7.0 Software defect management model

This section defines the Software defect management method on rewritable media, e.g. CD-RW, DVD-RW.

There are two types of defect management. The one is Host-based defect management (Software defect management) and the other is Logical Unit-based defect management (Hardware defect management).

In the case of Software defect management, a Host retrieves defect information from the Logical Unit and performs defect management at Host's desired timing. In the case of Hardware defect management, defect management is automatically performed by the Logical Unit like DVD-RAM Logical Unit.

Though the capacity of media is drastically increased, the life of RW media is relatively short. The number of overwritable cycles is usually one thousand or several thousands. Therefore some information sectors may be worn-out by writing of many data in the span of the media life.

The goal of this model is to provide a mechanism for ensure data readability and media interchangeability after writing the data on a medium by Host. In addition, this model provides a sophisticated real-time defect management method with collaboration between Host & Logical Unit.

This Software defect management model defines two defect management modes. The one is Persistent defect management (Persistent-DM) mode and the other is Distributed real-time defect management (DRT-DM) mode.

7.1 Basic actions for Software defect management

The basic operation of on-line defect management consists of the following three actions.

1. Certification
   Certify blocks on a medium
2. Detection
   Detect the use of defective block
3. Management
   Manage data on a defective block or manage data to be written on a defective block.
   Usually, data on a defective block or data to be written on a defective block is replaced to healthy block.

7.2 Persistent defect management (Persistent-DM) mode

The "Certification" and the "Detection" action are taken by verify after write operation of Host. Then "Management" action is taken by the Host.

A Host ***shall*** verify data on a medium after write the data. The Logical Unit ***shall*** perform media certification if the Certification is enabled and one of the following commands is issued to the Logical Unit:

- "READ (10)", "READ (12)" with Streaming bit set to zero, "VERIFY (10)", and "WRITE AND VERIFY (10)" commands.

The certification result is stored in Defective Block Information (DBI) memory of the Logical Unit. According to the supported DBI memory model of the Logical Unit, the DBI data may be cleared and updated by these commands.

By using DBI memory, multiple blocks are able to be certified by Logical Unit at one command.

For Persistent-DM mode, Logical Unit and media need not support Defect Level Transition model described in Section 7.9.1.

7.3 Distributed real-time defect management (DRT-DM) mode

In addition to the functionality of the Persistent-DM mode, the DRT-DM mode provides functionality that is suitable for real-time streaming applications.

To record real-time streaming data on a medium, usually the replacement of a defective block is suspended or disabled to avoid interruption of real-time recording. In the DRT-DM mode, "Certification" action is taken by read operation of

Host. “Detection” action is taken by write operation of Host. Host can take “Management” action later. Therefore, DRT-DM mode can minimize performance decrease for real-time operation.

Logical Unit performs media certification in response to READ (10), READ (12) or VERIFY (10) command. Then Logical Unit stores the certification result in DBI memory of the Logical Unit. At the writing a packet, Logical Unit reports recovered error on WRITE (10) and WRITE (12) command by checking the stored DBI. To keep compatibility with Persistent-DM mode, Logical Unit ***shall*** certify the medium and then should check the DBI memory in response to READ (10), READ (12), VERIFY (10) or WRITE AND VERIFY (10) command.

DBI data ***shall*** be cached in DBI memory. Host can retrieve the stored DBI data at appropriate timing. To keep compatibility with Read-only application that access the disc directly, Host can suspend Recovered error reporting on READ (10) or READ (12) command. Host can use Recovered error reporting on WRITE (10) or WRITE (12) command instead.

DRT-DM mode has 2 types of DBI memory model. One is large DBI buffer model. Another is small DBI cache memory model. In case of small DBI cache memory model, the certification result of READ (10)/READ (12) command is stored in Read DBI (RDBI) cache. The certification result of VERIFY (10) command and WRITE AND VERIFY (10) command is stored in Write DBI (WDBI) cache. WRITE (10)/WRITE (12) command check RDBI. If defective packet is found, the DBI data is copied to WDBI.

For DRT-DM mode, Logical Unit and media ***shall*** follow the Defect Level Transition model described in Section 7.9.1. When a fatal error occurs, Type 1 or Type 2 Defect levels shall have been detected by the Logical Unit before the fatal error happens.

7.4 Standard Playback model

To specify the interchangeable error level between writable Logical Unit and read-only Logical Unit, standard playback model is defined.

7.4.1 Standard Playback model for DVD-RW media

Ordinary Consumer Electronics (CE) DVD player that supports playback of DVD-RW media is defined as standard player for the standard playback model. Error correction order of the standard player is assumed as

1. PI error correction
2. PO erasure error correction
3. EDC error detection.

No additional error correction is done by the standard player.

Note: Standard Playback model for other media is not yet defined.

7.5 Four types of defect level

This Software defect management model defines four types of defect to handle appropriate operation according to each type of defect.

- Type 1: Recovered light defect
  The conceptual criterion is that after 50 - 100 overwrite cycles, the packet may cause uncorrectable error on standard playback model and number of retry seek operation is small. For DVD-RW media, the recommended error threshold is that the number of PI uncorrectable line is 8 through 15. The number of Seek retry times should be smaller than the number of Seek retry times of Type 2. The packet that the defect level is lower than or equal to this defect level should be good for data recording/playback with Consumer Electronics products.
- Type 2: Recovered heavy defect
  The conceptual criterion is that several seek retries are required to read the packet correctly and reading of the packet may become fatal error on standard playback model. And after 50 - 100 overwritten cycles, reading of the packet may become fatal error even with the best error correction of the Logical Unit. For DVD-RW media, the recommended error threshold is that the number of PI uncorrectable line is 16 or higher. To read a packet correctly many seek retry

operations is allowed. The packet that has this defect level is not good for data recording/playback with Consumer Electronics products.

- Type 3: Un-recovered read error defect
  Un-recovered read error happens or has happened.
- Type 4: Write error defect
  Write error has occurred by WRITE (12) command with Streaming bit value of 1. Some of the specified sectors are not written correctly.

7.6 Enhanced Defect Reporting

Reporting of RECOVERED ERROR is controlled by the Post Error (PER) bit in *14.11.3.1, "Read/Write Error Recovery Parameters Mode Page"* on page 335. RECOVERED ERROR only reports one packet address information by REQUEST SENSE data. Enhanced Defect Reporting that uses DBI memory in Logical Unit provides multiple packet error reporting capability to increase system performance.

Various RECOVERED ERROR ASC/ASCQs are defined for software defect management purpose. Enhanced Defect Reporting uses three types of error levels for media certification. Only ASC/ASCQ 1/18/05 RECOVERED DATA - RECOMMEND REASSIGNMENT ***shall*** be reported when Type 1 or Type 2 defect level is detected during media certification. If Type 3 defect level is detected during WRITE (10)/WRITE (12), VERIFY (10) or WRITE AND VERIFY (10) command execution, 3/11/0B UNRECOVERED READ ERROR - RECOMMEND REASSIGNMENT ***shall*** be reported. When Type 4 defect level is detected during ~~WRITE (10)/~~WRITE (12) with streaming bit=1~~, VERIFY (10) or WRITE AND VERIFY (10)~~ command execution, 1/18/05 RECOVERED DATA - RECOMMEND REASSIGNMENT ~~3/0C/03 WRITE ERROR - RECOMMEND REASSIGNMENT~~ ***shall*** be reported.

If Logical Unit found defective blocks during verify operation of VERIFY (10) and WRITE AND VERIFY (10) command, the command ***shall*** be terminated with Check Condition when all blocks specified by command are certified or when DBI memory overflow is occurred. If DBI memory overflow is occurred, DBI Full (DBIF) bit of DBI descriptor in GET PERFORMANCE Command for the packet that caused DBI buffer full ***shall*** be set to 1. In case of small DBI cache model of DRT-DM mode, the certification result is stored in WDBI (Write DBI) cache.

In case of DRT-DM mode, if Logical Unit finds fatal error occurrence at previous read operation, DBI data of the fatal error is stored in DBI memory. When Logical Unit receives Write command to the fatal error packet, Logical Unit ***shall*** terminate the Write command with Check Condition status, ASC/ASCQ 3/11/0B UNRECOVERED READ ERROR - RECOMMEND REASSIGNMENT after completion of data transfer. The transferred data ***shall*** be written on the media as usual.

To keep compatibility with Read-only application, for example DVD-Video playback software, reporting of recovered error on READ (10) or READ (12) can be suspended by the Enhanced Media Certification and Defect Reporting (EMCDR) field in *14.11.3.1, "Read/Write Error Recovery Parameters Mode Page"* on page 335. DBI memory allows polling of defect packet information without using recovered error reporting. EMCDR field controls media certification and error reporting on selected commands as shown Table 76 - *Definition of PER bit and EMCDR field of Persistent-DM mode* on page 192 and Table 77 - *Definition of PER bit and EMCDR field of DRT-DM mode* on page 195.

When a medium is certified, the rotation speed of Logical Unit needs to be adjusted to appropriate certification speed. The speed may be similar to writing speed of the Logical Unit. By setting PER bit and EMCDR field to 0, Host can disable media certification. Logical Unit can use the highest speed for Read operation at this setting.

At Power-on reset and hard reset, PER bit and EMCDR field ***shall*** be set to 0.

The default values of PER bit and EMCDR field are 0.

7.7 Implicit Synchronize Cache

When a medium certification is enabled and Read or Verify command is issued, and if the data to be read by the command is still remaining in the write cache of the Logical Unit, the unwritten data shall be committed to a physical medium and the Logical Unit ***shall*** read from the medium and certify the data to perform medium certification correctly.

7.8 Persistent-DM mode behavior

In the Persistent-DM mode, the Host ***shall*** check the error level of the packets after write. Logical Unit stores the certification result corresponds to one READ (10)/READ (12) with Streaming bit = 0/VERIFY (10)/ WRITE AND VERIFY (10) command in DBI memory. One of three DBI memory models is used. As for DBI memory model, see *7.10, "DBI memory management"* on page 197.

Host ***shall*** enable media certification by setting of PER bit or EMCDR field.

In Persistent-DM mode, media certification by READ (12) with Streaming bit =1 is not required. Some Logical Units cannot guarantee Real-Time Streaming playback on 1X CLV speed in PC environment. When READ (12) command with Streaming bit =1 is issued, the rotation speed is usually higher than the speed for certification. Thus the certification may not be able to be performed. The Type 1 error level is detected by using READ (10)/READ (12) with Streaming bit = 0 /VERIFY (10) command. The Type 1 error level means the packet readability is good enough for real-time playback i.e. READ (12) with Streaming bit = 1 should not have trouble on reading the packet.

A Host ***shall*** check the error level of the packet using READ (12) with Streaming bit = 0 to keep the disc compatible with standard playback model.

7.8.1 Recovered Error reporting control for Persistent-DM mode

When the PER bit is set to one and/or EMCDR field is set to one or higher, the Logical Unit perform certification and report recovered error on READ (10)/READ (12) with Streaming bit =0/VERIFY (10)/WRITE AND VERIFY (10) command.

If PER bit is set to zero, the EMCDR field controls the recovered error for defect management as defined in Table 76. In this case, the ASC/ASCQ ***shall*** be 1/18/05 RECOVERED DATA - RECOMMEND REASSIGNMENT.

If PER bit is set to one, various recovered errors will be returned for any type of command. And if EMCDR field is set to zero, the reported recovered error for defect management is vendor specific. If EMCDR field is set to other than zero, the reported recovered error for defect management ***shall*** be 1/18/05 RECOVERED DATA - RECOMMEND REASSIGNMENT.

Table 76 - Definition of PER bit and EMCDR field of Persistent-DM mode

PER bit	EMCDR field value	Media certification [a]	Recovered error reporting [b]		
			READ[c]	VERIFY[d]	Other commands
0	0	Disabled	N/A	N/A	No
	1	Enabled	No	No	No
	2	Enabled	No	Yes	No
	3	Enabled	Yes	Yes	No
1	0	Enabled	N/A	N/A	Yes [e]
	1	Enabled	Yes	Yes	Yes
	2	Enabled	Yes	Yes	Yes
	3	Enabled	Yes	Yes	Yes

a. on READ (10)/READ (12) Streaming =0/VERIFY (10)/WRITE AND VERIFY (10) command
b. 1/18/05 ***shall*** be used for defect management purpose except for footnote e case.
c. on READ (10)/READ (12) Streaming=0. READ (12) Streaming =1 is not included
d. on VERIFY (10)/WRITE AND VERIFY (10) command. 3/11/0B may be reported.
e. Logical Unit is allowed to use any recovered error code to keep legacy compatibility

7.8.2 Recommend Host sequence of Persistent-DM mode

At the time of disc mounting

1. Turn on media certification (EMCDR field in Read/Write Error Recovery Parameters Mode Page)
2. Try to recognize file system of the disc
3. If the Host's File System driver does not support the file system on the disc, turn off media certification (EMCDR field in Read/Write Error Recovery Parameters Mode Page). Then pass the disc to the next possible file system driver.

At the time of disc writing

1. Write several packets
2. Verify the written several packets
3. If recovered error is reported, retrieve DBI information.

At the time of disc unmounting

1. Synchronize all cached data to the disc
2. Turn off media certification (EMCDR field in Read/Write Error Recovery Parameters Mode Page)
3. unmount the disc

7.9 DRT-DM mode behavior

The basic 3 actions of defect management are performed by different commands and timing. Certification and Detection are separated in Read command and Write command, and are connected by DBI memory. Either small DBI cache model or large DBI buffer model shall be used.

The EMCDR field controls the command of returned recovered error message. Host can receive recovered error message by Host's desired command. (e.g. media access command) Host can retrieve DBI data at appropriate timing.

1. Certification is performed at READ (10), READ (12) or VERIFY (10) command. The result is stored in DBI memory.
2. Detection is performed at WRITE (10)/WRITE (12) command checking DBI memory. The result is reported as RECOVERED ERROR of WRITE (10)/WRITE (12) command.
3. Management is performed by Host. If Host received RECOVERED ERROR at completion of Write command, Host ***shall*** perform necessary management of data that has important information. The Host can retrieve DBI data from DBI buffer at any time.

There are 2 type of memory models for DBI memory. One is large DBI buffer memory model that covers all packets on the media. This never cause DBI buffer overflow. Another is small DBI cache memory model. This model has a special scheme to minimize cache overflow. But cache overflow is possible.

The EMCDR field controls DRT-DM actions. When Logical Unit reads medium and the EMCDR field is set to the value other than 0, the Logical Unit ***shall*** certify packets on the medium and store the certification result into DBI memory regardless of Streaming bit setting of READ (12) command. In case of DRT-DM mode, media certification by READ (12) with Streaming bit =1 ***shall*** be supported.

In this mode, when write error is happen at WRITE (12) command with Streaming bit value of 1, the result ***shall*** be stored in DBI memory. Error reporting is dependent on the PER bit and EMCDR field setting. If error reporting is disabled, no error shall be reported. In this case, the Host should check DBI data after the writing operation with Streaming =1 if necessary.

7.9.1 Defect Level Transition model

In case of real-time stream recording, Host and Logical Unit cannot perform verify after write operation and defect management. Because data allocation of the real-time stream, e.g. real-time Video data, ***shall*** be determined before writing on the medium to keep data format compatibility and playback compatibility. The real-time stream data flows from Host to Logical Unit continuously. Usually there is no time for verify after write operation and defect management. Therefore to guarantee the readability of written packet, Host needs to verify the packet before write.

In case of DRT-DM mode, Logical Unit and media ***shall*** support Defect Level Transition model. If there is neither physical impact to media (e.g. scratch, finger print) nor physical impact to Logical Unit (e.g. shock, vibration), error level of a packet ***shall not*** change from no error level to fatal level. Type 1 error or Type 2 error ***shall*** be reported before the packet becomes unreadable by ordinary direct overwrite cycles.

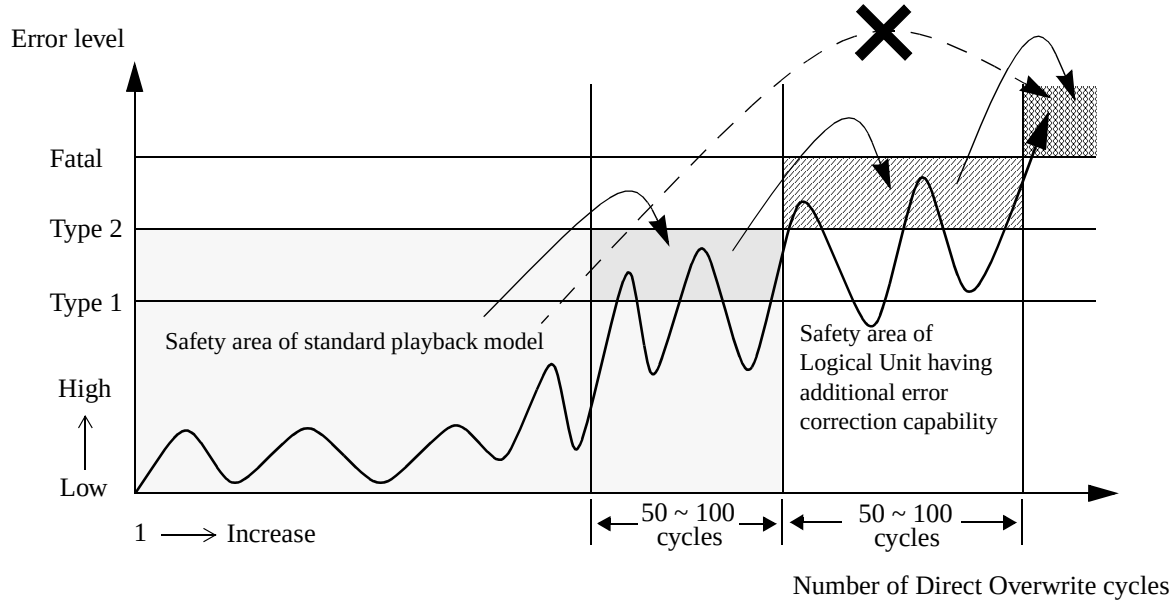

Figure 77 - Example of error rate transition

7.9.2 Certification

At Read command, Logical Unit ***shall*** certify specified blocks to be read. The result is stored in DBI memory. In case of small DBI cache model, the DBI memory is named RDBI (Read DBI) cache. The information of actually transferred blocks ***shall*** be stored. The information of the blocks those are out of range of command (e.g. read by look ahead buffering, but not transferred to Host) ***shall not*** be stored. Because the blocks may be replaced and may not be used by Host already.

If Logical Unit found defective blocks in VERIFY (10) or WRITE AND VERIFY (10) command, the command ***shall*** be terminated with Check condition when all blocks specified by command are certified or when DBI cache overflow is occurred. Logical Unit ***shall*** report recommended error to Host. The result is stored in DBI memory. In case of small DBI cache model, the DBI memory is named WDBI (Write DBI) cache.

READ (10)/READ (12) command and VERIFY (10) command ***shall*** be performed as usual. If fatal error was detected, Logical Unit ***shall*** report the error as usual.

7.9.3 Detection of use of defective block

Detection is performed at WRITE (10)/WRITE (12) command. Logical Unit ***shall*** check all written block address by RDBI cache or DBI buffer. In case of small DBI cache model, when defective block is used by Write command, Logical Unit ***shall*** store the information in DBI memory named WDBI (Write DBI) cache. Logical Unit ***shall*** terminate the Write

command with Check Condition after all data is transferred. All buffered data ***shall*** be written on the media properly even if Write command is terminated with Check Condition.

If fatal error was detected, Logical Unit ***shall*** report the error as usual.

7.9.4 Management of defective block

When Host pauses current real time operation, Host ***shall*** perform defect management of used defective blocks if necessary. Some of information on defective blocks may have important data to be replaced. Some other may not be needed to replace. In case of real time data e.g. video stream, those information blocks are not allowed to be replaced. Host ***shall*** select suitable defect management method for the data.

If Host received Recovered Error at Write command, some of information had been written on defective blocks. Host ***shall*** read the DBI data by GET PERFORMANCE command type 4. Host ***shall*** determine which data on defective blocks ***shall*** be managed.

7.9.5 Delayed replacement of data on defective block

The Recovered Error reported by Logical Unit means some of used sectors by Write command are not reliable. After hundred (it may be a few hundreds initially, a few times finally) overwrite cycle, the block should be unreadable. Therefore, Host can read the written data from defective blocks, and can write them into spare area. For example, in the case of UDF, Host ***shall*** maintain its Sparing Table of UDF Spareable Partition.

7.9.6 Recovered Error reporting control for DRT-DM mode

When the PER bit is set to one and/or EMCDR field is set to one or higher, the Logical Unit ***shall*** perform media certification and ***shall*** report Recovered Error on READ (10)/READ (12)/VERIFY (10)/WRITE (10)/WRITE (12)/ WRITE AND VERIFY (10) command regardless of Streaming bit setting.

If EMCDR field is set to zero, Logical Unit ***shall not*** store the certification result in DBI cache.

If PER bit is set to zero, the EMCDR field controls the recovered error for defect management as defined in Table 77. In this case, the ASC/ASCQ ***shall*** be 1/18/05 RECOVERED DATA - RECOMMEND REASSIGNMENT or 3/11/0B UNRECOVERED READ ERROR - RECOMMEND REASSIGNMENT. The 3/11/0B UNRECOVERED READ ERROR - RECOMMEND REASSIGNMENT is returned for VERIFY (10)/WRITE (10)/WRITE (12)/WRITE AND VERIFY (10) command. The 3/11/0B UNRECOVERED READ ERROR - RECOMMEND REASSIGNMENT on WRITE (10)/WRITE (12)/WRITE AND VERIFY (10) command means that host issued write command to the Type 3 defect level packet. The write data has been written to the packet even if this error was returned. In case of WRITE AND VERIFY (10) command, fatal error was not happened on the packet at verify operation of the command.

The error code of the write failure on WRITE (10)/WRITE (12)/WRITE AND VERIFY (10) command is not defined in this model. See each media model section and WRITE (10)/WRITE (12)/WRITE AND VERIFY (10) command sections.

The error code of the read failure on READ (10)/READ (12) command is not defined in this model. See each media model section and READ (10)/READ (12) command sections.

If PER bit is set to one, various recovered errors will be returned for any type of command. And if EMCDR field is set to zero, the reported recovered error for defect management is vendor specific. If EMCDR field is set to other than zero, the reported recovered error for defect management ***shall*** be 1/18/05 RECOVERED DATA - RECOMMEND REASSIGNMENT.

Table 77 - Definition of PER bit and EMCDR field of DRT-DM mode

PER bit	EMCDR field value	Media certification [a]	Recovered error reporting [b]			
			READ[c]	VERIFY[d]	WRITE[e]	Other commands

Table 77 - Definition of PER bit and EMCDR field of DRT-DM mode

0	0	Disabled	N/A	N/A	N/A	No
	1	Enabled	No	No	No	No
	2	Enabled	No	Yes	Yes	No
	3	Enabled	Yes	Yes	Yes	No
1	0	Enabled	N/A	N/A	N/A	Yes [f]
	1	Enabled	Yes	Yes	No	Yes
	2	Enabled	Yes	Yes	Yes	Yes
	3	Enabled	Yes	Yes	Yes	Yes

a. on READ (10)/READ (12)/VERIFY (10)/WRITE AND VERIFY (10) command
b. 1/18/05 ***shall*** be used for defect management purpose except for footnote <f> case.
c. on READ (10)/READ (12)
d. on VERIFY (10)/WRITE AND VERIFY (10) command. 3/11/0B may be reported.
e. on WRITE (10)/WRITE (12). 3/11/0B may be reported.
f. Logical Unit is allowed to use any recovered error code to keep legacy compatibility

7.10 DBI memory management

To avoid or minimize DBI data overflow with minimum Logical Unit's hardware resources, three different memory models are defined to store DBI in Logical Unit. They are simple DBI memory model, large DBI buffer model and small DBI cache model.

The DBI data ***shall*** be cleared when the Logical Unit is reset by Power on reset or Hard reset and when medium is ejected.

The DBI data ***shall not*** be cleared when PER bit and EMCDR field are both set to 0.

7.10.1 Simple DBI memory model

The simple DBI memory model is permitted only for Persistent-DM mode. All stored data in DBI memory is updated at the beginning of medium certification. DBI memory stores at least information of 10 packets. The Number of packets field in Software Defect Management Feature Descriptor indicates the number of packets that can be stored in DBI memory.

7.10.2 Large DBI buffer memory model

Some Logical Units, e.g. Logical Unit that supports hardware defect management, have enough memory to cover the whole medium for defect management. In this case, Logical Unit's memory can cover DBI data for all packets on C/DVD-RW media actually or virtually. For example, Logical Unit stores DBI data into DBI bitmap that can cover entire disc. Logical Unit's memory can store about 10% different packet start address of entire disc and length of consecutive defective packets. DBI data ***shall*** be cleared when disc is ejected.

7.10.3 Small DBI cache model

Logical Unit has small memory to store DBI data. To minimize DBI data overflow and to allow effective Host operation, small DBI cache model is defined. The DBI data remains in DBI cache even if the data is read by a Host.

7.10.3.1 Three level memory construction for DBI cache

Three different level memory blocks are defined for DBI cache to minimize data overflow. Data ***shall*** be cleared when disc is removed. In case of large DBI buffer model, the DBI data is stored into DBI buffer directly, then these 3 level memory are unified in single DBI buffer.

- BDBI (Buffer DBI) memory to store certification information of sectors in data buffer
- RDBI (Read DBI) cache memory to copy data from BDBI by Read command
- WDBI (Write DBI) cache memory to copy data from RDBI by Write command, copy data from BDBI by Verify command

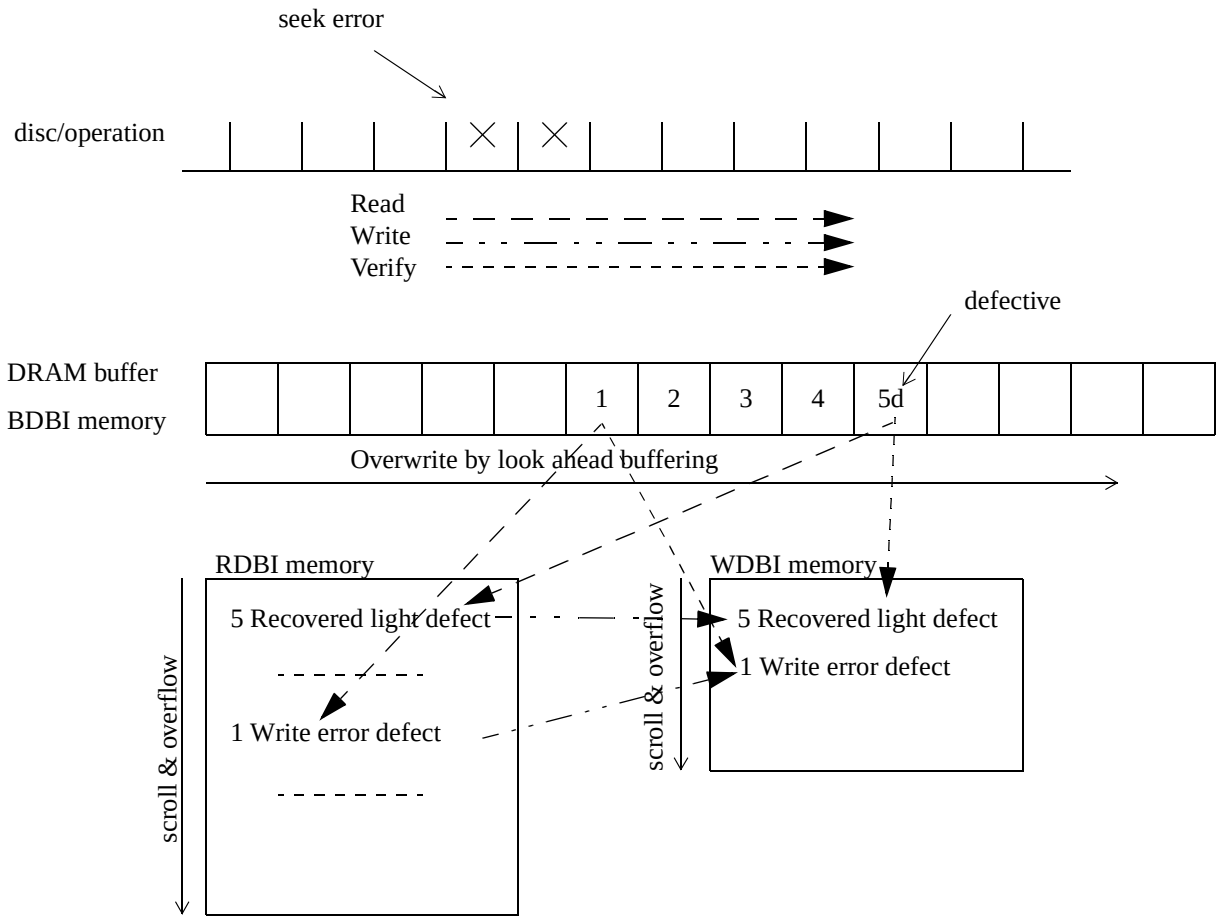

Figure 78 - Example of DBI memory

7.10.3.2 Adjust DBI cache for a real-time application

In case of large DBI buffer model, Logical Unit ***shall*** report the Number of DBI cache zones field value of 1 in Software Defect Management Feature Descriptor. The Logical Unit ***shall*** report single DBI cache zone that starts from LBA 0 to the end of the medium by GET PERFORMANCE Command with Type 05h.

By access to multiple files, data in RDBI and WDBI can be overflowed easy. To protect overflow of the important information, disc volume space is divided into a few zones named DBI cache zone. RDBI and WDBI memory are allocated for each DBI cache zones. For UDF file system and DVD-VR application, minimally 2 DBI cache zones are necessary.

1st DBI cache zone: from LBA 0 to before VR object files. There are very important UDF descriptors and information that are not covered by Sparing of UDF. And there are important contents that can be replaced to Spare Area.

2nd DBI cache zone: from beginning of VR object files to end of disc volume space. There are real time contents that can not be replaced to Spare Area.

Table 78 - Example of DBI cache zones image

Zone	Major contents	Remark	Sparing
0	VRS	from 10h	not covered
	AVDP	100h	
	main Volume Descriptor Sequence	by AVDP	very important many overwritten file system data
	reserve Volume Descriptor Sequence	by VDS	
	Logical Volume Integrity Descriptor	by VDS	
	primary Sparing Table	by VDS	
	Spare Area	by VDS	
	secondary Sparing Table	by VDS	
	Beginning of Spareable Partition	by VDS	subject of sparing
	Free Space Bitmap	by VDS	
	root File Entry for root directory	by VDS	
	File Entry for DVD_RTAV	by root File Entry	
	VR_MANAGR.IFO	by VR File Entry	
	VR_MANAGR.BUP	by VR File Entry	
1	VR_MOVIE.VRO	by VR File Entry	subject of sparing but not suitable to spare
	VR_AUDIO.VRO	by VR File Entry	
	VR_STILL.VRO	by VR File Entry	