Positioning Errors Indication by Seek Error Rate and Other Hdd Parameters

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Abstract-The dependence of the change of the SMART parameter 7 Seek error rate value on the operating time, which characterizes the frequency of errors when positioning the block of magnetic heads, is considered. This parameter is critical in the sense that the greater its value, the worse the condition of the mechanical part of the structure and / or the surface of the hard disk having these values. The scientific task of the study is to establish the relationship in the failed hard drives between the specified parameter and the values of other reliability parameters for information stores of various manufacturers. In the course of the study, the drives of the HGST, Hitachi, Samsung, ST, Toshiba, WDC trademarks operated in the Backblaze largest commercial data centre were analysed.The analysis revealed the relationship between this parameter and the parameters 1 Read error rate (frequency of errors (when reading data from the disk), the origin of which is due to the hardware of the disk), 5 Reallocated sectors count (the number of reallocated sectors), 196 Reallocation event count (the number of reallocation operations), 197 Current pending sector count (the number of sectors that are candidates for replacement). It is shown that the nature of the change in the values of the considered parameters depends on the manufacturers of the hard drives. It is proposed to carry out an individual assessment of the reliability of the positioning mechanism for a block of magnetic heads of information storage devices using the parameters identified as a result of the study.

*Keywords:*Magnetic Head Positioning, Hard Drive, Reliability, Information, Security, Drive.

1.Introduction

To ensure the security of information, it is necessary to timely and completely copy data from an unreliable drive to a new and reliable drive. For this purpose, SMART technology (self-monitoring, analysis and reporting technology [1]) is usually used for internal assessment of the state of a computer's hard drive, as well as a way of predicting its possible failure. The paper considers the dependence of the change on the operating time of the parameter 7 Seek error rate which characterizes the error rate when positioning the block of magnetic heads. This parameter is critical in the sense that the greater its value, the worse the condition of the mechanical part of the structure and / or the surface of the hard disk. The scientific task of the study is to establish in a failed hard drive a relation between the specified parameter and the values of other reliability parameters for information stores of various manufacturers.

In the course of the study, the parameters of failed drives of the HGST, Hitachi, Samsung, ST, Toshiba, WDC brands operated in the Backblaze largest commercial data centre were analysed. The analysis revealed the relationship between the parameter 7 Seek error rate and parameters 1 Read error rate (frequency of errors when reading data from the disk; the origin of the errors is due to the hardware of the disk), 5 Reallocated sectors count (the number of reallocated sectors), 196 Reallocation event count (the number of reallocation operations), 197 Current pending sector count (the number of sectors that are candidates for reallocation).

It is shown that the very existence of the values of the considered parameters and the nature of their change depending on the operating time of the information storage devices depends on the manufacturer.It is proposed to carry out an individual reliability assessment for the positioning mechanism of a block of magnetic heads in information storage devices using the parameters identified as a result of the study.

2.Methods

To analysethe dependence of the parameter values on the operating time of information storage devices on hard magnetic disks that have failed, we studied the SMART data provided on the Backblaze website [2].45 parameters of SMART 92530 type were examined for 93 drives and 6 brands: HGST (Hitachi Global Storage Technologies), Hitachi (later HGST), Samsung, ST (Seagate), Toshiba, WDC (Western Digital) for the period from April 10, 2013, until December 31, 2016It was found that at the end of the study period 79.58% of drives continued to work normally, 14.74% were prematurely decommissioned, and 5.68% failed.

In total, information about the semantic value of more than 80 SMART parameters is available, but most of them are not used by manufacturers. Therefore, Backblaze specialists recorded only 40 of them in 2013-2014, and since 2015, 45 parameters with numbers 1-5, 7-13, 15, 22, 183, 184, 187-201, 220, 222-226, 240 -242, 250-252, 254, 255 (in 2015, 22, 220, 222, 224, 226 were added).

Three groups can be distinguished among these parameters: the group which values accumulate (of the "count" type), the values of which reflect the rate of change (of the "rate" type or similar in meaning), the group which values are associated with other parameters (also of the "count" type or similar).According to another classification, three groups of parameters can also be identified: those associated with the state of the memory space,or the surface of the disks;those associated with the positioning of the write / read heads;and those associated with the mechanical part of the hard drive design.

Data storage defects can also be divided into two large groups: physical and logical. Physical defects include surface defects, servo errors, and bad hardware sectors. The latter arise due to a malfunction in the mechanical part of the structure or the electronics of the drives. Such problems include breakage of the heads, displacement of the disks or a bent shaft as a result of an impact; dusting the hermetic zone, as well as various interruptions in the operation of electronics. Errors of this type are usually catastrophic and cannot be corrected programmatically.

Logical defects arise not because of surface damage, but because of violations of the sector operation logic.They can be divided into correctable and uncorrectable.Logical defects have the same external manifestations as physical ones, and they can be distinguished only indirectly, according to the results of various tests.

The essence of the research method is to compare the changes in the values of the SMART parameters of the failed information storage devices and to identify time coincidences in them.

3.Results and Discussion

When analysing the parameter 7 Seek error rate, which characterizes the error rate when positioning a block of magnetic heads, a failed hard drive of the HGST trademark revealed a coincidence in time of the change in values with parameters 1, 5, 196, 197 (Figure 1).And here, first, an increase in the value of parameter 7 coincides with an increase in the value of the remaining specified parameters. Then, a decrease in the parameter 7 value coincides with a decrease in the value of the parameter 197 only.The value of parameter 1 remains stable, while the values of parameters 5 and 196 continue to grow.Therefore, when analysingwith the use of relative [3] or absolute [4] values, this circumstance must be taken into account.

A similar coincidence, but not with all of the specified parameters, was noted for other failed drives of such manufacturers as HGST (7 in total), Hitachi (see Figure 2) (1 piece), WDC (see Figure 3) (9 pieces), for which parameter 7 had nonzero values. For disks produced by such manufacturers as Samsung and Toshiba, that lost working capacity, their value was equal to zero or absent.

As can be seen from Figures 1-3, the failure of a hard drive is usually associated with a sharp jump in the number of reallocated sectors, which may be due to a missed positioning of the write/read head on the track.In addition, sometimes there are cases of constant or rather smooth change in the number of reallocated sectors or even their complete absence, in which a disk failure still occurs.This suggests that parameter 7 is independent, and the rest only reflect the consequences of failures when positioning the block of magnetic heads.
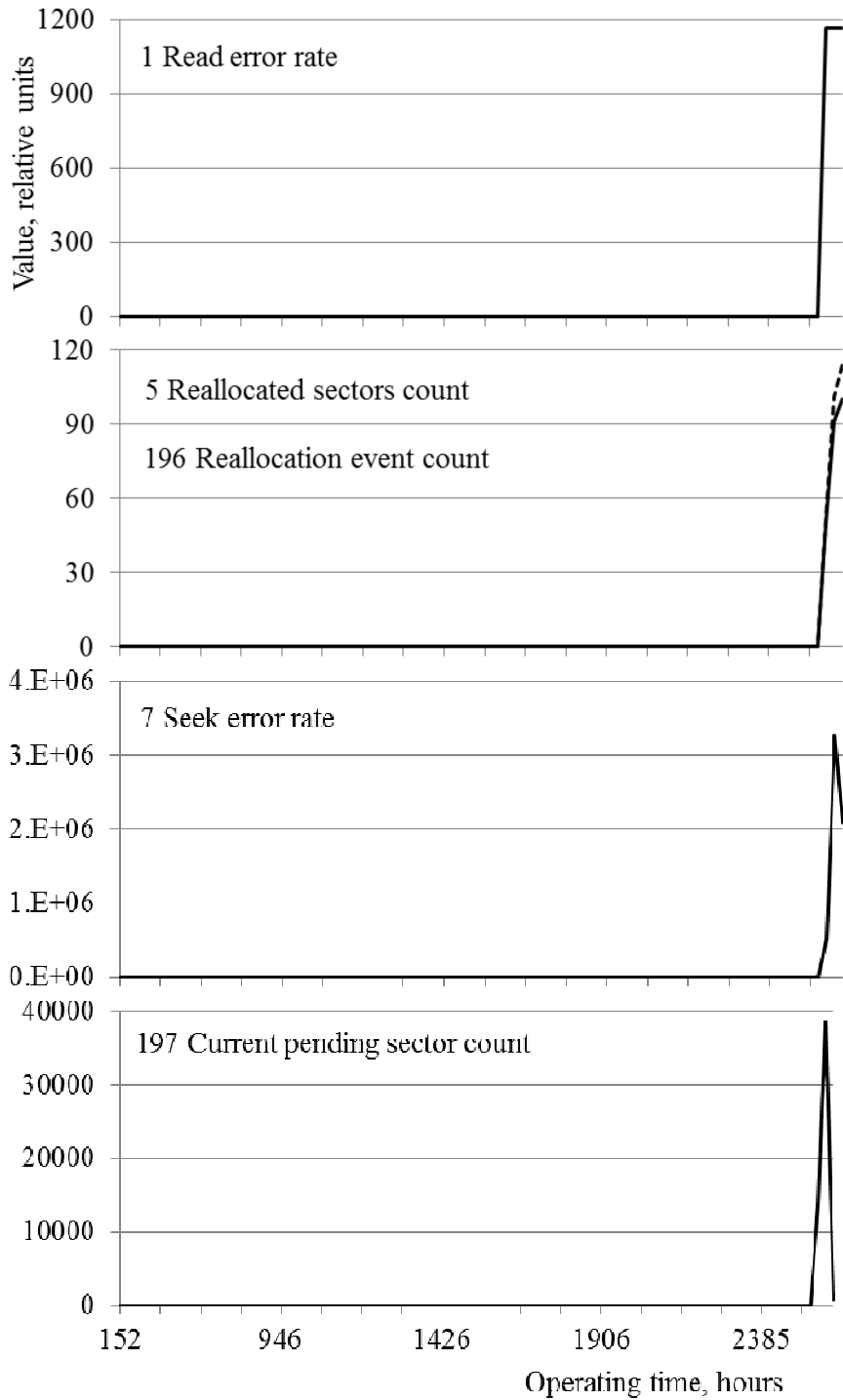
Figure 1. Parameter 1, 5, 7, 197 (solid lines), 196 (dotted lines) values depending on the operating time for a failed hard drive model HGST HMS5C4040ALE640 with the number PL1331LAGTLW3H and with a capacity of 4 TB

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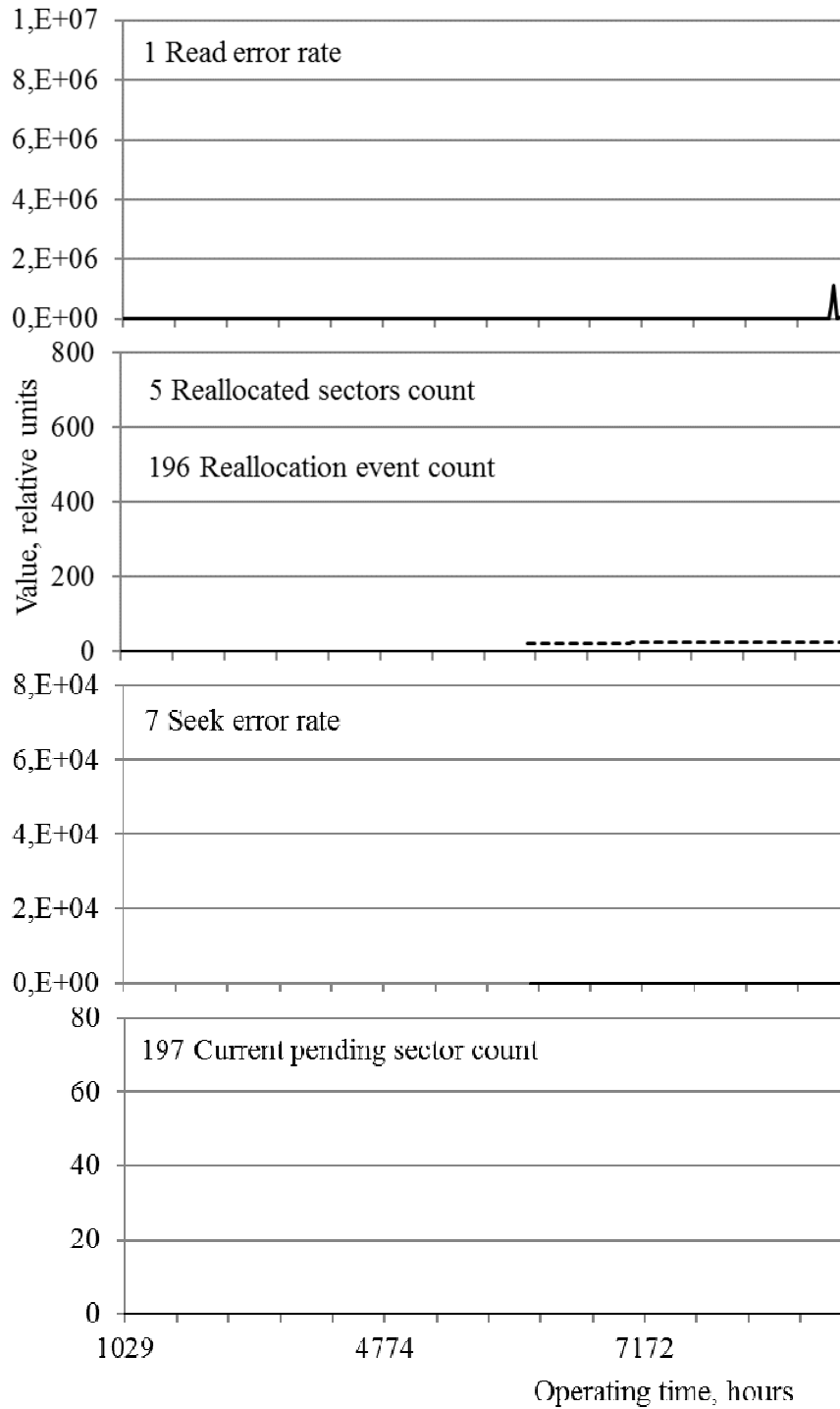
Figure 2. Parameter 1, 5, 7, 197 (solid lines), 196 (dotted lines) values depending on the operating time for the failed Hitachi HDS5C4040ALE630 model hard drive with the number PL1311LAG22RAA and with a capacity of 4 TB
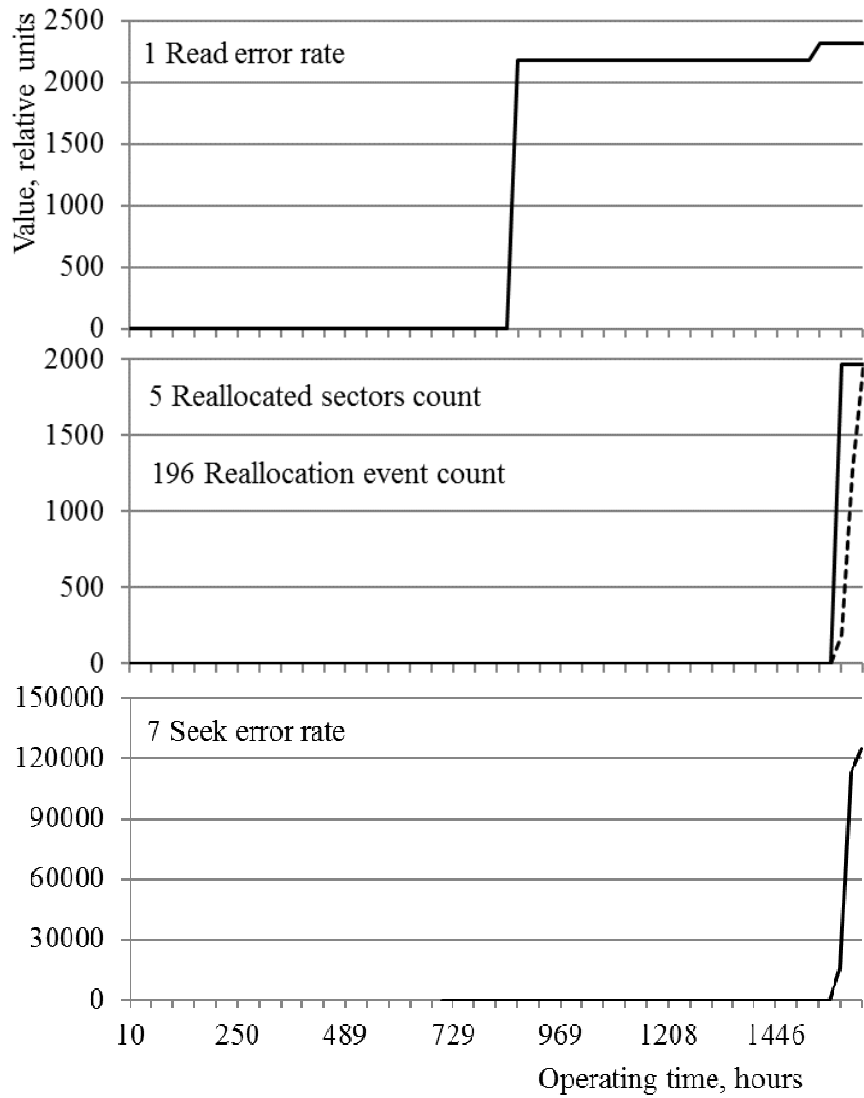
Figure 3. Parameter 1, 5, 7 (solid lines), 196 (dotted lines) values depending on the operating time for a failed hard drive model WDC WD30EFRX with the number WD-WCC1T1088681 and with a capacity of 3 TB

For hard drives of the ST brand manufactured by Seagate, the coincidence is also observed not with a sharp change in the value of parameter 7, but with its absolute value (Figures 4, 5).At the same time, reallocation of sectors in most cases occurs immediately as whole tracks (in a quantity which is multiple of 8), which is fully consistent with a large number of failures due to the positioning of the write / read heads of ST drives. By the number of failures, parameter 7 with nonzero values is in second place (3365 units) after parameter 1 (4146 units).

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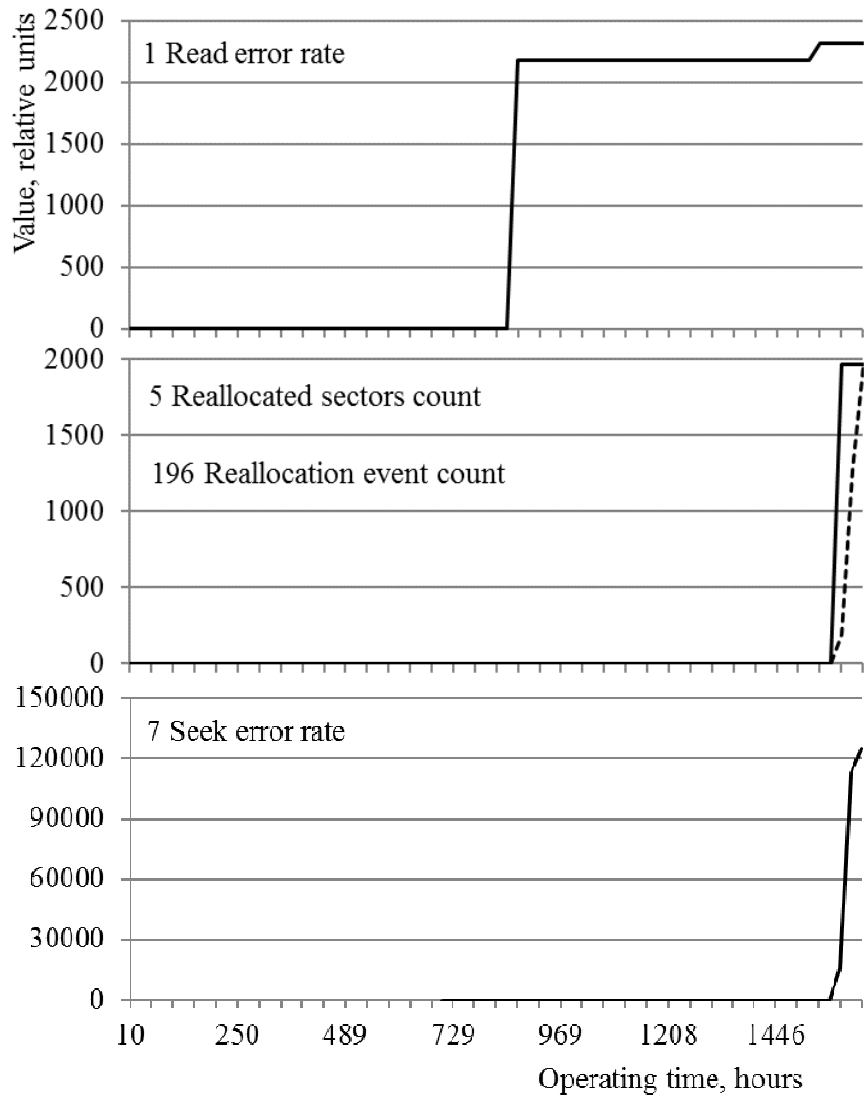
Figure 4. Parameter 1, 5, 7, 197 values depending on the operating time for a failed hard drive of model ST4000DM000 with number Z3025ZT4 and with a capacity of 4 TB
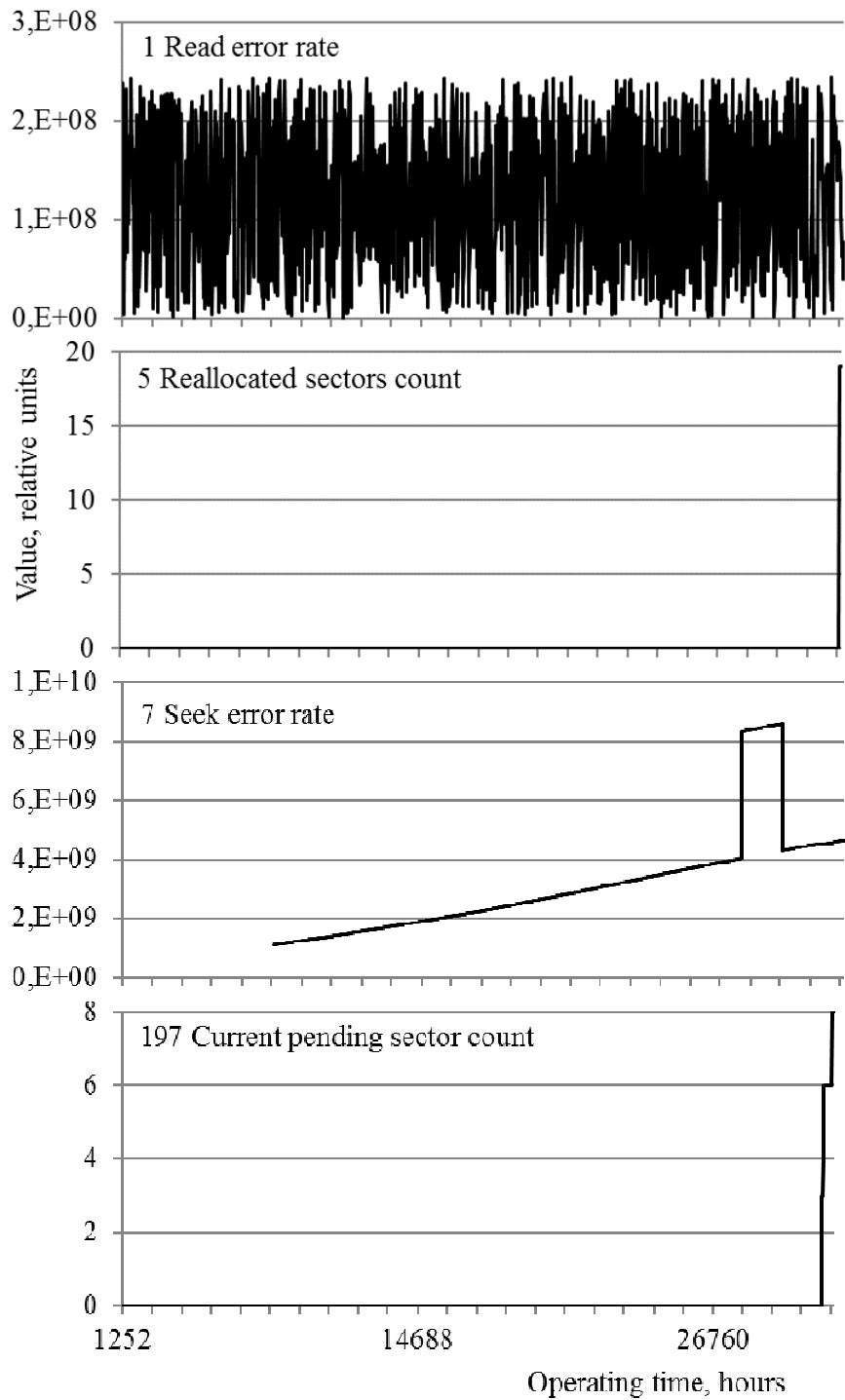
Figure 5. Parameter 1, 5, 7, 197 values depending on the operating time for the failed hard drive of model ST4000DX000 with the number Z1Z0279D and with a capacity of 4 TB

It should be noted the chaotic nature of the change in parameter 1 for ST hard drives. Due to the large share of this brand in the total number (62.08%), they bring this chaos into the values averaged over all drives.Because of this, Backblaze experts refused to use this parameter in the analysis of disk reliability.Nevertheless, even taking into account these circumstances, it can be used as an indicator: if it is different from zero, then some violations occur when reading information.

Here parameter 1 Read error rate characterizes the frequency of errors when reading data from a disk, the origin of which is due to the hardware of the disk. This is the number of internal corrections of data that were performed before being output to the interface.Frighteningly huge numbers may be output. Parameter 5

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Reallocated sectors count characterizes the number of reallocated sectors. When a disk detects a read/write error, it marks the sector as "reallocated" and transfers the data to a dedicated backup area.An increase in the value of this attribute may indicate deterioration in the surface of the disk platters. Parameter 7 Seek error rate is a characteristic fora frequencyof errors in the positioning of the magnetic heads.The more of them, the worse is the condition of themechanical part of the structureand / or the surface of the hard disk.Also, the parameter value can be affected by overheating and external vibrations, for example, from neighbouring disks in the basket. Parameter 196 Reallocation event count shows the number of reallocation operations.The attribute characterizes thetotal number of attempts to transfer information from reallocated sectors to the backup area.Both successful and unsuccessful attempts are taken into account. Parameter 197 Current pending sector count indicates the number of sectors that are candidates for substitution.They have not yet been identified as bad, but reading from them is different from reading a stable sector, these are the so-called suspicious or unstable sectors. In case of successful subsequent reading of the sector, it is excluded from the list of candidates. In the case of repeated erroneous readings, the drive tries to restore it and performs a reallocation operation. An increase in the value of this attribute may indicate physical degradation of the hard drive.

As can be seen from Figures 1-5, parameters 5 and 196 are cumulative; their values only increase depending on the operating time. And the values of the parameter 197 can both increase and decrease if the sectors-candidates for replacement are really reallocated. But they are not very convenient to assess the mechanical reliability of drives, because they depend not only on the state of the mechanism for positioning the magnetic heads. And the parameter 7 may well be used to assess reliability. Moreover, both parameter changes (for HGST, Hitachi, and WDC) and its absolute values (for ST) are important for this parameter.For disks from Samsung and Toshiba manufacturers, the parameter was zero or absent.

The number of failed drives depending on the operating time has two types: falling and dome-shaped [5]. The first type means that disk failures occur immediately after the start of their use, the so-called "infant mortality". The second type is associated with wear and tear and occurs mainly after the expiration of the two-year warranty period. As can be seen from the above figures, failures associated with the positioning of the block of magnetic heads can be of either of two types.

4.Summary

As a result, according to the results of the study, it was found that five SMART parameters have coincident changes in parameter values for failed hard drives. These are parameters with numbers 1, 5, 7, 196, 197. However, one of them, namely parameter 1, which characterizes the error rate when reading data from a disk, produces random large digital values for hard drives of the ST brand manufactured by Seagate. Of course, even in this case, it can be used as an indicator of the presence of problems with the disk, but only parameter 7 is intended and really directly speaks precisely of the errors in the positioning of the magnetic heads of the hard drives. Parameters 5, 196 and 197 show the consequences of these positioning errors in the form of the number of reallocated sectors, reallocation operations, and sectors that are candidates for replacement.

The scientific novelty of the obtained results lies in the fact that on the basis of the identified parameters characterizing the positioning mechanism of the block of magnetic heads of hard drives, it is possible to develop criteria for the danger of drive failures. They are justified due to the existence of the fact that, as a result of the analysis, the coincidence in time of changes in the values of these parameters exists.

5.Conclusions

Similar studies on the same data with heterogeneous disk groups were carried out in [6], where a search was made for universal predictors of disk failures that could be applied to disks of all makes and models. The main problem was a significant number of SMART parameters, data for which were not available for most brands and models of disks. As a result, the authors were forced to discard parameters that were absent in at least 90% of the disks, after which only 21 parameters remained.

In [7–11], the SMART parameters of the specified data set of the Backblaze data centre were also used to determine the intensity and predict failures of disk information storage devices.

Therefore, the issue of assessing the reliability of information storage devices by the values of SMART parameters is really important for ensuring data security in any organization. Based on the detected coincidence in time of changes in the values of the parameters of the hard drives that are out of order, it is proposed to solve the problem of individually assessing the reliability of information storage devices with respect to the positioning mechanism of the magnetic head unit using the identified parameters.

6.Acknowledgements

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