TECHNICAL WHITE PAPER



Citrix XenDesktop[™] v7.1 Tintri Native Clones Deep Dive

CİTRIX° READY

Exploring Citrix XenDesktop[™] v7.1 Provisioning using Tintri Native Clones on VMware vSphere[™] 5.1 and Tintri VMstore[™] TECHNICAL WHITE PAPER, Revision 0.1, April 2014

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Executive Summary

This paper explores machine creation & provisioning technologies in Citrix XenDesktop 7.1 deployed on Tintri VM-aware storage. The target audience includes IT admins, architects, and other technical roles that already have some experience with XenDesktop, vSphere and storage. If you do not have any experience with XenDesktop yet, we strongly suggest you follow our XenDesktop 7.1 Quick Start Guide to get a functional XenDesktop environment in place, and then continue reading this paper.

There are three methods available to provision XenDesktop virtual desktops:

- 1. Citrix Provisioning Services (PVS).
- 2. Machine Creation Services (MCS).

3. Tintri Native space and performance efficient VAAI Clones.

All three methods are all fully supported and work very well on Tintri VMstore systems. Deciding which method(s) to use for your organization depends on many factors, and the goal of the series of papers to give you more insight into each technology to help you make a well-informed decision for your enterprise.

This paper focuses on Tintri Native Clones and is intended to complement a main paper covering all methods: XenDesktop 7.1 Provisioning & Machine Creation Deep Dive. Without further ado, let's dive in!

Consolidated list of practices

The table below includes the recommended practices in this document. Click the text in the *Recommendation* column or see the section later in the document that corresponds to each recommendation for additional information.

Tags	Recommendation
Paging, swap files and patching	Do: If all of the virtual workstation VMs are paging often, you may not have allocated enough RAM to the VMs and should consider increasing RAM for each VM.
Paging, swap files and patching	Do: Use XenDesktop deployment that leverages a master image that can be updated once, centrally, in a more space-efficient deployment method.
Backup & DR of Tintri Native Clones Machine Catalogs	Do: Consider using per-VM local snapshots using SnapVM™ on the array for point-in- time backups, if required.
Backup & DR of Tintri Native Clones Machine Catalogs	Do: Tintri Native Clones would usually be used in special circumstances where the VMs are persistent and dedicated to an individual (e.g., developers), and the uniqueness of each VM is critical to your business, you may want to protect them to preserve business continuity and include them in your DR plan.
Backup & DR of Tintri Native Clones Machine Catalogs	Do: Consider using Tintri's ReplicateVM™ to protect your VMs on remote VMstore systems.
Backup & DR of Tintri Native Clones Machine Catalogs	Do: Consider utilizing DR infrastructure for pre-prod & staging tests as a way to maxi- mize infrastructure investments and test your DR copies often by making them a part of regularly scheduled business procedures.

Tintri Native Clones (VAAI) Overview

VMware vStorage APIs for Array Integration, or VAAI as it is more commonly referred to, is a powerful VMware technology baked into every Tintri VMstore. In a nutshell, VAAI offloads some tasks from the vSphere host to the storage device to leverage efficiencies built into an array. Tasks common to a XenDesktop environment that are improved through the use of VAAI include copying of disks (.vmdk files) and cloning entire VMs.

The benefit associated with VAAI allows for the actions requested from the vSphere client, PowerShell, or Citrix XenDesktop controllers take seconds to complete instead of minutes. An additional benefit is that there is no additional IO or compute overhead incurred on the host, resulting in higher VM density per host compared to linked clones comprised of VMware nonpersistent disks with REDO files.

How does VAAI work? Instead of actually writing a copy of data for a clone, the data stays in place and pointers are put in place within the array to use the data as if it were an additional copy owned by another VM.

VAAI is utilized automatically and assists in both MCS and PVS methods of provisioning described in the above sections, but "Tintri Native Clones" can be used as an alternative standalone method to further explore the ins and outs of running XenDesktop on Tintri.

Using this method, we end up with a collection of VMs that appear to be independent, selfcontained VMs from a vSphere perspective. However, each clone does not take up any additional space and is linked back to a common Tintri snapshot:

TINTRÍ							Sea	rch VM Alerts (1) Setting	s Diagr	iose Logout
Dashboard	Virtual Machine	25								
VMs Virtual d	isks Snapshot	s Y						Sta	ts at 6:00 P	M Clone Refres
VM .	IOPS	MBps	Reserves %	Latency ms	Flash hit %	Provisioned	Used GiB	Cloned from	VMwan	Tintri si UUID
CTX-VAAI-1	0	0.0	0.1	0.0	100	40	2.0	TintriVAAI-base Apr 14 2:25PM	0.0	0.0 5005a3
CTX-VAAI-10	0	0.0	0.1	0.0	100	40	1.9	TintriVAAI-base Apr 14 2:25PM	0.0	0.0 5005da
CTX-VAAI-11	0	0.0	0.1	0.0	100	40	2.4	TintriVAAI-base Apr 14 2:25PM	0.0	0.3 5005cf8
CTX-VAAI-12	0	0.0	0.1	0.0	100	40	1.9	TintriVAAI-base Apr 14 2:25PM	0.0	0.0 5005be
CTX-VAAI-13	0	0.0	0.1	0.0	100	40	1.9	TintriVAAI-base Apr 14 2:25PM	0.0	0.0 500508
CTX-VAAI-14	0	0.0	0.1	0.0	100	40	2.0	TintriVAAI-base Apr 14 2:25PM	0.0	0.0 50057f
CTX-VAAI-15	0	0.0	0.1	0.0	100	40	2.4	TintriVAAI-base Apr 14 2:25PM	0.0	0.3 5005c9
CTX-VAAI-16	0	0.0	0.0	0.0	100	40	1.9	TintriVAAI-base Apr 14 2:25PM	0.0	0.0 500524
CTX-VAAI-17	0	0.0	0.1	0.0	100	40	2.0	TintriVAAI-base Apr 14 2:25PM	0.0	0.0 50057b
CTX-VAAI-18	0	0.0	0.1	0.0	100	40	2.0	TintriVAAI-base Apr 14 2:25PM	0.0	0.0 5005a3
CTV MAAT 10	0	0.0	0.1	0.0	100	40	2.0	Tintelizant have not to a popple	0.0	0.0 500525

Figure 1-1: Virtual Machines, Cloned from column.

The clone relationships can also be seen from the VMstore UI. Simply navigate to the Snapshots view within the Virtual Machines tab and add the "Clone Count" column to the table view.

In the example shown in this screenshot, we have 25 VMs based on the same snapshot:

VMe Virtual disks Sna	nshots				Clone Delete Refres
	psnots				Cione Delete Refres
VM name or description	Search text in Source VM or Des	cription fields			more options >>
					~
Source VM	Created	Description	Changed MB	Туре	Clone count
CitrixXD71Eval	2014 Apr 10, 9:30AM	daily scheduled	130	Scheduled	0
CitrixPVS02	2014 Apr 10, 11:00AM	daily scheduled	0	Scheduled	0
CitrixPVS01	2014 Apr 10, 12:00PM	daily scheduled	104	Scheduled	0
CitrixPVS01	2014 Apr 10, 8:00AM	daily scheduled	478	Scheduled	0
CitrixPVS02	2014 Apr 10, 7:00AM	daily scheduled	0	Scheduled	0
CitrixSQL01	2014 Apr 10, 9:00AM	daily scheduled	196	Scheduled	0
TintriVAAI-base	2014 Apr 14, 2:25PM	for CTX-VAAI	3,045	Auto	25
CTXWIN8PVS-0001	2014 Feb 26, 10:08PM	for CTXWIN8PVS-0002	224	Auto	53
DOM_4CLONING	2014 Apr 3, 7:23PM	for DC-W2012-3	7,893	Auto	1
DC-W2012-3	2014 Apr 3, 7:52PM	for DCw2012_4CLNG	560	Auto	1
Dom-2012-3	2014 Apr 1, 3:31PM	for Dom-2012-2	917	Auto	1
Dom-2012	2014 Mar 25, 1:21PM	for Dom-2012-2	1,984	Auto	1
Dom-2012-2	2014 Mar 31, 7:59PM	for Dom-2012-3	825	Auto	1
DC-W2012-4	2014 Apr 3, 1:56PM	for DOM-TTClone	815	Auto	1
DCw2012_4CLNG	2014 Apr 10, 4:10PM	for DomJBox	1	Auto	1
PVS-NonPers	2014 Mar 26, 2:11AM	for PVS-NonPers	71	Auto	25
tion all a 1	2012 Aug 14 2:020M	for tingle	40	Auto	

Figure 1-2: Virtual Machines, Clone count column.

Using this provisioning method in its simplest form as shown in this section, a deployment strategy like this is quick and easy to put in place if you manage your virtual desktops similarly to your traditional physical desktops. Updates to the OS, anti-malware, and applications would all be handled through 3rd party tools, such as Microsoft WSUS, SCCM, GPO's, or any other enterprise management system.

The Good, the Bad & the Ugly

This section is devoted to highlighting Pros, Cons and Gotchas for this specific method of provisioning desktops. In some environments weakness listed may be a showstopper, whereas in other environments, it may not cause any inconvenience at all. One size does not fit all, so one needs to weigh the importance of each strength/weakness based on the environment in which the solution is going to be deployed.

Pros

Provisioning and maintenance.

- Easy to create space and performance efficient VMs.
- Full visibility of all IO activity can be seen per-VM in the VMstore.
- Great for persistent desktops that are assigned to a specific user instead of configuring your delivery group for a random pool.
- Can be combined with a 3rd party configuration management solution for updates and compliance, such as SCCM, WSUS, Group Policies, etc.
 - If you are new to any sort of VDI and have run traditional desktops up to now, this method can be run the same as you would have run your physical desktops, giving you time to re-focus your strategy to take advantage of all the benefits Virtual Desktops offer that physical desktops don't, such as their proximity to data and high-bandwidth, assuming the servers & services are local to the Workstation VMs.
- VMs can be easily cloned using CloneVM[™] for test/dev

Data protection and disaster recovery.

• SnapVM[™] can be used for local data protection for quick recovery.

ReplicateVM[™] can be used for protecting VMs at a per-VM level.

Cons

Provisioning and maintenance.

- Does not have a mechanism to update a master image.
- Weaker audit trail compared with PVS and MCS.

Storage and IO consumption

- Very space efficient at first, but as time goes on and updates are made within the Guest OS (i.e. Windows and anti-malware updates), VM changes will drift further from the master Tintri snapshot, consuming additional space.
- In order to create a new machine catalog or add to an existing one, each cloned VM needs to be powered on for Guest Customization process to run. Although the cloning completes in seconds, the resulting boot storm & reboots of systems running sysprep can put stress on your hosts, depending on how many VMs are being created.

Gotchas

If you are creating a new machine catalog of VMs for an updated image version and plan to delete the old ones, the VM ID will change. While the data in any given VM is not of value given 100's of other copies, the historical performance and usage baselines associated with the VMs may be lost (vCenter, vCOPs, or some other monitoring tool).

Big Bang Theory – Machine Catalog Creation Process

To create our Machine Catalog of Tintri Native Clones, we'll perform these steps:

- 1. Base the pool of Tintri Native Clones on the Master Image prepared for MCS or PVS.
- 2. Using the Tintri UI, clone the Master Image VM, specify how many clones you want and be sure to apply a guest customization specification. If you do not have a guest customization spec, create one in vCenter using the vSphere Web Client.

TINTRI Dashboard Virtual Machin	8						Search	VM Aliens	(1) Sell
VMs Virtual disks Snapshot	v n								
· IOPS	s MB	s Reserve	s Laten	cy m	Flash hit 9	Provisione	Used GiB	UUID	Cloned fro
TintrivAAI-base	37	1.3	0.4	0.9	100	42	16.4	5005c1de-7_	Win81Logn
Aug D			-	0.0	100	0	3.6	52632709-0	
ucsad	Right-Cli	ck VM and select:	Clone	0.0	100	38	21.3	5005602c-1	
vc2			_	0.6	100	110	=122.4	52187¢97-5	-
kMware vCenter Server Ar	0	0.0	0,3	0.0	100	0	- 22.7	501e68/5-9	
vSphere Data Protection	95	4.3	3.5	0.5	100	876	50.8	50053597-7_	
Win2012GoldImg	0	Crea e new VMs fr	om TintriVA	AI-base					× 1.28,
Wm201282_0C_Eval	D								
With2KB JAD 2 dome	0	Snapshot:	Current Cr	ash-cons	istent state				-
With1-TestCloneWithCom	0		Current V	4-consiste	ent state				
Wasé I_Clane	0		Mon Apr 1	4 5:30AM		Machine	s will be autor	matically	IntEy
finitations) 122 al 122 million at provincial	1075. 0 700		Sun Apr 1	3 5:30AM		CTX-V	Med serially a AAI-1, CTX-V	as: /AAI-2, t	•
IOPS Heps Latency more	-	Clone name:	CTX-VAAI	_		7	etc		
600 1		Datastore:	local						-
		Host / Cluster:	vc2.ttucs.	tm: UCS	Blades				-
500		Customization:	Windows	8 - EVAL					-
		Count:	25						
400							S Cle	one Cancel	
300				_					

Figure 3-1: Create new VMs from TintriVAAI-base.

- 3. After Tintri clone VMs have been created and added to vCenter, **power on the VMs** to finalize the customization process.
- 4. The Guest Customization process runs sysprep, gives the VMs unique names, assigns license keys and joins the VMs to the AD domain.
- 5. Once the process has completed, verify that the Computer accounts exist in AD for the newly created machines. If not, make sure your AD topology has had time to replicate between DCs. If the Computer accounts still aren't present, your guest OS customization process may have failed and requires investigation.

6. Using Citrix Studio, **create a machine** catalog and specify that the machines are based on "**Another service or technology**" (as shown in screenshot)

Studio	Machine Management
	As part of creating a Machine Catalog, the way you plan to provision machines influences the recommended Machine Catalog type.
✓ Introduction	Learn more
Operating System and	This infrastructure will be built using:
Hardware	 Virtual machines
Machine Management	Physical hardware
Desktop Experience	
Virtual Machines	Desktop images are managed using:
Summary	Machine Creation Services (MCS)
	Provisioning Services (PVS)
	Q Another service or technology I will manage my deticitio ganges with something other than Citrix technology. I have existing Master Images already prepared.

Figure 3-2: Create Machine Catalog.

7. Select the VMs you just created (shown below) and map each to their corresponding Windows AD accounts when prompted.

Studio	Virtual Machines	
	Select VMs	
Introduction	CIX-VAAI-19 0	
Operating System and	CTX-VAAI-2 🕄	î
Hardware	CTX-VAAI-20 🕄	
Machine Management	CTX-VAAI-21	Π
Desktop Experience	CTX-VAAI-22 🕤	
Virtual Machines	CTX-VAAI-23 🕤	
Summary	CTX-VAAI-24 🕄	
	CTX-VAAI-25 🕤	
	CTX-VAAI-3	
	CTX-VAAI-4	*
		_

Figure 3-3: Create Machine Catalog.

- 8. Move your AD computer accounts into a specified XenDesktop OU to ensure the appropriate GPOs and settings apply.
- 9. Assign machines from your new Machine Catalog to a Delivery Group. You are good to go!

Consideration Factors

This section provides additional factors specific to this method that are useful in evaluating how best to run your XenDesktop infrastructure.

Paging, swap files and patching

The swap files on a Tintri VMstore are thin-provisioned and do not consume space until data is written to them. Data will be written to swap when memory is under pressure in the host. To reclaim storage space consumed by swapped memory, a power-cycle of the VMs is all that is required.

When memory is under pressure in the VM, it is written to the pagefile within a VM, which consumes space within the vmdk. Unfortunately, that space is not reclaimed on a reboot or power cycle. However, the page file should continue to dirty the same blocks. Generally speaking a page file is approximately the same size as VM memory, so consider this space as an operational requirement for each clone (at rest or while powered on).



Do: If all of the virtual workstation VMs are paging often, you may not have allocated enough RAM to the VMs and should consider increasing RAM for each VM.

All updates to the VMs should be considered as they too will create data change from the time of the original clone, which will consume capacity from your VMstore for each VM. Example, you apply Windows Service Pack X, which accounts for 1 GB of changed blocks. The amount of capacity consumed will be linear for the number of VMs you have. 500 VMs x 1 GB = 500 GB consumed. However, 1 GB changed in a single master image with 500 VMs linked to it = 1 GB consumed from the datastore.



Do: Use XenDesktop deployment that leverages a master image that can be updated once, centrally, in a more space-efficient deployment method.

Persistence

If persistence is important to your organization, consider using Tintri Native clones. If your desktops require persistence across reboots and power cycles, determine if it's your whole desktop you need to keep, or just the User's profile.

Audit & Compliance

Environments with strict audit and change control may need to provide evidence for certain administrative activities. Check the logs to ensure expected actions are in fact recorded, and are sufficient evidence to meet the audit and compliance requirements of your environment.

Does activity within your desktops need to be maintained for security or compliance purposes? If so, you can't depend on the event logs of stateless systems as all traces of guest activity is lost on reboot or power cycle. If the Event logs or other monitoring software within the guest require retention, consider a centralized logging solution to record and maintain yours logs outside of your desktops VMs.

Additional Factors

In addition to these, there are many other factors to consider that are common to all of the methods of provisioning that are detailed in XenDesktop 7.1 Provisioning and Machine Creation Deep Dive paper and we recommend you review that paper as well.

Audit & Compliance

In environments with strict audit and change control, you may need to provide evidence for certain administrative activities. MCS has audit logging built in, which is enabled by default. Check the logs to ensure that actions you expect to be recorded are in fact recorded, and are sufficient evidence to meet the audit and compliance requirements of your environment.

Does activity within your desktops need to be maintained for security or compliance purposes? If so, you can't depend on the event logs of stateless systems as all traces of guest activity is lost on reboot or power cycle. If the Event logs or other monitoring software within the guest require retention, consider a centralized logging solution to record and maintain yours logs outside of your desktops VMs.

Additional Factors

In addition to these, there are many other factors to consider that are common to all of the methods of provisioning that are detailed in the main Provisioning and Machine Creation Deep Dive paper and we recommend you review that paper as well.

Management & Housekeeping

"The Only Thing That Is Constant Is Change" – Heraclitus

You don't need to be in IT very long to appreciate this quote! IT environments constantly change; staying on top of the changes is critical. This section is dedicated to raising awareness to some of the overall support & management costs.

Adding additional VMs to a catalog

Adding additional VMs to a catalog of Tintri Native clones is as simple as the creation process. Simply clone the snapshot that was used to create the original collection of clones to create more, and then add them within Citrix Studio to the same Machine Catalog (or a new one). Once in a machine catalog, you'll want to also add them to your delivery group to make them available for users to log on to.

Although it is simple clone out many more from the same snapshot or VM you used before, consider updating the image to bring it current (Windows updates, AV updates, etc) before making new clones. By updating your base before cloning, you'll benefit from capacity savings you won't otherwise have because he the data involved in each update would be saved uniquely for each clone.

The Image Update Process

This method of machine provisioning does not update easily as PVS and MCS deployments do. Updates would primarily be taken care of on the network and within the guests as opposed to being made in a single master image.

If a new master image is to be rolled out, it's best to create a new Machine Catalog containing a new batch of clones and present that to your users while hiding the old version until it is deprecated and ready for deletion. The new clones consume very little space each upon creation and powered off VMs do not consume any host resources (CPU/Memory/Network/etc.).

Image Versions

Keeping a record of image versions is best handled by keeping a VM for each new version in a dedicated folder in vCenter. Use an additional clone and do not add it into your Citrix Machine Catalogs. We recommend labelling this VM in a way that identifies it as version placeholder, such as Win81_XD_v13. When you need a new version, clone this to Win81_XD_v14, power on the VM and make your guest changes, and then make clones to populate a new machine catalog.

Data Protection & Disaster Recovery (DR) Overview

Backup and DR for XenDesktop environments need to consider more than simply ensuring good copy of data is available somewhere, such as a backup tape or offsite location. Desktops aren't often backed up for their unique data, but are instead the tools (OS + Applications + Configuration) that allow users to access their data (databases, email, application-specific files, etc.). A full and comprehensive DR strategy is out of scope for this paper, but this section provides some direction on what should be considered for backups.

You can break your XenDesktop infrastructure down to three major components:

- XenDesktop Infrastructure Servers XenDesktop Controllers, StoreFront, SQL servers, etc.
- XenDesktop Machine Catalogs The virtual workstation VMs.
- Dependencies User profiles, redirected folders, data, and the rest of the corporate infrastructure (i.e. the goods that users access their virtual desktops to access).

In the paper, we'll look only at the Machine Catalog. In XenDesktop 7.1 Provisioning & Machine Creation Deep Dive paper, we'll cover some backup & DR aspects of XenDesktop Infrastructure Servers, but the dependencies are largely out of scope other than mentioning them so they are not overlooked.

Backup & DR of Tintri Native Clones Machine Catalogs

A XenDesktop machine catalog comprised Tintri Native Clones is relatively easy to backup and protect. The VMs act like typical VMs to any backup software that supports VM backups. Using your backup software, simply select the VMs to backup and back them up.

Typically, virtual desktops do not have anything unique about them so all you would need to backup is a master and then repeat the process of creating the machine catalogs to restore them. This does not consume a lot of backup storage or processing overhead.



Do: Consider using per-VM local snapshots using SnapVM[™] on the array for point-in-time back-ups, if required.

Space consumed by snapshots is simple to monitor in the Tintri UI and can be found:

- Summarized in the space gauge on the main dashboard.
- In the snapshot summary page.
- In the Virtual Machines summary list with Tintri Snapshots column added in the Tintri UI.

Do: Tintri Native Clones would usually be used in special circumstances where the VMs are persistent and dedicated to an individual (e.g., developers), and the uniqueness of each VM is critical to your business, you may want to protect them to preserve business continuity and include them in your DR plan.

Do: Consider using Tintri's ReplicateVM[™] to protect your VMs on remote VMstore systems.

Tintri ReplicateVM leverages per-VM snapshots to only replicate incremental block-level changes between snapshots after dedupe and compression, for up to 95 percent reduction in WAN utilization. Multiple sites replicating to a single site provides additional WAN efficiency

because of cross-site deduplication Tintri ReplicateVM preserves space efficiency of clone VMs on remote VMstore systems, reducing the storage footprint for data protection while maintaining high performance.

To use ReplicateVM, simply create a snapshot and protection schedule for each VM, or set a global schedule and let each VM adopt it. To recover a VM on the remote side, simply clone it to a new VM and will be added to inventory. Adding it back to your XenDesktop infrastructure will vary depending on whether you have two or more active sites, or one site that is replicated and brought up in the remote site with the same identity.



Do: Consider utilizing DR infrastructure for pre-prod & staging tests as a way to maximize infrastructure investments and test your DR copies often by making them a part of regularly scheduled business procedures.

Conclusion

While there is no "right" or "wrong" method to use for your XenDesktop deployment, there are pros and cons associated with each. There are some use cases where this method of provisioning will work well, such as a one-time "set it & forget it" deployment, similar to the rollout of standard physical PCs; but in a large and dynamic environment, this method alone probably won't cover all of your needs.

We recommend you review our main Provisioning and Machine Creation Deep Dive that discusses many factors critical to a successful XenDesktop deployment, regardless of the provisioning method you choose. Additionally, review the Deep Dive papers specific to PVS and MCS and consider mixing and matching the best from each.

Additional Resources – Reference URLs

Tintri Links

- XenDesktop 7.1 Quick Start Guide Covers all the perquisite tasks required to get a XenDesktop environment up and running on Tintri storage.
- XenDesktop 7.1 Provisioning & Machine Creation Deep Dive Referenced throughout this paper as "the main" provisioning deep dive paper and contains information that applies to all XenDesktop provisioning methods, and compares the method discussed in this paper to alternative methods.
- XenDesktop 7.1 Provisioning Services (PVS) Deep Dive A similar paper to this one that focuses on PVS as an alternative method of provisioning virtual desktops.
- XenDesktop 7.1 Machine Creation Services (MCS) Deep Dive A similar paper to this one that focuses on MCS as an alternative method of provisioning virtual desktops.
- XenDesktop Best Practices white paper.
- NFS Best Practices.
- Additional resources.

Citrix Links

- Citrix XenDesktop eDocs.
- Citrix Blog series that focus on image management:
 - Part 1: PVS The myths and tales of image management.
 - Part 2: MCS The myths and tales of image management.
 - Part 3: MCS vs View Composer.

Other

- VMware FAQ for VAAI.
- Login VSI Load Testing tool for VDI environments.
- FSLogix.

Appendix A – Environment Details

This guide was written to be applicable to any server hardware and all supported versions of VMware vSphere. In case your own results vary from what you've seen in this paper, here is a high-level overview of the lab equipment used:

Hardware

Storage: Tintri VMstore T540 running Tintri OS v2.1.2.1 Servers: Cisco UCS B22-M3 blades

Software

VMware vSphere 5.1 U2 – Build 1612806 Tintri vSphere Web Plugin v1.0.0.1 (includes the Best Practices Analyzer tool) Server OS: Windows Server 2012 R2 – Datacenter Edition Desktop OS: Windows 8.1 Citrix XenDesktop 7.1 Citrix PVS Provisioning Services 7.1