Simulation of Dynamic Rebuild in Video Storage Server

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In this project, we have to investigate the performance of dynamic rebuild algorithms for a video-on-demand system.

Assume that we have a video server that has $N_D + 1$ disks. Each disk has a disk block size of $8K$ bytes. Each client needs a MPEG1 stream with an average of 1.5Mbps bandwidth. Each disk has an average transfer bandwidth of 80Mbps. For simplicity, assume that we have a service round of 1 second and we assume the following disk characteristics:

<table>
<thead>
<tr>
<th>Disk Capacity</th>
<th>2.25 GBytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cylinders (CYL)</td>
<td>5288</td>
</tr>
<tr>
<td>Transfer rate</td>
<td>80 Mbps</td>
</tr>
<tr>
<td>Maximum rotational latency</td>
<td>8.33 milliseconds</td>
</tr>
</tbody>
</table>

\[
\text{seek}(d) = \begin{cases} 
0.6 \times 10^{-3} + 0.3 \times 10^{-3} \times \sqrt{d} & \text{if } d < 400 \\
5.75 \times 10^{-3} + 0.002 \times 10^{-3} \times d & \text{if } d \geq 400 
\end{cases}
\]

Table 1: Seagate Barracuda 4LP Disk Parameters

We also assume that we stripe the movie in the round-robin manner and that the stripe size is 24 KBytes. Let say we have $N_D$ movies and the starting stripe disk for movie $i$ is on disk $i$, where $i = 1, 2, ..., N_D$. (Actually, we need to consider the disk shift for the parity). Each request will have a equal probability of accessing any movies in the VOD server.

Now assume that disk 1 failed. Your assignment is to determine the following:

- Under the failure mode, what is the maximum number of clients ($N_{max}$) that the VOD system can support?
- What is the failed disk rebuild time if the number of client is $x\%$ of $N_{max}$, where $x = 0.1, 0.2, 0.3, ..., 0.9$. Assume that you will use the three rebuild algorithms we have discussed in class.