

The Advantages and Disadvantages of Codec Between RDP Code and EVENODD Code

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Abstract. With the rapid change of The Times, the number of people and devices continues to grow, and the amount of data begins to explode, which brings great challenges to the current data storage means. In this context, this paper mainly compares the advantages and disadvantages of RDP code and EVENODD code in RAID6 disk array system. This paper first introduces the coding principle and decoding principle of RDP algorithm, and then introduces the coding principle and decoding principle of EVENODD code. Finally, the two algorithms are compared in performance, redundancy data element and coding cost. Compared with EVENODD algorithm, RDP algorithm has obvious advantages in all aspects. Through the analysis of the calculation results, RDP algorithm is significantly better than EVENODD algorithm in terms of data elements to be called, redundant elements and coding calculation cost. This shows that using RDP coding algorithm can reduce system overhead and improve system performance and efficiency. Therefore, RDP codes have a better advantage in RAID6 disk array systems. In summary, this paper compares the advantages and disadvantages of RDP encoding and EVENODD encoding. The calculation results show that the algorithm can significantly increase the amount of data transmission and redundant data while reducing the overhead. This provides an effective guarantee for the reliable operation of RAID6 disk array system. This research has certain guiding significance to improve the performance and reliability of the system.

Keywords: RAID6 disk; RDP code; EVENODD code.

1. Introduction

According to the program storage idea proposed by the father of the computer, the storage system is the most important part of the computer system, because in the computer, no matter how the data is the most fundamental, and the data needs to be saved in the storage system [1]. In recent years, with the expansion of population and economic growth, more and more people have access to the Internet, and a huge amount of information is generated in the interaction [1,2]. Such information is stored in the storage system in the form of data, but more and more data will also lead to errors in the storage system, and if the storage system is wrong, the significance of the storage system will be lost [3,4]. In order to ensure this, error reporting and recovery of the storage system is very necessary [5]. At the same time, disks, as the current storage carrier, face a series of problems such as data errors caused by the expansion of the storage system, mechanical loss, performance improvement lag capacity improvement, and so on [5]. Therefore, more attention should be paid to the disk storage system with high reliability. No matter what kind of disk, in the context of the growing big data, there are certain defects and shortcomings in the face of various problems before us, and the storage scale can be simply superimposed in quantity [6]. In the face of the reality of the surge in data volume, the gradual increase in storage device failures will still become normal. Therefore, erasure code and copy technology are needed to solve the problem as a reliable method at present [7].

At present, the research on fast recovery of disk failure is generally to reduce the recovery time by adding extra storage space, but not much by coding [8,9]. EVENODD code and RDP code are commonly used encoding strategies in array storage systems. This article will focus on how the two different strategy approaches work, and which one has the advantage in terms of performance, redundancy, and overhead [10,11].

2. RDP and EVENODD code

2.1. RDP Coding and Decoding

RDP code is a kind of MDS (optimal redundancy rate) encoding in $(p-1) \times (p+1)$ array that only needs to perform XOR operation [1]. The front square of the array needs to store data, and the rear matrix of the array is used to store the check code obtained through the XOR operation. The front square and rear matrix are $(p-1) \times (p-1)$ and $(p-1) \times 2$ respectively, and the front matrix is also called the data matrix, and the rear matrix is called the check matrix [5]. Column P-1 is called the P1 check disk, and column p is called the P2 check disk. The parity disk P1 can be obtained through the XOR calculation of the peer data. The parity disk P2 and the parity disk P1 need different calculation methods to ensure that the parity data is valid. The data on the parity disk P2 is calculated by the data on the corresponding 45° diagonal and the parity disk P1 [1]. The simple algorithm is displayed in Fig 1.



Fig 1. RDP coding schematic

It can be seen from the figure that the P1 check disk is obtained by the XOR operation of all data in the same line, while the data in the P2 check disk is obtained by the data in the same color position in the figure and the XOR calculation of the P1 check disk. Interestingly, it can be seen from the figure that the data in the white block in the table did not participate in the calculation of the P2 check disk.

This is the principle of RDP coding. Similarly, for RDP coding, when a single data disk fails, as shown in Fig 2, the repair algorithm of RDP coding is to repair by reading P1 check disk and the data corresponding to P1 check disk, and the amount of data to be extracted during single data repair is $(p-1) \times (p-1)$ data block. This data block is the same size as the entire data disk [6].

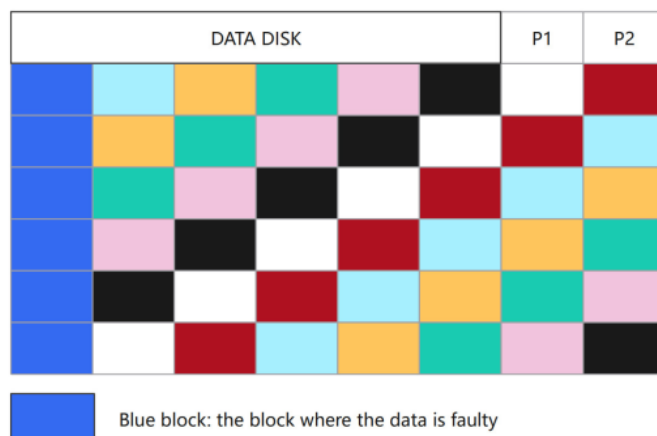


Fig 2. RDP code decoding diagram

2.2. EVENODD Coding and Decoding

The EVENODD code is an MDS (optimal redundancy rate) encoded in a $(p-1) \times (p+2)$ array, requiring only the XOR operation [2]. The front square of the array needs to store data, and the back square of the array is used to store the check code obtained through the XOR operation. The front and back squares are $p \times (p-1)$ and $(p-1) \times 2$, respectively, where p is a prime number greater than two. The front square is also called the data matrix, and the back square is called the check matrix [4]. Column $P-1$ is called the $P1$ check disk, and column p is called the $P2$ check disk. The parity disk $P1$ is obtained by performing the XOR operation on the peer data. To ensure the validity of the parity data, the calculation methods of parity disk $P2$ and parity disk $P1$ are different. The data on parity disk $P2$ is calculated with the data on parity disk $P1$ on the 45° diagonal line [1]. The simple algorithm is displayed in Fig 3.

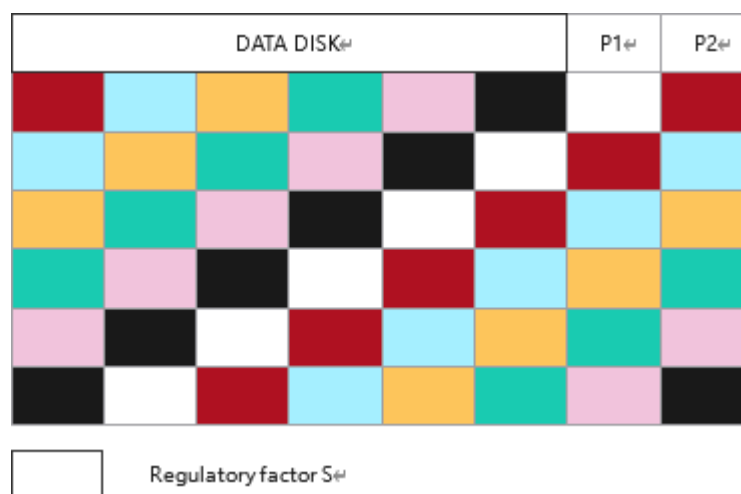


Fig 3. EVENODD Coding schematic

When a single data device fails, EVENODD coding and RDP coding adopt the same idea and method in the traditional recovery method, that is, only through the line check P recovery, the number of read data elements is $p \times (p-1)$ [1]; The idea of hybrid decoding method is to reuse some data elements by checking redundancy P and Q [2]. However, different from RDP coding, EVENODD hybrid decoding must first read $P-1$ data elements to construct regulatory factor S due to the existence of regulatory factor s . The failed data element is then recovered by adjusting the factor S , the diagonal check redundancy Q , and all other surviving data elements on the diagonal check [7]. The simple algorithm is displayed in Fig 4.

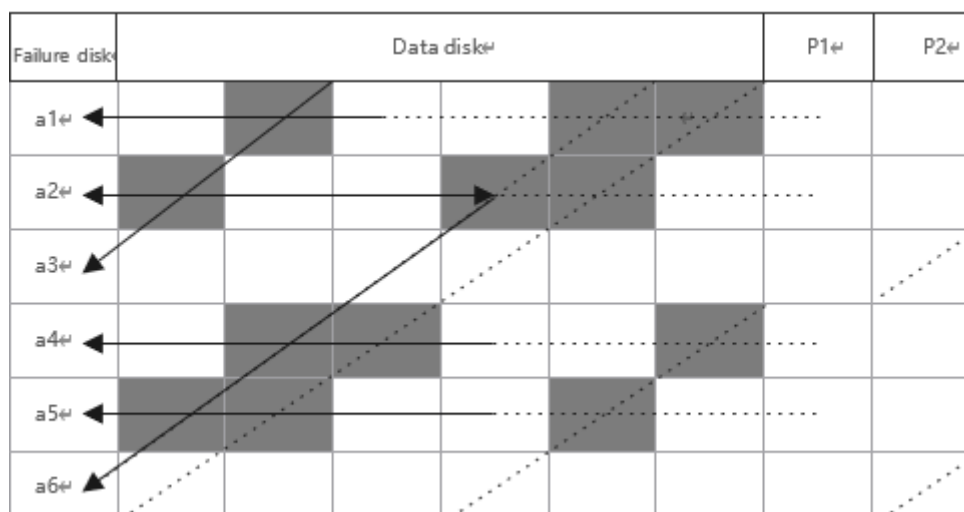


Fig 4. EVENODD Decoding diagram

The black square is used to represent the data elements needed to recover the two failure blocks, the data elements needed to recover the failure blocks are represented by the implementation, and the dashed line represents the data elements needed to construct the regulator. The arrow indicates that the failed data pointed by the arrow is recovered through the data block on the horizontal line.

3. Comparison of two code

3.1. Performance comparison between RDP repair and EVENODD repair

Through the preliminary understanding of RDP code and EVENODD code encoding and decoding steps, we can understand that RDP code and EVENODD code are better methods in encoding and decoding, and repair error data. Both of which are very useful methods. Where is the difference between the two, this article will compare RDP code and EVENODD code from multiple dimensions such as the quality of recovery performance, the ratio of recovery performance, and the overhead required for coding calculation. Through the above, we can also know the relationship between the required call data elements of RDP code and EVENODD code and p [1], starting from $p=7$, we can get a comparison diagram of the required call data elements of RDP code and EVENODD code In Fig 5.

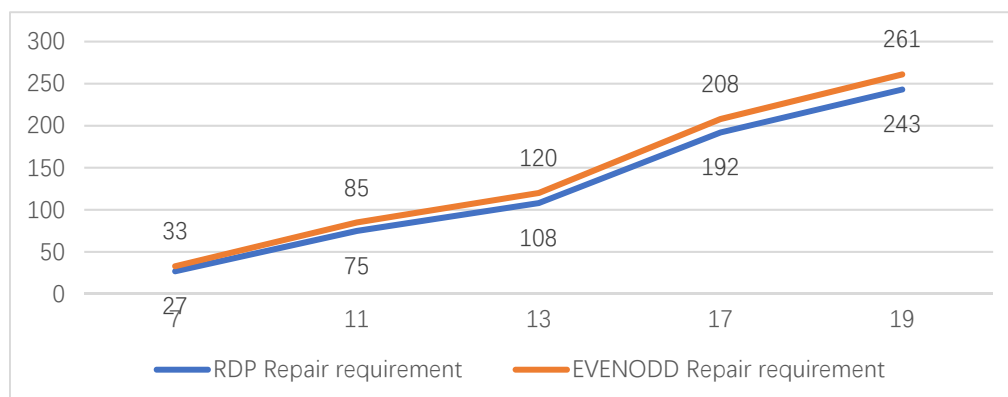


Fig 5. Performance comparison between RDP and EVENODD Quick repair method

As shown in Table 1 below, the number of data elements to be read for single data device failure repair using the RDP code of the hybrid repair algorithm is $\frac{3(p-1)^2}{4}$, and the number of data elements to be read for single data device failure repair using the EVENODD code of the hybrid repair algorithm is $\frac{(3p+1)(p-1)}{4}$ [1].

Table 1. Performance comparison table between the RDP method and EVENODD method

P	RDP performance	EVENODD performance	Difference value
7	33	33	6
11	85	85	10
13	108	120	12
17	192	208	16
19	243	261	18
P	$\frac{3(p-1)^2}{4}$	$\frac{(3p+1)(p-1)}{4}$	$p-1$

On the other hand, it can be seen from Table 1 above that the difference between the data element to be read by RDP code repair and that to be read by EVENODD code repair is 6 when $p=7$, 10 when $p=11$, ... 18 at $p=19$. The difference increases with the increase of p , indicating that the data redundancy gap increases with the increase of p 0, so conclude that RDP code repair method is superior in terms of repair performance.

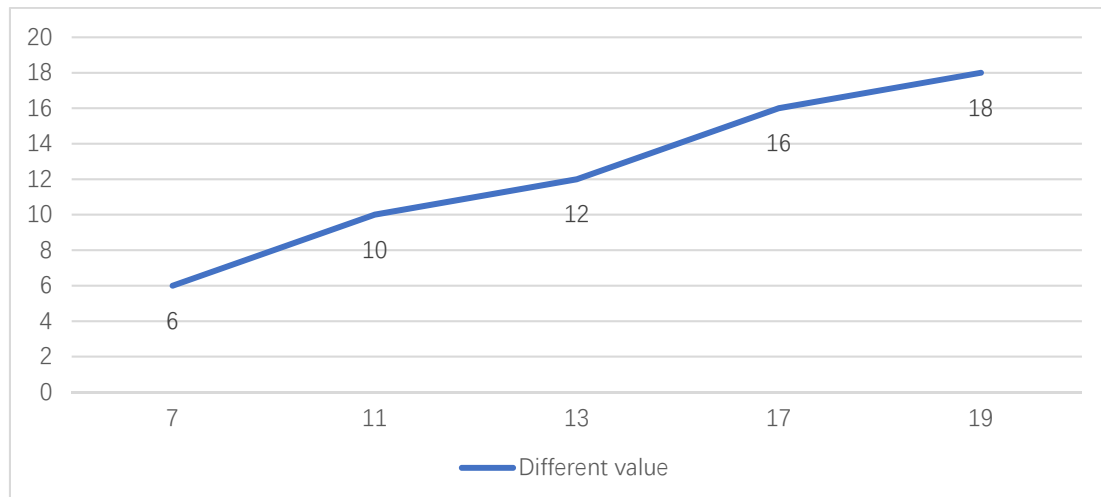


Fig 6. The difference between the data element required by RDP repair and the data element required by EVENODD repair methods

3.2. Comparison of performance improvements and unit redundancy ratio

Similarly, from Table 1, we can calculate the performance improvement of the RDP method compared to the EVENODD method.

$$1 - \left[\frac{3(p-1)^2}{4} \div \frac{(3p+1)(p-1)}{4} \right] = \frac{4}{3p+1} \quad (1)$$

Through, to calculate the specific value of performance increase of RDP method after the continuous increase of prime p. When p=7, compared with the two methods, the performance increase ratio is 18.2%, when p=11, the performance increase ratio is 11.8%, and when p=13, the performance increase ratio is 10%. When p=19, the performance increase ratio is 6.90%. As p increases, then get this equation: $\frac{4}{3p+1}$. As can be seen in Figure 7, the performance increase ratio will become smaller and smaller as the value of prime number p becomes larger and larger. But it still serves as proof that RDP outperforms EVENODD in performance.

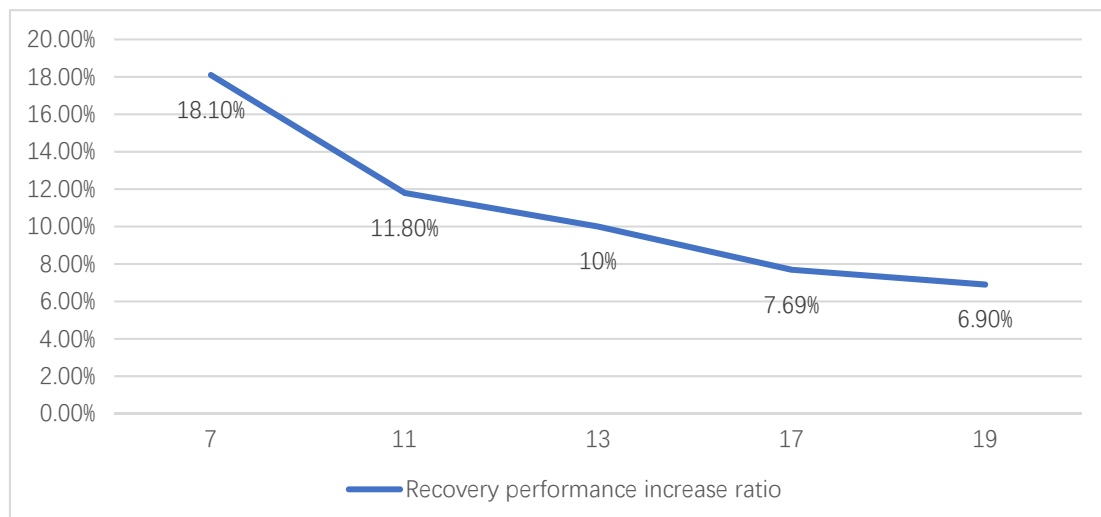


Fig 7. Diagram showing the rate of increase in the recovery performance of the RDP method compared to the EVENODD recovery method

The recovery performance improvement coefficient of unit redundant system

$$Q = \frac{\text{Performance improvement ratio}}{\text{Added the ratio of redundancy to the storage system}} \cdot 0 \quad (2)$$

By definition, we can see that the ratio of new redundancy in the system is

$$\frac{\text{A redundant disk is added}}{\text{Data Disks Number of data disks in the simulation}} = 1/p, 0 \quad (3)$$

So, $Q = \frac{4}{3p+1} \div \frac{1}{p} = \frac{4p}{3p+1}$ can be obtained, Then, it can proceed to Fig 8 below.

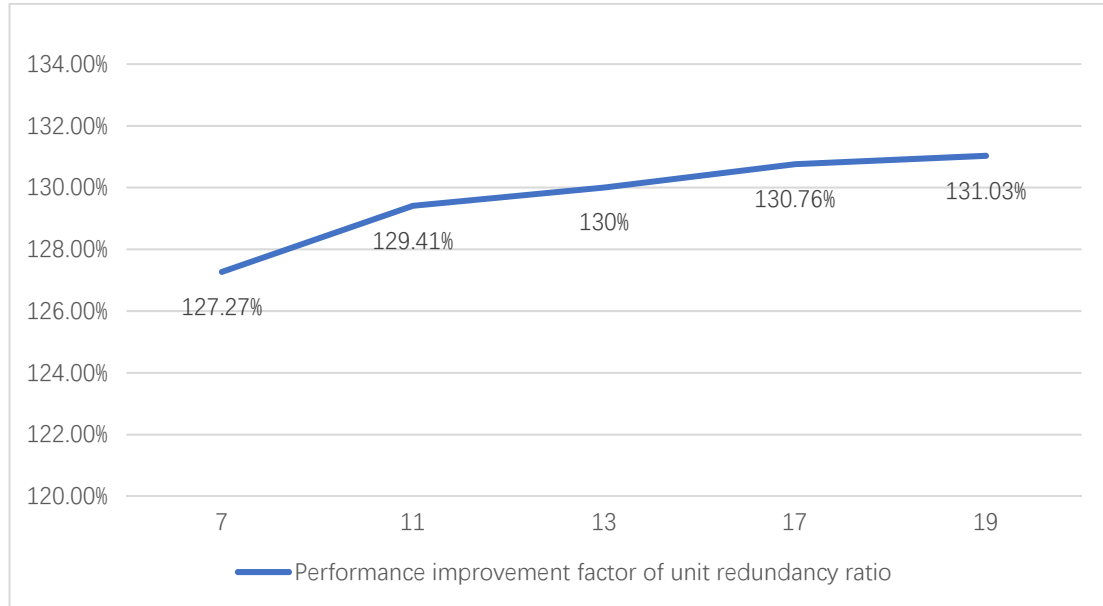


Fig 8. Schematic diagram of the performance improvement coefficient of unit redundancy ratio

It can be seen from the calculation $\frac{4p}{3p+1}$ that the maximum value of the unit redundancy lifting coefficient Q of RDP code is $\frac{4}{3}$, and the value of Q is 1.27 when the prime number $p=7$, and the value of Q will be closer and closer to the value of $\frac{4}{3}$ as p becomes larger and larger. Although the performance improvement ratio of the above RDP method compared with EVENODD method decreases with the increase of p , it can still be concluded that the performance of the RDP method is better than EVENODD method based on the increasing of the unit redundancy improvement coefficient 0.

3.3. Comparison of calculation cost between RDP and EVENODD encoding

In addition, in erasure codes, the coding cost is also an important index to measure erasure codes. Here, the encoding efficiency of erasure codes is measured by calculating XOR times in unit data element.

Definition: XOR number of unit data: $\text{XOR unit} = \frac{\text{XORrow} + \text{XORdia} + \text{XoRx}}{\text{blocktotal}} [1].$

Where, the XOR number of unit data of the three-fault-tolerant RDP corresponding to the RDP code is number of data blocks $\frac{\text{XORrow} + \text{XORdia} + \text{XoRx}}{\text{blocktotal}} = 3 - \frac{3}{p-1} [1].$

The XOR number of EVENODD method is $\frac{\text{XORrow} + \text{XORdia} + \text{XoRx}}{\text{blocktotal}} = 3 - \frac{1}{p-1}$ total number of data blocks 0, as shown in Fig 9:

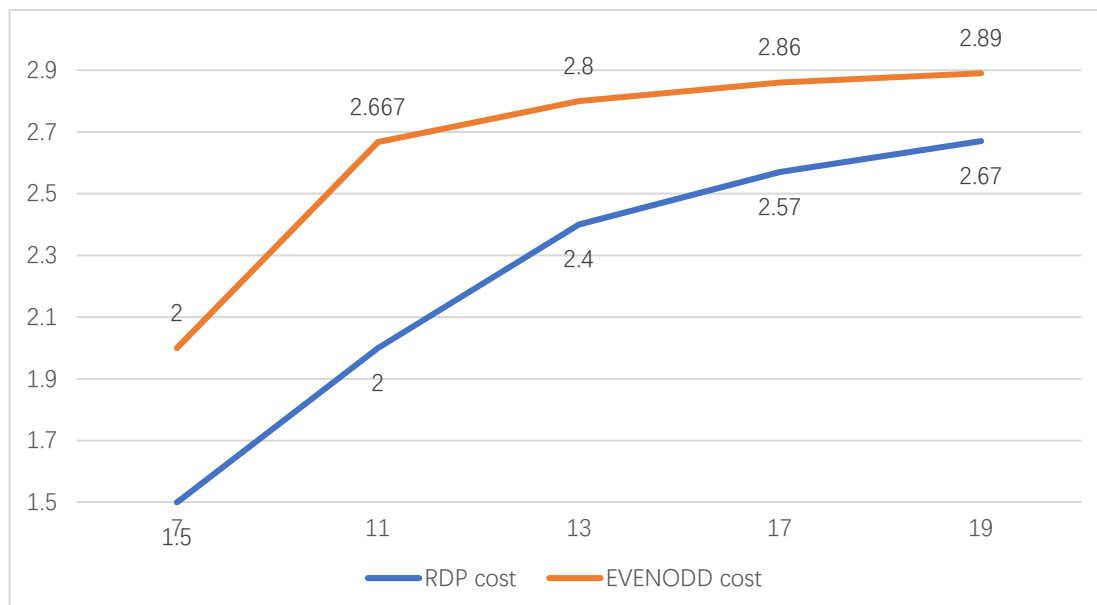


Fig 9. Diagram of the overhead required to calculate RDP encoding and EVENODD encoding

It is not difficult to see in Fig 9 that when p is very small, the difference between the cost of RDP encoding computation and EVENODD is large, but as p becomes larger, the difference between the two becomes smaller and smaller. However, from the current trend and performance of the figure, it can draw the conclusion that the calculation cost of RDP code is less than EVENODD.

4. Conclusion

The rapidly changing times, the growth of the population, as well as the growth of Internet-connected devices, have led to an explosion in the amount of data worldwide, which poses a huge challenge to the current data storage. No matter what the storage medium, in the face of today's explosive growth of data, the probability of error will increase dramatically. At the same time, the performance of storage media such as disks lags far behind the growth of capacity, making the simple pile material impossible to solve. Faced with this background, a high reliability and low-cost erasure code technology is needed to solve the problem. This technology has been valued and widely used by many Internet companies in the era of big data, but with the increase in the amount of data, it is still difficult to meet the current needs of RAID-6 and RAID-7 coding. In this case, this paper proposes to compare RDP code with EVENODD code, and draws the following conclusions:

In terms of performance, RDP code calls fewer data elements than EVENODD code when calling data elements. In terms of performance increase ratio, with the increase of the prime number p , the increase ratio gradually decreases, but the performance of the unit redundancy element keeps increasing, making the performance increase ratio reliable. At the same time, the computational coding cost is also an important factor to measure the coding cost. Although we can know that RDP and EVENODD cost are gradually consistent when p is increasing, the computational cost of RDP is significantly due to EVENODD code when p is small.

This study of RDP code and EVENODD code still has many shortcomings, such as small amount of data compared between the two codes, insufficient dimensions of comparison, lack of certain reliability, and because of the theoretical formula comparison, lack of practical application as support. It is hoped that improvements will be made in the subsequent research to give some direction to the storage system in this era of big data.

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