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A Universal Construction to implement Concurrent Data Structure for NUMA-multicore

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Concurrent Data Structures (CDS)

Used everywhere: kernel, libraries, applications

Issues:

- High copying overheads
- NUMA-oblivious design
- Read-side overhead
- Complex

Goals

- Design a new Universal Construction (called CR),which transforms a sequential implementation of a data structure into a concurrent implementation

➢ Provide efficient read-side performance

➢ Provide scalable write-side performance on NUMA-multicore

Our method: CR

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  - NUMA-aware write: Use a shared log to synchronize cross-nodes threads and use delegation to synchronize local threads

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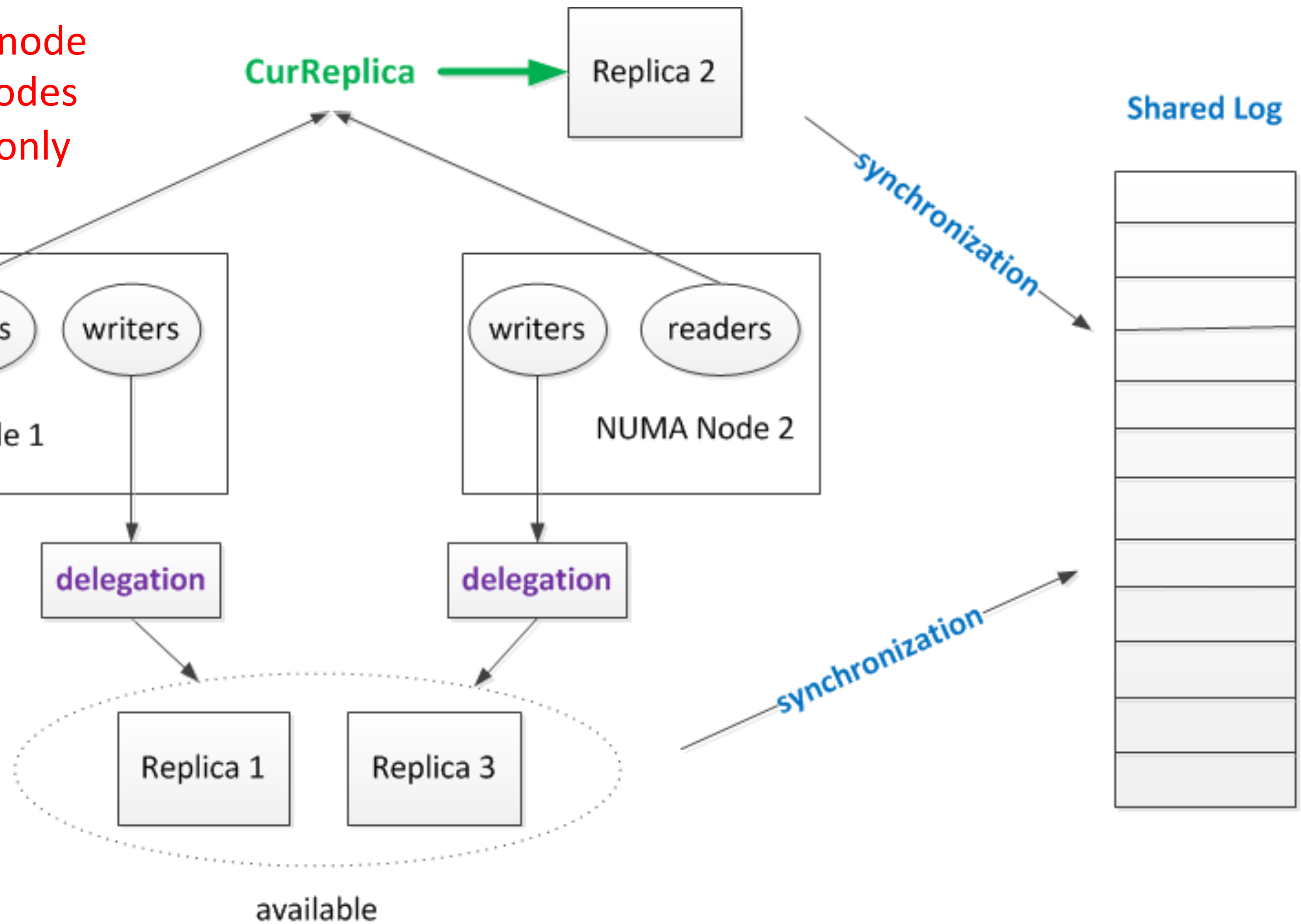
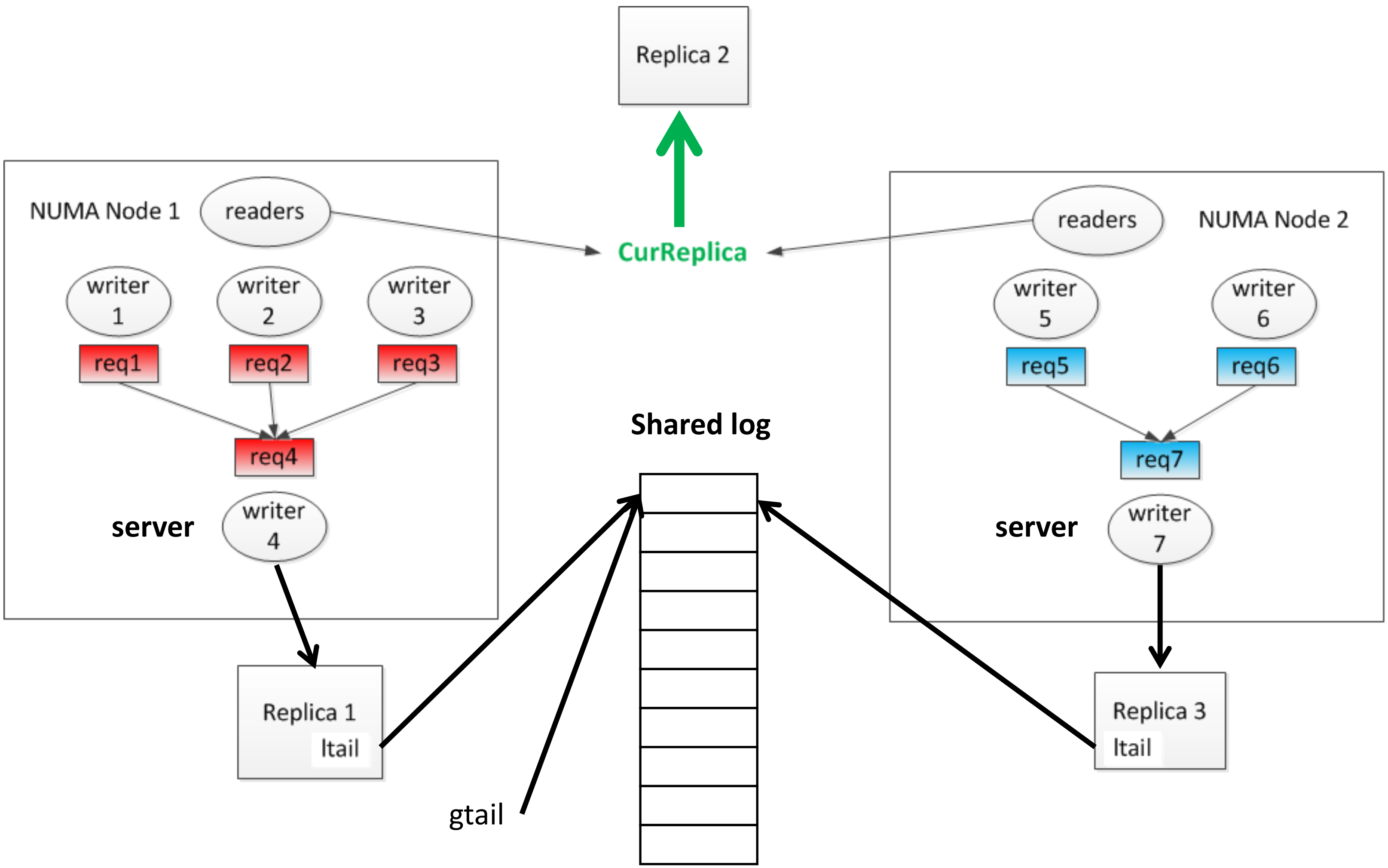
  - Efficient Read: Keep one up-to-date replica for read-only access at all times
  - NUMA-aware write: Use a shared log to synchronize cross-nodes threads and use delegation to synchronize local threads
  - Without requiring inner knowledge of the data structure

Structure Chart for CR

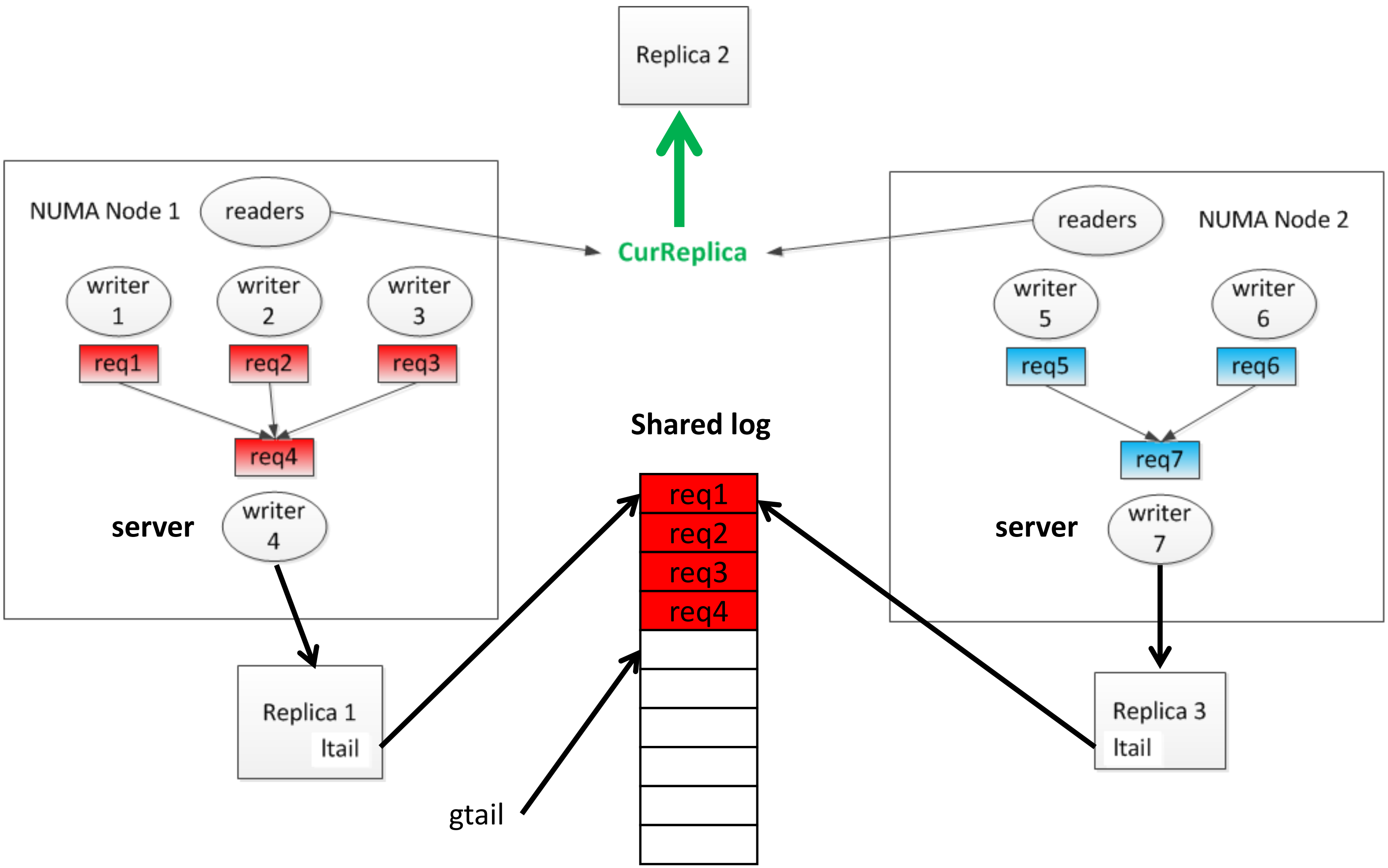
1 Delegation within a node
2 Shared log across nodes
3 CurReplica for read-only



Delegation : Collect requests within a NUMA node 1



Delegation : Write requests within a NUMA node 1



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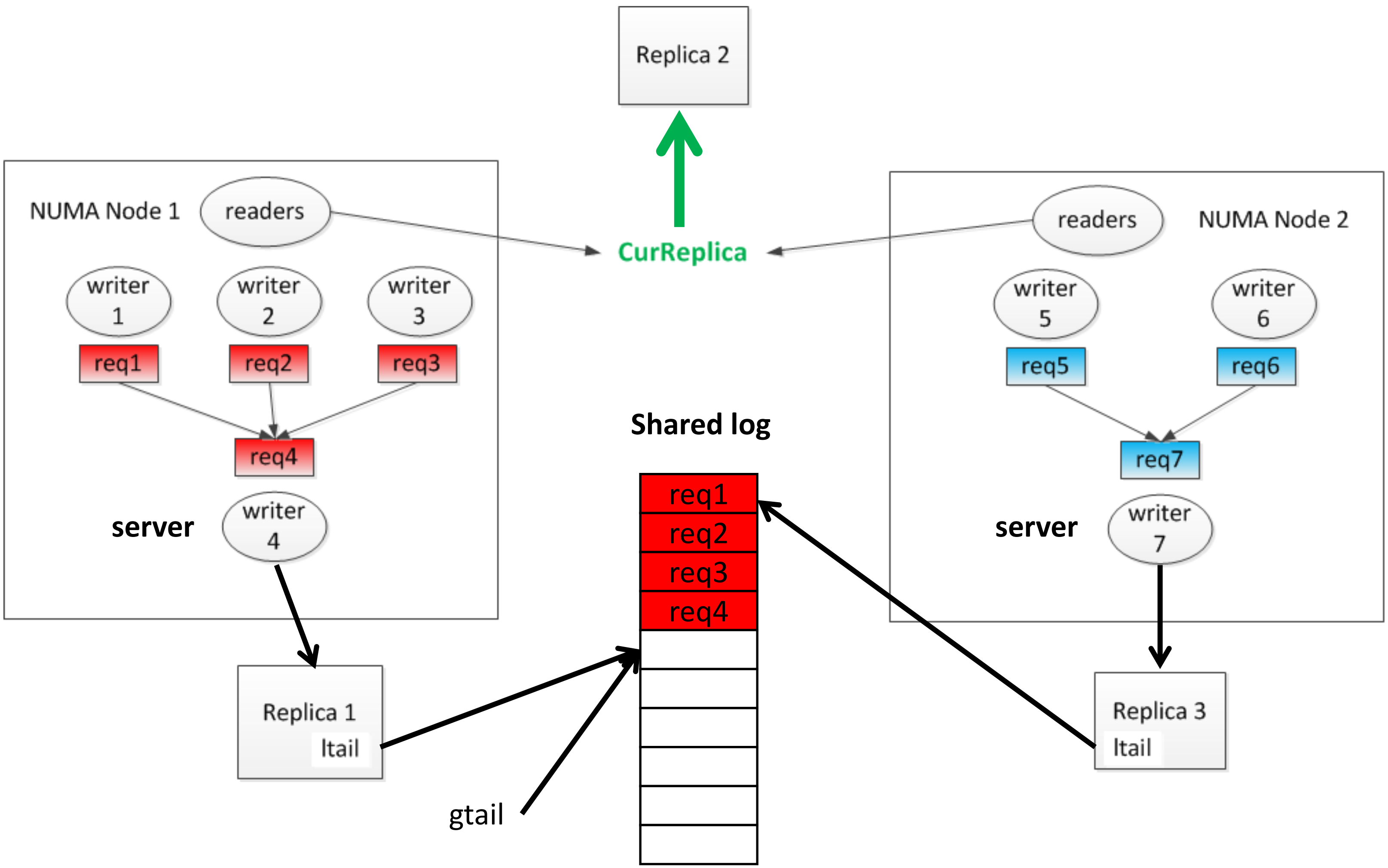
Shared log : Execution for requests from a NUMA node 1



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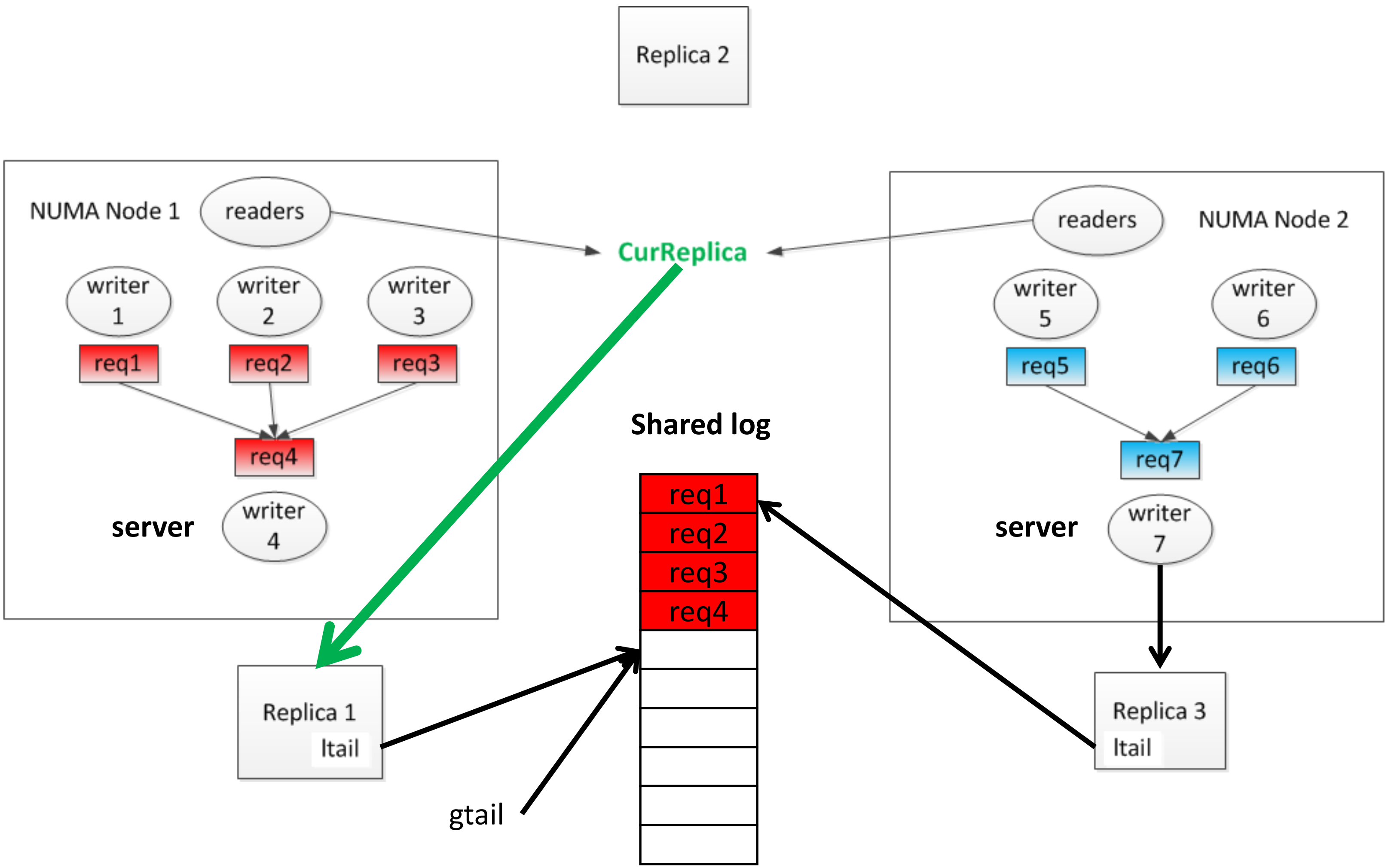
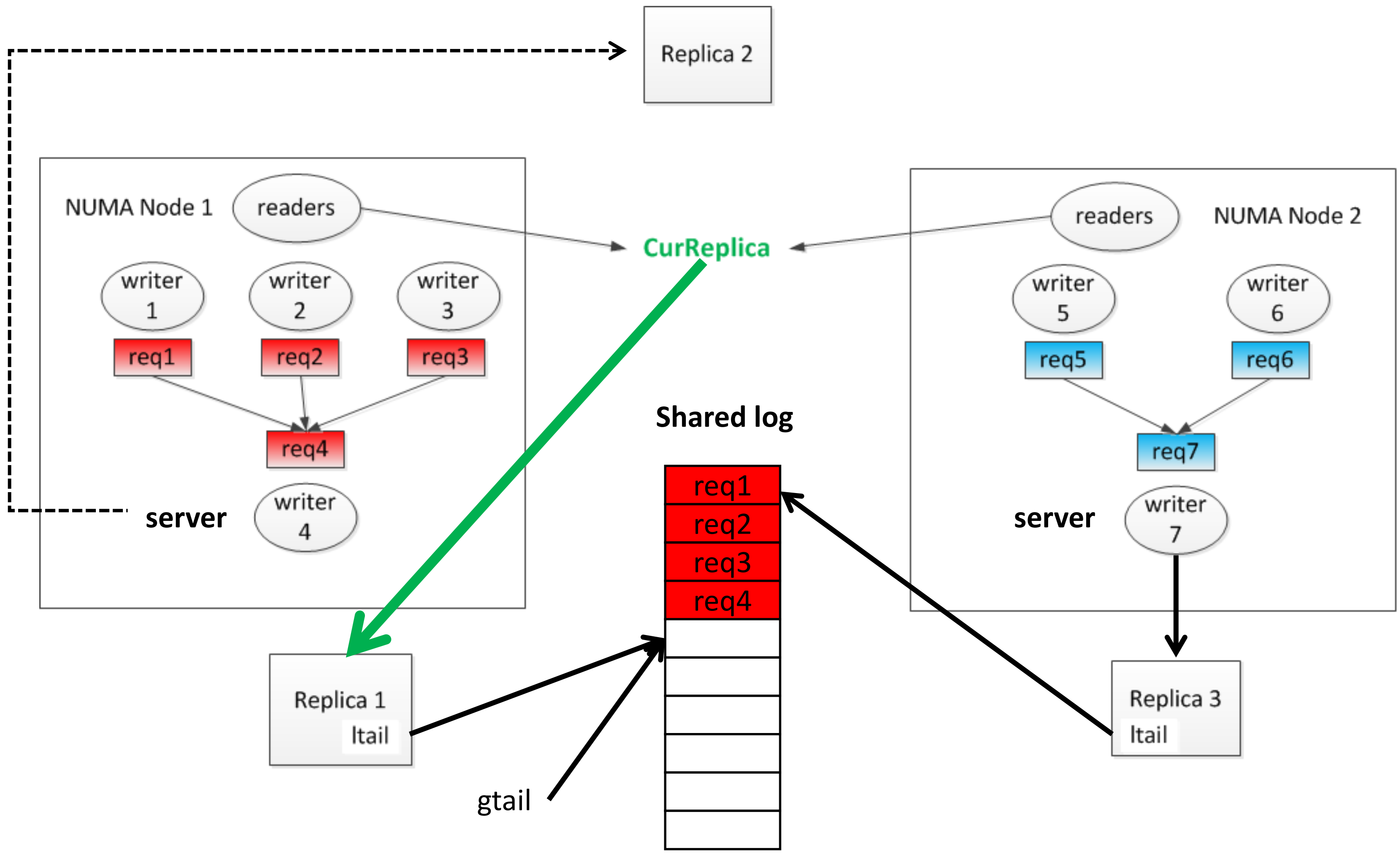
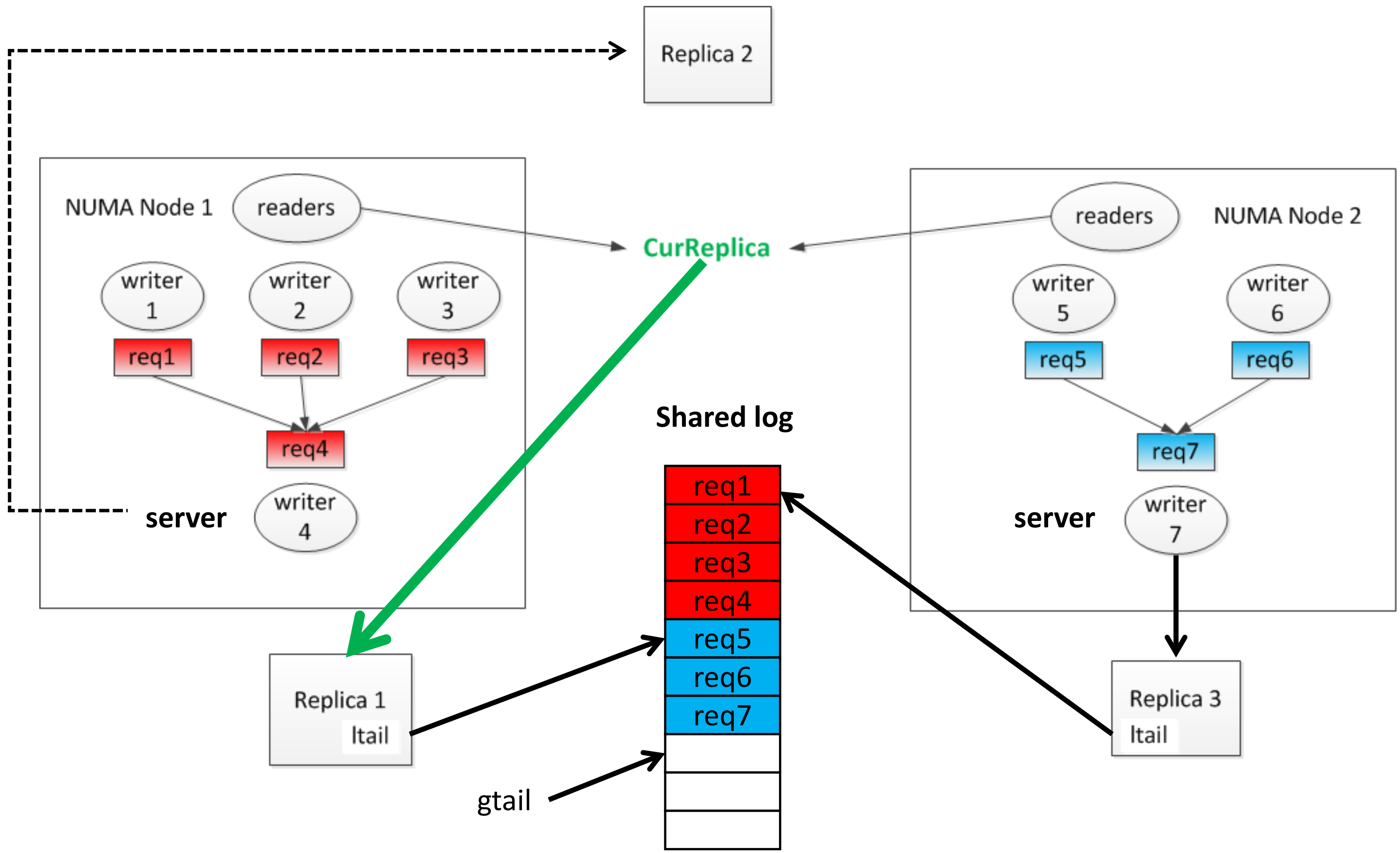
Transition CurReplica to Replica 1



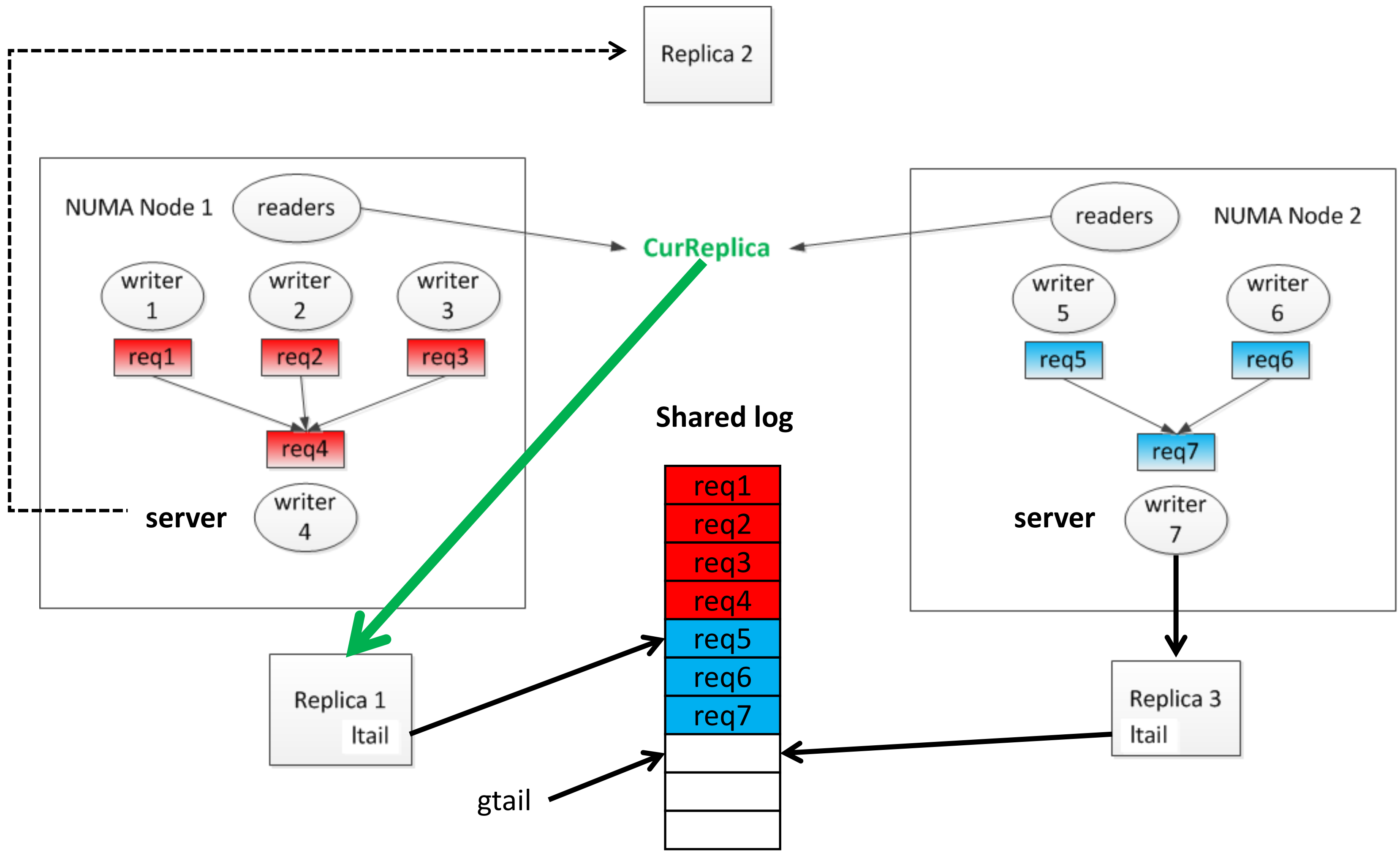
Transition CurReplica to Replica 1



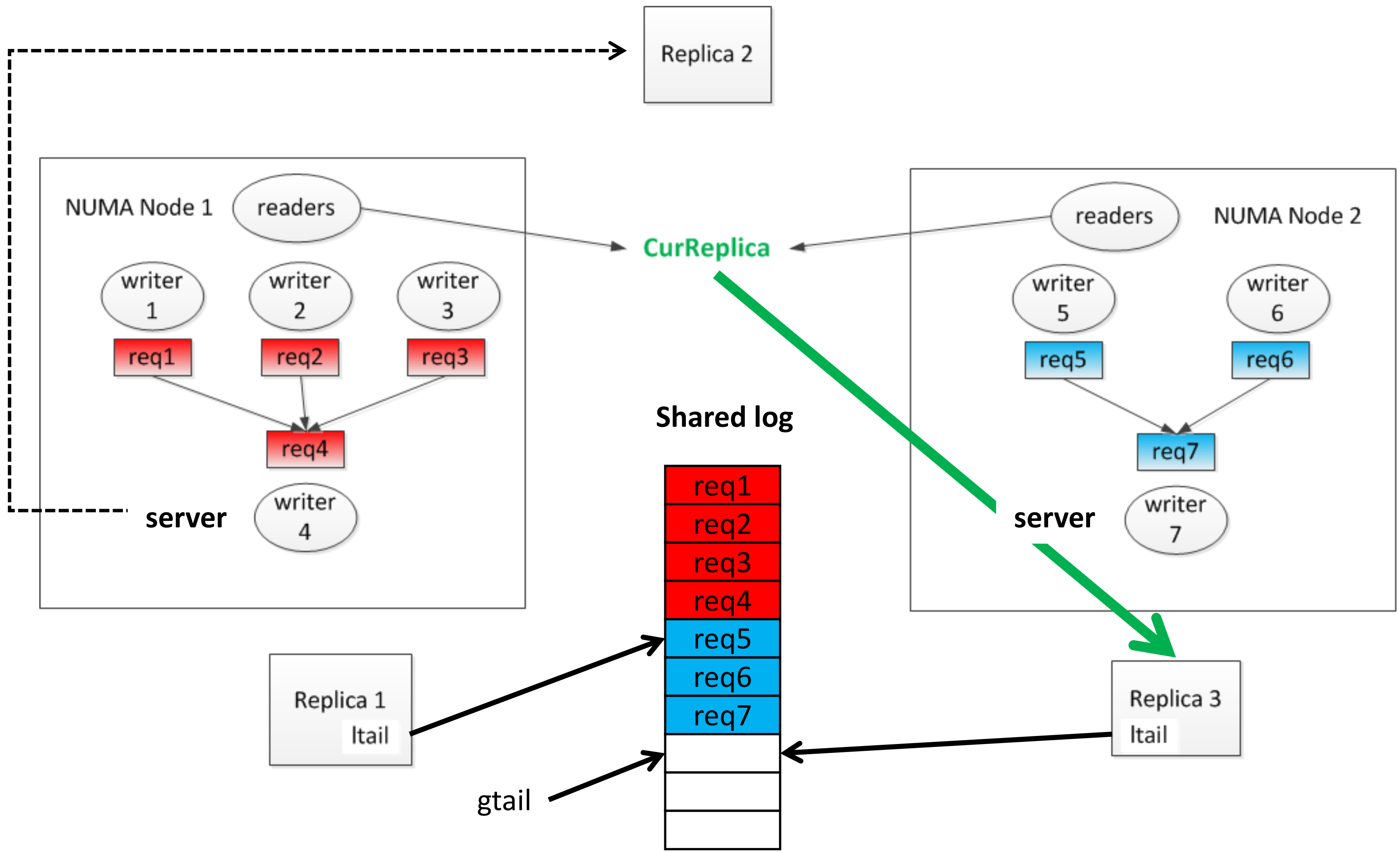
Delegation : Collect and write requests within a NUMA node 2



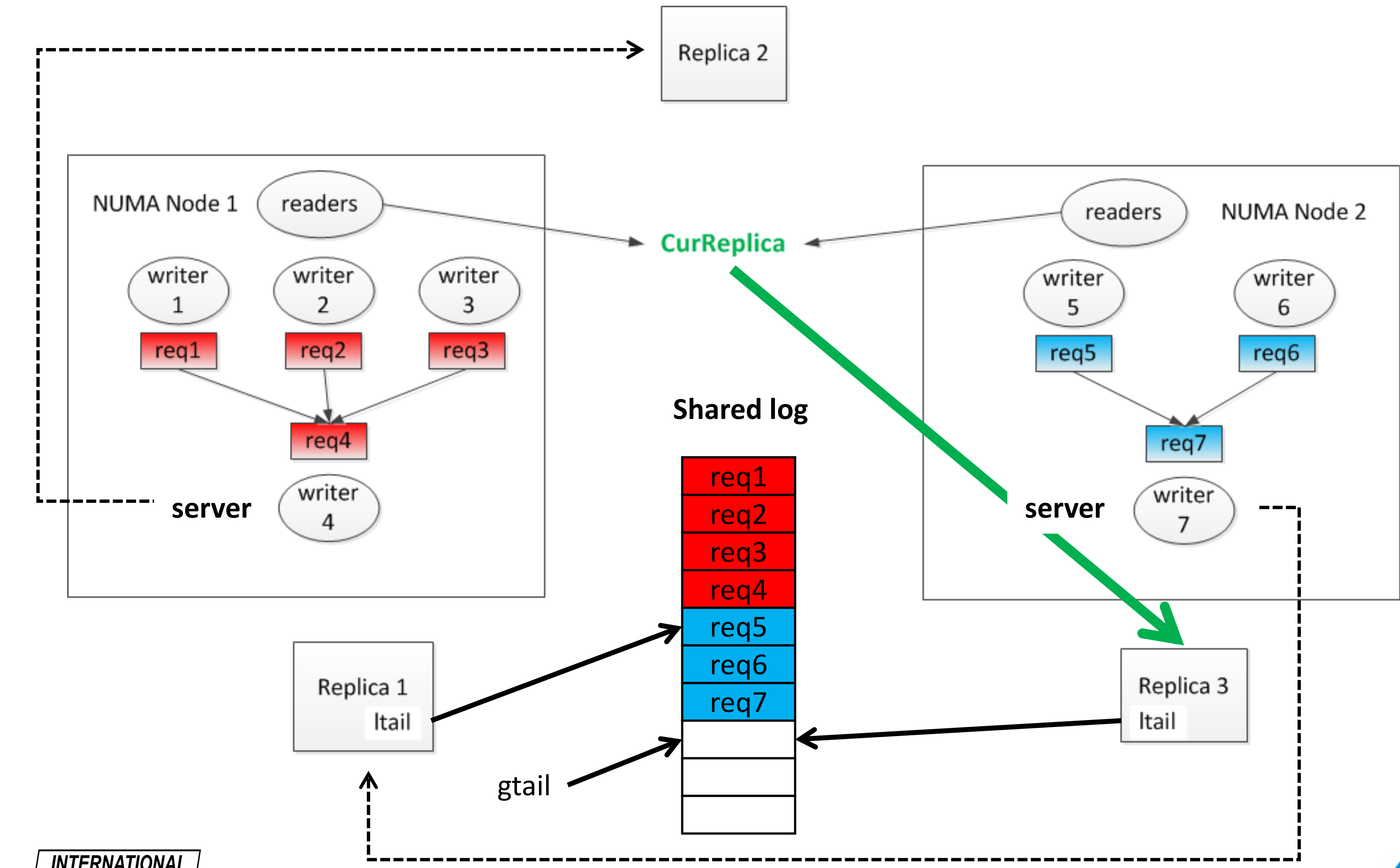
Shared log: Synchronization and execution for requests



Transition CurReplica to Replica 3



Transition CurReplica to Replica 3



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Results

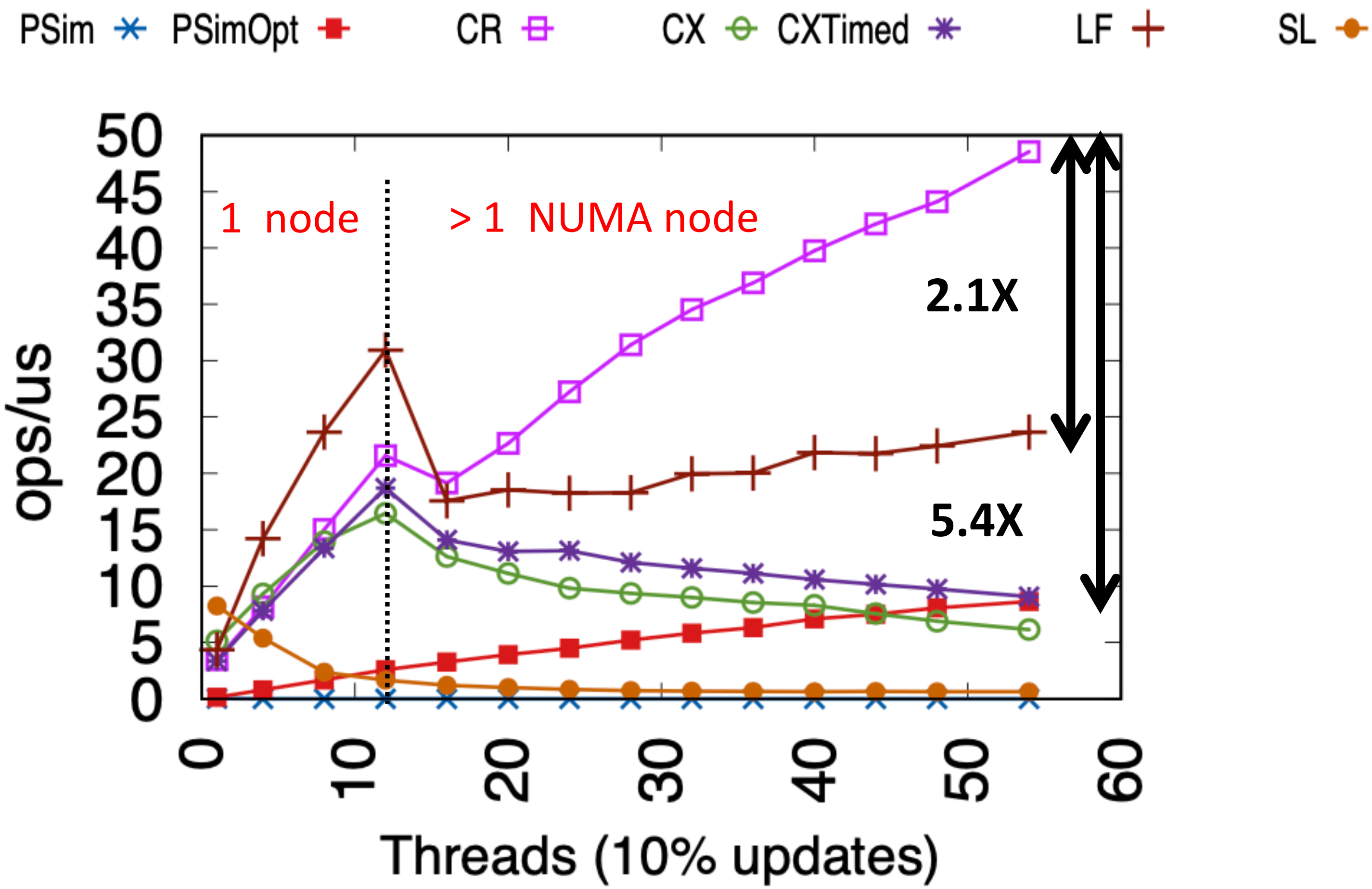
Sever:

2 NUMA nodes

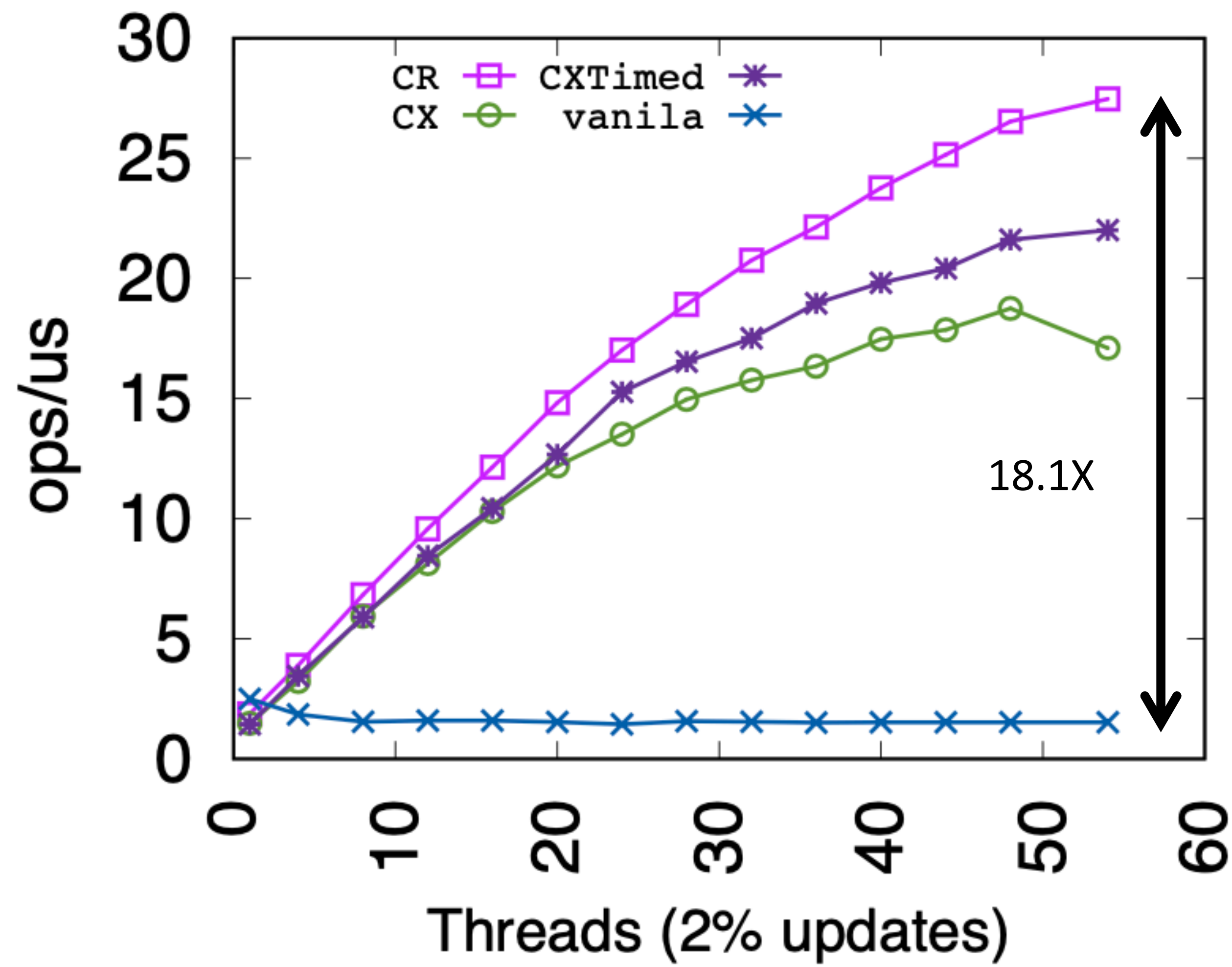
14 cores/node + hyperthreading

(total 56 hardware threads)

Skiplist Priority Queue – 10% Updates



Using CR in KyotoCabinet – 2% Updates



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Conclusion: CR Works Well

- Keep one update-to-date replica for read-only access at all times
- Use a shared log to synchronize cross-nodes threads
- use delegation to synchronize local threads

Thank you!