Archie: A Speculative Replicated Transactional System

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What do we want for our transactional application?

High availability

Strong consistency

High performance

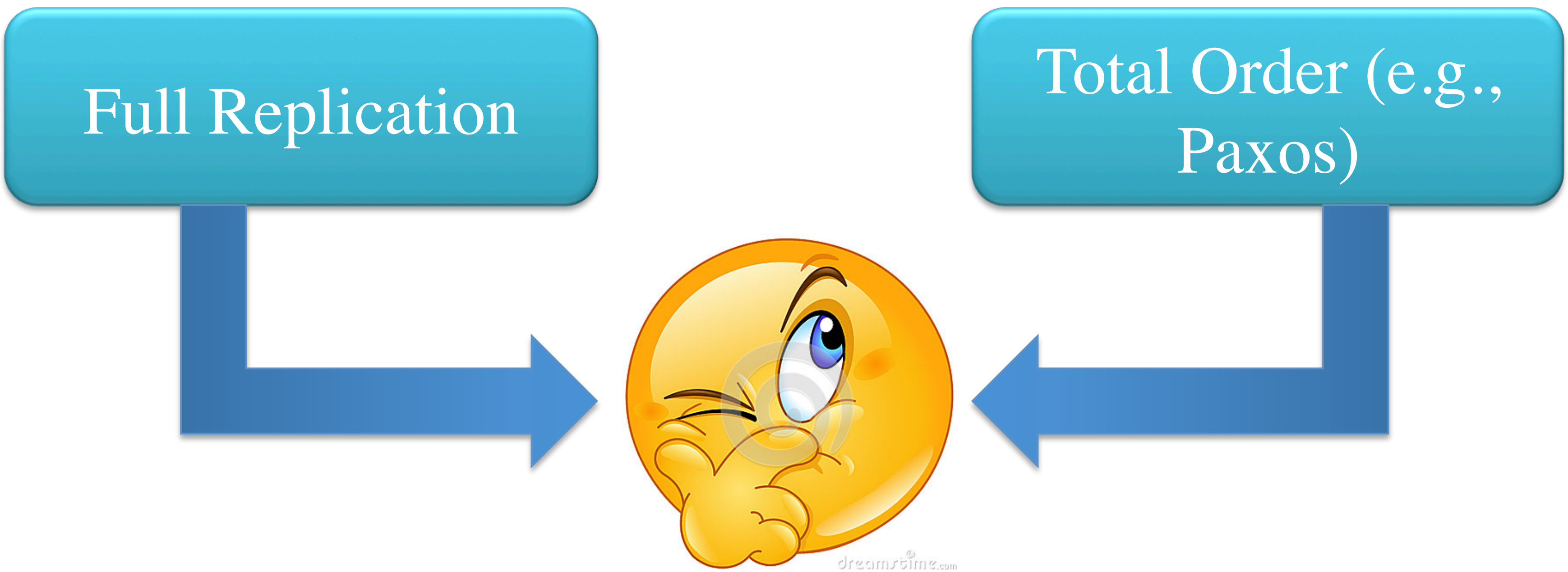
Programmability

Great scalability in small/med size

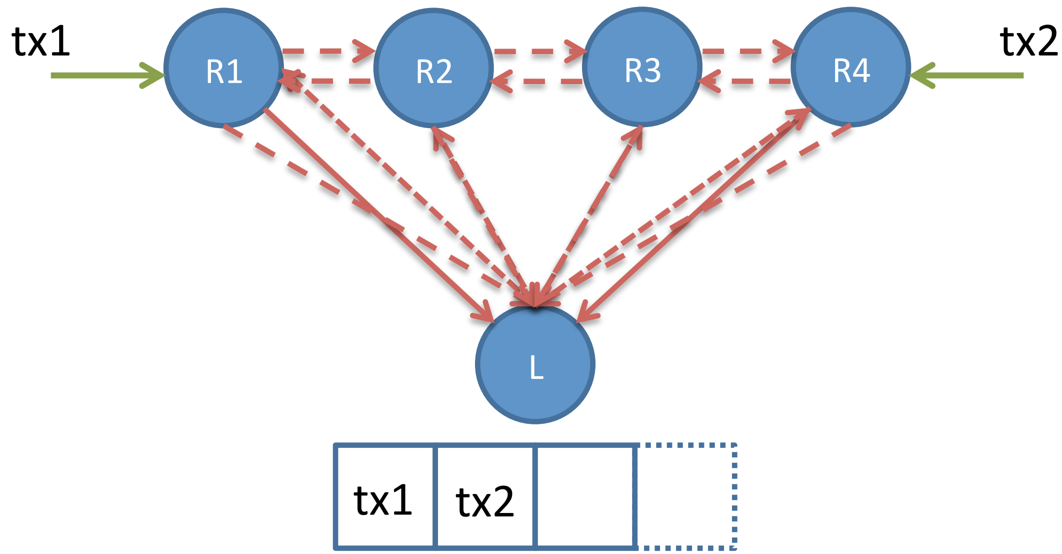
Fault tolerance

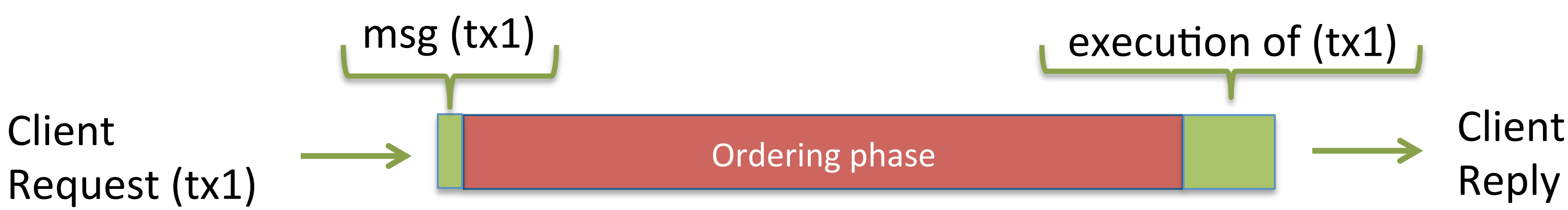
Low latency

Commonly used building blocks

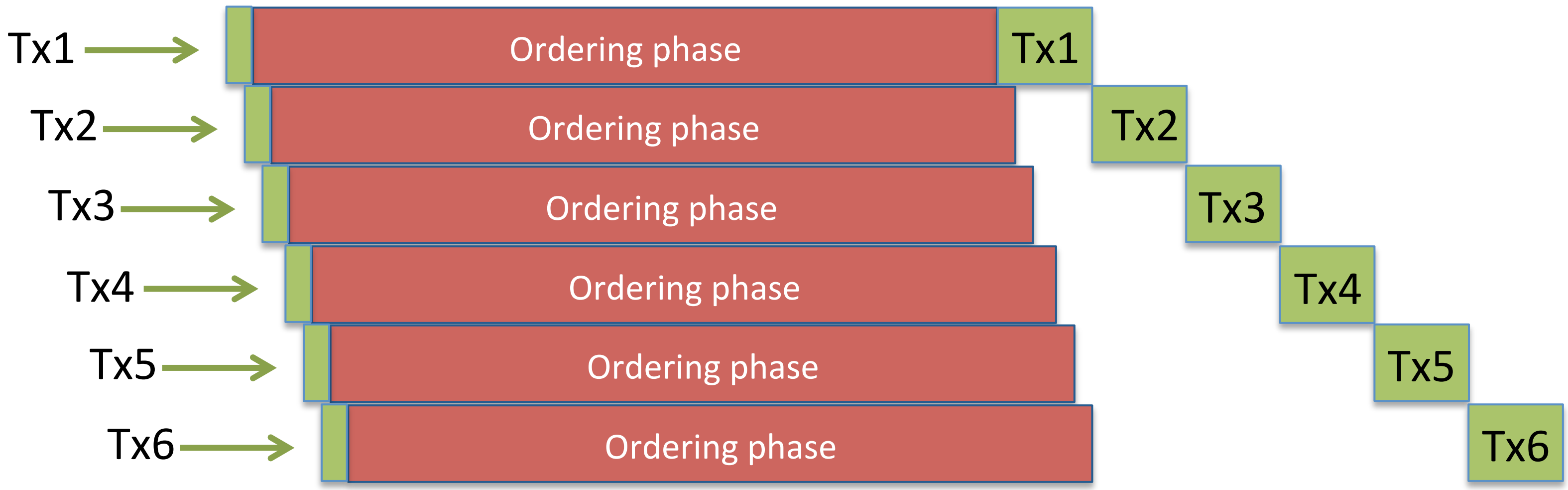


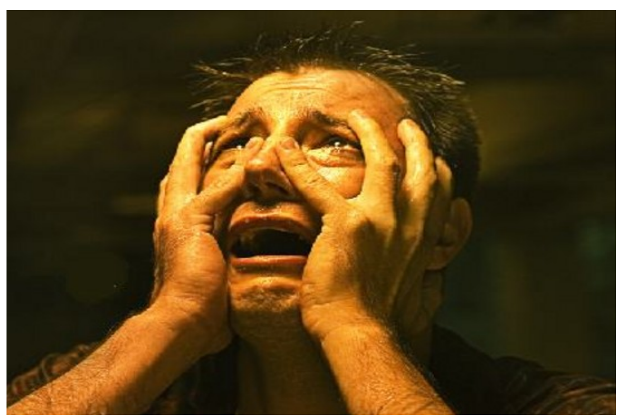
How does it work when combined?





…and when the load increases?



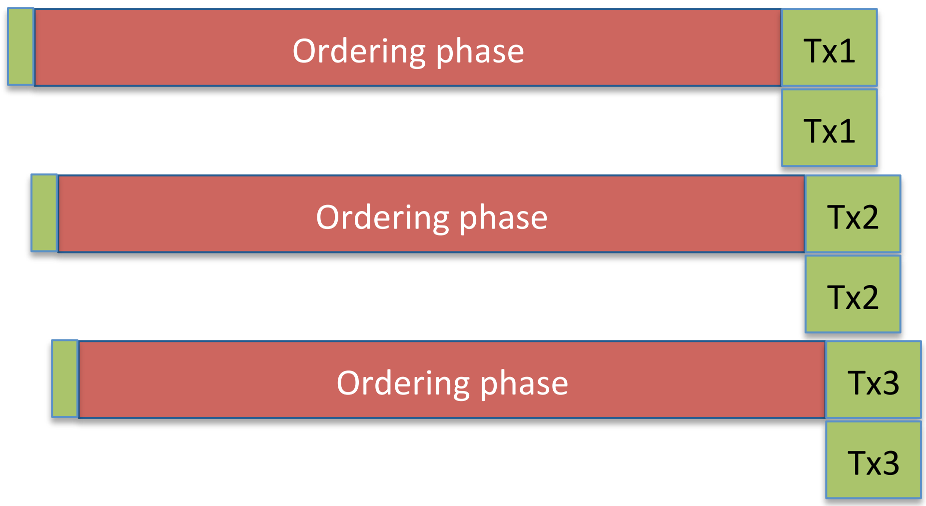


Goal:
Boost performance in the common case

Challenge:

Transaction response time = total order latency

Anticipate the work

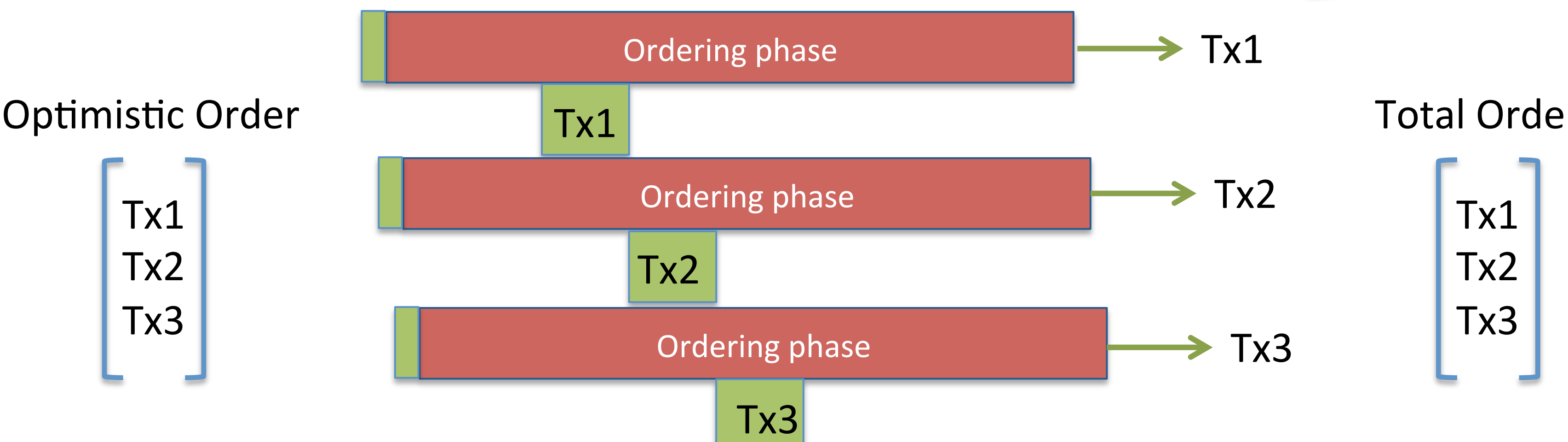


- Exploitation of an early notification triggered during the ordering phase (called *optimistic-delivery*)

Reliable Optimistic Delivery

- Avoid any mismatch between the optimistic delivery order and total order
- Maximize the time between the optimistic delivery and the establishment of the total order

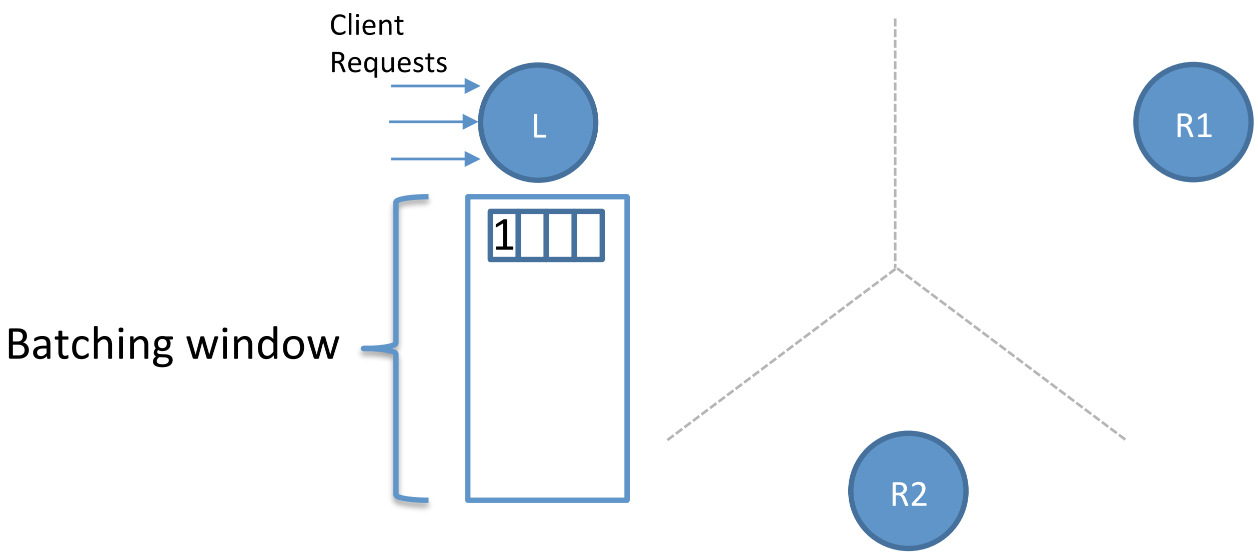
Stable leader



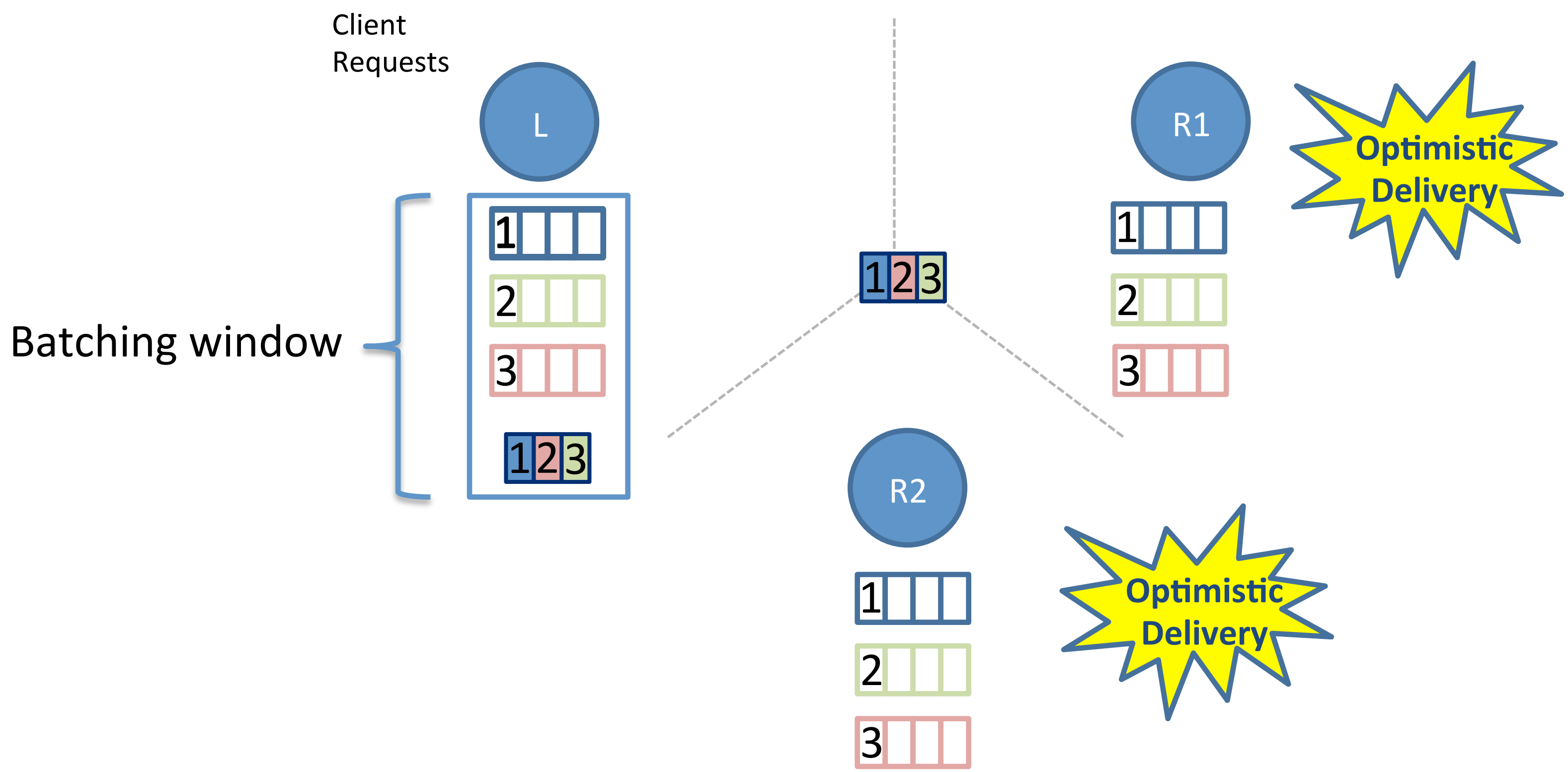
MIMOX

- Multi Paxos + Reliable Optimistic Delivery
  - Exploit the leader's batching time for maximizing the overlapping time
  - Exploit the leader's knowledge for making the optimistic delivery reliable
    - Tag messages with leader's expected order

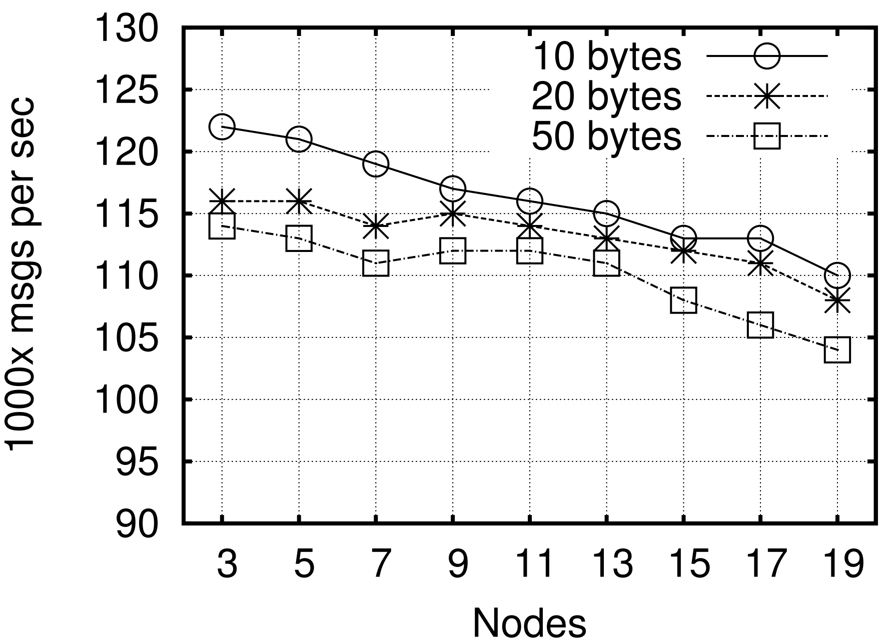
MIMOX: Batch creation

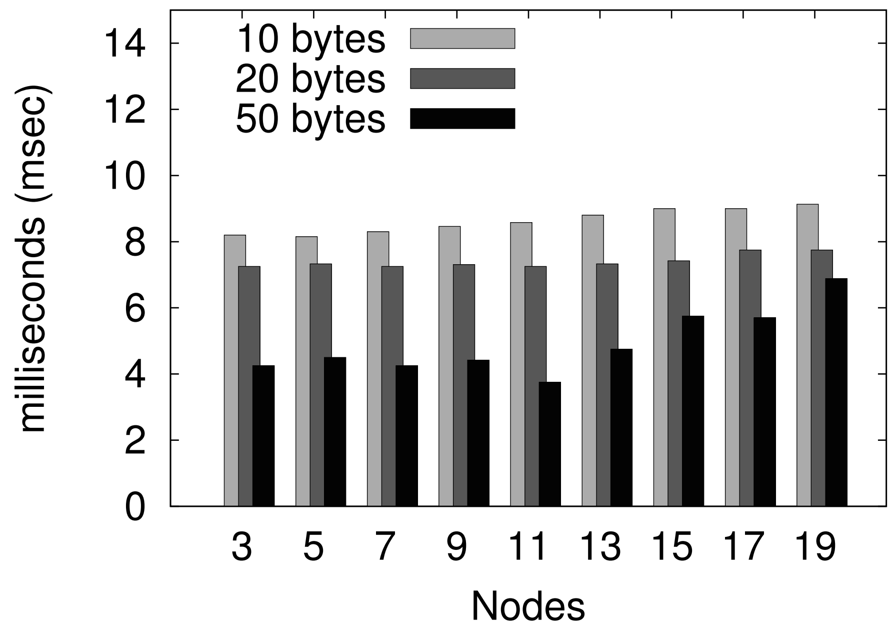


MIMOX: Batch broadcast

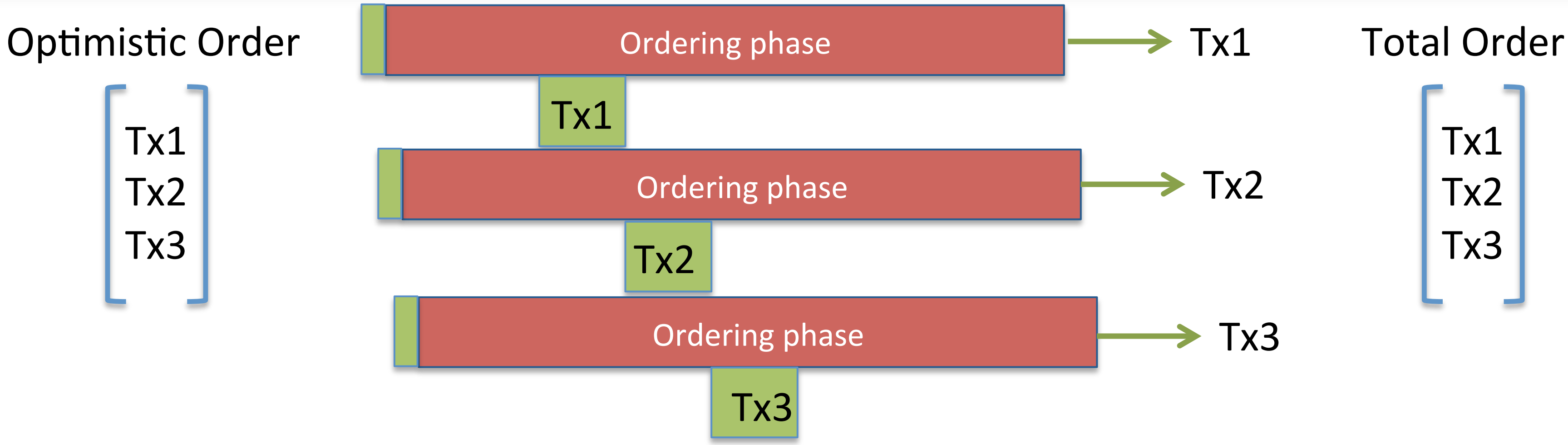


MIMOX: Performance





Transaction Processing



- Exploit parallelism
- Commit in order
- Minimal overhead for conflict detection and resolution

Key points of ParSpec

- Reduce problem's complexity by activating MaxSpec transactions at-a-time
  - meta-data's size is fixed
  - set of possible conflicting transactions is limited
- Parallel execution but in-order speculative commit (*x-commit*)

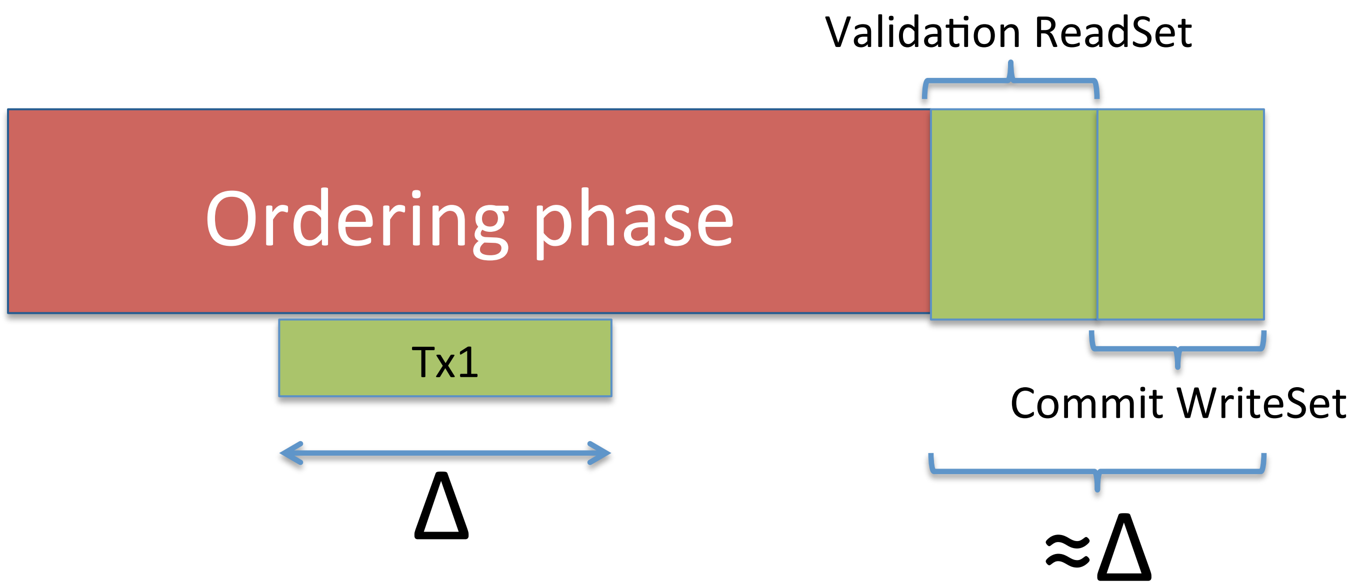
ParSpec: details

Optimistic Order: | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | MaxSpec = 4

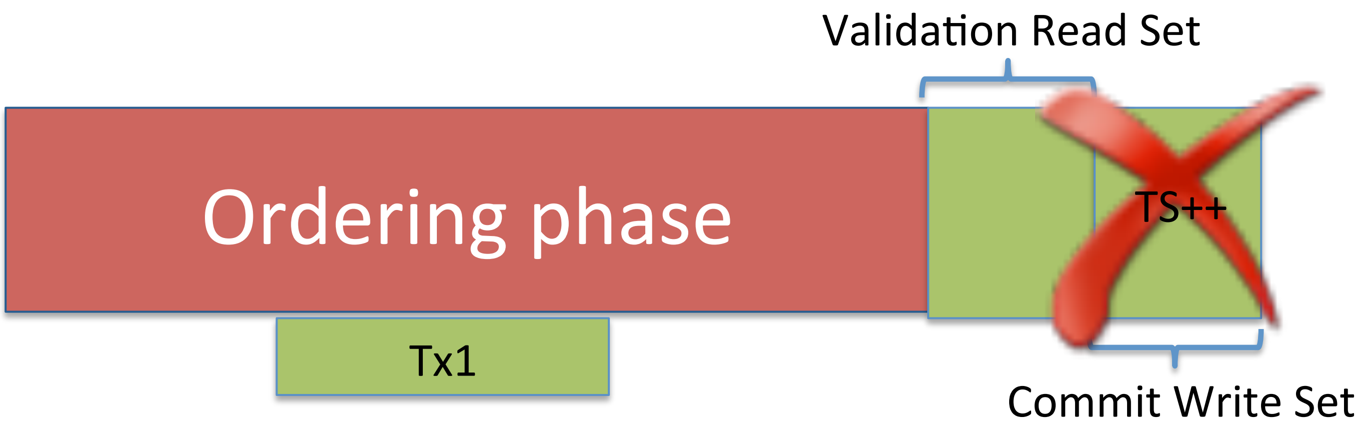
T2 (X): Begin	T3 (X): Begin	X: Read bit-array	Abort bit-array
		0 0 0 0	0 0 0 0
		0 0 0 0	0 0 0 0
	Read(X)	0 0 1 0	0 0 0 0
	Wait	0 0 1 0	0 0 0 0
Read(X)		0 1 1 0	0 0 0 0
Write(X)		0 1 1 0	0 0 0 0
X-commit			0 0 1 0
	Abort; Re-execute	OR bitwise	

Is this enough for achieving the goal?

- Unfortunately not…

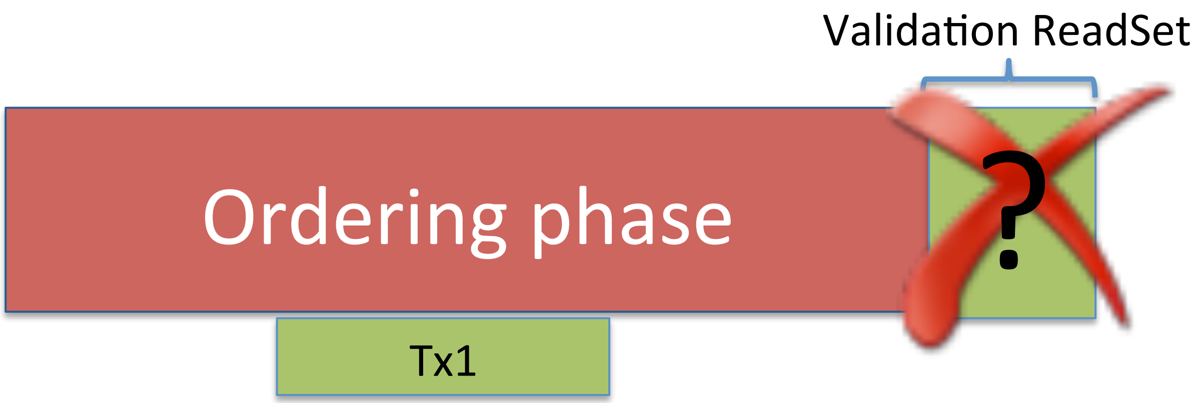


Solution for Write Set



- Speculative versions are associated with an tentative commit timestamp, which is the expected commit timestamp in case of no mismatch between optimistic and total order

Solution for Read Set



- If the leader is not either crashed or suspected (it is stable), then there is no chance of mismatch between optimistic and total order
- ParSpec commits according to optimistic order and make them visible during the total order

We made it!

Ordering phase

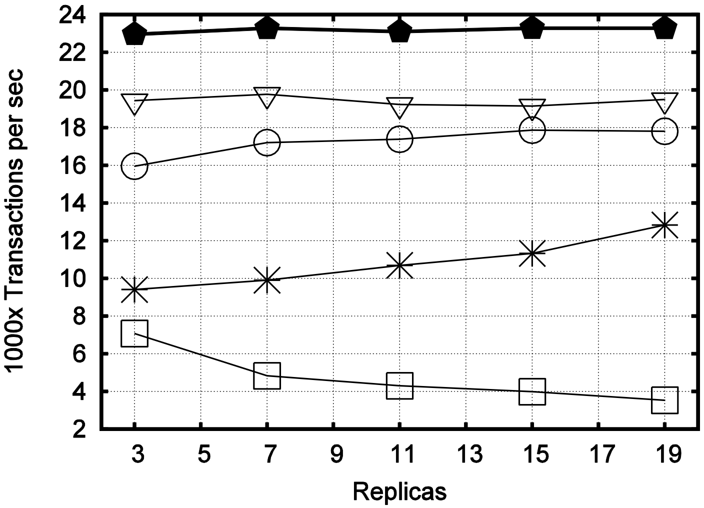
TS++

Tx1

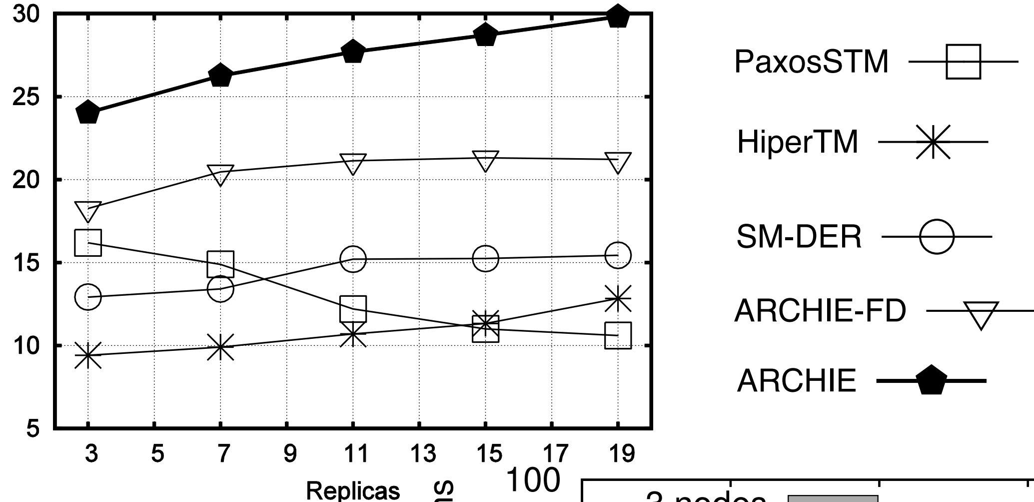
Evaluation

- Testbed – PRObE cluster (19 nodes)
  - AMD Opteron 6272, 64-core, 2.1 GHz CPU
  - 128 GB RAM and 40 Gbps Ethernet
- Benchmarks
  - Bank, TPC-C and Vacation
- Competitors
  - PaxosSTM: DUR-based approach; it suffers from remote aborts
  - SM-DER: Post final delivery single-thread execution
  - HiperTM: SM-DER based single thread execution
  - Archie-FD: Archie but post final delivery parallel processing

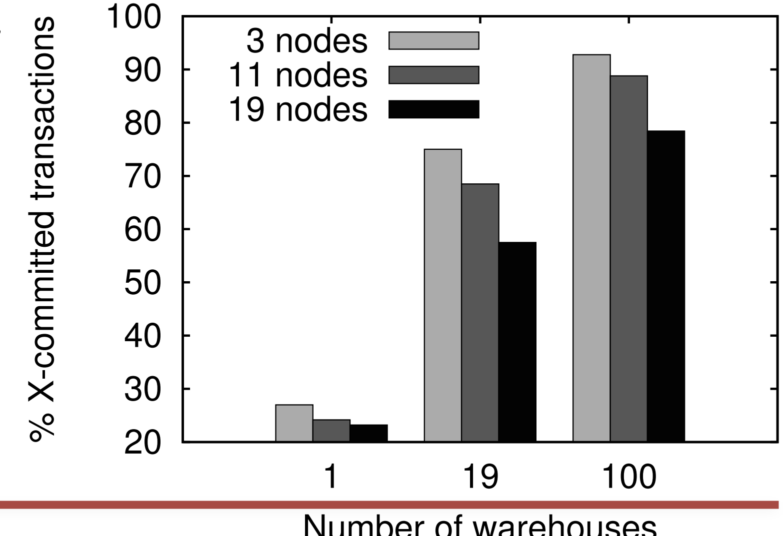
Evaluation: TPC-C



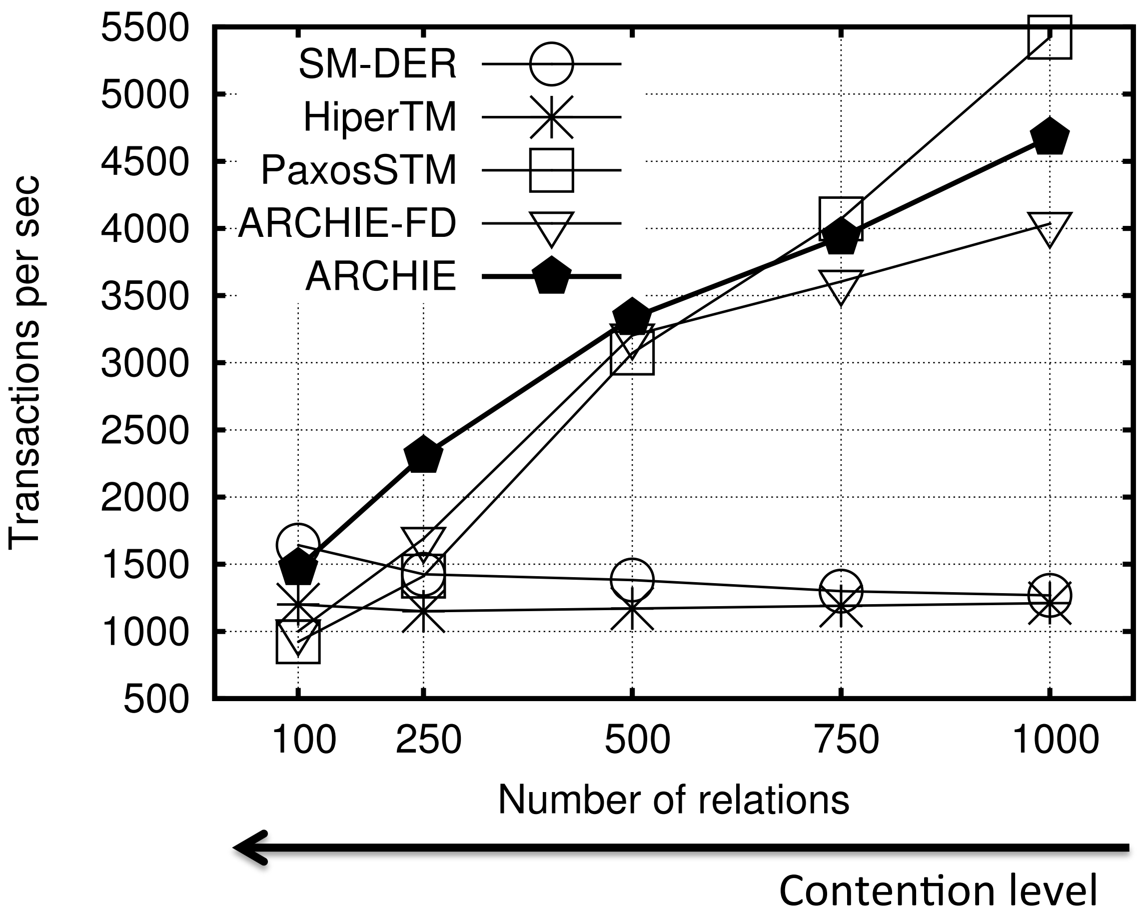
Throughput
19 warehouses



Throughput
100 warehouses



Evaluation: Distributed Vacation



Thanks!

Questions?

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Research project's web-site: www.hyflow.org