



RAID4S: Adding SSDs to RAID Arrays

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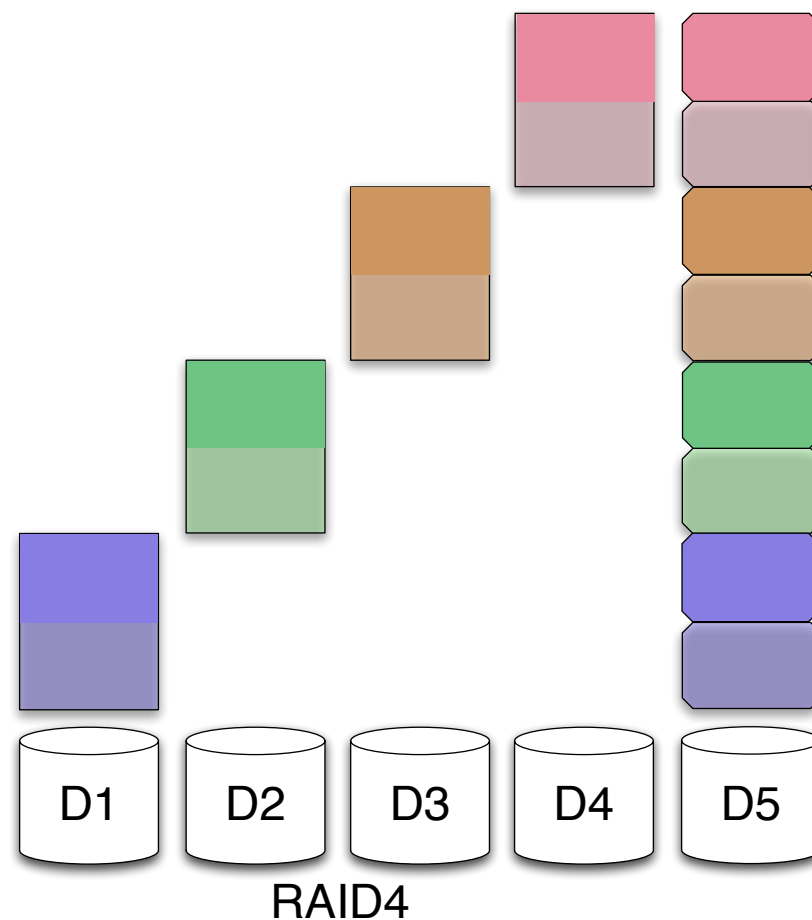
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RAID Small Write Problem

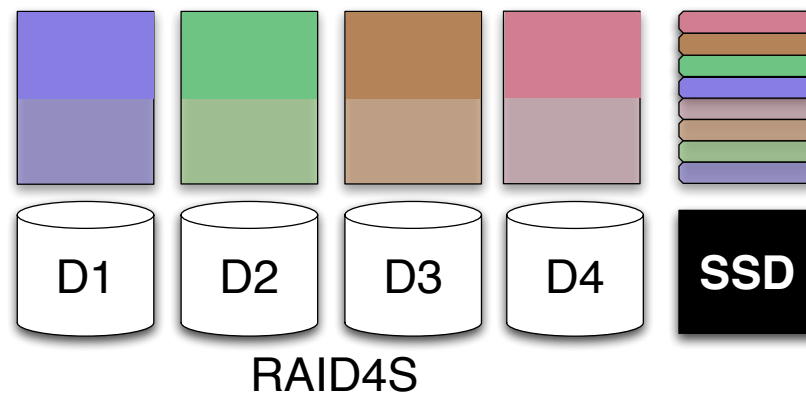
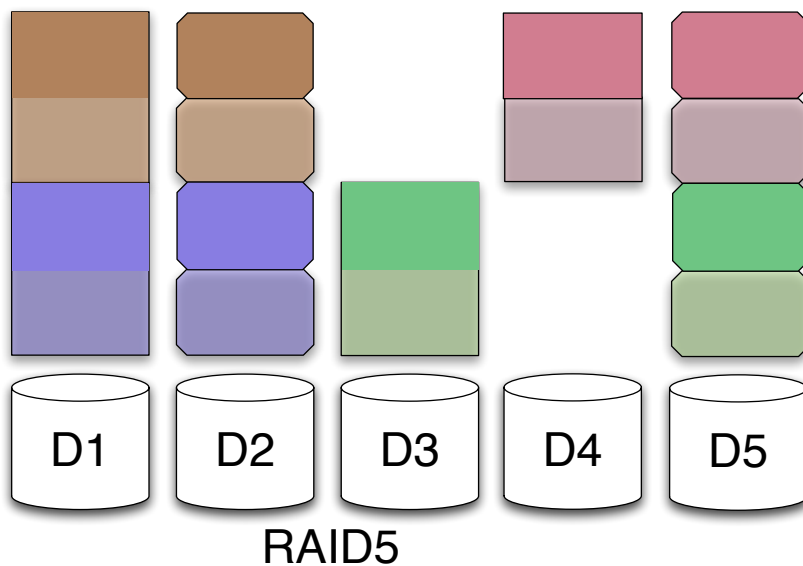
- Big storage = RAID
- 1 write \rightarrow 2 reads + 2 writes
- Other solutions avoid small writes
 - Coalesce, log, NVRAM
- For remaining small writes
 - Use solid state drives!
 - Faster, lower power, but more expensive



RAID4S Solves Small Write Problem

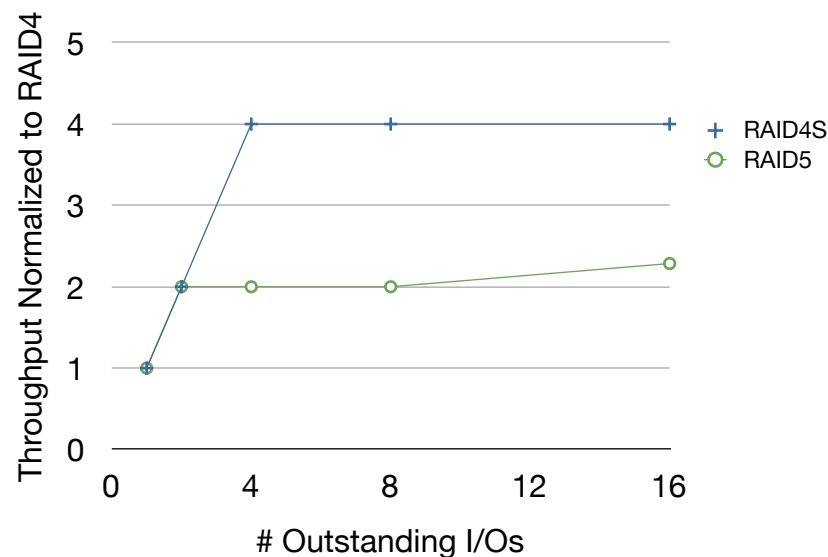
RAID5 parallelizes some small writes

RAID4S parallelizes N=4 small writes



RAID4S Up To 4X Faster

- Analysis based on:
 - Western Digital WD20EADS drive
 - Intel X25-E SSD
- Fully random workload
 - All small writes
- Stripe size $N=4+1$
- Results normalized to RAID4 throughput (2MB/s)
- RAID4S is best with $\geq N$ outstanding I/Os



Conclusions

- RAID4S outperforms RAID4 and RAID5 for small write workloads
- Future work:
 - Full evaluation with server workload traces
 - Including cost analysis
 - Real implementation with SSD
 - RAID6S? (RAID with multiple parities)
- Questions?