

SANGFOR

VMware Virtual Machine Data Migration Solution

Part 1: Introduction to Online Migration Technology

Make Your Digital Transformation Simpler and Secure

Sangfor Technologies

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1. Introduction

Data migration is a crucial part of replacing a VMware virtualization platform. It involves seamlessly transferring data, applications, and configurations from an existing virtual environment to a new platform, ensuring smooth business transition and minimal downtime. The success of this process depends not only on advanced technology and careful planning but also on a deep understanding of business processes and data architecture.

This document will delve into VMware virtual machine data online migration technologies, strategies, processes, and best practices. It serves as a comprehensive guide to help enterprises successfully complete this critical task. Let's explore how well-planned data migration can lay a solid foundation for future business development.

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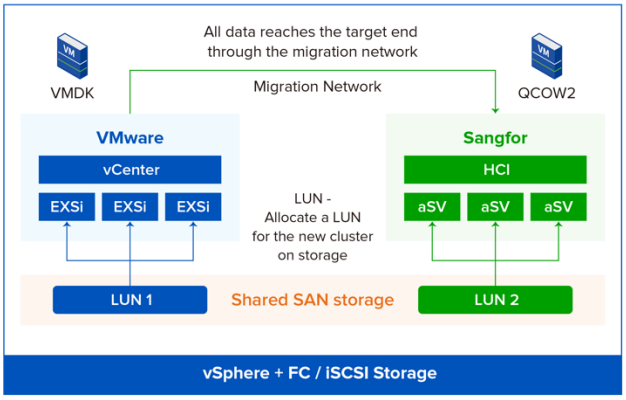
2. Background of Virtual Machine Migration Technology

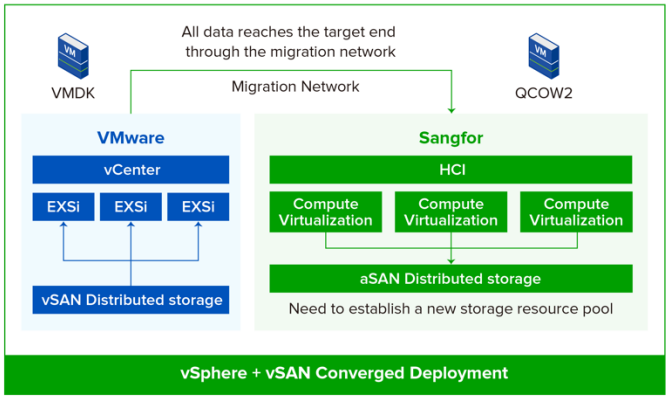
Currently, most mainstream virtualization platforms are developed based on KVM. Unlike VMware ESXi, which uses the VMDK format, KVM employs QCOW2 as its virtual disk image format. Since QCOW2 cannot directly read VMDK files to boot virtual machines, the essence of virtual machine migration is converting VMDK data into a format recognized by KVM. The main concern in this process is data integrity—ensuring that the migrated data is accurate, stable, and secure, allowing the virtual machine to operate normally after migration while minimizing any impact on business operations during the migration process.

In practical user environments, VMware virtualization platforms typically have two deployment modes:

- vSphere with FC or iSCSI storage (disaggregated deployment)
- vSphere with vSAN storage (integrated deployment)

For both deployment types, the data migration path remains the same. Since the newly established virtualization platform cannot directly read and use VMDK files, a migration network is required to transfer virtual machines from the vSphere environment to the new storage medium for format conversion. This necessitates a stable and efficient data transfer link and sufficient storage space on the target platform.

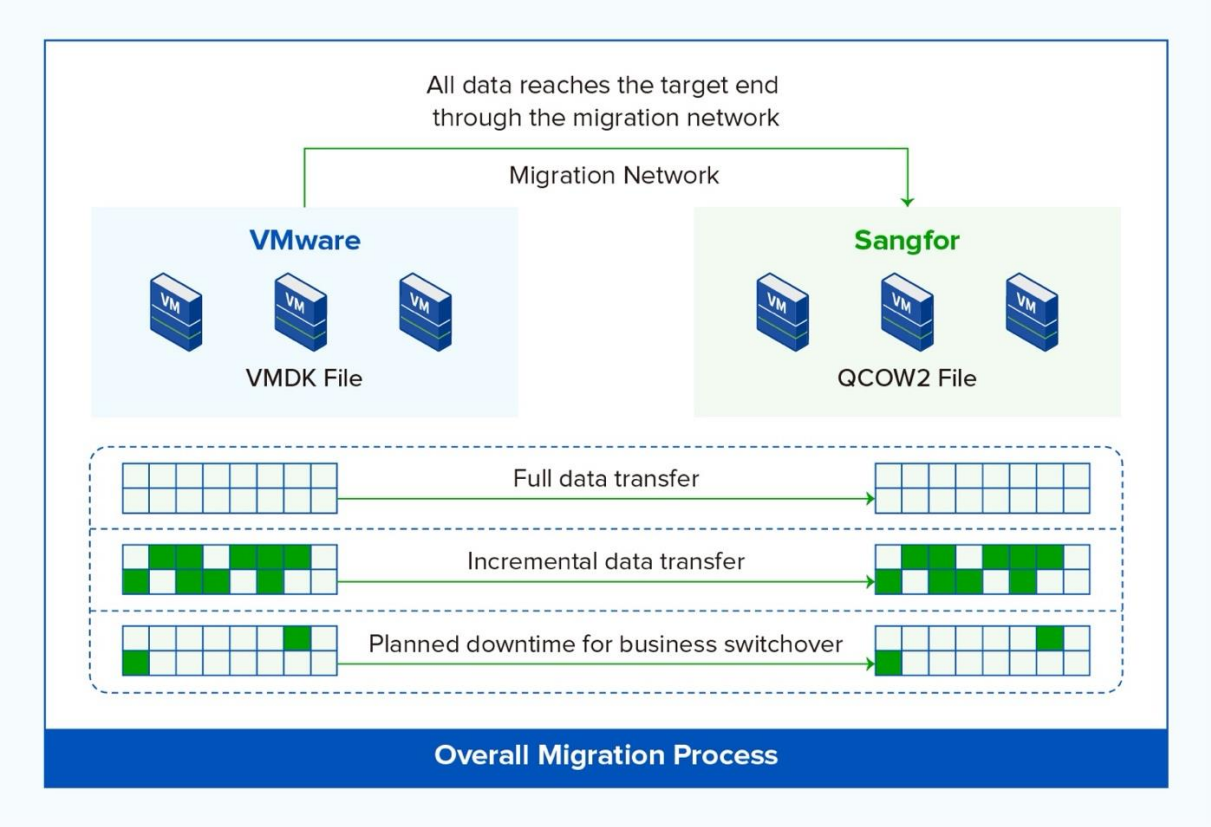




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VMware provides an option to export and import virtual machines in OVA format. However, this method requires the virtual machine to be shut down throughout the process, making it increasingly impractical as business continuity demands rise. As a result, this approach has been gradually replaced by online migration solutions using an initial full transfer plus continuous incremental updates.

The mainstream migration approach today employs **a full initial transfer + continuous incremental transmission model**, allowing online migration without affecting the virtual machine's running state. By increasing transfer frequency, the differential data volume is reduced, ensuring data consistency by synchronizing the last differential data before switching over.



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Migration Methods and Technologies

Agentless Migration Based on VDDK Interface

- Sangfor Cloud/Virtualization Platform Managed Migration
  Uses Sangfor's virtualization platform to manage vCenter and execute data migration.

- SCMT Agentless Point-to-Point Migration
  Uses Sangfor Migration Tool (SCMT) to interface with vCenter for data migration.

Agent-Based Migration Based on OS File System Copy

- SCMT Agent-Based Point-to-Point Migration
  Uses a migration tool with an agent plugin for file system-based migration.

- SCMT Agent-Based Hot Backup Migration
  Uses a migration tool with an agent plugin, leveraging CDP (Continuous Data Protection) technology.

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3. Snapshot-Based Migration Using VDDK Interface (Agentless)

Agentless migration technology leverages virtualization platforms or migration tools interfacing with vCenter's VDDK API. It issues snapshot and data transmission commands to ESXi. During full migration, snapshots capture and transmit all data, while incremental migration utilizes snapshots to compare and transfer only changed data.

After transmission to the target platform, the virtualization platform converts the VMDK data format into QCOW2, enabling compatibility with the destination system. During format conversion, the system injects drivers, installs VMtools, and optimizes system configurations, ensuring the source data can be used seamlessly by the virtual machine.

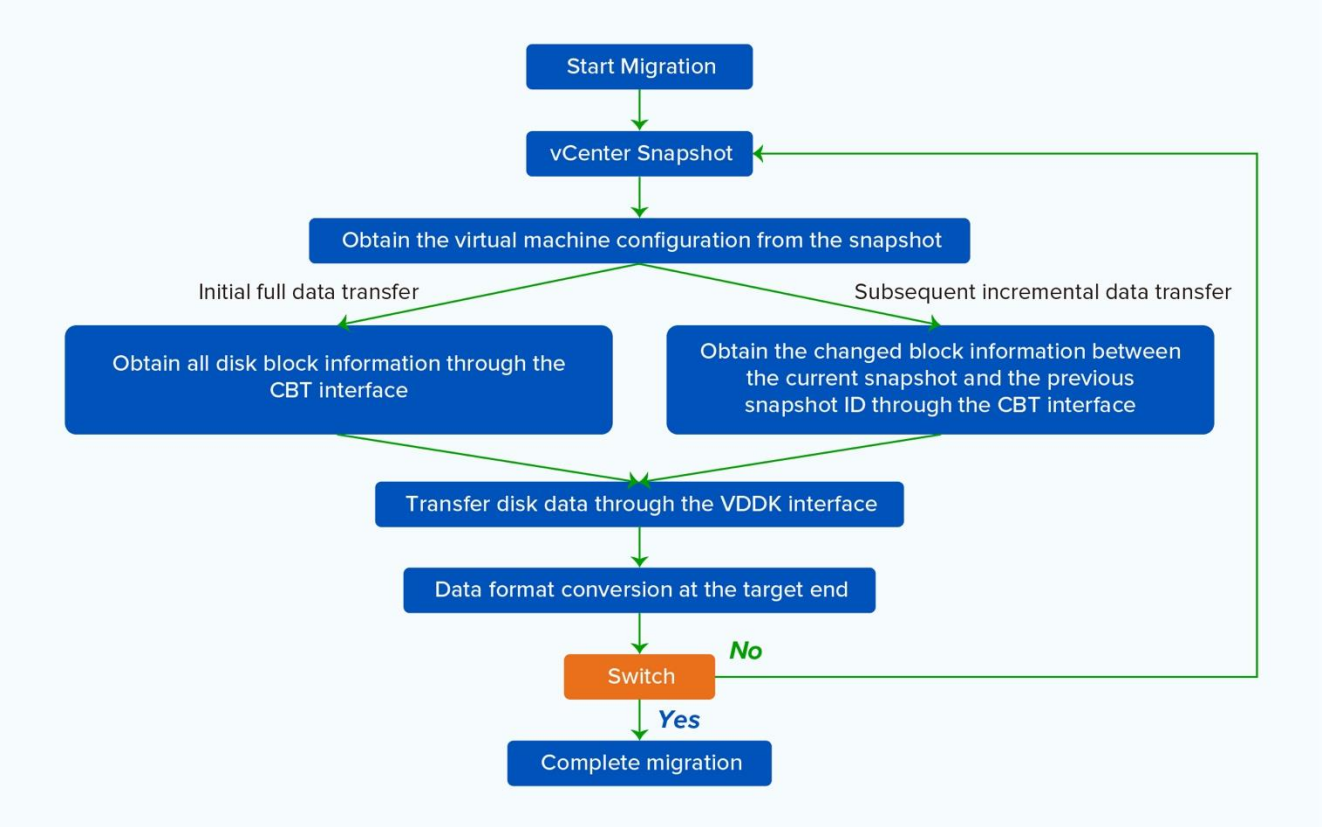


Figure: Implementation Logic of Agentless Migration Technology

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Advantages:

Simple operation—users do not need a complex migration setup and can rely on standard API integration.

Disadvantages:

- Since this method relies on snapshots, every transmission requires snapshot creation and deletion, significantly degrading the read/write performance of VMDK files. This could impact active business operations.
- The VDDK interface is provided by vCenter, not ESXi, requiring a vCenter deployment within the VMware resource pool.
- Different vCenter versions exhibit varied API behaviors, so it is essential to verify vCenter and ESXi version compatibility before migration.

VMware platform compatibility list (for agentless method)	
VMware	ESXi: 5.5/6.0/6.5/6.7/7.0/7.0.2/8.0/8.0U3/above
	vCenter: 5.5/6.0/6.5/6.7/7.0/7.0.2/8.0/8.0U3/above

Figure: Sangfor Agentless Migration with VMware Versions Compatibility

3.1 Sangfor Agentless Migration Management

Sangfor Cloud/Virtualization platform natively supports VMware management, allowing vCenter migration via ports 443 and 902. This enables batch system migrations while the virtual machines remain powered on, shutting down only in the final phase to complete the migration—similar to vMotion, ensuring a simple and efficient migration process.

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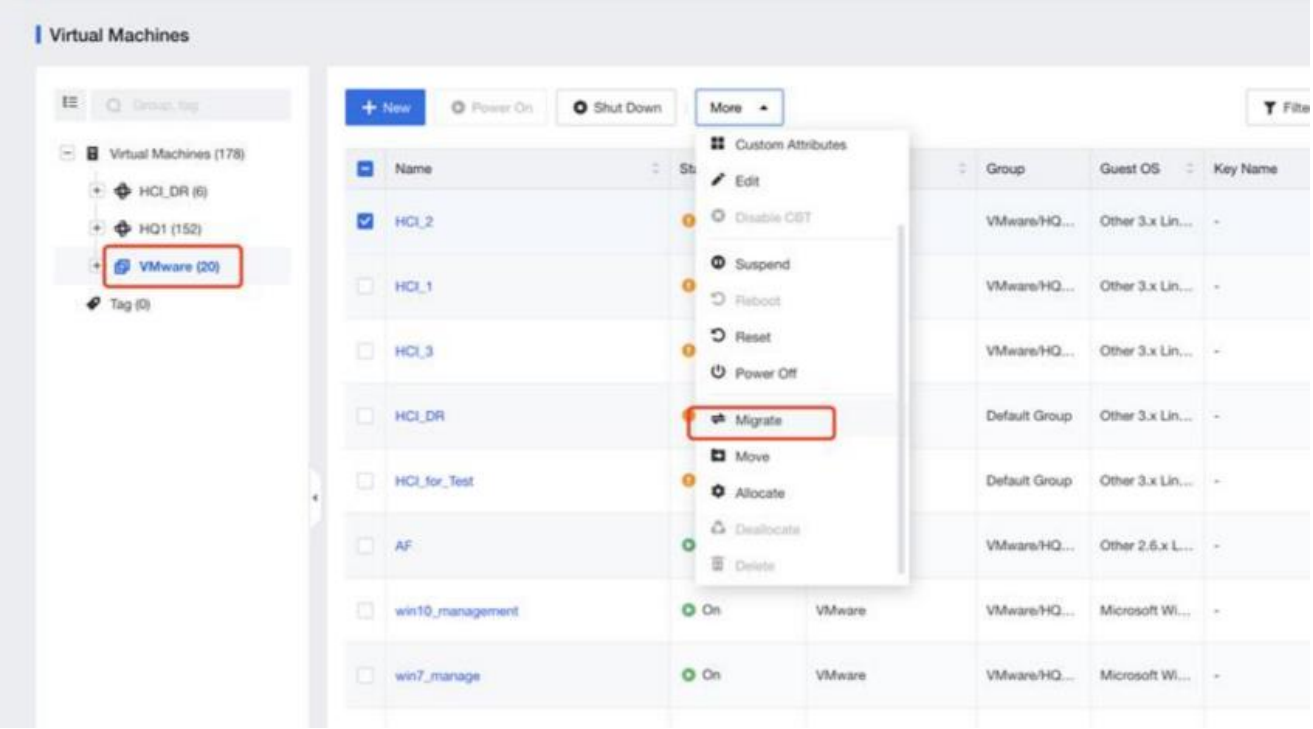


Figure: Interface of the Managed Migration Product Implementation

The agentless migration approach is integrated with the routine operation and maintenance management platform. During migration, there is no need to deploy specialized migration tools or set up complex network environments, nor is it necessary to install agent plugins. This method is suitable for batch migration requirements of standalone application systems.

However, this method does not allow configuration modifications during migration and requires manual or automatic switching with the source VM powered off. For more granular control, such as configuration adjustments, deduplication, or bandwidth limitations, the SCMT migration tool is recommended.

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3.2 Sangfor Agentless Migration Tool

Sangfor provides the SCMT migration tool, utilizing the same VDDK-based agentless technology to interact with vCenter and execute migration tasks. Compared to managed migration, SCMT offers additional capabilities, including migration configuration adjustment, scheduled switchovers and virtual machine verification, making the entire migration workflow suitable for a wider range of scenarios.

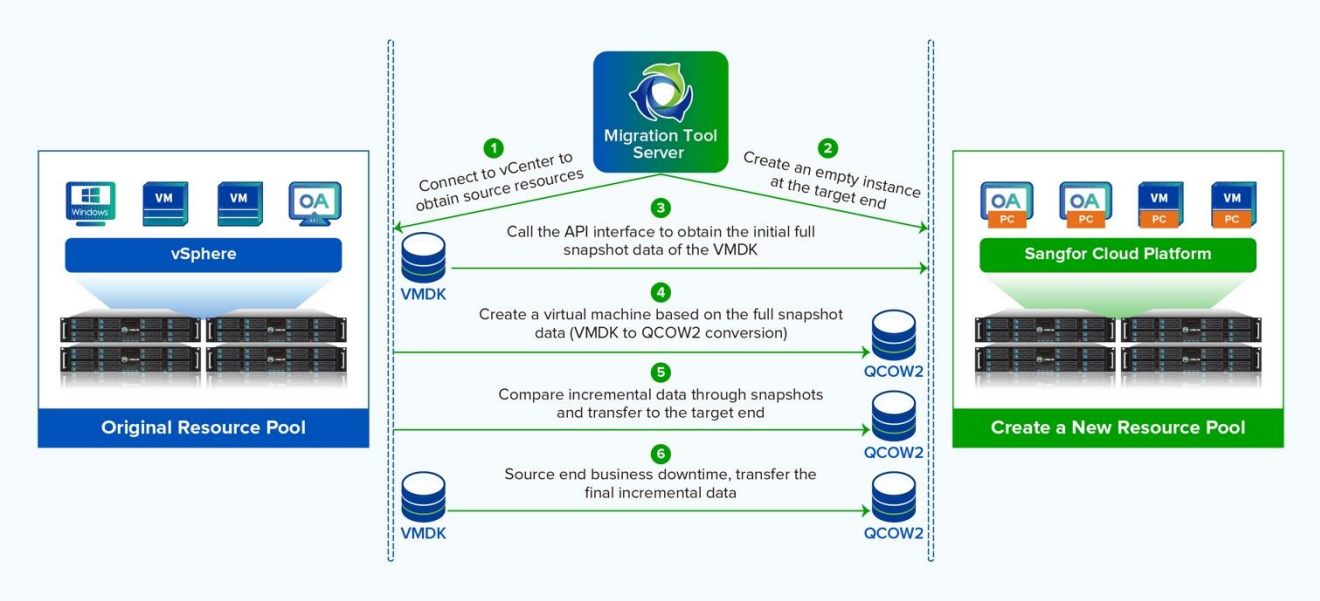


Figure: Agentless Migration Logic of the Migration Tool

The SCMT migration tool supports deployment on Sangfor's cloud/virtualization platform, enabling migration tasks to be completed without additional physical hardware resources. Moreover, SCMT incorporates a relatively comprehensive functional design in the migration process, offering a visible interface for the entire migration procedure and integrating more thorough migration risk alerts. When creating a new migration plan, it allows for the optimization of system resources, IP/MAC addresses, and application configurations, eliminating the need for multiple system restarts during migration configuration changes.

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Post-migration switchover does not require shutting down the source operating system, making the migration process safer and the risks more manageable. It supports manual switchovers, scheduled switchovers, and batch switchovers capabilities, making it more suitable for unattended and non-database cluster migration scenarios.

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4. OS File System-Based Data Copy (Agent-Based)

Agent-based migration installs an Agent plugin in the source OS to directly read file system disk blocks for data transfer. During full migration, the Agent reads all disk blocks and continuously monitors changes for incremental migration. Transmitted data is directly saved in QCOW2 format, eliminating the need for disk format conversion.

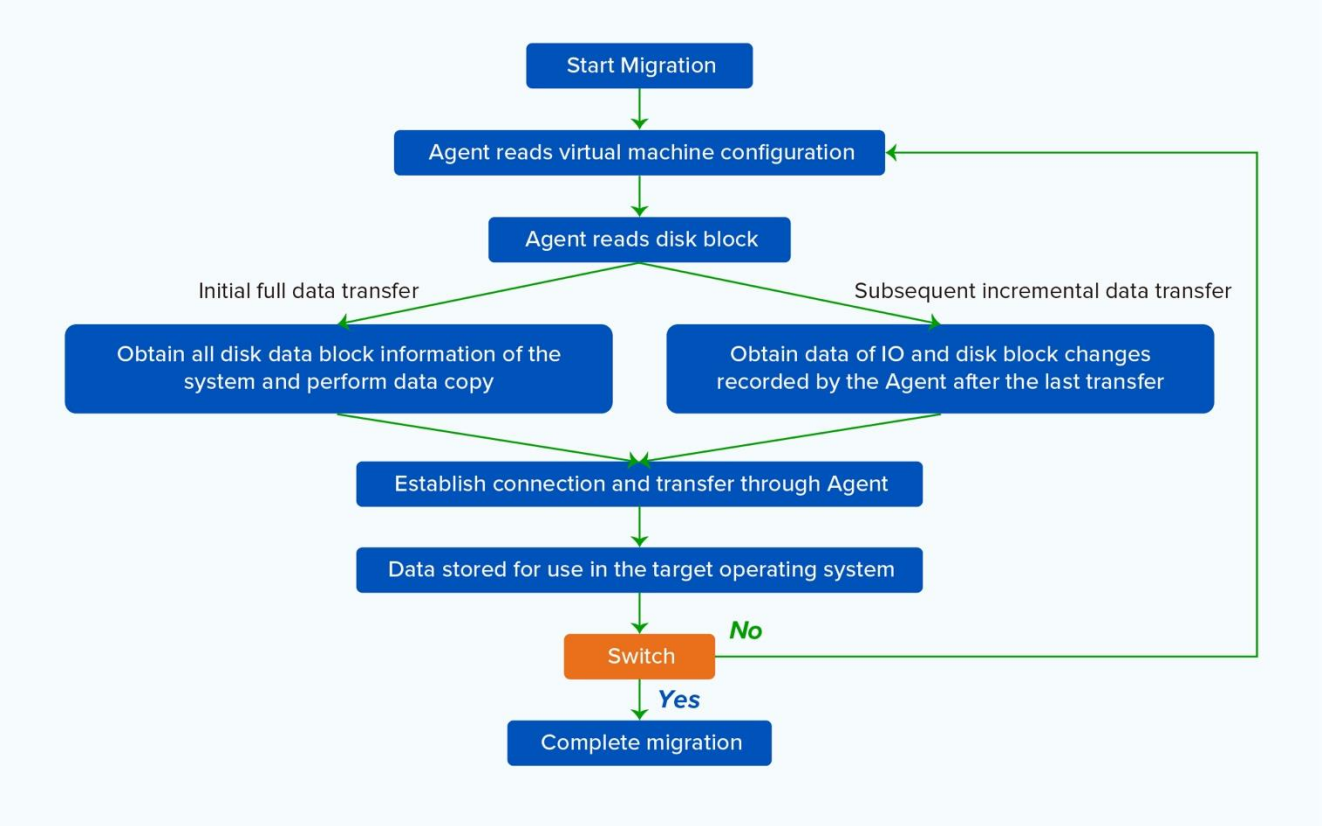


Figure: Implementation Logic of Agent-based Migration Technology

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Advantages:

- Direct disk block reading avoids complex image format conversions and driver compatibility issues, reducing migration failure risks.
- Does not rely on snapshots, preventing performance degradation.
- Higher frequency data transfers minimize downtime.

Disadvantages:

- Requires Agent installation on each migrating system, increasing operational workload.
- Consumes source OS CPU and memory resources during data transfer.

When using Agent-based migration, ensure the source OS file system is compatible with the Agent to avoid data reading issues. Additionally, reserve sufficient CPU and memory resources to prevent performance contention with business applications.

Disk and file system support list	
File	ext2, ext3, ext4, xfs, FAT, FAT32, NTFS, Refs
Device format	lvm, GPT, MBR, Dynamic volume, Spanned volume, Striped volume

Figure: Sangfor Agent-based Migration with VMware Versions Compatibility

4.1 Sangfor Agent-Based Point-to-Point Migration

Sangfor's migration tool, SCMT, supports data copying and migration of file systems through the Agent plugin mode. After installing the Agent on the source operating system, it connects to the SCMT server to receive migration tasks and data transfer commands issued via the SCMT interface.

It also facilitates the transfer of full and incremental data by reading disk blocks within the operating system. Utilizing the Agent plugin can minimize the impact on the source system and enhance migration efficiency.

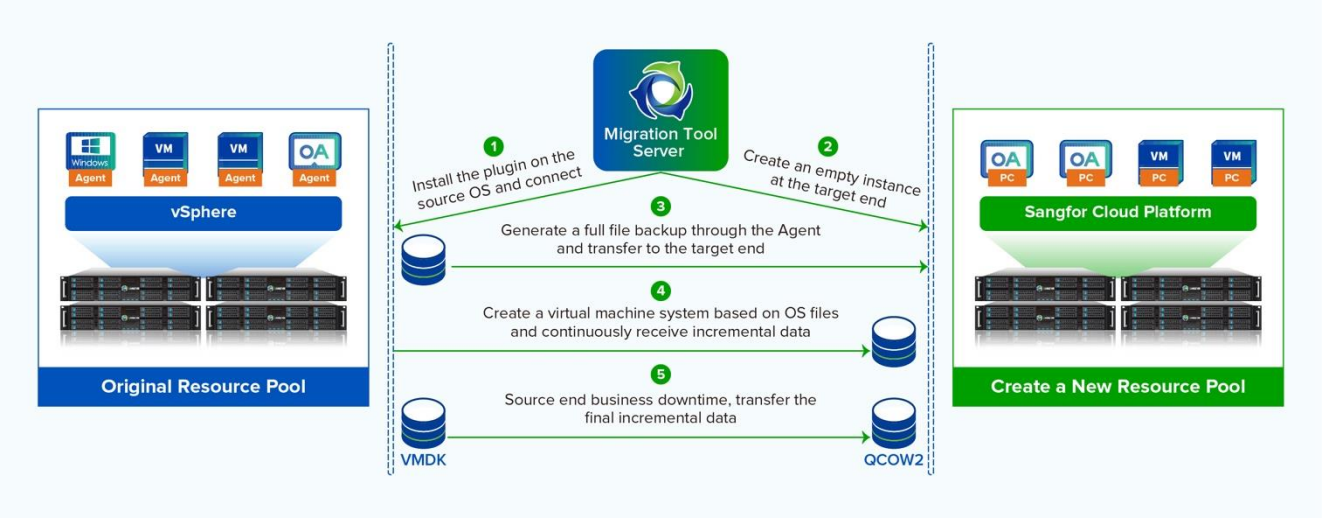


Figure: Agent-based Migration Logic of the Migration Tool

The migration tool's agent plugin occupies less than 3% of the source operating system's CPU and less than 260MB of memory during data transfer, making the performance impact negligible. Using the agent for minute-level data transfer increases the frequency of incremental data transfers, reduces the downtime for business switching, and achieves system switch and startup within 5-10 minutes, suitable for applications with high business continuity requirements. Compared to agentless backup, the agent-based migration method avoids the performance impact caused by taking snapshots of the source operating system, making it more suitable for single-machine database systems sensitive to performance. Additionally, the agent reads data at the file system layer, meaning it can migrate raw disk or pass-through volume data recognized by the source system, which is not achievable with agentless methods.

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4.2 Sangfor Agent-Based Hot Backup Migration

The Sangfor Migration Tool (SCMT) provides hot backup migration based on Continuous Data Protection (CDP) technology. Using the agent plugin, it backs up the full data and per-second data changes to the SCMT server. Then, through the hot backup plan, the server's backup data is pushed to the target virtualization platform. After receiving the full data, the target generates a brand-new business virtual machine, completes driver injection and configuration modifications, and enters a semi-boot state, synchronizing per-second differential data changes with the migration source. During business downtime switching, the target's semi-boot state virtual machine can quickly complete IP drift and business takeover, further shortening the downtime switching time.

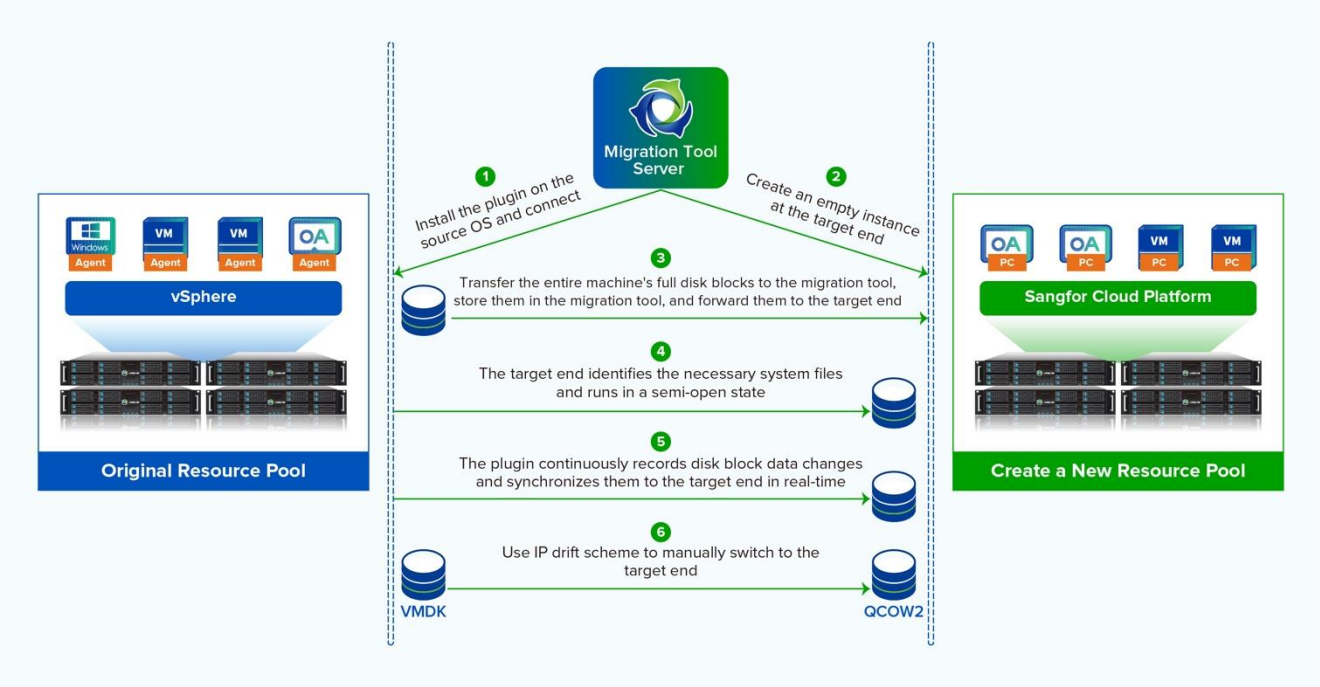


Figure: Agent-based Hot Backup Migration Logic of the Migration Tool

The SCMT hot backup migration mode uses CDP to synchronize differential data to the target in real-time, reducing the data transfer time during the switching process to seconds. The target system can complete the transition from a semi-boot state to normal operation and business takeover within 30 seconds. Automatic IP drift avoids the network switching and configuration restart process, achieving business downtime switching in about 1 minute, suitable for system migration scenarios with high business continuity requirements.

However, compared to point-to-point migration, the implementation and operation process is more complex. It requires installing plugins for the source operating system, designing CDP backup strategies and hot backup migration plans, reserving sufficient backup space for the SCMT server, and manually installing the PE connection environment for the target virtual machine. Therefore, point-to-point migration is generally recommended for typical scenarios, while hot backup migration is considered for special scenarios.

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5. Comparison of Migration Methods

	Agentless		Agent-Based	
Technical Differences	Does not require installing plugins on the source operating system Relies on vCenter interfaces, simple environment		Requires installing plugins on the source operating system for migration Relies on specialized migration tools, more complex communication matrix	
	Based on snapshots, affects read/write performance of the source Cannot migrate raw disk/LUN pass-through data		Plugin resource overhead is minimal, negligible impact Supports migration of any space that can be formatted by the operating system	
Technical Comparison	Managed Migration	SCMT Tool Migration	Point-to-Point Migration	Hot Backup Migration
Migration Environment	Does not require deploying migration tools, simple environment	Requires deploying migration tools, more complex environment	Requires deploying migration tools, source needs plugin installation	Source installs plugin, prepares target PE
Migration Process	Fully automated, process uncontrollable	Migration process visible, overall process controllable	Migration process visible, overall process controllable	Migration process visible, overall process controllable, relatively complex configuration steps
Performance Impact	VMware external snapshot performance decreases by 40%	VMware external snapshot performance decreases by 40%	Plugin running state: CPU usage < 3%, memory usage < 260MB	Plugin running state: CPU usage < 3%, memory usage < 260MB
Downtime	5-10 mins	5-10 mins	5-10 mins	1-2 mins

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