

# HP Thin Clients Flash/SSD Selection



## Table of contents

Executive summary .....	2
Introduction .....	2
Considerations for selecting storage devices .....	2
Operating system write filter enablement .....	2
Operating system size .....	2
NAND flash and flash controllers .....	2
Comparing flash storage devices, uMLC option to hard disk drives .....	3
Storage requirements.....	3
HP recommendations.....	3
For more information .....	5

## Executive summary

Windows-based thin client environments that include more than the typical virtualized desktop scenario and/or require writes to the local storage device should be carefully evaluated and may need a higher endurance and/or larger capacity local storage device.

This paper provides considerations for selecting the appropriate storage device and recommendations from HP for optimal performance and data accessibility.

## Introduction

Flash-based drives, or solid-state drives (SSDs), are the primary operating system (OS) storage media for thin clients supporting a highly virtualized operating environments. Thin clients display a hosted session from a data center through standard IP networks which minimizes the required size of local flash-based storage. In a traditional thin client environment, data is stored securely in the remote data center and not in the local storage device.

HP thin client computers use two types of flash memory: single-level cell (SLC, 1-bit per cell) and multi-level cell (MLC, 2-bits per cell). SLC flash memory provides an economical solution when supporting 4 GB and smaller capacities. MLC flash memory can support 8 GB and greater capacities at a lower cost than SLC flash memory. HP thin client offerings with Windows Embedded Standard 7E and newer Windows operating systems come with a minimum of 16 GB SSD. Because the classic thin client use cases seldom require writing to flash memory storage, multi-level cell (MLC) flash memory is used to provide the best cost and performance. However, several factors are driving an increased storage size requirement and therefore the use of larger-capacity local storage devices. These include the following:

- Growth of Windows® Embedded operating system images
- Increased size of Windows updates
- Increased usage of local applications and local data storage
- Increased use of thin clients in non-typical environments and use cases (e.g. desktop PC replacement)

If your environment requires more than the typical virtualized desktop scenario and/or has a unique need to routinely write to the local storage device, HP recommends carefully considering the storage technology needed to support this unique environment. New innovations available for some MLC SSD devices have enhanced the durability at a reasonable price point.

## Considerations for selecting storage devices

### Operating system write filter enablement

Thin clients running Windows Embedded operating systems include a write filter which is enabled by default and prevents writes to the local flash memory storage. Thin clients are protected from accidental writes when this write filter is enabled, as indicated by a green lock icon in the system tray. With the Enhanced Write Filter enabled, thin client users cannot commit updates to the flash memory storage thereby protecting the system from malware and viruses. If a virus or other issue is detected, a simple reboot can clear it. Disabling the write filter (including using the File-Based Write Filter) can result in damage to your storage device over time if the device does not have the capacity for the number of write/erase (also known as program/erase) cycles.

### Operating system size

You should carefully consider the storage requirements of your operating system and deployed applications. Newer Windows operating systems might require increased storage capacity because of their larger image sizes. For example, thin clients running Windows Embedded 8.1 Industry requires a 32 GB storage solution to ensure enough free capacity for the operating system and its future updates. Extreme workload cases might require an even a higher endurance storage solution, a larger storage solution or a traditional spinning hard drive solution.

### NAND flash and flash controllers

Technology continues to evolve, particularly in the flash storage market. The latest NAND flash lithographics are shrinking, so it has fewer electrons available to store the information. However, better, smarter controllers are minimizing the number of writes that NAND flash experiences resulting in improved product reliability. Some MLC devices are capable of using only half of the 2-bit cell, and this innovation enhances the lifecycle by factor of 5. These devices are called Ultra MLC (uMLC) flash. For operating environments which need to regularly write to flash, this offers more robustness than standard MLC at significantly lower cost than SLC.

## Comparing flash storage devices, uMLC option to hard disk drives

Use the following table to compare the capacity and price of solid-state drives based on SLC flash memory, MLC flash memory, uMLC flash memory, and a typical 500 GB hard-disk drive (HDD).

### SSD types used in thin clients compared to hard-disk drives (HDDs)

SSD – Data Points	SLC*	MLC*	uMLC**	500 GB HDD 7200 rpm***
Bits per cell	1	2	2 (only 1 is used)	n/a
Program/erase cycles (2x nm)	60000–100000	3000	15000	n/a
Read time	25 us	50 us	50 us	~11000–15400 us (non-cached)
Program time	200–300 us	600–900 us	600–900 us	~7200–9200 us
Erase time	1.5–2 ms	3–5 ms	3–5 ms	n/a
Estimated retail cost for 16 GB as of November 2014 (unless noted)	~\$300+	\$69–79	\$109–119	\$109–149 (500 GB)
	* Source: Anandtech.com, Nov. 16, 2012, <i>Samsung SSD 840: Testing the Endurance of TLC NAND</i> ** Source: Phison Electronics Corp. *** Source: TomsHardware.com, 2013, <i>All 2013 Mobile HDD Charts</i>			


It is important to consider how long the thin client product will be used in your environment. For example, if the product will be operated with either File-Based Write Filter or Disabled Write Filter, the storage solution recommended would be uMLC, higher capacity MLC, and/or hard-disk drive (HDD).

## Storage requirements

If the thin clients run with Disabled Write Filter or use the File-Based Write Filter allowing local applications to write to the SSD, you should thoroughly monitor the flash drive erase count of worst case usage models in your environment to help determine your highest needs. For effective sampling, monitor a variety of the highest use-case deployments for a period of a few weeks (200 or more hours) under normal configuration, considering any planned operating system transitions, local installations, and platform requirements. This method evaluates the storage requirements needed to meet the operational demands of the deployment in a worst-case scenario. Any planned deployments without the write filter enabled and/or heavy operation (24/7) writing to the SSD are more likely to need a larger flash memory device, uMLC, or a spinning hard drive solution. Contact HP Support for assistance in reviewing your deployment.

## HP recommendations

HP recommends the following based on your usage environment and operating conditions:

- Typical thin client environments using the Enhanced Write Filter and do not expect extremely frequent operating system changes and/or re-imaging can select the standard storage offered which is MLC flash memory.
- Thin client environments that expect frequent or regular operating system changes must confirm that their usage model is within the capabilities of the flash memory device selected. If the amount of write activity increases, a different type of flash memory or a higher capacity storage device may be needed.
- If the write filter is disabled in the thin client environment (  ) or if File-Based Write Filter permitting writing to local storage is used, HP recommends confirming that the usage model is verified to be within the specified capabilities of the local flash device or follow the recommendations in the table below.
- Standard HP Linux image deployments are typically highly virtualized and are well supported by the standard flash solution. No changes or review is recommended unless there is a custom application regularly writing to system's flash.

HP Configuration (Windows-based)	HP Recommendation
All products using Enhanced Write Filter with MLC flash	Standard SSD offered, typically 16 GB or 32 GB MLC
Thin Client using Disabled Write Filter or File-Based Write Filter with local application writing regularly to flash	Windows Embedded Standard 7: 16 GB uMLC SSD Windows Embedded 8 or later: 64 GB MLC SSD
t820, mt41, mt40, other notebook designs with File-Based Write Filter or Disabled Write Filter	64 GB or larger MLC SSD or HDD
t510, t610 with File-Based Write Filter or Disabled Write Filter	Contact HP Support to confirm drive health of your deployment.

## For more information

For more technical information about flash technology, see the following article:  
<http://h10032.www1.hp.com/ctg/Manual/c03757461.pdf>.

Contact HP Support for additional information about selecting your storage device.

To help us improve our documents, please provide feedback at [hp.com/solutions/feedback](http://hp.com/solutions/feedback).

### Sign up for updates

[hp.com/go/getupdated](http://hp.com/go/getupdated)

---

© Copyright 2014 Hewlett-Packard Development Company, L.P.

Microsoft, Windows, and Windows Vista are U.S. registered trademarks of the Microsoft group of companies.

The information contained herein is subject to change without notice. The only warranties for HP products and services are set forth in the express warranty statements accompanying such products and services. Nothing herein should be construed as constituting an additional warranty. HP shall not be liable for technical or editorial errors or omissions contained herein.

First Edition: December 2014

