SAP High Availability in virtualized environments running on Windows Server 2012 Hyper-V

Part 1: Overview

Introduction

Almost everyone is talking about virtualization and cloud computing these days. This doesn’t mean though that certain “old-fashioned” topics suddenly vanished into thin air.

While there might be new and better or more efficient ways how those tasks can be accomplished they are still necessary. No matter which platform or software package is used – at some point it’s e.g. required to upgrade an operating system. Virtualization and cloud computing won’t make this obsolete. It might be hidden within a service offering but somehow it still has to be done.

Virtualization and private cloud are changing IT processes and will add a lot of value. But it doesn’t change the fact that like before an answer is needed regarding the question what happens if some kind of natural disaster knocks out a data center.

High Availability (HA) and Disaster Recovery (DR) continue to be essential topics for every IT department. The same is valid for planned hardware or software maintenance time slots. Moving stuff to a public cloud might take it away from the customer site. As mentioned earlier – this doesn’t mean it’s no longer existent. Now the cloud provider has to take care and provide appropriate SLAs.

It’s also not the case that the way how businesses work today would maybe no longer require sophisticated HA or DR solutions. Well - it’s the opposite. Looking at the study from Aberdeen below one can see evidence that system downtime became even more critical for businesses over the last few years.

http://blogs.aberdeen.com/it-infrastructure/the-cost-of-downtime-is-rising/
There are of course different reasons for system downtime. One can find reports like this one which provide a ranking for the most common system downtime causes:

**Quorum DR Report**

Top 4 Types of Disasters:

- 55% Hardware Failure
- 22% Human Error
- 18% Software Failure
- 5% Natural Disasters

Average Downtime per event: 3.4 days
Average cost per hour: $74000

Other sources like the one below state that over a third up to 75% (according to some studies) of all disaster root causes might be in fact some kind of human errors:

The whole HA topic is pretty complex. Besides the obvious failures and also planned maintenance windows which lead to system downtime there are a lot of additional aspects which have an impact on system availability. Here is a short list of samples just to give an idea:

- organizational aspects (e.g. one single system admin, process documentation )
- data center infrastructure (e.g. air condition, power source )
- servers (e.g. Single-Point-Of-Failure SPOF – all servers in one single rack )
- OS (e.g. planned downtime for patches, upgrades )
- storage (e.g. failures, firmware updates )
- applications (e.g. failure, upgrade, patches )
- integration of different software (e.g. HA of integrated 3rd-party systems )
- performance (e.g. unacceptable performance means unavailability for users )
- security (e.g. DoS attack, ADS server failure )
- network (e.g. HA of switches or DNS server )
- clients (e.g. connectivity to backend system )

This document will focus only on the technical aspects of operating a core SAP NetWeaver stack in a virtualized environment running on Windows Server 2012 Hyper-V. It doesn't cover the business side where a customer has to assess the costs of system downtime versus the costs of a high availability / DR solution.

The huge momentum of virtualization and private cloud doesn't make high availability obsolete. One important question which therefore has to be answered:

how to achieve high availability in a virtualized environment ?

The next chapter will give a first answer in form of a brief overview. More details especially about the technical implementation will be described in future blogs.
Windows Server 2012 introduced a lot of new features and capabilities related to high availability in physical and virtual environments. WS 2012 is a real breakthrough especially for virtualized SAP landscapes as all the limitations in the former Hyper-V release are gone. There is no reason anymore to abstain from the benefits of working with virtualized servers which provide not only more flexibility but also better overall availability of business critical applications.

The new features which are especially relevant for SAP installations can be grouped into three main categories:

1. Virtualization
2. Cloud
3. Enterprise Readiness

Here is a shortlist of important features in Windows Server 2012 which will make life for SAP landscape and infrastructure administrators so much better. For further details on all these features please check the links at the end of this document:

**Scalability**
- up to 320 logical CPUs and 4TB memory on a Hyper-V host
- up to 64 virtual processors and 1TB memory per virtual machine

**Network virtualization**
- virtual network switches
- different IP ranges for VMs and physical host via WS2012 DHCP policies
- NIC teaming built-in

**Disk/Storage**
- up to 1 million IOPs per virtual machine
- SR-IOV (Single Root IO Virtualization – accelerate IO to PCI devices such as network cards)
- virtual fibre channel (vSAN)
- SMB 3.0

**Live Migration**
- live migration in non-clustered environment
- shared nothing live migration
- live migration of multiple VMs at the same time

**Hyper-V Replica**
- asynchronous replication of a VM (block level replication) to a remote site

**Powershell**
- 2000+ new PowerShell cmdlets (around 160 for Hyper-V)
Windows Server Failover Clustering Improvements:

- up to 64 cluster nodes and 8000 VMs per cluster
- Cluster Aware Updating – CAU
- Improved Quorum configuration
- Continuous availability – transparent SMB 3.0 failover
- Integrated task scheduler (HA)
- Improved Cluster Shared Volumes (CSV)
Basic WS2012 Hyper-V HA scenarios

While there are many improvements in Windows Server 2012 / Hyper-V related to high availability the main feature to manage unplanned downtime is still WSFC. Therefore the basic concepts which were described for Windows Server 2008 R2 are still valid. Let’s look now at six major HA scenarios and show how Windows Server 2012 Hyper-V provides an enterprise ready virtualization platform even for the most critical SAP Business Suite installations:

Different HA categories when virtualizing the whole SAP landscape:

1. Partial : virtualizing application servers / dialog instances only and keeping the database as well as message server and ERS on bare-metal.
   This is the easiest way to start with virtualization in a SAP landscape. No specific HA configuration is needed for application servers / dialog instances. It’s handled by redundancy. One just has to make sure that there are enough of them running on different physical servers.

2. Low : rely on storage only (e.g. RAID) / backup

3. Medium : accept downtime due to HA only on host level

4. High : HA on host level + application level inside VMs

5. Ultra : HA across data centers or fire safety zones

6. Ultra+ : business continuity -> adding disaster recovery in 3rd remote DC
Legend of pictograms used in the graphics on the following pages:

- **Windows Server 2012**
  Hyper-V Host

- **Local storage**
  (iSCSI, FC, SSD, Pass-through)

- **Shared storage**
  (iSCSI, FC, CSV, SMB 3.0, SAN)

- **Storage Virtualization**
  across site boundaries or data center boundaries via sync replication/mirror

- **VM on Hyper-V online**

- **VM on Hyper-V offline**

- **VM failover -> not existent yet**

- **SQL Server 2012**

- **SAP Application Server**

- **SAP SPOF ( (A)SCS )**
  Message Server + Enqueue Replication Server ERS
Scenario 1 - Partial: virtualizing application servers / dialog instances only and keeping the database as well as message server and ERS on bare-metal

A first and easy step into the world of virtualization could be to just run the SAP application servers / dialog instances in virtual machines. For these instances there is no need for specific failover considerations. HA is achieved by redundancy. It's important that enough instances are available and distributed over multiple physical servers or server racks to avoid a Single-Point-Of-Failure (SPOF). Depending on the workload they might share the cluster nodes with the database or Enqueue Replication Server (ERS) bare-metal installations.

This concept also works for planned downtime (e.g. OS patching inside a VM). One could even think about just deleting a VM and creating a fresh VM from a template with current OS patch level and installing a new SAP application server / dialog instance from scratch “on the fly” which will then be added to the existing SAP landscape as described here:


This means that all existing HA concepts for the database and the ERS stay the same in this first phase of virtualization. For very conservative customers this approach allows to get familiar with Hyper-V and all the functionality around it including great features like live migration without touching the most critical components yet like the main database server.
HA Scenario 2 – Low: rely only on storage (e.g. RAID) / backup

Options:
- Shutdown -> create consistent copy via Hyper-V Replica
- VM Export
- Usage of existing SAN Replication to create backup copy
- Backup on VM OS level
- Suitable for training, project, demo or sandbox systems

The lowest level of HA means no specific considerations on the host / VM level or inside the VM. One just relies on the storage which might provide some level of HA e.g. via RAID. It could be still useful though to use live migration for moving a VM because of server maintenance. In this regard virtualization reduces planned downtime by default.

This configuration is fine for training, project or sandbox systems. Depending on the lifetime of those systems it’s good practice to create a copy/backup to be able to restore in case of a crash or corruption.
There are customers who want HA but are fine with implementing it just on the host / VM level. This gives protection against hardware failures and reduces downtime for physical server maintenance either by a manual failover of complete VMs or live migration to relocate VMs to another cluster node.

What it cannot cover though is full HA on the application level inside the VMs. A standard SAP HA installation on Windows requires a failover cluster. To abstain from a guest failover cluster therefore means to abstain from a SAP HA installation. This is related to the message server and ERS. For SQL Server the issue could be minimized by using AlwaysOn in SQL Server 2012 which can keep two database copies in sync mode.

For many customers it’s absolutely sufficient to work with this level of HA. Of course regular downtime windows are required to handle e.g. OS patches inside the VMs.
HA Scenario 4 – High: HA on host level + application level inside VMs

For the highest level of uptime using a SAP HA installation and where it’s required to allow rolling updates inside the virtual machines to further minimize planned as well as unplanned downtime a combination of host-level failover and guest clustering is possible and supported. SAP note 1374671 “High Availability in Virtual Environment on Windows” describes the items to consider:

What may NOT happen in this scenario is a failover of a VM on host-level which could end up in a situation where both SAP SCS instances run on the same physical server. This would jeopardize the whole idea of SAP ERS and replicated enqueue.

So far we just looked at local HA using one physical storage box. The next scenario shows how it looks like if one wants to be also safe in case of a fire in the data center.
HA Scenario 5 – Ultra: HA across Data Centers or fire safety zones

To protect against more severe failures inside a data center (e.g. fire) it’s necessary to think about HA across fire safety zones or even across separate data centers. Using SQL Server 2012 AlwaysOn it’s possible to just use some local storage on both sides as the database takes care of synchronous replication across the borders. But what about the SAPMNT directory and other non-database data which sits on the file system? Sure - one can try to keep two copies manually up-to-date on both sides.

If it’s required though to provide the highest level of HA like before within one data center then there is no other way than using some kind of storage virtualization based on replicating the file system in sync mode. This could be accomplished by storage replication features on the storage hardware level or software based solutions like Falconstor, Symantec, Steeleye or Libelle.

The storage virtualization implementation has then also to integrate with Windows Failover Cluster. This way it’s possible to install WSFC across data centers or fire safety zones.
HA Scenario 6 – Ultra+:
Business Continuity -> adding disaster recovery in 3rd remote DC

Last but not least it’s important to assess if a DR solution is required / useful. Looking at the scenario before - it could be enough for a customer to implement HA across data centers. The limited distance to allow synchronous replication will be still sufficient to also protect against fire and very likely also flooding or even an earthquake. It might look different though thinking about political instability, energy disruption, a huge hurricane or some other very extreme weather conditions which might heavily impact an area spanning a few hundred miles. For the latter case one would need a remote DR site where typically some kind of asynchronous replication will be used. There are different options how to implement DR where one has to weigh between costs and benefit which is also related to the question how long it might take to bring a DR site online.

A simple way could be to use a database feature like AlwaysOn in SQL Server 2012 to create a DR copy of the database in a remote data center or public cloud. In the rare case of a total disaster it could be then acceptable to just install a fresh SAP system and restore the database DR copy. It’s obviously much more effort to try to create a consistent DR copy of a complete SAP landscape including the file system (e.g. SAPMNT directory) and maybe consisting of different databases and different OS types.

Storage vendors like NetApp offer solutions for DR of a complete SAP landscape. But there are also software companies like Libelle in Germany who provide DR solutions which allow to create consistent DR copies even across heterogeneous environments.
Talking about DR and asynchronous replication automatically raises the question if/how the new Hyper-V replica feature in WS2012 can be used for SAP landscapes.

Hyper-V replica is not meant to replace SQL Server AlwaysOn. This leaves e.g. the option to create an asynchronous replication of the SAP SPOF server or cluster nodes holding the SAPMNT directory and the VMs running the SAP application servers.

As it’s asynchronous one has to keep in mind that depending on the activity (e.g. installing a new SAP kernel) there might be an inconsistent state on the target site for a limited period of time (up to approximately five minutes on Windows Server 2012) until the next replication phase will make it consistent again.

In its current version Hyper-V replica is VM based. There is no out-of-the-box synchronization when replicating multiple VMs.
Now let's assume one wants to do a standard HA installation of the SAP SCS instances in a virtualized environment. On Windows/SQL Server this automatically leads to a guest failover cluster configuration. And this means that there must be a shared device which both VMs can see and which holds e.g. the SAPMNT directory and the SAP binaries.

Unfortunately the current version of Hyper-V replica doesn't support shared devices between two VMs. As a result - for the SAP SCS instances in a fully virtualized environment one has to choose between the following two major options:

a, SAP HA installation and guest failover cluster but no Hyper-V replica
b, no SAP HA installation but the possibility to use Hyper-V replica

Hyper-V replica as released on Windows Server 2012 cannot replicate shared disks, such as those used in a typical two node ASCS cluster. In such cases it would be possible to create a script to copy the SAPMNT directory to a local disk (such as C: drive) periodically.
You will find additional information under the following links:

“SAP NetWeaver High Availability and Business Continuity in Virtual Environments with VMware and Hyper-V on Microsoft Windows”
http://scn.sap.com/docs/DOC-32869

“What's New in Failover Clustering”

“Installing the Failover Cluster Feature and Tools in Windows Server 2012”
http://blogs.msdn.com/b/clustering/archive/2012/04/06/10291601.aspx

“Hyper-V Cmdlets in Windows PowerShell”

“Failover Clusters Cmdlets in Windows PowerShell”

“What's new in Microsoft Hyper-V Server 2012”

“Configure and Use Live Migration on Non-clustered Virtual Machines”

“Shared Nothing Live Migration on Windows Server 2012”

“Follow me and learn Windows Server 2012 – Cluster Aware Updating”

“Over 1 million IOPS from a single VM”

“New and Improved Networking Capabilities in Windows Server 2012”

“NIC Teaming (NetLBFO) Cmdlets in Windows PowerShell”

“How to Move Highly Available (Clustered) VMs to Windows Server 2012 with the Cluster Migration Wizard”

http://www.aidanfinn.com/