they assist with implementing their multimedia delivery requirements and policies for their organization.

**HDX RichGraphics**

HDX RichGraphics technologies are designed to deliver 2D, “2.5D” and 3D graphics to users over a wide range of network connections. Progressive Display improves responsiveness by sending moving images with lossier compression than images at rest. **HDX 3D Pro Graphics** allows industries such as Manufacturing, Engineering, Graphics Design, and Architecture to safeguard intellectual property in the datacenter, but still provide the ability for users to work remotely. Support for Microsoft RemoteFX is under development and will allow low cost terminal devices to access graphical and multimedia content rendered on the XenDesktop server.

Progressive Display and HDX 3D Pro Graphics are currently available for XenDesktop 4, and HDX RemoteGraphics with RemoteFX will be available after the release of Windows Server 2008 R2 SP1.

**HDX 3D Pro Graphics**

HDX 3D Pro Graphics is the core set of software components that are deployed to the graphics desktop and to the endpoint machine. Pro Graphics utilizes different image compression technologies than standard XenDesktop. For the most advanced graphic performance, Citrix offers GPU-based compression utilizing the NVIDIA CUDA-enabled GPUs processing power. For this level of compression, an upgraded version of the Virtual Desktop Agent is applied to the physical desktop or server responsible for hosting the graphics-intensive application and a special version of the Citrix client is deployed on the endpoint (the endpoint is not required to have a graphics card). If the host has a non-NVIDIA GPU, then the CPU codec can be used with the standard Citrix plug-in for Windows and Linux clients. Bandwidth requirements for optimal performance should be at least 2Mbps with the GPU codec and 3Mbps for the CPU codec. The necessary upgraded components for the GPU codec be downloaded using a MyCitrix account and configured based on

HDX 3D Pro Graphics utilizes the GPU codec for high-density image compression while retaining excellent image quality by dynamically adjusting the image quality when it detects degradation in network conditions. Lossy compression can be adjusted to reduce the bandwidth consumption and improve responsiveness for the user, such as in the case of connecting over the WAN. Since users’ preferred image quality differs between models and applications, the lossy compression settings can be directly controlled by the user with the Image Configuration Tool, as described in the next section.

**Image Configuration Tool**

The Image Configuration Tool can be accessed in the Windows system tray of the virtual desktop with RichGraphics enabled and provides the user with the ability to control image quality in order to improve responsiveness, as shown below.

![Image Configuration Tool](image)

**Figure 10: Image Configuration Tool for HDX 3D Pro Graphics**

The Image Configuration Tool includes a slidebar that can be used to control the amount of lossy compression, thereby reducing bandwidth usage and delivering a more responsive application. This is especially useful for designers and engineers, when attempting to manipulate models over low bandwidth connections. Keyboard shortcuts are also configurable by the user, so that the Image Configuration Tool can be hidden from view while working within the desktop. The Fixed Quality checkbox is intended for LAN users, where sufficient bandwidth is always expected and performance is consistent, even while delivering the highest quality images. When the Fixed Quality checkbox is checked, *Image Quality Intelligence* (automatic tuning of image quality as network conditions change) is turned off. The 2D Drawing checkbox is specifically designed to improve image movement and reduce drag while manipulating complex 2D models, by forcing the use of the
CPU codec. And the Lossless checkbox disables both image compression and Image Quality Intelligence, thereby ensuring the highest possible quality with pixel-wise lossless frames, as required for medical imaging.

HDX Adaptive Orchestration

HDX Adaptive Orchestration is an overarching concept describing the ability of XenDesktop to deliver a high definition user experience over any network by utilizing different system components of the end-to-end delivery system. Hence, HDX Adaptive Orchestration is not a technology component that is directly configurable. The best practices for employing HDX Adaptive Orchestration are described in each of the individual HDX sections of this document. As mentioned in the Product and Technology Overview section of this document, SmartRendering is the key technology behind HDX Adaptive Orchestration and the best practices for configuring it as part of HDX Broadcast and HDX MediaStream are described in those respective sections.

HDX RealTime

HDX RealTime technologies are designed to optimize the audio and video collaboration and delivery capabilities for users over any network. This is primarily achieved by applying Citrix policies to voice- and video-specific circumstances. Citrix policies control the amount of lossy compression applied to audio and video that is delivered over ICA. The user experience for VoIP and Video collaboration applications can be improved for users by applying different Citrix policies for different situations, such as LAN or WAN scenarios.

Citrix XenDesktop 4 has been released with state-of-the-art audio codecs that greatly reduce the bandwidth used for delivering voice communications, while retaining high quality. The Optimized-for-Speech codec is specifically optimized for real-time communications (softphones, voice chat). The Speech codec is able to reduce bandwidth by providing very quick encoding times, making it ideal for real-time communications where latency must be minimized to enable natural conversation. The option to enable the Speech codec is listed as the “Medium sound quality; good performance” setting under the “Client Devices – Sound Quality” sub-menu in the Presentation Server Console in XenDesktop 4, as shown in the following figure.
This medium quality setting is generally recommended and is particularly useful to accommodate users connecting remotely over the WAN. It can also be implemented to reduce bandwidth consumption for highly-congested networks, such as in the example of call centers using IP softphones delivered via XenDesktop or XenApp.

A new feature in XenDesktop 4 is support for webcams for LAN-connected users so that they can participate in video conferences from their virtual desktops. Citrix policies can also be used to reduce bandwidth consumption for video collaboration in much the same way as for voice collaboration. In the case of video rendering, Image Acceleration is also used in HDX RealTime. Different compression settings can be specified within the Presentation Server Console to control the appropriate amount of video quality and bandwidth consumption desired. Unlike for audio, there is no video-specific session limit that can be specified as a Citrix policy. However, an overall session limit can be implemented in the “Bandwidth – Session Limits” sub-menu in the Presentation Server Console. It should be noted that this may have an adverse impact on the way that webcams deliver data “upstream” to the virtual desktop, however.
HDX Plug-n-Play

HDX Plug-n-Play for XenDesktop provides two important capabilities: simple usability for peripheral devices for users and refined access control and security for administrators. HDX Plug-n-Play provides reliable connectivity for USB, multi-monitor, printers, smart cards and other peripheral devices by utilizing proven Citrix technologies. A general rule is that if both the local machine’s and virtual desktop’s operating systems are able to recognize the device and properly install device drivers, then XenDesktop is able to provide seamless access to and usage of these devices. Most commonly-found devices do not require separate driver installations for use with XenDesktop. However, to use advanced capabilities of some of these devices, such as with Logitech webcams and Philips microphones, a separate software installation may be needed. In this case, device drivers and software must be installed on both the local machine and the virtual desktop.

HDX Plug-n-Play provides administrators with the ability to control the use of peripheral devices, place restrictions on bandwidth usage of different devices and secure drive access in a XenDesktop environment. As with other HDX technologies, Citrix policies are used to perform these different tasks. Printing functionality for users’ desktops can also be carefully controlled in ways such as disabling printer driver installations, printer auto-creation and printing bandwidth limits. For safeguarding data and intellectual property, Citrix policies can be created to restrict drive access and clipboard mappings. Additional encryption policies can also be configured to protect against eavesdropping. As mentioned previously, Citrix policies can be applied to different types of connections to differentiate between more-trusted LAN users versus remote access users.

Figure 82: Citrix Policies for Enabling Client USB Devices
HDX SmartAccess

HDX SmartAccess provides end users with the same external access point for all devices and locations while still providing administrators with secure control over the environment. HDX SmartAccess technology has been part of Citrix Access Gateway and Citrix XenApp for many years.

Citrix Access Gateway can be used to filter user access based on proper credentials and endpoint requirements. The result of these security checks determines the resources available to the user in two distinct places in the XenDesktop environment: (1) the published resources available to the user, such as either particular applications or desktops as displayed on the Web Interface, and (2) the security restrictions put in place within the applications or desktops, such as peripheral devices, drive mappings, printers, etc. Citrix policies interpret the results of Access Gateway filters and apply particular security restrictions accordingly. The HDX Plug-n-Play section of this document describes the security restrictions that can be put in place within XenDesktop through Citrix policies.

HDX SmartAccess also includes a Single Sign-on feature to improve the user experience by reducing authentication prompts and simplifying the organization of multiple credentials. The Single Sing-on feature provides added security by centralizing password management for all applications. More information is available at http://support.citrix.com/product/pm/.

HDX WAN Optimization

HDX WAN Optimization is the term used to describe the functionality of Citrix Branch Repeater, as mentioned in the Technology Overview section. Using Citrix Branch Repeater with XenDesktop allows for a high quality user experience over the WAN by providing Protocol Optimization, Traffic Prioritization and Compression to desktop and application delivery, as described in the Technology Overview section of this document. Citrix Branch Repeater is very beneficial when multiple users in a single location utilize the same content, such as with Windows Media videos that can be rendered client-side with HDX MediaStream. Branch Repeater is typically deployed to a branch office that already has a congested WAN link. The best practices for using Citrix Branch Repeater with XenDesktop are described in the document titled “Performance Assessment and Bandwidth Analysis for Delivering XenDesktop to Branch Offices”, and can be found at the following URL: http://support.citrix.com/article/ctx124457.
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HDX MediaStream


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HDX RichMedia


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HDX RealTime


HDX SmartAccess


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HDX WAN Optimization

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HDX Experience Monitor

- HDX Experience Monitor download and support information: 
  [http://support.citrix.com/article/CTX123058](http://support.citrix.com/article/CTX123058)

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