CSE 102 **Assignment**
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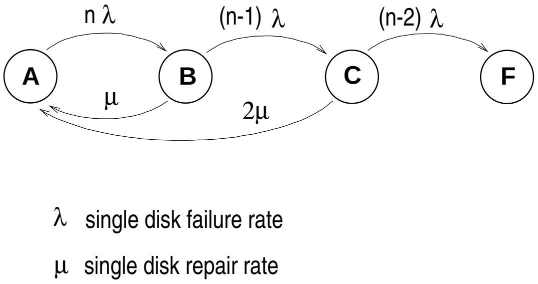
We consider a disk array of five identical drives configured either as a RAID Level 5 storage system or as a RAID Level 3 system. The disk drives each feature 7200 rpm speed; each track contains 65KB divided into 512 byte sectors. The minimum and maximum seek latencies are 4ms and 16ms respectively. For these exercises a small data object consists of no more than 512 bytes and a large data object no more than a megabyte. These disk drive controllers provide no spindle synchronization.

1. What is the service time T_S for the two varieties of data objects on a five disk RAID Level 5 as well as RAID Level 3 storage configurations? (four questions)
2. What is the single array response time T_R for these two varieties of data objects when the array has best possible bus connections? The utility of the ensemble is $\frac{1}{2}$ i.e. the ratio of arrival rate to service rate is $\frac{1}{2}$.
3. What maximum client read rate(s) can the RAID Level 5 configuration sustain for small data objects and for large data objects? Answer the same question for a RAID Level 3 configuration with five disks.
4. Assume that one of the disk drives fails. What is done to reconstruct the desired but unaccessible data of the failed unit? Answer the question for RAID Level 5 as well as the RAID Level 3 configuration.
5. What client read rate can this configuration sustain during the *degraded* mode, e.g. during the time a disk is unaccessible?
6. Assume the disk failure rate is $1/500,000$ per hour and that a failed disk can be replaced with its data within 15 minutes. Derive an expression for the reliability function $r(t)$ of the RAID Level 5. What is $r(t)$ for a RAID Level 3 configuration with five disks?
7. What is the mean time to data loss MTTDL for the RAID Level 5 configuration? Answer the same question for the RAID Level 3 configuration. Express your results in years. How sensitive is the MTTDL to the repair rate?
8. Derive the MTTDL for RAID Level 6; the Markov model is given in the figure below. The reliability group contains a total of n disks.



How much does the ability to rebuild two disks (in state **C**) improve the MTTDL? How much does the MTTDL decrease if we are able to rebuild only one disk at a time? The alternative Markov model has a "repair" transition from **C** to state **B** with rate μ rather than the transition from **C** to **A**.