Brief Announcement: Robust and Private Distributed Shared Atomic Memory in Message Passing Networks

PODC'15

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Distributed Computing and Systems
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Content

We focus on emulation **shared memory** in **message passing** networks.

Opportunity: Cadambe et al. (2014): A **coded shared atomic memory algorithm** for message passing architectures.

We are going to see how to provide

- **robustness** against semi-Byzantine attacks,
  - i.e., corruption of stored data,
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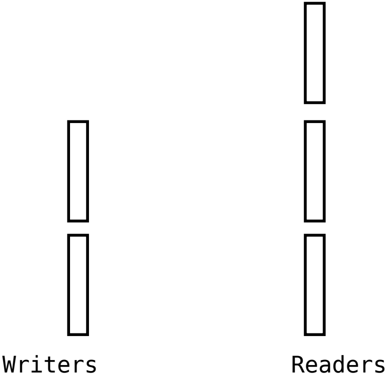
We use **Reed-Solomon codes**

Multi Reader Multi Writer Shared Memory in Message Passing Networks



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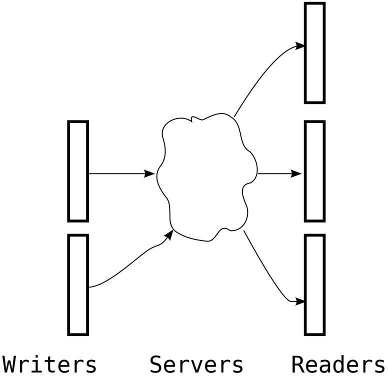

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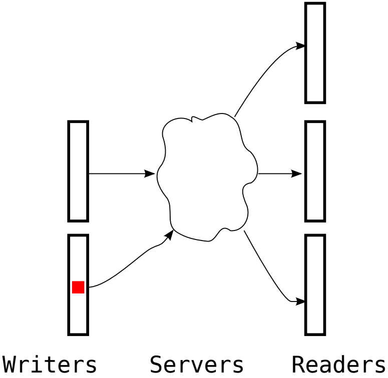

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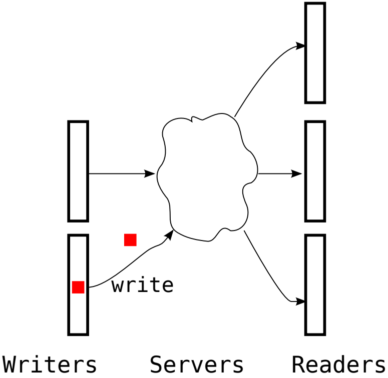

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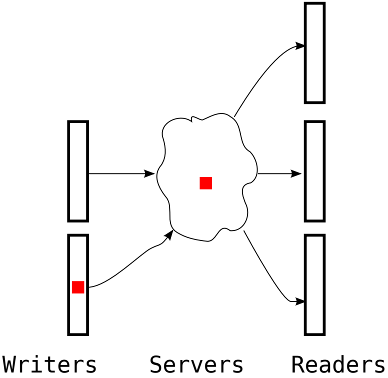

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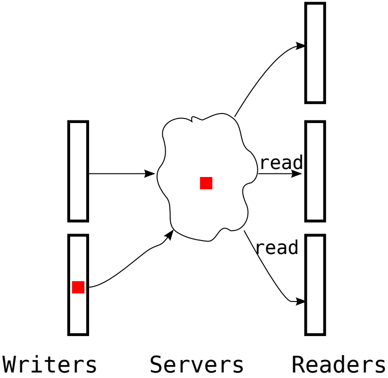

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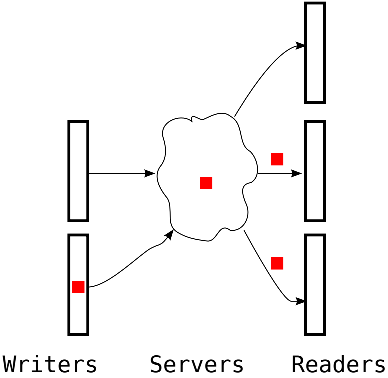

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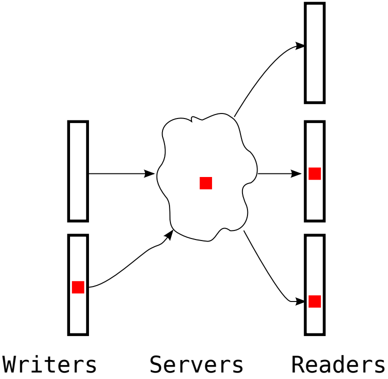

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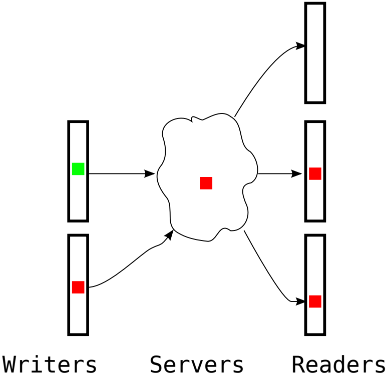

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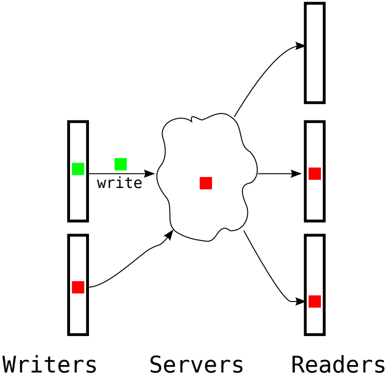

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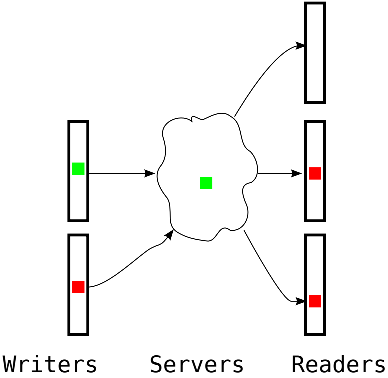

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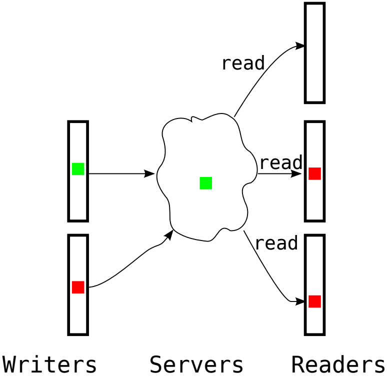

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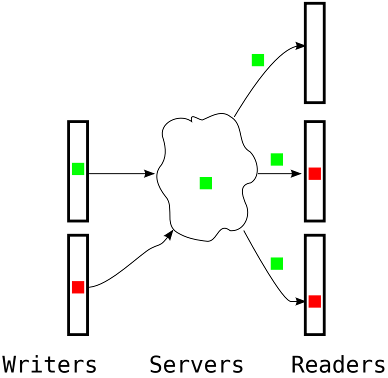

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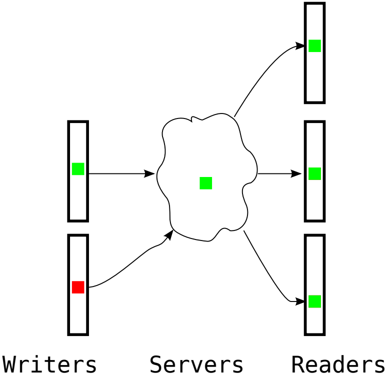

Multi Reader Multi Writer Shared Memory in Message Passing Networks

(Most) related work: Attiya, Bar-Noy, and Dolev (ABD), Cadambe et. al

Cadambe et al. address the following:

- atomicity and liveness and
- storage and communication costs.

They solve atomicity and liveness in a ABD-like manner.

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- length k vector $\rightarrow$ length N vector.
- tolerates $\leq N - k$ erasures.

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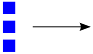

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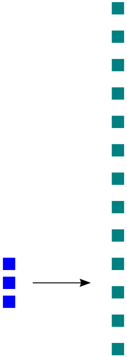

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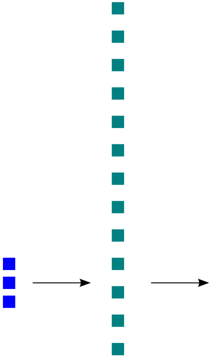

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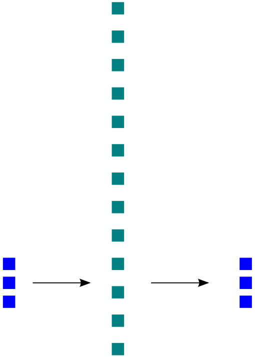

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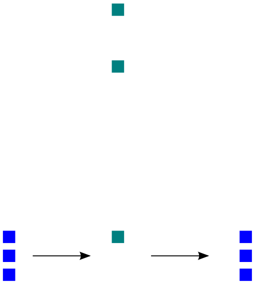
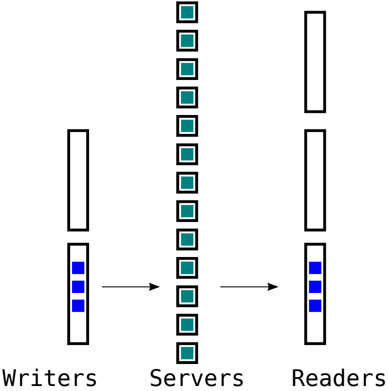


Coded Atomic Storage Algorithm

- N servers.
- $\lceil \frac{N+k}{2} \rceil$-quorums.



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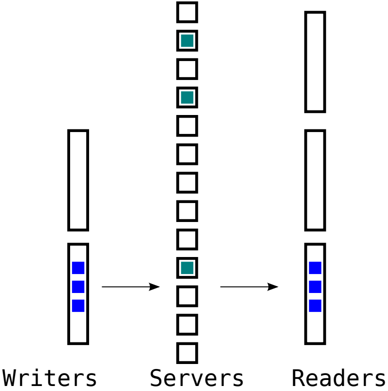

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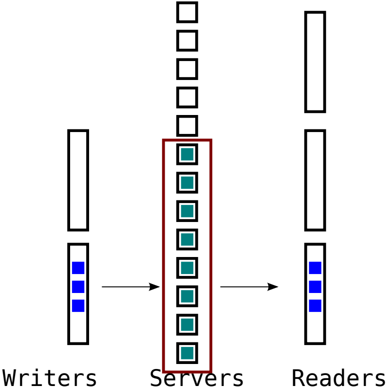

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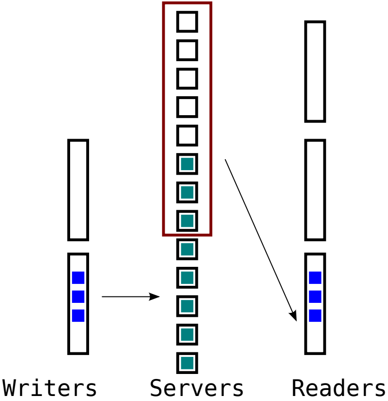

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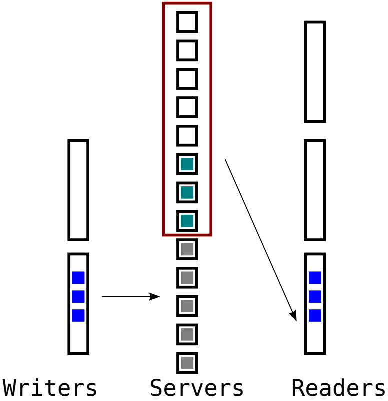


Our contribution

We address:

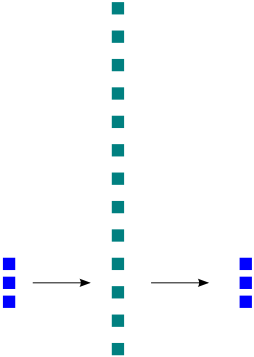
- Robustness against semi-Byzantine attacks.
- Privacy of the data.

We use

- (N, k)-**Reed-Solomon** codes and
- **Berlekamp-Welch** error correction.

Robust and Private Coded Atomic Storage

- (N, k)-Reed-Solomon code.
- For e corrupt elements, we need to read $2e$ more elements.



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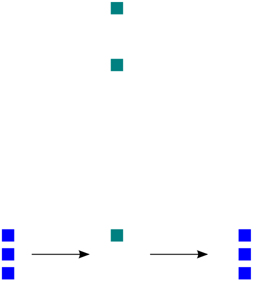

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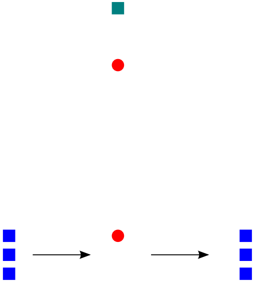

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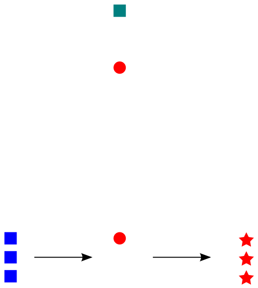

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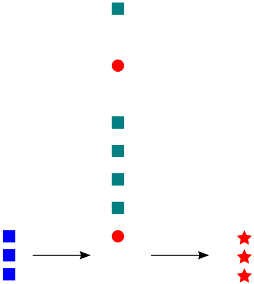

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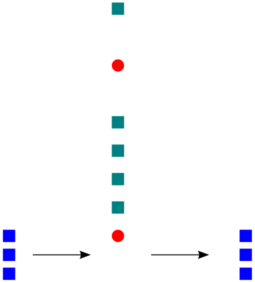

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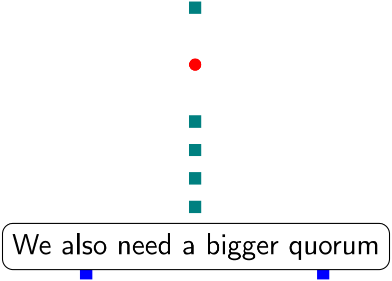
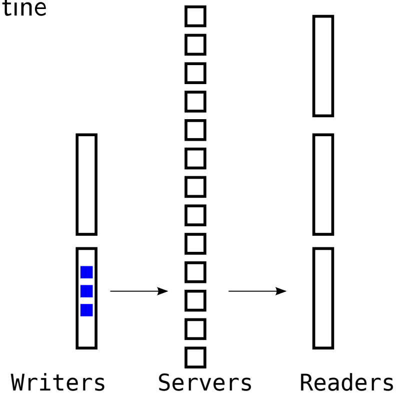


We also need a bigger quorum

Robust and Private Coded Atomic Storage

- $\lceil \frac{N+k+2e}{2} \rceil$-quorums.
- Up to $f < N - \lceil \frac{N+k+2e}{2} \rceil$ failures.
- Up to e semi-Byzantine servers.



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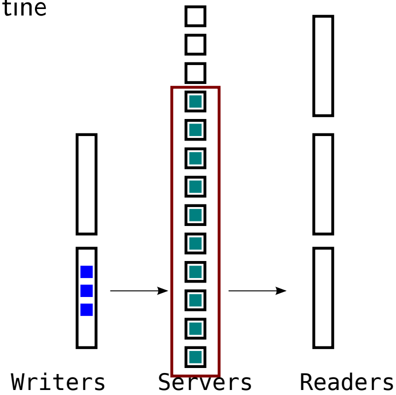

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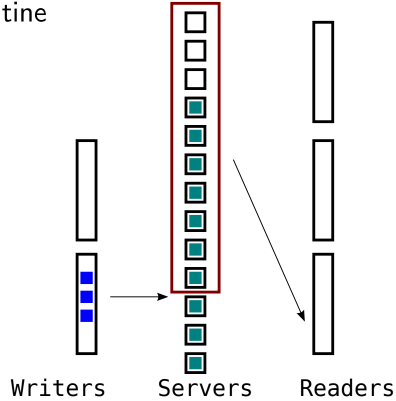

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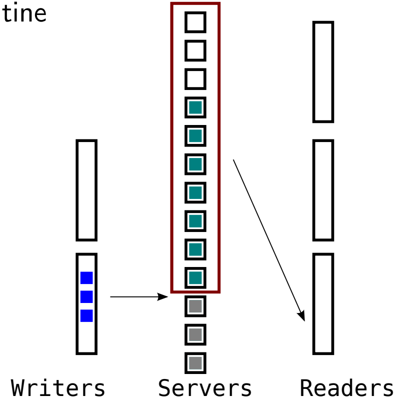

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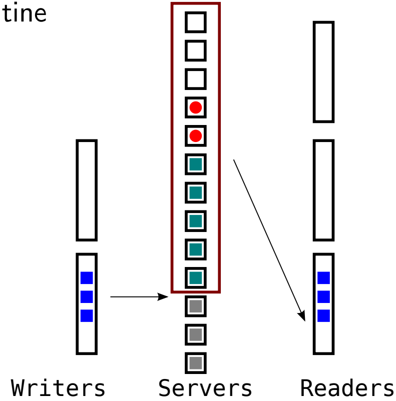
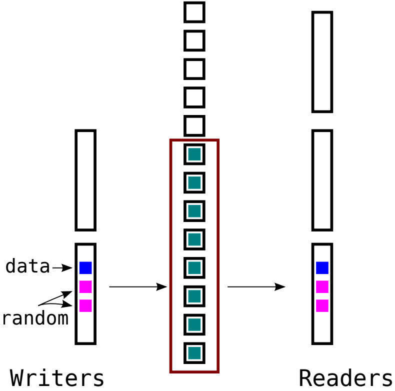


Robust and Private Coded Atomic Storage

- McEliece & Sarwate: Reed-Solomon codes are related to Shamir's **secret sharing**.
- Only sets of $\geq k$ server can reveal the secret.



Conclusion

Using special cases of coding (Reed-Solomon) and decoding (Berlekamp-Welch), we show:

- *robustness*, corrupted data by Byzantine server can be tolerated and
- *privacy*, even a small amount of server cannot restore the data.