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Ballard Synergy Corporation hereby presents a first draft of the device model for direct access devices for review by the SCSI-2 working group.

Direct Access Device Model

Blocks

A direct access device (DAD) consists of a number of blocks of data. Most DADs require that all blocks of data on the device be the same size, although many will allow that size to be specified when the device is prepared for use. Note that the blocks being discussed in this device model are device blocks. These are not necessarily the same as SCSI logical blocks.

The data in the block can be divided into three categories. The first is device control information, the second is user information, and the third is error detection/correction information. Some DADs may lack control or error information. For example, a RAM disk would not have either of these.

Device control information consists of data that the device needs to access the block. For example, a Winchester type hard disk would contain the sector number in the device control information of the block.

User information is the data that is supplied by the user of the device.

Error detection/correction information is used to detect errors in accessing the data in the block, and to correct those errors when they occur.

Addressing

Each block on a direct access device has an "address". An address is a way of identifying the block.

The format of an address is device specific. For instance, the address of a block on a RAM disk would simply consist of an integer from one to the number of blocks on the device. The address of a block on a typical hard disk consists of three integers, which represent the cylinder, track, and sector number of the block.

Block Organization

Many DADs organize the blocks into groups. For example, Winchester type hard disks have groups of blocks known as "tracks", and groups of tracks known as "cylinders". These groups relate to the physical organization of the device.

Accessing

A DAD provides some simple method of accessing a block by specifying the address of the block and the desired type of access (read or write). For some direct access devices, accessing a block is a two step process. The first step involves preparing the device to access the block, and the second consists of access the data.

For example, a Winchester type hard disk drive contains a sensor, called a "head", that reads data from the disk. The head is attached to a moveable arm that is used to position the head to the track the block is in. To read a block, the device must first be prepared by positioning the head to the location of the track that contains the block. This operation is called a "seek". Once the head is correctly positioned, the block may be read.

The blocks on a DAD may be accessed in any order. The time to access a given block will depend on which block was last accessed, but for most DADs this time will be relatively short (typically a few milliseconds, although some optical storage devices may take several seconds).

It is this ability to access blocks by address in any order that distinguishes DADs from sequential access devices (SADs) such as magnetic tape. Although a SAD may provide some form of block addressing, there is no simple way to access a specified block on a SAD, other than starting from the beginning and then going forward until the desired block is reached.

Formatting

Many DADs require that the control information and error detection/correction information be correctly written for each block before that block may be accessed. This is known as "formatting". DADs that require formatting will usually provide some method for the user to perform the format operation. For example, a Winchester type hard disk will usually have an operation that formats one track. This may be done for each track to format the device, thus making the device available for the storage of user data.

Some DADs are formatted by the manufacturer, and do not have any method for the user to format them should the need arise. Devices that can not be formatted by the user will usually be read-only devices that should never develop the need for re-formatting.

Error Handling

Most DADs provide some sort of error handling capability. This can either be at a low level (error correcting codes on each block), or at a higher level (remapping of known bad blocks to alternate good bloks). Many will provide both levels of error handling.

Low Level

Most DAD devices provide low level support for the detection and correction of errors. This consists of some sort of error detection or error correction code on each block.

When the block is accessed, the error detection code is checked. Any errors that are detected are corrected by the error correction code if they are not too severe.

Many DADs that support error correction will have a mechanism to report to the user if a block of data needed error correction. If the error is repeatable, then the user may

decide to use a higher level of error handling to correct the problem.

High Level

At a higher level, many DADs provide support for bad block reassignment. This allows attempted accesses to a block that is considered bad to be redirected to a replacement block.

The amount of support for bad block reassignment is very device specific. Some devices will have no support, leaving bad block assignment entirely up to higher level software. Some devices will provide fields in the device control information of each block that indicate if the block is bad, and tell where the replacement block is to be found.