DDS Assignment 2

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Date: 20th May 2020

1. Introduction

Erasure Coding:

Erasure coding is a means to protect data. In it, data is broken into fragments, expanded, encoded with redundant information, and stored in different locations or storage media. And so, if a storage media fails or data is corrupted, the data can be reconstructed from parts stored in other storage media.

Erasure Coding is primarily derived from a mathematical equation:

$$N = K + M$$

1. N is the number of machines that will store data
2. M is the number of failures system can tolerate
3. K is the number of blocks needed to recover the data

2. Assignment Overview

The goal of the assignment is to simulate a backup system that works on erasure coding and analyse the performance and failure rate of a backup system.

For simulation, we have used the following parameters.

NODE_LIFETIME = 30 Days

NODE_UPTIME = 8 Hours

NODE_DOWNTIME = 16 Hours

SERVER_LIFETIME = 1 Years

SERVER_UPTIME = 30 Hours

SERVER_DOWNTIME = 2 Hours

MAXT = 10 Years

N = 10

Single Block:

3. Experiment 1:

Lifetime of the Backup system for Different Data Sizes/K Values

Aim: To analyse the lifetime of a backup system based on erasure coding with regard to data size with a single block per server

How: Extremely low to high data sizes are considered with constant Upload and Download speeds. To study the lifetime/average years of the backup system, 10 iterations are made over which the average age is analysed.

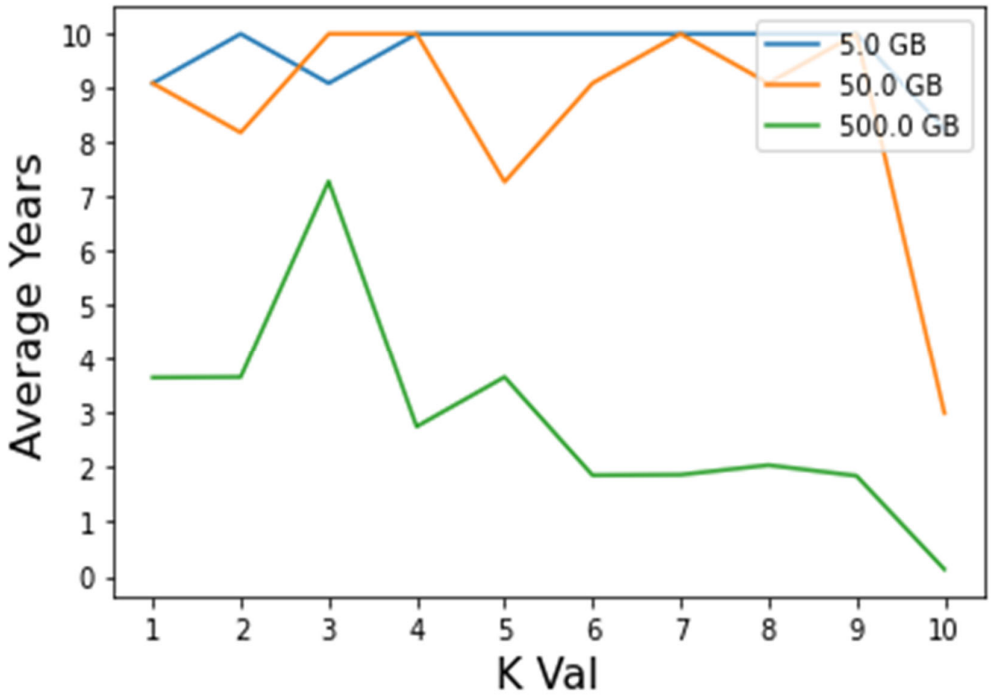
Parameters Used:

Data Sizes: 5 GB, 50 GB, 500 GB

Upload and Download Speed: 500 KB, 2 GB

K Values: 1, 2, 3 , 4 , 5 , 6 , 7 , 8 , 9 , 10

Results:



Observations:

It is quite clear from the above graph that data size plays a very important role in the age of a backup system. Also, with the increase in the number of blocks(K), the average lifetime of the system tends to shorten. This could be due to the fact that with an early failure, not all K blocks are available for recovering data to the local machines and the system seems to fail completely.

4. Experiment 2:

Lifetime and Failure Rate of a backup system with different Upload and Download Speed with Different Data Sizes

Aim: To analyse the lifetime and failure rate of a backup system based on erasure coding with different Upload and Download speeds on different data sizes.

How: To analyse the system performance, extremely low to high Upload and Download speeds are considered over 10 iterations for different Data Sizes (Low to High).

Parameters Used:

Data Sizes: 5 GB, 50 GB, 500 GB

Upload Speeds: 500 KB, 5 MB

Download Speeds: 2 MB, 8 MB

K Values: 1, 2, 3 , 4 , 5 , 6 , 7 , 8 , 9

Results:

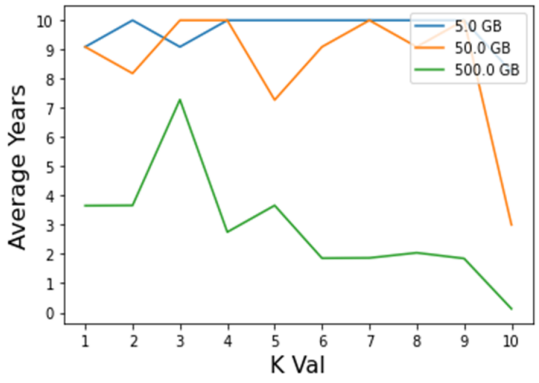


Figure 2: 500KB/2 MB

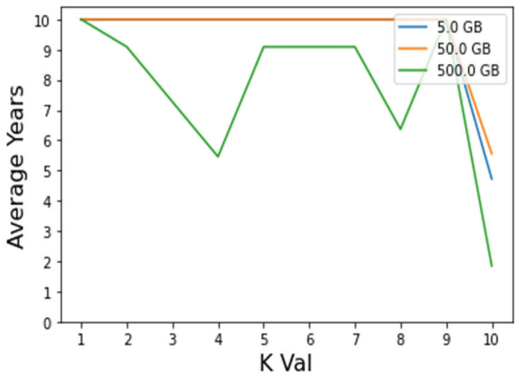


Figure 3: 5 MB/8 MB

How: To analyse the failure rate, extremely low to high Upload and Download speeds are considered over 5 iterations for different Data Sizes (Low to High).

Parameters Used:

Data Sizes: 5 GB, 50 GB, 500 GB

Upload Speeds: 50 KB , 500 KB, 5 MB

Download Speeds: 300KB, 2 MB, 8 MB

K Values: 1, 2, 3 , 4 , 5 , 6 , 7 , 8 , 9 , 10

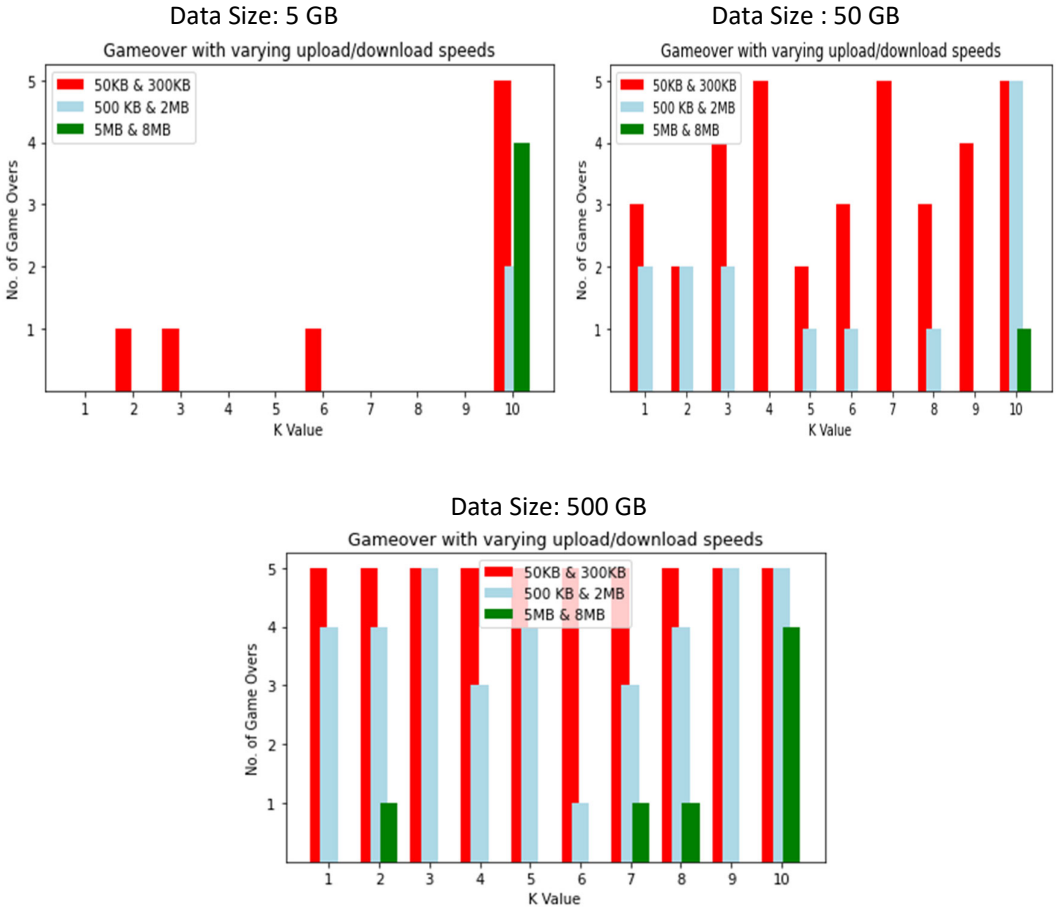


Figure 4: Failure Rate for different upload and download speed

Observations:

From figure 2 and 3, it is observed that the lifetime of system has significantly gone up with the increase in the upload and download speeds. The backup system with 5GB, and 50 GB of data seemed to have lasted longer than that of 500GB of data.

From figure 4, Although the first graph (5 GB) does not have too many failures, the failure rate is still present for the system which works on low upload and download speed. With an increase in data size, the failures have gone up for all upload speeds and download speeds, however, the red bar (50 KB & 300 KB) in still in the lead, followed by the blue (500 KB &2 MB).

Another important thing to notice is that when K = N (no redundancy), there are more failures than any other K value. Without redundancy, singular chunks are stored on storage nodes, one per node. If the node fails, the data may be lost.

Multiple Blocks:

5. Experiment 1:

Lifetime of the Backup system for Different Data Sizes/K Values with multiple blocks per server

Aim: To analyse the lifetime of a backup system based on erasure coding with regard to data size

How: Extremely low to high data sizes are considered with constant Upload and Download speeds. To study the lifetime/average years of the backup system, 10 iterations are made over which the average age is calculated of multiple blocks per server.

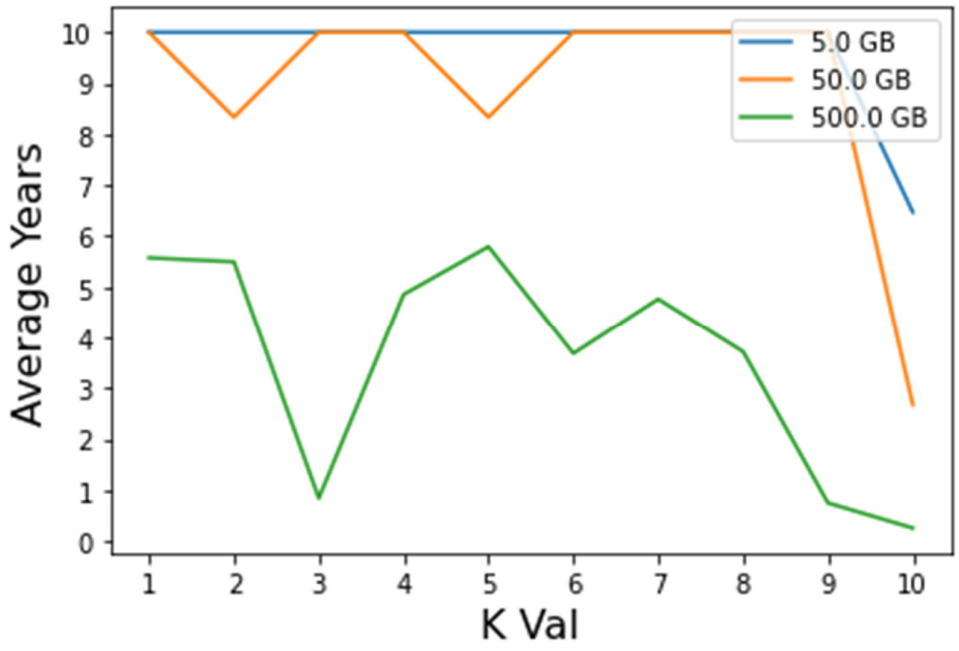
Parameters Used:

Data Sizes: 5 GB, 50 GB, 500 GB

Upload and Download Speed: 500 KB, 2 GB

N: 10

K Values: 1, 2, 3 , 4 , 5 , 6 , 7 , 8 , 9, 10



Observations:

From the above graph, it can be said that with the increase in the number of blocks per server, the average lifetime of the system is far better.

6. Experiment 2:

Varying Upload and Download Speed with Different Data Sizes with multiple blocks per server.

Aim: To analyse the lifetime and failure rate of a backup system based on erasure coding with different Upload and Download speeds on different data sizes.

How: To analyse the system performance, extremely low to high Upload and Download speeds are considered over 10 iterations for different Data Sizes (Low to High).

Parameters Used:

Data Sizes: 5 GB, 50 GB, 100 GB, 250 GB, 500 GB

Upload Speeds: 500 KB, 5 MB

Download Speeds: 2 MB, 8 MB

N: 10

K Values: 1, 2, 3 , 4 , 5 , 6 , 7 , 8 , 9, 10

Results:

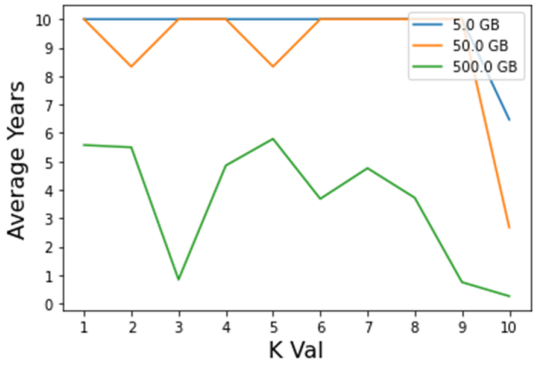


Figure 5: 500KB/2 MB

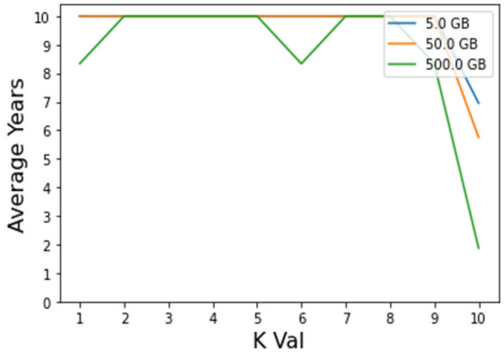


Figure 6: 5 MB/8 MB

How: To analyse the failure rate, extremely low to high Upload and Download speeds are considered over 5 iterations for different Data Sizes (Low to High).

Parameters Used:

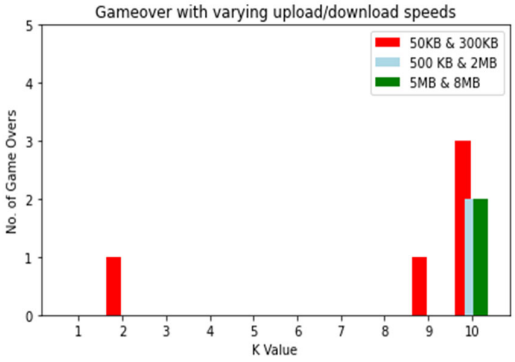
Data Sizes: 5 GB, 50 GB, 500 GB

Upload Speeds: 50 KB , 500 KB, 5 MB

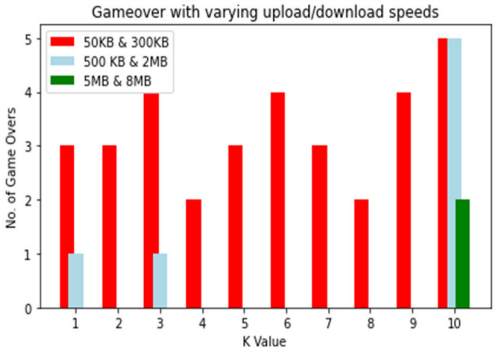
Download Speeds: 300KB, 2 MB, 8 MB

K Values: 1, 2, 3 , 4 , 5 , 6 , 7 , 8 , 9 , 10

Data Size: 5 GB



Data Size: 50 GB



Data Size: 500 GB

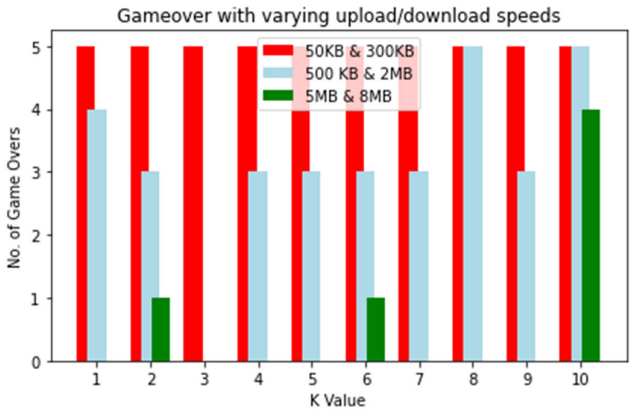


Figure 9: Failure Rate for different upload and download speeds.

Observations:

From figures 5 and 6, the average lifetime has increased for systems with multiple blocks per server. Unlike systems with single block per server, systems with multiple blocks have lesser failure rate. Having more number of blocks to recover data from, improves the probability of the backup system to perform well.

7. Conclusions:

Interplay between the parameters:
From all the above experiments, it can be said that the Data Size and the Upload and Download speeds play a significant role in the behaviour of a backup system.
A system with a good speed performs better than one with lower speed.

To achieve reliability a lot of parameters should be considered. From the above experiments, it is quite evident that upload and download speed are 2 major parameters that can impact the reliability of a system. So, choosing a right internet connection for a given data size is important (if the budget is unlimited, always choose the best bandwidth!).

K value is also an important factor. In all the scenarios discussed above, the performance of the system where K = N was bad and therefore, it is not reliable.
However, as redundancy type cannot be changed once chosen (from replication to erasure coding or vice versa), this mode allows one to choose erasure coding even if their cluster is smaller than recommended. Once the cluster has grown, more beneficial redundancy modes can be chosen.