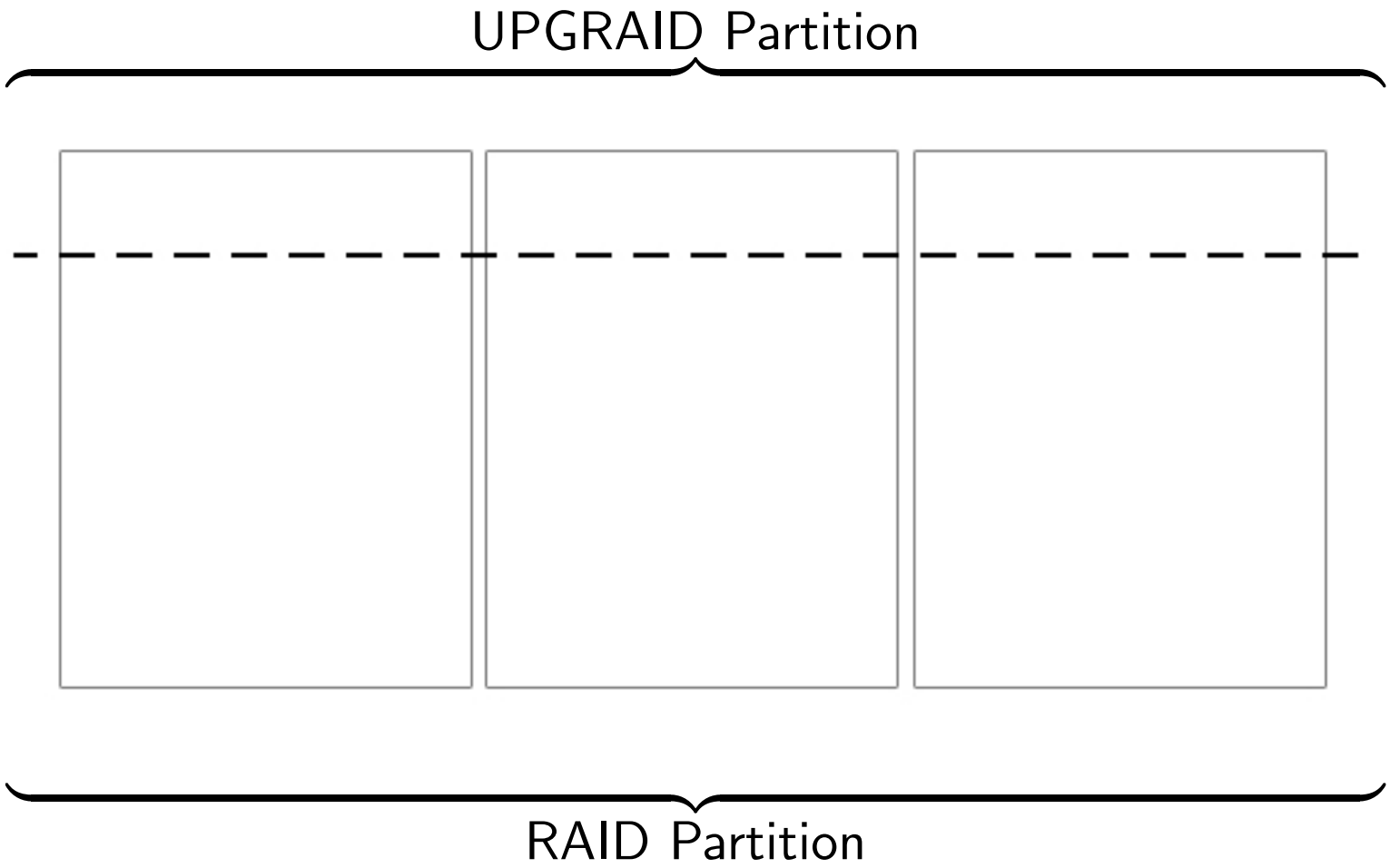
UPGRAID

Usage-based striPe replicatinG RAID

Joseph Naps, Ellen Wagner

August 10, 2007

Project Overview



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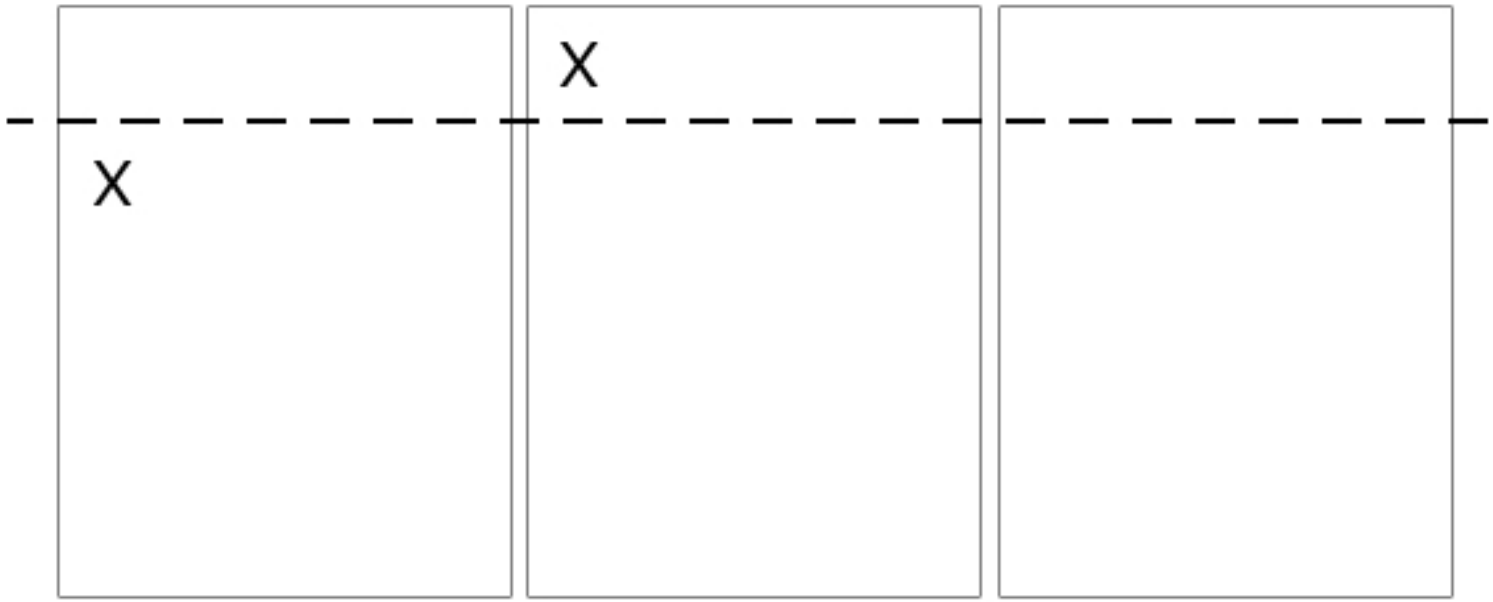

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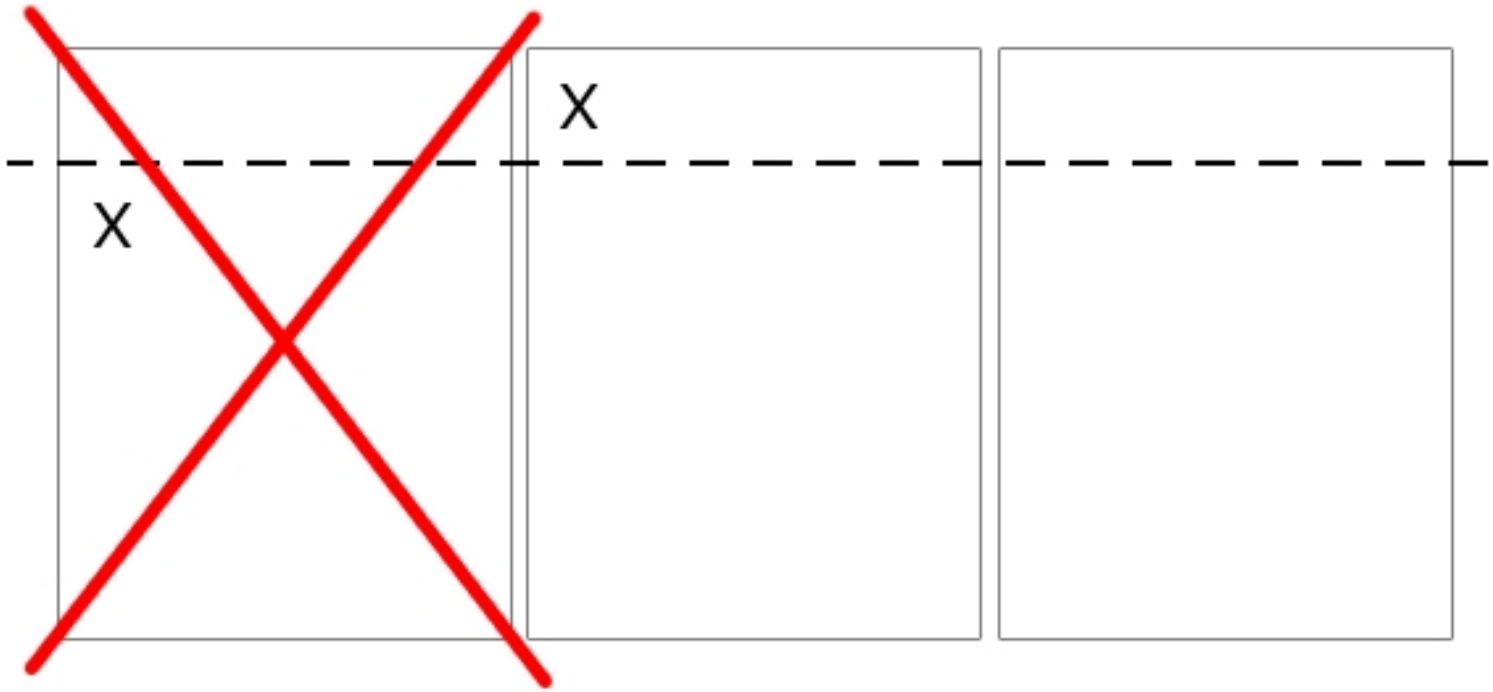

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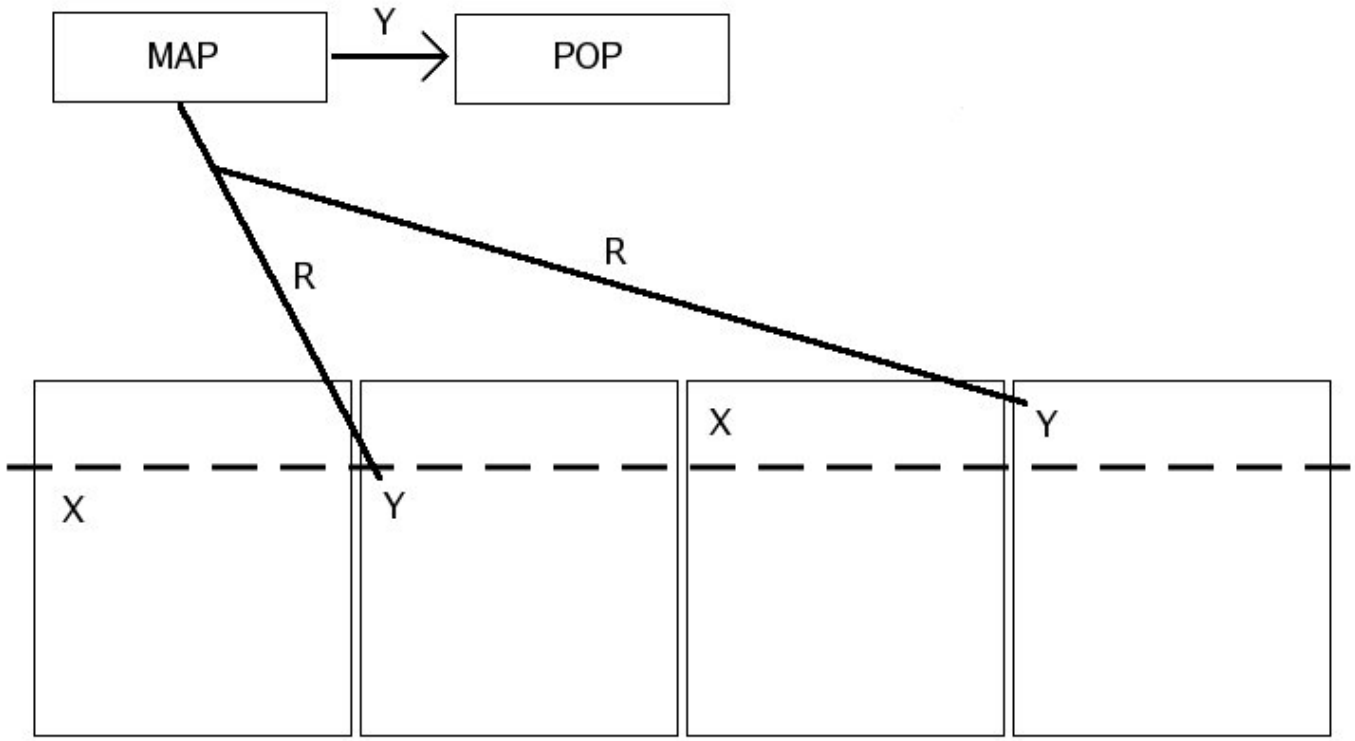

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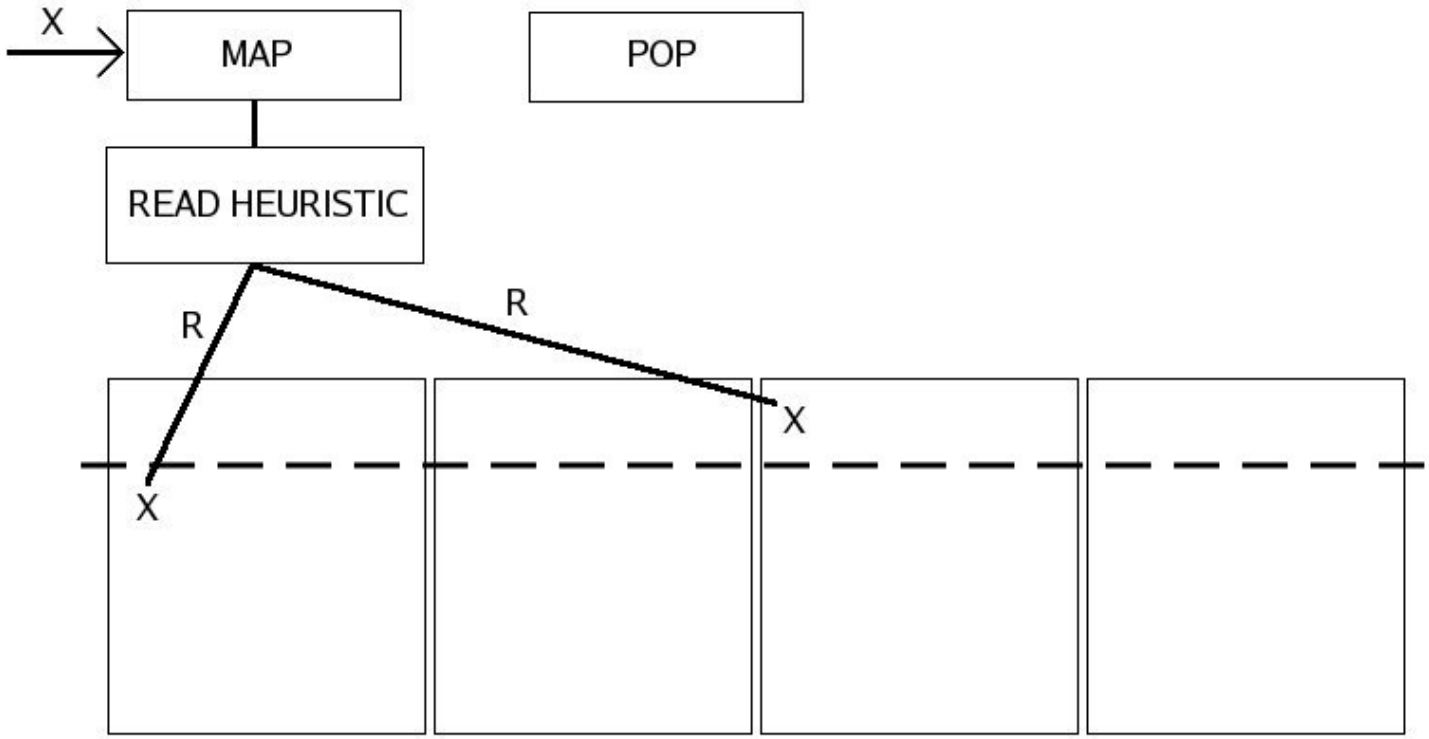

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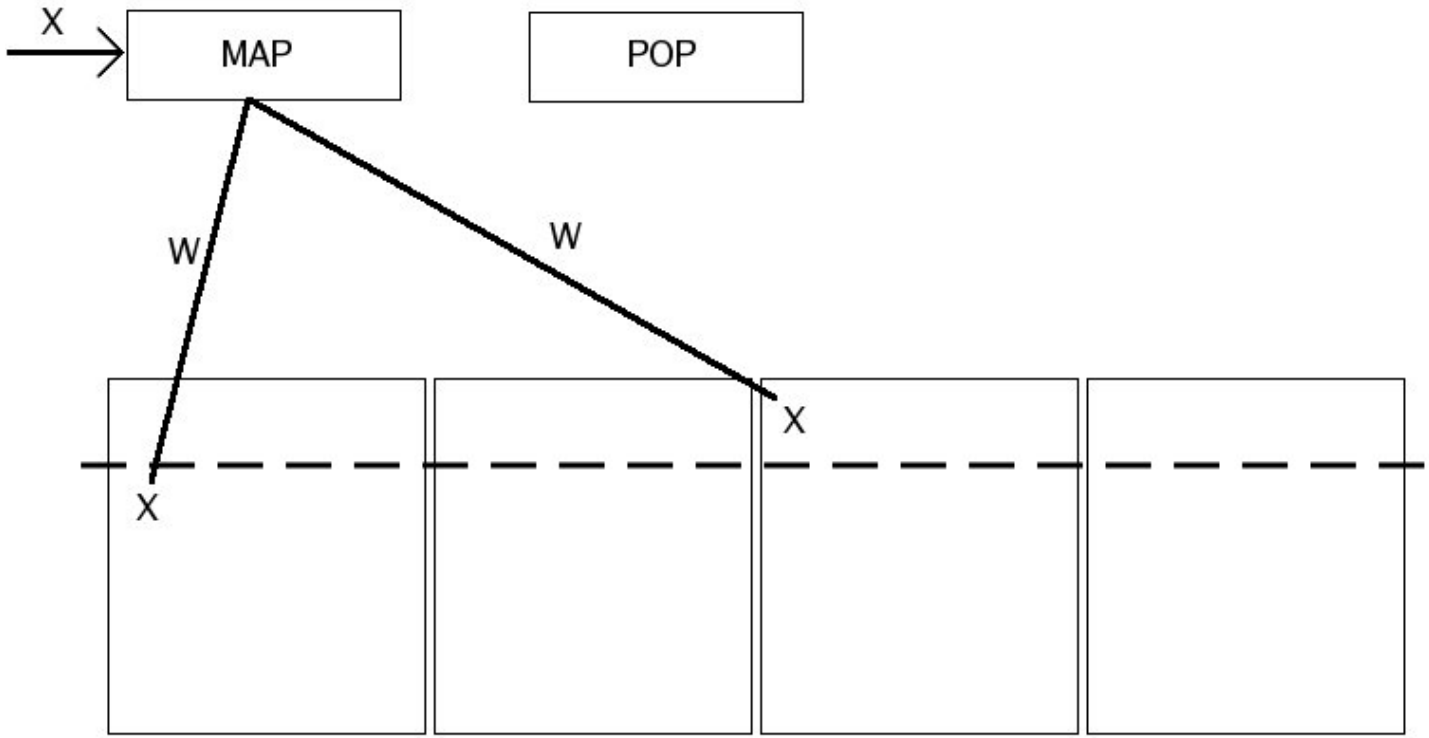

What We Learned

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- Kernel Compilation

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- Reading poorly documented code
- Properly documenting code
- Working with low-level C code
- Block I/Os in Linux

Approach

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- Read Replication

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- Write Replication

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- Read Indirection

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2. If the stripe is eligible, a read request to the entire stripe is generated.
3. Once that read request completes, a write is generated and put into a queue to await being sent to an UPGRAID partition.

Approach - Read Replication

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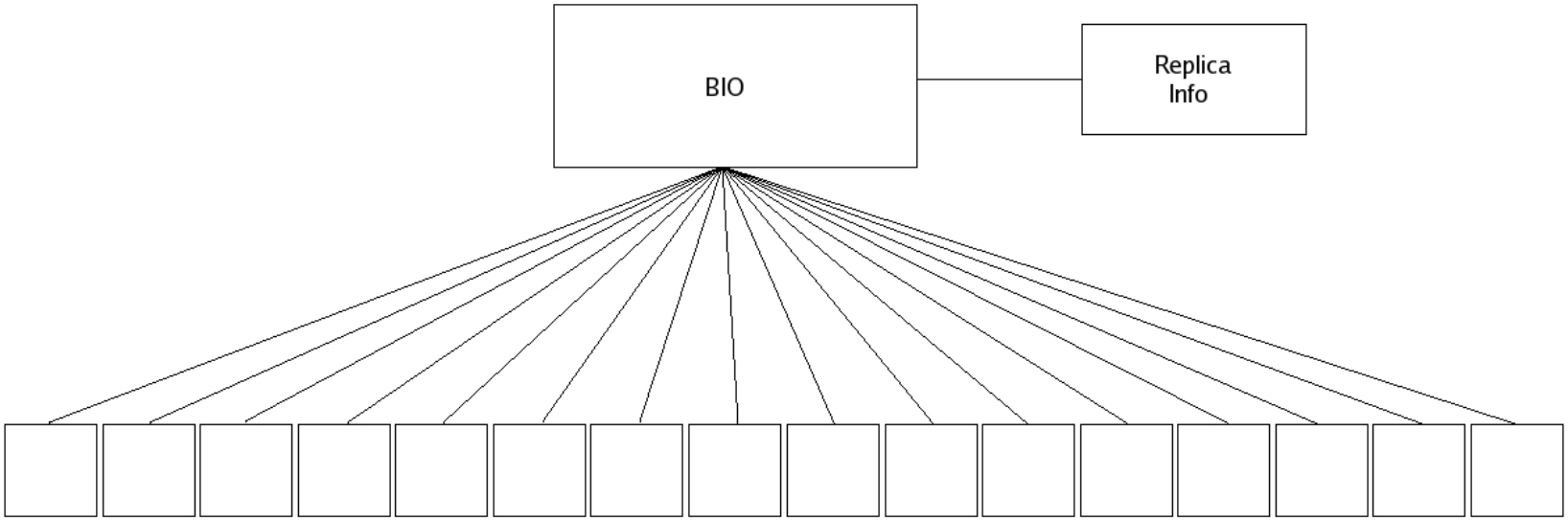

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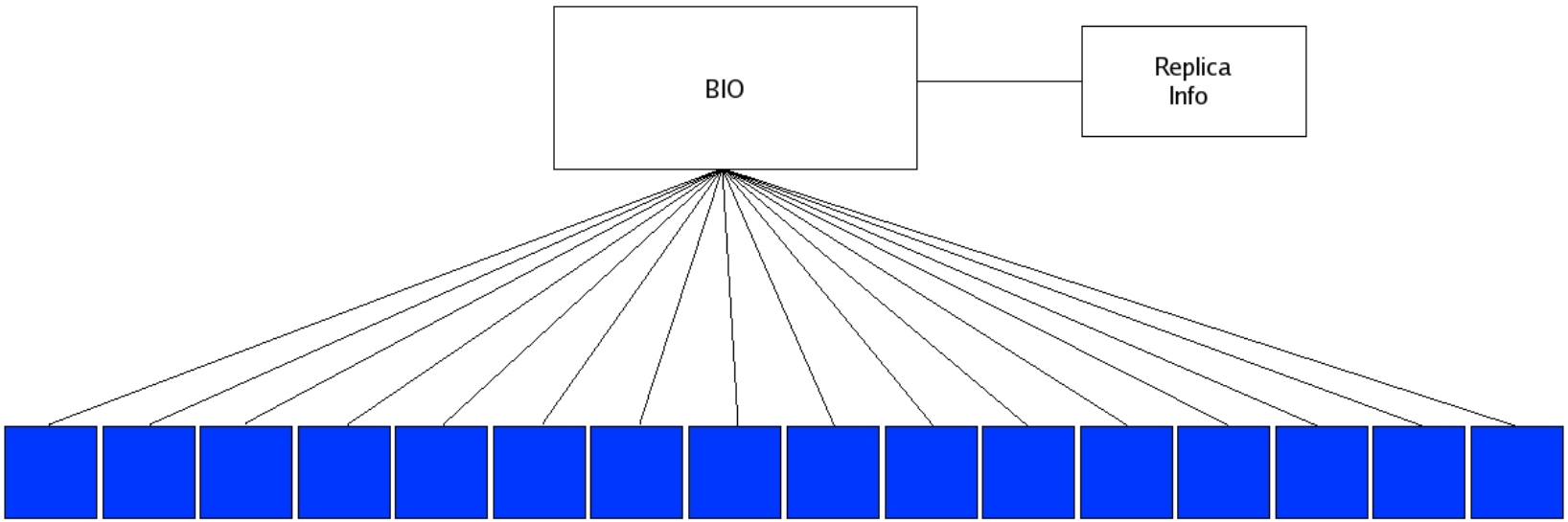

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5. The modified write is sent to a queue to await submission to the proper UPGRAID partition.

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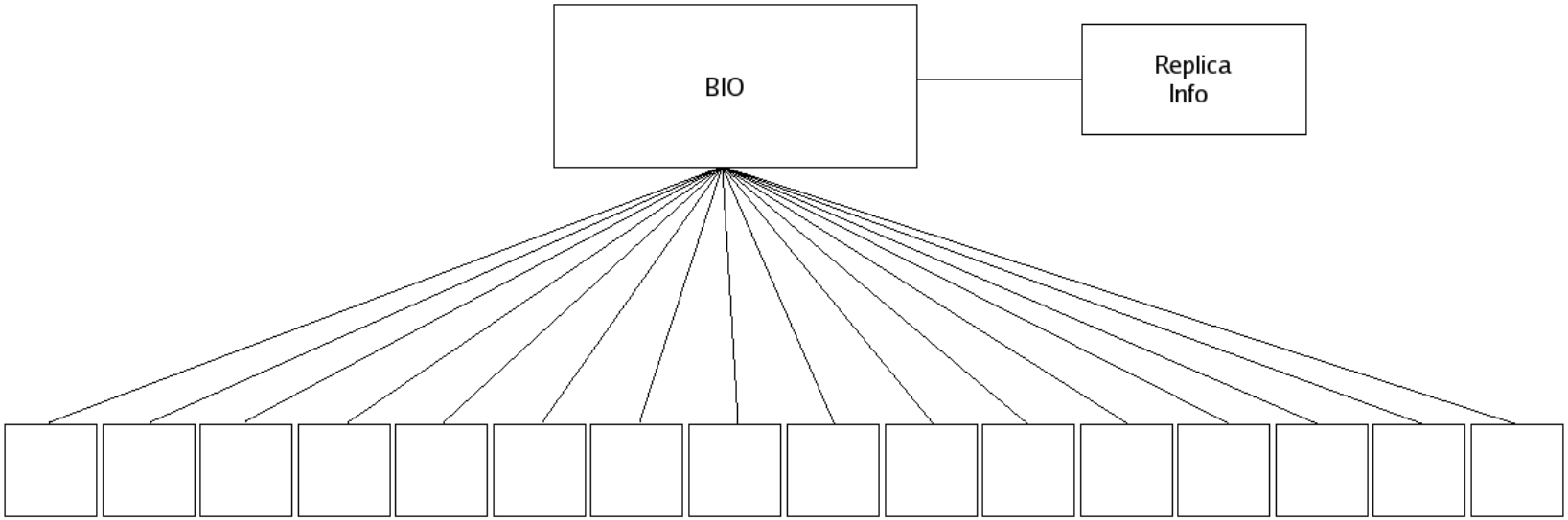

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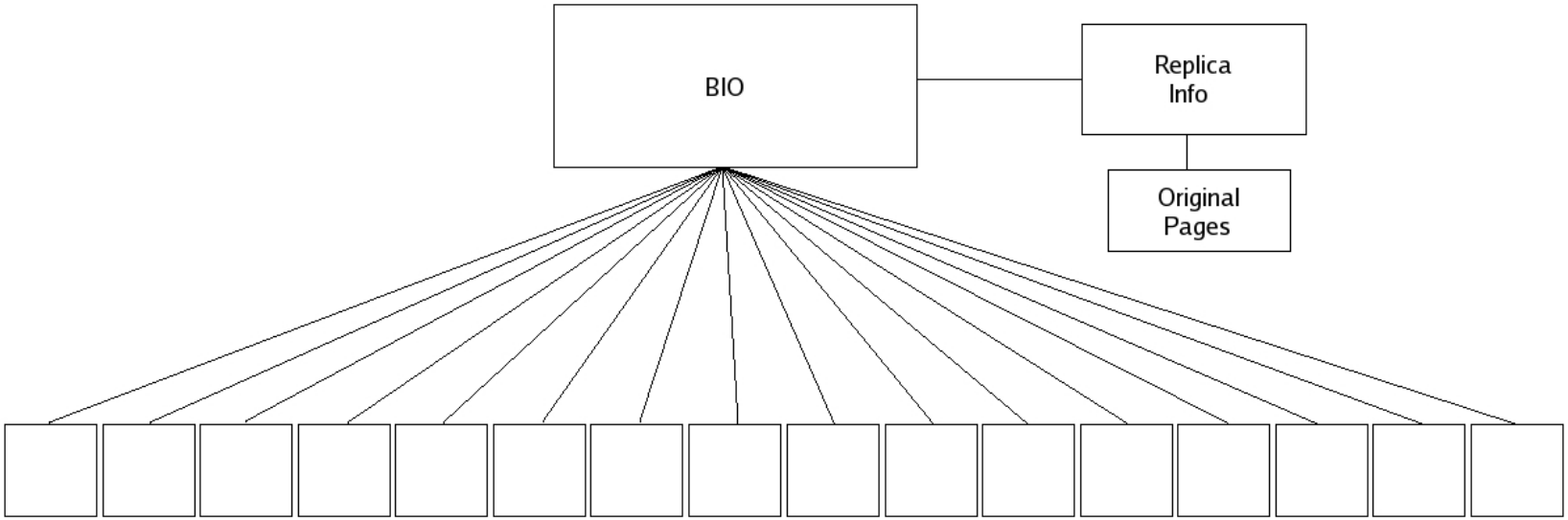

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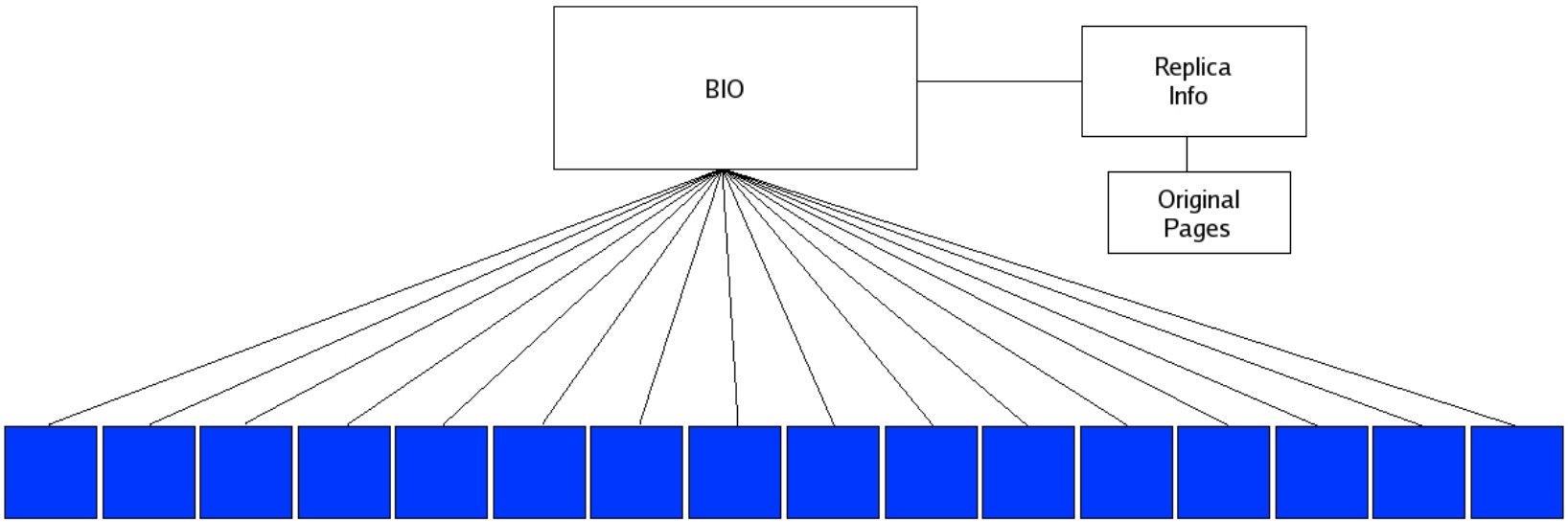

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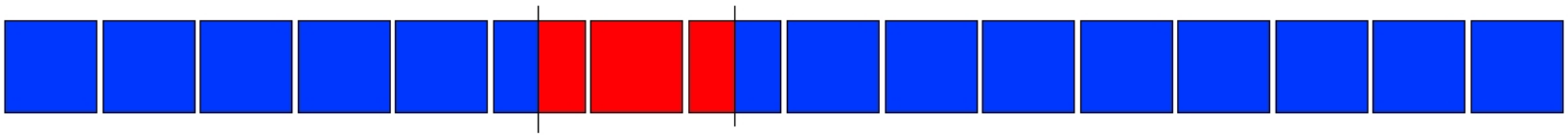

Approach - Read Indirection

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1. UPGRAID determines if the request should be sent to the RAID5 partition or UPGRAID partition by looking at the head position of each drive. This drive that has the smallest distance to move is chosen to fulfill the request.

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2. The request is then sent to the appropriate disk and the application proceeds upon completion of that read request.

Approach - Write Indirection

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1. The write request to the RAID5 partition is cloned.
2. This cloned request gets sent to the appropriate location on the UPGRAID partition at the same offset into the stripe as the original write, thereby preserving the mirroring property between the two stripes.

Testing Tools

UPGRAID

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Testing Tools

- Integrity Checker

Testing Tools

- Integrity Checker
- Workload Profiler

Integrity Checker

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Integrity Checker

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- Automated user level application to test reads and writes to specific blocks.
- Uses:
  - Check and see if data was written to the correct block.
  - Make sure that modules are performing correctly.

Integrity Checker

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  - Read Phase
    - Generates a random read workload across the disk space.
  - Read and Compare Phase
    - Reads back in the original write workload and compares the data to ensure there was no data corruption.

Workload Profiler

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  - throughput

Future Work

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Future Work

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- Testing and debugging of replication, indirection, and popularity code
- Reconstruction

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Future Work - Read Heuristic

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- We have looked into the code and think that it can be ported to UPGRAID with a few modifications.

Future Work - Testing and Debugging

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- Once the system is more stable with autorwbench UPGRAID can be deployed on a file system.

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- Not considered in detail yet

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Future Work - Reconstruction

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  - Popularity-based Reconstruction (PRO)
- An entirely new approach could be developed for UPGRAID

Future Work - Reconstruction via DOR

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Future Work - Reconstruction via DOR

- DOR works by generating a thread for each disk that is responsible for fulfilling requests to that disk for the purpose of rebuilding the data of the failed disk.
- There is also a master thread that is responsible for coordinating the actions of the disk threads.
- It is possible that UPGRAID could work directly below the master thread and indirect rebuild requests for replicated blocks to the replicas stored on UPGRAID partitions.

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- This approach would likely be more complex but its popularity based operation seems like good fit with UPGRAID.
- It may be good if we defined these "hot zones" to align with the stripes of the RAID5 disk. This would make reconstruction using the replicated stripes easier.

Extremely Preliminary Results

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- 10MB write workload
- 100MB read workload
- Run in a virtual machine

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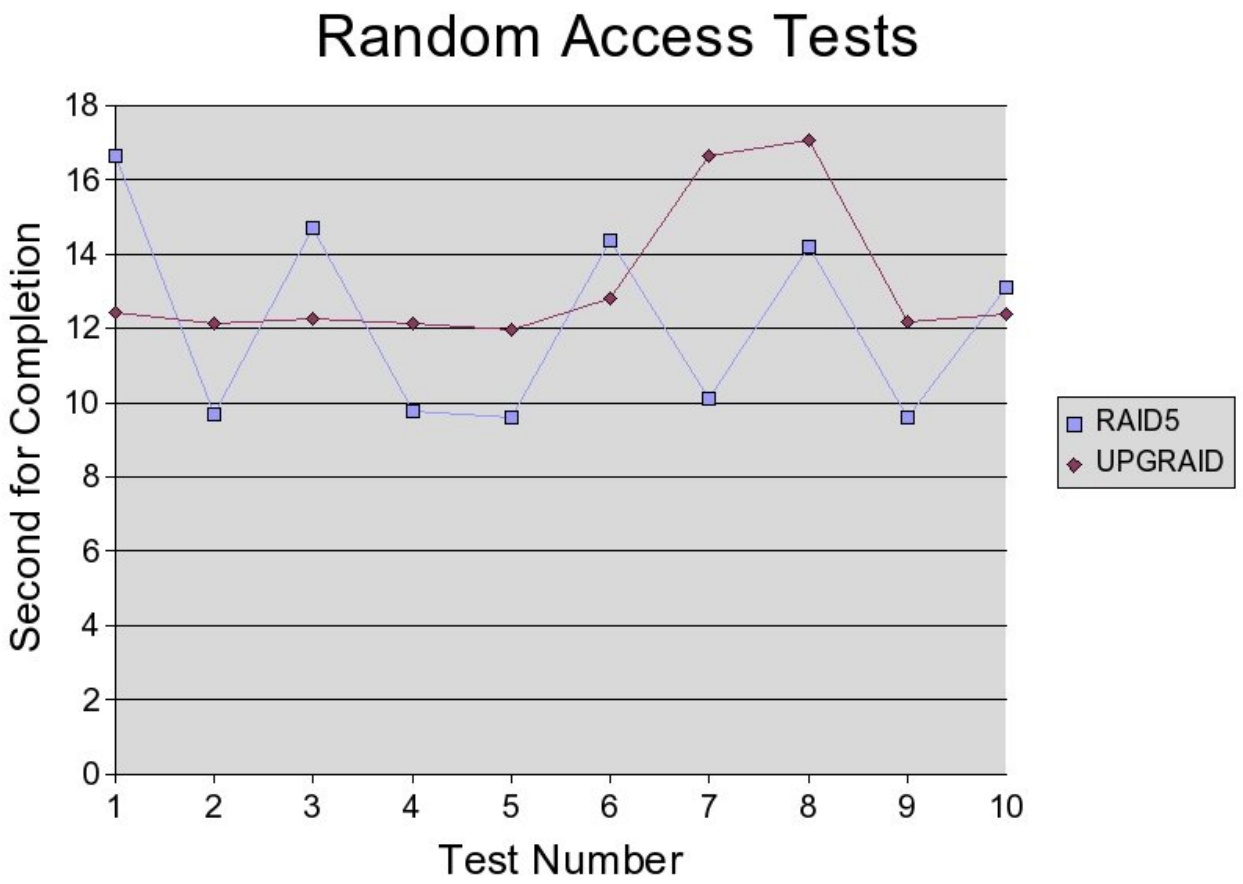

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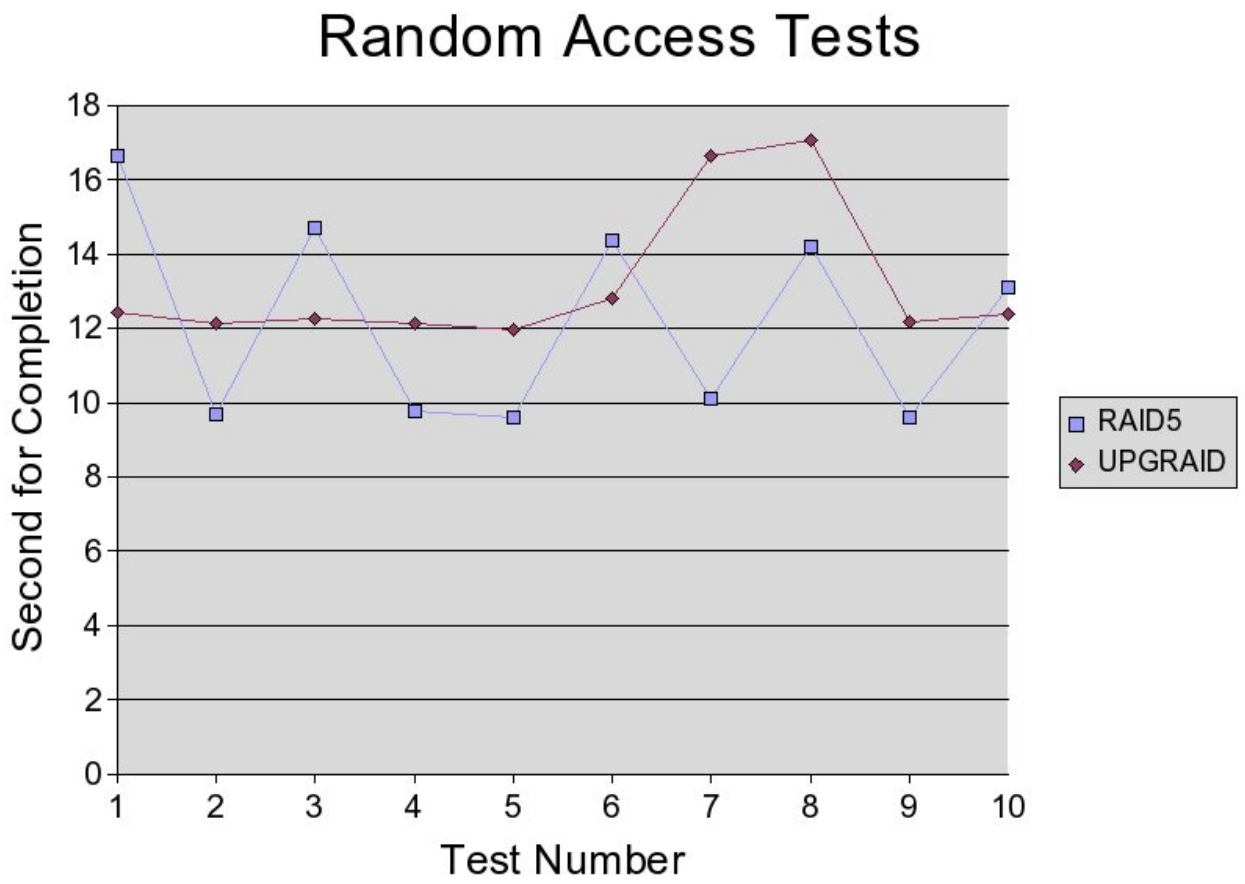

- RAID5 Average - 12.187 seconds

Extremely Preliminary Results

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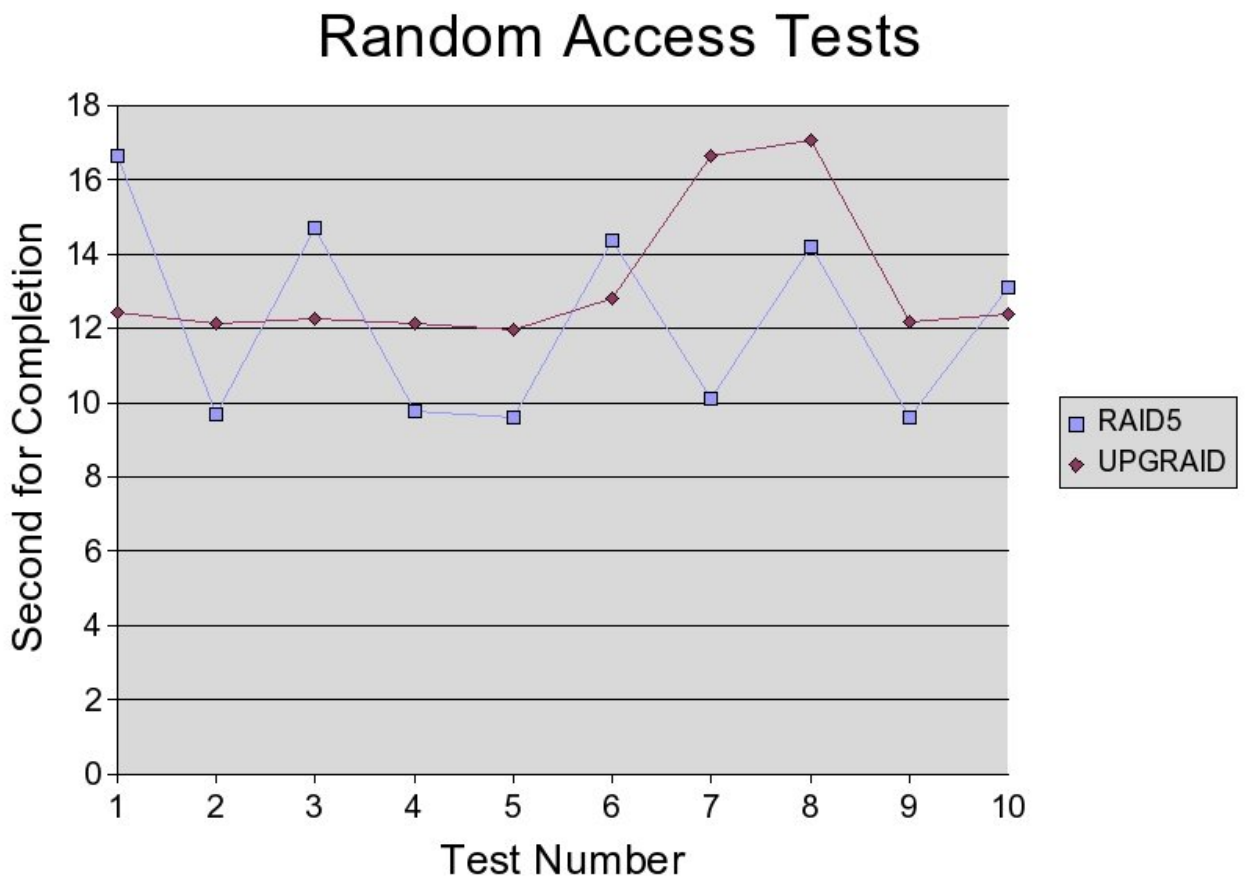

- RAID5 Average - 12.187 seconds
- UPGRAID Average - 13.1984 seconds

Extremely Preliminary Results

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- Due to the current instability of the system this data should be taken with a grain of salt.

Questions or Comments?

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