Memory in Cassette (MIC):

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For the first time a memory chip is incorporated in a computer tape cartridge

As the uncompressed storage capacity of tape media accelerates past the 20GB mark, customers are demanding greater visibility, better reliability and faster access to their stored data, whether in a standalone drive or automated loader/library configuration. Typical tape design architectures incorporated conventional mechanical means, such as faster search speeds to improve access performance. Even using these techniques, the average access time to a file contained on a 20GB or larger tape drive did not get below 50 seconds. Media statistics, such as error counts or the hardware vendors did generally not provide load counts at all and tape volume serial information was affixed using bar code labels.

When designing the new 8mm tape technology called Advanced Intelligent Tape (TM), Sony recognized the need to improve the overall performance of the tape mechanism and thus provided for the incorporation of a captive memory chip within the media cartridge. This is the first time that such a feature, which Sony calls MIC or Memory In Cassette, has been utilized in a computer tape peripheral.

Building upon the design innovations initially developed by the consumer products group. Sony's AIT team expanded the use of the flash memory chip within the AIT architecture to capture various systems and user related statistics directly within the MIC structure to enhance data reliability, error prediction and access performance. Having these parameters stored as part of the media itself provides fast and comprehensive access to on-tape structures and media statistics by any MIC-compatible AIT drive, without having to read the physical media.

The customer benefits of MIC include the following:

- Faster access to data;
- Better reliability through predictive diagnosis of media degradation;
- Faster and more reliable access to volume serial information;
- Better data-set management through use of user-specified volume and partition notes;
- Greater data integrity through a fault-tolerant system log; and
- Enhanced media security through the use of decryption codes stored in the MIC.

The MIC Concept

The MIC hardware consists of a 2Kbit EEPROM that is mounted within the data cartridge and includes a 5-pin interface to the drive or other external connection (See Fig 1). Using a serial interface to the memory chip, the AIT drives are able to store and retrieve selected information directly from the chip and use this to provide real-time benefits to customer applications.

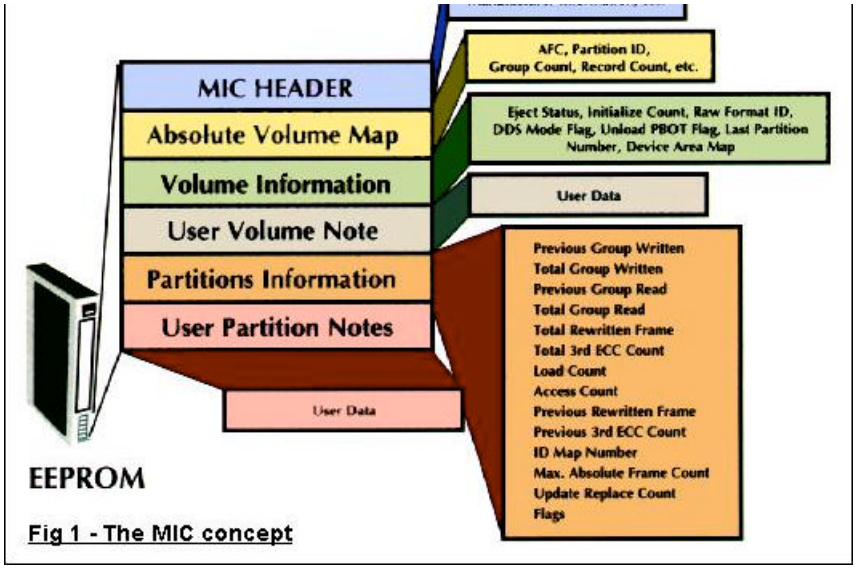

Fig 1 - The MIC concept

The information stored within the MIC consists of a combination of drive and user generated information, as shown in the illustration. The user information is accessible using two Vendor Unique SCSI commands, called "AIT MIC Select" and "AIT MIC Sense." Drive-related information is stored and retrieved automatically under the control of the drive firmware.

The MIC information consists of data written at the time of cartridge manufacture, data written when the media is first loaded into an AIT drive, portions updated as part of a read, write or load sequence, and finally portions that can be written directly by a user's application.

Improved Access to Data

The total information now contained within the MIC can be used in a variety of ways to enhance tape sub-system benefits to users. The first area of benefit is improved access to data. When used in conjunction with tape partitioning, the use of MIC can cut total data access time by up to 50 percent compared to conventional methods. Referring to Fig 2 can show the improvement.

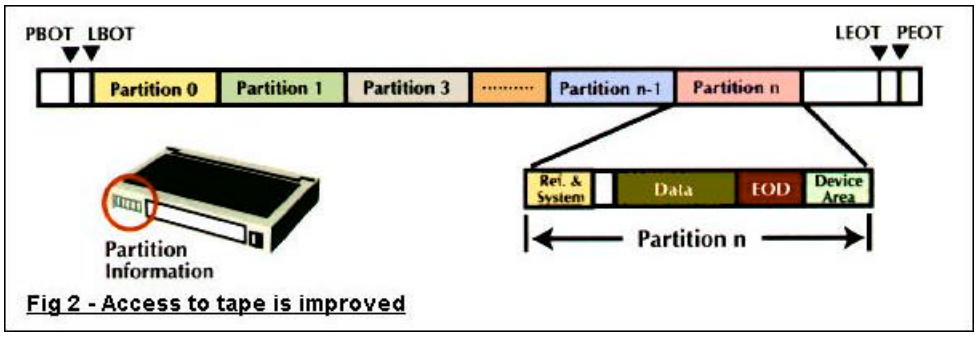

Fig 2 - Access to tape is improved

By utilizing the "device area" within each partition's format, the AIT drive can load the tape at any partition, read the system log information directly from the MIC and proceed to the targeted file, without first reading the tape. This saves considerable access time, since without MIC, the system log information would have to be read from the tape (usually at partition "0") and then the drive would need to proceed to search down tape to the target file from the beginning of tape. When used in this manner, the access time for an Append Write operation could be a little as 13 seconds, compared to more than 70 seconds without MIC and partitioning. Fig 3 illustrates the sequence.

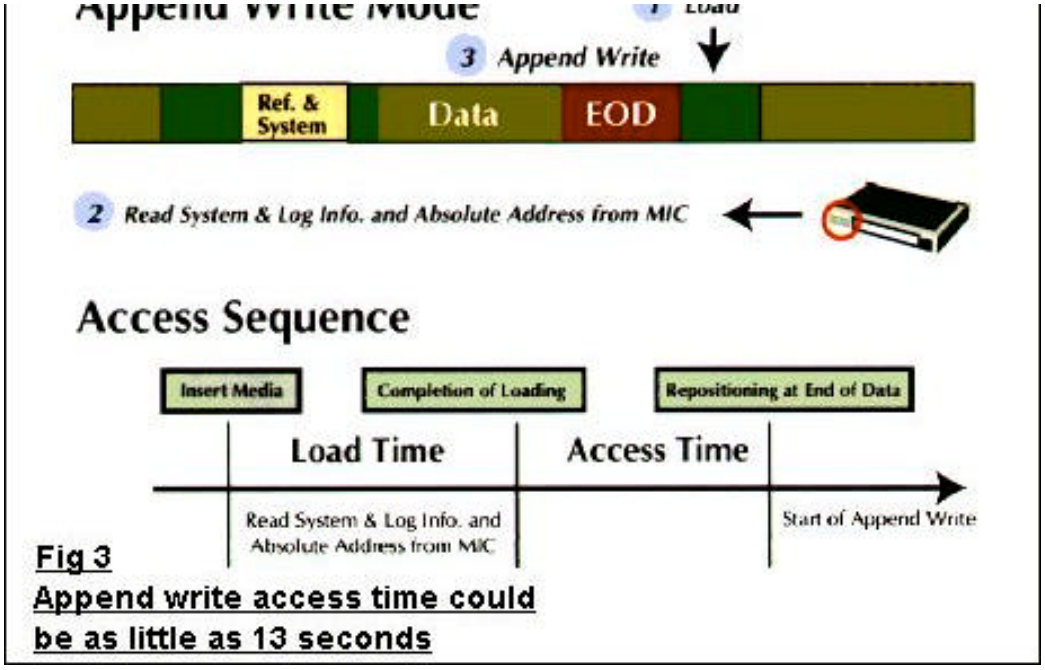

Fig 3
Append write access time could be as little as 13 seconds

Fast Forward Search Mode

In addition, the MIC can also be used to accelerate access times by utilizing its stored information in combination with an innovative high-speed "fast forward" search speed of 150 times nominal (about 120 inches per second) to space forward several files or partitions. During the high-speed search phase, the information from the MIC is used to calculate the approximate distance of the target file. At this point the AIT drive will revert back to its normal search speed of 75 times nominal (about 60 inches per second) to read the on tape identification area and locate the specific block or partition (Fig 4).

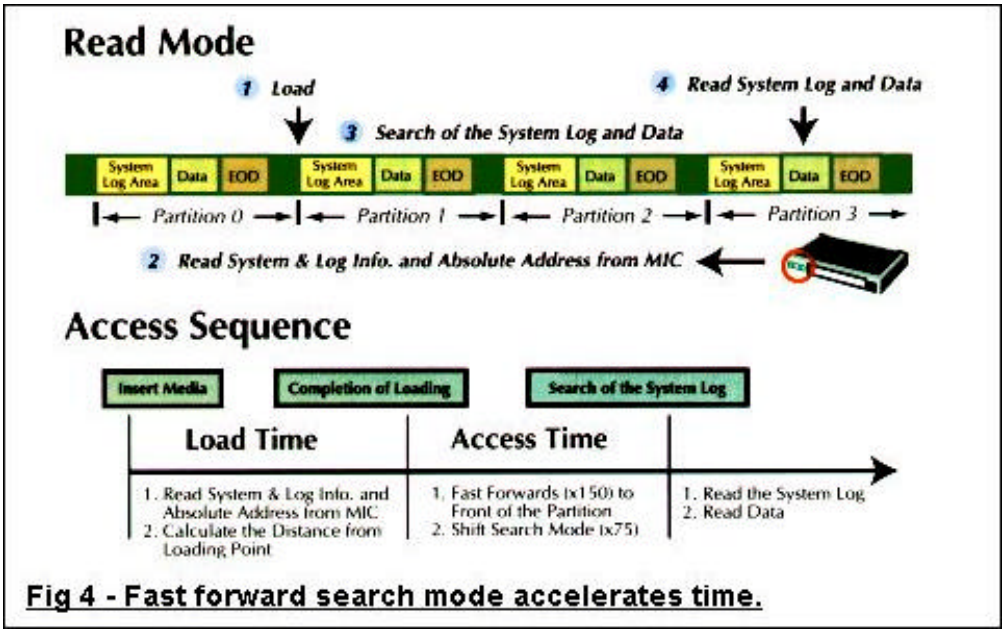

Fig 4 - Fast forward search mode accelerates time.

Volume Management/Data Security

Other benefits derived from the use of MIC include volume management and reliability by taking advantage of the ECC count and load count information to predict media-related failures. In addition to this, the information stored within the MIC can be used to replace or enhance bar-code readers for tape library products and provide substantially more information to the library application than the physical volume serial number. This also could reduce the cost of some

library systems, and enhance the performance of media recognition systems. Some of the current tape library bar-code systems have difficulty in recognizing the bar codes consistently and accurately with different media colors. The MIC system, on the other hand, is fully electronic and is not sensitive to background light or media coloration. As a result, a MIC-based library system will improve media auditing performance over vision-based systems that may require several re-tries during the auditing process.

Another feature of the MIC architecture is enhanced data integrity and security of critical customer data. The system log information typically stored on tape is also redundantly stored within the MIC to provide the enhanced data access techniques described earlier. In addition to the access time improvements, this feature provides a level of fault tolerance for customer data by providing a secondary source for this information should either the critical tape log or the MIC log area be damaged.

In addition, special applications that require a high level of information security can utilize the user data areas contained within the MIC structure to specify decryption keys. These keys can then be used to authorize access to the data on tape. Government security agencies, as well as the entertainment industry, can take advantage of this feature to protect their transportable media from unauthorized access or duplication.

Summary

The design of Sony's AIT architecture incorporating the innovative MIC chip addresses and overcomes many of the limitations being encountered in today's tape products and applications. Faster access to data, better identification of volumes and data-sets, predictability of media degradation and enhanced security of transportable data are all key elements that define a new era in tape drive and media design. Conventional tape drive designs have tended to focus mainly on recording density and data transfer performance improvements, while neglecting the need for improvements in data access and media management. Sony's AIT architecture is the result of a more balanced approach to addressing the demands of today and tomorrow's tape storage applications. And Sony expects the MIC technology in particular, to greatly impact the future of the tape storage industry.

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