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WHITEPAPER

Keeping Legacy Systems Alive: Solid-State Replacements/Upgrades for Electromechanical Drives

Introduction

There is often a requirement to support specialised computers and computer-based systems that were designed decades ago but which must continue to operate in critical applications and difficult environments.

These *legacy systems* are found in both military and commercial applications and include systems for radar and air traffic control systems, automated test equipment (ATE), telecommunications (public and private switches), weather monitoring, flight simulators, airborne reconnaissance, industrial process control, public utilities, seismic data acquisition, and sonar/radar data logging.

In many cases, maintenance is the responsibility of engineers that were not even born when the systems were installed. Also, these disparate systems often share a common set of problems caused, in part, by their specialised nature.

Non-portable Software

In many cases the operating system and applications software cannot easily be moved to the latest suitable hardware platform. For example, the application's correct real-time operation may be hardware dependent. Also, dedicated safety critical software may have taken many years to develop, verify and certify as being intrinsically safe; air traffic control and nuclear power station systems are prime examples.

Both the cost and time required to convert or re-engineer the software for a new operating system and hardware – and to test and certify its operation – are usually unacceptably high. Also, porting to a new platform may be limited by legacy interfaces and security issues.

Hardware Obsolescence

On the other hand, the impact of hardware obsolescence on the operating cost, reliability, availability and maintainability of the legacy system may be unacceptable.

In many cases the electronics in the host processors may continue to meet reliability and performance targets. The more serious problem often lies with the failure rate of electromechanical peripherals, such as tape drives, disk drives, magneto-optical (MO) drives and floppy disk drives.

Obsolete tape and disk drive products may set the speed limit in systems that experience a growth in required performance and will finally limit system availability, as the spare part reserve is depleted and repair becomes expensive and uncertain. The 'Bottom-of-the-barrel' effect will result in a continuous reduction in reliability.

Where modern data storage products are concerned, the rate of development is, and has been, so fast that a system can fall rapidly into the legacy category within years or even months of final acceptance. Although the wise purchaser of new systems will plan to procure critical lifetime

spares, budgetary constraints may well limit this approach. In addition, later spending restraints may well extend the required life of the system beyond that for which it was intended.

Operating Environment

Legacy systems are often required to work in unique and difficult operating environments, where the cost and logistics of overall system replacement or upgrade can pose seemingly insurmountable problems.

These can range from the need for continuous operation without downtime at remotely controlled sites to the harsh physical environments experienced by airborne or other mobile or marine installations. In these situations, any solution should enhance both reliability and environmental immunity and extend system life.

The Non-Standard Interface

In the early days of the industry no real attempt was made to standardise on storage product interfaces beyond the ambit of the computer or host system manufacturer. Indeed, in some cases, deliberate differences were a feature of such interfaces to prevent the attachment of third-party products. With the passage of time a more open approach began to develop, initially producing *de facto* standards of the dominant manufacturers, and the terms Diablo, SMD, Seagate, SASI and ESDI may resonate with older engineers.

With the advent of the Small Computer Systems Interface (SCSI – “scuzzy”) standard, developed by the American National Standards Institute (ANSI), aspects of earlier de facto interfaces began to coalesce into a sensible, usable, professional standard.

The SCSI standard has become a set of documents, the intent being to cover a wide range of peripheral types. However, many OEMs of drives did not adopt the full standard and tweaked in ways to pair certain models to a specific host.

The Hardware Emulator Solution

In many cases it is possible to prolong legacy system life, and increase performance, reliability, and environmental immunity, by identifying and replacing the high-risk hardware elements.

For hard disk, floppy and tape this can be done by emulating their function directly at the legacy interface level (plug compatibility) and using industrial grade flash memory – such as Compact Flash (CF), CFast or M.2 - for data storage. Cost per GB, and per device, is typically much lower than when the host system was first conceived, allowing increased storage capacity, flexibility and functionality.

The ideal flash-based, solid-state emulator provides a general solution for legacy drive replacement at product level. The primary rule, almost the first law, is that the upgrade must not require software or hardware changes to the target host system.

The second rule, and invariably the case, is that emulator reliability in terms of mean time between failure (MTBF) be improved far beyond the original equipment specification, as should its immunity to harsh environments.

There are no moving mechanical parts, and where the host system allows it, this often has the effect of increasing system throughput, as emulated access (seek) time can be greatly reduced. Other advantages, in most cases, include a reduction in weight, a lower power draw and a quieter drive.

The physical footprint can be reduced, but the standard approach is to provide a mechanically identical match, i.e., the solid-state drive is a fit, form and function (FFF) replacement.

SCSIFlash

Solid Sate Disks Limited 's (SSDL's) SCSIFlash effectively provides a bridge between the original SCSI legacy interface and flash memory.

While there are other bridge devices on the market, many adopt a single interpretation of the SCSI ANSI standard and, with fixed firmware, are often not compatible with the wide variety of host adaptors implemented in the real world.

SCSIFlash is programmable and aimed at replacing legacy data storage devices without requiring any changes to the host OS or device driver software. The need for programmability arises for a number of reasons, including:

- **Limitations in the original standard.** As the SCSI standard evolved it needed to address the range of peripherals and product manufacturers emerging. This meant a degree of flexibility was introduced. Supplementary documents were created for hard disk, removable MO disk, tape, and RAID. Vendors were permitted to identify unique aspects of their product, including manufacturer, model type and capacity. With many hosts it is essential to reflect similar data from the emulator to achieve correct operation.
- **Historically inadequate host design.** This was aimed purely at integrating one product/host interface, without full compliance with the SCSI standard or concern for second sourcing or future proofing, resulting in unique device dependency. **Note: there too many variations to describe here.**
- **Different block/sector sizes.** While the standard SCSI block/sector size is 512 bytes, 256, 1012, 2024 and others are all possible and must be accommodated the replacement drive is to be truly general purpose.
- **Deliberate pairing.** Features designed in to make the interchange of products difficult in order to support the host vendors' marketing objectives.

A successful programmable emulator, such as the SCSIFlash, will have a range of options that can be set by the user, together with a range of application specific firmware that can be loaded to address the above issues.

It will also provide appropriate diagnostic tools to support integration, together with the means to upload new dedicated or revised emulator firmware.

In many cases the user will have several SCSI-based legacy products, spread across one or more hosts. If they can obtain them, they will need to hold spares for each. SCSIFlash, on the other hand, is typically loaded with a range of firmware options, as is SCSIFlash-Fast which has read/write speeds of up to 80MB/s and storage capacities of up to 1TB.

The user simply selects the firmware to match the host's requirements. In this way spares can be greatly reduced, from keeping several obsolete types in stock to just a single solid-state drive.

Note: SCSIFlash-Fast's SCSI version is set to that of the host system (SASI, SCSI-1, SCSI-2 or Ultra3) and the disk sector size can be set to 256, 512, 768, 1024, 2048 or 4096. Other features include its ability to automatically detect 16- or 8-bit data operation, as well as single-ended (SE) and low voltage different (LVD) signalling.

Data Security and the Ethernet Facility

There are many cases where the data stored will be classified. However, where security constraints allow, an Ethernet Option enables remote back-ups of a complete image of CF, CFast or M.2 memory whenever required; allowing the image to be transferred via a secure network and restored later.

Universal TCP is used for disk image transfers with remote execution of back-up and restore operations controlled by a user; typically, Ethernet supporting GUIs for both Windows (32/64 bit) and OS9. Such a supplementary interface further enables remote maintenance, including host software update, and a reduction in downtime in the unlikely event of emulator failure.

Further security can be added through encryption, password protection and quick secure erase (data destruction).

Reliability and Product Life

As expected, and realised in the field over many years, a solid-state replacement is vastly superior to the electromechanical products it replaces in terms of reliability and product life. However, it should be realised that there are two parts to the replacement drive: the SCSIFlash bridge and the flash device (CF, CFast or M.2). In terms of reliability and product life assessment, based on field results, it only makes sense to consider these as a pair. This being the case, the flash device is critical and only those types approved by the drive's manufacturer (SSDL) are considered.

The type of flash selected depends primarily on the application and the attributes of the different flash technologies must be considered. For applications that rarely write to the emulator, i.e. read intensive applications, it may be possible to use high quality Multi-Level Cell (MLC) flash, but for write intensive applications, such as the one considered here, only industrial grade Single-Level Cell (SLC) must be used.

Historically, some customers have expressed concern with regard to the wear problem fundamental to writing to flash memory. However, the manufacturers of the industrial grade SLC Flash based devices approved by SSDL have addressed this problem with advanced embedded wear levelling algorithms, and we now have experience of many critical write-intensive applications over the last twelve years without issue. SSDL therefore believe this technology to be fully proven.

The field MTBF for the combination of SCSIFlash bridge and approved flash-based memory is in excess of 8,000,000 hours. This figure is based on analysis of an installed base of 455 SCSIFlash emulators operating in a known telecommunications public switch (NEBS) environment over a period of four years. The lack of any SLC flash MTBF type failures beyond infant mortality is very significant. In addition, there was only a single in-service MTBF failure of a SCSIFlash unit.

Fault diagnosis, effective MTTR, life, and data security are also improved. Repair is by replacement of just the flash device or the entire drive, but we see none of the fall-off in performance or gradual degradation we all experience with the target products.

Hard Disk Comparison

Quoting Seagate*

“It is common to see predicted MTBF ratings between 300,000 to 1,200,000 hours for hard disk drive mechanisms”, but “Historically, the field MTBF, which includes all returns regardless of cause, is typically 50-60% of projected MTBF”. For the Seagate Barracuda SATA drive, a representative unit, the predicted MTBF is 1,200,000, but the anticipated field MTBF is therefore only 720,000 hours.

In addition, Seagate limit the number of drive stop/starts (see host B) to “250 average motor start/stop cycles per year”.

**Note the text in parenthesis is taken from Seagate literature and their copyright is acknowledged*.

Total Cost of Ownership (TCO)

Flash technology-based servers are already replacing conventional disk arrays in the latest high-performance systems. Over a 5-year period the Flash SSD overall true cost (TCA) is on par with the disk array, even if the original SSD purchase price was double. TCO is much reduced and will typically show a 90% reduction (reference SanDisk/Lenovo) in infrastructure and power costs. Much of this benefit is seen when legacy hosts are upgraded to use Flash based emulators.

Your Legacy Support Problem

If your legacy support problem is a good fit with our solution, the first step is to contact us, providing as much information as possible about the application, the target product and system, and the host interface to be emulated.

To assist you, we can provide an “Emulation Questionnaire”.

In many cases a match will be found with a product from our range. Alternatively, a small adjustment might be needed to achieve full compatibility. In the very worst case, a feasibility study may be required, followed by the design and manufacture of a dedicated solution.

About Us

Solid State Disks Ltd (SSDL) and Arraid are part of the Reactive Group of companies and specialize in the design, development and integration of solid-state-based replacement drives for hard disk, floppy-disk, magneto-optical and tape drives.

ISO 9001:2000 approved, and with over 80 years of combined experience, SSDL has completed numerous flash-based bespoke projects for UK defence primes, both airborne and marine, providing a range of modified tape and disk emulators, together with their mission data loaders. Selected by BAE, Thales, Ultra, Selex, DRS, EDS (HP), SAAB Qinetiq, MoD and NATO, our products have also become widely accepted in the telecommunications industry.

To support our customers that rely on the SCSI interface we have developed the SCSIFlash-2 programmable emulator that allows high performance flash to be interfaced to legacy host systems without software change.

SSDL is also a member The International Institute of Obsolescence Management (IIOM).

Overview of SSDL’s Swap-In Upgrades/Replacements for Electromechanical Drives

- SCSIFlash:
  - Legacy SCSI-1 and SCSI-2 disk/tape/MO/zip/Bernoulli/floppy drive emulation.
  - Write speeds of up to 10MB/s.
  - 50-, 68-pin and 80-pin connectors.
  - Memory type: Compact Flash
  - An optional Ethernet port means the drive can be used with SSDL’s Flash2GUI software (for backups and system recovery).

- SCSIFlash-Fast:
  - Legacy SASI, SCSI-1, SCSI-2 and Ultra3
  - Write speeds of up 80MB/s.
  - 68- and 80-pin connectors
  - Memory type: CFast or M.2

- An optional Ethernet port means the drive can be used with SSDL's Flash2GUI software (for backups and system recovery).

- FloppyFlash:
  - Legacy floppy and floppy-tape emulation (Legacy floppy drive bridge to Compact Flash).
  - Available with SLIM-26, FLAT-34, 5.25" & 8 Shugart edge connector interfaces with full height and half height frames.
  - Data transfer rate of 125 to 500kB/s.
  - Can replace both soft and hard sectored floppies and set to operate at various data rates with the matching data encoding schemes (FM, MFM, or MMFM). Similarly, the emulated track configuration is programmable.
  - An optional Ethernet port means the drive can be used with SSDL's Flash2GUI software (for backups and system recovery).

Contact Us

Contact Solid State Disks Ltd or Arraid to discuss your legacy system support and obsolescence issues.

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