CLAIMS

WHAT IS CLAIMED IS:

1. A method for operating a memory controller, comprising:

receiving, from a host, a request for a fragmentation level of a file stored in a memory device;

determining a read performance level of the file based on a logical-to-physical (L2P) address mapping table corresponding to the file without reading the file from the memory device; and

determining the fragmentation level based on the read performance level.

2. The method according to claim 1, wherein the request comprises a plurality of logical addresses of the file, and wherein determining the read performance level of the file comprises:

reading the L2P address mapping table from the memory device;

determining an average consecutive physical address length of the file based on the plurality of logical addresses of the file and the L2P address mapping table; and

determining the read performance level based on at least the average consecutive physical address length and a predetermined read performance curve.

3. The method according to claim 2, wherein determining the average consecutive physical address length of the file comprises:

mapping the plurality of logical addresses to physical address segments according to the L2P address mapping table, wherein each of the physical address segments comprises one or more consecutive physical addresses; and

determining the average consecutive physical address length, wherein the average consecutive physical address length is determined based on a sum of a quantity of the one or more consecutive physical addresses comprised in each of the physical address segments and a quantity of the physical address segments.

4. The method according to claim 3, wherein:

each logical address of the plurality of logical addresses is a logical block address (LBA); and

each physical address in the physical address segments is a physical block address (PBA).

5. The method according to claim 2, wherein the predetermined read performance curve is determined by performing a random read experiment on the memory device using test data of various chunk sizes.

6. The method according to claim 2, wherein determining the read performance level comprises:

determining an initial read performance level corresponding to the average consecutive physical address length based on the predetermined read performance curve; and

determining whether the average consecutive physical address length is larger than a threshold.

7. The method according to claim 6, wherein determining the read performance level further comprises:

in response to determining that the average consecutive physical address length is larger than the threshold, determining the read performance level as the initial read performance level.

8. The method according to claim 6, wherein determining the read performance level further comprises:

in response to determining that the average consecutive physical address length is not larger than the threshold, determining the read performance level as the initial read performance level adjusted by a value that is determined based on a distribution of physical addresses of the file among a number of planes of the memory device.

9. The method according to claim 6, wherein:

the read performance level is determined based on the initial read performance level and the value;

the value is determined based on how evenly the physical addresses of the file are spread among the number of planes of the memory device; and

the value is smaller if the physical addresses of the file are spread more evenly among the number of planes of the memory device.

10. The method according to claim 1, wherein the memory device comprises a three-dimensional (3D) NAND Flash memory device.

11. The method according to claim 1, wherein the request is a File Based Optimization (FBO) request under a Universal Flash Storage (UFS) 4.0 technical standard.

12. The method according to claim 1, further comprising:

returning the fragmentation level to the host;

receiving a command from the host to perform defragmentation, wherein the host transmits the command in response to determining that the fragmentation level is above a fragmentation level threshold; and

performing the defragmentation based on the received command.

13. A memory system comprising:

a memory device; and

a memory controller comprising one or more processors and a computer storage medium, wherein the computer storage medium is coupled to the one or more processors and stores programming instructions for execution by the one or more processors to cause the memory controller to perform operations comprising:

receiving, from a host, a request for a fragmentation level of a file stored in the memory device;

determining a read performance level of the file based on a logical-to-physical (L2P) address mapping table corresponding to the file without reading the file from the memory device; and

determining the fragmentation level based on the read performance level.

14. The memory system according to claim 13, wherein the request comprises a plurality of logical addresses of the file, and wherein determining the read performance level of the file comprises:

reading the L2P address mapping table from the memory device;

determining an average consecutive physical address length of the file based on the plurality of logical addresses of the file and the L2P address mapping table; and

determining the read performance level based on at least the average consecutive physical address length and a predetermined read performance curve.

15. The memory system according to claim 14, wherein determining the average consecutive physical address length of the file comprises:

mapping the plurality of logical addresses to physical address segments according to the L2P address mapping table, wherein each of the physical address segments comprises one or more consecutive physical addresses; and

determining the average consecutive physical address length, wherein the average consecutive physical address length is determined based on a sum of a quantity of the one or more consecutive physical addresses comprised in each of the physical address segments and a quantity of the physical address segments.

16. The memory system according to claim 15, wherein:

each logical address of the plurality of logical addresses is a logical block address (LBA); and

each physical address in the physical address segments is a physical block address (PBA).

17. The memory system according to claim 14, wherein the predetermined read performance curve is determined by performing a random read experiment on the memory device using test data of various chunk sizes.

18. A non-transitory computer storage medium, wherein the non-transitory computer storage medium is coupled to one or more processors of a memory controller and stores programming instructions for execution by the one or more processors to cause the memory controller to perform operations comprising:

receiving, from a host, a request for a fragmentation level of a file stored in a memory device;

determining a read performance level of the file based on a logical-to-physical (L2P) address mapping table corresponding to the file without reading the file from the memory device; and

determining the fragmentation level based on the read performance level.

19. The non-transitory computer storage medium according to claim 18, wherein the request comprises a plurality of logical addresses of the file, and wherein determining the read performance level of the file comprises:

reading the L2P address mapping table from the memory device;

determining an average consecutive physical address length of the file based on the plurality of logical addresses of the file and the L2P address mapping table; and

determining the read performance level based on at least the average consecutive physical address length and a predetermined read performance curve.

20. The non-transitory computer storage medium according to claim 19, wherein determining the average consecutive physical address length of the file comprises:

mapping the plurality of logical addresses to physical address segments according to the L2P address mapping table, wherein each of the physical address segments comprises one or more consecutive physical addresses; and

determining the average consecutive physical address length, wherein the average consecutive physical address length is determined based on a sum of a quantity of the one or more consecutive physical addresses comprised in each of the physical address segments and a quantity of the physical address segments.