Configuring a Virtual Disk Cache Mode

WHAT?

Virtual machines use disk caches to make reading and writing operations more effective.

WHY?

Selecting an appropriate disk cache mode affects performance and data security of a virtual machine.

EFFORT

It takes up to 15 minutes to understand what a virtual disk cache is and how individual cache modes are different. To configure a cache mode either by using Virtual Machine Manager or **`virsh`** takes another 10 minutes.

REQUIREMENTS

- Advanced knowledge of the Linux system administration.
- A working `libvirt` environment with at least one virtual machine set up.
- Installed Virtual Machine Manager application.
- `root` privileges.

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1 Virtual disk cache

A disk cache is a memory used to speed up the process of storing and accessing data from the hard disk. Physical hard disks have their cache integrated as a standard feature. For virtual disks, the cache uses VM Host Server's memory and you can fine-tune its behavior.

1.1 How does a disk cache work?

Normally, a disk cache stores the most recent and frequently used programs and data. When a user or program requests data, the operating system first checks the disk cache. If the data is there, the operating system quickly delivers the data to the program instead of rereading the data from the disk.

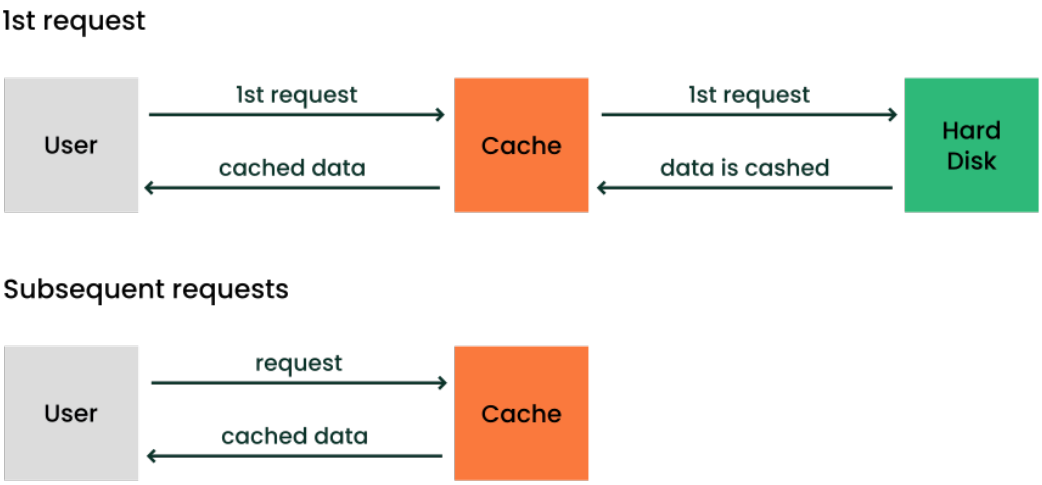

FIGURE 1: CACHING MECHANISM

1.2 Benefits of disk caching

Caching of virtual disk devices affects the overall performance of guest machines. You can improve the performance by optimizing the combination of cache mode, disk image format, and storage subsystem.

2 Virtual disk cache modes

A virtual disk is an essential part of a virtual machine (VM). To speed up disk reading and writing operations, you can enable a caching mechanism. This article describes available disk caching modes and how they behave with regards to data integrity and live migration of VMs. The cache modes are sorted from the safest one to the least safe one.

Important

If you do not specify a cache mode, `writeback` is used by default.

VIRTUAL DISK CACHE MODES

none

The host cache is bypassed, and reads and writes happen directly between the hypervisor and the storage device. Because the actual storage device may report a write as completed when the data is still placed in its write queue only, the guest's virtual storage adapter is informed that there is a *writeback* cache. This mode is equivalent to direct access to the host's disk.

writethrough

Writes are reported as completed only when the data has been written to the storage device, which happens immediately. The guest's virtual storage adapter is informed that there is no *writeback* cache, so the guest does not need to send flush commands to manage data integrity.

directsync

Similar to *writethrough* but the host cache is bypassed.

writeback

`writeback` uses the host disk cache. Writes are reported to the guest as completed when they are placed in the host cache. Cache management handles writing cached data to the storage device, which can happen later. The guest's virtual storage adapter is informed of the *writeback* cache and therefore expected to send flush commands as needed to manage data integrity.

unsafe

Similar to the *writeback* mode, except all flush commands from the guests are ignored. Using this mode implies that the user prioritizes performance gain over data security.

Warning: Possible data loss

Using the *unsafe* mode can cause data loss in case of a host failure. Do not use this mode for production workloads.

default

The default cache mode of the used hypervisor is enabled.

2.1 Cache modes and data integrity

writethrough, none, directsync

These modes are considered to be the safest when the guest operating system uses flushes as needed. For unsafe or unstable guests, use *writethrough* or *directsync*.

writeback

This mode informs the guest of the presence of a write cache, and it relies on the guest to send flush commands as needed to maintain data integrity within its disk image.

Warning

Using the *writeback* mode exposes the guest to data loss in case of a host failure. It is caused by the gap between when a write is reported as completed and when it is written to the storage device.

unsafe

This mode is similar to *writeback* caching, except the guest flush commands are ignored.

Warning: Possible data loss

Using the *unsafe* mode can cause data loss in case of a host failure. Do not use this mode for production workloads.

2.2 Cache modes and live migration

The caching of storage data restricts the configurations that support live migration. Currently, only `raw` and `qcow2` image formats can be used for live migration. If a clustered file system is used, all cache modes support live migration. Otherwise, the only cache mode that supports live migration on read/write shared storage is `none`.

The `libvirt` management layer includes checks for migration compatibility based on several factors. If the guest storage is hosted on a clustered file system, is read-only, or is marked shareable, then the cache mode is ignored when determining if migration can be allowed. Otherwise, `libvirt` does not allow migration unless the cache mode is set to `none`.

Warning: Unsafe live migration

If you need to do a live migration with a different cache mode than `none`, use the `--unsafe` option, for example:

```
> virsh migrate --live --unsafe
```

Be aware that this option may cause loss of data that the migrated VM is caching.

Tip

When using the `native` asynchronous I/O mode (AIO) in `libvirt`, the cache mode `none` is required. Using a different caching mode switches the AIO mode back to the default `threads`.

3 Configure using Virtual Machine Manager

1. Start Virtual Machine Manager, left-click the name of an existing VM, and select *Open* to open the VM console window.
2. From the VM console window, click *View* › *Details* to open the detailed information about the VM's virtual hardware.
3. From the left list, select the disk for which you want to configure the cache mode and unfold its *Advanced options*.
4. From the *Cache mode* drop-down list, select the cache mode that matches your scenario.

5. Confirm with *Apply*.

4 Configure using `virsh`

1. Open your favorite terminal application and identify the VM.

```
> sudo virsh list --all
Id   Name       State
---------------------------
-    sle15sp5   shut off
```

2. Identify the disk for which you want to configure the cache mode.

```
> sudo virsh domblklist sle15sp5
Target   Source
----------------------------------------
vda      /home/example-user/virt/sle15.qcow2
sda      -
```

3. Dump the XML definition of the VM to a file.

```
> sudo virsh dumpxml sle15sp5 > virt/sle15sp5.xml
```

4. Edit the dumped XML file and search for a `<disk/>` definition that includes a path to your disk in the `<source>`definition, for example:

```
<disk type='file' device='disk'>
  <driver name='qemu' type='qcow2' cache='writethrough'/>
  <source file='/home/example-user/virt/sle15.qcow2'/>
  <target dev='vda' bus='virtio'/>
  <address type='pci' domain='0x0000' bus='0x04' slot='0x00' function='0x0'/>
</disk>
```

5. Update the `<driver/>` definition and append `cache='CACHE_TYPE'`. Replace *`CACHE_TYPE`* with one of the caching modes described in *Section 2, "Virtual disk cache modes"*. For example:

```
<driver name='qemu' type='qcow2' cache='writethrough'/>
```

6. Save the updated XML definition and update the VM accordingly, for example:

```
> sudo sudo virsh define  virt/sle15sp5.xml
Domain 'sle15sp5' defined from virt/sle15sp5.xml
```

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