

# Graduate Operating Systems

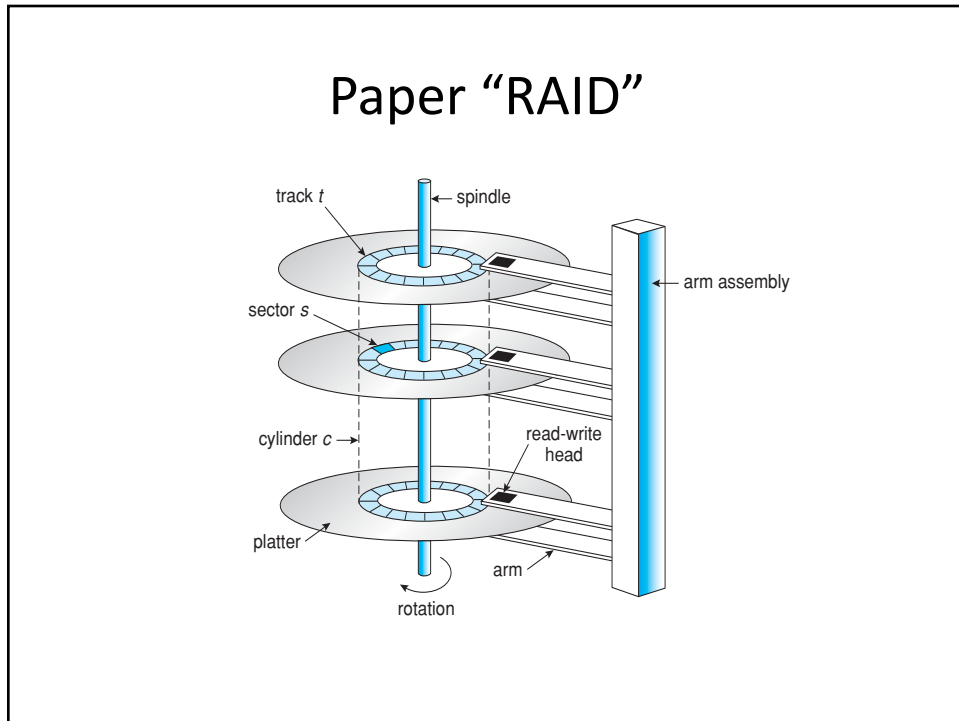
Fall 2021

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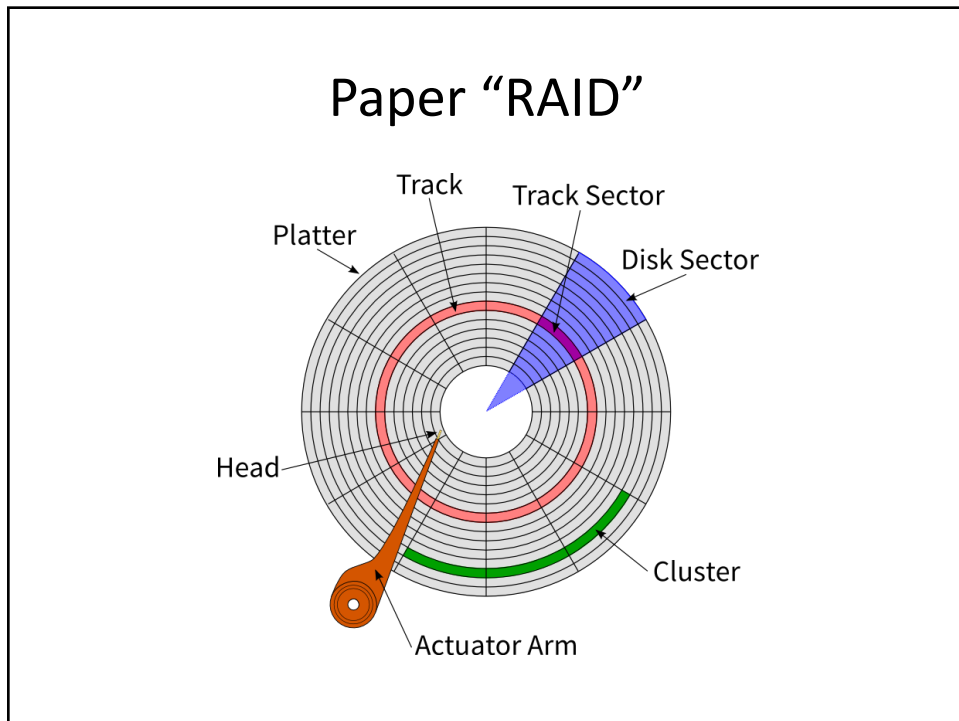
## Paper “RAID”

- Redundant array of independent disks
- *What are the two main goals of RAID?*
- *What is Amdahl’s Law?*
- *What are downsides of redundant disks?*

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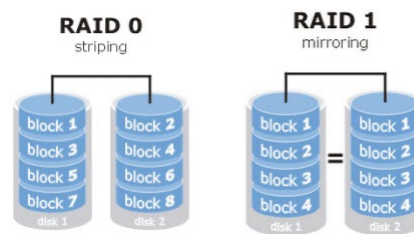
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## Paper “RAID”

- Seek time, rotational latency, data transfer time
- *What are techniques to reduce these times?*
- DMA (Figure 2)



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## Paper “RAID”

- Fine-grained vs. coarse-grained interleaving
- “Hot spots”; concentrated/distributed patterns
- Load balancing

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## Paper “RAID”



(a) RAID 0: non-redundant striping.



(b) RAID 1: mirrored disks.



(c) RAID 2: memory-style error-correcting codes.



(d) RAID 3: bit-interleaved parity.



(e) RAID 4: block-interleaved parity.



(f) RAID 5: block-interleaved distributed parity.



(g) RAID 6: P + Q redundancy.

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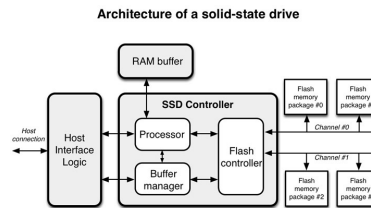
## Paper “RAID”

- Reliability and correlated disk failures
- Buffering/caching
- Floating parity
- On-line spare disks
  
- *Thoughts on RAID? Pros/cons?*
- *Do Google, Microsoft, Facebook, etc. use RAID?*

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## Paper “Differential RAID”

- SSD vs. HD
- SLC vs. MLC
- Bit error rate (BER)
- Correlated failures
- Age differential: **low vs. high differential?**
- Diff-Raid technique 1: distribute parity unevenly (**why?**)
- Diff-Raid technique 2: reshuffle parity on drive replacements (**why?**)



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## Paper “Differential RAID”

- Pages & blocks; erase operations
- Wear-leveling algorithms
- RAID-5 load balancing & reliability
- **Diff-RAID: why focus on parity distribution?**
- Uneven parity distribution
- “Aging older devices faster”
- **Thoughts on Diff-RAID? Pros/cons?**

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