Modular Composition of Coordination Services

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YAHOO! RESEARCH

Google

Coordination Services

Apache Zookeeper

etcd

Doozer

CONSUL

Used for configuration & metadata storage, global locks, leader election, service discovery, and more…

Who uses coordination services?

Google

hadoop

facebook

pied piper

in

airbnb

Goldman Sachs

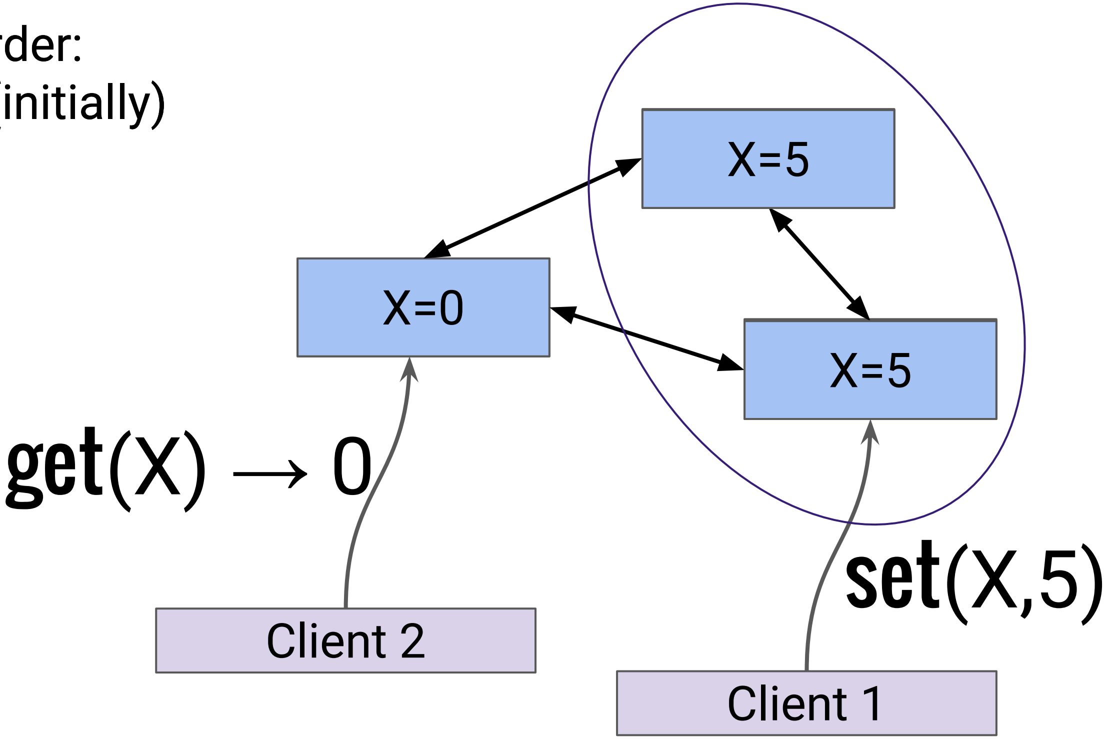
IBM

YAHOO!

Coordination Services Structure

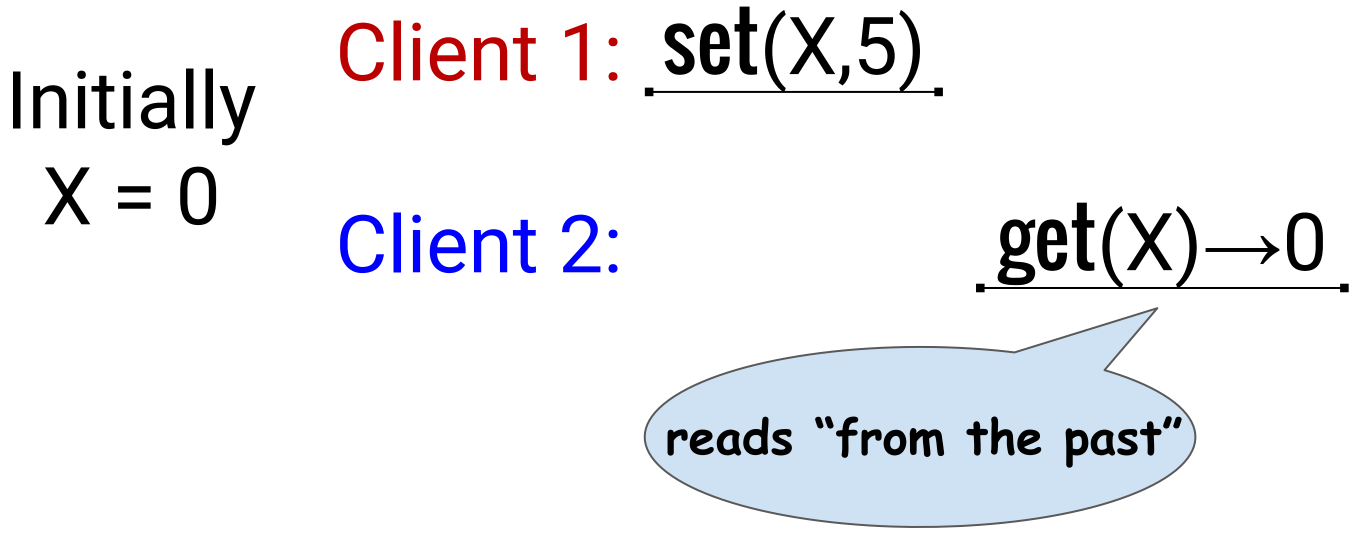
Updates order:

1. X = 0 (initially)
2. X = 5

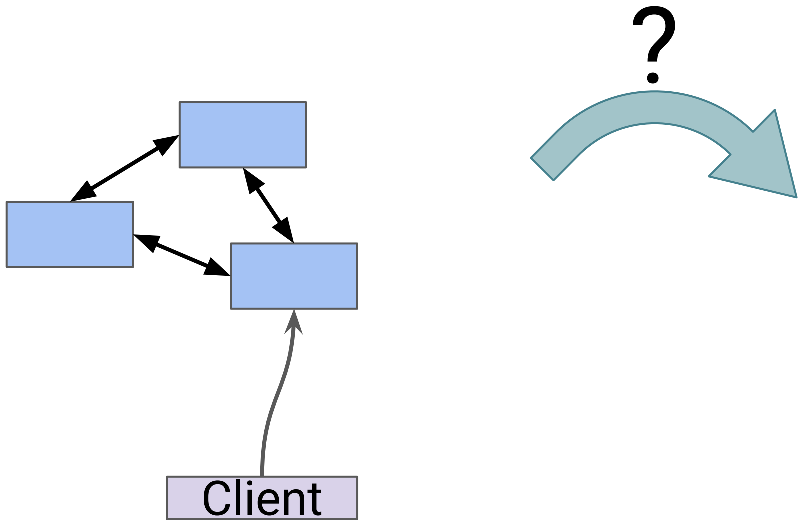


Coordination Services Semantics

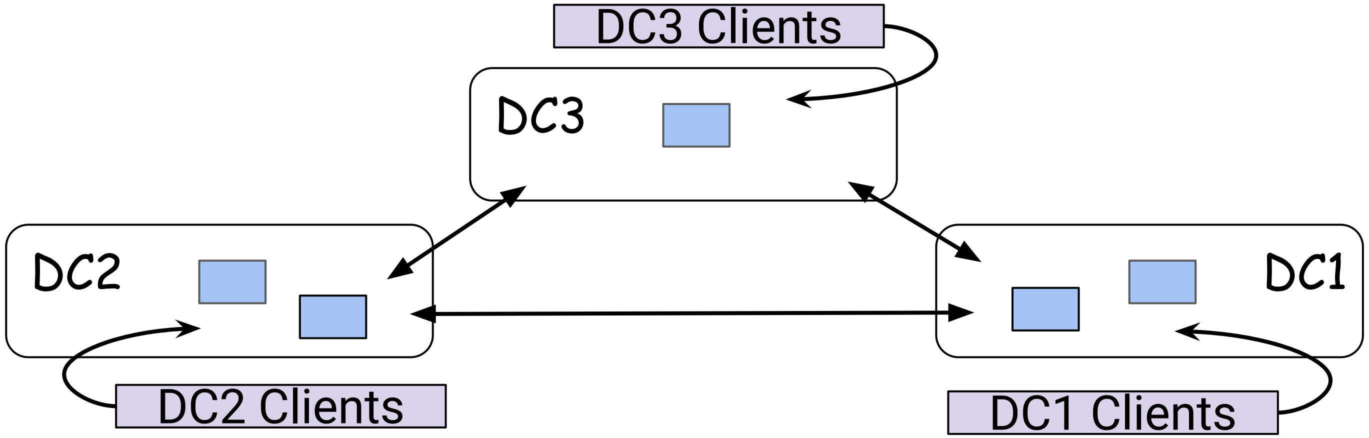
1. Clients see the same order of updates (linearizable updates)
2. Reads might be served from the past



Challenge: Coordination Service over WAN

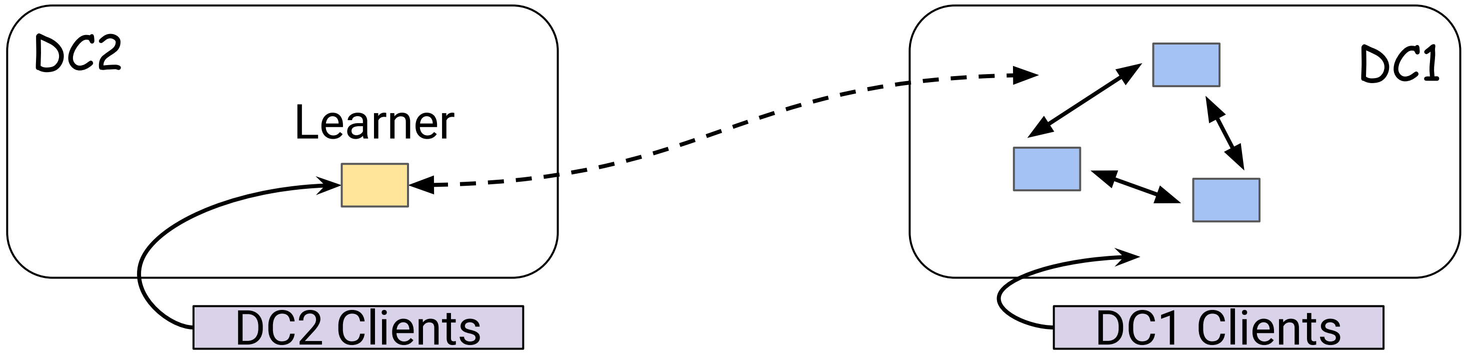


Coordination Services over WAN



	Updates	Reads	Correctness	Example
Distributed Service	Very slow	Fast	Yes	ACMS, Zeus, Megastore

Coordination Services over WAN



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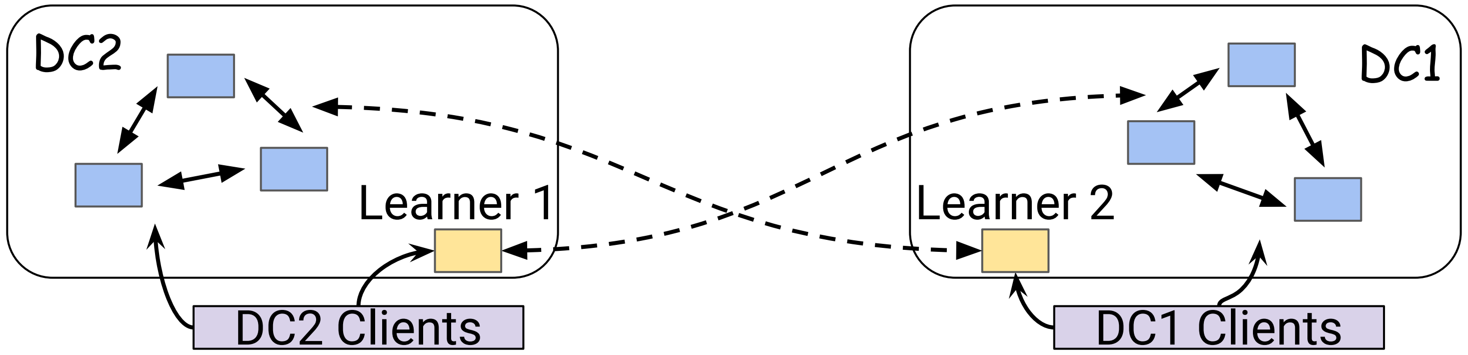
Coordination Services over WAN



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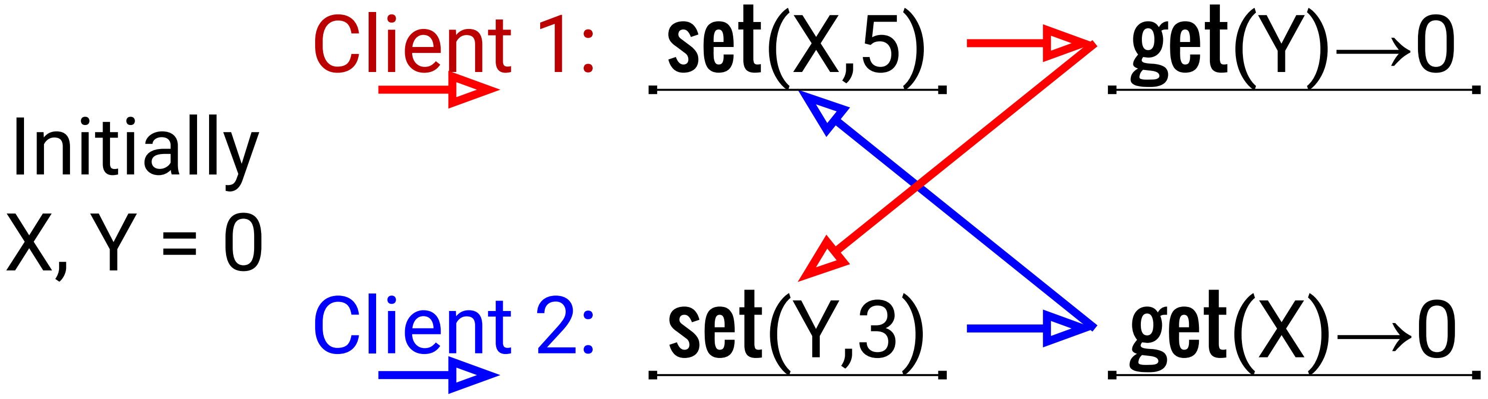
Multiple Co-located services + Learners	Fast	Fast	No	Global service discovery

Multiple Services Deployment - Correctness

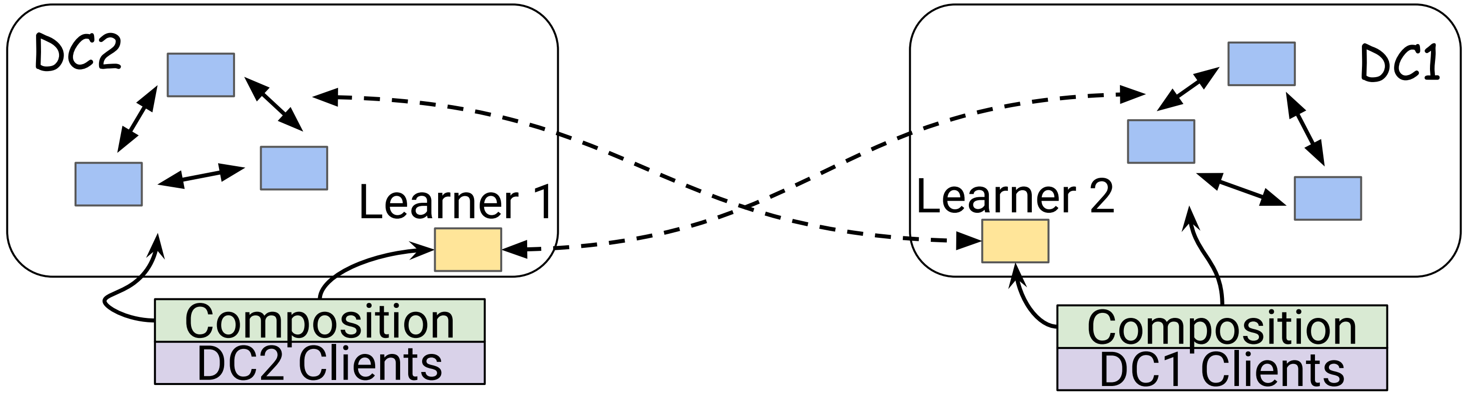


- Clients see different order of updates:

  Client 1: x=0 →x=5 →y=0 →y=3

  Client 2: y=0 →y=3 →x=0 →x=5

Our Solution: Modular Composition



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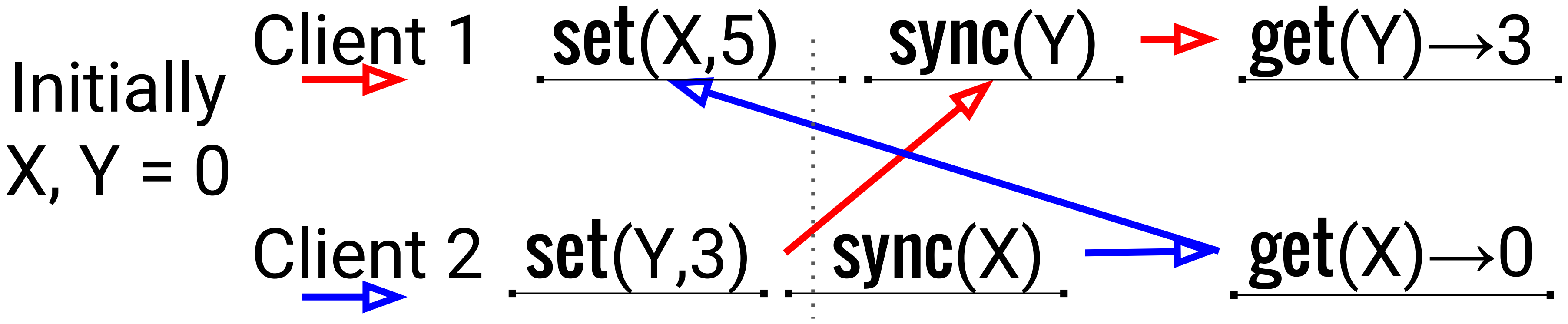
Modular Composition	Fast	Fast	Yes	Our implementation: ZooNet

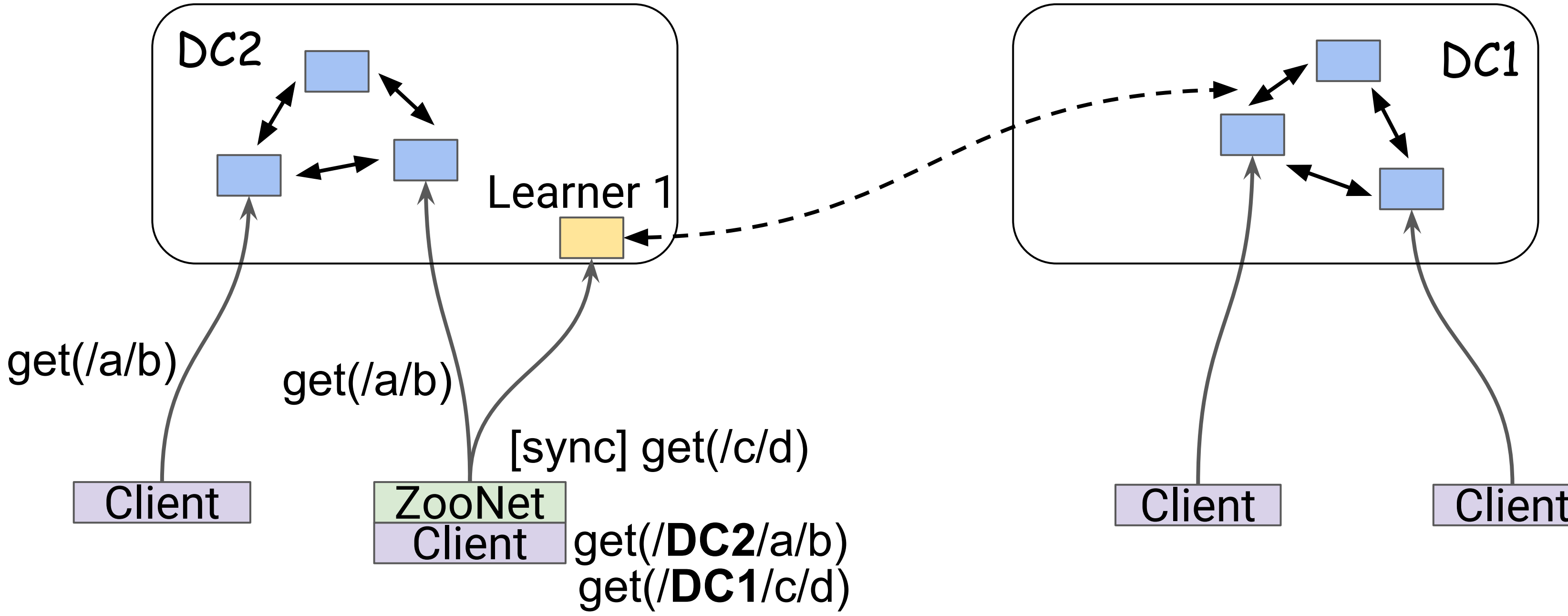
Modular Composition - Algorithm

Linearizable operation (sync) upon switching service instance

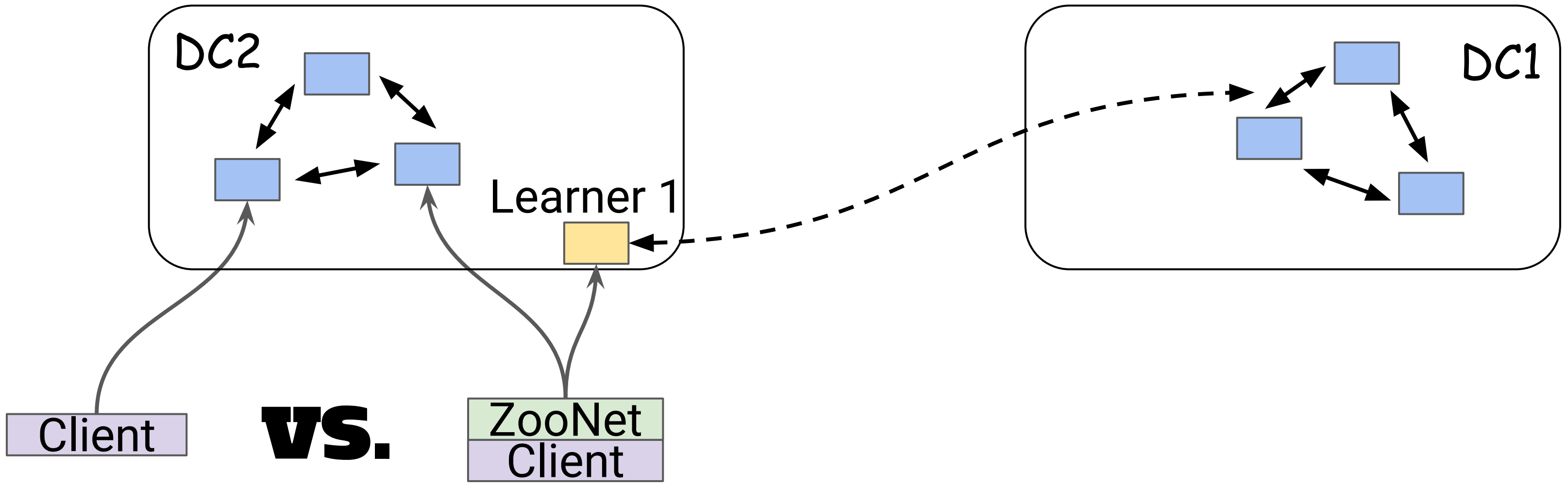


- Clients see same order of updates :
  y=0 → y=3 → x=0 → x=5

ZooNet - Modular Composition of ZooKeepers



ZooNet - Cost of Consistency

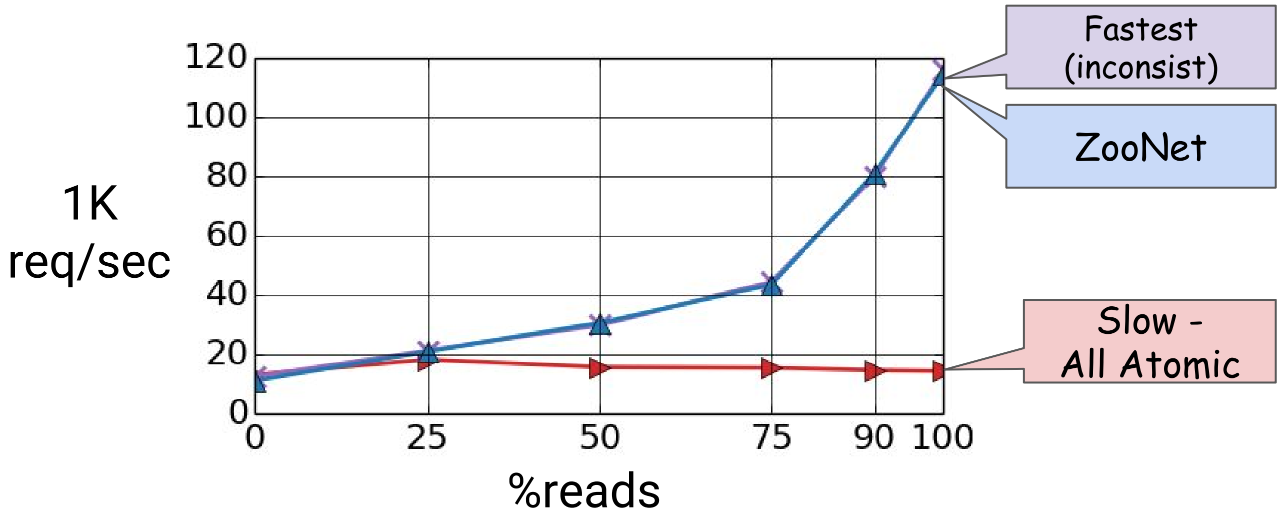


Vary locality:

- Spatial: % local access
- Temporal: # consecutive accesses to same DC

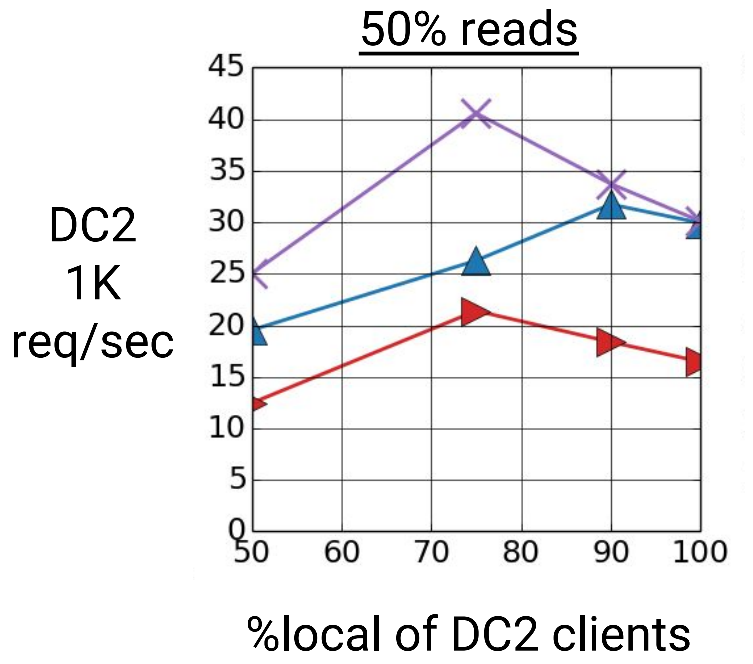
ZooNet Evaluation - Cost of Consistency

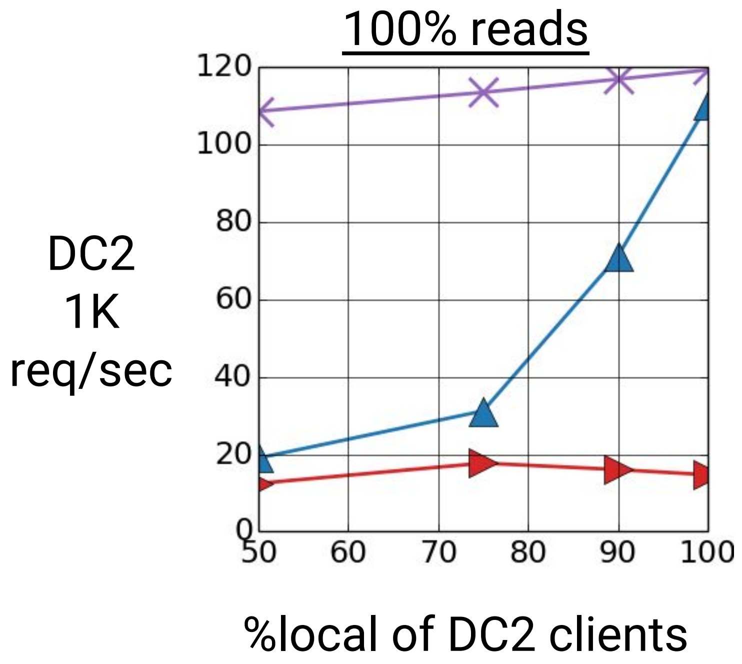
100% spatial locality:



ZooNet Evaluation - Cost of Consistency

No temporal locality, varying spatial locality:





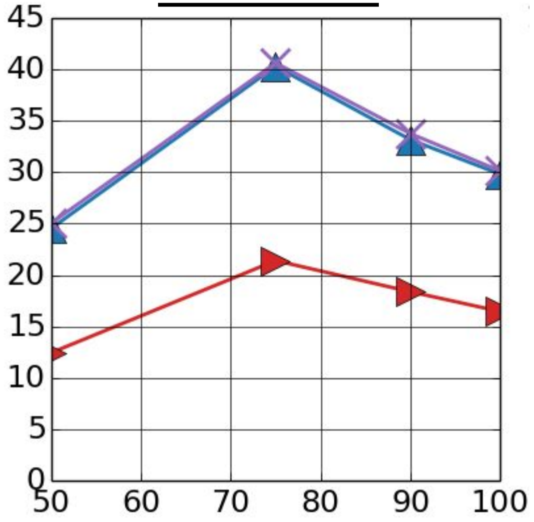
Fastest (inconsist)
ZooNet
Slow - All Atomic

ZooNet Evaluation - Cost of Consistency

With temporal locality, varying spatial locality:

50% reads

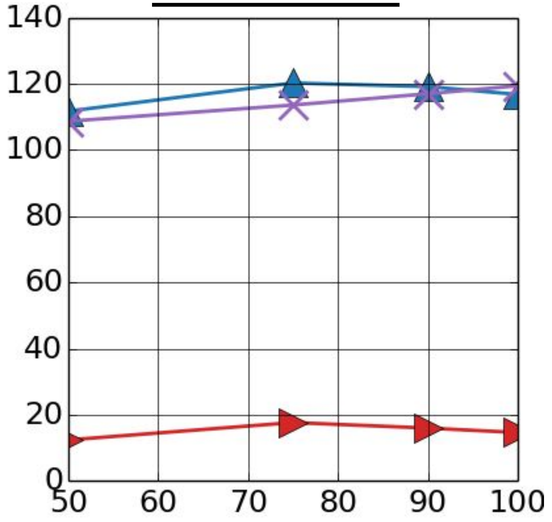
DC2 1K req/sec



%local of DC2 clients

100% reads

DC2 1K req/sec



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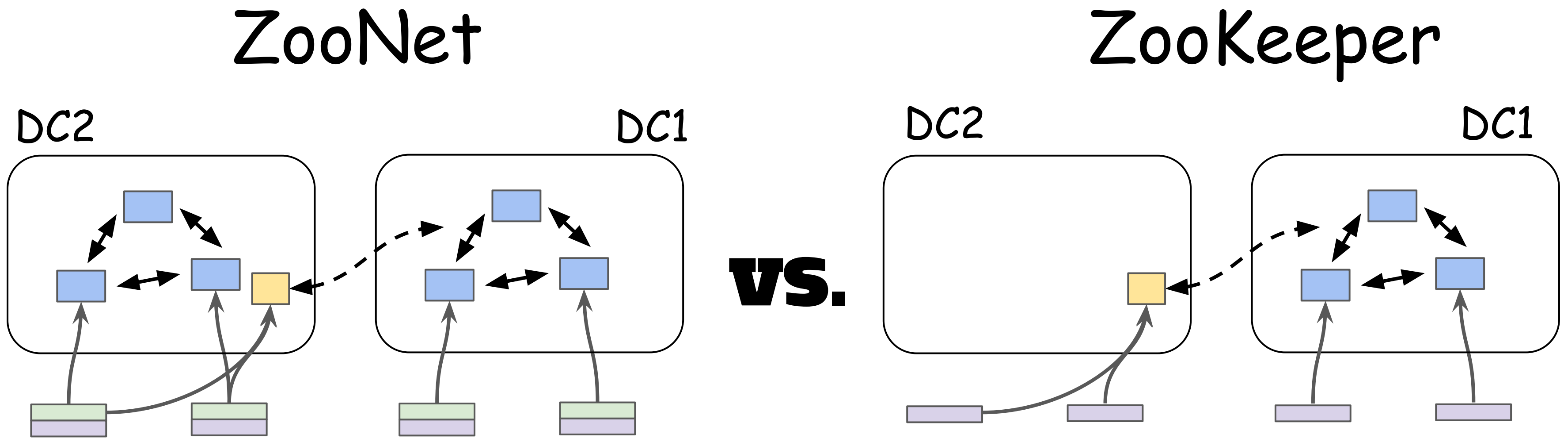
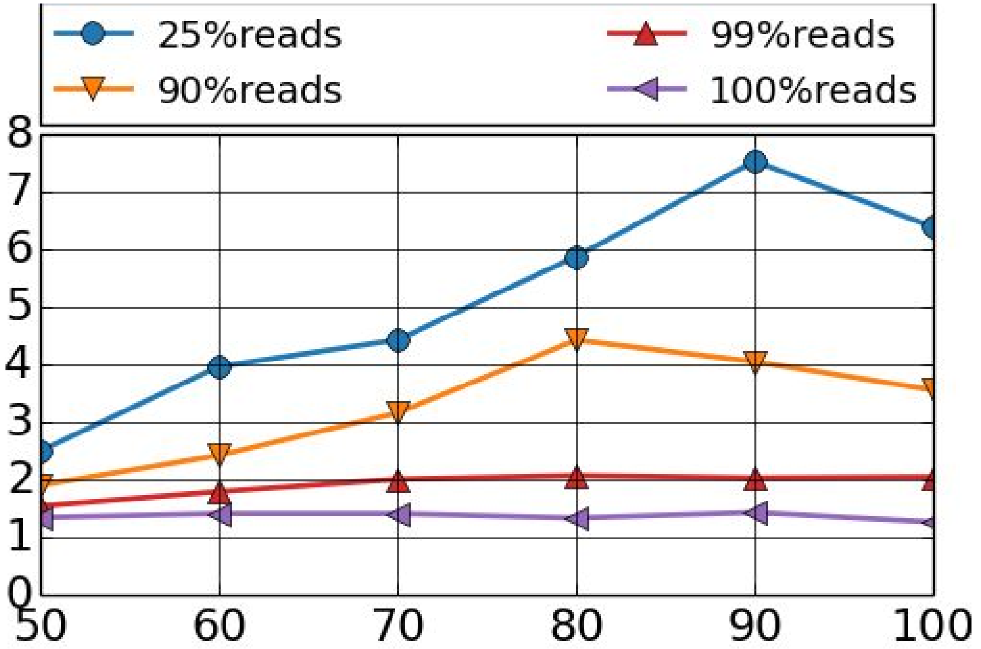
ZooNet vs. ZooKeeper Evaluation



ZooNet vs. ZooKeeper Evaluation

With temporal locality, varying spatial locality of DC2 clients:

DC2
Throughput
Speedup
ZooNet/ZooKeeper



%local of DC2 clients

Zookeeper - Server Side Improvement

- We improved ZooKeeper:
  - **Performance** - reads blocked for no reason
  - **Starvation** in read-intensive workloads

- In a nutshell:
  - 2 clients connecting to same server blocked each other
  - Not required by semantics
  - We isolated clients

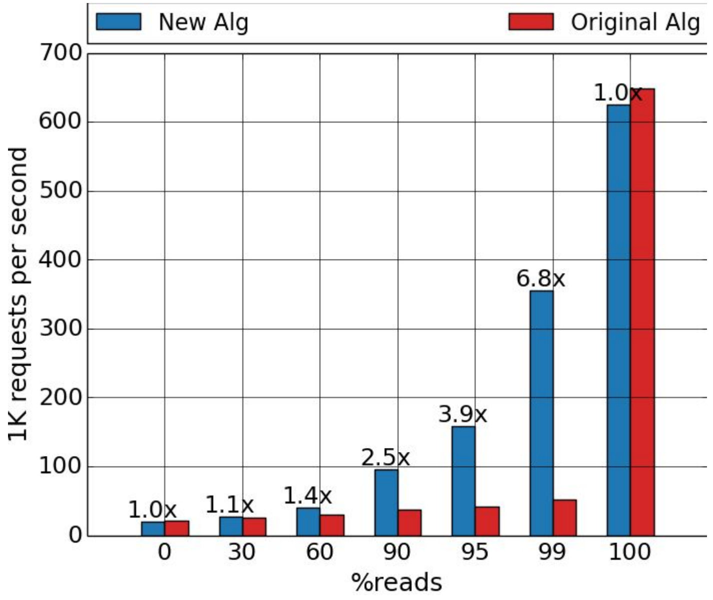
- Committed into ZooKeeper trunk

See Jira ZooKeeper-2024 for more experiments and details

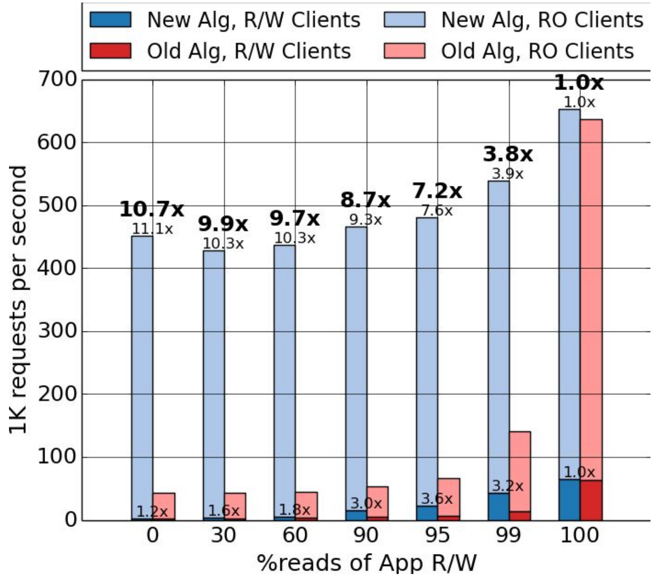
ZooKeeper Improvment: Evaluation

Single ZK of 5 servers, 900 clients:

100% R/W clients:



10% R/W, 90% RO clients:



Conclusion

- ✓ Performance
  ✓ Simplicity
  ✓ Correctness
- Small change in the client side
- Backward compatible
- Higher locality ⇒ Lower cost

+Improving ZooKeeper up to x10

Thank you!