

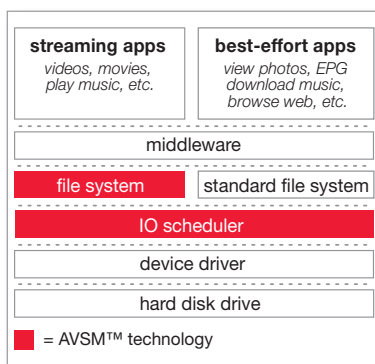
Hitachi Audio-Visual Storage Manager

AVSM™ streaming media subsystem technology for digital video recording products

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Highlights

- Promotes STB/DVR system reliability
 - Lowers HDD duty cycle and operating temperature
 - Reduces file system corruption due to hard errors
 - Lowers field failure rates and support cost
- Enhanced end-user viewing experience
 - Improved quality of service for up to 14 HD video streams
 - Highly predictable multi-room HD streaming performance
 - Eliminates file system fragmentation and related performance degradation
- Easy integration helps lower design and manufacturing costs
 - POSIX API with extensions for AV streaming simplifies integration of mixed streaming and best-effort applications
 - Supports HDDs from many manufacturers
 - Adapts to variability in HDD performance
 - Minimal system footprint, requires no additional hardware resources



Applications

- STBs and IP-STBs with DVR
- Home media servers with DVR
- Multi-channel video surveillance DVRs

The latest cable and satellite DVR-capable set-top boxes (STBs) can record TV pro-grams, download and stream digital media from the Internet and make entertainment content available throughout the home. Recording and playing multiple streams simultaneously, however, places huge demands on the hard disk drive (HDD) and on the conventional PC file systems used by most DVRs.

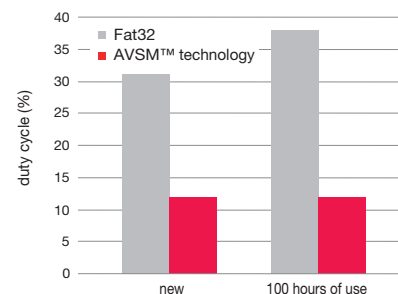
Many widely used file systems, such as ext3 and FAT32, have no inherent ability to distinguish between a streaming application, e.g. playing a movie, and a best-effort task, e.g. viewing a photo. In streaming applications, the video frames or audio data must be delivered to the display, HDD or speakers in a predictable, uninterrupted way. So when conventional file

systems are used in heavily loaded streaming environments, at some point, the deadlines for time-critical streaming tasks cannot be consistently met. As a consequence, frames are dropped, drives are overworked, operating temperatures rise, and quality of service (QoS) begins to diminish. Over time, as these file systems age, heavily fragmented disks can lead to chronic performance degradation and sometimes hard failure. Many of the quality and reliability problems normally attributed to HDDs can be mitigated by a different approach to streaming file management.

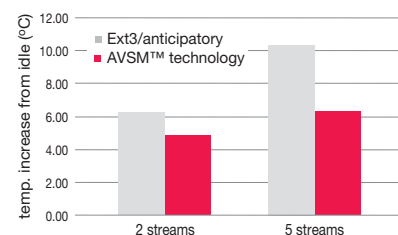
Improved reliability and performance

The AVSM technology subsystem consists of a streaming media file system and IO scheduler designed for hard-disk management in DVR applications such as STBs. It handles streaming and best-effort file operations with exceptional QoS and predict-able performance that does not degrade with time or use. AVSM technology can reduce HDD duty cycle by up to 60% (almost 3X) compared to conventional file systems, promoting improved HDD reliability and fewer DVR system failures in the field.

Put simply, AVSM technology makes disk drives work smarter. It handles multiple HD streams, even in multi-room configurations, by distinguishing between time-critical and best-effort file operations, and optimizing task scheduling to maximize HDD performance. Advanced deadline-based scheduling algorithms help guarantee that streaming tasks meet their deadlines and best-effort tasks are handled as quickly as possible without disrupting the AV streams.



*AVSM technology can reduce duty cycle up to 60% compared to a FAT32 file system when processing HDTV streams.**



*AVSM technology can lower operating temperature when compared to ext3 file systems.**

Exceptional field reliability

By reducing duty cycle, operating temperature, and file system corruption, AVSM technology can increase system reliability and lower field support costs.

- For streaming AV systems, there is often a trade-off between HDD duty cycle and QoS. For example, at low streaming loads, any excess HDD bandwidth can be used to improve QoS by topping up read buffers (or emptying write buffers) or to increase the percentage of HDD idle time. AVSM technology optimizes duty cycle subject to a system QoS objective specified by the system designer. The AVSM technology IO scheduler works to minimize the HDD duty cycle while meeting the target QoS objective. This feature can substantially reduce the HDD duty cycle at low streaming loads (the most common operating mode), leading to improved HDD reliability.
- AVSM technology's improved metadata handling and redundancy provide enhanced resilience to file system corruption due to hard errors or intermittent problems such as shock events (bumping the DVR while in use). This, in turn, helps to reduce field failures and lower support costs.

Predictable QoS

AVSM software technology can dramatically improve and support predictable performance for streaming and best-effort applications.

- With standard PC file systems, performance degrades over time, particularly when the drive is near capacity. Duty cycle frequently increases due to disk fragmentation resulting in increased HDD failure rates even at low AV streaming loads. AVSM software technology was designed from the ground up to manage storage and access of digital media files. It helps eliminate QoS issues related to fragmentation, thus performance does not degrade over time.

* Results obtained in test conditions, actual field performance may vary.

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- AVSM technology can enable a DVR to handle up to 14 simultaneous ATSC HDTV streams without QoS degradation. It is extensible from single SD stream to multi-room, multi-stream, HD-capable systems.

Simple design and integration

AVSM technology is easy to integrate into existing applications. It runs under a Linux VFS interface with a standard POSIX API that incorporates simple extensions to handle streaming AV commands.

- The AVSM technology traffic mixer guarantees QoS for the AV streams and best effort throughput for other applications while preventing them from impacting each other. This makes it easy for a software designer to integrate new best-effort applications—even after the original design is complete—without having to worry about their unintended impact to deadline-driven streaming traffic.
- Command response times and raw HDD performance can vary for each brand or model of hard disk drive. AVSM technology adapts to the performance and response times for each drive on which it's installed, to help achieve QoS goals.

AVSM Technology Specifications

System bandwidth

ATSC HD streams at 19.39 Mbps	up to 14 read up to 4 write + 8 read up to 4 write + 4 read with FF & FR trick modes at up to 15 fps
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Drive requirements

HDD	ATA standard 3.5" 7200 RPM desktop HDD
Host CPU	200 MHz MIPS® CPU/1 Ghz Intel® CPU
Memory	4 MB buffer memory per stream
Operating system	Linux 2.6.12

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