Hyper-V - VM Live Migration

Hyper-V Live Migration is first introduced in Windows Server 2008 R2 and enhanced lot in later versions. Hyper-V live migration moves running virtual machines from one physical server to another with no impact on virtual machine availability to users. By pre-copying the memory of the migrating virtual machine to the destination server, live migration minimizes the transfer time of the virtual machine. A live migration is deterministic, which means that the administrator, or script, that initiates the live migration determines which computer is used as the destination for the live migration. The guest operating system of the migrating virtual machine is not aware that the migration is happening, so no special configuration for the guest operating system is needed

Requirements
Common requirements for any form of live migration:
- Two (or more) servers running Hyper-V that:
    - Support hardware virtualization.
    - Use processors from the same manufacturer. For example, all AMD or all Intel.
    - Belong to either the same Active Directory domain, or to domains that trust each other.
- Virtual machines must be configured to use virtual hard disks or virtual Fibre Channel disks (no physical disks).
- Use of an isolated network, physically or through another networking technology such as VLANs, is recommended for live migration network traffic.

Requirements for live migration in a cluster:
- Windows Failover Clustering is enabled and configured.
- Cluster Shared Volume (CSV) storage in the cluster is enabled.

***Note*:** Physical disks that are directly attached to a virtual machine (pass-through disks) are supported when all of the following conditions are met:

- The virtual machine configured with one or more physical disks is running on a Hyper-V failover cluster.
- The virtual machine configuration file is hosted on a Cluster Shared Volume (CSV).
- The physical disks are configured as a storage disk resource under control of the failover cluster and are properly configured as a dependent resource for the virtual machine.

Scenarios for the usage of 'Live Migration'
- Physical maintenance of the Hyper-V Host with no downtime
- Can be used in normal business hours
- Manual or automatic movement of virtual workloads

Analysis of Live Migration:

After initiating a live migration, the following process occurs:

1. Live migration setup occurs.

During the live migration setup stage, the source server creates a connection with the destination server. This connection transfers the virtual machine configuration data to the destination server. A skeleton virtual machine is set up on the destination server and memory is allocated to the destination virtual machine. At this time, the cluster does some basic checking, such as validating that the target host can receive the source virtual machine – sufficient memory, disk connectivity, etc.

2. Memory pages are transferred from the source node to the destination node.

In the second stage of a live migration, the memory assigned to the migrating virtual machine is copied over the network to the destination server. This memory is referred to as the "working set" of the migrating virtual machine. A page of memory is 4 KB.

During this phase of the migration, the migrating virtual machine continues to run. Hyper-V iterates the memory copy process several times, with each iteration requiring a smaller number of modified pages to be copied. After the working set is copied to the destination server, the next stage of the live migration begins.

3. Modified pages are transferred.

The third stage of a live migration is a memory copy process that duplicates the remaining modified memory pages to the destination server. The source server transfers the CPU and device state of the virtual machine to the destination server.

During this stage, the network bandwidth available between the source and destination servers is critical to the speed of the live migration. The faster the source server transfers the modified pages from the migrating virtual machines working set, the more quickly the live migration is completed.

The number of pages transferred in this stage is determined by how actively the virtual machine accesses and modifies the memory pages. The more modified pages there are, the longer it takes to transfer all pages to the destination server.

After the modified memory pages are copied completely to the destination server, the destination server has an up-to-date working set of VM.

Note: You can cancel the live migration process at any point before this stage of the migration

4. The storage handle is moved from the source server to the destination server.

During the fourth stage of a live migration, control of the storage associated with VM such as any virtual hard disk files or physical storage attached through a virtual Fibre Channel adapter, is transferred to the destination server.

5. The virtual machine is brought online on the destination server.

In the fifth stage of a live migration, the destination server now has the up-to-date working set of VM, as well as access to any storage used by VM. At this point VM is resumed.

6. Network cleanup occurs.

In the final stage of a live migration, the migrated virtual machine is running on the destination server. At this point, a message is sent to the network switch. This message causes the network switch to obtain the new the MAC addresses of the migrated virtual machine so that network traffic to and from VM can use the correct switch port.

The live migration process completes in less time than the TCP time-out interval for the virtual machine being migrated. TCP time-out intervals vary based on network topology and other factors. The following variables may affect live migration speed:

- The number of modified pages on the virtual machine to be migrated—the larger the number of modified pages, the longer the virtual machine will remain in a migrating state.
- Available network bandwidth between source and destination servers.
- Hardware configuration of source and destination servers.
- Load on source and destination servers.
- Available bandwidth (network or Fibre Channel) between servers running Hyper-V and shared storage.
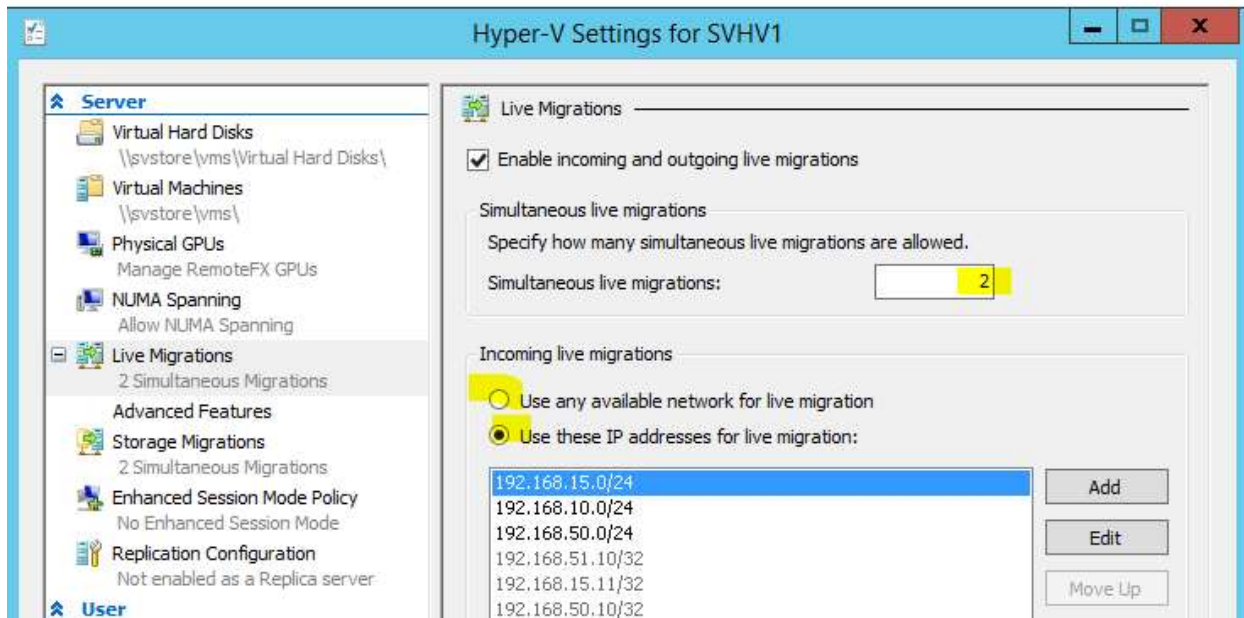
Stages:
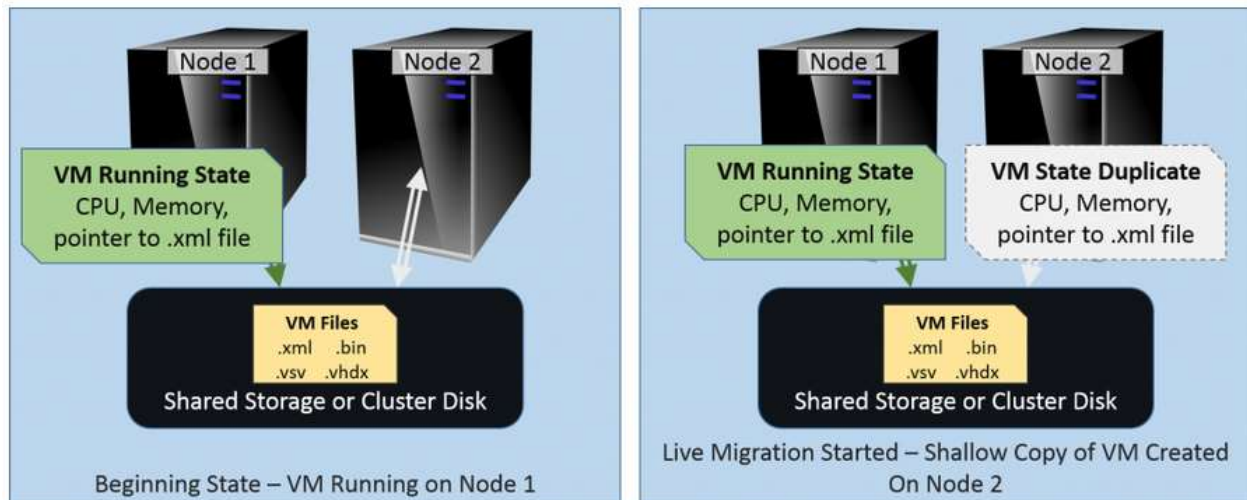
Live Migration Phase 1

Live Migration Phase 2
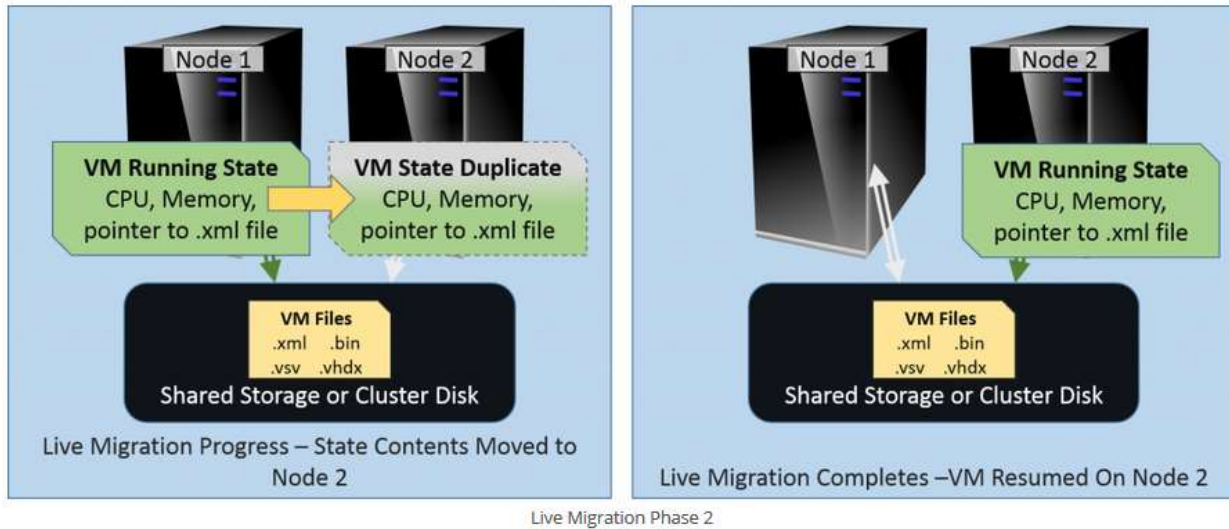
Settings that Affect Live Migration Speed

Maximum Concurrent Live Migrations

The first is found in the host's Hyper-V settings with a simple limit on how many Live Migrations can be active at a time:


If you only have a single adapter enabled for Live Migration, then this setting has a very straightforward effect. If the number is higher, individual migrations will take longer. If the number is lower, any given migration will be faster but queued machines will wait longer for their turn. Overtly, this does not truly affect the total time for all machines to migrate. However, you should remember from the above

discussion that the virtual machine must be paused for the final set of changes to be transferred. If you have a great many virtual machines moving at once, that delay might need to be longer as there will not be as much bandwidth available for that final bit. Differences will likely be minimal.

Live Migration Transmission Methods

The second group of speed-related settings are found on the host's advanced Live Migration settings tab, visible in this screenshot:
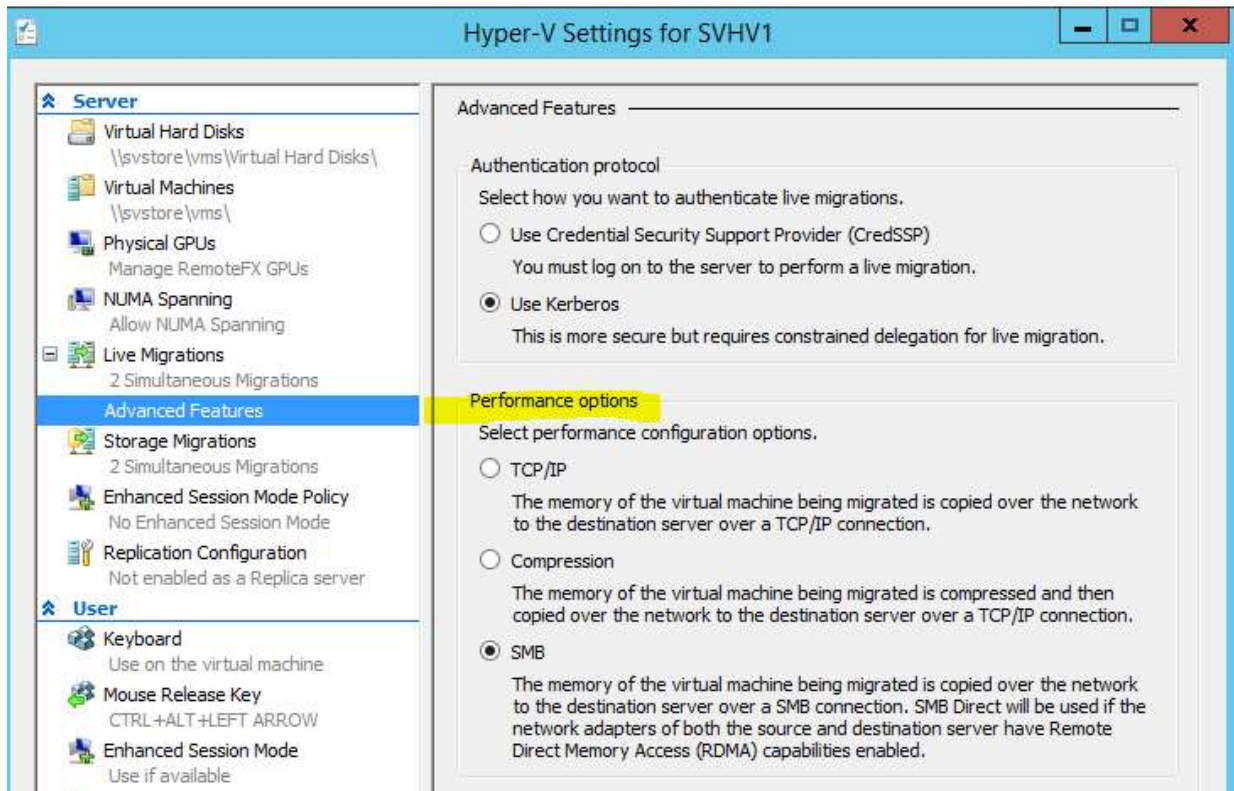

In larger scale deployments, such as private cloud deployments or cloud hosting providers, this update can reduce overhead on the network and CPU usage in addition to reducing the amount of time for a live migration. Hyper-V administrators can configure the appropriate live migration performance options based on their environment and requirements

Option	Description
TCP/IP	The memory of the virtual machine is copied to the destination server over a TCP/IP connection. This is the same method that is used in Hyper-V in Windows Server 2012.
Compression	The memory content of the virtual machine that is being migrated is compressed and then copied to the destination server over a TCP/IP connection. **Note:** This is the **default** setting in Hyper-V in Windows Server 2012 R2.
SMB	The memory content of the virtual machine is copied to the destination server over a SMB 3.0 connection. - SMB Direct is used when the network adapters on the source and destination servers have Remote Direct Memory Access (RDMA) capabilities enabled. - SMB Multichannel automatically detects and uses multiple connections when a proper SMB Multichannel configuration is identified. For more information, see Improve Performance of a File Server with SMB Direct.

How to do Live Migration - GUI & PowerShell

As with Quick Migrations, Failover Cluster Manager is the native GUI tool that can perform a Quick Migration.

1. Switch to the **Roles** tree node.
2. To move multiple VMs, use CTRL+ Click to select them.
3. Right-click the VM(s) to be moved.
4. In the context menu, go to **Move** and **Live Migration**.
    1. To allow the cluster to select the destination, click **Best Possible Node.**
    2. To manually choose the destination, click **Select Node…** This will cause a dialog to appear with all cluster nodes displayed. Double-click one or highlight it and click **OK**.
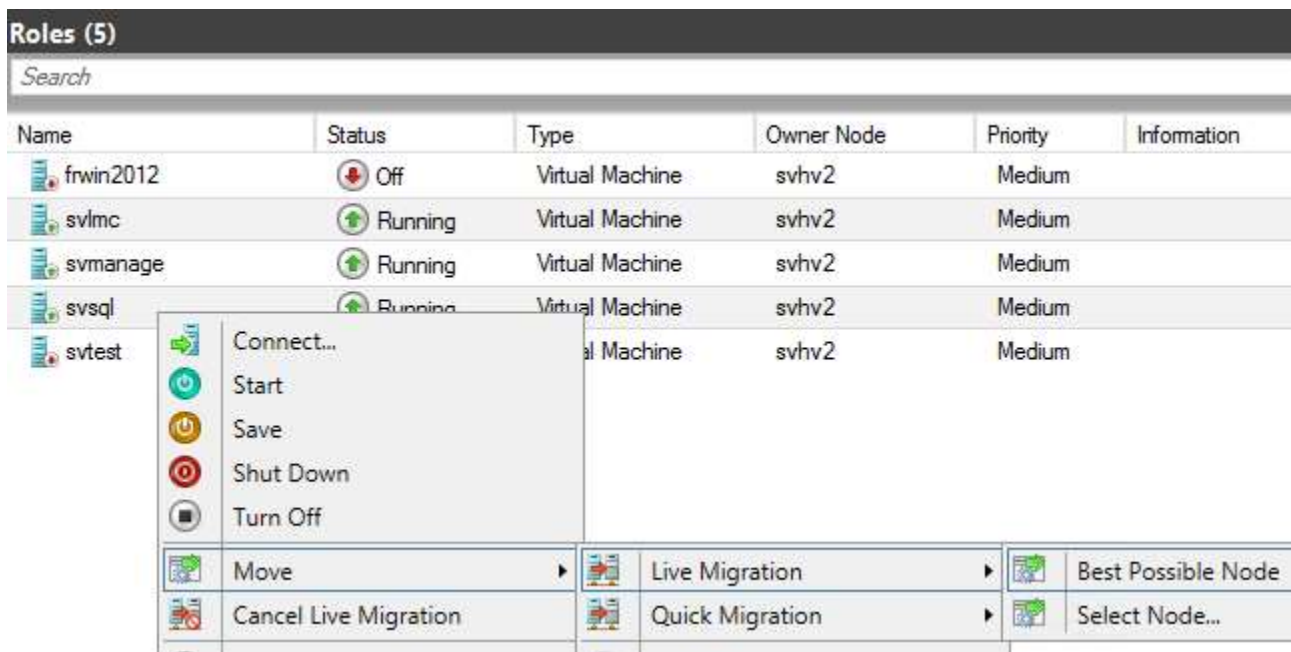
If you have selected more virtual machines than can be migrated at once, the cluster will choose the maximum number and begin moving them. The rest will show a status of **Migration queued**.

PowerShell command to do Quick Migration

Open PowerShell with "Run As Administrator"

Move-ClusterVirtualMachineRole -Name <VM Name> -Node <Hyper-V Host Name> -MigrationType Live -Wait 0

Or

Move-VM -ComputerName <HostName> -Name <VMname> -DestinationHost <Dest hostname>

Note:

- *If you do not specify –Node, the cluster decides where to place the virtual machine(s)*
- Move-VM will fail if the virtual machine is not on and it requires a destination host to be specified. If not run from the source host, it will also fail if delegation is not enabled.