FASST: FAST, SCALABLE, AND SIMPLE DISTRIBUTED TRANSACTIONS

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MOTIVATION

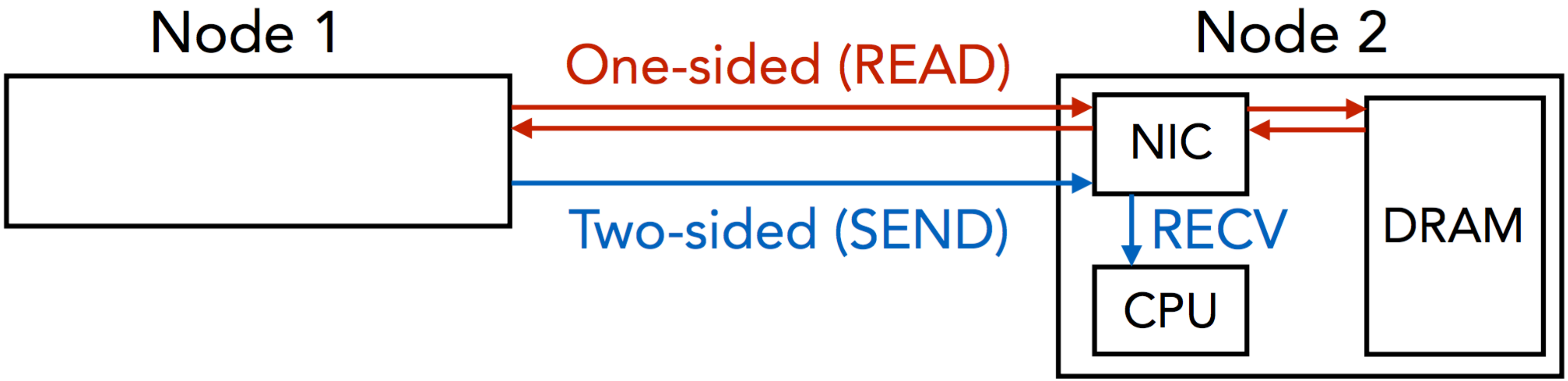
RDMA is great! We can build fast distributed stores!

Existing systems all use 1-sided RDMA

- Need for multiple round trips for B-Trees etc.
- Need to maintain connection state (queue pairs)

Approach: Design RPC layer that is fast, simple, scalable

ONE-SIDED VS TWO-SIDED



COMPARING RDMA MODES

	SEND/RECV	WRITE	READ/ATOMIC
RC	✓	✓	✓
UC	✓	✓	✗
UD	✓	✗	✗

Table 1: Verbs supported by each transport type. RC, UC, and UD stand for Reliable Connected, Unreliable Connected, and Unreliable Datagram, respectively.

PAPER CONTRIBUTIONS

1. Design RPC using two-sided unreliable datagram verbs
2. Support parallel RPCs using co-routines
3. Optimizations for batching
4. Detect / Handle packet loss ?

NEED FOR DATAGRAM RPCS

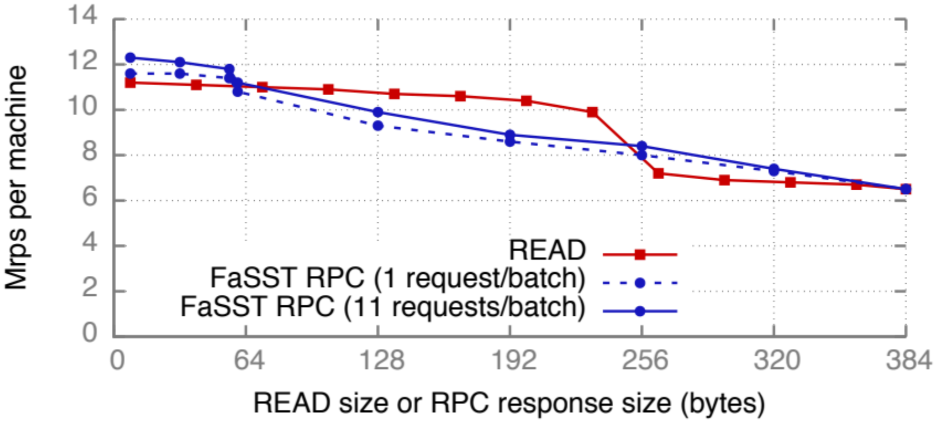
How to do index operations ?

- FaRM: Inline values with keys
- DrTM: Replicate index

Queue pair scaling

- Connection state per thread to all recipients
- Optimizations like sharing queue pairs (affect performance)
- Datagram transport require no state!

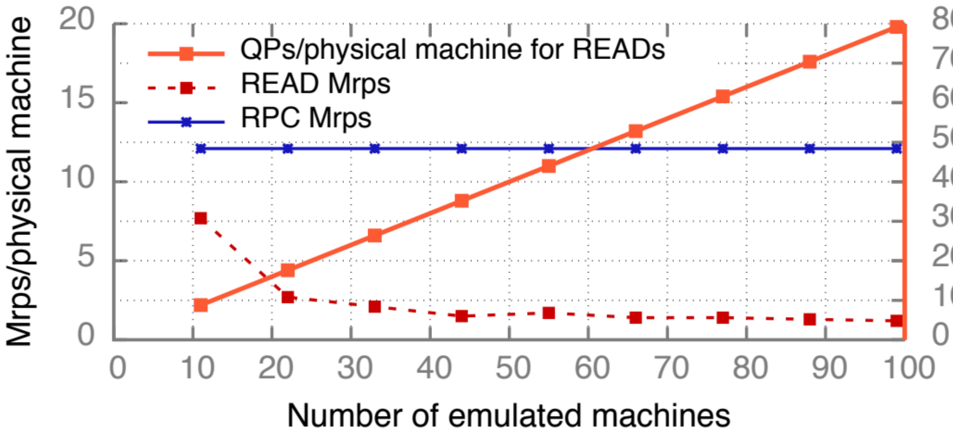
DATAGRAM RPCS VS ONE-SIDED



(a) CX3 cluster (ConnectX-3 NIC)

Real cluster of 6 nodes

Emulated cluster



FASST RPCS

Coroutines

- RDMA latency ~10us
- Use coroutines to yield while waiting for response
- Small number (~20) coroutines per thread

Master/worker

- Master co-routine handles request from remote machines
- Workers run application logic and issue RPC requests

RPC OPTIMIZATIONS

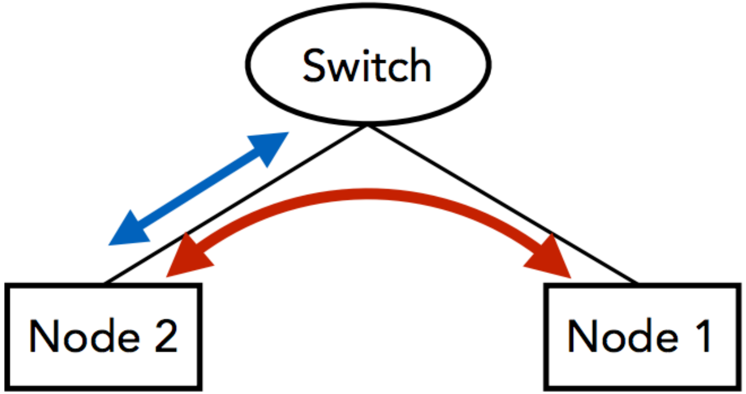
Request Batching

- Each request has to ring NIC "Doorbell" from CPU
- Coalesce multiple messages (e.g., multi-key transaction)
- Invoke coroutine once per batch
- Batching is *opportunisitic*

Cheap RECV posting

- Need to limit size of RECV queue
- Required modifying *NIC driver*

RELIABILITY



- No end-to-end reliability
+ Link layer flow control
+ Link layer retransmission

No packet loss in

- 69 nodes, 46 hours
- 100 trillion packets
- 50 PB transferred

RELIABILITY ?

Handling packet loss

- Use timeout to check if coroutine got reply
- On timeout, kill the FaSST process on the machine!
- Timeouts can be large – don’t affect other threads
- Application-level recovery (second talk)

Pros/cons of this approach ?

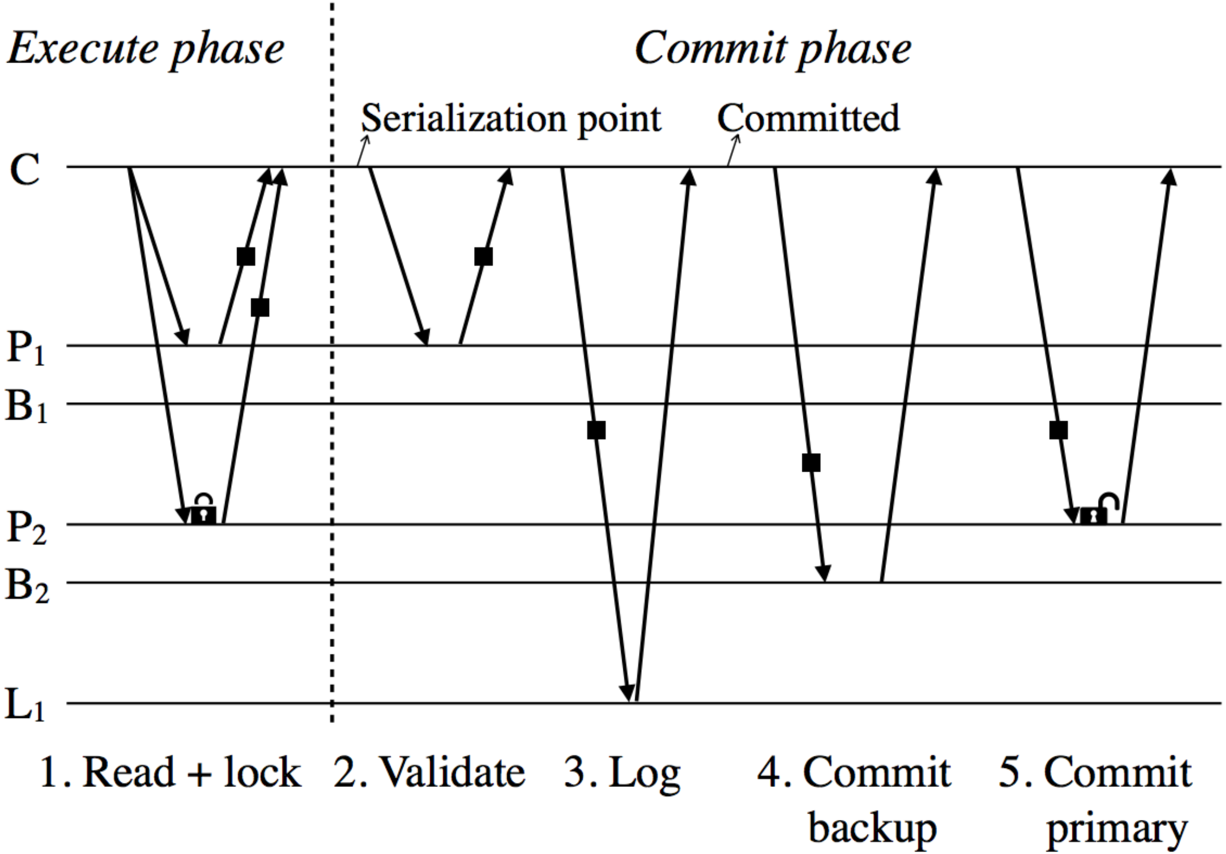
LIMITATIONS

RPC messages smaller than MTU (4KB)

Each co-routine issues one message per destination per batch

Why ? Keep RECV queues small

FASST TRANSACTIONS



FASST API

Applications create read sets and write set

- `AddToReadSet(K,*V)` and `AddToWriteSet(K, *V, mode)`
- Lazily evaluated (not run until `Execute` is called)
- Allows batching
- Applications can call Execute multiple times!

Transaction status

- Commit() / Abort() based on transaction result

SUMMARY

One-sided RDMA read vs two-sided RDMA RPC

RPCs: useful building block

Need to handle link reliability

More debate:

"Deconstructing RDMA-enabled Distributed Transactions: Hybrid is Better!"