

# **XenDesktop and XenApp Best Practices – Reference Guide**



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## Overview

The foundation of any good XenDesktop or XenApp enterprise design should be adherence to a collection of best practices which are based upon knowledge gathered from previous enterprise deployments, lab validations, and lessons learned in the field. Such best practices are just a starting point for a design, as an organization's specific design requirements will often necessitate deviation from the recommended path. By using the following recommendations as a starting point, the foundation of the design will be robust enough to support many different deployment scenarios.

This document consolidates and summarizes the best practices for XenApp and XenDesktop environments. As products evolve, best practices also change, which is why each best practice discussed in this document is associated with a specific product and version, which includes the following:

- XenDesktop 5.0, 5.5, 5.6
- XenApp 6.0, 6.5

Additional best practices are provided for those products which provide complimentary functionality to both XenDesktop and XenApp, including:

- Citrix Provisioning Services
- Citrix XenServer
- Citrix Profile Manager
- Microsoft Hyper-V
- VMware vSphere

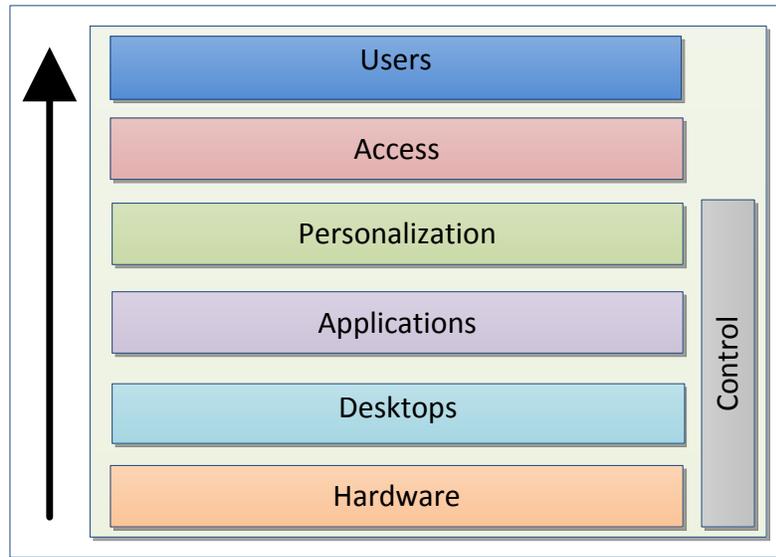
For further guidance and more detailed information, please refer to the [XenDesktop Design Handbook](#).

The recommendations provided within this document may not be appropriate for every environment. Therefore, all best practices within this document should be evaluated in an isolated test environment prior to being implemented in production.

**Caution:** Some of the best practices in this document will require you to edit the registry. Using Registry Editor incorrectly can cause serious problems that might require you to reinstall your operating system. Citrix cannot guarantee that problems resulting from the incorrect use of Registry Editor can be solved. Use Registry Editor at your own risk. Be sure to back up the registry before you edit it.

## Document Structure

The structure of the document reflects the common technology layers seen within any XenDesktop or XenApp infrastructure. This layer model is outlined below:



- **General Recommendations:** This section discusses best practices and recommendations, which are not directly related to specific features or technologies and apply to all Citrix projects.
- **Control Layer:** Provides best practice recommendations for XenApp farm design, XenDesktop site design, database recommendations, license server recommendations, networking and Active Directory integration.
- **Hardware Layer:** Outlines best practices for the three major hypervisors - Citrix XenServer, Microsoft Hyper-V and VMware vSphere.
- **Desktops Layer:** This section focuses on the desktop image (including optimizations) and desktop image delivery best practices.
- **Applications Layer:** This section provides best practices on application integration into the virtual desktop
- **Personalization Layer:** Details the best practices for printing, profiles and policies.
- **Access Layer:** Provides best practices for Citrix Web Interface as well as the Citrix Receiver/Plug-Ins.
- **User Layer:** Provides recommendations on the users of the system including training recommendations.

## General Recommendations

| Area                               | Best Practice  | Applies To       |
|------------------------------------|--|------------------|
| Methodology                        | <p>A structured and proven methodology should always be followed. The <a href="#">Citrix Consulting Methodology</a> consists of four clearly defined phases – Analysis, Design, Build/Test and Rollout. Each phase consists of a series of checkpoints and deliverables that helps to ensure that no key step is missed.</p> <p>In addition, the <a href="#">Desktop Transformation Model</a> offers specific guidance on how to move from a device centric, distributed management paradigm to a more user-centric, virtualized model. For step-by-step help with free tools, expert guidance, and peer benchmarks, please refer to <a href="#">Citrix Project Accelerator</a>.</p> | XD 5.x<br>XA 6.x |
| Application compatibility checking | <p>When moving to a new operating system or application delivery technology it is important to verify application compatibility as soon as possible so that there is sufficient time available to perform any remedial work required. Citrix <a href="#">AppDNA</a> allows the application assessment to be performed quickly, while also providing detailed information on any remedial actions required.</p>   | XD 5.x<br>XA 6.x |
| Separation of components           | <p>With enterprise deployments, key infrastructure roles should be hosted on dedicated servers to enhance security, scalability, high availability and support. Examples include Web Interface servers, XenDesktop Controllers, Zone Data Collectors, Provisioning Servers, License servers and Database servers.</p>  | XD 5.x<br>XA 6.x |
| Test Environment                   | <p>An isolated test infrastructure should be implemented so that software, configuration and hardware changes can be verified prior to being implemented in production. The test environment should mirror the production environment as closely as possible.</p>  | XD 5.x<br>XA 6.x |



|                              |  |                  |
|------------------------------|--|------------------|
| Hotfixes and Service Packs   | <p>Hotfixes and updates for the operating system, applications, and Citrix components should be kept up-to-date to ensure optimal performance, stability, and security. For Citrix specific hotfixes the following recommendations apply:</p> <ul style="list-style-type: none"><li>• Service Packs and Hotfix Rollup Packs should always be installed</li><li>• Security Fixes and hotfixes marked as critical should always be installed</li><li>• General public hotfixes and limited release hotfixes should be installed on an “as needed” basis only</li></ul> <p><b>Important:</b> Always test updates and hotfixes in a test environment prior to rolling them out in production. Furthermore, it is strongly recommended that patches are applied consistently across relevant server roles and virtual desktop groups.</p> | XD 5.x<br>XA 6.x |
| Dedicated Management Servers | <p>For enterprise environments, Citrix recommends implementing dedicated XenApp-based management servers which host all tools and applications required for Citrix infrastructure management. Administrators access these programs either as Published Applications or as part of a Published Desktop. This ensures that the performance of none of the Citrix infrastructure servers (i.e. XenApp Zone Data Collectors, XenDesktop Controllers or Application Servers) is impacted by normal day-to-day management tasks. The XenApp-based management servers should be installed with the Controller Mode enabled, otherwise XenApp console requests cannot be processed locally on the management server.</p>   | XA 6.x<br>XD 5.x |



## Control Layer

### XenDesktop Controllers

| Area                          | Best Practice   | Applies To |
|-------------------------------|---|------------|
| Scale Up/Out                  | <p>The decision to scale up (increase the number of virtual desktops / users per site) or scale out (add additional sites) is influenced by the following factors:</p> <ul style="list-style-type: none"><li>• Location and needs of the users or your organization - If your organization is a service provider, you might want to dedicate a site to each organization for which you provide service. Multiple sites might make it easier to demonstrate compliance with specific service level agreements.</li><li>• Geographic layout of your organization - XenDesktop Sites should not span multiple physical locations unless a fault tolerant, low latency link is provided because the Controllers are constantly accessing the SQL Database and regularly communicating with the virtual desktops. XenDesktop might experience unexpected behavior if significant levels of latency exist between the Controller, SQL Database and virtual desktops.</li><li>• Consider using multiple XenDesktop sites to minimize the impact from a site wide outage, for example SQL database corruption. For some environments, the increase in management overhead can be outweighed by the decreased risks.</li></ul> | XA 6.x     |
| Redundancy                    | Every XenDesktop site should have at least two Controllers for reasons of redundancy.   | XD 5.x     |
| Controller Roles              | The XenDesktop Site Services role should not be manually assigned to the XenDesktop Controllers as it can interfere with the automatic load balancing and failover mechanisms of XenDesktop.  | XD 5.x     |
| Virtual Desktop Reboot Policy | To prevent boot storms from negatively affecting performance due to a significant number of users logging off simultaneously, virtual desktops should typically be configured so that they do not automatically reboot at logoff. Instead, configure the idle desktop settings within the Desktop Group to ensure that the desktops are rebooted once a day, outside business hours. For more information, please refer to the following Citrix Knowledgebase Article CTX127842 – <a href="#">How to Configure the Logoff Behavior of a Desktop Group in XenDesktop 5</a> .   | XD 5.x     |
| Time Sync                     | Due to the VDA registration process relying on Kerberos authentication, the VDAs and Controllers should have their time synchronized. The Network Time Protocol (NTP) should be used to synchronize   | XD 5.x     |



|                            |   |                  |
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|                            | the time across all components.   |                  |
| Scalability                | <p>Sufficient resources should be assigned to the XenDesktop Controllers, based on the results from scalability testing, to ensure that they do not become a bottleneck during periods of peak activity such as boot storms and logon storms. Citrix has performed internal testing on the scalability of the XenDesktop Controller role and found that:</p> <ul style="list-style-type: none"><li>• A physical XenDesktop Controller (2 x quad core 1.86GHz / 16GB RAM) can handle more than 20,000 virtual desktop boots / user logons within 20 minutes.</li><li>• A virtual XenDesktop Controller (2 x vCPU / 4 GB RAM) can handle more than 2,500 virtual desktop boots / user logons within 4 hours.</li></ul> <p>For further information, please refer to the Citrix Knowledgebase Article CTX128700 – <a href="#">XenDesktop Planning Guide – XenDesktop Scalability</a>.</p> | XD 5.x           |
| Host Connection Throttling | <p>The values for the maximum number of active actions and the maximum number of new actions per minute should be adjusted according to the capabilities of the hypervisor pool. Initial values should equal the number of hosts multiplied by two. Higher values should only be enabled after comprehensive scalability testing has been completed as they could negatively impact performance and user perception.</p>  | XD 5.x           |
| Desktop Director Hosting   | <p>The Desktop Director role should be hosted on dedicated servers for large-scale XenApp and XenDesktop deployments which have more than 50 concurrent users of Desktop Director. Multiple Desktop Director Servers should be load balanced via an intelligent load balancing appliance (i.e. Citrix NetScaler) which can verify the availability of the Microsoft Internet Information Service and the Desktop Director website.</p> <p>For more information, please refer to Citrix eDocs – <a href="#">Installing and Upgrading Desktop Director</a>.</p>   | XD 5.x<br>XA 6.5 |



## XenApp Controllers

| Area            | Best Practice   | Applies To |
|-----------------|---|------------|
| Number of Farms | <p>Most XenApp deployments consist of a single farm. However, there are some circumstances where it makes more sense to deploy multiple farms. The decision to implement a single farm or multiple farms is influenced by the following factors:</p> <ul style="list-style-type: none"><li>• Location and needs of the users or your organization - If your organization is a service provider, you might want to dedicate a farm to each organization for which you provide service. Multiple farms might make it easier to demonstrate compliance with specific service level agreements.</li><li>• Geographic layout of your organization - If your IT infrastructure is organized by region and managed in a decentralized manner, multiple farms could improve farm performance. Multiple farms could also save time when coordinating farm administration and simplify troubleshooting farm-wide issues.</li><li>• Network infrastructure limitations - In WANs with high latency or error rates, multiple farms may perform better than a single farm with multiple zones.</li><li>• Organizational security policies concerning server communications - Multiple farms may be required for regulatory compliance.</li><li>• Balance between reducing management overhead and increasing risk - For some environments the increased management overhead associated with multiple farms is outweighed by the decreased risk.</li></ul> <p>For more information, please refer to Citrix eDocs – <a href="#">Deciding How Many Farms to Deploy</a>.</p> | XA 6.x     |
| Number of Zones | <p>In general, Citrix recommends using the fewest number of zones possible, with one being optimal. If all farm servers are in one location, configuring only one zone for the farm does not reduce performance or make the farm harder to manage. However, in large networks, such as organizations with data centers on different continents, grouping geographically-related servers in zones can improve farm performance.</p> <p>For more information, please refer to Citrix eDocs – <a href="#">Designing Zones for a XenApp Deployment</a>.</p>   | XA 6.x     |
| Dedicated Zone  | <p>A data collector is a server that hosts an in-memory database that maintains dynamic information about</p>   | XA 6.x     |

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| <p>Data Collectors / XML Brokers</p> | <p>the servers in the zone, such as server loads, session status, published applications, users connected, and license usage. Data collectors receive incremental data updates and queries from servers within the zone. Data collectors relay information to all other data collectors in the farm. The use of dedicated Zone Data Collectors helps to improve the performance of the user logon process and administrative tasks during period of high load.</p> <p>The Citrix XML Broker functions as an intermediary between the other servers in the farm and the Web Interface. When a user authenticates to the Web Interface, the XML Broker:</p> <ol style="list-style-type: none"> <li>1. Receives the user’s credentials from the Web Interface and queries the server farm for a list of published applications that the user has permission to access. The XML Broker retrieves this application set from the Independent Management Architecture (IMA) system and returns it to the Web Interface.</li> <li>2. Upon receiving the user’s request to launch an application, the broker locates the servers in the farm that host this application and identifies which of these is the optimal server to service this connection based on several factors. The XML Broker returns the address of this server to the Web Interface.</li> </ol> <p>The following recommendations provide guidelines on when to implement dedicated Data Collectors and XML Brokers:</p> <ul style="list-style-type: none"> <li>• For XenApp Farms with more than 10 servers, implement a dedicated Zone Data Collector. This server is installed with the Controller Mode enabled, a Zone Election Preference of “Most Preferred” and does not host any user applications.</li> <li>• For XenApp Farms with more than 20 servers Citrix recommends implementing a dedicated Backup Zone Data Collector in addition to a dedicated Zone Data Collector. The Backup Zone Data Collector is also installed with Controller Mode enabled, a zone election preference of “Preferred” and should not be used to host any user applications.</li> <li>• Dedicated XML-Brokers should be implemented for all XenApp farms with more than 2,000</li> </ul> |  |
|--------------------------------------|--|--|

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|------------------------------------|---|---------------|
|                                    | <p>concurrent users or for farms where periods of heavy logon traffic is anticipated. Start with two dedicated XML-Brokers and scale out as required. Dedicated XML-Brokers are XenApp Servers which are installed with the Controller Mode enabled, have been assigned a default zone election preference, do not host any user applications and are used for Web Interface to XenApp farm communications.</p> <p>For more information, please refer to Citrix eDocs – <a href="#">To Configure Zones and Backup Data Collectors</a></p>   |               |
| <p>Session-Only Mode</p>           | <p>XenApp 6.5 introduces a new model for XenApp servers, referred to as Session Only mode to help improve on IMA and data store performance during farm joins and Local Host Cache (LHC) synchronization. The XenApp server mode specifies whether the server can only host sessions (Session Only Mode) or if it can also perform the controller functions of being elected a data collector and hosting the XML broker role (Controller Mode). Therefore, only those servers which could be Zone Data Collectors or XML Brokers should be configured in Controller Mode. For more information, please refer to Citrix eDocs – <a href="#">XenApp Server Mode</a>.</p> | <p>XA 6.x</p> |
| <p>Order of hotfix deployments</p> | <p>The order of hotfix deployments is very important, especially in large or complex farm configurations. Citrix recommends the following order of deployment:</p> <ol style="list-style-type: none"> <li>1. Zone data collector</li> <li>2. Backup zone data collectors</li> <li>3. Member servers</li> </ol> <p>For more information, please refer to CTX120842 - <a href="#">Best Practices for Citrix XenApp Hotfix Rollup Pack Installation and Deployment</a></p>   | <p>XA 6.x</p> |
| <p>Configuration Logging</p>       | <p>The Configuration Logging feature tracks administrative changes made to the XenApp environment and should be enabled for all enterprise environments. By generating the reports that this feature makes available, it is possible to determine what changes were made, when they were made, and which administrators made them. This is especially useful when multiple administrators are modifying the configuration of a server farm. It also facilitates the identification and, if necessary, reversion of administrative changes.</p>  | <p>XA 6.x</p> |

## SQL Database

| Area              | Best Practice  | Applies To |
|-------------------|--|------------|
| SQL DB Redundancy | <p>The XenDesktop Controllers leverage the SQL database to store the static configuration as well as dynamic user session related information. Although existing connections will be unaffected, an outage of the SQL database will prevent new users from accessing a virtual desktop. Therefore the database should be made redundant by means of SQL Mirroring or Clustering.</p> <ul style="list-style-type: none"> <li> <b>Mirroring:</b> Database mirroring increases database availability with almost instantaneous failover. Database mirroring can be used to maintain a single standby database, or <i>mirror database</i>, for a corresponding production database that is referred to as the <i>principal database</i>. Database mirroring runs with either synchronous operation in high-safety mode, or asynchronous operation in high-performance mode. In high-safety mode with automatic failover (recommended for XenDesktop) a third server instance, known as a <i>witness</i>, is required, which enables the mirror server to act as a hot standby server. Failover from the principal database to the mirror database happens automatically and typically completed within a few seconds. It is a good practice to enable VM-level HA (or a similar automatic restart functionality) for at least the witness to ensure SQL service availability in case of a multi-server outage.         </li> <li> <b>Clustering:</b> Failover clustering provides high-availability support for an entire instance of SQL Server. A failover cluster is a combination of one or more nodes, or servers, with two or more shared disks. A SQL Server failover cluster instance appears on the network as a single computer, but has functionality that provides failover from one node to another if the current node becomes unavailable. The transition from one node to the other node is seamless for the clients connected to the cluster.         </li> </ul> <p>For test environments a third redundancy option “VM-level HA” can be used. VM-level HA only works with a virtual SQL Server, which needs to be marked for High Availability at the hypervisor layer. This means in case of an unexpected shutdown of the virtual machine or the underlying host, the hypervisor will try to restart the VM immediately on a different host. While “VM-level HA” can minimize downtimes</p> | XD 5.x     |

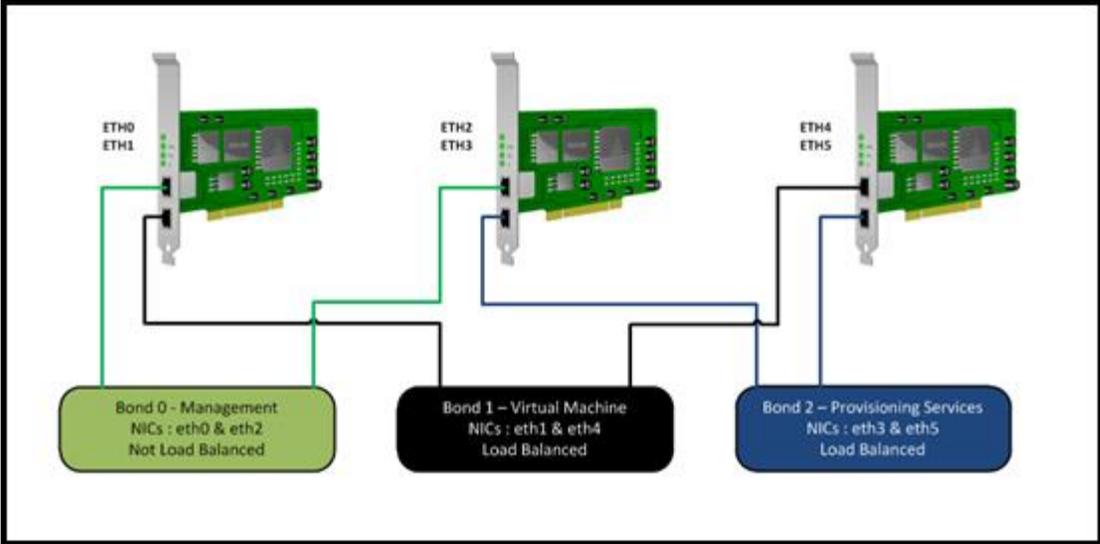
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|                  | <p>in power-outage scenarios, it cannot protect from OS level corruption.</p> <p>For more information, please refer to the following resources:</p> <ul style="list-style-type: none"> <li>• MSDN – <a href="#">SQL Server 2008 R2 High availability Solutions Overview</a></li> <li>• Citrix eDocs – <a href="#">XenDesktop High Availability Planning</a></li> <li>• CTX127939 – <a href="#">SQL Database Sizing and Mirroring</a></li> </ul>  |                  |
|                  | <p>The data store is a central repository for the static configuration of the XenApp farm. This includes items such as the configuration of published applications, worker groups and load evaluators. During normal farm operation, the data store is accessed every 30 minutes by each server to ensure their local host cache is current. The data store is also accessed if the farm configuration is modified or static information is requested by tools such as the Citrix AppCenter Console or other Citrix query-based utilities.</p> <p>The data store is not accessed when a user logs in, disconnects, or reconnects to the farm. All the information needed for a client to establish a connection to a XenApp server is stored in the Local Host Cache (LHC). If the data store is unavailable, users will still be able to connect to the XenApp farm. However, support staff will be unable to use the Citrix AppCenter Console or other Citrix query based utilities for any configuration changes. As such, SQL Mirroring or Clustering should be used to ensure that the data store is highly available. For more information, please refer to the Citrix Knowledgebase Article CTX111311 – <a href="#">Using SQL Database Mirroring to Improve Citrix XenApp Server Farm Disaster Recovery Capabilities</a>.</p> | XA 6.x           |
| SQL DB Backups   | <p>The XenDesktop and XenApp databases should be backed up at regular intervals to mitigate the impact from disasters and to reduce the size of the SQL transaction log. For more information, please refer to the Citrix Knowledgebase Article CTX126916 – <a href="#">XenDesktop 5 Database Transaction Log Growing Excessively</a>.</p>   | XD 5.x<br>XA 6.x |
| Database locking | <p>The XenDesktop Database can become heavily utilized under load (i.e. by executing get-brokerdesktopusage) in a large environment. Therefore Citrix recommends enabling the Read_Committed_Snapshot option on the XenDesktop database to remove contention on the database from read queries. This can improve the interactivity of Desktop Studio and Desktop Director. It should</p>   | XD 5.x           |

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|                        | <p>be noted that this option may increase the load on the tempdb files.</p> <p>The Read_Committed_Option can be enabled using the following command:<br/> ALTER DATABASE CitrixXenDesktopDB SET READ_COMMITTED_SNAPSHOT ON</p> <p><b>Note:</b> It may be necessary to switch the database to single-user mode to enable the Read_Committed_Option. If so, perform the steps:</p> <pre>ALTER DATABASE CitrixXenDesktopDB SET SINGLE_USER WITH ROLLBACK IMMEDIATE ALTER DATABASE CitrixXenDesktopDB SET READ_COMMITTED_SNAPSHOT ON ALTER DATABASE CitrixXenDesktopDB SET MULTI_USER</pre> <p><b>Note:</b> If a mirrored database is used, please refer to the Microsoft Blog Post – <a href="#">How to Enable RCSI for a Database with Database Mirroring</a>.</p> |        |
| SQL Server Scalability | <p>Sufficient resources should be assigned to the SQL Server, based on the results from scalability testing, to ensure that it does not become a bottleneck during periods of peak activity. Citrix has performed internal testing on the scalability of the SQL Server role and found that:</p> <ul style="list-style-type: none"> <li>• A physical SQL 2008 R2 server (2 x quad core 1.86GHz / 16GB RAM / HA Mirroring configuration) can support a XenDesktop site with more than 20,000 virtual desktops.</li> <li>• A virtual SQL 2008 R2 server (2 x vCPU / 4 GB RAM / HA Mirroring Configuration) can support a XenDesktop site with more than 2,500 virtual desktops.</li> </ul>   | XD 5.x |



## License Server

| Area                                  | Best Practice   | Applies To       |
|---------------------------------------|---|------------------|
| Citrix License Server - Redundancy    | <p>For typical environments (incl. enterprise grade) it is best practice to implement a single license server as a virtual machine or virtual appliance, which is configured for VM-level HA (automatic reboot). Although this can be seen as a single point of failure this does not impact the availability of the overall Citrix infrastructure, as every Citrix product supports a license server outage of up to 30 days without any decrease in functionality. Alternate options for license server HA are Clustering or Hot / Cold stand-by implementations. For more information, please refer to Citrix eDocs – <a href="#">Licensing Architecture Overview</a>.</p> <p><b>Note:</b> On XenApp servers the information required to provide the 30 day license grace period is stored locally on every server. In PVS based infrastructures, the relevant information is updated on every XenApp server during runtime, but reset back to the state stored within the vDisk upon reboot. In case the vDisk has not been in maintenance within the last 30 days, the license server fails and the XenApp servers are rebooted, no new user sessions can be established. Therefore, the MPS-WSXICA_MPS-WSXICA.ini should be redirected to a file share, as described within CTX131202 - <a href="#">Provisioned XenApp Servers Stop Accepting Connections if they are Restarted when the License Server is Unavailable</a>. This does not apply to XenDesktop infrastructures, due to differences in the license checkout architecture.</p> | XD 5.x<br>XA 6.x |
| Citrix License Server - Scalability   | <p>Scalability testing should be performed to ensure that the specification assigned to the Citrix License Server is capable of meeting the demands of the environment. Internal scalability testing indicates that a single Citrix license server (2 cores / 2GB RAM) can issue approximately 170 licenses per second or 306,000 licenses per 30 minutes.</p>  | XD 5.x<br>XA 6.x |
| Microsoft License Server - Redundancy | <p>Microsoft recommends implementing two Remote Desktop Services (RDS) License Servers with the licenses divided evenly between both machines for reasons of redundancy. The RDS servers can be specified using Microsoft Group Policy. In case the first license server contacted by the Session Host is not available or does not have licenses available the second license server will be contacted. The Group Policy setting is located at:</p> <ul style="list-style-type: none"><li>• Computer Configuration\Policies\Administrative Templates\Windows Components\Remote Desktop Services\Remote Desktop Session Host\Licensing</li></ul>  | XA 6.x           |

| Area  | Best Practice  | Applies To               |
|---|--|--------------------------|
| <p>Diversely Routed Network Connections</p> | <p>Many servers today are supplied with network cards offering two or more ports. As such, it is important that any bonds created consist of connections from two separate physical network cards so that a single card failure does not bring down the bond. The following diagram demonstrates how a host with three dual port network card can be configured to provide network bonds for management, virtual machine and provisioning traffic.</p>  | <p>XD 5.x<br/>XA 6.x</p> |
| <p>Quality of Service</p>                   | <p>Quality of Service (QoS) should be enabled on over-utilized WAN connections (upstream and downstream), to ensure a consistent level of performance for the Citrix ICA / HDX connections even during periods of heavy congestion. In order to achieve this, the TCP ports 1494 or 2598 should be included in the highest possible QoS service class. Please also consider ports being used for advanced features such as “Audio over UDP Real-time Transport” and “Multi-Stream ICA”.</p>  | <p>XD 5.x<br/>XA 6.x</p> |

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| End-to-End connection speed | <p>For optimal user performance, ensure that there is sufficient bandwidth and that network latency is kept to a minimum. Even short term LAN/WAN congestion can have a noticeable impact on performance.</p> <p>All network links related to the XenDesktop and XenApp environment should be monitored to ensure that bottlenecks are proactively detected. Common bottlenecks include the uplinks for blade switches or file servers, internet connections, WAN connections and connections between security zones or branch connections.</p>  | XD 5.x<br>XA 6.x |
| Speed and Duplex            | <p>For 10/100BASE-T networks, Citrix recommends hard-coding the speed and duplex settings for all ports (server and client) on the NIC and on the switch.</p> <p>For 1000/10GBASE-T networks, auto negotiation for speed and duplex settings is required as defined in RFC802.3-2008. For more information, please refer to RFC802.3-2008 – <a href="#">Local and Metropolitan Area Network Standards</a> (page 608 / chapter 28D.5).</p>  | XD 5.x<br>XA 6.x |
| DHCP Redundancy             | <p>Provisioned virtual desktops and XenApp servers rely on DHCP for the distribution of IP addresses. Therefore, it is vital to implement a highly available DHCP infrastructure using one or more of the following options:</p> <ul style="list-style-type: none"> <li>• A single active DHCP server with a “Cold Stand-by”</li> <li>• Two active DHCP servers with a “Split Scope”</li> <li>• DHCP Cluster or DHCP HA Appliances</li> </ul> <p>For more information, please refer to Microsoft TechNet – <a href="#">Design Options for DHCP Availability and Fault Tolerance</a>.</p> | XD 5.x<br>XA 6.x |
| DNS Redundancy              | <p>XenDesktop and XenApp environments require DNS for inter-component communication. Therefore, it is vital to configure a minimum of two DNS servers for each zone on every server and virtual desktop for reasons of redundancy.</p>   | XD 5.x<br>XA 6.x |
| DNS Dynamic Updates         | <p>XenDesktop requires a fully functioning DNS solution for the XenDesktop Controllers as well as the Virtual Desktops. As Virtual Desktops typically obtain IP addresses by means of dynamic DHCP the ability to dynamic update DNS A-Records is required.</p>  | XD 5.x<br>XA 6.x |



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| DNS Aliases | The XenDesktop and XenApp servers should be configured to use DNS Aliases when accessing infrastructure components such as the Citrix License Server and Database Server(s) rather than hostname or IP address. This helps to simplify management during certain maintenance and disaster recovery scenarios. For more information, please refer to the Citrix Blog - <a href="#">Simplify your XenApp\XenDesktop with DNS aliases</a> .   | XD 5.x<br>XA 6.x |
| Security    | Do not expose virtual desktops / XenApp servers or any infrastructural component of XenDesktop / XenApp directly to an untrusted network, such as the Internet. All connections which are used to transfer user credentials (i.e. end-point to Web Interface), should be secured by means of SSL encryption.   | XD 5.x<br>XA 6.x |
| Ports       | <p>Ensure the following TCP/UDP ports are open in between the XenDesktop infrastructure and/or client components.</p> <p><b>XenDesktop Controller → XenDesktop Controller / Infrastructure Servers</b></p> <ul style="list-style-type: none"> <li>• Citrix XenServer TCP 80/443</li> <li>• Microsoft Hyper-V TCP 8100</li> <li>• VMware vSphere TCP 443</li> <li>• XenDesktop Controller TCP 80/443</li> <li>• Citrix License Server TCP 7279 / 27000</li> <li>• SQL Database TCP 1433 / 1434</li> <li>• Domain Controller TCP 135, 139, 389</li> <li>• DNS TCP 53</li> </ul> <p><b>XenDesktop Controller ↔ Virtual Desktops</b></p> <ul style="list-style-type: none"> <li>• TCP 80, 135, 3389, 5985</li> </ul> <p><b>Virtual Desktops ↔ ICA Clients</b></p> <ul style="list-style-type: none"> <li>• TCP 1494, 2598</li> <li>• UDP 16500-16509</li> </ul> <p>For more information, please refer to CTX101810 – <a href="#">Communications Ports Used by Citrix Technologies</a>.</p> | XD 5.x<br>XA 6.x |



## Active Directory

| Area                            | Best Practice  | Applies To       |
|---------------------------------|--|------------------|
| Active Directory Configurations | <p>In general Citrix infrastructure components, virtual desktops and XenApp Servers should be located inside dedicated organizational units, to allow greater flexibility for applying Group Policies or other Active Directory related management tasks.</p> <p>Citrix recommends the following configuration for XenApp server farms with Active Directory:</p> <ul style="list-style-type: none"><li>• XenApp servers are in their own Organizational Units (OUs).</li><li>• Create OUs for Worker Groups (application silos), keeping servers from different Worker Groups organized in their own OUs. However, it is possible to create Worker Groups that span multiple OUs. Please note that XenApp Worker Groups which are based on OUs will reflect AD changes with a latency of up to 96 minutes. For more information, please refer to CTX124481 – <a href="#">Advanced Farm Administration with XenApp Worker Groups</a>.</li><li>• The server farm domain has no trust relationships with non-Active Directory domains, as this can affect operations requiring trusted domains.</li><li>• All servers reside in the same domain. However it is possible to span a farm across multiple trusting and non-trusting domains.</li><li>• The server farm is in a single Active Directory forest. If a farm has servers in more than one forest, users cannot log on by entering user principal names (UPNs). UPN logons use the format <i>username@UPN identifier</i>. With Active Directory, UPN logons do not require a domain to be specified, because Active Directory can locate full UPN logons in the directory. However, if the server farm has multiple forests, problems occur if the same UPN identifier exists in two domains in separate forests.</li></ul> <p>Citrix recommends the following configuration for XenDesktop environments with Active Directory:</p> <ul style="list-style-type: none"><li>• XenDesktop Controllers and virtual desktops are located in separate Organizational Units (OUs).</li><li>• XenDesktop Controllers and virtual desktops are located within the same Active Directory Forest.</li></ul> | XD 5.x<br>XA 6.x |

|                       |   |                  |
|-----------------------|---|------------------|
|                       | <p>However it is possible to span a XenDesktop environment across multiple forests.</p> <p>For more information, please refer to the following Citrix Knowledgebase and eDocs articles:</p> <ul style="list-style-type: none"> <li>• Citrix eDocs – <a href="#">Recommendations for Active Directory Environments (XenApp)</a></li> <li>• Citrix eDocs – <a href="#">Planning for Accounts and Trust Relationships</a></li> <li>• Citrix eDocs – <a href="#">Active Directory Considerations</a></li> <li>• CTX122417 – <a href="#">Using XenDesktop with multiple Active Directory Forests</a></li> </ul>  |                  |
| Loopback Policy       | <p>In case group policy based user configurations need to vary between the local endpoint device and a virtual desktop / XenApp Server, Citrix recommends using the “Group Policy Loopback Processing Mode”. This mode allows user configurations to be applied via GPOs that are linked to the OU of the computer object rather than the user object. To set user configuration per computer, follow these steps:</p> <ol style="list-style-type: none"> <li>1. In the Group Policy Microsoft Management Console (MMC), click Computer Configuration.</li> <li>2. Locate Administrative Templates, click System, click Group Policy, and then enable the Loopback Policy option.</li> </ol> <p>For more information, please refer to the Microsoft Knowledgebase Article KB231287 - <a href="#">Loopback processing of Group Policy</a>.</p> | XD 5.x<br>XA 6.x |
| Assigning Permissions | <p>Whenever possible, permissions (i.e. user rights, administrative access or application assignment) should be assigned to user groups rather than individual users. This will help to simplify the management of users and permissions.</p>   | XD 5.x<br>XA 6.x |



## Systems Management

| Area                           | Best Practice   | Applies To       |
|--------------------------------|---|------------------|
| Monitoring                     | <p>Scalability testing should be performed to determine the maximum number of users that can be supported without causing performance to be degraded past an acceptable threshold. Key metrics should be recorded during the scalability testing process to identify the maximum thresholds of the processor, memory, disk and network subsystems.</p> <p>All production infrastructure components, including virtual machines, virtualization hosts, storage infrastructure, and network appliances should be closely monitored at all times. Alerts should be configured based on the scalability testing results so that key personnel are alerted when key thresholds are exceeded.</p>             | XD 5.x<br>XA 6.x |
| Capacity Planning / Management | Results from the monitoring tools should be analyzed at regular intervals to ensure that sufficient infrastructure is in place to support business requirements. Proper capacity planning and management will help to ensure that business growth does not result in performance bottlenecks.   | XD 5.x<br>XA 6.x |
| Backup                         | <p>At a minimum, backup the following XenDesktop and XenApp components so that it is possible to recover from a complete failure:</p> <ul style="list-style-type: none"><li>• XenDesktop database</li><li>• XenApp database</li><li>• Provisioning Services database</li><li>• Provisioning Services vDisks (virtual desktops and XenApp servers)</li><li>• XenServer VM/Pool metadata (or equivalent for other hypervisors)</li><li>• Dedicated virtual desktops</li><li>• Web Interface configuration</li><li>• License files</li><li>• User profiles / home folders</li></ul> <p><b>Note:</b> To simplify the backup and restore process, user data should not be stored on the virtual desktops</p> | XD 5.x<br>XA 6.x |



|                     |   |                          |
|---------------------|---|--------------------------|
|                     | <p>or XenApp servers.</p> <p>It is assumed that there is a fast and automated rebuild process for the servers (XenDesktop Controller, XenApp server, Web Interface server, Provisioning Server, etc.). If this assumption is not true for your organization, all infrastructure servers must also be backed up.</p>   |                          |
| Backup Retention    | <p>The “Grandfather-Father-Son” principle should be followed for all Citrix related backups. Furthermore, monthly full backups (grandfather backups) should be retained for a period of at least six months at an offsite storage location so that Citrix data can be restored in the event that the onsite backups are destroyed. For more information, please refer to the following article <a href="#">Grandfather-Father-Son Backup</a>.</p>   | <p>XD 5.x<br/>XA 6.x</p> |
| Restore Test        | <p>A full disaster recovery restore test should be completed at least twice a year to verify the integrity of the backups and to ensure that the support staff are familiar with the process.</p>   | <p>XD 5.x<br/>XA 6.x</p> |
| XenDesktop Upgrades | <p>Citrix recommends the following steps when upgrading an existing XenDesktop site:</p> <ol style="list-style-type: none"> <li>1. Test the upgrade within a dedicated test environment</li> <li>2. Backup the XenDesktop site database</li> <li>3. Perform the upgrade of the production environment outside peak load times</li> <li>4. If necessary, upgrade the license server to ensure compatibility with the new version of XenDesktop</li> <li>5. Upgrade 50% of the XenDesktop Controllers</li> <li>6. Upgrade the XenDesktop database using XenDesktop Desktop Studio or the automatically created SQL scripts (Note: The upgrade of the database requires DB_Owner permissions)</li> <li>7. Upgrade the remaining XenDesktop Controllers</li> </ol> <p>For more information, please refer to the Citrix Knowledgebase Article CTX128748 – <a href="#">Best Practice for Upgrading a XenDesktop 5 Site</a>.</p> | <p>XD 5.x</p>            |
| Change Management   | <p>Most enterprise XenApp or XenDesktop deployments are administered by several individuals or teams which can make it challenging when trying to track down changes. Creating a change management plan within your organization makes it easier to pinpoint changes and makes troubleshooting more efficient. In addition, the Configuration Logging feature of XenApp can be enabled to record changes made within the management console for later viewing.</p>  | <p>XD 5.x<br/>XA 6.x</p> |
| Test Environment    | <p>Citrix strongly recommends implementing a full test environment that matches the production</p>  | <p>XD 5.x</p>            |

|  |   |               |
|--|---|---------------|
|  | <p>environment as closely as possible. This environment should not only include the servers, but items such as switches, routers, firewalls, NAT devices, and LAN/WAN simulation equipment. Without a dedicated test environment, it is not possible to thoroughly test changes and scenarios. Citrix recommends the following testing strategy:</p> <ul style="list-style-type: none"> <li> <p>• <b>Development.</b> The development infrastructure exists outside of the production network. Typically it consists of short-lived virtual machines, whose configuration should match the configuration in production as closely as possible. The purpose of the development phase is to provide change requestors a non-production environment to perform proof of concepts, determine integration requirements and perform iterative testing as part of a discovery phase to making changes. Proposed changes should be documented so they can be applied in the test phase.</p> </li> <li> <p>• <b>Test.</b> The test environment is a standalone 1:1 copy of the production infrastructure and is used to confirm that the proposed changes can be easily repeated prior to the pre-production staging environment. The changes made should follow exactly from the documentation provided from discoveries made in the development stages. If testing fails within the testing stage, the architect must determine the severity of failure and determine whether minor updates to documentation is sufficient or a full development cycle is needed.</p> </li> <li> <p>• <b>Pre-Production.</b> The staging environment can be co-located with the production environment, as the changes should be tightly managed. The goal of staging is to implement the proposed changes with little risk or uncertainty. It is expected that any changes made to the staging infrastructure have been tested and documented for repeatability. There should not be any iterations or adjustments required within this phase. For updates, the starting point for all systems in the staging environment should be the current production status. However for new deployments, the architect will determine the appropriate start point; whether an existing system or newly created. During this phase, User Acceptance Testing (UAT) should be performed.</p> </li> <li> <p>• <b>Production.</b> The production environment is the fully redundant and scalable solution for normal usage of the XenDesktop and XenApp environments.</p> </li> </ul> | <p>XA 6.x</p> |
|--|---|---------------|



|                          |  |                  |
|--------------------------|--|------------------|
| Maintenance Tasks        | <p>Regular maintenance of the XenDesktop and XenApp environment should be completed (daily, weekly, monthly and yearly) to ensure that the environment is operating at its full potential. Typical tasks include:</p> <ul style="list-style-type: none"><li>• Event Log and Alert Review</li><li>• Reboot Schedule Check</li><li>• Configuration Logging Review</li><li>• Hotfix Review</li><li>• Printer Driver Review</li><li>• Plugin Upgrade</li><li>• Certificate Replacement</li><li>• Capacity Assessment</li><li>• Backup Restoration Test</li></ul> <p>For more information, please refer to the Citrix Knowledgebase Article CTX133786 – <a href="#">Operations Guide - Support and Maintenance Citrix Desktop and Datacenter</a>.</p> | XD 5.x<br>XA 6.x |
| Delegated Administration | <p>Delegated administration should be implemented for all high-security environments to ensure that admin privileges are restricted based on role. This will help to improve security and reduce incorrect configurations within the environment.</p>  | XD 5.x<br>XA 6.x |
| Naming Scheme            | <p>A standard naming convention should be defined for all key infrastructure components, including servers, databases and service accounts which identifies the role or function, location and affiliation of the component.</p> <p>Further guidance for server name schemes can be found within KB909264 - <a href="#">Naming conventions in Active Directory for computers, domains, sites, and OUs</a>.</p>   | XD 5.x<br>XA 6.x |
| Automated Server Build   | <p>An automated server build process should be developed for all server roles of a Citrix infrastructure, regardless if Provisioning Services or a traditional ESD solution is used. Doing so ensures a fast and consistent build process and helps to simplify server management and troubleshooting.</p>   |                  |

# Hardware

## General

| Area                               | Best Practice  | Applies To       |
|------------------------------------|--|------------------|
| Scale Up/Out                       | <p>The decision to scale up (add more resources to a single host) or scale out (add additional hosts) should be based on the amount of space available, tolerance to risk, cooling/power capacity and maintenance/hardware or hosting costs. With due consideration for specific requirements, Citrix generally recommends scaling out rather than up in most situations.</p>  | XD 5.x<br>XA 6.x |
| Address Space Layout Randomization | <p>Address Space Layout Randomization (ASLR) protects against buffer overrun attacks by loading system code and applications into different locations within memory. For more information, please refer to the Microsoft Blog – <a href="#">Windows 7 and Windows 2008 R2 SP1 add new Virtualization Innovations</a>.</p> <p>As many organizations try to protect their XenApp servers and virtual desktops from viruses, malware and other operating system exploits, it is advisable to keep ASLR enabled, which is the default setting. ASLR functionality is included with Windows 2008, Windows 2008 R2, Windows Vista and Windows 7.</p>   | XD 5.x<br>XA 6.x |
| High Availability                  | <p>Each group of virtualization hosts should include at least one additional host (N+1) so that a single server failure does not cause resource contention. This ensures that rolling upgrades and maintenance windows can be planned without impacting production workloads.</p> <p>The hardware selected for the virtualization hosts should have sufficient internal redundancy to meet the requirements of the business, including disk, power, cooling, storage and network connections. Depending on requirements, it may be necessary to offer different levels of redundancy per virtualization pool. Business Service Level Agreements may for example, dictate that some pools must provide high levels of performance during server outages, whereas for others, it may be acceptable to run a degraded service for a short period of time. Resource Pool design for Citrix XenServer should reflect these requirements.</p> <p>When multiple virtual machines exist for each server role (Web Interface, Zone Data Collectors, XenDesktop Controllers, SQL Servers, etc.) ensure that they are not all hosted on the same physical</p> | XD 5.x<br>XA 6.x |

|                | <p>virtualization host. This will help to ensure that the failure of a single virtualization host does not result in a service outage. In addition, the physical virtualization hosts supporting the core infrastructure components should ideally be located in different chassis/racks.</p>   |                  |          |             |                       |             |                       |       |            |   |          |     |       |           |   |          |      |      |        |            |   |          |      |     |           |   |          |       |     |       |            |   |        |       |     |           |   |      |       |     |        |
|----------------|---|------------------|----------|-------------|-----------------------|-------------|-----------------------|-------|------------|---|----------|-----|-------|-----------|---|----------|------|------|--------|------------|---|----------|------|-----|-----------|---|----------|-------|-----|-------|------------|---|--------|-------|-----|-----------|---|------|-------|-----|--------|
| CPU Overcommit | <p>The processor requirements of the virtual machines should not exceed the combined CPU processing capacity of the host. Furthermore the effective CPU utilization of the host should not exceed 80% during normal operations. If the host CPU capacity is overloaded, the performance of individual virtual machines will be degraded. Furthermore it is important to allocate resources (i.e. 1 core / 2GB RAM) for the hypervisor itself.</p>   | XD 5.x<br>XA 6.x |          |             |                       |             |                       |       |            |   |          |     |       |           |   |          |      |      |        |            |   |          |      |     |           |   |          |       |     |       |            |   |        |       |     |           |   |      |       |     |        |
|                | <p>The majority of XenDesktop deployments use a CPU overcommit ratio of between 4:1 and 8:1. However, some high-performance virtual desktops may require multiple physical CPUs per virtual desktop. Extensive scalability testing should be performed prior to production to identify an appropriate virtual to physical CPU ratio. The following table outlines the initial virtual machine recommendations for virtual desktops.</p> <table border="1" data-bbox="543 760 1673 1110"> <thead> <tr> <th>User Category</th> <th>OS</th> <th>vCPU</th> <th>RAM</th> <th>IOPS (est.)</th> <th>Users per Core (est.)</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Light</td> <td>Windows XP</td> <td>1</td> <td>1-1.5 GB</td> <td>3-5</td> <td>10-12</td> </tr> <tr> <td>Windows 7</td> <td>1</td> <td>1-1.5 GB</td> <td>5-10</td> <td>8-10</td> </tr> <tr> <td rowspan="2">Normal</td> <td>Windows XP</td> <td>1</td> <td>1-1.5 GB</td> <td>6-10</td> <td>7-9</td> </tr> <tr> <td>Windows 7</td> <td>2</td> <td>1.5-2 GB</td> <td>10-20</td> <td>5-7</td> </tr> <tr> <td rowspan="2">Heavy</td> <td>Windows XP</td> <td>2</td> <td>2-4 GB</td> <td>20-40</td> <td>2-4</td> </tr> <tr> <td>Windows 7</td> <td>2</td> <td>4 GB</td> <td>25-50</td> <td>2-4</td> </tr> </tbody> </table> <p>For more information, please refer to the Citrix Knowledgebase Article CTX127277 – <a href="#">Hosted VM-Based Resource Allocation</a>.</p> | User Category    | OS       | vCPU        | RAM                   | IOPS (est.) | Users per Core (est.) | Light | Windows XP | 1 | 1-1.5 GB | 3-5 | 10-12 | Windows 7 | 1 | 1-1.5 GB | 5-10 | 8-10 | Normal | Windows XP | 1 | 1-1.5 GB | 6-10 | 7-9 | Windows 7 | 2 | 1.5-2 GB | 10-20 | 5-7 | Heavy | Windows XP | 2 | 2-4 GB | 20-40 | 2-4 | Windows 7 | 2 | 4 GB | 25-50 | 2-4 | XD 5.x |
| User Category  | OS  | vCPU             | RAM      | IOPS (est.) | Users per Core (est.) |             |                       |       |            |   |          |     |       |           |   |          |      |      |        |            |   |          |      |     |           |   |          |       |     |       |            |   |        |       |     |           |   |      |       |     |        |
| Light          | Windows XP  | 1                | 1-1.5 GB | 3-5         | 10-12                 |             |                       |       |            |   |          |     |       |           |   |          |      |      |        |            |   |          |      |     |           |   |          |       |     |       |            |   |        |       |     |           |   |      |       |     |        |
|                | Windows 7   | 1                | 1-1.5 GB | 5-10        | 8-10                  |             |                       |       |            |   |          |     |       |           |   |          |      |      |        |            |   |          |      |     |           |   |          |       |     |       |            |   |        |       |     |           |   |      |       |     |        |
| Normal         | Windows XP  | 1                | 1-1.5 GB | 6-10        | 7-9                   |             |                       |       |            |   |          |     |       |           |   |          |      |      |        |            |   |          |      |     |           |   |          |       |     |       |            |   |        |       |     |           |   |      |       |     |        |
|                | Windows 7   | 2                | 1.5-2 GB | 10-20       | 5-7                   |             |                       |       |            |   |          |     |       |           |   |          |      |      |        |            |   |          |      |     |           |   |          |       |     |       |            |   |        |       |     |           |   |      |       |     |        |
| Heavy          | Windows XP  | 2                | 2-4 GB   | 20-40       | 2-4                   |             |                       |       |            |   |          |     |       |           |   |          |      |      |        |            |   |          |      |     |           |   |          |       |     |       |            |   |        |       |     |           |   |      |       |     |        |
|                | Windows 7   | 2                | 4 GB     | 25-50       | 2-4                   |             |                       |       |            |   |          |     |       |           |   |          |      |      |        |            |   |          |      |     |           |   |          |       |     |       |            |   |        |       |     |           |   |      |       |     |        |

|  | <p>The vCPUs allocated to the XenApp servers should not exceed the logical cores within the given hardware. Experience has shown that greater levels of scalability are achieved by not overcommitting the CPU. The following table outlines the initial virtual machine recommendations for XenApp servers.</p> <table border="1" data-bbox="613 344 1602 808"> <thead> <tr> <th>Sockets</th> <th>Cores / Sockets</th> <th>Cores / Server</th> <th>VM Count</th> <th>vCPU per VM</th> <th>RAM per VM</th> </tr> </thead> <tbody> <tr> <td colspan="6">32-bit Operating Systems (Windows 2003, Windows 2008)</td> </tr> <tr> <td>2</td> <td>2</td> <td>4</td> <td>2</td> <td>2</td> <td>4</td> </tr> <tr> <td>2</td> <td>4</td> <td>8</td> <td>2</td> <td>4</td> <td>4</td> </tr> <tr> <td>4</td> <td>4</td> <td>16</td> <td>4</td> <td>4</td> <td>4</td> </tr> <tr> <td colspan="6">64-bit Operating Systems (Windows 2003, Windows 2008, Windows 2008 R2)</td> </tr> <tr> <td>2</td> <td>2</td> <td>4</td> <td>2</td> <td>2</td> <td>8</td> </tr> <tr> <td>2</td> <td>4</td> <td>8</td> <td>2</td> <td>4</td> <td>16</td> </tr> <tr> <td>4</td> <td>4</td> <td>16</td> <td>4</td> <td>4</td> <td>16</td> </tr> </tbody> </table> <p>For more information, please refer to the Citrix Knowledgebase Article CTX129761 – <a href="#">XenApp Virtualization Best Practices</a>.</p> | Sockets        | Cores / Sockets | Cores / Server | VM Count   | vCPU per VM | RAM per VM | 32-bit Operating Systems (Windows 2003, Windows 2008) |  |  |  |  |  | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 4 | 8 | 2 | 4 | 4 | 4 | 4 | 16 | 4 | 4 | 4 | 64-bit Operating Systems (Windows 2003, Windows 2008, Windows 2008 R2) |  |  |  |  |  | 2 | 2 | 4 | 2 | 2 | 8 | 2 | 4 | 8 | 2 | 4 | 16 | 4 | 4 | 16 | 4 | 4 | 16 | XA 6.x |
|--|--|----------------|-----------------|----------------|------------|-------------|------------|---|--|--|--|--|--|---|---|---|---|---|---|---|---|---|---|---|---|---|---|----|---|---|---|--|--|--|--|--|--|---|---|---|---|---|---|---|---|---|---|---|----|---|---|----|---|---|----|--------|
| Sockets  | Cores / Sockets  | Cores / Server | VM Count        | vCPU per VM    | RAM per VM |             |            |   |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |    |   |   |    |   |   |    |        |
| 32-bit Operating Systems (Windows 2003, Windows 2008)                  |  |                |                 |                |            |             |            |   |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |    |   |   |    |   |   |    |        |
| 2  | 2  | 4              | 2               | 2              | 4          |             |            |   |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |    |   |   |    |   |   |    |        |
| 2  | 4  | 8              | 2               | 4              | 4          |             |            |   |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |    |   |   |    |   |   |    |        |
| 4  | 4  | 16             | 4               | 4              | 4          |             |            |   |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |    |   |   |    |   |   |    |        |
| 64-bit Operating Systems (Windows 2003, Windows 2008, Windows 2008 R2) |  |                |                 |                |            |             |            |   |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |    |   |   |    |   |   |    |        |
| 2  | 2  | 4              | 2               | 2              | 8          |             |            |   |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |    |   |   |    |   |   |    |        |
| 2  | 4  | 8              | 2               | 4              | 16         |             |            |   |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |    |   |   |    |   |   |    |        |
| 4  | 4  | 16             | 4               | 4              | 16         |             |            |   |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |    |   |   |    |   |   |    |        |
| Memory Overcommit / Dynamic Memory                                     | <p>Memory overcommit can be used to increase the number of virtual desktops that each virtualization host can support. Memory overcommit automatically adjusts the memory of running virtual machines between specified minimum and maximum values. This allows virtual machines to borrow/lend additional memory when required. Overcommitting memory by a large percentage will often result in a poor user experience as more RAM must be paged to disks, which are much slower than RAM. Many organizations have been able to overcommit memory by 5-10% without a noticeable impact to the users. Plus, using memory overcommit is a great way to deal with fault tolerance. For example, in a failure situation, more desktops could be hosted on fewer hosts if memory overcommit is used. There might be a performance hit for the desktops, but it is only during a failure situation. For more information, please refer to the Citrix Blog – <a href="#">Safe Practice for Memory Overcommit</a>.</p>   | XD 5.x         |                 |                |            |             |            |   |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |    |   |   |    |   |   |    |        |
|  | <p>As users are dynamically load balanced across XenApp servers, memory usage between servers should be similar, helping negate the need for dynamic memory allocation techniques. Also, if virtual machine</p>  | XA 6.x         |                 |                |            |             |            |   |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |    |   |   |   |  |  |  |  |  |  |   |   |   |   |   |   |   |   |   |   |   |    |   |   |    |   |   |    |        |

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|                            | <p>migration strategies are used, this could cause memory overcommit resulting in aggressive paging and poor performance across all XenApp virtual machines. Therefore, it is advisable to set fixed values for the memory reservations of virtual XenApp servers. For more information, please refer to the Citrix Knowledgebase Article CTX129761 – <a href="#">XenApp Virtualization Best Practices</a>.</p>   |                          |
| <p>Pool/Cluster Design</p> | <p>Creating separate virtualization pools for the XenApp servers, virtual desktops and infrastructure servers helps to simplify load balancing and ensures that the virtual desktops don't impact the performance of key infrastructure roles (AD, SQL, XenDesktop Controllers, Zone Data Collectors, etc.). In addition, separate virtualization pools allow for the High Availability features of the hypervisor to be tailored to the specific requirements of either desktops or servers. For example, if VM-level HA is not required for virtual desktops, the entire desktop pool can be built without the High Availability features enabled, which can result in substantial savings on hypervisor license costs.</p>   | <p>XD 5.x<br/>XA 6.x</p> |
| <p>Network Connections</p> | <p>The virtualization host's networking resources are shared by the virtual machines it supports. If insufficient bandwidth exists, users will experience a degraded level of performance. As such, Citrix recommends the use of fast network cards and switches (1Gbps or greater) to help address this concern.</p> <p>If sufficient infrastructure exists, performance may be improved by separating different types of network traffic across multiple physical NICs, for example management, virtual machine, storage, provisioning and backup traffic can all be isolated from each other. The actual configuration will vary depending on the characteristics of the deployment and the number of network cards available. The following configurations provide a reference point for XenServer implementations based on the number of network cards available:</p> <p>2 x NICs –</p> <ul style="list-style-type: none"> <li>• 2 x NICs (bonded) – management, storage, virtual machine, provisioning, backup</li> </ul> <p>4 x NICs –</p> <ul style="list-style-type: none"> <li>• 2 x NICs (bonded) – management, provisioning and virtual machine</li> <li>• 2 x NICs (bonded) – storage (iSCSI /NFS) and backup</li> </ul> <p>6 x NICs –</p> | <p>XD 5.x<br/>XA 6.x</p> |

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|                                 | <ul style="list-style-type: none"> <li>• 2 x NICs (bonded) – management and virtual machine</li> <li>• 2 x NICs (bonded) – provisioning</li> <li>• 2 x NICs (bonded) – storage (iSCSI / NFS) and backup</li> </ul> <p>8 x NICs –</p> <ul style="list-style-type: none"> <li>• 2 x NICs (bonded) for virtual machine</li> <li>• 2 x NICs (bonded) for management/HA</li> <li>• 2 x NICs (bonded) for storage (iSCSI / NFS) and backup</li> <li>• 2 x NICs (bonded) for provisioning</li> </ul> <p>The recommendations above are specific to hosts which contain multiple 100Mb or 1Gbps NICs. If hosts are configured with 10Gb network cards, then it is likely that VLANs will be used to segregate virtual machine, provisioning and backup traffic. Citrix XenServer 'management' traffic cannot however, be subject to 802.1q VLAN tagging and must use the default/native VLAN. With the evolution of technologies such as HP Virtual Connect or Cisco UCS it is also possible to configure multiple virtualized NICs, assigned variable amounts of bandwidth from an overall 10Gb maximum. In these situations, the virtualized NICs are typically fully redundant and do not require further protection at the hypervisor layer.</p> |                          |
| <p>Power Management Options</p> | <p>Power Management features reduce the CPU Core Speed, which can save power but also negatively impact the performance of virtual guests by increasing CPU and/or memory latency. Therefore it is recommended to disable any power saving features, such as C-States, C1E-Support or Speedstep. Furthermore, BIOS controlled power management programs (i.e. Dynamic Power Savings Mode (HP) or Power Management Mode – Balanced (Dell)) should be disabled or set to “Maximum Performance”.</p>   | <p>XD 5.x<br/>XA 6.x</p> |
| <p>Hyper-Threading</p>          | <p>Hyper-threading is a technology developed by Intel that enables a single physical processor to appear as two logical processors. Hyper-threading has the potential to improve the performance of workloads by increasing user density per VM (XenApp only) or VM density per host (XenApp and XenDesktop). For other types of workloads, it is critical to test and compare the performance of workloads with Hyper-threading and without Hyper-threading. In addition, Hyper-threading should be configured in conjunction with the vendor-specific hypervisor tuning recommendations. It is highly recommended to use new generation server hardware and processors (e.g. Nehalem+) and the latest version of the hypervisors to</p>   | <p>XD 5.x<br/>XA 6.x</p> |

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|                        | <p>evaluate the benefit of Hyper-threading. The use of hyper-threading will typically provide a performance boost of between 20-30%.</p>  |               |
| <p>General Storage</p> | <p>The storage infrastructure is a vital component of every virtual desktop environment, which can cause severe stability and performance issues if not designed properly. The following list provides the most important storage best practices:</p> <ul style="list-style-type: none"> <li>• A storage device must be setup in a fully redundant manner. This means all components (i.e. network ports &amp; links, storage controllers, power adapters or RAID controllers) should be fault tolerant.</li> <li>• LUNs accessed by means of Fibre Channel or iSCSI should not host disks for more than 20-30 virtual machines, in order to avoid read/write latency caused by SCSI reservations or SCSI queuing. For environments based on VMware vSphere 5.x and a VAAI-capable storage array, the maximum number of virtual machines per LUN should not exceed 75.</li> <li>• Workloads with high I/O footprints (i.e. large database systems) should not be hosted on the same set of disk spindles as the virtual desktops.</li> <li>• The file systems of all layers (i.e. virtual machine, hypervisor, storage) must be fully aligned.</li> </ul> <p>For more information, please refer to the following Citrix Knowledgebase Articles and Blog:</p> <ul style="list-style-type: none"> <li>• CTX118397 – <a href="#">Introduction to Storage Technologies</a></li> <li>• CTX130632 – <a href="#">Storage Best Practices</a></li> <li>• Blog Post – <a href="#">Sizing LUNs – A Citrix perspective</a></li> </ul> | <p>XD 5.x</p> |



## Citrix XenServer

| Area                   | Best Practice   | Applies To       |
|------------------------|---|------------------|
| Configuration Maximums | <p>A XenServer deployment should not exceed the stated configuration limits. A selection of important configuration maximums are defined below (valid for XenServer 6.1 at the time of writing):</p> <ul style="list-style-type: none"><li>• Concurrent general-purpose VMs per host: 150*</li><li>• Concurrent virtual desktop VMs per host: 150*</li><li>• Concurrent virtual desktop VMs using IntelliCache per host: 150*</li><li>• Concurrent protected VMs per host with HA enabled: 60*</li><li>• Hosts per Pool: 16<sup>+</sup></li></ul> <p>* For systems running more than 50 VMs it is recommended that 2940MB of RAM is allocated to dom0 (See CTX134951 – <a href="#">Configuring Dom0 Memory in XenServer 6.1</a> for more details). The maximum number of VMs/host supported is dependent on virtual machine workload, system load, and certain environmental factors. Citrix reserves the right to determine what specific environmental factors affect the maximum limit at which a system can function.</p> <p>+ Although Citrix supports up to 16 virtualization hosts per XenServer resource pool, experience has shown that restricting resource pools that use Machine Creation Services to eight hosts and resource pools that use Provisioning Services to 12 hosts offer the best results.</p> <p>For more information, please refer to the Citrix Knowledgebase Article <a href="#">CTX134789 – XenServer 6.1 Configuration Limits</a>.</p> <p>Please find information in regards to the Configurations Maximums for XenServer 6.0 in CTX131047 - <a href="#">XenServer 6.0 Configuration Limits</a>.</p> <p>Note: These configuration maximums are theoretical values that may vary according to the characteristics of the environment.</p> | XD 5.x<br>XA 6.x |



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| Optimize for XenApp        | On systems utilizing pre-Nehalem processors, the XenServer setting “Optimize for XenApp” provided increased scalability. Since the release of the Nehalem processors, this functionality is now provided at the hardware layer (Intel EPT / AMD RVI). As such, this XenServer setting should not be enabled for hosts with state of the art processors.   | XA 6.x           |
| Control Domain Scalability | With XenServer 5.6 Feature Pack 1 and above the XenServer Control Domain (Dom0) can make use of multiple cores (default is 4), significantly increasing the Control Domain and Resource Pool scalability. XenDesktop deployments typically consist of a large number of virtual machines, which implies a high Control Domain load, therefore XenServer 5.6 Feature Pack 1 or higher should be used. For more information, please refer to the Citrix Blog – <a href="#">Tuning XenServer for maximum Scalability</a> .   | XD 5.x           |
| Receive-Side Copy          | <p>Since XenServer 6.0, the XenServer Control Domain (Dom0) is able to offload network traffic handling tasks to the virtual guests. While this helps to free up Dom0 vCPU resources it can decrease the maximum VM-level network throughput. Therefore, Citrix recommends:</p> <ul style="list-style-type: none"> <li>• When virtualizing a large numbers of small virtual machines (i.e. virtual desktops) on each host, leave the Receive-Side Copy functionality enabled.</li> <li>• When virtualizing a small number of powerful virtual machines (i.e. Provisioning servers), which need maximum network throughput, disable Receive-Side Copy. RSC can be disabled per virtual guest using the following registry key: <ul style="list-style-type: none"> <li>○ HKLM\SYSTEM\CurrentControlSet\services\xenvif\Parameters <ul style="list-style-type: none"> <li>▪ “ReceiverMaximumProtocol” = 0 (DWORD)</li> </ul> </li> </ul> </li> </ul> | XD 5.x<br>XA 6.x |
| VM High Availability       | <p>XenServer HA should be enabled so that the Pool Master role will be automatically transferred between hosts in the event of a failure.</p> <p>In two-host resource pools, ensure that the management and storage communication uses a separate physical network to avoid the possibility of host fencing in the event of a network failure. If this can’t be accomplished, a three-host pool may be required. For more information, please refer to the Citrix Knowledgebase Article CTX119717 – <a href="#">XenServer High Availability</a>.</p>  | XD 5.x<br>XA 6.x |
|                            | Pooled virtual desktops should not be configured to automatically restart as this will conflict with the  | XD 5.x           |

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|                            | power operation commands issued by the XenDesktop Controllers.   |        |
|                            | The XenApp servers should be configured with a high-availability priority of 'Restart if Possible' so that sufficient resources and are available to support the users.  | XA 6.x |
| XenDesktop Host Connection | If the XenServer pool master becomes unavailable, the XenDesktop Controllers will be unable to manage the power state of the virtual machines in the affected pool. A typical side effect would be that desktop groups could run out of available powered-on desktops and new users may be unable to connect. To avoid this scenario, each XenServer resource pool should be configured for high availability so that a new pool master can be automatically elected. Every pool member is capable of redirecting pool management requests to the pool master, via http redirects, so also ensure that XenDesktop is configured to communicate with multiple XenServer hosts within each pool. Configuring multiple XenServer hosts within each pool will have no effect if the pool master becomes unavailable and high availability is not enabled for the pool. | XD 5.x |



## Microsoft Hyper-V (based on Windows Server 2008 R2)

| Area                         | Best Practice  | Applies To       |
|------------------------------|--|------------------|
| Configuration Maximums       | <p>A Hyper-V / System Center Virtual Machine Manager (SCVMM) infrastructure should never exceed the configuration maximums outlined by Microsoft. A selection of important configuration maximums are defined below (valid at time of writing):</p> <ul style="list-style-type: none"><li>• Concurrent VMs per host: 384</li><li>• Concurrent VMs per Cluster: 1000</li><li>• Hosts per Cluster: 16</li><li>• Max. vCPUs per logical processor: 12:1 (when Windows 7 guests only) / 8:1 (otherwise)</li><li>• Hosts per SCVMM Server: 400*</li><li>• Running VMs per SCVMM Server: 8000**</li></ul> <p>* For SCVMM 2008 implementations with more than 150 Hyper-V Hosts Microsoft strongly recommends enabling the server-optimized Garbage Collector (please refer to the best practice below for implementation details)</p> <p>** Citrix has found that the best performance is achieved when each VMM server is limited to managing 2000 virtual desktops.</p> <p>For more information, please refer to the following articles:</p> <ul style="list-style-type: none"><li>• Microsoft TechNet - <a href="#">Requirements and Limits for Virtual Machines and Hyper-V in Windows Server 2008 R2</a></li><li>• Microsoft TechNet - <a href="#">Supported Configurations for SCVMM</a></li></ul> <p>Note: These configuration maximums are theoretical values that may vary according to the characteristics of the environment.</p> | XD 5.x<br>XA 6.x |
| SCVMM 2008 High Availability | <p>If the VMM server is unavailable, XenDesktop will not be able to manage the power state of the virtual desktops that it manages or create additional virtual desktops. Therefore, Microsoft Failover Clustering should be included in the design to ensure that the VMM server is highly available. For more</p>  | XD 5.x<br>XA 6.x |

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|                     | information, please refer to the Microsoft Blog Post – Creating a Highly Available VMM server.  |                          |
| Windows Power Plans | <p>Enabling the “High performance” power plan on every Hyper-V server ensures that the processors run at the highest performance state. For resource intensive workloads (i.e. Hyper-V) the default power plan - “Balanced” may cause performance issues and increase the average response time of tasks.</p> <p>To change a power plan:</p> <ol style="list-style-type: none"> <li>1. Click on Start and then Control Panel.</li> <li>2. From the list of displayed item under Control Panel click on Power Options, which takes you to the Select a power plan page. If you do not see Power Options, type the word 'power' in the Search Control Panel box and then select Chose a power plan.</li> <li>3. By default, the option to change power plans is disabled. To enable this, click the ‘Change settings that are currently unavailable’ link.</li> <li>4. Select the ‘High Performance’ option</li> <li>5. Close the ‘Power Option’ window.</li> </ol> <p>For more information, please refer to the Microsoft knowledge base article KB2207548 - <a href="#">Degraded overall performance on Windows Server 2008 R2</a>.</p> | <p>XD 5.x<br/>XA 6.x</p> |
| Virtual Disk Format | <p>Fixed size virtual disks (VHD) should be used for all Hyper-V based virtual machines because they offer significantly better write performance than dynamically expandable VHDs. For more information, please refer to the Microsoft Whitepaper - <a href="#">Virtual Hard Disk Performance</a>.</p>   | <p>XD 5.x<br/>XA 6.x</p> |

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| <p>Synthetic NICs</p>     | <p>Hyper-V features a synthetic network adapter that uses significantly less processor overhead than the emulated network adapter that mimics existing hardware. The synthetic network adapter communicates between the child and root partitions over the VMBus by using shared memory for more efficient data transfer.</p> <p><b>Note:</b> Synthetic NICs do not support PXE boot, which is required for Provisioning Services Target Devices.</p> <p>For more information, please refer to the following documents:</p> <ul style="list-style-type: none"> <li>• Microsoft MSDN - <a href="#">Checklist: Optimizing Performance on Hyper-V</a></li> <li>• CTX128750 - <a href="#">Hyper-V Synthetic Network Interface Card Reinitializes on New Provisioning Services Target</a></li> <li>• CTX124687 - <a href="#">XenDesktop with Microsoft Hyper-V Design Guide</a></li> </ul> | <p>XD 5.x<br/>XA 6.x</p> |
| <p>Save-State Files</p>   | <p>Microsoft Hyper-V automatically creates a save-state file for each virtual machine in the same location as the virtual machines configuration file. This save-state file has a .BIN extension and will be equal to the amount of memory assigned to the virtual machine when the virtual machine boots. In the case of static memory assignments, the size of the file on disk does not change. However, with dynamic memory assignments the file starts at the size of the minimum dynamic memory assigned and grows as the memory assigned to the virtual machine increases. Therefore, when planning for storage capacity, verify the storage will have enough space to include the maximum size of dynamic memory for all virtual machines. For more information, please refer to CTX124687 - <a href="#">XenDesktop with Microsoft Hyper-V Design Guide</a>.</p>              | <p>XD 5.x<br/>XA 6.x</p> |
| <p>Hyper-V Management</p> | <p>The Hyper-V Manager and Cluster Manager admin tools should not be used after SCVMM has been implemented because they can cause inconsistencies within the SCVMM database.</p>  | <p>XD 5.x<br/>XS 6.x</p> |

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| Cluster Shared Volumes (CSV) | <p>A Cluster Shared Volume (CSV) allows virtual machines that are distributed across multiple cluster nodes to access their Virtual Hard Disk (VHD) files at the same time. The following recommendations should be considered during the Cluster Shared Volume design:</p> <ul style="list-style-type: none"><li>• Microsoft recommends that the CSV communications take place over a different network to the virtual machine and management traffic.</li><li>• The network between cluster nodes needs to be low latency to avoid any lag in disk operations but doesn't need to be high bandwidth due to the minimal size of metadata traffic generated under normal circumstances.</li></ul> <p><b>Note:</b> Since Clustered Shared Volume communication occurs over the Server Message Block (SMB) protocol, the Client for Microsoft Networks and File and Printer Sharing for Microsoft Networks services must be enabled on the network adapters used for the cluster network. Disabling NetBIOS over TCP/IP is recommended.</p> <p>For more information, please see the Microsoft TechNet article <a href="#">Requirements for Using Cluster Shared Volumes in a Failover Cluster in Windows Server 2008 R2</a>.</p> |  |
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## VMware vSphere

| Area                   | Best Practice  | Applies To       |
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| Configuration Maximums | <p>A vSphere deployment should not exceed the stated configuration limits. A selection of important configuration maximums are defined below (valid at time of writing):</p> <ul style="list-style-type: none"> <li>• Concurrent VMs per host: 512</li> <li>• Concurrent VMs per Cluster: 3000</li> <li>• Hosts per Cluster: 32</li> <li>• Hosts per vCenter Server: 1000</li> <li>• Running VMs per vCenter Server: 10000</li> <li>• Concurrent vSphere Clients per vCenter: 100</li> </ul> <p>For more information, please refer to the following VMware documentation:</p> <ul style="list-style-type: none"> <li>• <a href="#">VMware vSphere Configurations Maximums for vSphere 4.1</a></li> <li>• <a href="#">VMware vSphere Configurations Maximums for vSphere 5.0</a></li> <li>• <a href="#">VMware vCenter 4.1 Server Performance and Best Practices</a></li> <li>• <a href="#">vCenter Server 5.x and vSphere Client Hardware Requirements</a>.</li> </ul> <p>Note: These configuration maximums are theoretical values that may vary according to the characteristics of the environment.</p> | XD 5.x<br>XA 6.x |

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| Hyper-Threading | <p>The HaltingIdleMsecPenalty parameter should be adjusted on hosts that meet the following conditions so that vCPUs which have fallen behind can catch up:</p> <ul style="list-style-type: none"> <li>• More than 50% CPU utilization</li> <li>• Number of vCPUs = number of pCPUs +/- 25%</li> <li>• There are bursty CPU usage patterns</li> </ul> <p>For more information, please refer to the VMware Knowledgebase Article KB1020233 - <a href="#">Guidance for Modifying vSphere's Fairness/Throughput Balance</a>.</p>   | XD 5.x<br>XA 6.x |
| vCenter         | <p>VMware vCenter is a critical component in a XenDesktop environment due to its central role of managing all communication between XenDesktop and vSphere. Since each VMware vSphere server cluster relies on vCenter to perform cluster management and other hosting infrastructure tasks, the delivery of desktops may be hindered should the vCenter server encounter high-stress conditions and become slow or unavailable. VMware best practices for installing Virtual Center 5.0 can be found in the Knowledge Base article <a href="#">2003790</a>. Further recommendations can be found within the <a href="#">Performance Best Practices for VMware vSphere 5.0 – White Paper</a>.</p> <p>Citrix Consulting recommends that the vCenter Server be highly available for all production XenDesktop and XenApp environments. While the loss of a vCenter server will not effect current XenDesktop connections, administrators will lose the ability to make changes to and manage the vSphere cluster configurations. High availability for vCenter can be achieved by placing the vSphere host running the vCenter Server in a VMware HA cluster. If the host supporting the vCenter Server fails, the vCenter Server will be restarted on another host in the cluster. It is recommended that the startup priority for the vCenter Server is changed from a default value of 'medium' to 'high'. Also, ensure that other services that the vCenter Server depends on, such as Active Directory, DNS and the SQL hosting the vCenter data store are also configured with a 'high' startup priority.</p> | XD 5.x<br>XA 6.x |
| Network Adapter | <p>The VMXNet3 Network Adapter should be selected to improve network throughput and reduce processor utilization. For more information, please refer to the following VMware articles: KB001805 - <a href="#">Choosing a network adapter for your virtual machine</a>, and <a href="#">Performance Evaluation of VMXNET3 Virtual Network Device</a>.</p> <p><b>Note:</b> When Windows 7, Windows Vista, Windows 2008, and Windows 2008 R2 operating systems using the VMXNet3 driver are imaged to a Provisioning Services virtual disk it is not possible to boot a target</p>   | XD 5.x<br>XA 6.x |

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|                          | <p>device from the vDisk other than the Golden Image. The target device fails with a STOP 7B Blue Screen error. For more information, please refer to the Citrix Knowledgebase Article CTX125361 – <a href="#">Target Device Fails to Start with VMXNet3 Drivers</a>.</p> <p>In addition, hotfix <a href="#">CPVS56SP1E011</a> should be applied to Provisioning Services 5.1 and 5.6 environments to prevent target devices using the VMXNet3 driver from crashing.</p>  |                          |
| SCSI Adapter             | <p>Virtual machines with a high I/O footprint, such as Database Servers or Provisioning Servers, should be configured to use the Paravirtual SCSI Adapters instead of the default adapter. For more information, please refer to the VMware Knowledgebase Article KB1010398 - <a href="#">Configuring disks to use VMware Paravirtual SCSI (PVSCSI) adapters</a>.</p>   | <p>XD 5.x<br/>XA 6.x</p> |
| Transparent Page Sharing | <p>Enabling or disabling Transparent Page Sharing has not been shown to either help or hurt performance on newer systems (Windows 2008, Windows 2008 R2, Windows Vista and Windows 7). However, older systems (Windows 2003 and Windows XP) have benefited, mostly because the page sizes are smaller (4K), thus making it easier to share pages of memory. If TPS is enabled, the Windows Address Space Layout Randomization (ASLR) should be turned off to improve efficiency.</p>  | <p>XD 5.x<br/>XA 6.x</p> |
| Host Swapping            | <p>In most environments, all XenApp servers and virtual desktops are actively hosting users at the same time. Swapping out memory from one XenApp host or virtual desktop will degrade performance for all virtual machines as the memory keeps getting transferred to/from disk. Therefore, based on typical XenApp / XenDesktop usage patterns, host swapping should be avoided by ensuring the availability of sufficient physical memory resources for the virtual machines.</p> <p><b>Note:</b> In the event that host swapping cannot be avoided Solid-State Drives (SSD) should be considered for the swap cache. For more information, please refer to the VMware Knowledgebase Technical Paper – <a href="#">What’s New in VMware vSphere 5.0 Performance</a>.</p> | <p>XD 5.x<br/>XA 6.x</p> |



## Desktops

### General

| Area                                  | Best Practice   | Applies To       |
|---------------------------------------|---|------------------|
| Multiple Image Provisioning Solutions | When possible, reduce complexity by using either Provisioning Services or Machine Creation Services but not both. For more information, please refer to the Citrix Knowledgebase Article CTX128543 – <a href="#">XenDesktop Planning Guide: Desktop Image Delivery</a> .  | XD 5.x<br>XA 6.x |
| Virtual Desktop Publishing            | Virtual desktops should be assigned based on groups rather than individual user accounts. This follows the <a href="#">Microsoft AGDLP</a> (Account, Global, Domain Local, Permission) principle.   | XD 5.x<br>XA 6.x |
| General Desktop Optimization          | The operating systems of the virtual desktops and XenApp application servers should be optimized to reduce IOPS requirements, improve performance and improve logon times. For more information, please refer to the following Citrix Knowledgebase Articles:<br><br>CTX124239 – <a href="#">Windows XP Optimization Guide</a><br>CTX127050 – <a href="#">Windows 7 Optimization Guide</a><br>CTX131577 – <a href="#">XenApp 6.x Optimization Guide</a>   | XD 5.x<br>XA 6.x |
| Antivirus Configuration               | When configuring antivirus software it is important to find the right balance between performance and security. As a guideline, consider implementing the following recommendations: <ul style="list-style-type: none"><li>• Scan on write events or only when files are modified. It should be noted that this configuration is typically regarded as a high security risk by most antivirus vendors. In high-security environments, organizations should consider scanning on both read and write events to protect against threats that target memory, such as Conficker variants.</li><li>• Scan local drives or disable network scanning. This assumes all remote locations, which might include file servers that host user profiles and redirected folders, are being monitored by antivirus and data integrity solutions.</li><li>• Exclude the pagefile(s) from being scanned.</li><li>• Exclude the Print Spooler directory from being scanned.</li></ul> | XD 5.x<br>XA 6.x |

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|                         | <ul style="list-style-type: none"> <li>• Exclude specific files and folders within the \Program Files\Citrix directory that are accessed heavily or modified frequently.</li> <li>• Remove any unnecessary antivirus related entries from the Run key (HKLM\Software\Microsoft\Windows\Current Version\Run).</li> <li>• If pass-through authentication is being used, for example in a XenDesktop or Shared Hosted desktop scenario, exclude the XenApp Online Plug-in bitmap cache directory (typically %AppData%\ICAClient\Cache).</li> <li>• If using the streamed user profile feature of Citrix Profile management, ensure the antivirus solution is configured to be aware of Hierarchical Storage Manager (HSM) drivers.</li> </ul> <p>For more information, please refer to the Citrix Knowledgebase Article CTX127030 – <a href="#">Citrix Guidelines for Antivirus Software Configuration</a>.</p> |                  |
| Scheduled Tasks         | Scheduled tasks are sometimes used to perform maintenance activities on the virtual desktops, XenApp servers and supporting infrastructure. The use of scheduled tasks can sometimes cause periods of slow performance. Therefore, scheduled tasks should ideally be run outside of business hours. In addition, the execution of scheduled tasks should be randomized to reduce the performance impact on central infrastructure such as storage, network and databases.  | XD 5.x<br>XA 6.x |
| CPU Resource Allocation | A single vCPU per virtual desktop is sufficient to satisfy the resource requirements of many users. However, a second vCPU might be needed for graphically intense HDX features including RealTime, 3D, or RichGraphics.   | XD 5.x           |
| HDX Monitor             | The <a href="#">HDX Monitor</a> tool should be installed on every virtual desktop and XenApp server to help simplify the process of troubleshooting issues with Smartcards, USB Devices and network performance. As there is a resource overhead associated with the use of this tool, access should be restricted to support staff only. For XenApp 6.5 or XenDesktop 5.x environments Desktop Director can be used to obtain this data.  | XD 5.x<br>XA 6.x |
| Boot Storms             | The simultaneous startup of multiple virtual desktops is a resource intensive process, particularly for the storage subsystem, that often causes periods of slow performance. To address this concern, the virtual desktop boot process should be completed prior to the start of the business day. In addition, the virtual desktop boot process should be staggered to help reduce the load placed on the environment.   | XD 5.x           |



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| Disk Alignment | Installations of Windows 2003 and Windows XP are misaligned by default which can affect storage performance. Therefore, the alignment should be corrected prior to the installation of the operating system. For more information, please refer to the Microsoft Knowledgebase Article KB929491 – “ <a href="#">Disk performance may be slower than expected when you use multiple disks in Windows Server 2003, in Windows XP, and in Windows 2000</a> ” or the NetApp white paper TR3747 – “ <a href="#">Best Practices for File System Alignment in Virtual Environments</a> ”. | XD 5.x<br>XA 6.x |
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## Machine Creation Services

| Area             | Best Practice  | Applies To |
|------------------|--|------------|
| Storage Protocol | NFS is the recommended storage solution for Machine Creation Services because it offers thin provisioning, which allows 0KB links to be created and snapshots that grow on demand. This feature significantly reduces storage requirements while also minimizing the time it takes to create new machines (Full copy vs. 0KB snapshot). In addition, NFS allows large storage repositories to be created, which can be accessed by many virtual machines simultaneously, without the occurrence of SCSI-locking or SCSI-queuing related performance issues. This helps to simplify the planning and management of the XenDesktop infrastructure.   | XD 5.x     |
| IntelliCache     | IntelliCache is a XenServer feature that caches temporary and non-persistent files for MCS based desktop workloads on the local disk of the host server. When using IntelliCache, a portion of the virtual machine runtime reads and writes occur on low-cost local storage rather than more expensive shared storage. As a result, IntelliCache may help to reduce the requirements for shared storage. The local disk sub-system must be provided with sufficient resources to cope with the additional IOPS requirements of IntelliCache or users will experience performance and stability issues. For more information, please refer to CTX129052 - <a href="#">How to Use IntelliCache with XenDesktop</a> . | XD 5.x     |



## Provisioning Services

| Area                                 | Best Practice  | Applies To       |
|--------------------------------------|--|------------------|
| Provisioning Services – Scale Up/Out | The decision to scale up (add more resources to a single host) or scale out (add additional hosts) should be based on the tolerance to risk and failover times, since the more target devices that are connected to a single Provisioning Server the longer the failover between Provisioning Server will take. Citrix internal testing identified a failover time of approximately eight minutes for 1.500 target devices.  | XD 5.x<br>XA 6.x |
| Distributed Farms                    | Although Provisioning Services farms can span multiple data centers, separate farms should be created per physical location for reasons of performance and high-availability.  | XD 5.x<br>XA 6.x |
| vDisk Type                           | <p>Provisioning Services supports the use of static and dynamic vDisks. Dynamic vDisks require less storage space and therefore reduce the time required to update, distribute and backup the vDisks. The type of vDisk selected will not affect the performance of a Provisioning Services Target Device or Provisioning Server with sufficient memory as the majority of the vDisk will be cached in memory. Therefore dynamic vDisks are recommended for standard image (read-only) use cases.</p> <p><b>Note:</b> Dynamic vDisks have a significantly lower write performance than fixed size vDisks. While this will not impact the performance during normal operations, the time for vDisk merge operations will increase.</p> <p>For private images (read/write), fixed size vDisks should be used due to their improved write performance over dynamic vDisks. For more information, please refer to the Microsoft White Paper - <a href="#">Virtual Hard Disk Performance</a>.</p> | XD 5.x<br>XA 6.x |
| Number of vDisks                     | The number of vDisks deployed should be kept to a minimum to help reduce the administrative overhead associated with their maintenance.  | XD 5.x<br>XA 6.x |
| Differencing Disk Merging            | Since PVS 6.0 vDisk versioning simplifies vDisk update and management tasks, providing a more flexible and robust approach to managing vDisks. A vDisk consists of a VHD base image file, any associated side-car files, and if applicable, a chain of referenced VHD differencing disks. Differencing disks are created to capture the changes made to the base disk image, leaving the original base disk unchanged. Each differencing disk that is associated with a base disk represents a different version.  | XD 5.x<br>XA 6.x |

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|                      | <p>For optimal performance, the number of VHD chains should be kept to a minimum (5-7 maximum). The following recommendations should be followed to limit the impact from each additional AVHD (snapshot of the base VHD file) increasing the overall IOPS overhead:</p> <ul style="list-style-type: none"> <li>• When updating a vDisk, maintain the test AVHDs so that you have the ability to rollback changes based on test results</li> <li>• Merge AVHDs before moving into UAT/Pilot. This will reduce the number of AVHD files referenced by the target and result in a smaller storage footprint.</li> <li>• Once updates are accepted, merge with the base so that a single VHD is delivered to all production targets and archive the new base.</li> </ul>   |                  |
| vDisk Store Location | <p>Storing vDisks on a CIFS/SMB network share helps to simplify vDisk management by reducing the number of vDisk copies required. The following conditions must be in place to facilitate memory caching on the Provisioning Servers:</p> <ul style="list-style-type: none"> <li>• The network share must have a fully redundant configuration and provide sufficient performance to cope with the demands of the environment.</li> <li>• The network share (or the file server respectively) should be monitored closely, in order to be able to detect outages or shortages proactively.</li> <li>• Both the file server hosting the network share as well as the Provisioning Servers need to be configured for the SMB 2.x protocol.</li> <li>• The following RegKeys must be configured on every Provisioning Server (the sample below outlines the RegKeys for W2K8R2) <ul style="list-style-type: none"> <li>• HKLM\SYSTEM\CurrentControlSet\services\LanmanWorkstation\Parameters<br/>“EnableOplocks” = dword:0x00000001</li> <li>• HKLM\SYSTEM\CurrentControlSet\services\mrxsmbs\Parameters<br/>“OplocksDisabled” = dword:0x00000000<br/>“CscEnabled” = dword:0x00000001</li> <li>• HKLM\SYSTEM\CurrentControlSet\services\LanmanServer\Parameters<br/>“autodisconnect” = dword:0x0000ffff</li> </ul> </li> </ul> | XD 5.x<br>XA 6.x |

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|                                | <p>“Smb2” = dword:0x00000001</p> <p>For more information, please refer to the following Citrix Blog – <a href="#">Provisioning Services and CIFS Stores</a>.</p>  |                          |
| <p>Write Cache Destination</p> | <p>There are five options for storing the cache file of provisioned virtual machines:</p> <ul style="list-style-type: none"> <li>• Cache on Device HD</li> <li>• Cache on Device Hard Drive Persisted</li> <li>• Cache in Device RAM</li> <li>• Cache on a Server Disk</li> <li>• Cache on Server Persisted</li> </ul> <p>The use of ‘Cache on Device HD’ is recommended for the majority of XenDesktop and XenApp implementations because it offers fast performance without consuming expensive RAM. Although the option to ‘Cache on Server’ is one of the cheapest and easiest to implement, it is generally not recommended because this significantly decreases the scalability of the Provisioning Servers. Furthermore it is necessary to implement a highly available network share for storing the write cache files, since otherwise the Provisioning Servers will become a single point of failure. For more information, please refer to Citrix eDocs - <a href="#">Selecting the Write Cache Destination for Standard vDisk Images</a>.</p> | <p>XD 5.x<br/>XA 6.x</p> |

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| <p>Redirecting files/folders to a persistent Write Cache Drive</p> | <p>With Shared Images, the write cache file is deleted at reboot causing all changes to be reset. To preserve important changes between reboots and to improve performance consider redirecting the following files or folders to the write cache drive:</p> <ul style="list-style-type: none"><li>• Windows Pagefile (automatically redirected by PVS)</li><li>• Windows Event Log</li><li>• Citrix Logs</li><li>• Anti Virus Pattern Files</li><li>• Microsoft App-V / Citrix Application Streaming Cache (see below for more details)</li><li>• Citrix EdgeSight Database</li></ul> <p><b>Important:</b> Files and folders, which are written to the write cache drive directly, will not be wiped upon reboot of the target device. This may cause additional management overhead.</p> | <p>XD 5.x<br/>XA 6.x</p> |
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| <p>Caching of Citrix Application Streaming Profiles</p> | <p>Caching streamed applications on a target device can minimize the disk write I/Os during run-time and lower the utilization of the network. In order to achieve the optimal results, the following guidelines should be considered:</p> <p>XenApp with PVS and local WriteCache Drive</p> <ul style="list-style-type: none"> <li>• Move the RadeCache and RadeStore directories to the local Write Cache Drive</li> <li>• Ensure the WriteCache Drive has sufficient disk space for hosting the cache directories. A minimum of 20GB should be available.</li> </ul> <p>Virtual Desktop (XD) with PVS or MCS</p> <ul style="list-style-type: none"> <li>• Move the RadeStore directory to the local Write Cache Drive (if applicable)</li> <li>• Create a VHD for every streaming profile, in order to enable the client to use the VHD mounting feature. Further information can be found in eDocs – <a href="#">To create a virtual hard disk</a>. The Offline Plug-In will auto-detect that the target is a virtual desktop and use VHD mounting.</li> </ul> <p>Further information:</p> <ul style="list-style-type: none"> <li>• <b>RadeCache:</b> Stores local copies of the streaming profiles. It can be configured by means on the ClientCache tool (C:\Program Files\Citrix\Streaming Client) or manually within the registry (HKLM\SOFTWARE\Citrix\Rade)</li> <li>• <b>RadeStore:</b> Stores registry hives, registry tab files, fonts, scripts, and merged rules of inter-isolation communication (IIC) profiles. It can be configured manually within the registry (HKLM\SOFTWARE\Citrix\Rade).</li> <li>• <b>Note:</b> Please ensure that the Ctx_StreamingSvc account has full access rights to the new directories.</li> </ul> |  |
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| Offline Database Support | <p>The Offline Database Support option allows Provisioning Servers to use a snapshot of the Provisioning Services database in the event that the connection to the database is lost. This option is disabled by default and is only recommended for use with a stable farm running in production. It is not recommended when running an evaluation environment or when reconfiguring farm components ‘on the fly’.</p> <p>A snapshot of the database is created and initialized at server startup. It is then continually updated by the Stream Process. If the database becomes unavailable, the Stream Process uses the snapshot to obtain information about the Provisioning Server and the target devices available to the server; this allows Provisioning Servers and target devices to remain operational. However, when the database is offline, Provisioning Services management functions and the Console become unavailable. For more information, please refer to Citrix eDocs – <a href="#">Offline Database Support</a>.</p> | XD 5.x<br>XA 6.x |
| Redundancy               | <p>Each Provisioning Services site should have at least two Provisioning Servers for redundancy. Virtualized Provisioning Servers should be distributed across multiple hypervisor hosts so that a single host failure does not result in a service outage. In addition, it is important to ensure that the failure of a single server does not degrade performance. For example, in a two Provisioning Server HA deployment, the failure of a single server might cause the remaining server to become overloaded</p>   | XD 5.x<br>XA 6.x |
| Ports / Threads          | <p>The sum of streaming ports (default 20) multiplied by the number of threads per port (default 8) should be equal to the maximum number of targets concurrently streamed by a single Provisioning Server (“# of ports” x “# of threads/port” = “max active clients”). Best performance can be obtained when the number of threads per port is not greater than the number of cores available on the Provisioning Server. For more information, please refer to the Citrix Blog – <a href="#">Ports &amp; Threads</a>.</p>  | XD 5.x<br>XA 6.x |
| Boot Pacing              | <p>A booting target device has a significantly higher performance impact on the Provisioning Server than an active target device. Therefore, adjust the maximum number of simultaneously booting devices supported per Provisioning Server according to the server resources available. This will help to ensure that the booting devices do not impact the performance of active devices.</p> <p>The maximum number of booting devices can be configured on the “Pacing Tab” within the server properties.</p>  | XD 5.x<br>XA 6.x |

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| Intermediate Buffering  | <p>The intermediate buffering feature can provide a significant performance boost for Windows Server operating systems, Windows Vista and Windows 7. Intermediate buffering is not beneficial in every situation (for example, Windows XP) and data loss within the write cache can occur in case the disk hosting the write cache is full. Therefore, intermediate buffering should be tested thoroughly in a development environment (for all hardware configurations) and the size of the write cache disk should be verified before being enabled in a production environment. For more information, please refer to the Citrix Knowledgebase Article CTX126042 – <a href="#">When to Disable Intermediate Buffering for Local Hard Drive Cache</a>.</p>   | XD 5.x<br>XA 6.x |
| Server Memory           | <p>The Windows operating system used to host Provisioning Server is able to partially cache vDisks in memory (system cache). In order to maximize the effectiveness of this caching process, a PVS server should have sufficient memory available. The following formula outlines how the minimum amount of memory for a Provisioning Server can be determined:</p> <ul style="list-style-type: none"> <li>• System Cache = 512MB + (# of active vDisks * Avg. data read from vDisk)</li> <li>• Total Server RAM = Committed Bytes under load + System Cache</li> </ul> <p>If the amount of data read from a vDisk is unknown and cannot be determined, it is a common practice to plan for a minimum of 2GB per active Desktop vDisk and 10GB per active Server vDisk. For more information, please refer to the Citrix Knowledgebase Article CTX125126 – <a href="#">Advanced Memory and Storage Considerations for Provisioning Services</a>.</p> | XD 5.x<br>XA 6.x |
| Server Operating System | <p>Provisioning Services should be hosted on a 64-bit operating system, preferably Windows Server 2008 R2, so that it can address large amounts of memory and benefit from improved file caching features.</p>   | XD 5.x<br>XA 6.x |
| Hardware                | <p>Provisioning Services typically has a very high I/O footprint and memory consumption (File Cache), which does not make it an ideal candidate for virtualization. Nevertheless, Citrix internal tests as well as many real world customer experiences show that Provisioning Services can be virtualized successfully, even in large enterprise environments.</p> <p>When virtualizing Provisioning Server, it is important to ensure that sufficient resources are available at all times. In case of a resource shortage (i.e. network or CPU congestion) additional latency might be introduced for target read / write operations. This will immediately and negatively impact the</p>   | XD 5.x<br>XA 6.x |

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|            | <p>performance of all connected target devices.</p> <p>For more information please refer to the Citrix Knowledgebase Articles CTX128645 - <a href="#">Design Considerations for Virtualizing Provisioning Services</a>.</p>  |                  |
| Networking | <p>The following networking best practices are recommended for Provisioning Services based environments:</p> <ul style="list-style-type: none"> <li>• Ensure the Provisioning Servers as well as critical target devices are connected redundantly to the network (i.e. NIC Teaming).</li> <li>• Provisioning Servers and target devices should be located within the same data center.</li> <li>• The latency between the Provisioning Servers and target devices should be as low as possible. Firewalls or network components performing packet inspection of the Provisioning Services traffic should be avoided.</li> <li>• Disable Spanning Tree or enable PortFast for all edge-ports connected to clients or the Provisioning Servers.</li> <li>• The use of fast networks helps to prevent Provisioning Services streaming traffic from causing network bottlenecks, particularly during boot storms.</li> <li>• Separate the Provisioning Services streaming traffic onto a dedicated network for large deployments or in situations where the network is saturated.</li> <li>• Citrix Provisioning Services uses, UDP Unicast, and could potentially cause issues with Storm Control Settings on network equipment.</li> </ul> <p><b>Note for Provisioning Services and Task Offloading:</b> The Microsoft TCP/IP transport can offload tasks to a network adapter that has the appropriate task offload capabilities. The Large Send Offload option segments TCP packets that are larger than 64KB. The network adapter then re-segments the message into multiple TCP frames to transmit on the wire. Re-segmenting and storing up packets to send in large frames causes latency and timeouts on Provisioning Server 5.x and older. Microsoft improved task offloading in Windows Server 2008 R2 and higher, however Provisioning Services Streaming service can be negatively impacted by having offloading enabled. Therefore it is recommended to disable task offloading when running Provisioning Services.</p> | XD 5.x<br>XA 6.x |

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|                           | <p>For more information, please refer to the Citrix Knowledgebase Article CTX117374 – <a href="#">Best Practices for Configuring Provisioning Server on a Network</a>.</p>  |                          |
| <p>Bootstrap Delivery</p> | <p>The information necessary to allow a target device to contact a Provisioning Server can be delivered in multiple ways - DHCP options, PXE boot or a dedicated ISO file. It is important to design the boot process in a redundant manner that can tolerate an outage of individual servers or network components otherwise target devices will fail to boot. For more information, please refer to Citrix eDocs – <a href="#">Getting the Bootstrap File</a>.</p> <p>When the virtual desktops/XenApp Servers and Provisioning Servers are part of the same broadcast domain or a redundant DHCP Relay has been implemented, the PXE service should be leveraged so that fault tolerance can be provided without increasing the complexity of the infrastructure. When using PXE the DHCP options 66 and 67 are not required.</p> <p>If boot information is to be provided using DHCP options 66 and 67 then a load balancer (i.e. Citrix NetScaler) should be used to load balance the TFTP service across multiple Provisioning Servers. For more information about implementing high availability for the TFTP service, please refer to the Citrix Knowledgebase Article CTX131954 - <a href="#">High Availability for TFTP</a>. When using DHCP options 66 and 67 PXE is not required.</p> <p>When using an ISO file to provide boot information to target devices, ensure that it is located on a fault tolerant CIFS share or it will become a single point of failure. For more information, please refer to Citrix eDocs – <a href="#">Using the Manage Boot Devices Utility</a>. When using ISO boot, neither DHCP options 66 and 67 nor PXE is required.</p> | <p>XD 5.x<br/>XA 6.x</p> |
| <p>Logon Servers</p>      | <p>A minimum of two Provisioning Servers should be specified within the bootstrap file for redundancy reasons. Please note that all Provisioning Servers within a farm can process target device logins from all sites. For more information, please refer to the Citrix Knowledgebase Article CTX119286 – <a href="#">Provisioning Server High Availability Considerations</a>.</p> <p>Please note that Provisioning Services Target Devices will pick a logon server randomly from the list of specified systems. Therefore, it is not necessary to sort the order of the logon servers.</p>  | <p>XD 5.x<br/>XA 6.x</p> |

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| Antivirus                         | <p>Citrix recommends the following Antivirus best practices for Provisioning Services based environments:</p> <ul style="list-style-type: none"> <li>• For Target Devices and Provisioning Servers <ul style="list-style-type: none"> <li>○ Scan on write/modify events only</li> <li>○ Scan local drives only (exclude network drives)</li> <li>○ Avoid scanning the Write Cache</li> </ul> </li> <br/> <li>• Exclude the following processes from being scanned on the target device: <ul style="list-style-type: none"> <li>○ BNDevice.exe</li> <li>○ BNNS.sys / BNNS6.sys</li> <li>○ BNNF.sys</li> <li>○ BNPort.sys</li> <li>○ Bnistack.sys / Bnistack6.sys</li> <li>○ BNITDI.sys</li> </ul> </li> <br/> <li>• Exclude the following processes from being scanned on the Provisioning Servers: <ul style="list-style-type: none"> <li>○ StreamService.exe</li> <li>○ StreamProcess.exe</li> <li>○ SoapServer.exe</li> </ul> </li> </ul> <p>For more information, please refer to the Citrix Knowledgebase Article CTX124185 – <a href="#">Provisioning Services Antivirus Best Practices</a>.</p> | XD 5.x<br>XA 6.x |
| Active Directory Machine Password | <p>When a target device accesses a vDisk in Standard Image mode, the Provisioning Server assigns the target device its name. If the target device is a domain member, the name and password assigned by Provisioning Server must match the information in the corresponding computer account within the domain; otherwise, the target device is not able to log on successfully. For this reason, the Provisioning Server must manage the domain passwords for target devices that share a vDisk. Therefore the “Disable machine account password changes” security policy must be enabled for all target device computer objects. For more information, please refer to Citrix eDocs – <a href="#">Managing Domain Passwords</a>.</p>  | XD 5.x<br>XA 6.x |
| ARP Cache                         | <p>The default lifespan of ARP cache entries was lowered from 10 minutes in Windows Server 2003 to a</p>  | XD 5.x<br>XA 6.x |

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|                              | <p>random value between 15 and 45 seconds in Vista/W2K8. As a result, the PVS bootstraps are twenty times more likely to experience a timeout during a Vista/W2K8 (or higher) boot. Perform the following steps on the Provisioning Servers, virtual desktops and XenApp servers to increase the ARP cache entry lifespan:</p> <ol style="list-style-type: none"> <li>1. Open a command shell window. At the command prompt, enter the following:<br/><b>netsh interface ipv4 show interfaces</b></li> <li>2. To set the ARP cache entry lifespan to 600 seconds, enter the following command:<br/><b>netsh interface ipv4 set interface &lt;PVS interface number&gt; basereachable=600000</b></li> <li>3. To verify the new setting, enter the following command:<br/><b>netsh interface ipv4 show interface &lt;PVS interface number&gt;</b></li> </ol> <p>The “Base Reachable Time” should be set to a value of 600,000 ms. and the “Reachable Time” to a value between 300,000 and 900,000 ms. For more information, please refer to the Microsoft Knowledgebase Article KB949589 – <a href="#">Description of Address Resolution Protocol (ARP)</a>.</p> |                          |
| <p>Audit Trail Archiving</p> | <p>The auditing capability of Provisioning Services should be enabled so that administrative actions can be tracked. This is especially useful when multiple administrators are modifying the configuration.</p> <p>The auditing feature is disabled by default. To enable auditing:</p> <ol style="list-style-type: none"> <li>1. In the Console tree, right-click on the farm, then select the farm Properties menu option.</li> <li>2. On the Options tab, under Auditing, check the Enable auditing checkbox.</li> </ol> <p>When auditing has been enabled, audit trail information will be stored within the Provisioning Services database along with general configuration data. As Provisioning Services will not delete audit data automatically, Citrix recommends archiving the audit data at regular intervals to prevent indefinite database growth. The Audit Trail data can be archived by issuing the following command on a Provisioning Server:</p> <p>MCLI Run ArchiveAuditTrail -p filename=&lt;filename&gt;</p> <p>Auditing information can be accessed from the Provisioning Services Console. Farm administrators can</p>              | <p>XD 5.x<br/>XA 6.x</p> |

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|  | right-click on a parent or child node in the Console tree to access audit information. The audit information that other administrators can access depends on the role they have been assigned. |  |
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## Applications

| Area                    | Best Practice  | Applies To                              |   |   |                    |                         |             |                                 |                          |                                |   |         |                                 |  |                            |              |                         |                      |   |   |                  |        |
|-------------------------|--|---|---|---|--------------------|-------------------------|-------------|---------------------------------|--------------------------|--------------------------------|---|---------|---------------------------------|--|----------------------------|--------------|-------------------------|----------------------|---|---|------------------|--------|
| Delivery Methodology    | <p>Applications can be delivered to the user's desktop either as an installed application, hosted on XenApp or dynamically delivered with either XenApp streaming or Microsoft App-V. As a starting point, the following table provides general recommendations for application delivery based on the category of the application.</p> <table border="1" data-bbox="525 527 1690 1128"> <thead> <tr> <th data-bbox="525 527 745 641">Categories</th> <th data-bbox="745 527 976 641">Base</th> <th data-bbox="976 527 1207 641">Anomalous</th> <th data-bbox="1207 527 1438 641">Resource Intensive</th> <th data-bbox="1438 527 1690 641">Technically Challenging</th> </tr> </thead> <tbody> <tr> <td data-bbox="525 641 745 852">Description</td> <td data-bbox="745 641 976 852">Common apps needed by all users</td> <td data-bbox="976 641 1207 852">Unique custom built apps</td> <td data-bbox="1207 641 1438 852">Have heavy system requirements</td> <td data-bbox="1438 641 1690 852">Large, complex apps with many moving parts and dependencies<br/>Mission Critical</td> </tr> <tr> <td data-bbox="525 852 745 966">Example</td> <td data-bbox="745 852 976 966">Microsoft Office, Adobe Acrobat</td> <td data-bbox="976 852 1207 966"></td> <td data-bbox="1207 852 1438 966">CAD/CAM, Google Earth, GIS</td> <td data-bbox="1438 852 1690 966">Epic, Cerner</td> </tr> <tr> <td data-bbox="525 966 745 1128">Primary Delivery Method</td> <td data-bbox="745 966 976 1128">Installed on Desktop</td> <td data-bbox="976 966 1207 1128">Streamed to Desktop or Hosted on Server</td> <td data-bbox="1207 966 1438 1128">Streamed to Desktop or Installed on Desktop</td> <td data-bbox="1438 966 1690 1128">Hosted on Server</td> </tr> </tbody> </table> <p>As there are multiple correct approaches, some application categories should be based on the current expertise level within the organization for streaming and hosting applications.</p> | Categories                              | Base  | Anomalous   | Resource Intensive | Technically Challenging | Description | Common apps needed by all users | Unique custom built apps | Have heavy system requirements | Large, complex apps with many moving parts and dependencies<br>Mission Critical | Example | Microsoft Office, Adobe Acrobat |  | CAD/CAM, Google Earth, GIS | Epic, Cerner | Primary Delivery Method | Installed on Desktop | Streamed to Desktop or Hosted on Server | Streamed to Desktop or Installed on Desktop | Hosted on Server | XA 6.x |
| Categories              | Base   | Anomalous                               | Resource Intensive                          | Technically Challenging   |                    |                         |             |                                 |                          |                                |   |         |                                 |  |                            |              |                         |                      |   |   |                  |        |
| Description             | Common apps needed by all users  | Unique custom built apps                | Have heavy system requirements              | Large, complex apps with many moving parts and dependencies<br>Mission Critical |                    |                         |             |                                 |                          |                                |   |         |                                 |  |                            |              |                         |                      |   |   |                  |        |
| Example                 | Microsoft Office, Adobe Acrobat  |   | CAD/CAM, Google Earth, GIS                  | Epic, Cerner  |                    |                         |             |                                 |                          |                                |   |         |                                 |  |                            |              |                         |                      |   |   |                  |        |
| Primary Delivery Method | Installed on Desktop   | Streamed to Desktop or Hosted on Server | Streamed to Desktop or Installed on Desktop | Hosted on Server  |                    |                         |             |                                 |                          |                                |   |         |                                 |  |                            |              |                         |                      |   |   |                  |        |
| Redundancy              | For reasons of redundancy, each XenApp Worker Group should be provided with at least N+1 redundancy so that a single server failure does not limit availability.   | XA 6.x                                  |   |   |                    |                         |             |                                 |                          |                                |   |         |                                 |  |                            |              |                         |                      |   |   |                  |        |

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| <p>Load Evaluator</p>                   | <p>Citrix recommends implementing custom load evaluators based on performance and scalability testing. In complex environments with multiple Worker Groups, Citrix often recommends creating unique “Custom” load evaluators for each Worker Group, effectively resulting in “load managed groups”. These load evaluators may have different rules and thresholds depending on the different resource bottlenecks identified during testing. If adequate testing cannot be performed prior to production, Citrix Consulting recommends implementing the following ”Custom“ load evaluator which can be applied to all servers as a baseline:</p> <ul style="list-style-type: none"> <li>• CPU Utilization Full Load: 80%, No Load: 10%</li> <li>• Memory Usage Full Load: 80%, No Load: 10%</li> <li>• Load Throttling High</li> <li>• Server User Load X</li> </ul> <p>Since the logon process is one of the most intensive actions a XenApp server undertakes, it is important to add the “Load Throttling” rule. This effectively limits the number of simultaneous logons that can occur at any given time. The “Server User Load” rule is also included for capping purposes – this is considered a best practice for resiliency. Organizations can choose an initial value of 100 (denoted by “X” above), but it is highly recommended that this value be customized based on the results from scalability testing.</p> | <p>XA 6.x</p>            |
| <p>Application / Desktop Publishing</p> | <p>Create groups for unique roles so that permissions can be assigned to a large numbers of users. An application published to one group of 1,000 users requires the validation of only one object for all 1,000 users. That same application published to 1,000 individual user accounts requires the validation of all 1,000 objects. This follows the <a href="#">Microsoft AGDLP</a> (Account, Global, Domain Local, Permission) principle.</p>   | <p>XA 6.x<br/>XD 5.x</p> |
| <p>Monitor Farm Health</p>              | <p>It is important to monitor the health of all servers in a XenApp environment and to be alerted when problems arise or might soon arise. Therefore Citrix recommend enabling the XenApp Health Monitoring and Recovery feature, which consists of various tests on core components. If any tests should fail, alerts can be triggered along with actions such as removing a server from load balancing. For more information, please refer to Citrix eDocs – <a href="#">Monitoring Server Performance with Health Monitoring &amp;</a></p>   | <p>XA 6.x</p>            |

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|                             | <a href="#">Recovery.</a>  |                  |
| XenApp Server Reboot Policy | <p>A rolling reboot schedule should be implemented for the XenApp Servers so that potential application memory leaks can be addressed and changes made to the provisioned XenApp servers can be reset. The period between reboots will vary according to the characteristics of the application set and the user base of each worker group. In general, a weekly reboot schedule provides a good starting point.</p> <p>Where possible, stagger the reboot process so that XenApp servers within a worker group are not all rebooted on the same night. This will help to prevent updates from bringing down all servers within a single worker group. For more information, please refer to CTX126043 - <a href="#">How to Create a Staggered Scheduled Server Reboot Policy in XenApp 6.x.</a></p> | XA 6.x           |
| CPU Optimization            | <p>The CPU Utilization Management feature can be used to improve the ability of a farm to manage resources and normalize CPU peaks when the farm’s performance becomes limited by CPU-intensive operations. When CPU utilization management is enabled, the server manages the share of the CPU allocated to each user. By default, this is an equal share. This prevents one user from impacting the productivity of other users and allows more users to connect to a server. Citrix recommends enabling the CPU Utilization Management Feature of XenApp.</p> <p>Please note that the Windows Server 2008 R2 – Remote Desktop Services (RDS) feature “Dynamic Fair Share Scheduling” (DFSS) needs to be disabled before XenApp CPU Utilization Management can be enabled.</p>                     | XA 6.x           |
| Memory Optimization         | <p>Enabling memory optimization improves the management of DLL allocation in both physical and virtual memory by creating shared DLLs for applications that are open in multiple sessions. Citrix recommends enabling this setting only after intensive application compatibility testing, as some applications are known to have compatibility issues with this feature.</p>  | XA 6.x           |
| Application Servers         | <p>A high-speed network connection should be implemented between the virtual desktops / XenApp servers and the application servers (e-mail servers, file servers, database servers, web servers, etc.). Ideally, use a Local Area Network with as few router hops and firewalls as possible. A slow connection is likely to cause unresponsive applications and poor performance.</p>  | XD 5.x<br>XA 6.x |
| Anonymous Users             | <p>If resources are published to authenticated users only, it is recommended to either disable or delete the local anonymous user accounts created during the installation of XenApp.</p>  | XA 6.x           |

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| <p>SMB 1.x Client Tuning</p> <p><b>Note:</b> Tuning SMB 1.0 is required in mixed (2003 / 2008 R2) environments, where SMB 2.0 cannot be used.</p> | <p>File Sharing in a Microsoft Environment is based on an application protocol called Server Message Block (SMB). When a device connects to a Microsoft file share on another computer it is acting as an SMB client.</p> <p>By default the SMB 1.0 Client network redirector can have only 50 outstanding SMB requests/commands open to a single file server. This is controlled by the MaxCmds registry value. All connections to remote servers are per computer not per user. This means all users on a XenApp Server open files over the same SMB session. In order to overcome this restriction and to avoid other SMB related issue, it is recommended to configure the following registry settings on every XenApp server in mixed environments:</p> <ul style="list-style-type: none"> <li>• HKLM\SYSTEM\CurrentControlSet\Services\Lanmanworkstation\Parameters <ul style="list-style-type: none"> <li>○ "MaxCmds"=dword:00002048 (dec)</li> </ul> </li> <li>• HKLM\SYSTEM\CurrentControlSet\Services\MRxSmb\Parameters <ul style="list-style-type: none"> <li>○ "MultiUserEnabled"=dword:00000001</li> </ul> </li> <li>• HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Policies\Explorer <ul style="list-style-type: none"> <li>○ NoRemoteRecursiveEvents"=dword:00000001</li> </ul> </li> <li>• HKLM\SYSTEM\CurrentControlSet\Services\Lanmanserver\Parameters <ul style="list-style-type: none"> <li>○ "MaxWorkItems"=dword:00008192 (dec)</li> <li>○ "MaxMpxCt"=dword:00002048 (dec)</li> <li>○ "MaxRawWorkItems"=dword:00000512 (dec)</li> <li>○ "MaxFreeConnections"=dword:00000100 (dec)</li> <li>○ "MinFreeConnections"=dword:00000032 (dec)</li> </ul> </li> </ul> <p>Furthermore the following registry keys are recommended for every file server interacting with XenApp systems:</p> <ul style="list-style-type: none"> <li>• HKLM\SYSTEM\CurrentControlSet\Services\Lanmanserver\Parameters <ul style="list-style-type: none"> <li>○ "MaxWorkItems"=dword:00008192 (dec)</li> </ul> </li> </ul> | <p>XA 6.x</p> |
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|                       | <ul style="list-style-type: none"> <li>○ "MaxMpxCt"=dword:00002048 (dec)</li> <li>○ "MaxRawWorkItems"=dword:00000512 (dec)</li> <li>○ "MaxFreeConnections"=dword:00000100 (dec)</li> <li>○ "MinFreeConnections"=dword:00000032 (dec)</li> </ul> <p>For more information, please refer to the Citrix Knowledgebase Article CTX131577 - <a href="#">XenApp 6.x Desktop Virtualization - Optimization Guide</a>.</p>  |        |
| SMB 2.x Client Tuning | <p>By default, the Windows SMB redirector throttles throughput across high-latency network connections to avoid network-related timeouts. Setting the DisableBandwidthThrottling registry value to 1 disables this throttling, enabling higher file transfer throughput over high-latency network connections.</p> <p>By default, the SMB redirector does not transfer payloads larger than approximately 64 KB per request. Setting the DisableLargeMtu registry value to 0 enables larger request sizes, which can improve file transfer speed.</p> <p>Therefore the following registry settings are recommended for all XenApp servers:</p> <ul style="list-style-type: none"> <li>● HKLM\System\CurrentControlSet\Services\ <ul style="list-style-type: none"> <li>○ LanmanWorkstation\Parameters</li> <li>○ "DisableBandwidthThrottling"=dword:00000001</li> <li>○ "DisableLargeMtu"=dword:00000000</li> </ul> </li> <li>● HKLM\SOFTWARE\Microsoft\Windows\ <ul style="list-style-type: none"> <li>○ CurrentVersion\Policies\Explorer</li> <li>○ NoRemoteRecursiveEvents"=dword:00000001</li> </ul> </li> </ul> <p>Further guidance can be found within CTX131577 - <a href="#">XenApp 6.x Desktop Virtualization - Optimization Guide</a>.</p> | XA 6.x |



## Personalization

### Printing

| Area                                      | Best Practice  | Applies To       |
|---|--|------------------|
| Number of Printer Drivers                 | <p>The number of print drivers installed on a single image should be kept to a minimum to help reduce management and potential stability issues. The Citrix Universal Print Driver should be used whenever possible to reduce the number of print drivers required.</p> <p>If used, third party print drivers should be installed consistently across XenApp Worker Groups and XenDesktop Desktop Groups to simplify the troubleshooting process and to provide the users with a consistent experience.</p> <p>Do not manually replicate large quantities of print drivers during production hours. Print driver replications are carried out over the Independent Management Architecture Service (IMA) and queued up in the data store database. When performing manual replications of drivers, try to do them after hours, if possible. For more information, please refer to the Citrix Knowledgebase Article CTX121060 – <a href="#">Best Practices for Replicating Print Drivers in XenApp</a>.</p> | XD 5.x<br>XA 6.x |
| Automatic Installation of printer drivers | <p>The automatic installation of print drivers should be disabled to ensure consistency across the virtual desktops and XenApp servers to simplify support and troubleshooting. Please note that the Windows Remote Desktop System (RDS) includes similar functionality. Therefore it is required to disable the automatic installation of printer drivers for RDP connections separately.</p>   | XD 5.x<br>XA 6.x |
| Kernel Mode Drivers                       | <p>Kernel Mode print drivers should be avoided because they can cause server failures. Newer User Mode print drivers operate at a higher level and only impact the Print Spooler service. For some legacy printers only kernel mode (type 2) drivers exist. In such scenarios administrators should verify if printer driver mapping, the Citrix Universal Printer Driver or the Universal Print Server can be leveraged in order to avoid installing the legacy driver on a XenApp server / virtual desktop.</p>  | XD 5.x<br>XA 6.x |
| Printer Driver Testing                    | <p>Third party print drivers should be tested extensively prior to being implemented in production. The <a href="#">Citrix StressPrinters</a> tool can be used to help validate print drivers.</p>   | XD 5.x<br>XA 6.x |
| EMF Universal                             | <p>Citrix recommends the EMF based Citrix Universal Printer Driver whenever possible, since it utilizes</p>  | XD 5.x           |



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|---------------------------------|---|------------------|
| Driver vs. XPS Universal Driver | advanced print stream optimization algorithms, which are not available for XPS at this point in time.   | XA 6.x           |
| Print Job Routing               | <p>Routing jobs through a network print server is ideal for fast local networks, but is not optimal for WANs. The spooling of print jobs using the network printing pathway method (XA/XD → Print Server → Printer) uses more bandwidth than using the client pathway (XA/XD → Client → Printer); many packets are exchanged between the host server / virtual desktop and the print server. Therefore high-throughput low-latency network connection is recommended for network printing pathway scenarios, in order to prevent slow printing performance. This is caused by the architecture of the RPC protocol, which is not optimized for WAN connections. When printing jobs cross a network with limited bandwidth, Citrix recommends routing jobs through the client device so that the ICA protocol compresses the jobs and enables the administrator to limit the maximum consumable bandwidth. If this is not possible, for example when a thin client without printing capabilities is used, the Citrix Universal Print Server should be implemented. Furthermore Quality of Service should be configured in order to prioritize ICA/HDX over any kind of printing traffic, to ensure a good in-session user experience.</p> <p>For further information, please refer to CTX134943 – <a href="#">XenDesktop and XenApp Printing Planning Guide</a>.</p> | XD 5.x<br>XA 6.x |
| Auto-Creating Client Printers   | In environments with a large number of printers per user, Citrix recommends to auto-create only one default printer. Auto-creating a smaller number of printers creates less overhead on the server / virtual desktop resources (memory / CPU) and can reduce user logon times. However, in environments where users with limited computer skills need to print to a wide variety of local printing devices, auto-creating all client printers will improve the user experience and can reduce support calls.   | XD 5.x<br>XA 6.x |



## Profiles

| Area                  | Best Practice   | Applies To       |
|-----------------------|---|------------------|
| User Profile Strategy | <p>A user's profile plays a critical role in determining how successful the user experience is within a virtual desktop scenario. Even a well-designed virtual desktop / application delivery solution can fail if users are frustrated due to lengthy logon times or lost settings, since first time experience may leave a lasting impression severely impacting acceptance.</p> <p>As Microsoft Windows itself offers multiple profile solutions, which are supplemented by various 3rd party software companies and their products, it is critical to have knowledge about all base profile technologies and to perform detailed planning to be successful. For most environments it is a best practice to implement an advanced user profile solution such as Citrix Profile Management, instead of standard Windows profile solutions (i.e. roaming profiles). Doing so helps to prevent user profile corruption or bloat and therefore ensures fast logon times. For more information, please refer to the Citrix Knowledgebase Article CTX128701 – <a href="#">User Profile Planning Guide</a>.</p> | XD 5.x<br>XA 6.x |
| Logon Scripts         | <p>User logon scripts should be kept to a minimum to minimize user logon times. Furthermore, it is important that the logon scripts are adapted to the requirements and restrictions of a virtual desktop environment. For example, it is not necessary to perform software inventory checks or update checks upon user logon if the virtual desktops are provisioned by means of Provisioning Services or Machine Creation Services.</p> <p><b>Note:</b> Replacing traditional logon scripts with Group Policy Preferences often helps to reduce logon times. Further information can be found in Microsoft TechNet – <a href="#">Group Policy Preference Getting Started Guide</a>.</p>   | XD 5.x<br>XA 6.x |

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| Folder Redirection | <p>The use of folder redirection can help to reduce the size of the profile and improve logon times. Therefore, consider redirecting the following folders to a file share:</p> <ul style="list-style-type: none"><li>• Contacts</li><li>• Desktop</li><li>• Documents</li><li>• Downloads</li><li>• Favorites</li><li>• Links</li><li>• Music</li><li>• Pictures</li><li>• Saved Games</li><li>• Searches</li><li>• Start Menu</li><li>• Videos</li></ul> <p>Redirection of the AppData folder should be carefully evaluated. It is important to note that doing so can significantly increase the load of the file server hosting this share and may cause application issues. For further information please refer to the following <a href="#">Blog - Citrix Profile Management and VDI – Doing it Right</a>.</p> | XD 5.x<br>XA 6.x |
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## Citrix Profile Manager

| Area                         | Best Practice  | Applies To       |
|------------------------------|--|------------------|
| Active Write Back            | By enabling the Active Write Back feature, Citrix Profile Manager detects when an application has written and closed a file, and copies the file back to the network copy of the profile during idle periods. However, Citrix Profile Management does not copy any registry changes back to the network, except during an ordered logoff. As such, there is a risk that the registry and files may get out of alignment on provisioned systems, where locally cached profile information is wiped upon reboot. Therefore it is recommended to disable the Active Write Back functionality for non-persistent Provisioning Services or Machine Creation Services scenarios.   | XD 5.x<br>XA 6.x |
| MFT Cache File               | The MFT file is an internal cache file used by Citrix Profile Management to speed up processing of Change Journal notifications. When configuring Profile Management on images provisioned by Provisioning Services or Machine Creation Services, deleting the MFT file from the image before switching the image back to Shared mode can speed up logon times. For more information, please refer to Citrix eDocs – <a href="#">Provisioned or Persistent</a> .   | XD 5.x<br>XA 6.x |
| Cross Platform Functionality | <p>Profiles in Microsoft Windows XP and Windows Server 2003 are known as Version 1 profiles. Those in Windows Vista, Windows 7, Windows Server 2008, and Windows Server 2008 R2 are known as Version 2 profiles. The folder structure (or namespace) of Version 1 profiles is mostly interchangeable; the folders on Windows XP and Windows Server 2003 are almost identical. Likewise, the structure of Version 2 profiles is mostly interchangeable. However, the namespace is different between Version 1 and Version 2 profiles. The folder structure was changed in the later operating systems to provide user-specific folders isolated for user and application data. Version 1 profiles store data in the root folder, Documents and Settings. Version 2 profiles store data in a more intuitively named folder called Users. For example, the folder contents of AppData\Local in Windows 7 is the same as the contents of Documents and Settings\&lt;username&gt;\Local Settings\Application Data in Windows XP.</p> <p>The Cross Platform functionality in Citrix Profile Manager allows settings to be migrated between Version 1 and Version 2 profiles. This feature should be disabled after the migration process is complete as it can have a negative impact on logon/logoff performance. For more information, please refer to Citrix eDocs – <a href="#">Cross Platform Settings</a> and the <a href="#">Managing Roaming User Data Deployment Guide</a>.</p> | XD 5.x<br>XA 6.x |



## Policies

| Area                 | Best Practice  | Applies To       |
|----------------------|--|------------------|
| Overlapping Settings | Do not enable conflicting or overlapping settings in Remote Desktop Session Host Configuration and Citrix XenDesktop / XenApp Policies. In some cases, Remote Desktop Session Host Configuration provides similar functionality to Citrix policy settings. When possible, keep all settings consistent (enabled or disabled) for ease of troubleshooting.  | XD 5.x<br>XA 6.x |
| Policy Configuration | <p>In general Active Directory group policy should be used to centrally configure the XenDesktop and/or XenApp environments. Implementing policies through Active Directory group policy provides a number of benefits over Desktop Studio, including:</p> <ul style="list-style-type: none"><li>• Citrix and Microsoft policies are maintained in a single location</li><li>• Policies are automatically replicated across domain controllers</li></ul> <p>In case of advanced filtering mechanisms, such as filtering for endpoint names or IPs, Machine Type, Tags or Access Control (Smart Access) is required, Citrix Policies should be created within XenDesktop Studio / XenApp AppCenter on an exception basis.</p> <p><b>Important:</b> Please note that policies created within XenDesktop Studio / XenApp AppCenter will always have a lower priority than policies applied by Active Directory.</p> <p>A baseline policy should be applied to all users and XenApp servers/virtual desktops to ensure adherence to company policy. Additional policies should be created, prioritized and filtered appropriately when an exception to the baseline policy is required. Group policies should be aligned with the Organizational Unit structure to streamline policy management and to reduce redundant policies. For more information, please refer to the Citrix Knowledgebase Article CTX134081 – <a href="#">Citrix XenApp and XenDesktop Policies Planning Guide</a>.</p> | XD 5.x<br>XA 6.x |

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| Number of Policies | <p>While keeping the number of policies to a minimum can simplify troubleshooting and maintenance, it will not have a significant impact on user logon performance. In order to optimize the time required to process GPOs it is recommended to separate policy areas which are changed frequently and involve Client Side Extensions (CSE) into dedicated (functional) policies. For example if the Internet Explorer configuration is modified on a regular schedule a dedicated IE Maintenance Policy should be created. Furthermore it is recommended to avoid configurations which slow down policy processing, such as the “Process even if Group Policy objects have not changed” setting.</p> <p>For more information, please refer to TechNet – <a href="#">Optimizing Group Policy Performance</a>.</p> | XD 5.x<br>XA 6.x |
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## Access

### ICA/HDX

| Area          | Best Practice  | Applies To       |
|---------------|--|------------------|
| Optimizations | <p>In XenDesktop 5.5 / XenApp 6.5 (or later), Adaptive Display is enabled by default. Adaptive Display dynamically adjusts image quality and frame rates to deliver the best possible user experience when viewing graphics or server-rendered video content over a limited bandwidth network connection. Adaptive Display is the successor to the Progressive Display technology. Adaptive Display is self-tuning and generally does not require configuration. However, in certain scenarios additional optimizations may be required. The following ICA/HDX protocol tuning options should be evaluated incase adjustments are needed:</p> <ul style="list-style-type: none"><li>• Disable “View window contents while dragging”.</li><li>• Enable “Windows Media Redirection”.</li><li>• Enable “Flash acceleration” with client side content fetching.</li><li>• Enable “Audio over UDP Real-Time Transport”. Please note that this configuration requires audio quality to be set to “Medium – optimized for speech”.</li><li>• Set “Progressive compression level” to “Low” or any higher value (<b>Note:</b> This will disable Adaptive Display).</li><li>• Enable “Extra Color Compression” in very low bandwidth scenarios. Please note that the “Extra Color Compression Threshold” should be configured to an appropriate value.</li><li>• Enable “Lossy compression” for image compression or “Heavyweight compression” in case image quality loss is not acceptable (more CPU intensive).</li></ul> <p>For more information, please refer to the Citrix Knowledgebase Article CTX131859 - <a href="#">Best Practices and Recommendations for Citrix Receiver 3 and HDX Technology with XenDesktop 5.5</a>. The following blog posts also provide additional information:</p> | XD 5.x<br>XA 6.x |

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|                        | <ul style="list-style-type: none"> <li>• Citrix Blog – <a href="#">HDX Progressive Display – Don't forget to turn it on</a></li> <li>• Citrix Blog – <a href="#">Fine Tuning HDX 2D Graphics Experience over WAN</a></li> <li>• Citrix Blog – <a href="#">Dynamic Color Compression cuts bandwidth consumption by 35%</a></li> <li>• Citrix Blog – <a href="#">Tuning HDX MediaStream server-rendered multimedia delivery</a></li> </ul>   |                  |
| Session Sharing        | <p>Session sharing is a mode in which more than one published application runs within a single ICA/HDX connection. Session sharing occurs when a user has an open session and launches another application that is published on the same XenApp server; the result is that the two applications run in the same session. Session sharing is configured by default when you specify that applications appear in seamless window mode.</p> <p>Inconsistent results may occur when applications are configured for different requirements, such as encryption and color depth. As session sharing helps to lower overall resource utilization, try to publish applications with consistent settings where possible.</p> | XA 6.x           |
| Frame Rate Adjustments | <p>On older client devices, the XenDesktop default frame rate (24 FPS) may cause the processor to be constantly utilized while showing graphically intense content (i.e. playing a server-rendered video). The frame rate used should be adjusted according to the capabilities of the end point devices. For more information, please refer to the Citrix Knowledgebase Article CTX123543 – <a href="#">How to Improve XenDesktop Video User Experience for Low Powered or Mobile Devices</a>.</p>  | XD 5.x           |
| Microsoft Lync         | <p>The processor utilization on the virtual desktops should be monitored in case two virtual CPUs (vCPUs) are required. Real-time voice and video are intensive activities that may benefit from two vCPUs.</p> <p><b>Note:</b> Having two vCPUs does not necessarily mean doubling the number of physical CPUs because physical CPUs can be shared across sessions. For more information, please refer to the Citrix Knowledgebase Article CTX124124 – <a href="#">Configuring XenDesktop 5.5 to deliver Microsoft Lync 2010</a>.</p>   | XD 5.x           |
| Multi Stream           | <p>For congested network connections which have Quality of Service (QoS) enabled, Citrix recommends using the ICA/HDX MultiStream feature which splits ICA/HDX traffic into four separate TCP streams allowing a more granular prioritization to be specified.</p> <p><b>Note:</b> When using Branch Repeater MultiStream does not need to be manually enabled.</p>  | XD 5.x<br>XA 6.x |
| Webcams                | <p>The preferred method of mapping a webcam into a virtual desktop session is to connect it as a webcam</p>  | XD 5.x           |

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|                                 | <p>object rather than using generic USB redirection. This is because the virtual channel for webcam traffic, which leverages the Citrix Webcam Video Compression (CTXMM virtual channel), uses much less bandwidth and is tolerant of network latency (WAN connections). Furthermore, this technology allows multiple webcam-enabled applications (e.g. GoToMeeting HDFaces, Microsoft Lync) to use the webcam “in parallel”, since the webcam is released when not in use.</p>   |                  |
| Headsets                        | <p>If using a headset, it is generally best to send the audio over the Bidirectional Audio virtual channel (CTXCAM) instead of using Generic USB Redirection. This approach helps to minimize bandwidth consumption.</p>  | XD 5.x           |
| USB Telephones                  | <p>There are two methods available for mapping USB Telephones into user sessions:</p> <ul style="list-style-type: none"> <li>• Redirection as audio device</li> <li>• Redirection as generic USB device</li> </ul> <p>When redirecting the USB telephone as an audio device, only audio signals will be transferred. This is very efficient and even works in low bandwidth / high latency scenarios. Control commands such as ‘pick up phone’ and ‘dial number’ and not supported with ‘redirection as audio device’. These advanced functions require the telephone to be mapped as a generic USB device (CTXGUSB virtual channel). The use of ‘Redirection as general USB device’ is not recommended for WAN users due to the additional bandwidth requirements.</p> | XD 5.x           |
| Softphones – Audio Devices      | <p>It is generally best to use a headset with a microphone to avoid picking up ambient noise and generating echoes in the audio. Citrix recommends using a good quality headset with noise and echo cancellation, instead of computer or webcam built-in microphones.</p>   | XD 5.x<br>XA 6.x |
| Softphones – Audio Codec        | <p>Configure bidirectional audio to use the Optimized-for-Speech codec (also known as Medium Quality). The bandwidth consumption with this codec is 56 kilobits per second (28 kilobits per second in each direction). This is a low latency codec that is ideal for voice communications.</p>  | XD 5.x<br>XA 6.x |
| Softphones – Audio transmission | <p>For an increased audio performance (especially over WAN connections) Citrix recommends enabling the “Audio over UDP Real-Time Transport”. This technology provides excellent tolerance of network congestion and packet loss. Please note that this feature requires audio quality to be set to “Medium – optimized for speech”.</p>   | XD 5.5           |



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| Client Resources           | Only map client resources into virtual desktop user sessions that are explicitly required, as each resource connection generates traffic between the virtual desktop and the physical end-point increasing network utilization during the session startup and also increasing user logon times for low bandwidth / high latency connections or slow end-points. The client resource connections can be controlled using policies.  | XD 5.x<br>XA 6.x |
| Session Timeouts           | User sessions that are in an idle or disconnected state consume resources which cannot be allocated to active users. Therefore, configure Idle and Disconnected Session Timeouts for all user sessions so that these resources can be reclaimed after a specified period of inactivity.  | XD 5.x<br>XA 6.x |
| ICA Encryption             | For End-to-End security encrypt ICA traffic between the endpoint device and the XenApp server / virtual desktop using 128-Bit encryption. ICA encryption can be configured using policies.   | XD 5.x<br>XA 6.x |
| HDX 3D Pro – Video Options | <p>Select the most appropriate HDX 3D Pro video option based on user requirements:</p> <ul style="list-style-type: none"> <li>• When remote access is required to 3D applications, the GPU compression option should be used. GPU compression is the best option in situations where bandwidth is limited and latency is high. This requires a CUDA capable graphics card with at least 96 CUDA cores (128 recommended) and drivers containing the respective CUDA libraries on the server.</li> <li>• When users are located on the LAN, it is recommended that a higher bandwidth option such as the CPU codec or Lossless be chosen. Both provide increased quality and detail over the GPU codec. <ul style="list-style-type: none"> <li>○ <b>CPU:</b> This option provides a fallback for those who do not have a GPU installed on the server. It is a middle ground between image quality and bandwidth.</li> <li>○ <b>Lossless:</b> Delivers a pixel perfect experience for accessing 3D applications (i.e. required for medical images). While it utilizes less CPU on the server than the other options, it is very bandwidth intensive.</li> </ul> </li> <li>• <b>Fixed vs. Variable Quality:</b> When utilizing the GPU or CPU options, end users have the ability to select from fixed or variable image quality. It is recommended that users on low-bandwidth connections or those experiencing overshoot when moving objects or slowness use the variable quality setting.</li> </ul> <p>For more information, please refer to Citrix eDocs – <a href="#">HDX 3D Pro User Experience</a>.</p> | XD 5.5           |
| HDX 3D Pro –               | The endpoint hardware device should have a 1.5GHz (or higher) processor in order to have sufficient  | XD 5.5           |

|                      |  |  |
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| Endpoint<br>Hardware | resources for real-time decoding of the HDX 3D Pro video stream. |  |
|----------------------|--|--|



## Web Interface

| Area                               | Best Practice  | Applies To       |
|------------------------------------|--|------------------|
| Web Interface Redundancy           | If Web Interface is unavailable, users will be unable to launch new virtual desktops or published applications. At least two Web Interface servers should be deployed to prevent this component from becoming a single point of failure. For more information, please refer to the Citrix Knowledgebase Article CTX125715 - <a href="#">Web Interface Best Practices for Avoiding Major Production Outages</a> .   | XD 5.x<br>XA 6.x |
| Web Interface Load Balancing       | Multiple Web Interface servers should be load balanced by means of an intelligent load balancing appliance (i.e. Citrix NetScaler), which is able to verify the availability of the Web Interface service on a constant basis. Other less sophisticated load balancing mechanisms such as Windows NLB are not able to perform similar checks and might forward user requests to Web Interface Servers which are not able to process new requests. For more information, please refer to the Citrix Knowledgebase Article CTX128563 - <a href="#">Planning Guide: Load Balancing Web Interface with NetScaler</a> .   | XD 5.x<br>XA 6.x |
| XenDesktop Controller Connectivity | Web Interface sites for XenDesktop should be configured to communicate with all XenDesktop Controllers. This ensures reliability in case of a controller outage as well as a distribution of the user authentication / virtual desktop aggregation load across all controllers.<br><br>For more information, please refer to the following Citrix Knowledgebase Articles: <ul style="list-style-type: none"><li>• CTX131255 - <a href="#">High Availability for XenDesktop - Reference Architecture</a></li><li>• CTX131256 - <a href="#">High Availability for XenDesktop - Implementation Guide</a></li></ul>  | XD 5.x           |
| XenApp XML Broker Redundancy       | Each Web Interface server should point to two or more XML Brokers for reasons of redundancy. For large enterprise infrastructures, which typically have higher redundancy requirements, the following two methods are recommended: <ul style="list-style-type: none"><li>• Using an industry proven load balancer with built-in XML monitors and session persistency, such as Citrix NetScaler, provides the best performance and user experience.</li><li>• If a load balancer is not available, each Web Interface server should be configured with the address of at least two XML brokers in each farm.</li></ul><br>In order to simplify troubleshooting as well as maintenance, it is recommended to implement a 1:1 Web | XA 6.x           |

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|                             | <p>Interface site to XML broker relationship. This can be achieved by disabling the automatic load balancing of the XML brokers within the Web Interface properties. Nevertheless a second XML broker should be added to every Web Interface site for redundancy reasons.</p> <p>For more information, please refer to the following Citrix Knowledgebase Articles:</p> <ul style="list-style-type: none"> <li>• CTX131762 - <a href="#">High Availability for Citrix XenApp - Reference Architecture</a></li> <li>• CTX131763 - <a href="#">High Availability for Citrix XenApp - Implementation Guide</a></li> </ul>   |                  |
| Securing HTTP / XML traffic | <p>Encrypt HTTP traffic between the user devices and the Web Interface servers as well as the XML traffic between the Web Interface servers and the XenDesktop site / XenApp Farm to prevent usernames/domain information being transferred in clear text and passwords being transferred using weak encryption. For more information, please refer to Citrix eDocs – <a href="#">Configuring Web Interface Security</a>.</p>  | XD 5.x<br>XA 6.x |
| Secure Ticketing Authority  | <p>If Access Gateway or Secure Gateway is to be used, configure at least two Citrix Secure Ticket Authorities to prevent this component from becoming a single point of failure. To prevent failed logons and to optimize logon times, ensure that the STAs specified within Access Gateway / Secure Gateway match the STAs specified within Web Interface, including the order specified.</p>   | XD 5.x<br>XA 6.x |
| Scalability                 | <p>Sufficient resources should be assigned to the Web Interface Server, based on the results from scalability testing, to ensure that it does not become a bottleneck during periods of peak activity. Citrix has performed internal testing on the scalability of the Web Interface Server role and found that:</p> <ul style="list-style-type: none"> <li>• A dual 2.2 GHz CPU server running Web Interface 5.4 can handle more than ~30,000 sessions per hour.</li> </ul>   | XD 5.x<br>XA 6.x |
| Socket Pooling              | <p>Socket Pooling should only be enabled if SSL is used to encrypt the XML communications between the Web Interface and the XenDesktop farm / XenApp site. If there is a corrupt socket and pooling is turned on there is the distinct possibility that Web Interface will continue to reuse the corrupt socket causing problems. Disabling Socket Pooling means that Web Interface rebuilds the sockets each time one is needed. Without SSL this is not an expensive process and should not cause any problems in an environment. Furthermore Socket pooling should not be used when the Web Interface is configured to use one or more servers running XenApp for UNIX.</p> | XD 5.x<br>XA 6.x |



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|---------------------------------|--|------------------|
| Web Interface Location          | For reasons of security, Web Interface servers should be located on the internal network rather than a DMZ or external networks. For remote access scenarios Web Interface traffic should be proxied by means of Citrix Access Gateway appliances located within the DMZ.  | XD 5.x<br>XA 6.x |
| Two Factor authentication       | <p>For reasons of security, two-factor authentication should be integrated into the Access Gateway and Web Interface solution for all untrusted networks (i.e. Internet). Two-factor authentication requires the presentation of two “factors”</p> <ul style="list-style-type: none"> <li>• "Something the user has" (i.e. Hardware Token)</li> <li>• "Something the user knows" (i.e. Pin)</li> </ul> <p>This authentication mode decreases the risk of unauthorized persons accessing the environment by impersonating internal employees.</p> | XD 5.x<br>XA 6.x |
| Certificate Revocation Checking | For scenarios where Web Interface servers are not connected to the internet, it is recommended to disable the Certificate Revocation Check (CRC) functionality, as described within CTX117273 - <a href="#">Web Interface 5.x Delay on First Page</a> .  | XD 5.x<br>XA 6.x |

## Citrix Plug-In / Receiver

| Area         | Best Practice   | Applies To       |
|--------------|---|------------------|
| Versions     | Administrators should ensure that users connecting to the XenApp / XenDesktop environment are doing so with the appropriate plug-in or receiver type and that it is updated and properly configured. Ensure that all users leverage the same version of the Citrix Plug-In / Receiver, in order to simplify the support of the environment. Plug-ins can be installed, updated and configured on client devices through Active Directory as well as with Receiver using Merchandising Server.                                       | XD 5.x<br>XA 6.x |
| Installation | Citrix recommends launching the Virtual Desktop Agent MSI (XdsAgent.msi) only through Autorun, not in stand-alone mode by double-clicking the file. This is because the personal vDisk feature does not function if the MSI is installed in stand-alone mode. Also, the installation requires providing configuration information that the Virtual Desktop Agent requires to function correctly. Furthermore, the MSI may not revert any changes that made manually. However, if it is required to launch the Virtual Desktop Agent | XD 5.x<br>XA 6.x |

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|  | MSI in stand-alone mode, please refer to eDocs - <a href="#">Launching the Virtual Desktop Agent MSI in Stand-alone Mode</a> for guidance. |  |
|--|--|--|



## Users

### Training & Support

| Area          | Best Practice  | Applies To       |
|---------------|--|------------------|
| Support Roles | <p>Citrix recommends the following support roles in order to support XenApp/XenDesktop infrastructures:</p> <ul style="list-style-type: none"><li>• <b>Level One Support.</b> Provide first-line support of reported issues. Initially, servicing support messages and phone calls. Would need to perform initial issue analysis, problem definition, ticket routing, and simple issue resolution. Additionally can handle requests for application access or support with configuring plugins. Would escalate issues to Production Support Engineer. Relevant experience: 1-2 years</li><li>• <b>Level Two Support (Production Support Engineer).</b> Primarily supporting day-to-day operations of virtual desktops environment, may include proactive monitoring and management. In addition, this role would also perform advanced troubleshooting and utilize available monitoring / advanced troubleshooting tools. Assist with resolving issues escalated by Level One Support. Escalates issues to Level 3. Relevant experience: 2-3 years</li><li>• <b>Level Three Support (Build Engineer).</b> Central point for architecting, designing, implementing, administering and maintaining Citrix desktop and application virtualization infrastructure. This person would focus on deploying new use cases and leading lifecycle management initiatives. Generally, one Build Engineer could focus on one use-case at a time. For example, three new concurrent use cases would require three Build Engineers. Escalates issues to software vendor specific Technical Support and notifies Level 4 about this issue. Relevant experience: 3-4 years</li><li>• <b>Level Four Support (Architect).</b> Primarily focusing on translating business requirements into technical architectures, designing the infrastructure or planning migrations. Not involved in day-to-day support. Relevant experience: 5+ years</li></ul> | XD 5.x<br>XA 6.x |



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| Recommended Certifications | Based on the support roles outlined above, Citrix recommends the following certifications: <ul style="list-style-type: none"><li>• Level One Support<ul style="list-style-type: none"><li>○ Citrix Certified Administrator (CCA) for XenApp and XenDesktop</li></ul></li><li>• Level Two Support (Production Support Engineer)<ul style="list-style-type: none"><li>○ Citrix Certified Advanced Administrator (CCAA)</li></ul></li><li>• Level Three Support (Build Engineer)<ul style="list-style-type: none"><li>○ Citrix Certified Enterprise Engineer (CCEE)</li></ul></li><li>• Level Four Support (Architect)<ul style="list-style-type: none"><li>○ Citrix Certified Integration Architect (CCIA)</li></ul></li></ul> | XD 5.x<br>XA 6.x |
|----------------------------|--|------------------|

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| Rev. | Change Description  | Updated By  | Date           |
|------|---|---|----------------|
| 1.0  | Initial Document  | Citrix Consulting Solutions <ul style="list-style-type: none"> <li>• Andy Baker</li> <li>• Thomas Berger</li> </ul> | March 9, 2012  |
| 1.1  | <p><b>Modified Best Practices</b></p> <ul style="list-style-type: none"> <li>• XenDesktop Controllers - Desktop Director Hosting</li> <li>• License Server - Citrix License Server Redundancy</li> <li>• Hardware General – High Availability</li> <li>• Networking - End-to-End connection speed</li> <li>• Provisioning Services - Audit Trail Archiving</li> <li>• Microsoft Hyper-V - Virtual Disk Format</li> </ul> <p><b>Added Best Practices</b></p> <ul style="list-style-type: none"> <li>• XenDesktop Controllers - Scale Up/out</li> <li>• XenApp Controllers - Configuration Logging</li> <li>• XenApp Controllers - Anonymous Users</li> <li>• Web Interface - Web Interface location</li> <li>• Web Interface - Two Factor Authentication</li> <li>• ICA/HDX - Session Sharing</li> <li>• Citrix Plug-In / Receiver - Installation</li> <li>• Provisioning Services - Distributed Farms</li> <li>• Provisioning Services - Number of vDisks</li> <li>• Microsoft Hyper-V - Hyper-V Management</li> <li>• Systems Management - Backup Retention</li> <li>• Systems Management - Test Environment</li> <li>• Systems Management - Delegated Administration</li> <li>• Systems Management - Naming Scheme</li> </ul> | Citrix Consulting Solutions <ul style="list-style-type: none"> <li>• Andy Baker</li> <li>• Thomas Berger</li> </ul> | April 11, 2012 |



|     |  |  |                          |
|-----|--|--|--------------------------|
|     | <p><b>Deleted Best Practices</b></p> <ul style="list-style-type: none"> <li>• XenDesktop Controllers - XenDesktop Sites and physical locations (incorporated into new Scale Up/Out Best Practice)</li> </ul>   |  |                          |
| 1.2 | <p><b>Modified Best Practices</b></p> <ul style="list-style-type: none"> <li>• Policies – Number of Policies</li> <li>• Hardware – General Storage</li> <li>• Hardware – Power Management Options</li> <li>• Networking – DNS Aliases</li> <li>• Profile Manager – MFT Cache File</li> <li>• Desktop – HDX Monitor</li> <li>• Provisioning Services – Bootstrap Delivery</li> <li>• Applications – XenApp Server Reboot Policy</li> <li>• Hyper-V – Configuration Maximums</li> <li>• Active Directory – Active Directory Configurations</li> </ul> <p><b>New Best Practices</b></p> <ul style="list-style-type: none"> <li>• Provisioning Services – Caching of Citrix Application Streaming Profiles</li> <li>• Active Directory – Assigning Permissions</li> <li>• System Management – Automated Server Build</li> <li>• Web Interface – Certificate Revocation Checking</li> <li>• Personalization – Printing section</li> <li>• Hyper-V – Cluster Shared Volumes</li> </ul> | <p>Citrix Consulting Solutions</p> <ul style="list-style-type: none"> <li>• Andy Baker</li> <li>• Thomas Berger</li> </ul> | <p>November 27, 2012</p> |
| 1.3 | <p><b>Modified Best Practices</b></p> <p>Provisioning Services - Networking</p>  | <p>Citrix Consulting Solutions</p> <ul style="list-style-type: none"> <li>• Ed Duncan</li> </ul>                           | <p>August 30, 2013</p>   |
| 1.4 | <p><b>Modified Best Practices</b></p> <p>Updated recommendation to disable Large Send Offload on all versions of Provisioning Services.</p>  | <p>Citrix Consulting Solutions</p> <ul style="list-style-type: none"> <li>• Ed Duncan</li> </ul>                           | <p>June 25, 2014</p>     |

## About Citrix

Citrix Systems, Inc. (NASDAQ:CTXS) is a leading provider of virtual computing solutions that help companies deliver IT as an on-demand service. Founded in 1989, Citrix combines virtualization, networking, and cloud computing technologies into a full portfolio of products that enable virtual workstyles for users and virtual datacenters for IT. More than 230,000 organizations worldwide rely on Citrix to help them build simpler and more cost-effective IT environments. Citrix partners with over 10,000 companies in more than 100 countries. Annual revenue in 2011 was \$2.20 billion.

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