

Data Protection

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Abstract

End-to-End data protection used provide vigorous data protection from application to media and application itself. As NVMe point of view E2E data protection is an optional mechanism. If it is enabled, then additional protection information (CRC) is added to the logical block and that is evaluated by the controller to check the integrity of the data. The additional protection information is presented in last or first eight bytes of the metadata based on the configuration.

Keywords: CRC, DIF, DIX, E2E, LBA, NVMe, PRACT, PRCHK

1. INTRODUCTION

The security or protection of the data is important while transferring or storing data into any of the device or storage media. The data transfer from one device or storage medium to another medium can be done with help of NVMe controller. NVMe has an optional data protection known as end to end data protection which adds the 16-bit CRC and reference tag to the each of the data block while data transferring. The end to end data protection can be enabled via protection information field.

The most commonly used data protection in NVMe are data integrity field and data integrity extension. In data integrity field, the protection information stored along with logical block data, while in data integrity extension, the protection information stored in the separate buffer.

Generation of protection information depends on “protection information action field” in the PRINFO. If PRACT bit is set to zero, then protection information is generated from the host.

If PRACT bit is set to one, then controller will generate the protection information based on the protection type while writing and strips the protection information while reading from the media and terminates the command if any error in the data.

DIF data storage:



Fig. 1. DIF storage format

In data integrity field, the metadata or protection information is interleaved between the logical block data and creates extended logical block. The above figure shows the metadata storage.

DIX data Storage:

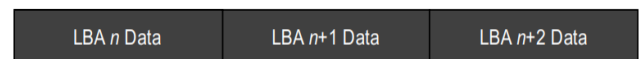
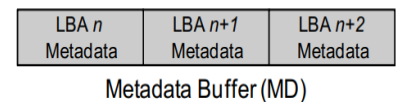


Fig. 2. DIX storage format

In DIX method the data is stored in the separate location called as metadata buffer and to access this location metadata pointer is used. The logical data is stored in the separate location and this is accessed by data pointer. The above figure shows the metadata storage in DIX method.

2. Format of Protection Information

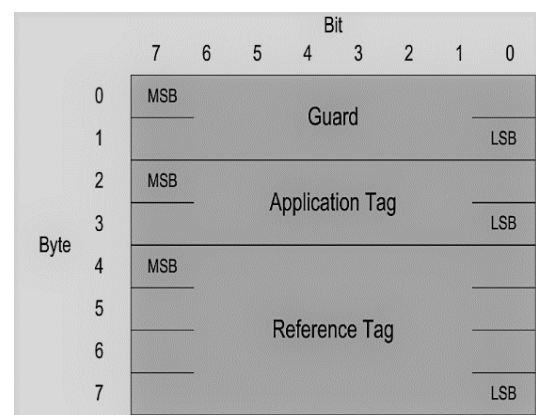


Fig. 3. Format of Protection information

The guard field contains the 16 bit CRC calculated over the logical block data. The application tag is used by the controller to disable the checking of protection information. Reference tag is used to find the out of order block transfer.

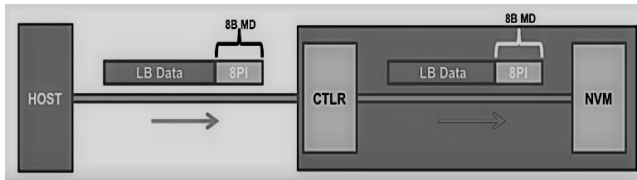


Fig.4. Write Command

The above figure shows the data transfer from host memory to the controller with protection information is of eight bytes and PRACT bit is set to zero. The controller verify this information if any error detected, then controller generates an interrupt and terminates the command.

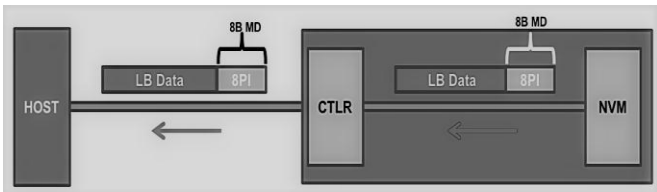


Fig. 5. Read Command

The above diagram shows read command with PRACT bit set to zero, the data transfer from controller to host memory with protection information is of eight bytes.

The generation and checking of protection information depends on the PRACT and PRCHK fields. If the protection information is generated then it can be checked or masked based on the protection information check fields. If the PRCHK field is set to non-zero, then protection information is evaluated by the controller else it will be skipped.

3 CONCLUSION

The data protection is very important in the field of data transfer and storage. The NVMe provides optional end to end data protection based on the protection action bit. If PRACT bit is asserted, then eight bytes of protection information is appended at the end of logical block data. The protection information is used to detect any error occurred during the data transmission and storage. It provides efficient data transfer between the media and the host.

REFERENCES

- [1] NVMe Express Revision 1.3
- [2] End-To-End Data Protection by Western Digital