

More and more Audio/Video devices are using hard drives these days. However, most hard drives have been designed to work in PCs, not MP3 players or digital video recorders. To meet the very specific demands of these devices, Hitachi has now helped to develop standard AV stream support for its ATA disk drives.

Don't delay—play

Hard disk drives developed for use in personal computers are now being used in Audio/Video devices such as MP3 players/digital jukeboxes and personal video recorders. AV systems play and record streams of data. If the stream is interrupted, the interrupt may result in missing audio or video information. Data must be delivered consistently at the rate required. Hitachi's Deskstar 7K400 is the first ATA drive to incorporate this important capability.

In AV applications, it may be better to have some small segment of incorrect data delivered in the stream than to have a long delay. Short delays may result in the loss of only a few pixels*. A long delay in the data stream would result in the loss of a larger block of data, which would be noticeable to a viewer. A new Streaming Command Set has been developed for ATA drives, which allows AV products to change drive behavior to meet AV system requirements.

Disk drive behavior

Hard disk drives are rotating media devices with circular tracks which store data. They have a fast actuator that moves the read/write heads from track to track. As a result, drives have variable time delays between commands and data transfers. Also, data transfers have pauses. When a drive receives a command to read data, the actuator moves to the required track. The disk, which is constantly rotating, then moves the data under the head and reading begins. If the data spans more than one track there is a delay, called skew, during which the heads move from the end of one track to the start of the adjacent track.

Occasionally there are additional delays for error recovery. These delays can be multiples of a revolution time. The drive can detect an error in the data read using the error correcting code at the end of each sector. If the data is not correct, the drive will automatically wait for the disk to go around again and re-read the data. The procedure for recovering from a data error can be many revolutions long,

using techniques such as micro-stepping off track. For computer systems where the data integrity is the highest requirement, the time delay is acceptable; but for AV systems, a long delay to get perfect data is not required, nor the preferred behavior.

AV Normal Behaviour

The ATA Streaming Command Set includes a set of tables that describes the normal drive performance. Drives are formatted with multiple zones, each zone having more sectors per track going from the inner zone to the outer zone. The tables describe the zone map. The average time for a seek from track to track is also provided. With this information, an AV system can estimate the time it will take to reach a track and the time required to read or write the data.

Using the streaming performance data, an AV device can determine the average time it will take to read or write data—but data from disk drives arrives in bursts. There is no data transfer during seeking and skew, followed by a high transfer rate when the head is passing over data. The pulsing nature of data transfer is smoothed out by system buffer memory. Fortunately, the data rate of disk drives is in excess of the data rate required for AV data streams. This allows AV systems to support multiple AV streams simultaneously.

AV Error Recovery Procedure Controls

In computer applications, drives may go into time consuming error recovery procedures to maximize the likelihood of returning correct data. In AV systems, data that is delayed is as useless as bad data. If the buffer runs empty there will be visible defects or a loss of signal.

The Streaming Command Set provides controls to set a time limit on error recovery. AV systems, using the performance data and the buffer capacity, determine how much time can be allotted to each command. By setting a time limit for each command, the AV system can manage the time allowed for drive error recovery, minimizing disruptions in the delivery of the AV stream. The drive handles all errors, based on conditions set by the AV system.

It is important to allow drives some error recovery time. At least three revolution times plus the data transfer time is recommended.

* Video information is stored as pixels. Pixel stands for picture element. It corresponds to the smallest thing that can be drawn on a computer screen. The amount of storage required for a pixel varies with the associated technology. Thus, simple black and white images require only one bit, 0 or 1. More complex technology such as color images requires more storage. For example 4 bits can store up to 16 colors; 16 bits can store 65,000 colors. HDTV requires even more storage for each pixel, since more details (colors and shades) are associated with this technology.

Read and Write Continuous

The Streaming Read/Write commands support the Read Continuous (RC) bit or Write Continuous (WC) bit. When a stream command is issued with RC or WC bit set, the drive will transfer the best data it can during error conditions, while completing the command within the time limit.

If read data is transferred that is not completely correct, an entry is placed in the Read Stream Error Log. Logging the data performs two functions. An AV system can find the defective data in a stream by looking in the log. Also, during RC operations, the Error bit is not used. Some operating systems go into a long error recovery procedure when they see the Error bit so it is suppressed during RC operations.

WC operations are also supported. There is a much lower probability of detecting an error during writing; but WC is useful in that a command will complete within the time limit by skipping inaccessible sectors and logging the write errors in the Write Stream Error Log.

AV Optimizations

The Streaming Command Set has features that allow an AV system to get maximum performance from a disk drive. The Configure Stream command allows the system to tell the disk drive how many simultaneous streams will be used and if they are read or write streams. This information allows the disk drive to optimize its buffer management.

The read stream command has a Non-Sequential or NS bit. The NS bit is used to tell the drive that the next command will not be the data following the current command. In AV operations, there are usually several read commands that request data in sequential order between seeks. Drives have a feature called read look ahead that keeps reading after a command has been completed. The data is put in a drive buffer to speed up the next read command if it is sequential. The NS bit tells the drive not to buffer the sequential data because the AV system knows it will not be needed.

Handle Stream Error

An additional optimization provided by the Streaming Command Set is the Handle Stream Error or HSE bit. AV applications may need data that must be correct, like computer system data, for software or file information, etc. The HSE bit allows an AV system to do full error recovery in steps, with other stream commands between attempts to do error recovery. If a command times out, the system can retry the command with the HSE bit set to 1. This causes the command to try again, starting at the level of error recovery that was reached at the previous try.

For example, a system may be running several streams of AV data and also need computer quality data. If an error occurs during the computer data read and the time limit is reached, the data is not returned. The system then services the AV streams, to keep the buffers full, and then retries the computer data command with HSE set to 1. The drive starts where it left off and continues until the data is accurately recovered or the time limit is reached. The system can continue this process until the computer data is recovered, without causing an interruption in the AV streams.

Summary

The new Streaming Command Set included in the ATA/ATAPI-7 standard provides a comprehensive set of tools for Audio/Video disk drive applications.

The ATA Streaming Command Set includes:

- Streaming Performance Log (to describe normal drive performance)
- Error Recovery Time Limits (to prevent long delays for error recovery)
- Continuous Read/Write Controls (to return/use partially correct data)
- Streaming Error Logs (to reduce time delays for system error processing)
- Configure Stream Command (to allow optimum drive buffer management)

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