HDX technologies for optimizing application and desktop delivery

A satisfying experience that is similar to or better than that of a local PC is essential, whether people are accessing their virtual apps and desktops from corporate-owned systems or personal mobile devices.

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Users expect a real-time response from the apps they are working with, both when they connect from reliable corporate networks (LANs) and when coming in over challenging wide area networks (WANs), such as 3G/4G/LTE mobile networks and satellite links that are typically low-bandwidth, high-latency and/or high packet-loss. HDX technologies, included with XenApp and XenDesktop, address these scenarios to ensure the best possible user experience at all times.

Over the past 25 years, the Independent Computing Architecture (ICA) standard developed by Citrix has become the de-facto protocol for highly-efficient delivery of app and desktop workloads across a wide variety of conditions and connection scenarios. HDX technologies extend the ICA protocol to satisfy modern demands for rich media apps, and leverage innovations in endpoint computing power to deliver a "high-definition" experience. This whitepaper provides an overview of HDX capabilities and their benefits for both end-users and IT administrators.

What is HDX?

HDX technologies offer a set of capabilities that deliver a "high-definition" experience to users of centralized applications and desktops, on any device and over any network. HDX technologies are built on top of the ICA remoting protocol, proven in large enterprise environments and accessed by millions of users globally.

Simply put, HDX is designed around three technical principles – intelligent redirection, adaptive compression, and data de-duplication – which are applied in different combinations to meet one or more of these business goals:

• Optimize the user experience
• Decrease bandwidth consumption
• Increase user density per hosting server

Technical principles behind HDX

1. **Intelligent redirection** determines which component in the chain, whether server, endpoint, network, or something else, could render application activity to meet the three design principles. HDX examines screen activity, application commands, network conditions, and capabilities of endpoint device and server to decide the optimal redirection.

   a. Client redirection leverages processing power on endpoints, if available, to free up the server to handle other processes or more users
   b. Device redirection intercepts peripherals such as webcams, printers, scanners, digital pens, and 3D mice at a local level to allow users to interact with these devices

2. **Adaptive compression** is a core intellectual property of the ICA protocol which allows rich multimedia display to be delivered on thin network connections. HDX chooses the most optimal compression codec and the best proportion of CPU and/or GPU utilization, after evaluating a number of variables such as the type of display (text, video, voice, multimedia), the type of input, the type of device (smartphone, tablet, desktop), network conditions, and so on. This is intelligently adapted per user, or even per-session, as necessary.

3. **De-duplication** of network traffic reduces the aggregate data sent between client and server by taking advantage of repeated patterns in commonly accessed data such as bitmap graphics, documents, print jobs and streamed media. Caching these patterns allows only changes to be transmitted across the network, eliminating duplicate traffic. HDX also supports multicasting of multimedia streams, where a single transmission from the source is viewed by multiple "subscribers" at one location, rather than one-to-one connections for each user.

In the following pages, we'll look at how these principles apply to different HDX technologies in more detail.
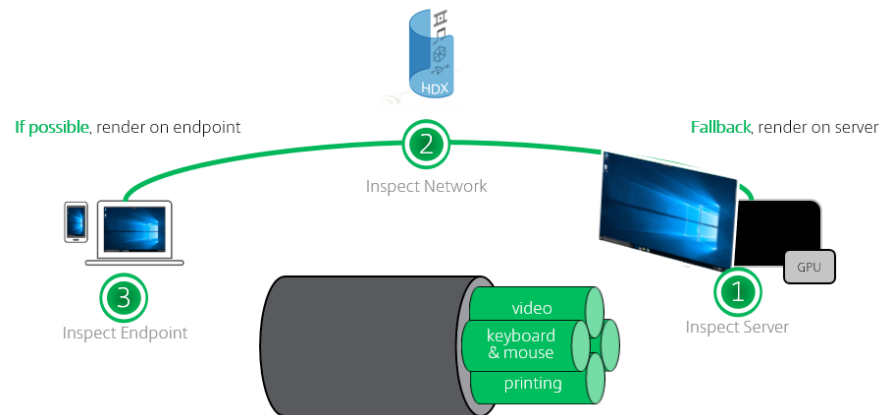

Figure 1: HDX is far more than just a protocol

Deliver smooth voice, video and multimedia performance

Users expect app and desktop delivery solutions to have "real time" audio and multimedia characteristics similar to what they receive from local app and desktop implementations. HDX technologies deliver bandwidth-efficient, crystal-clear voice, multimedia and video and are refined through the use of policies and templates.

Display optimization

• Thinwire advanced with deep compression of video and graphics using H.264 compression delivers better image quality and better bandwidth efficiency for highly animated workloads, server-rendered video or 3D graphics. Most modern mobile devices as well as Windows, Mac and Linux PC users have the endpoint computing power to decompress such streams on the fly. If not, adaptive compression always provides a fallback to alternatives listed below.

- Enhanced Thinwire display technology ensures a great user experience for general business use cases, delivering superior image quality and ultra-low bandwidth usage. Highly optimized algorithms provide maximum server scalability without compromising the end-user experience. Also, being fully backwards compatible, Enhanced Thinwire requires no client or Citrix Receiver upgrades, making it a perfect choice for legacy client deployments.
- Framehawk is a great alternative to dramatically improve user interactivity in unreliable network conditions, where high packet loss and latency are created due to spectral interference or distance. This is common in broadband wireless and mobile networks, where user experience is poor despite the availability of abundant bandwidth.

Unified communications

- Web conferences require real-time audio and, increasingly, high-fidelity video and screen-sharing as well. HDX ensures audio traffic always receives the highest network priority and includes packet tagging for QoS, on a dedicated virtual channel within the ICA protocol for RTP/ UDP audio. This minimizes latency for jitter-free audio quality.
- Client-side webcam compression for video communication reduces bandwidth requirements by an order of magnitude, ensuring a native user experience even on mobile networks or at very remote locations.
- Citrix has joint solutions with major unified communication (UC) vendors including Microsoft (Skype for Business, formerly Lync), Cisco (Jabber), and Avaya (one-X) to enable peer-to-peer communication between endpoints, when the app is centrally hosted in a virtual environment. Real-time optimization policies prevent latency due to "hairpinning", so audio and video can move from endpoint to endpoint without traveling all the way back to the central host in the datacenter. The result is a great user experience and higher user density on the host server.
- Multicast video support for Windows Media and Flash video permits a few, hundreds or even thousands of users to view video content that may be rendered and transmitted just once. This can produce as much as 95% savings in bandwidth and datacenter resources for live video events, news channels, and training programs delivered to branch offices.
- Multimedia redirection has a huge impact on reducing CPU utilization of the host servers allowing more users to be supported per server for greater scalability. Flash redirection and Windows Media redirection offload the playback rendering of rich content to compatible client devices, using server-rendered multimedia only as a fallback option.

Broad support for 4K resolution and multi-monitors

Ever-increasing use-cases in verticals such as medical, manufacturing and finance require high-resolution displays and/or setups with more than one monitor. XenApp and XenDesktop have extensive support for these scenarios by leveraging underlying graphics hardware capabilities along with HDX technologies for crisp, detailed images, smooth video and clear text.

Optimizing business and professional graphics with HDX 3D Pro

HDX 3D Pro is a specialized technology that pioneered the use of graphics processors (GPUs) in virtual apps and desktops. Today, there are virtualization-aware GPU cards available, which provide hardware acceleration to multiple virtual machines (VMs) using a single physical GPU. Originally designed for high-end 3D professional graphics, the technology is now available to optimize the performance of business graphics apps that leverage GPU acceleration, such as web browsers and Office apps.

2D business graphics

HDX supports business graphics acceleration through the use of a software rasterizer to render Microsoft DirectX using a CPU or GPU if available. On Microsoft endpoints, DirectX graphics command redirection offloads Windows desktop composition from the server for greater scalability and enhanced user experience.

Modern business apps, whether Microsoft Office apps or Web browsers, are often designed to leverage graphics processors. HDX technologies support multiple GPU vendors to deliver cost-effective graphics performance using GPU sharing on different platforms, such as Citrix XenServer, VMware vSphere, or bare metal. Depending on the workload, up to 150-200 users may benefit from accelerated business graphics delivered from a single server.

3D professional graphics

Citrix developed the first virtualization solution to support hardware-based GPU sharing of OpenGL and DirectX-based 3D professional graphics apps. This led to hardware acceleration of graphics commands for achieving smooth graphics performance, and breakthrough deep compression technologies for maximizing traffic throughput over low-bandwidth networks. The parameters can be tuned all the way up to lossless compression that enables delivery of pixel-perfect images for applications such as medical imaging.

Some 3D professional graphics apps that benefit from HDX 3D Pro:

- Computer-aided design, manufacturing and engineering (CAD/CAM/CAE) applications
- Product lifecycle and product data management apps (PLM/PDM)
- Geographical information system (GIS) software
- Picture archiving and communication systems (PACS) such as medical imaging

GPU sharing support

HDX 3D Pro allows you to provision a GPU to users in a flexible manner. To support designers and engineers who require dedicated graphics performance, provision one virtual GPU per user or VM using XenDesktop, on either XenServer or VMware vSphere. For more cost-effective deployments, provision many users to share a GPU to view and edit 3D models – as many as 64 users per VM per server – depending on the workflows and demands. In all cases, the latest drivers and codec versions supported by GPU vendors are available to the user.

Giving Windows apps a mobile-native look and feel with HDX Mobile

HDX Mobile improves the experience of Citrix Receiver users working in supported Windows applications and server-based desktops on mobile devices. HDX includes a native interface control channel allowing Windows apps to be re-factored for a touch experience while leveraging device features such as multi- touch gestures, native menu controls, camera and GPS device functions. Many touch features are available natively in XenApp and XenDesktop and do not require any application source code changes to activate.
Native touch features include:

• Automatic display of the keyboard when a text field has focus
• Larger picker control to replace Windows combo box control
• Multi-touch gestures such as pinch and zoom
• Inertia-sensed scrolling
• Touchpad or direct cursor navigation

Additional capabilities can be implemented using the HDX Windows Mobile Application SDK. It enables enterprise developers to update Windows applications just once for mobile devices using familiar Windows programming languages. The SDK includes more than 50 APIs. Following are examples of programmable mobility enhancements:

• Control how buttons are used on the mobile device; use local user interface controls instead of Windows controls
• Autosense display size and re-factor apps to use available resolution and horizontal layout on a tablet or smaller mobile device screen
• Integrate device functions such as telephone, SMS, GPS and camera with Windows app workflows

Enhancing thin clients with HDX SoC embedded technology

Citrix provides an SDK to system-on-chip (SoC) vendors that enables compute-intensive HDX algorithms to execute outboard from the CPU, allowing inexpensive processor-based devices to deliver a high-definition user experience. Device manufacturers using these SoCs have now brought to market a broad portfolio of low-cost HDX Ready thin clients, zero clients and other products. Unlike competing solutions that burn the remoting protocol into silicon, which can result in device obsolescence within months, the Citrix approach supports ongoing innovation without hardware replacement. Get the latest information on HDX SoC thin clients available from HP, Dell/Wyse, NComputing and others.

Accelerating printing and scanning

Citrix supports both local and network printing. Local printing entails redirecting and terminating the printer locally to allow the user to interact with it at native speeds. Network-based printing is supported using Citrix Universal Print Server and Universal Print Driver technologies.

Citrix developed these print driver and print server technologies from the ground up for network printing. They provide many of the features needed for daily printing while taking into consideration the amount of bandwidth a print job requires. Using a single driver to manage hundreds or thousands of printers also simplifies management of print drivers in the XenApp/XenDesktop environment. With the Universal Print Server, the print engine is moved to a Windows print server which prevents the need to install device-specific drivers in the machine image. Firewall-friendly printing protocols provide greater bandwidth efficiency than native Windows protocols and extend printing to non-Windows devices. The latest Universal Print Server also provides improved scalability, greater OS-support and performance monitoring. Additionally, it integrates with Citrix's Customer Experience Improvement Program (CEIP) to continually help make the product better.

CloudBridge branch caching analyzes commonly used data such as file header and footer content and company logos, and caches the content locally on the print server for retrieval by users without resending the data for each print job.

Although scanners can be supported through basic USB direction, the Citrix implementation permits additional intelligence between the endpoint and the host. Local scanner termination allows the user to interact with the peripheral at native USB speeds. Once the scan is completed, ICA compresses the scanned image and sends it to the host server; thus, the only content that travels over the network is a compressed image.

Supporting the largest variety of peripheral devices

HDX provides seamless plug-and-play connectivity for a broad range of devices such as webcams, music players, audio recorders and specialty peripherals. USB redirection to cloud makes these peripherals available within sessions hosted hundreds of miles away from the point of use. HDX technologies optimize USB traffic over common wide area network conditions to ensure real-time feedback and full-feature support. Support for digital pens, electronic signature pads, and drawing tablets in cloud-hosted apps is an important requirement in retail, finance, design, CAD and other such markets.

Ensuring the highest quality of service and reliability

HDX technologies ensure the highest quality of service and reliability through a combination of ICA traffic prioritization, branch office caching and ICA protocol optimizations.

Virtual app and desktop traffic competes with everything else on a network. To meet stringent service level agreements (SLAs), network administrators need tools that help prioritize and optimize application and desktop traffic to deliver a great user experience every day. HDX traffic prioritization capabilities include:

• Prioritizing virtual app and desktop traffic based on usage type by segmenting the communication channel into five independent streams through standard QoS routing techniques. Virtual desktop traffic can be segmented into: 1. dedicated real-time, 2. interactive, 3. background, 4. bulk and 5. RTP/ UDP voice channels.

- Application types can be identified, enabling network administrators to prioritize web and client-server applications alongside virtual apps and desktop traffic to maintain QoS while achieving the absolute best utilization of the available network bandwidth. A CloudBridge WAN optimization appliance is required for this functionality.

WAN optimized branch caching is accomplished by CloudBridge with integrated HDX caching technology to provide groundbreaking multi- user optimization for virtual desktops and applications. Organizations can get more from their existing network infrastructure while providing a high-definition experience to branch office workers.

HDX caching technology adaptively orchestrates with XenApp and XenDesktop to disable the native ICA compression used for optimizing single-user sessions. It then optimizes XenApp and XenDesktop delivery across multiple user sessions by locally caching and de-duplicating transmission of commonly accessed data, including bitmap graphics, files, print jobs and streamed media. Branch caching for hosted apps and desktops occurs transparently, requiring no additional configuration or tuning on the CloudBridge appliance or the XenApp/XenDesktop server.

ICA protocol optimizations include TCP flow control, traffic compression and protocol acceleration.

- Adaptive TCP flow control accelerates the flow of all TCP-based traffic, including ICA, by sensing and responding to high network latency and packet loss. The result is significantly higher network throughput and performance than with standard TCP implementations.
- Adaptive compression uses a highly tuned engine to compress ICA traffic based on its characteristics, as well as infrastructure capabilities and network conditions.
- Adaptive protocol acceleration performs intelligent acceleration of ICA traffic while sensing and responding to network and traffic conditions.

Improved overall diagnostics with new telemetry functionality is available on virtual desktops to assist with troubleshooting. This capability also leverages the Citrix Insight Services platform for centralized management of environmental health along with tight integration to Citrix Technical Support.

Simplifying administration with policy templates
Pre-defined HDX policy templates make it easy to ensure that users receive the best possible experience for their connection scenario while also meeting IT objectives. Templates for high server scalability, bandwidth-constrained WAN users, security and control, and a high-definition experience are included.

XenApp, XenDesktop and HDX technology

HDX technologies are the foundation of the Citrix apps and desktop delivery platform, which provides a superior virtual app and desktop solution accessible from any device, over any network and gives end users an application and desktop experience that rivals that of a local PC—even when people are using multimedia, real-time collaboration, USB peripherals and 3D graphics apps over low-bandwidth, high-latency networks. With XenApp and XenDesktop and HDX technologies, IT can successfully extend delivery of virtual apps and desktops beyond the corporate HQ to remote, mobile and branch office users.

For additional information, please visit citrix.com/hdx.

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