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Zeus

Locality-aware distributed transactions

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A. Dragojevic, B. Grot[*], B. Radunovic, Y. Zhang

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zeus-protocol.com

Thanks to: EPSRC Microsoft Research

Modern distributed datastores

Keep data

in-memory, **replicated**, **sharded**

across nodes of a datacenter

distributed datastore

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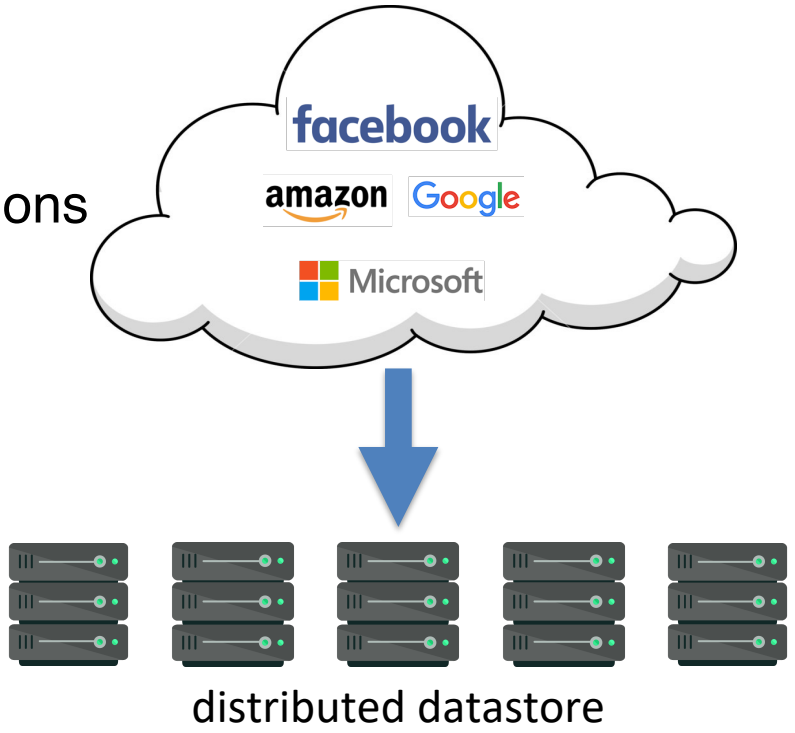
Backbone of transactional cloud applications



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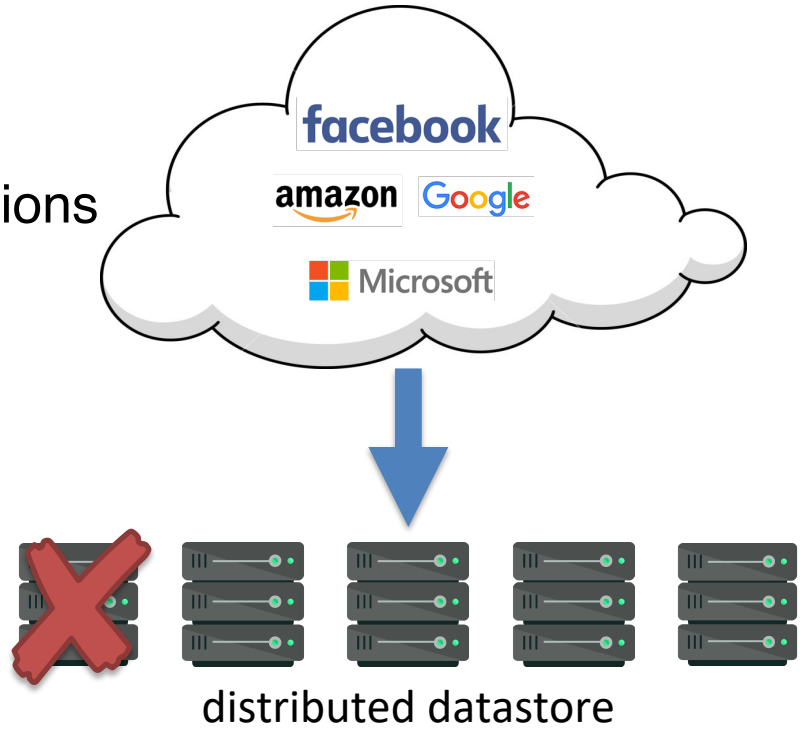

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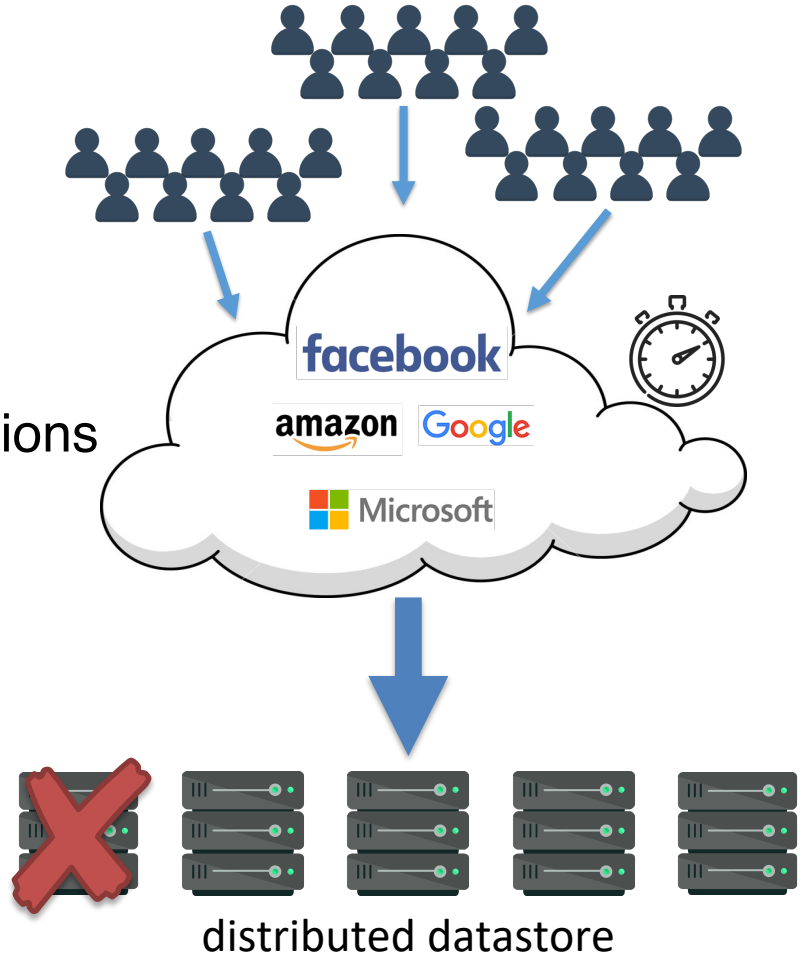

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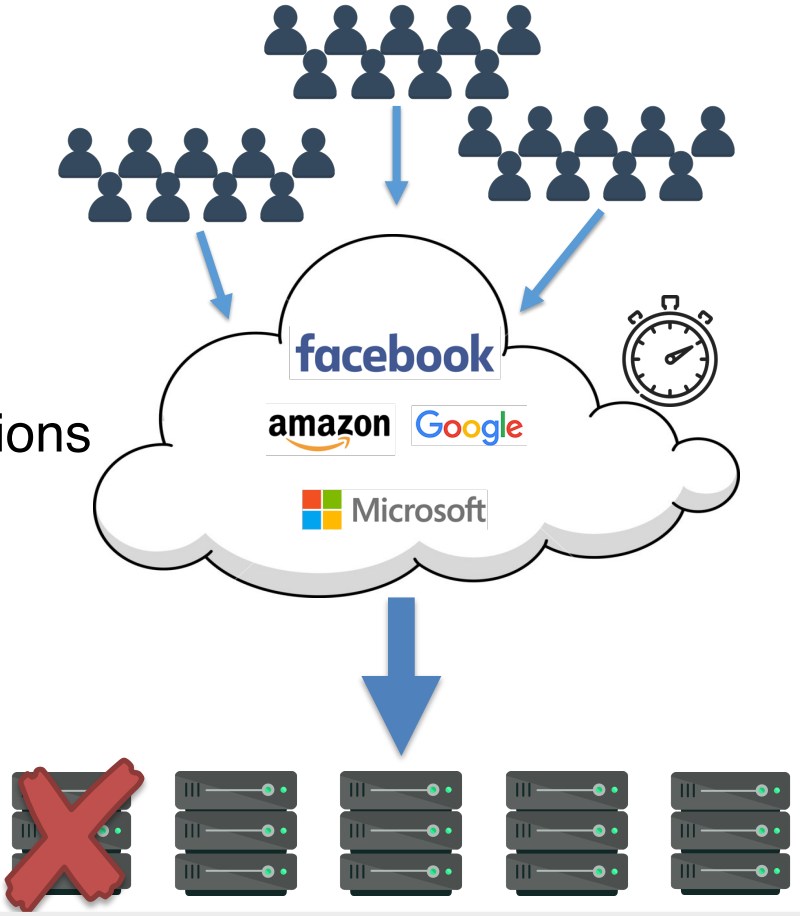

Traditional distributed txs well-known as expensive

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Observation

Many tx applications exhibit **dynamic locality**

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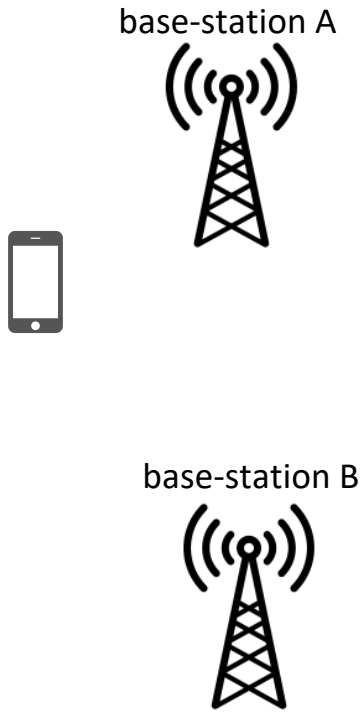
manages phone connectivity and handovers among base stations



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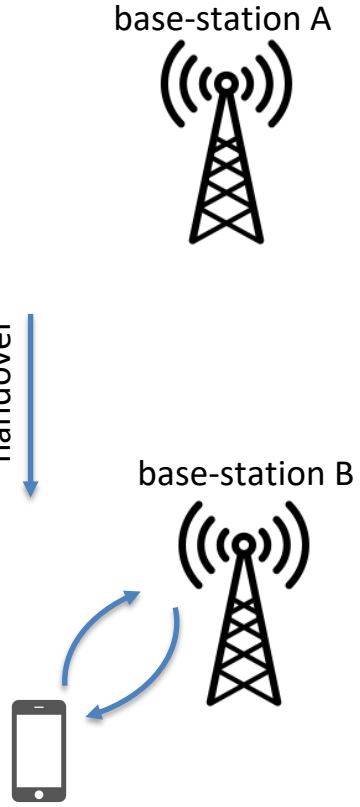
But locality is dynamic

changes at run-time
e.g., user commutes → base-station changes



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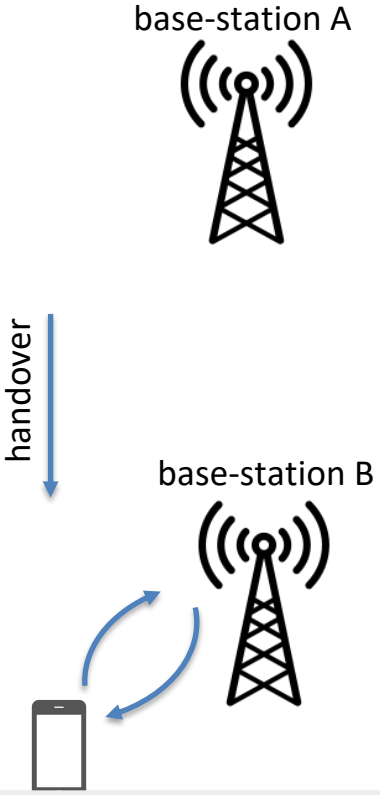

Can state-of-the-art datastores exploit dynamic locality?

State-of-the-art reliable datastores

Static sharding (e.g., consistent hashing)

Objects placed randomly on fixed nodes

- easy to locate and access objects
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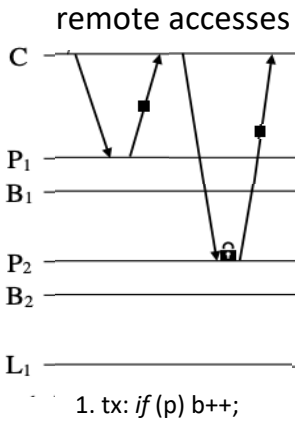

1. tx: *if* (p) b++;

Adapted from *FaSST* [OSDI'16]

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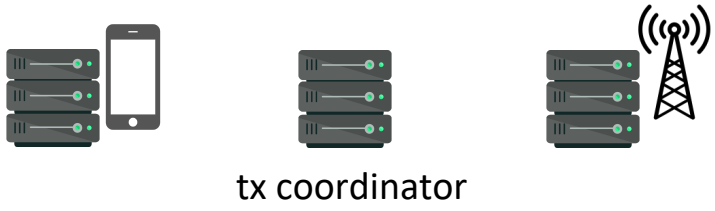

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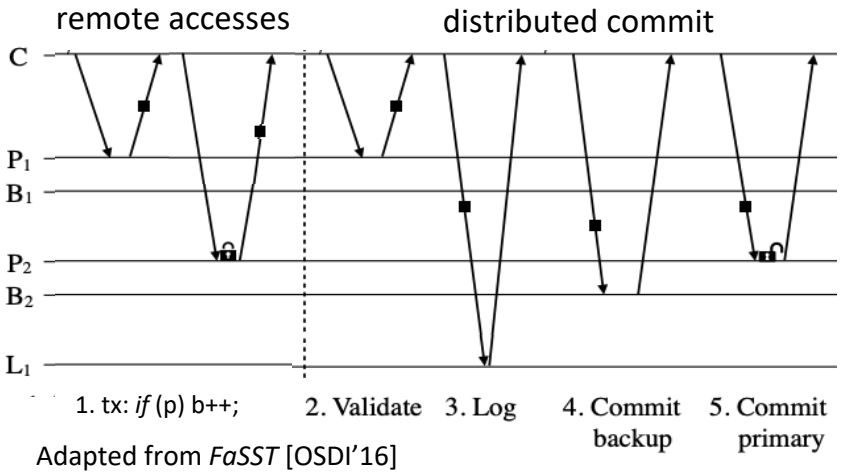

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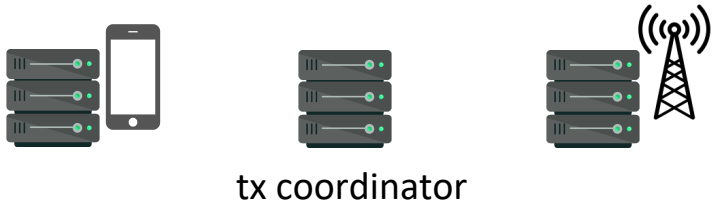

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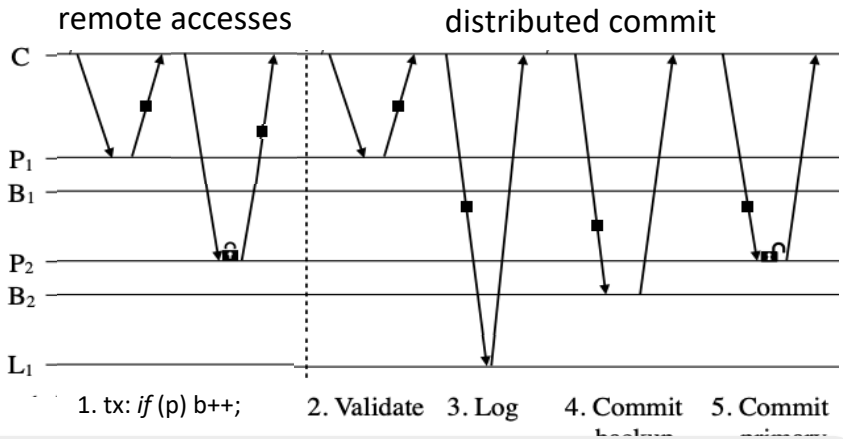

Cannot exploit locality → expensive reliable txs

Enter Zeus

Distributed datastore: exploits locality for fast reliable txs

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What are the exact steps?

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2.

3.

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How to get ownership reliably?

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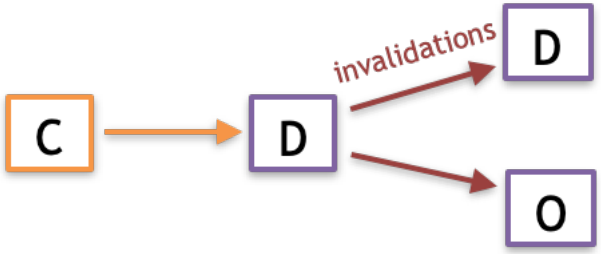

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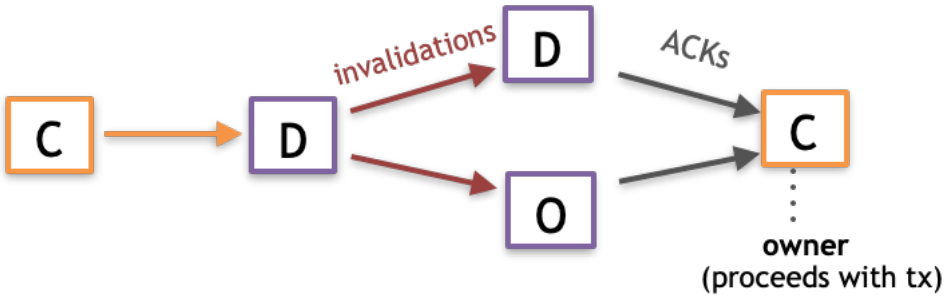

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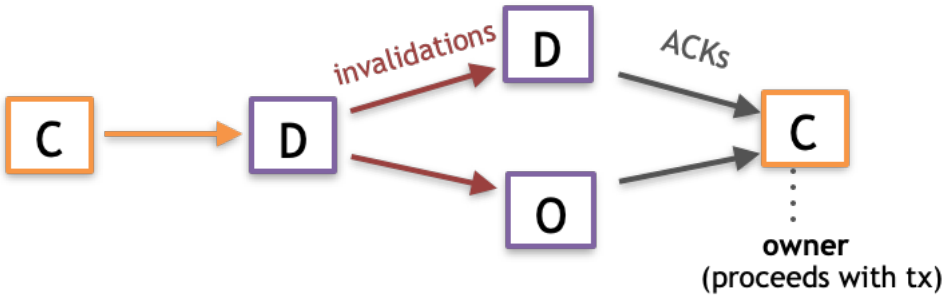

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Ownership is acquired & coordinator proceeds with tx ✓

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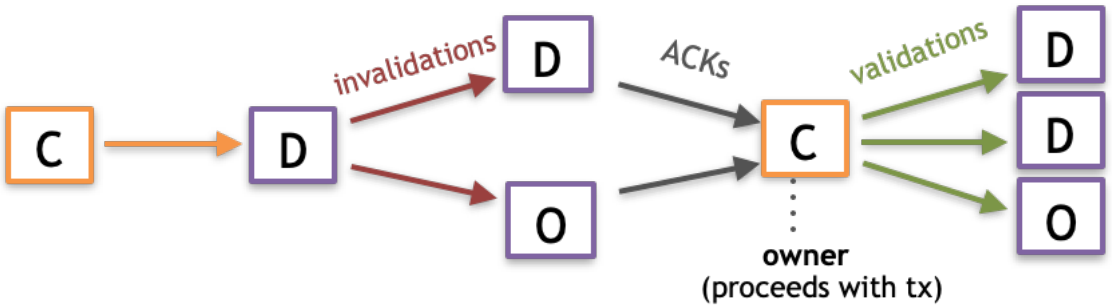

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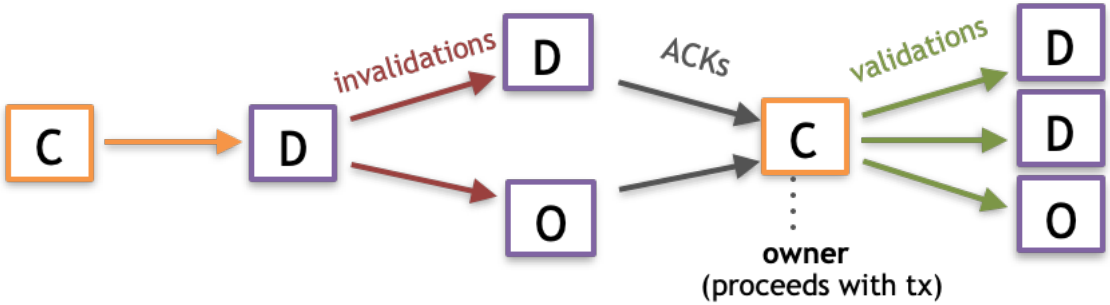

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as in Hermes [ASPLOS'20]

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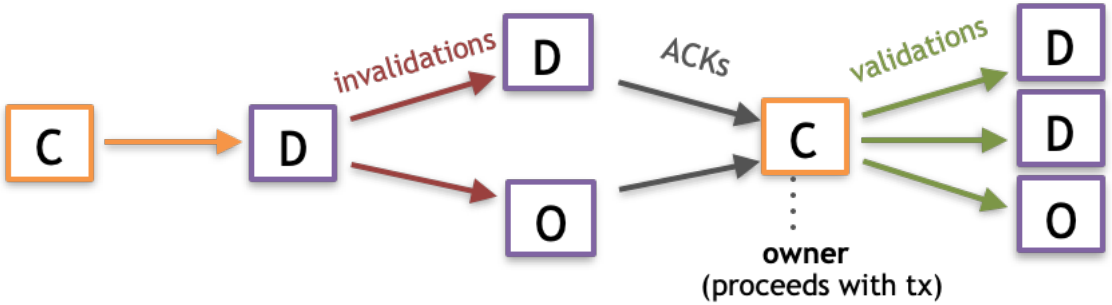

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✓ Correctness verified under conflicts and faults

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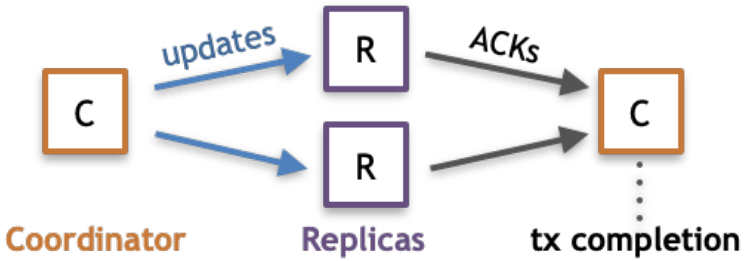
Great! But how efficient is reliable commit?

Reliable commit



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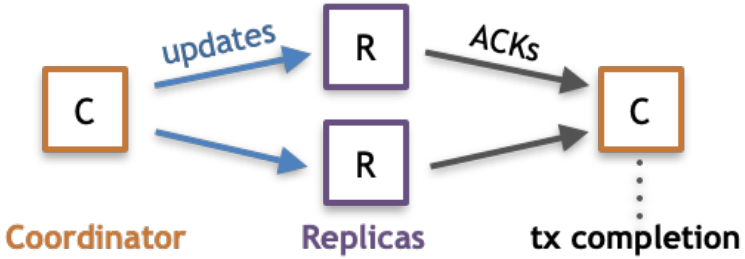

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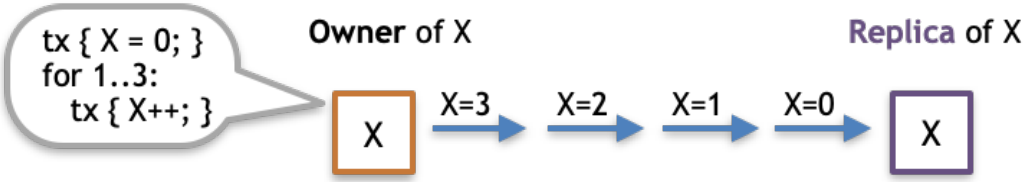

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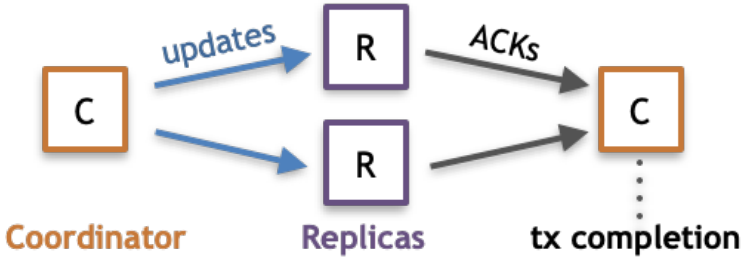

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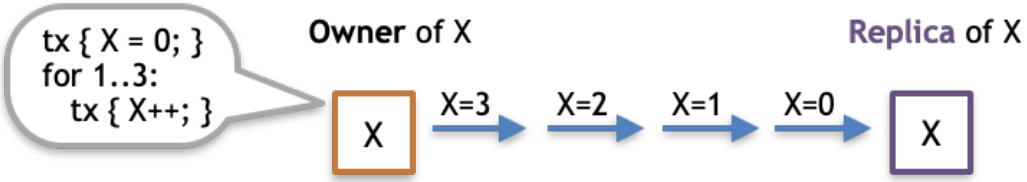

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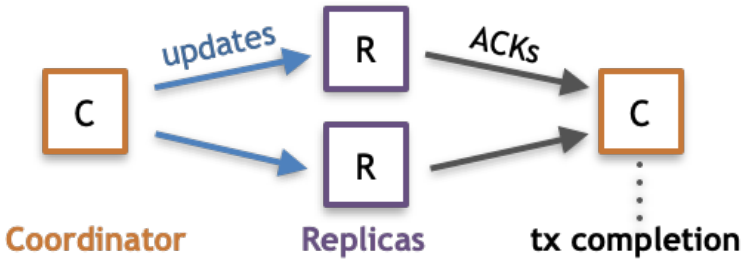

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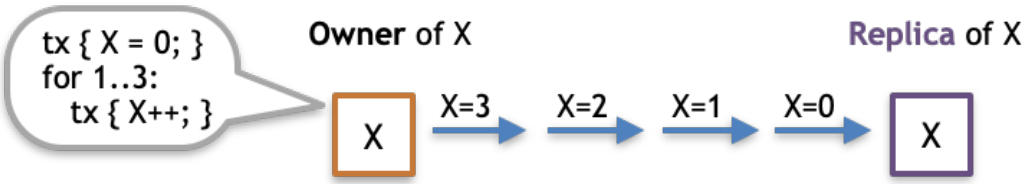

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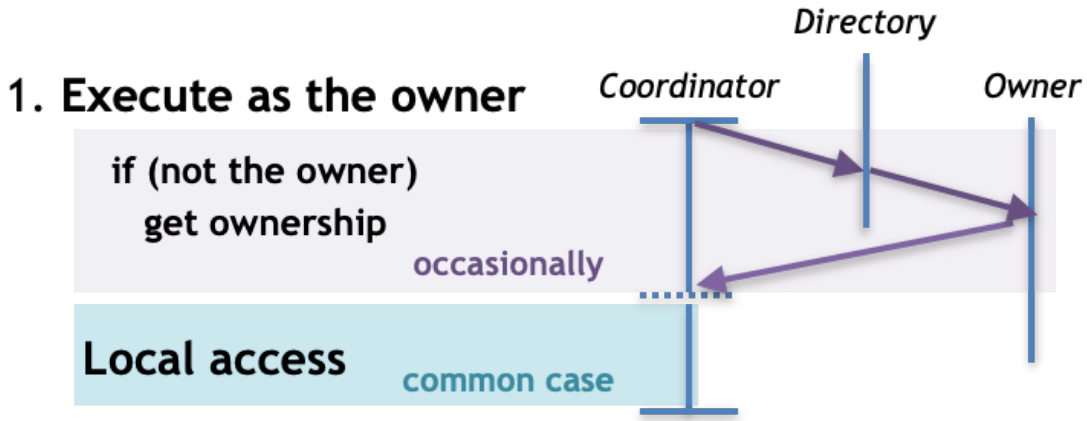

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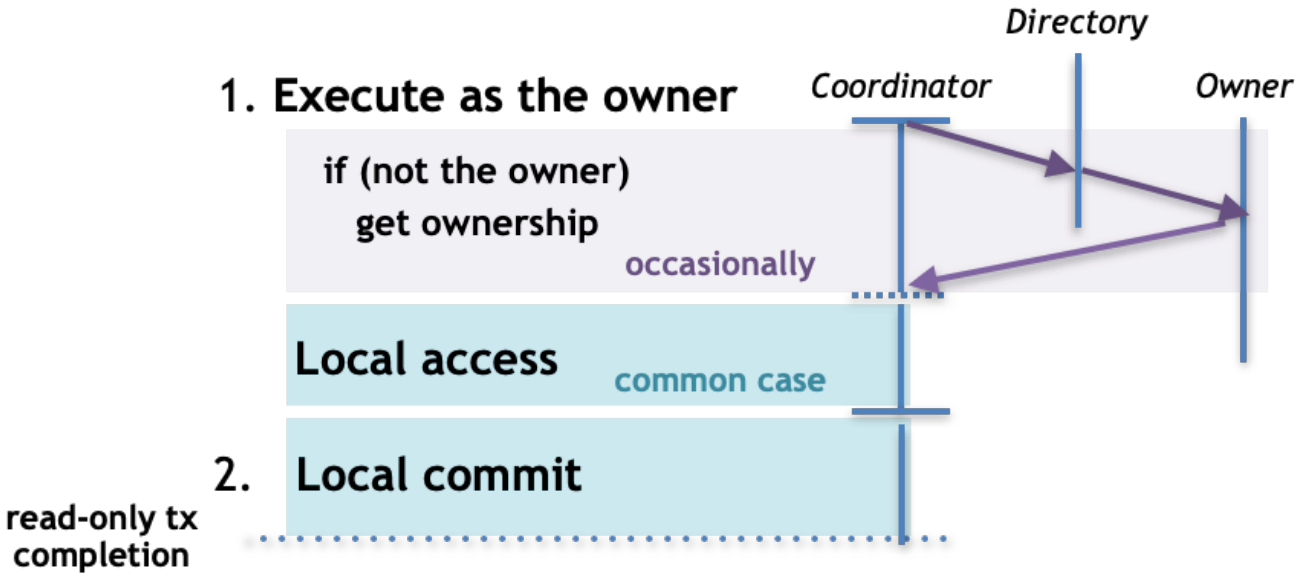

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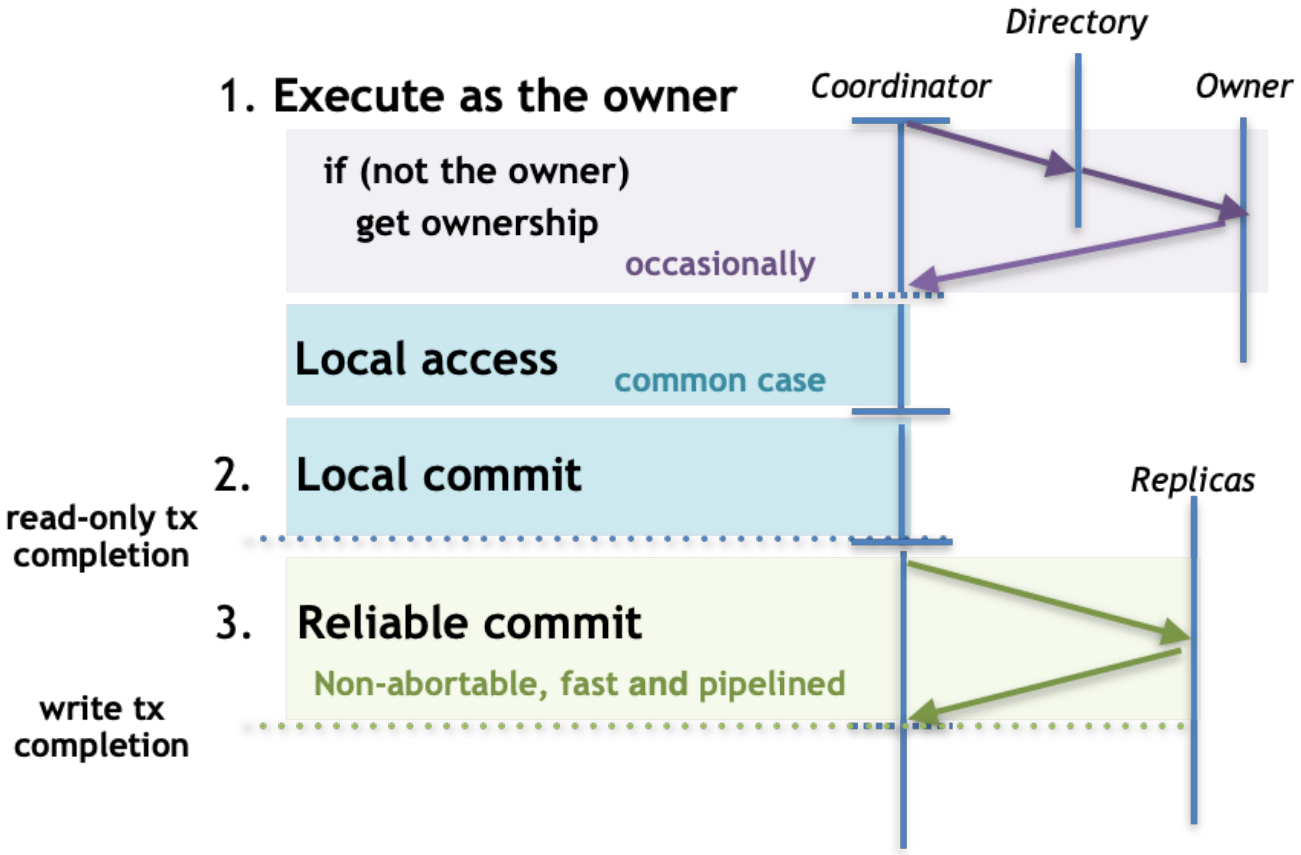

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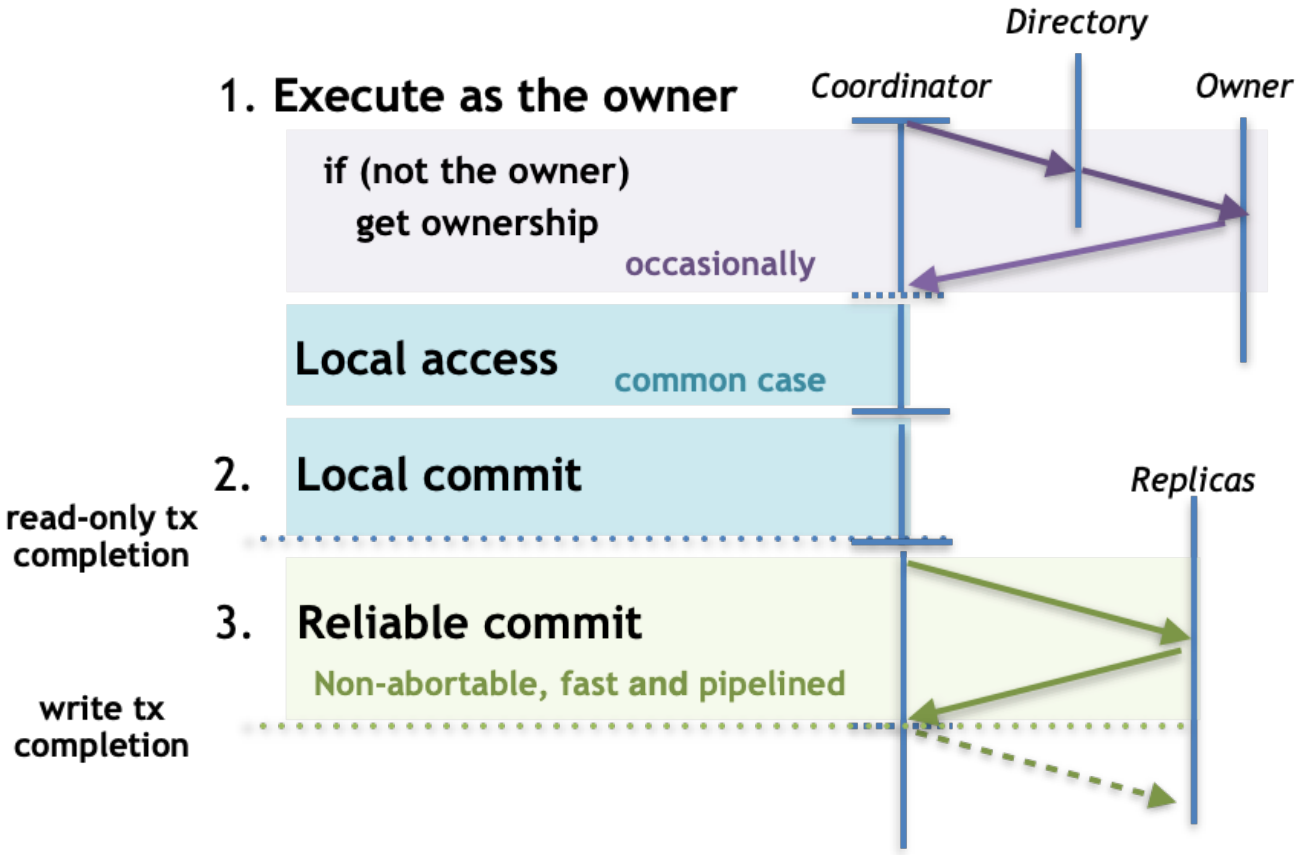

Local read-only txs at all replicas


Zeus: Locality-aware Distributed Transactions

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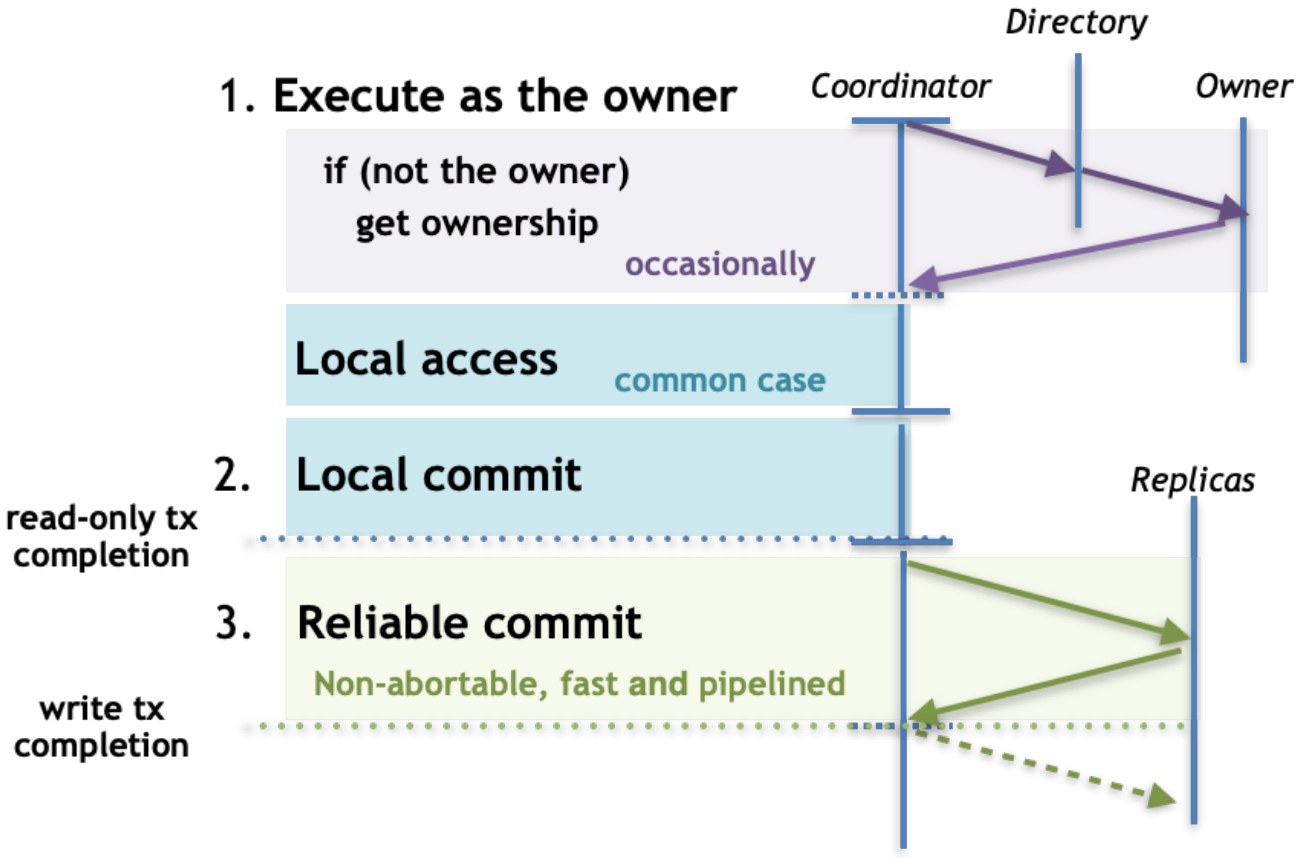

Local read-only txs at all replicas


Zeus: Locality-aware Distributed Transactions

Awesome! Does it translate into performance?

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6 nodes, 3-way replication,
Zeus 40Gb (no RDMA)

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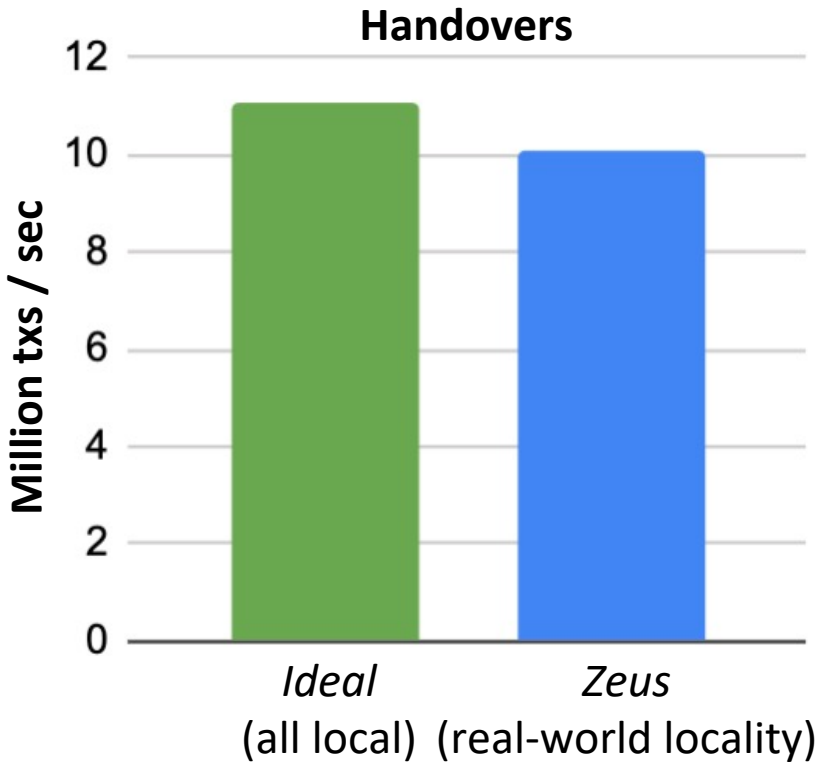

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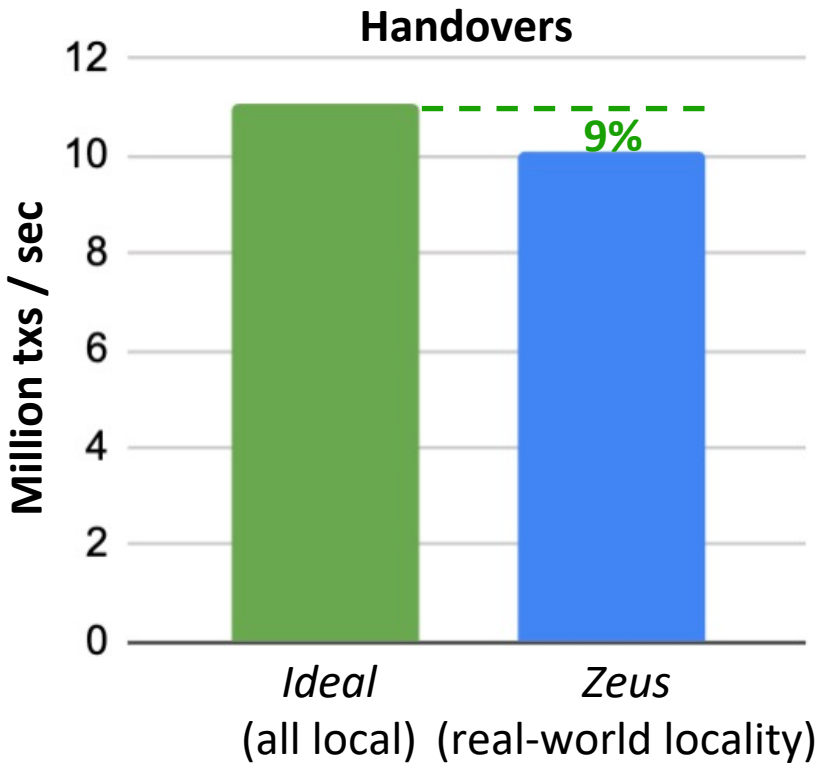

Zeus: **within 9% of ideal**

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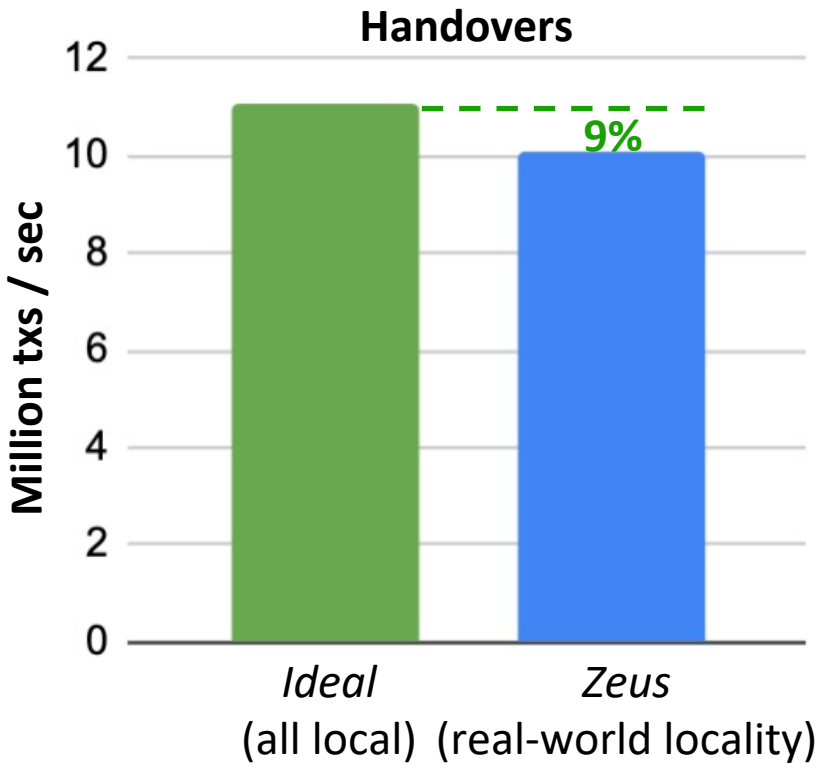

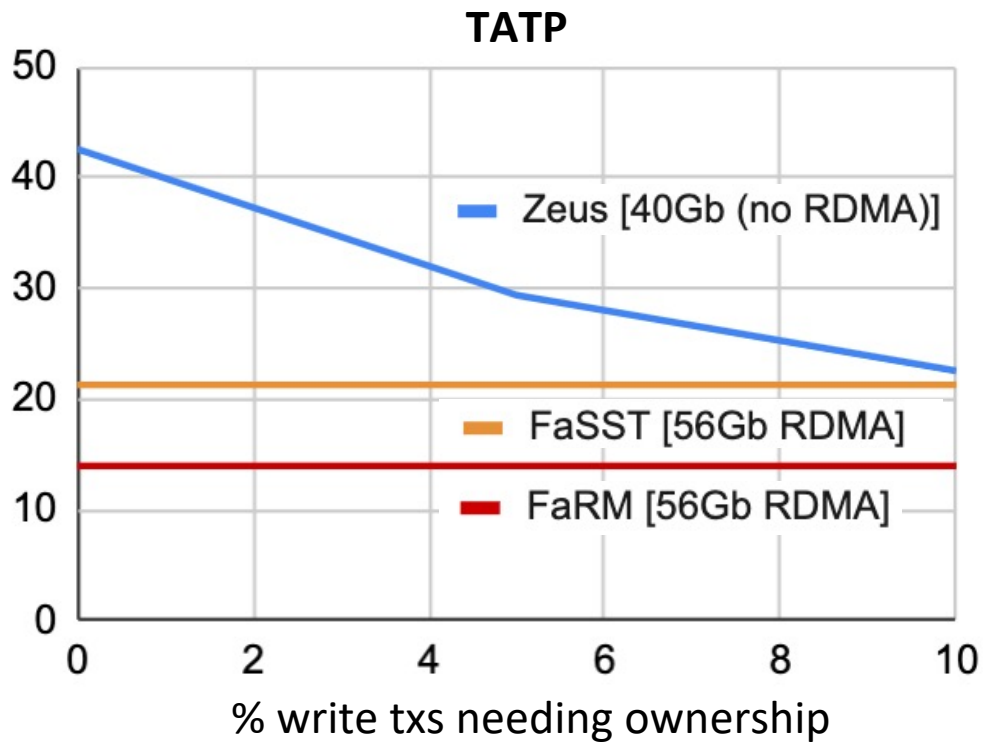

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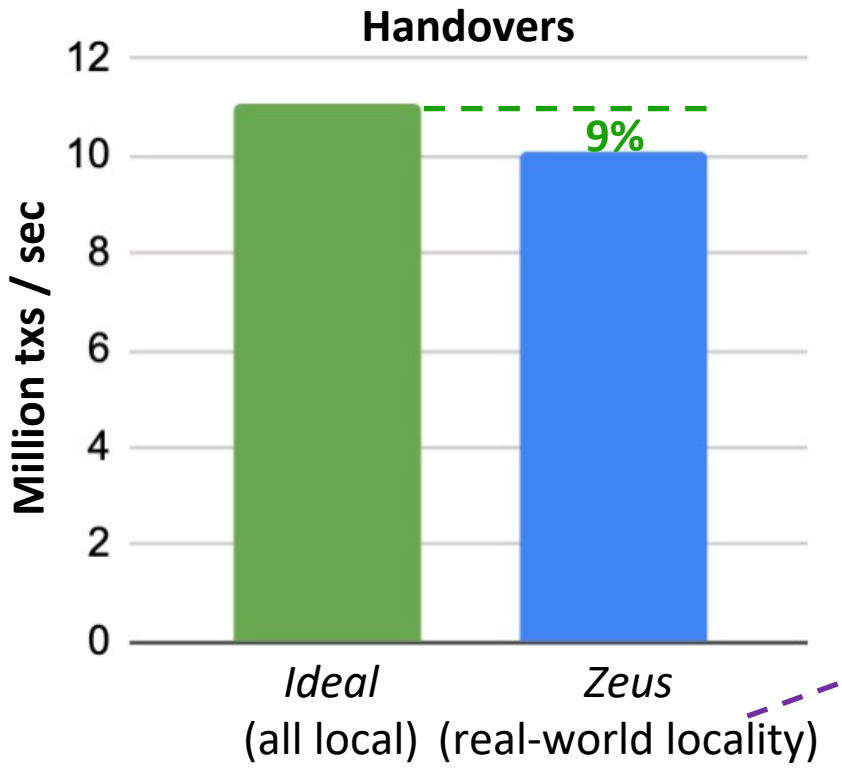

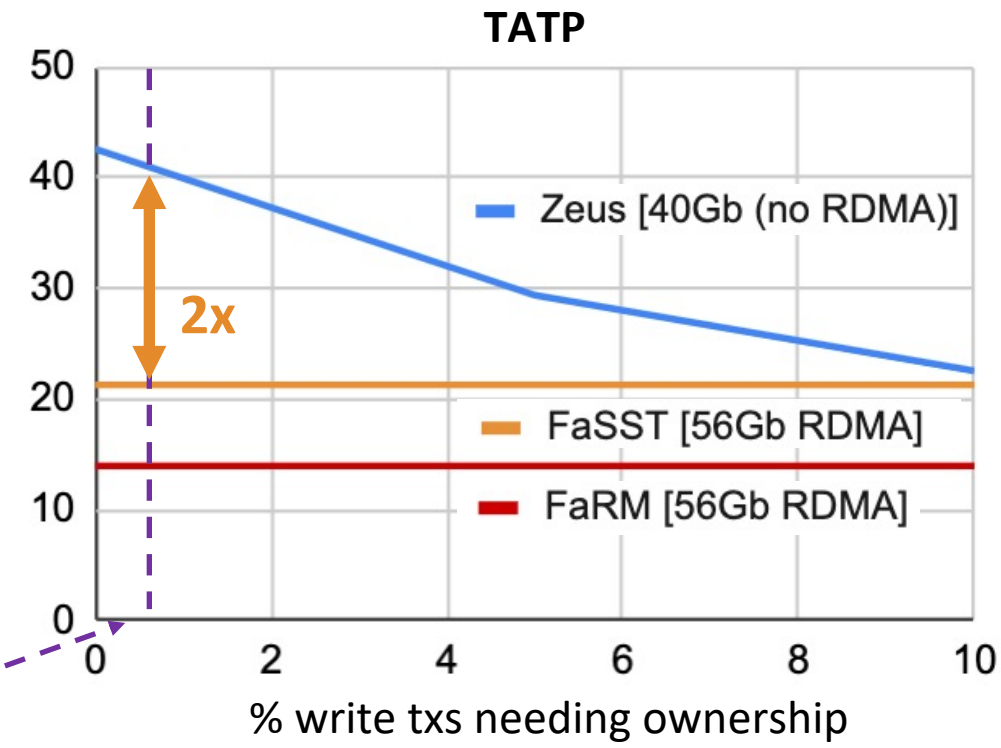

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Up to 40M.tx/s and **2x state-of-the-art**

FaSST [OSDI'16], *FaRM* [SOSP'15]
which use 56Gb RDMA

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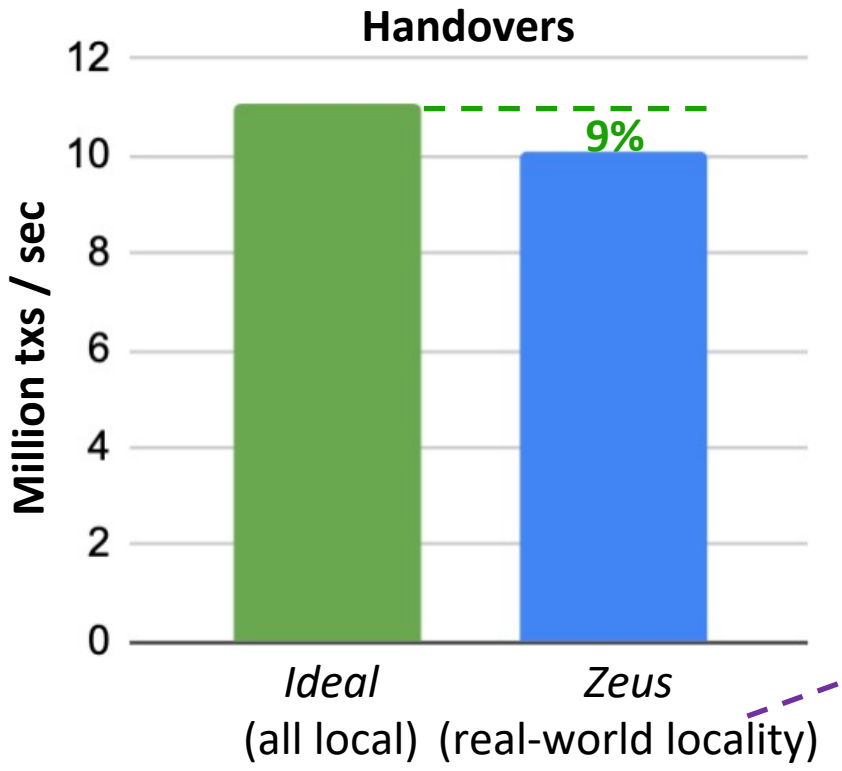
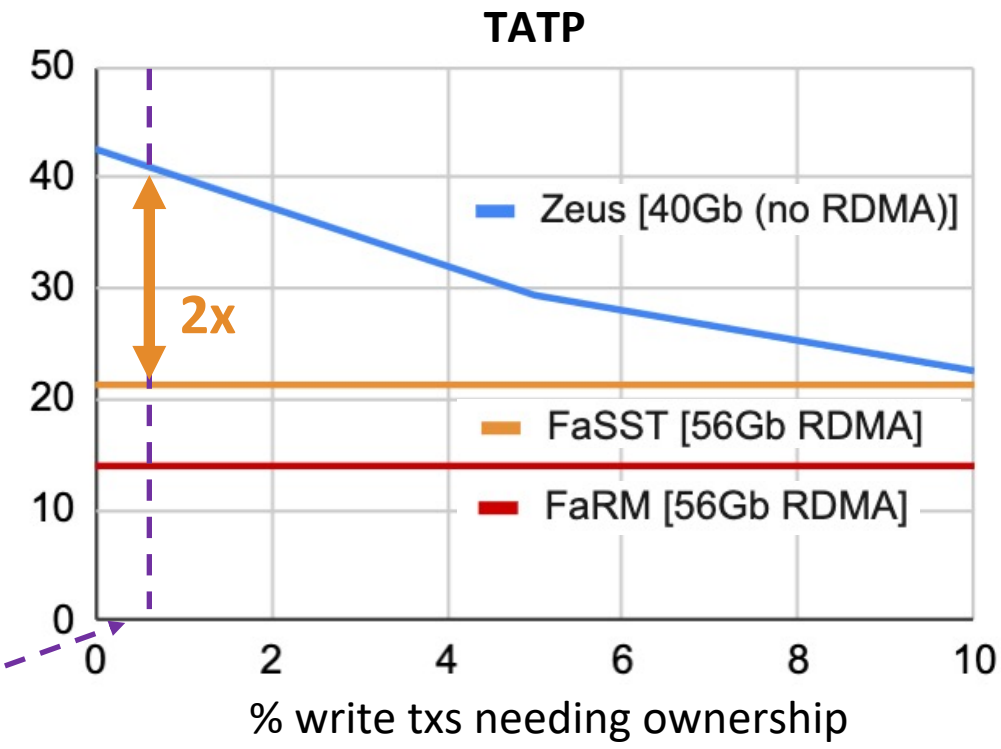
Performance

6 nodes, 3-way replication,
Zeus 40Gb (no RDMA)





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Paper: more benchmarks, ownership, latency ...

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Conclusion

State-of-the-art reliable txs over **static sharding**:

cannot exploit dynamic locality

remote accesses

costly **distributed commit**

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local accesses in the common case

single-node commit

- **local** for read-only txs
- **fast and pipelined** for write txs

zeus-protocol.com

TLA+ specification, Q&A …

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Bonus: programmability!


Zeus: Locality-aware Distributed Transactions

Artifacts Available acm

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Reliable txs with locality? Use Zeus!