

Windows Embedded for HP Thin Clients



Write Filter Best Practices

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Overview

The purpose of this white paper is to discuss the best practices and FAQs for using the Enhanced Write Filter (EWF), File-Based Write Filter (FBWF), and Unified Write Filter (UWF) on HP thin clients running Windows Embedded operating systems.

See the *Administrator Guide* or *Quick Reference Guide* for your operating system for more information on basic usage of write filters on HP thin clients (see [For more information](#)).

For more detailed overview and information about the architecture of each write filter, go to the following MSDN pages:

- EWF: [http://msdn.microsoft.com/en-US/library/ff793708\(v=winembedded.60\).aspx](http://msdn.microsoft.com/en-US/library/ff793708(v=winembedded.60).aspx)
- FBWF: [http://msdn.microsoft.com/en-us/library/ff794219\(v=winembedded.60\).aspx](http://msdn.microsoft.com/en-us/library/ff794219(v=winembedded.60).aspx)
- UWF: [http://msdn.microsoft.com/en-us/library/jj979962\(v=winembedded.81\).aspx](http://msdn.microsoft.com/en-us/library/jj979962(v=winembedded.81).aspx)

Caution

HP highly recommends proper write filter usage for standard thin client use cases. Proper usage includes making sure the write filter is enabled during standard user (non-administrator) operation and is only disabled by administrators temporarily to make necessary changes and updates to the system. Administrators should re-enable the filter as soon as updates are completed.

HP further recommends that the Windows Page File feature is never enabled unless the system is configured with a flash drive of sufficient capacity to support the high volume of writes this feature produces. The use of the Windows Page File feature with low-capacity drives will result in premature wearing of the drive, decreased performance, and a decrease in the lifecycle of the thin client.

If your use case requires usage of thin clients in a non-standard manner, please contact HP support to ensure that your thin client assets are configured properly.

Thin client memory architecture

Like all computer systems, thin clients have both physical storage and RAM. However, the usage of the resources differs slightly in thin clients.

Physical storage

The physical storage device that contains the operating system and related files is a solid state drive (SSD), also known as a flash memory module or flash drive. Flash memory is non-volatile, which means that the contents on the drive persist after every reboot. The advantage of flash drives over hard disk drives (HDDs) is that the read and write speed is much faster on flash drives due to the lack of moving parts (such as the read/write search arms in an HDD). However, there is a limit to how many writes can be performed on a flash drive before performance starts to degrade.

Windows is constantly writing to the drive it is installed on, but for the most part, these writes are not of a permanent nature. Most operating system-related writes are just to store data temporarily until the system needs that information again, but each time these writes occur they reduce the lifespan of the flash drive. To prevent excessive wear to and prolong the life of the flash drive, a Windows Embedded operating system uses a section of RAM called the RAMDisk for write data of a temporary nature (see [RAMDisk](#) for more information).

Write data that is not automatically sent to the RAMDisk would normally be written permanently to the flash drive if it weren't for the write filter. A write filter prevents permanent writes from being made to the flash drive, which appears as the C: drive by default on HP thin clients. However, an administrator can configure the write filter to allow permanent writes under specific circumstances. The exact method to accomplish this depends on which write filter you are using (which in turn depends on which Windows Embedded operating system you are running). For more information, see the *Administrator Guide* or *Quick Reference Guide* for your operating system.

RAM

The total RAM of a thin client is generally divided into 4 functions:

- Main system memory
- RAMDisk
- Write filter overlay/cache
- Dedicated video memory (if a thin client does not have a discrete video card)

Main system memory

This is where all application and operating system processing occurs (similar to any Windows operating system).

Caution

Windows Embedded operating systems are not designed for use with a page file. Using a page file on an HP thin client is unsupported. It will also significantly decrease the lifespan of the flash drive.

RAMDisk

The RAMDisk is a section of RAM used for write data of a temporary nature, such as most operating system-related writes. On HP thin clients, the RAMDisk appears as the Z: drive by default.

By default, the Temporary Internet Files and TEMP folders are redirected to the Z: drive, as are Windows logs and the print spooler. This keeps the write filter overlay/cache from filling up and enhances system security since the RAMDisk is cleared every reboot. The Temporary Internet Files folder is a favored place for viruses to land, and because it is cleared at every reboot, the threat is removed. The redirection also enhances performance since the read/write times for the RAM are much faster than for the flash drive. These folders continue to be redirected even if the write filter is turned off.

Write filter overlay/cache

A section of RAM is dedicated to storing write data that was intercepted by the write filter. This section of RAM is called either an overlay or cache, depending on the write filter you are using. Write data in the overlay or cache can be committed to the flash drive using the write filter GUI or command line, or it can be discarded by rebooting the system.

Caution

Free space in the overlay or cache can eventually run out. HP highly recommends doing a regular maintenance reboot to flush the stored write data.

Dedicated video memory

If a thin client does not have a discrete video card, the system makes use of Unified Memory Architecture (UMA), which allows a section of RAM to be dedicated exclusively to video operations. The amount of memory dedicated to UMA is set in the BIOS and takes effect in the chipset before the operating system boots. This memory is excluded from usable system memory resources.

If a thin client has a discrete video card, then no additional RAM is used.

Best practices

The following best practices will help ensure a secure and stable environment:

- Keep the write filter enabled when you are not performing necessary configuration.
- Monitor and modify the RAMDisk as necessary (see [Memory management](#) for more information).
- When installing large applications, increase the size of the RAMDisk or temporarily change the environment variables TMP and TEMP to point to C:\Temp (create the folder first, if needed). Be sure to change environmental variables back to their default settings after installation.

Note

A more detailed procedure might be available in the *Administrator Guide* for your operating system (see [For more information](#)).

Memory management

For the most part, the easiest RAM partition to manage is the UMA frame buffer. The size can range from 32 MB to 1 GB. The target size depends on how much video is used in day-to-day operations. If the thin client is used to connect to a remote session for general office work, then the video buffer can be lower since video operations will not be performed very often. On the other hand, if there is a lot of video streaming in the remote session, the video memory might need to be increased because often some of the rendering is left to the client device.

The same is the case with the RAMDisk. For more intense work, even in a remote session, the RAMDisk should be set to a larger size because there would be more I/O request packets (IRPs). For general office work, a smaller size would fulfill the need.

In all cases, it would be best to start with the default values and progressively adjust them as needed. Remember that increasing or decreasing the size of these two partitions has a direct relation to main system memory, which could have an impact on how many or even the type of programs that the system will be able to run.

As the Write Filter RAM cache memory fills up, the system will start to destabilize. When this happens, random errors can appear, or the system might even just crash. If possible, HP recommends performing regular maintenance reboots on all thin clients to clear the Write Filter RAM cache.

There are also certain functions that could have a detrimental effect on the thin client, so these best practices should be followed to minimize problems:

- Scheduled tasks—Often, in an enterprise environment, there are tasks set to maintain personal systems such as desktops and notebooks. However, these same tasks can harm the flash drive on the thin client and should not be run. One example is Disk Defragmenter. Not only would Disk Defragmenter have no real value on an SSD, it would write directly to disk and shorten the life of the flash drive. Other reoccurring tasks, such as Windows Update and WinSat should also be avoided so the flash drive is not subjected to excessive writes.
- Image builds
 - When building an image, it is best to turn off the write filter and redirect the Temporary Internet Files and TEMP directories to the C: drive. Often, the RAMDisk does not have enough free space for application installers, so it could cause various issues during application installation. Building an image in this way avoids these problems and is as close to building an image in full Windows as possible. Install all necessary applications, make sure that all necessary reboots are performed (some applications require more than one) and then redirect the Temporary Internet Files and TEMP directories back to the RAMDisk. Then, turn on the write filter and test the system with the image.
 - It is important to make sure that none of the applications installed require, or even attempt to configure, a page file, as this is not supported.
 - When building or cloning an image, do not take up all of the space on the flash drive. A small amount of space should be left for the EWF volume, which is created by the operating system. 10 MB of space will allow plenty of room for the volume.

Registry filtering

Caution

HP does not support or recommend attempting to persist registry changes through write filters, as Windows is very complex and dependencies are not always clear. Usage of the Registry Exclusion List built into UWF or of the Registry Filter tool by Microsoft is **at your own risk**.

The Registry Filter is a tool by Microsoft included in the Windows Embedded operating systems to help persist registry changes through write filters. However, not all keys are supported. HKCU settings are not supported. Microsoft supports only two default settings (TSCAL & Domain Secrets), but does not support custom implementations by an OEM. Registry Filter documentation is limited, and limitations on registry key/branch size and the number of entries were not documented. Monitored keys might not be written through if changes are made before the Registry Filter initializes on boot. Changes are only written during a graceful shutdown.

For more information

For more information about Windows Embedded on HP thin clients, go to <http://www.hp.com/go/hpsc> (search for your thin client model and see the Manuals page for documentation).

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