Virtual Consensus in Delos

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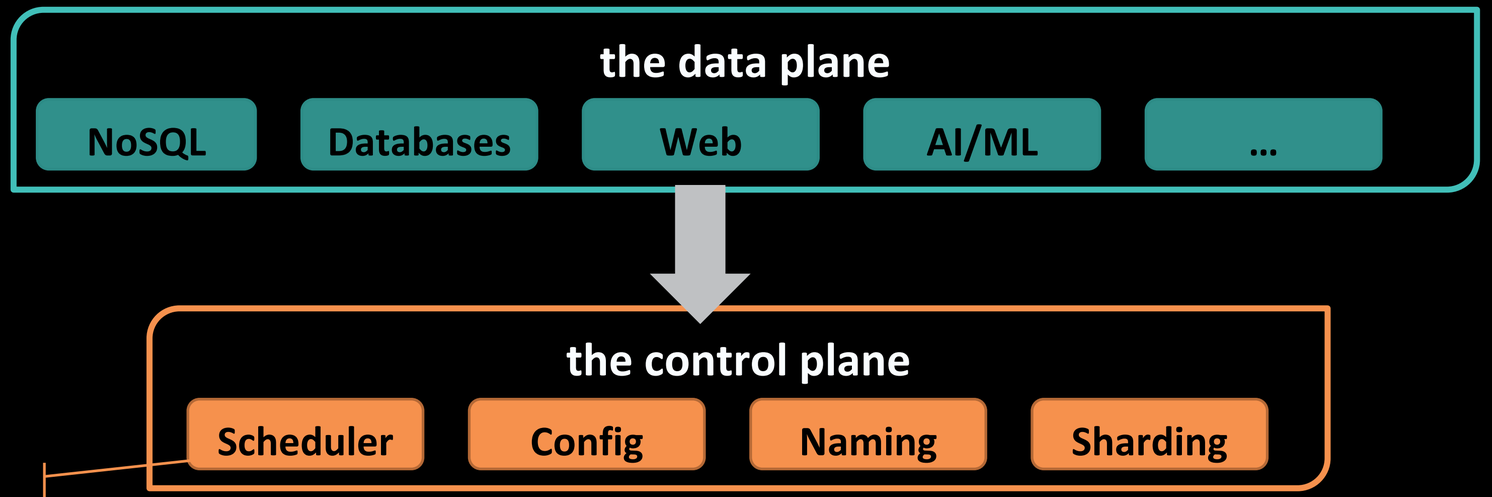
Santosh Ghosh, Hazem Hassan, Aaryaman Sagar, Rhed Shi, Jingming Liu, Filip Gruszczynski
Xianan Zhang, Huy Hoang, Ahmed Yossef, Francois Richard, Yee Jiun Song

Facebook, Inc.

the Facebook stack

turtles all the way down…



[Twine, OSDI 2020]

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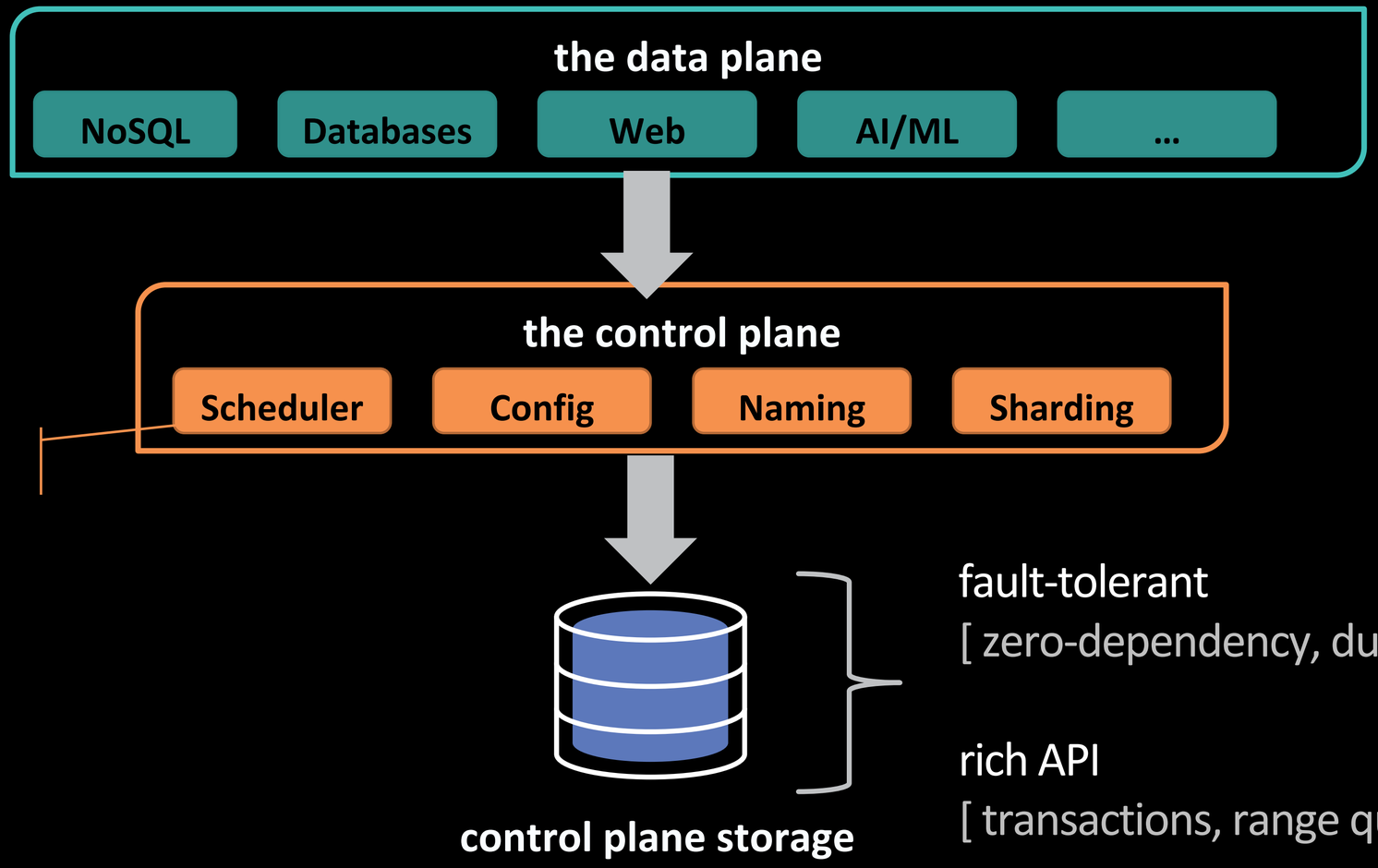

fault-tolerant

[zero-dependency, durable, highly available]

rich API

[transactions, range queries, secondary indices]

the need for a new storage system

why not use an existing system?

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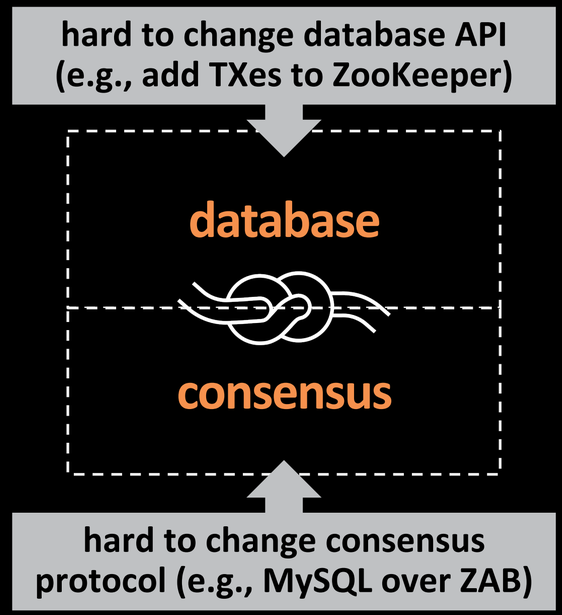
why not use an existing system?

why not modify an existing system?



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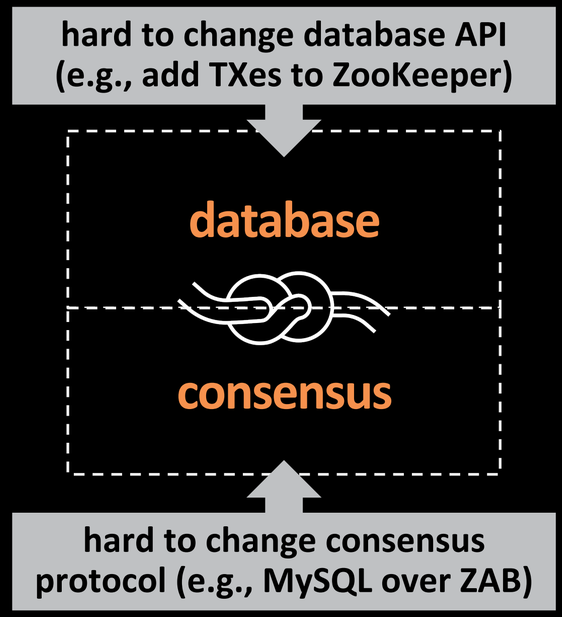

problem statement circa 2017:
can we build a zero-dependency, fault-tolerant system with a rich API… *in months?*

the Delos storage system

or: “how to build a production-ready storage system in eight months”

the Delos storage system

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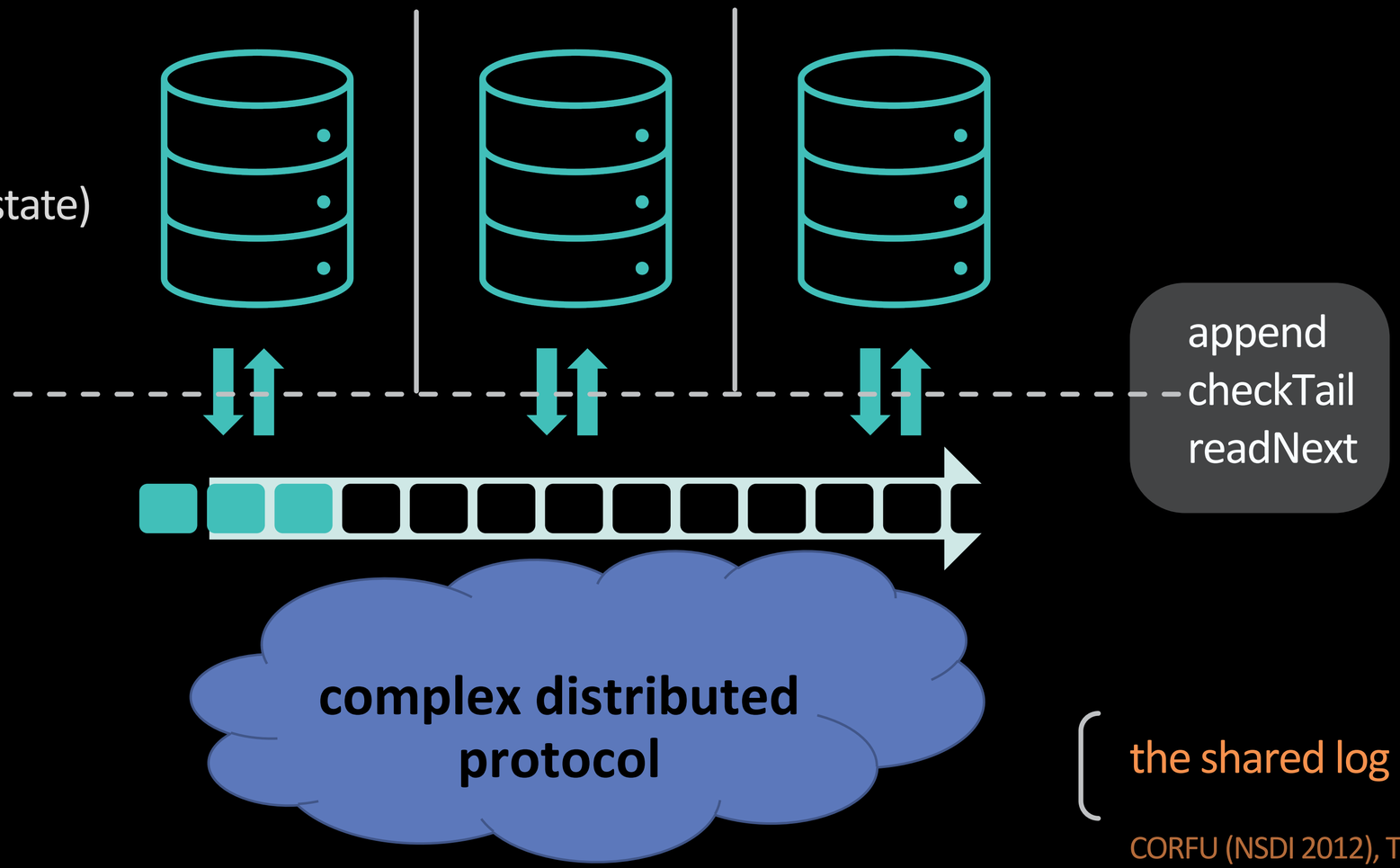


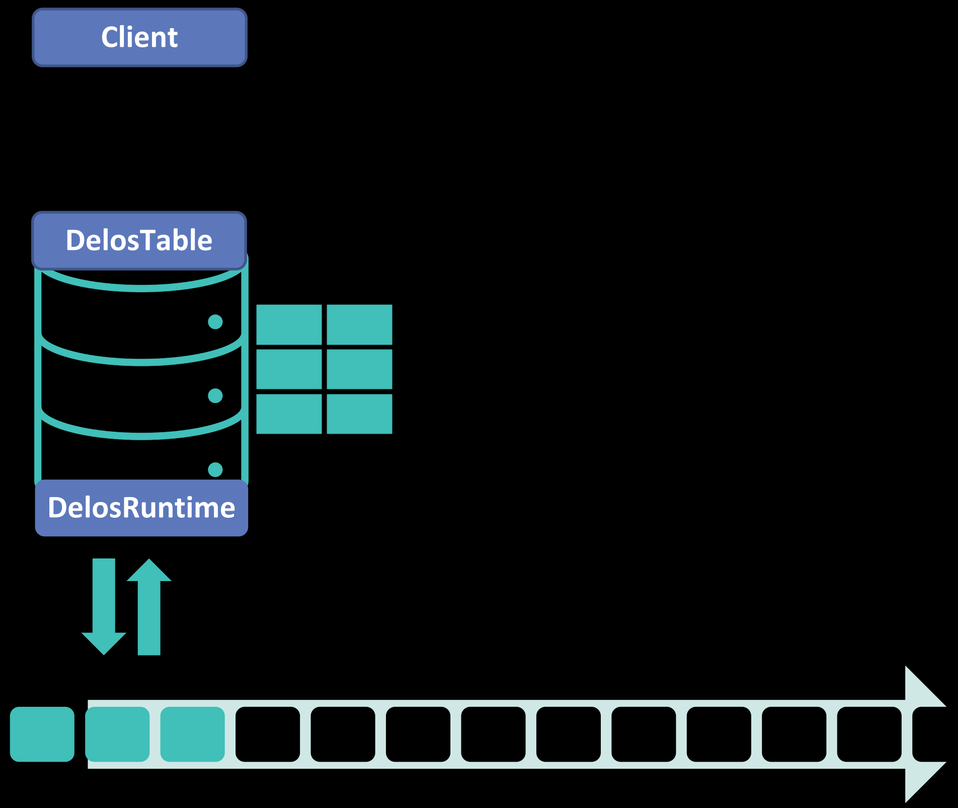
the shared log is an API for consensus

CORFU (NSDI 2012), Tango (SOSP 2013), Hyder (SIGMOD 2015), CorfuDB, LogDevice, Scalog (NSDI 2020)...

the Delos storage system: above the log

database
(materialized state)

shared log
(consensus)



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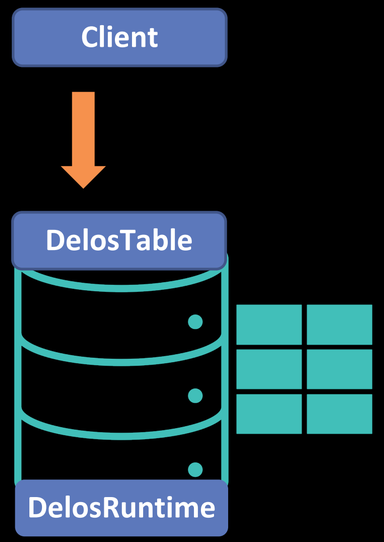

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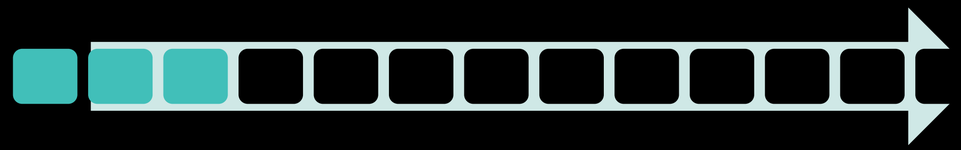

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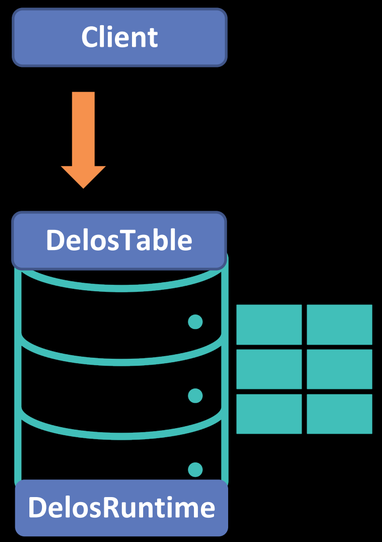

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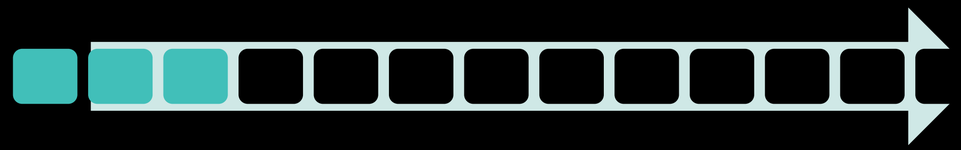

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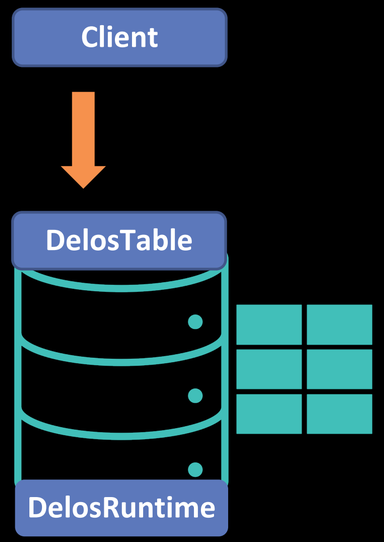

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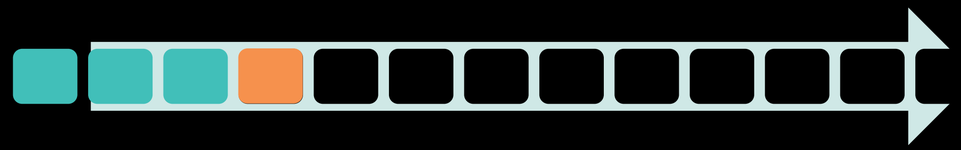

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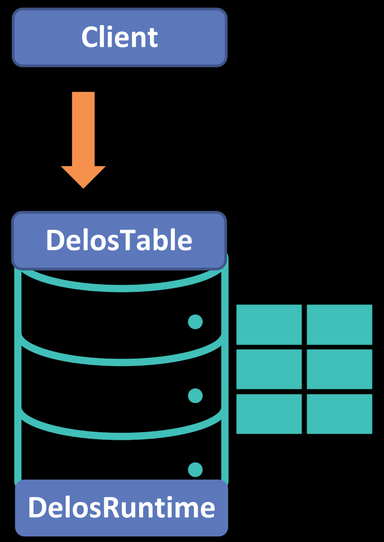

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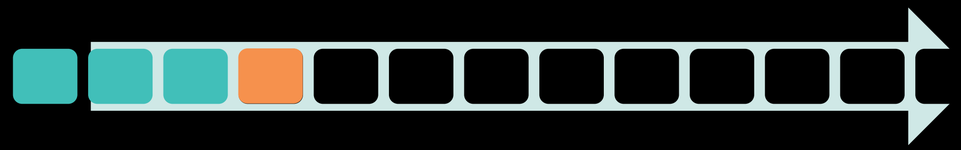

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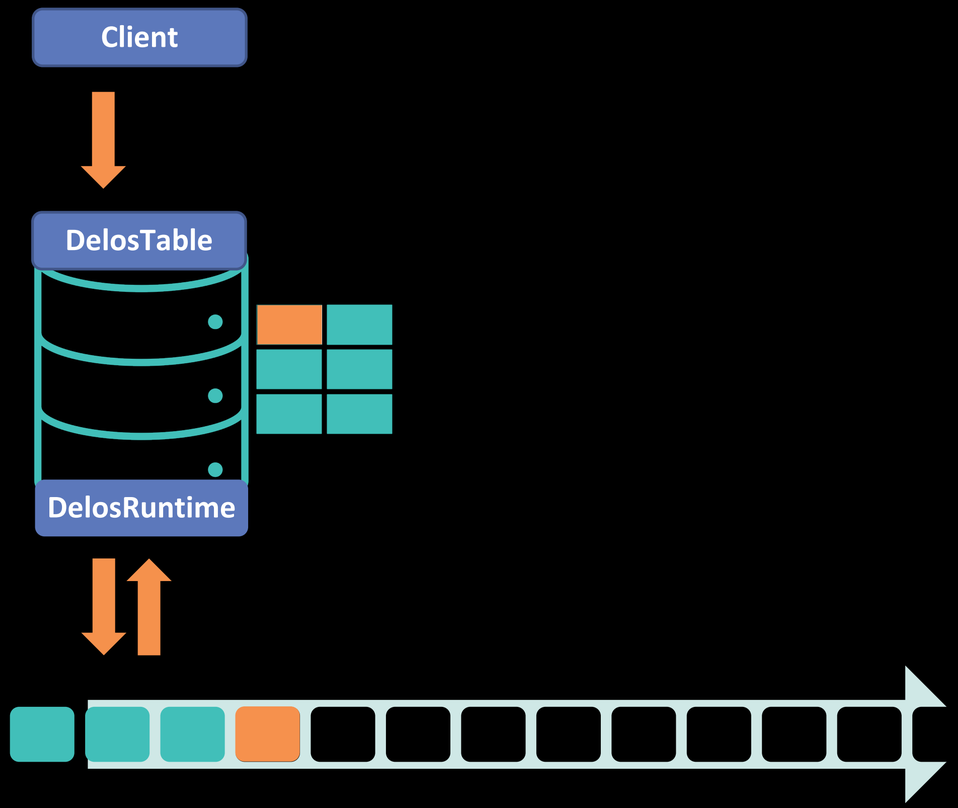

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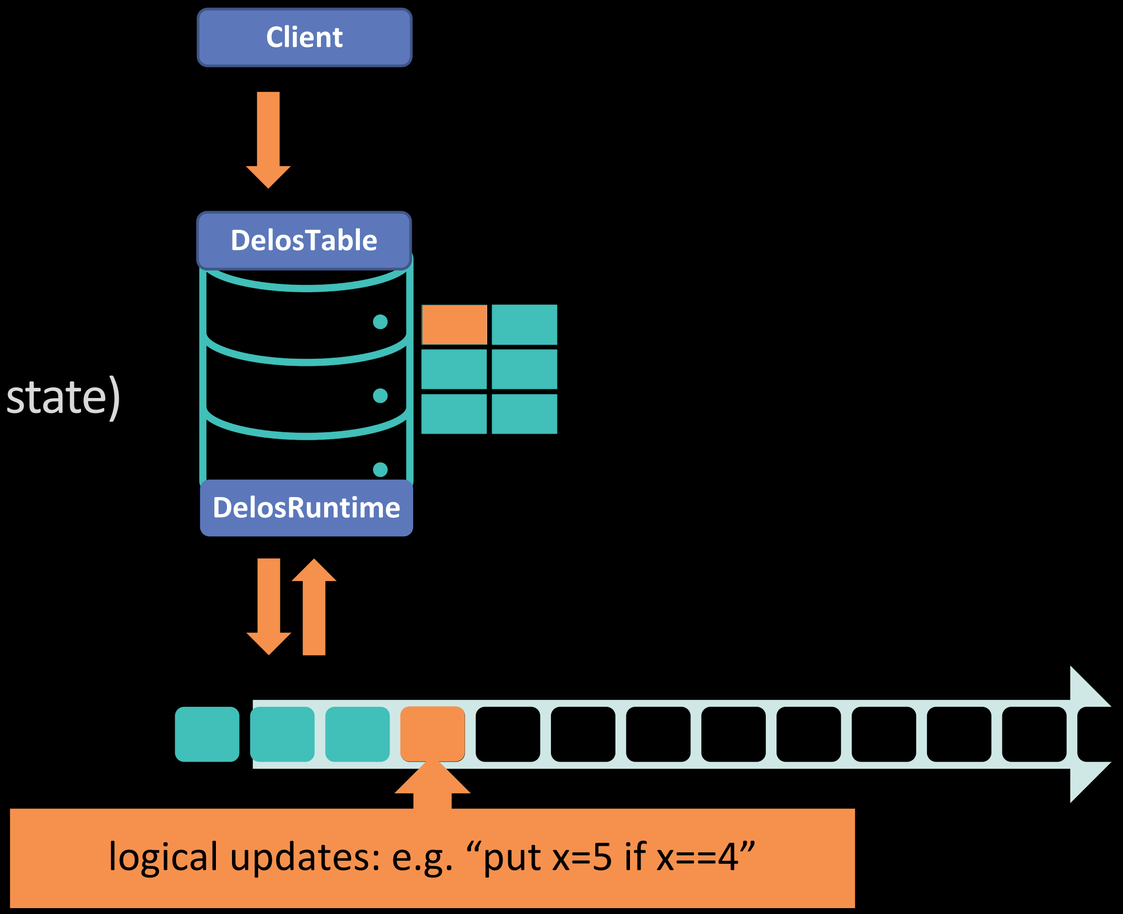

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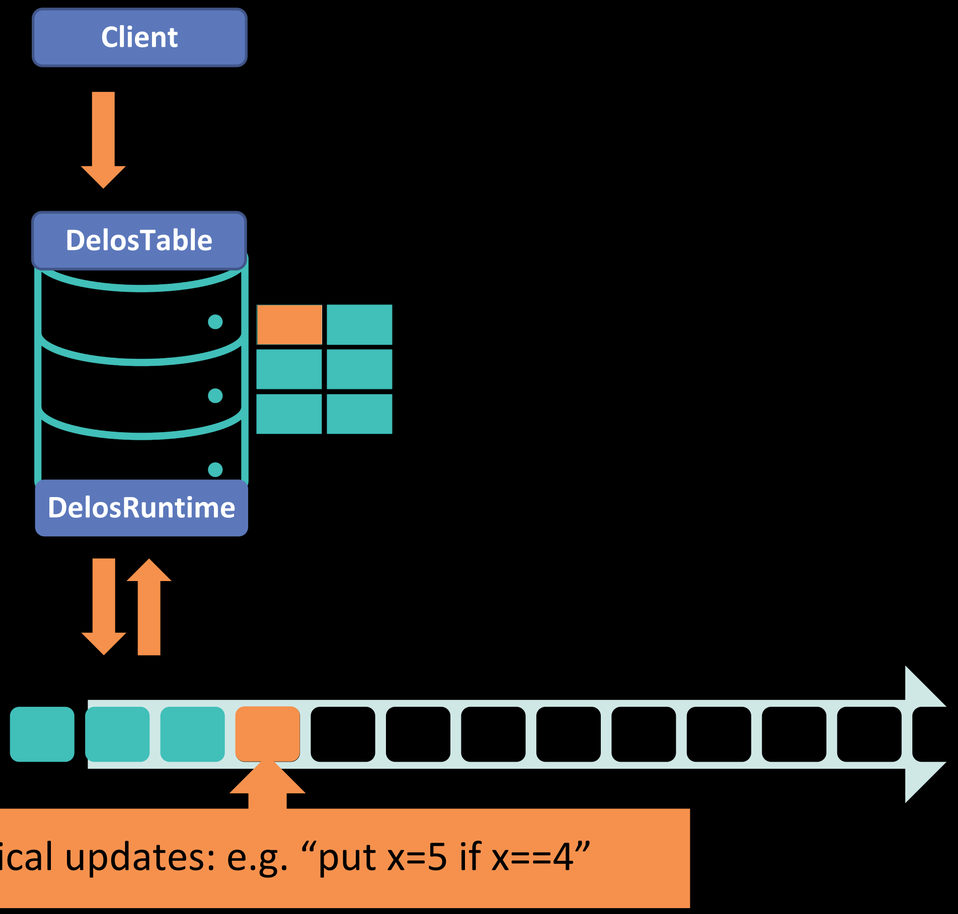

simple protocols above the log

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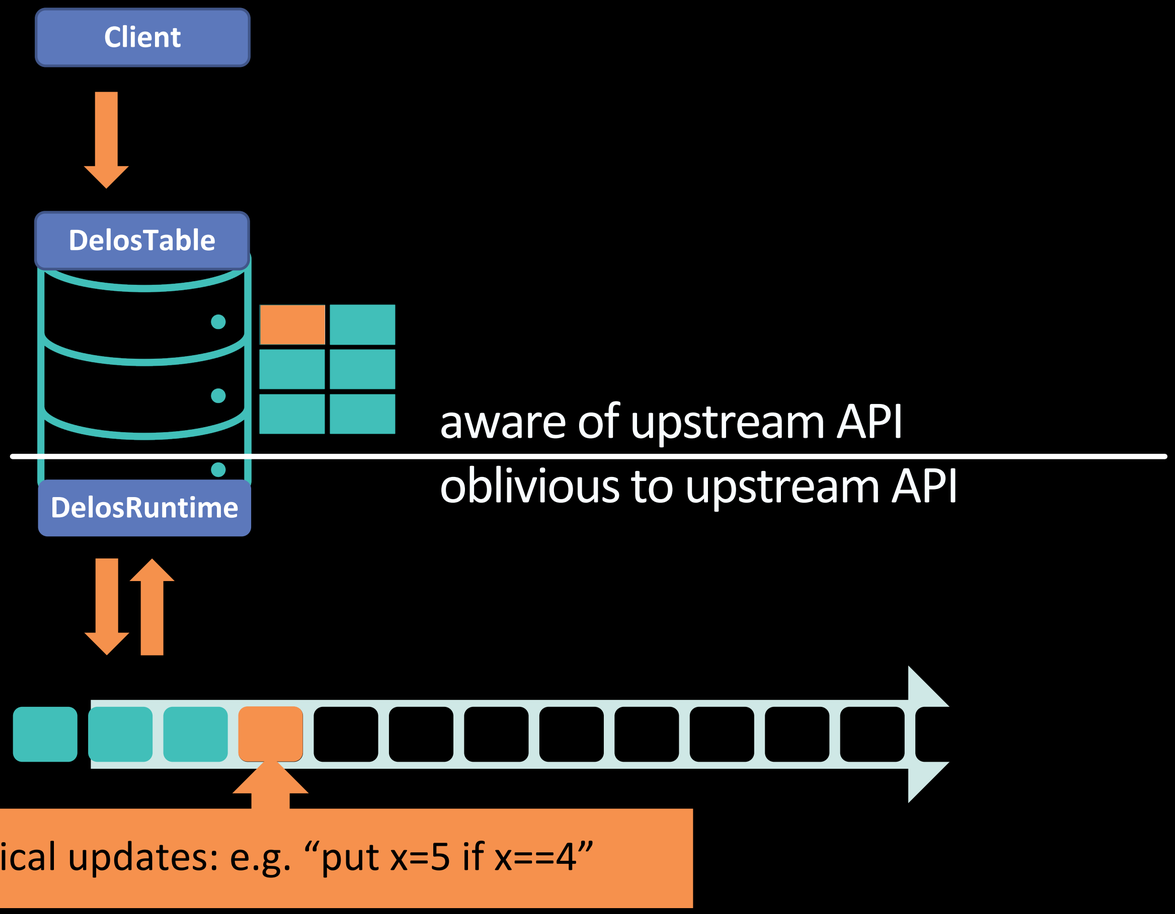

simple protocols above the log

easy to support new APIs

the Delos storage system: below the log

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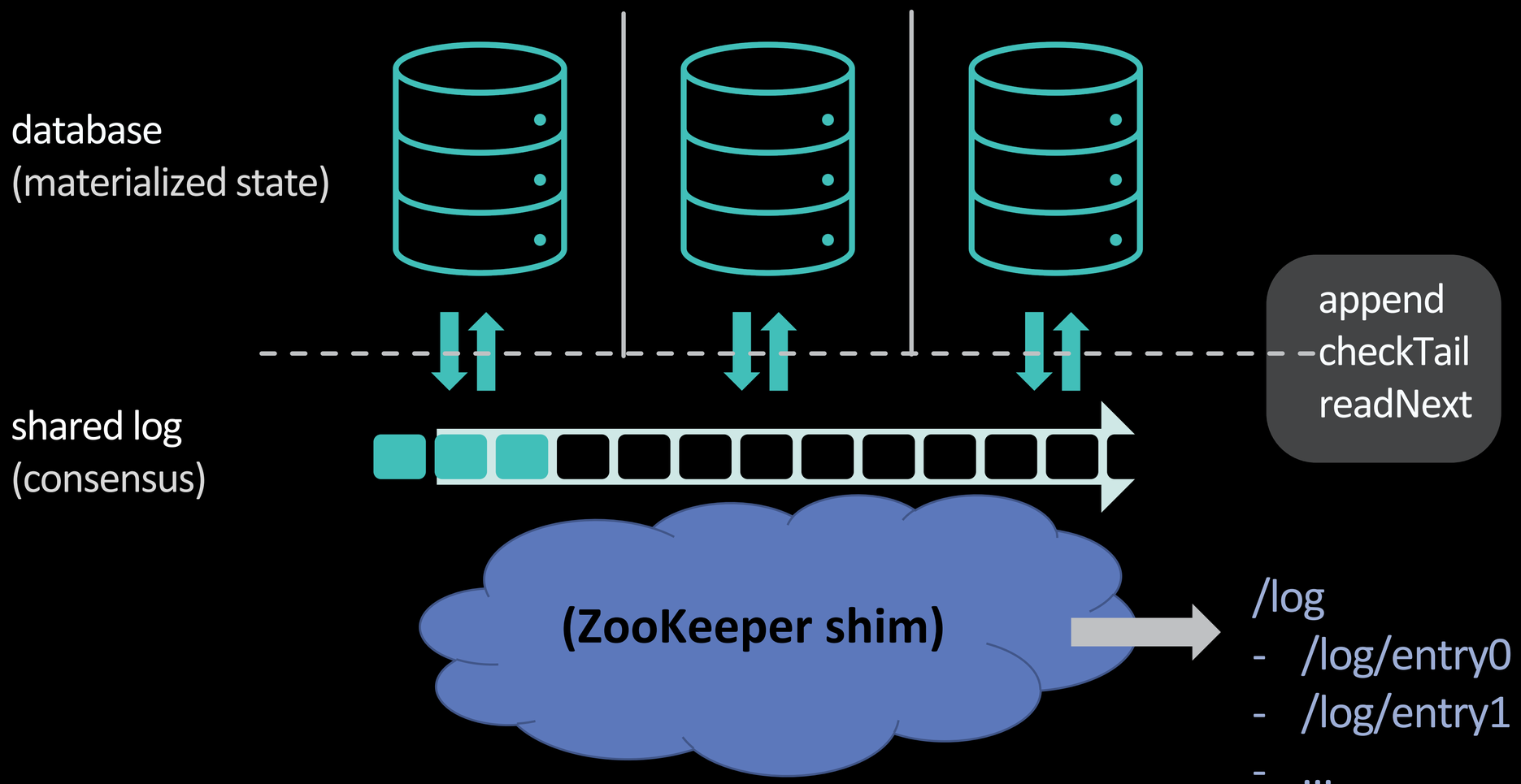

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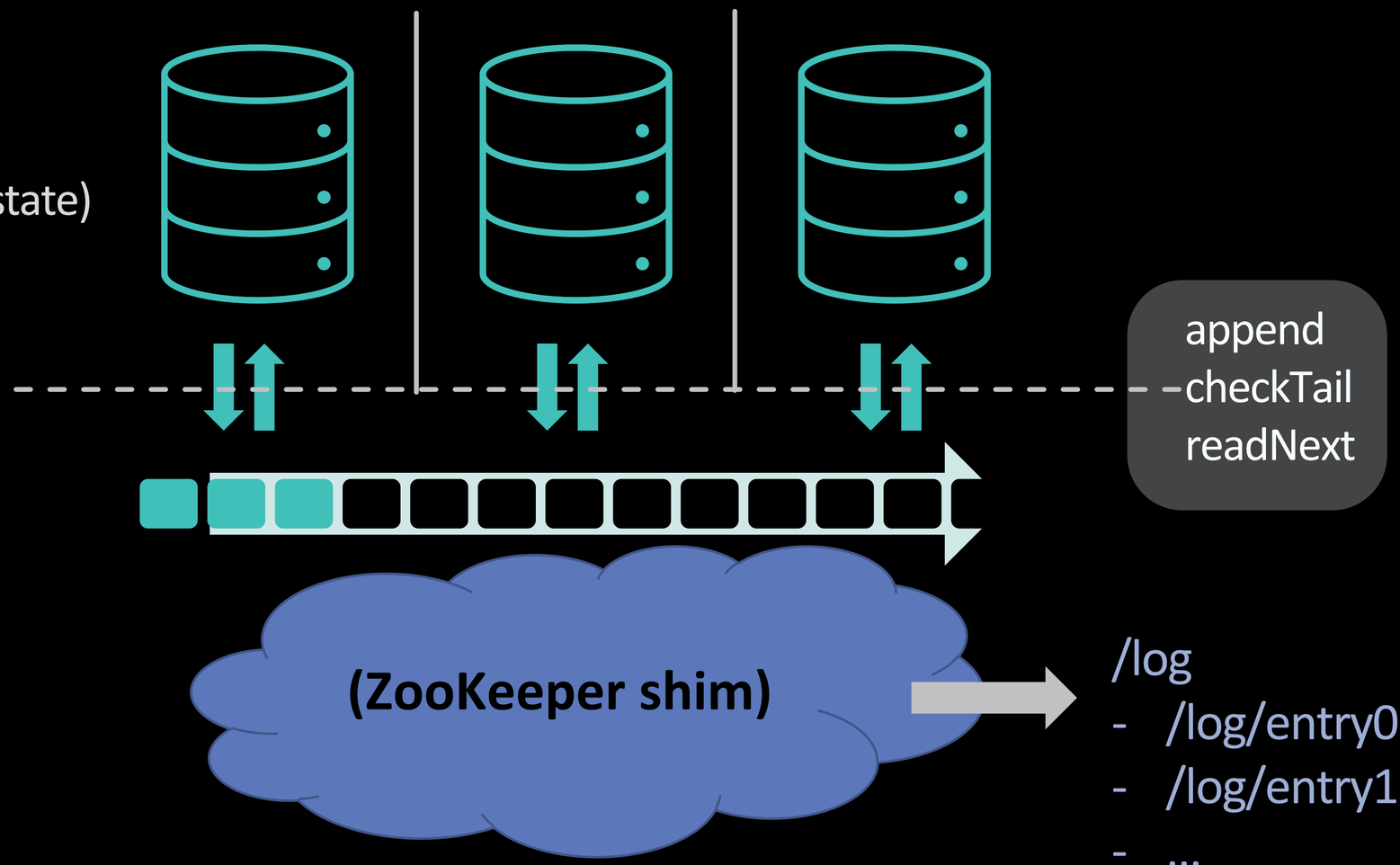

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- highly reliable

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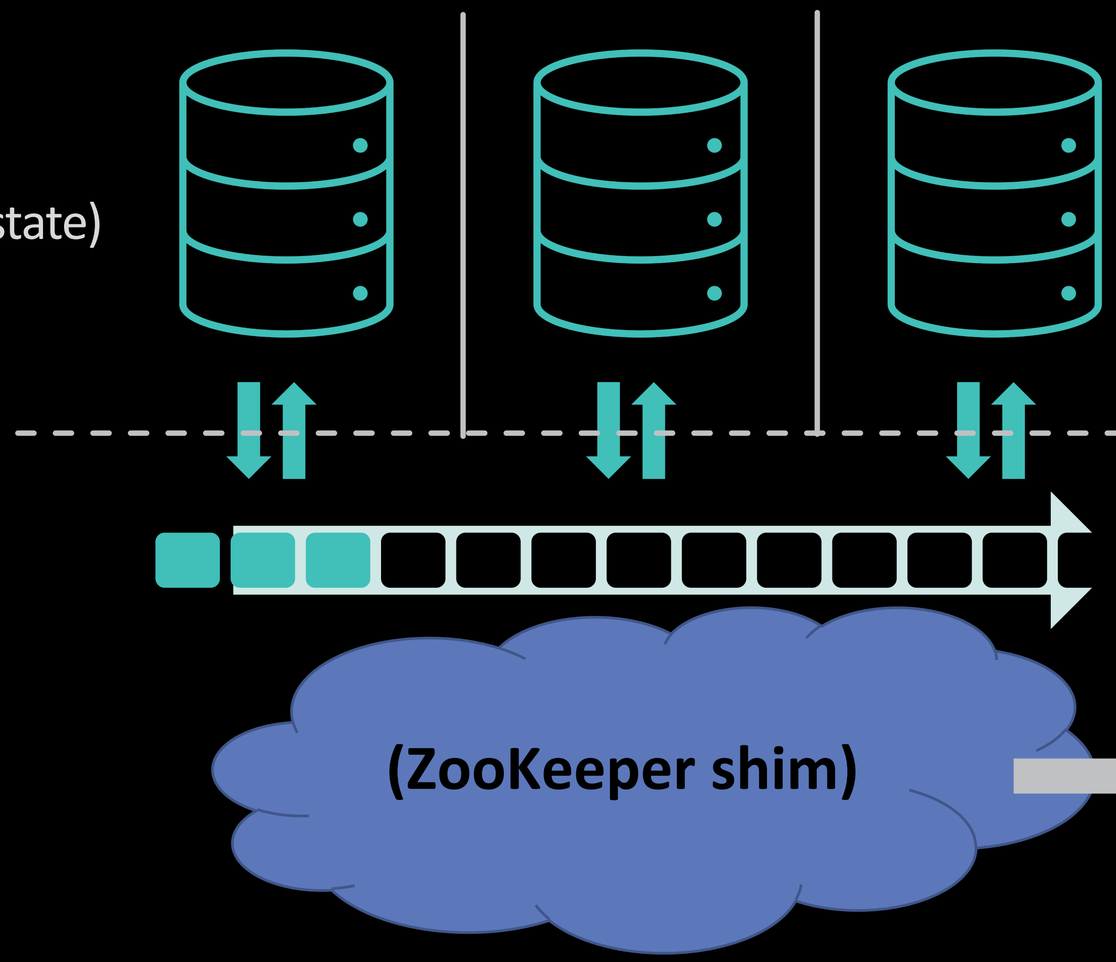

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cons:
- very inefficient and slow
- service dependency

how do we develop a new shared log?
(without re-implementing MultiPaxos…)

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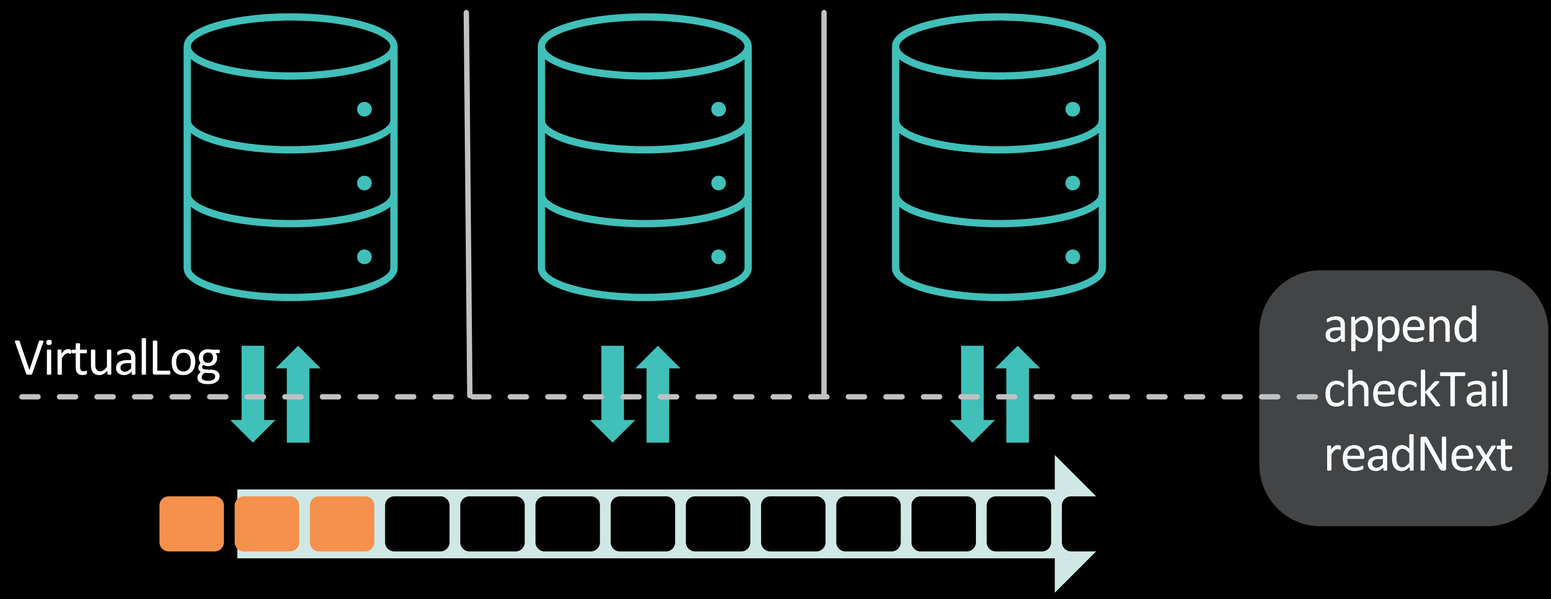
Virtual Consensus!

virtualizing consensus via the VirtualLog



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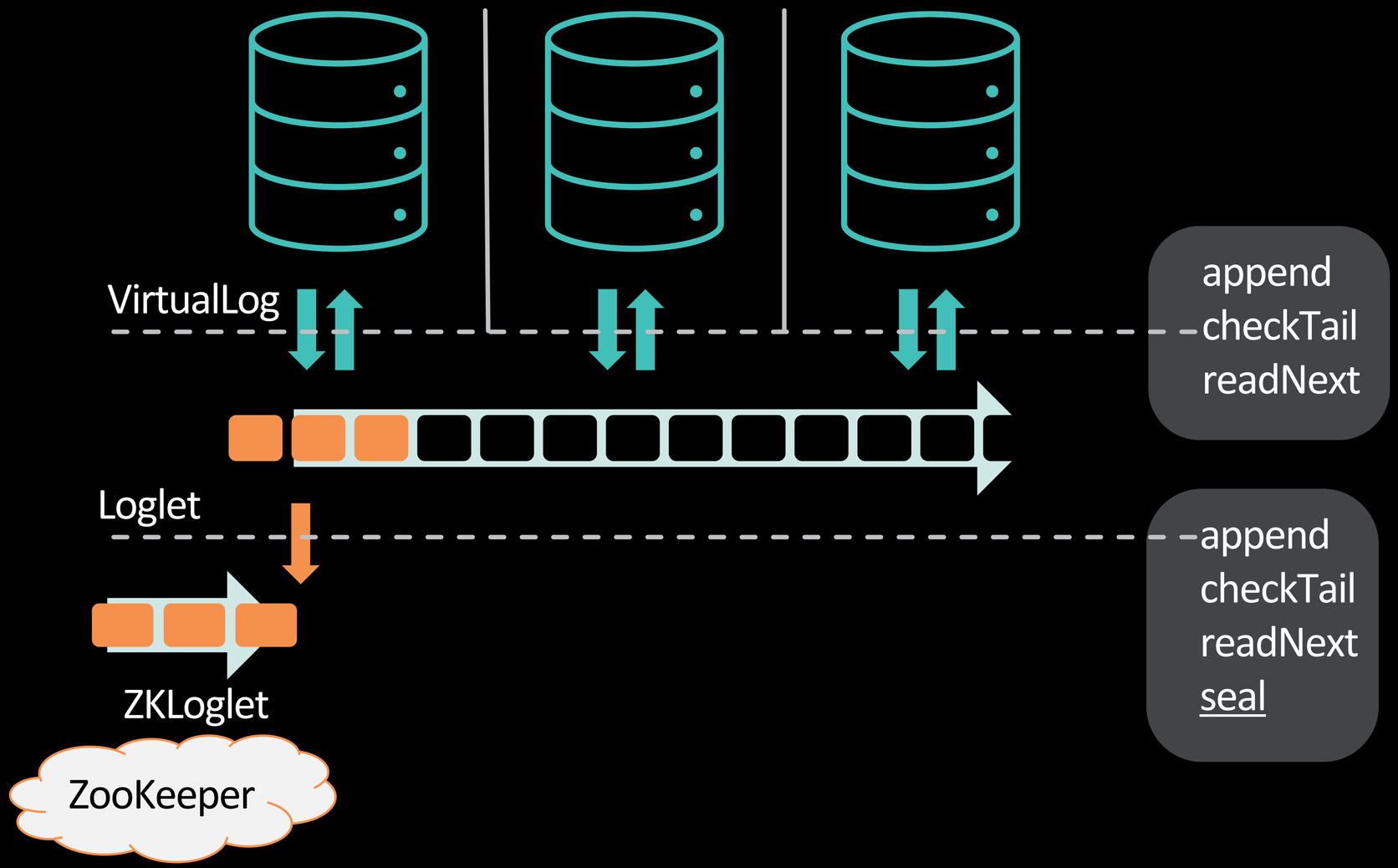

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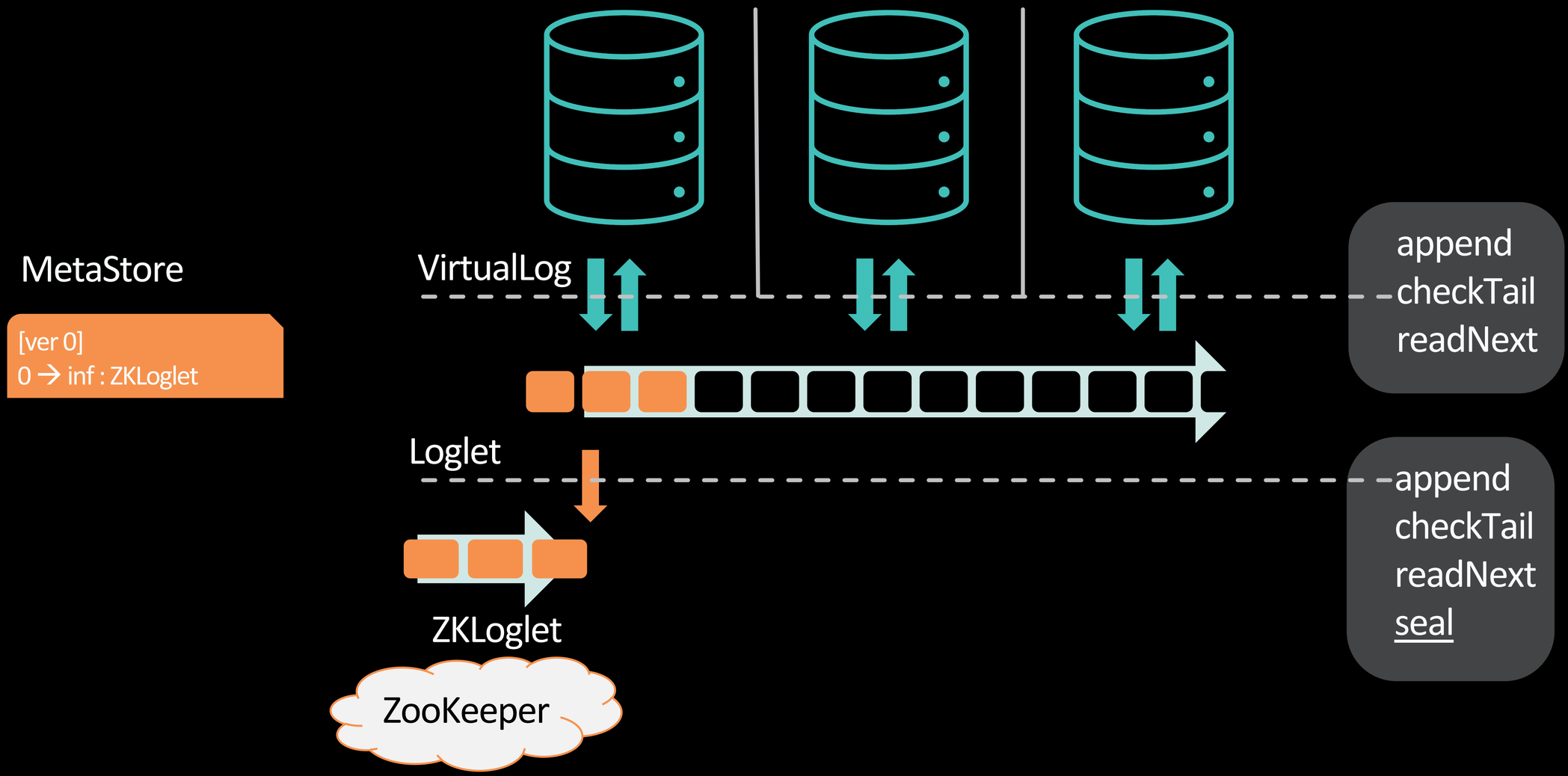

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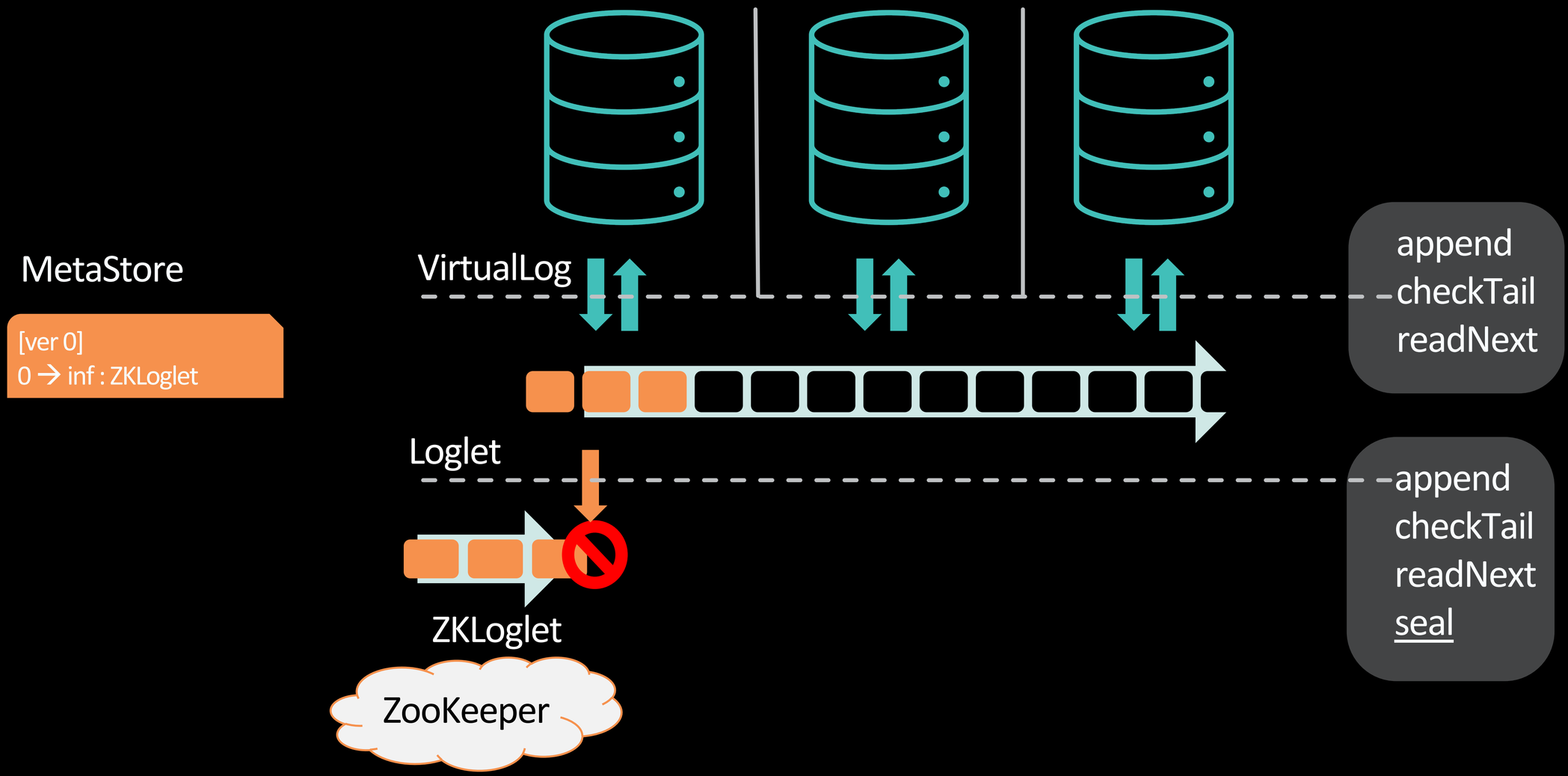

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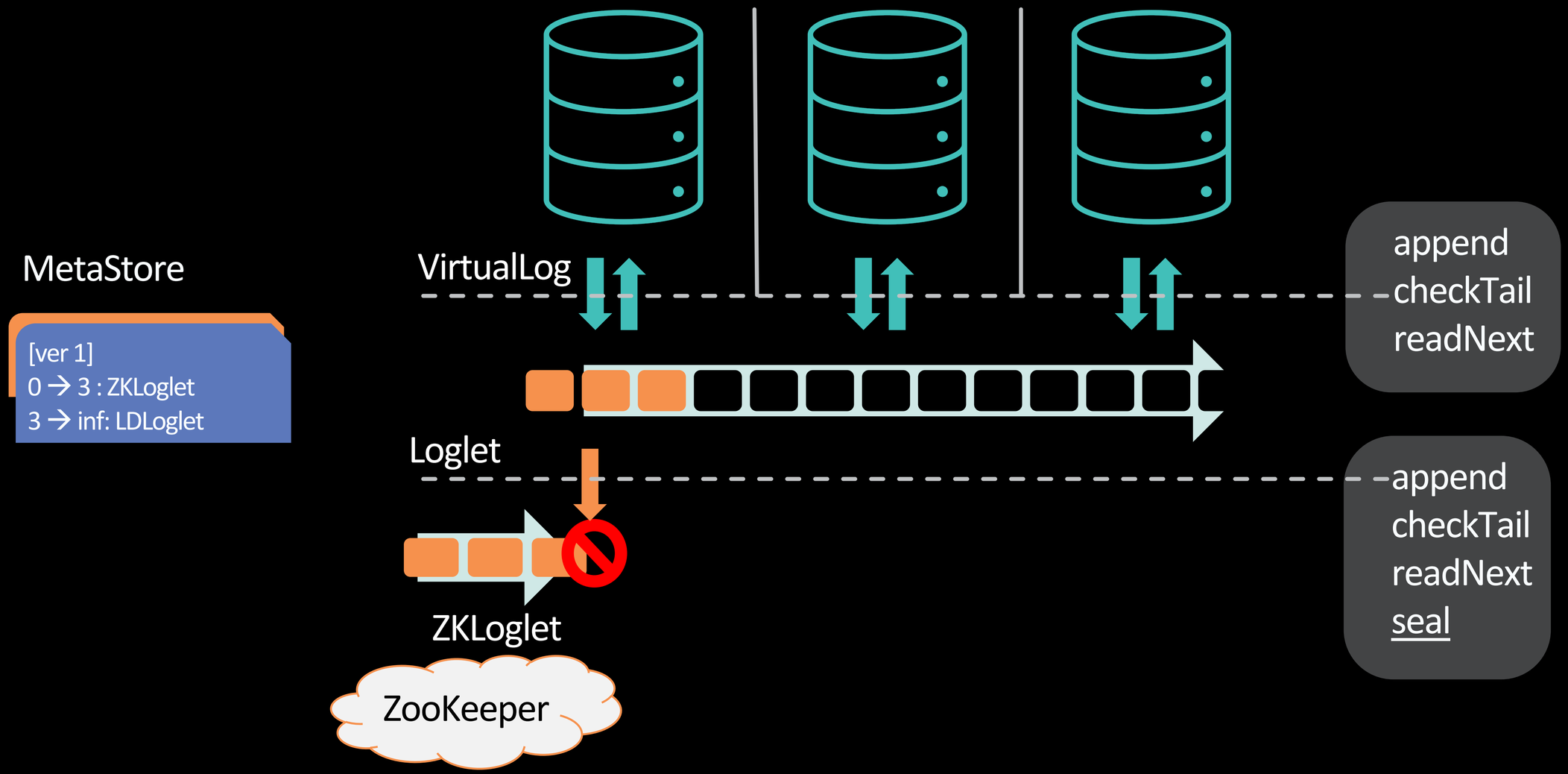

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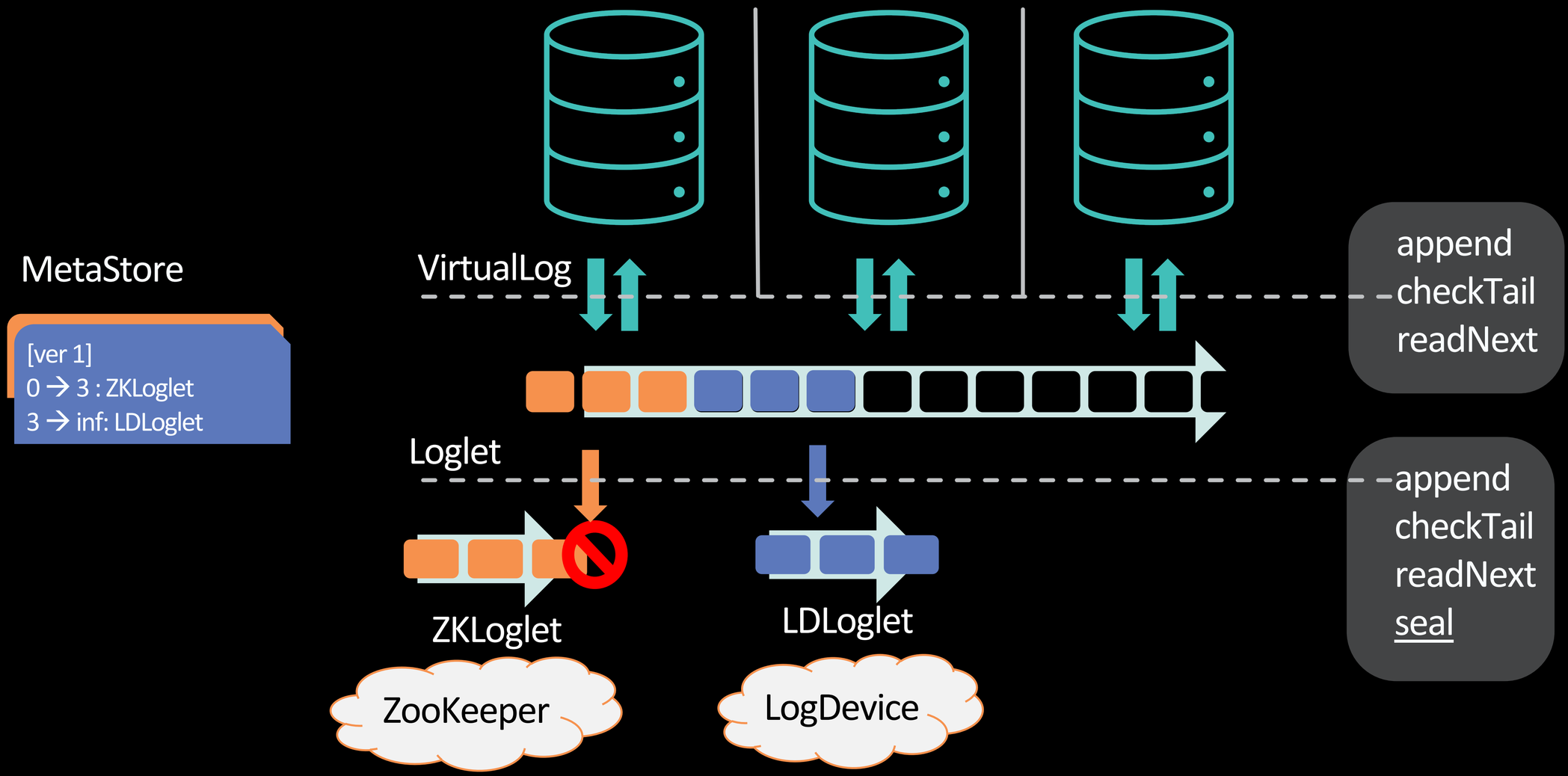

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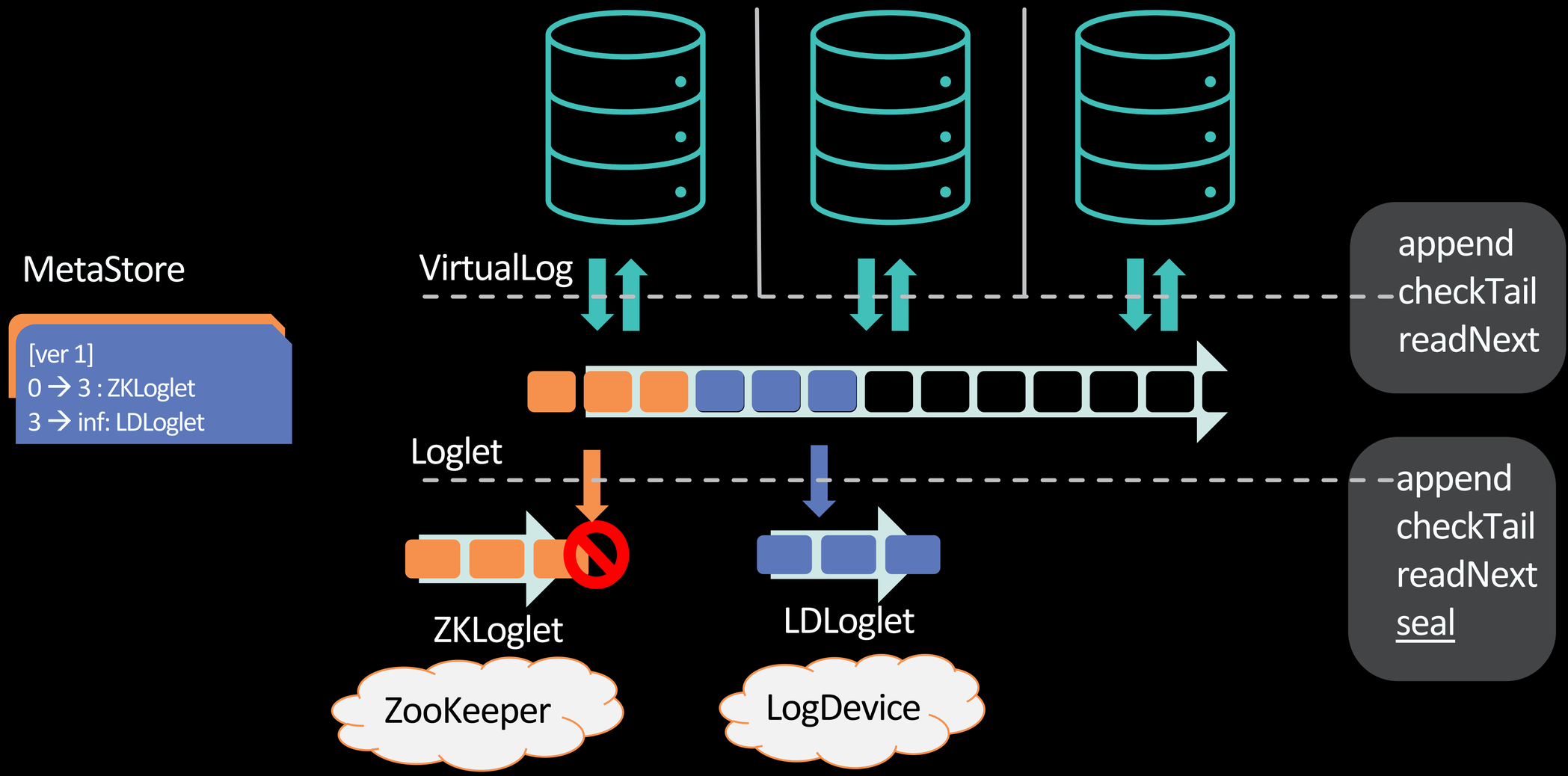

we can deploy a new Loglet without downtime!

difficult to build a log that is simple, fast, fault-tolerant

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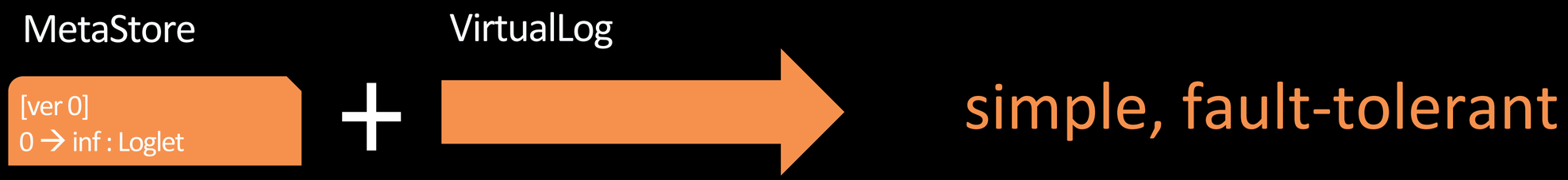

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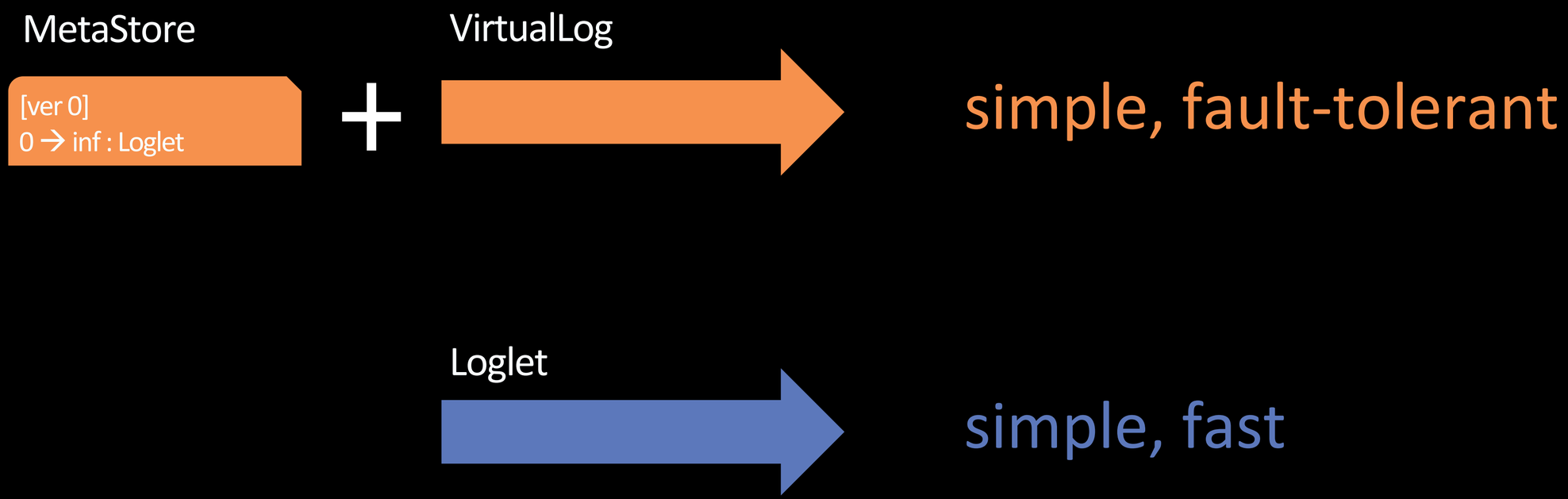

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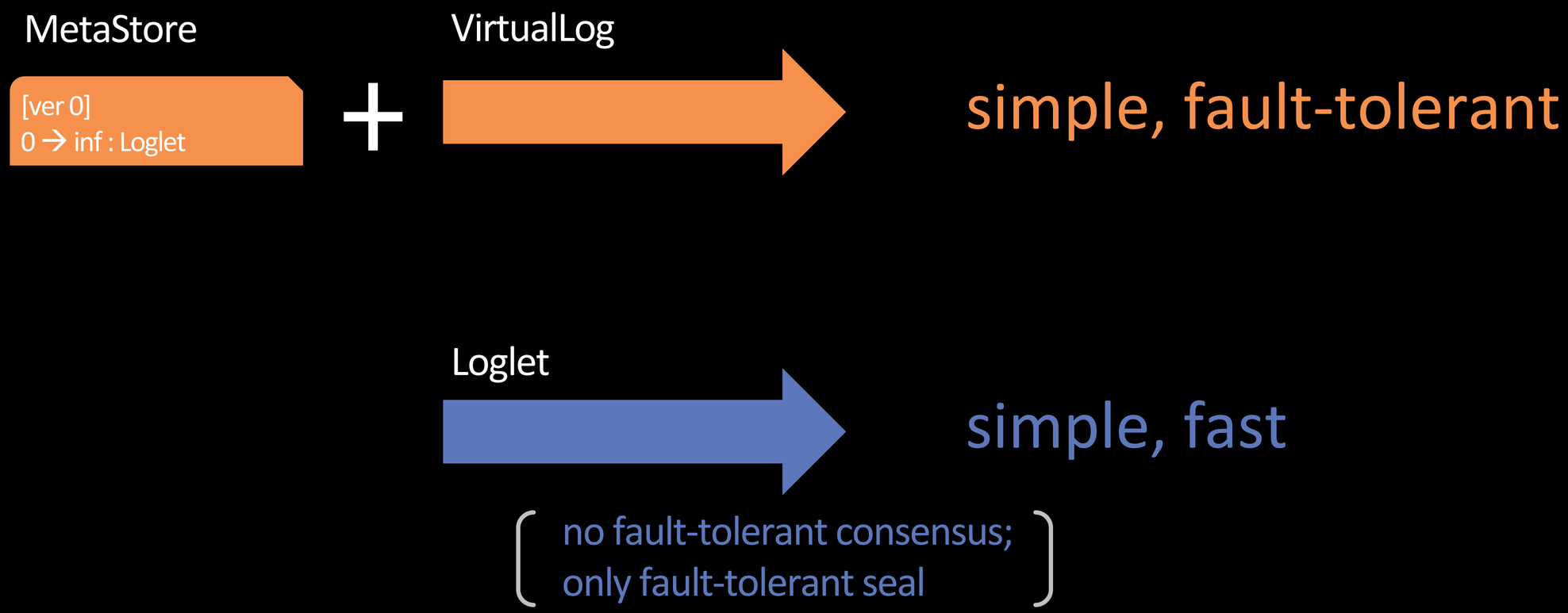

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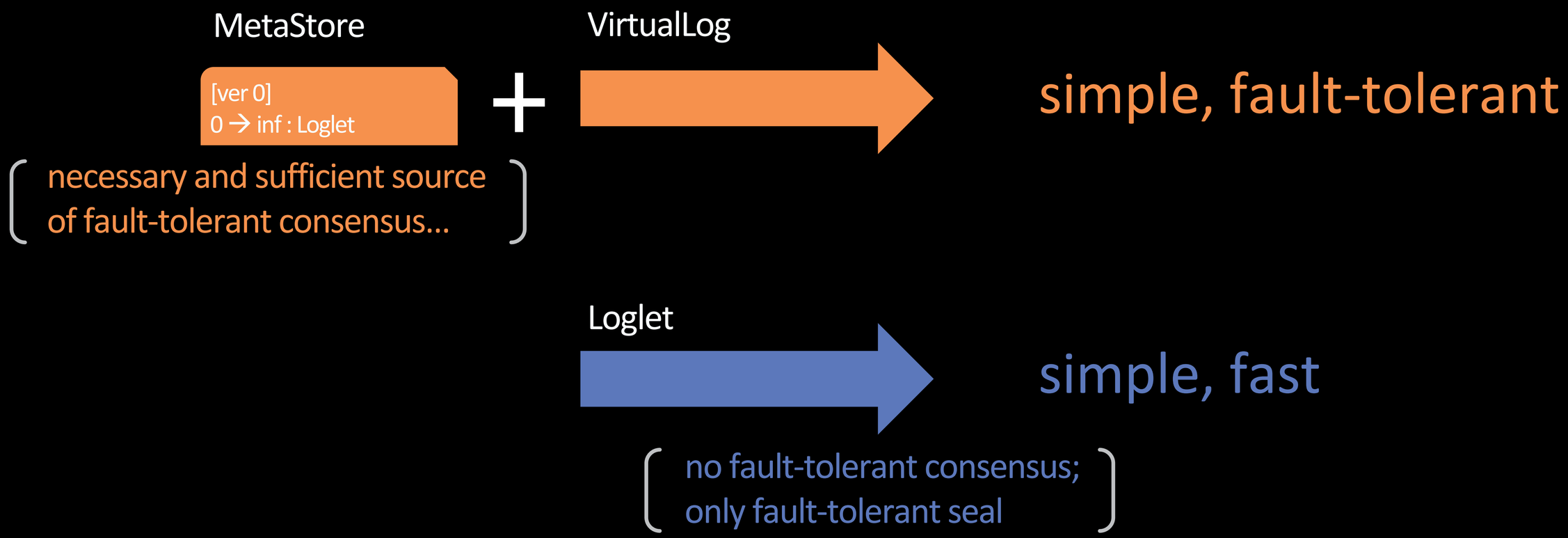

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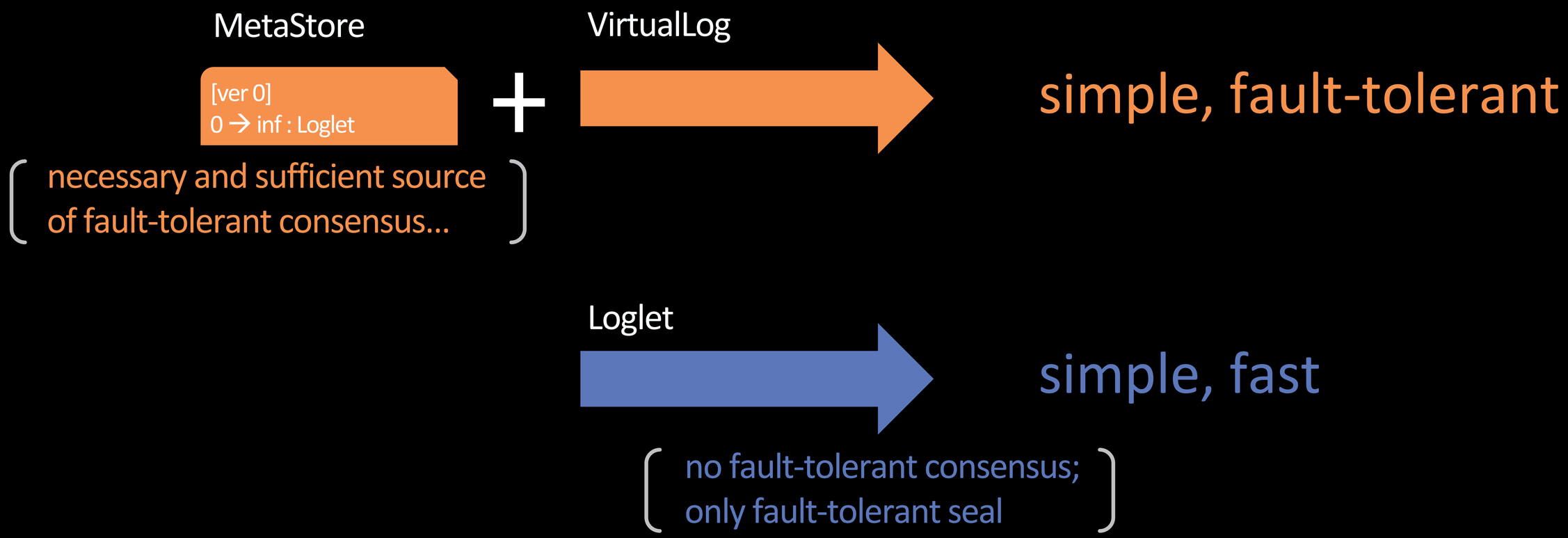

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the Loglet provides failure-free ordering

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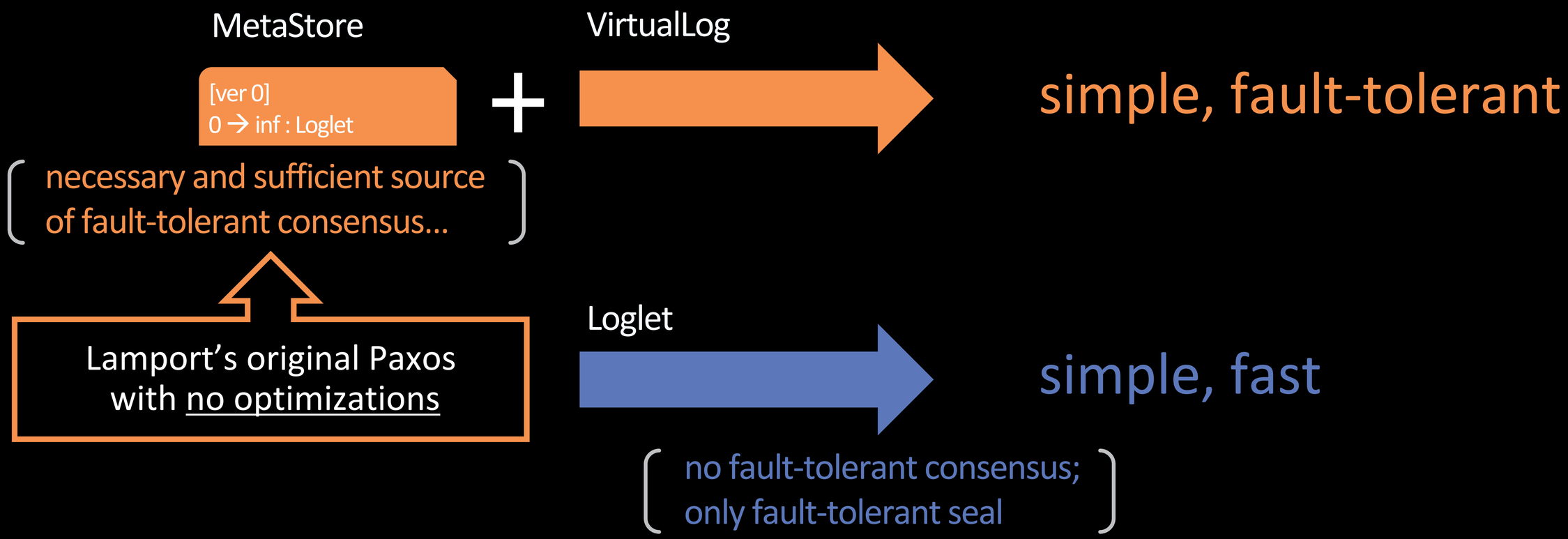

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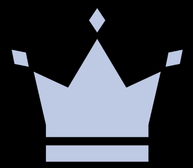
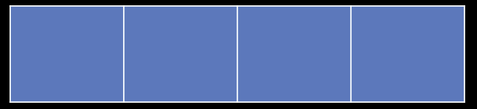
the NativeLoglet

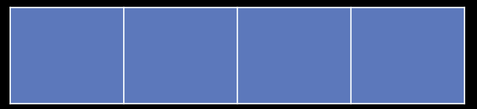
Delos Runtime (client)

sequencer

LogServer







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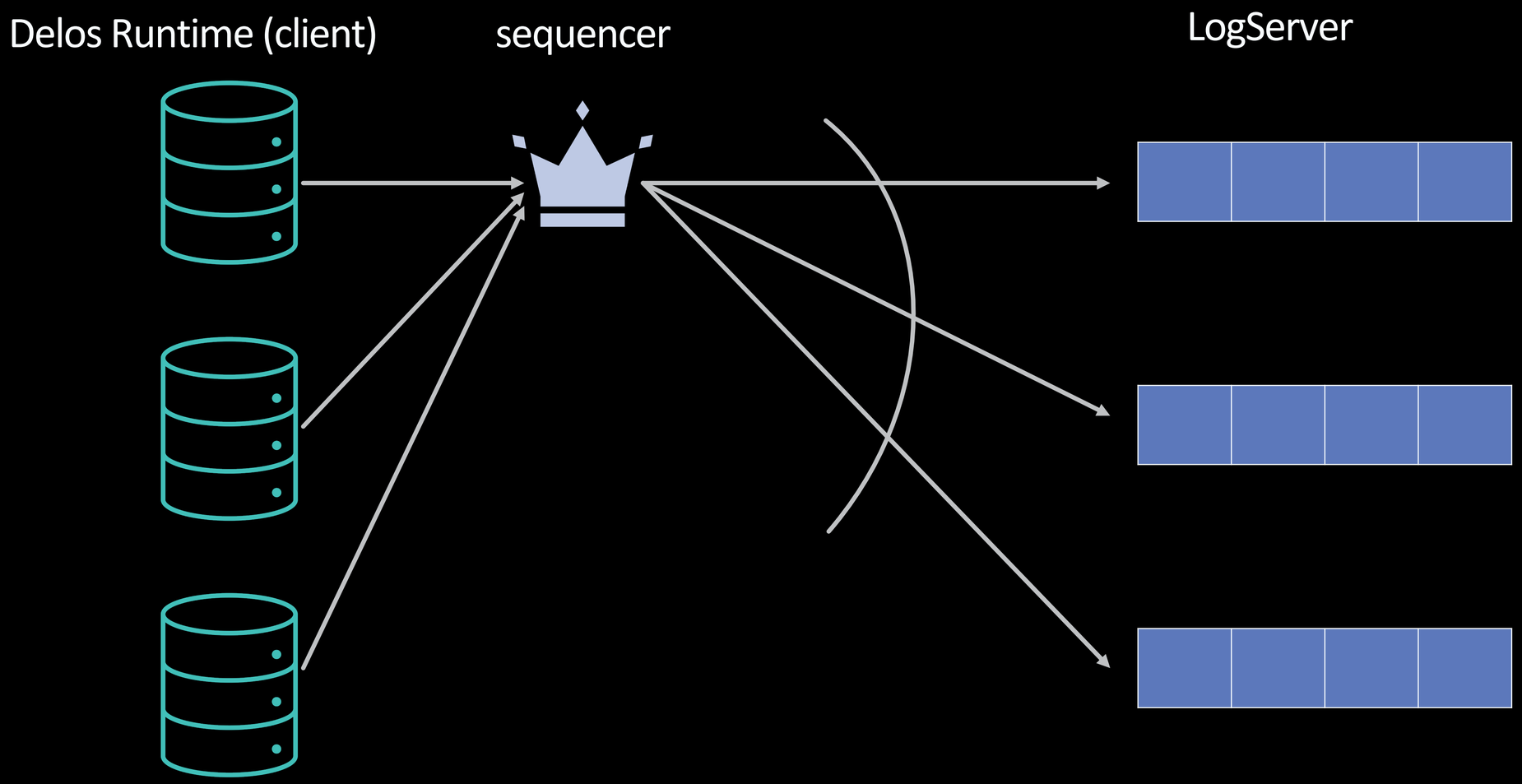

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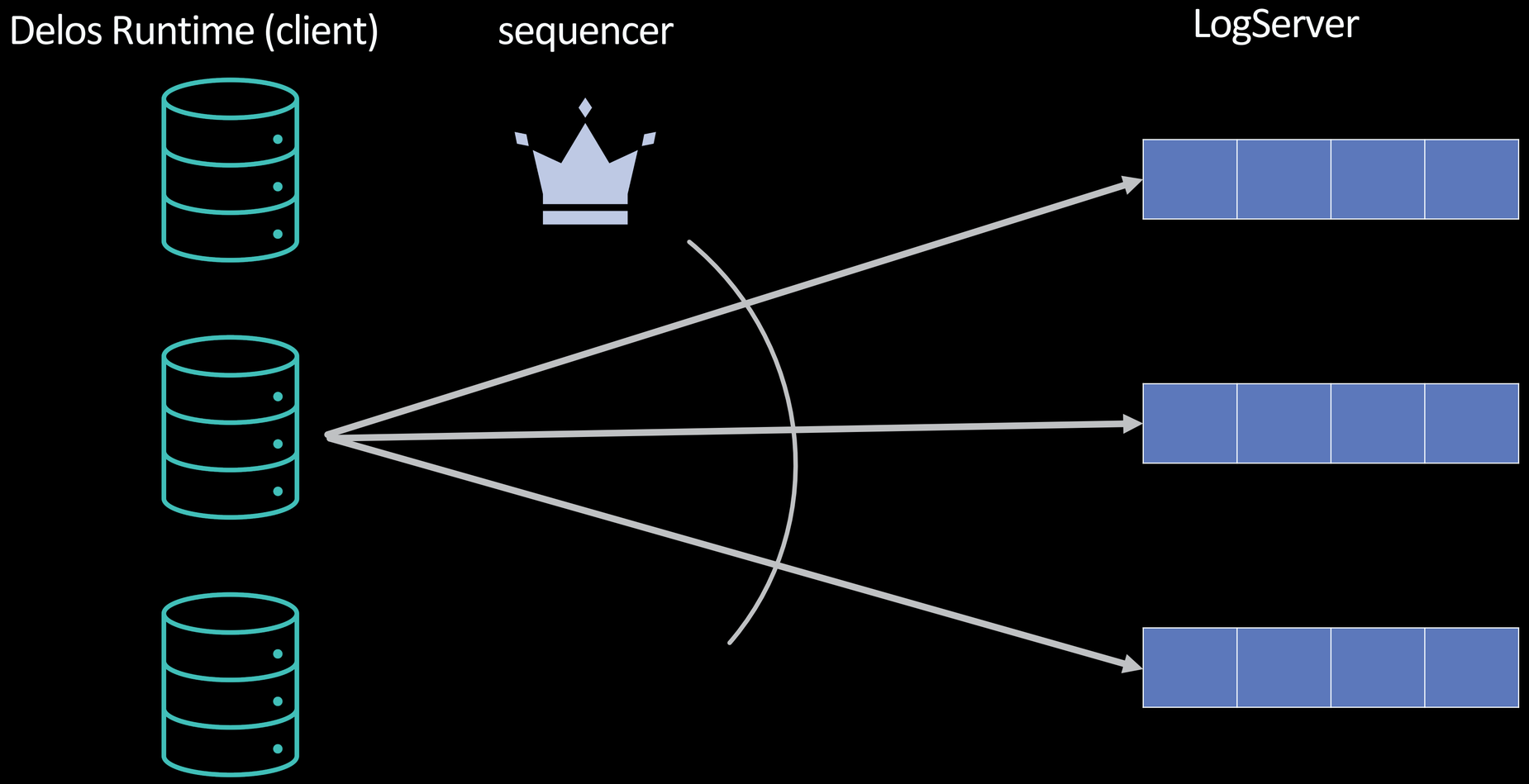

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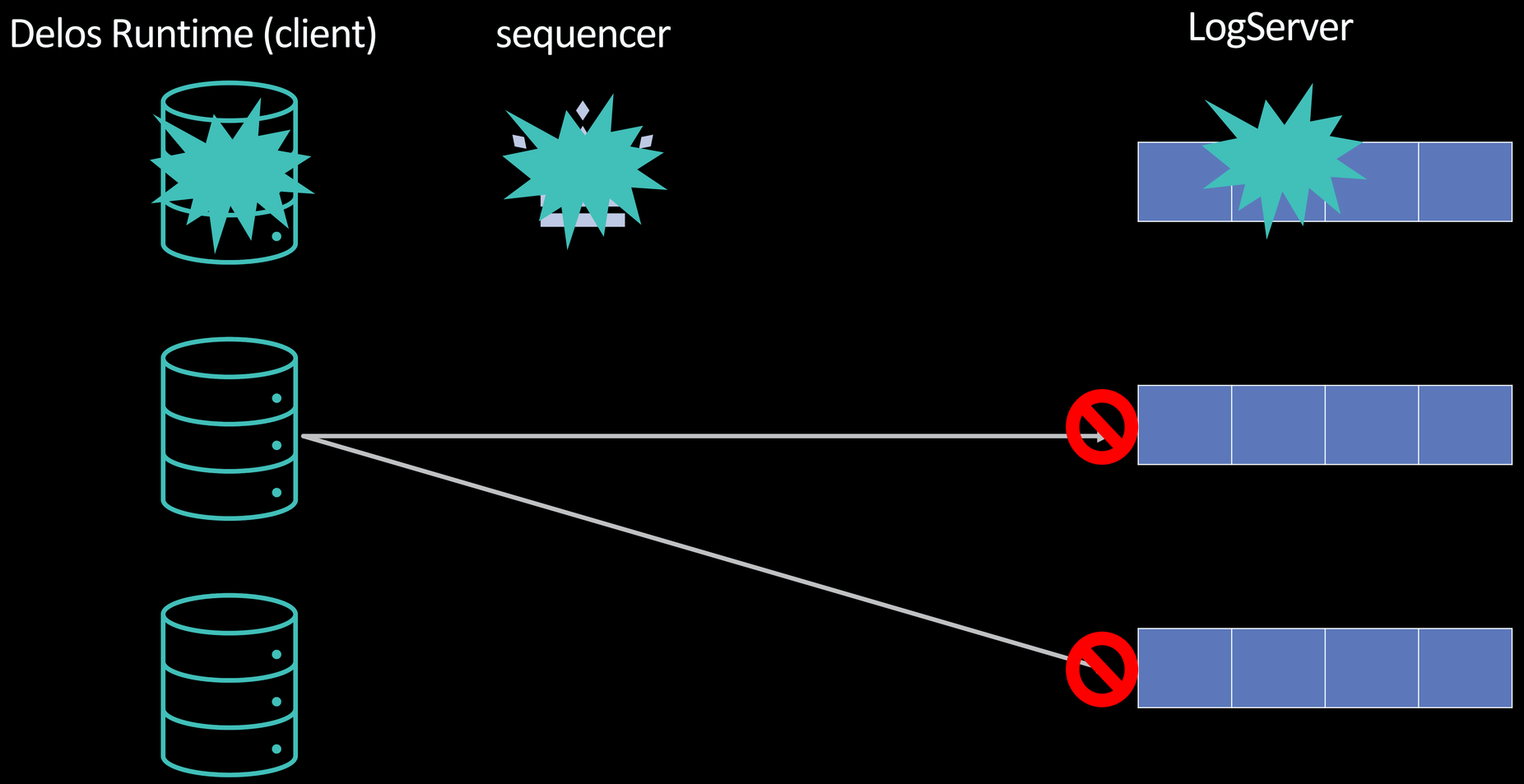

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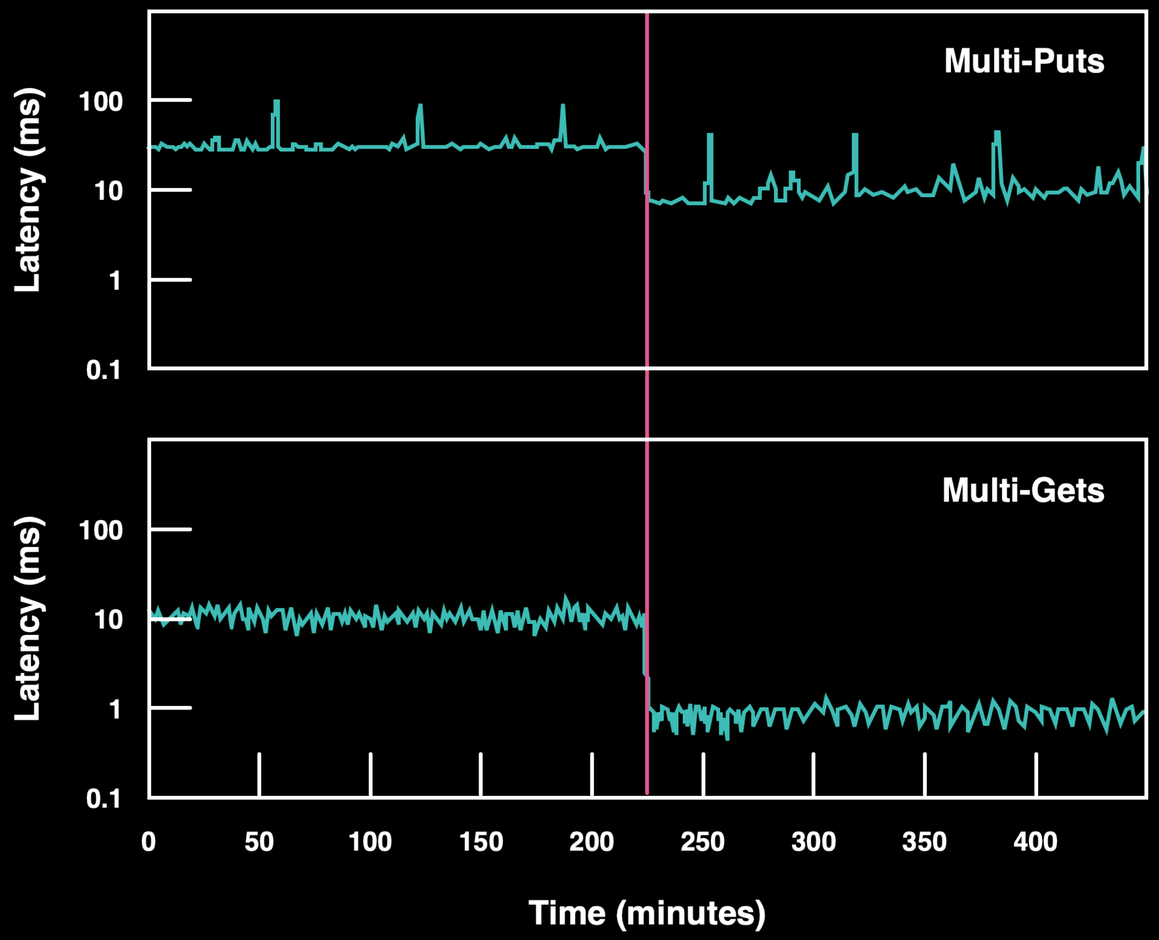
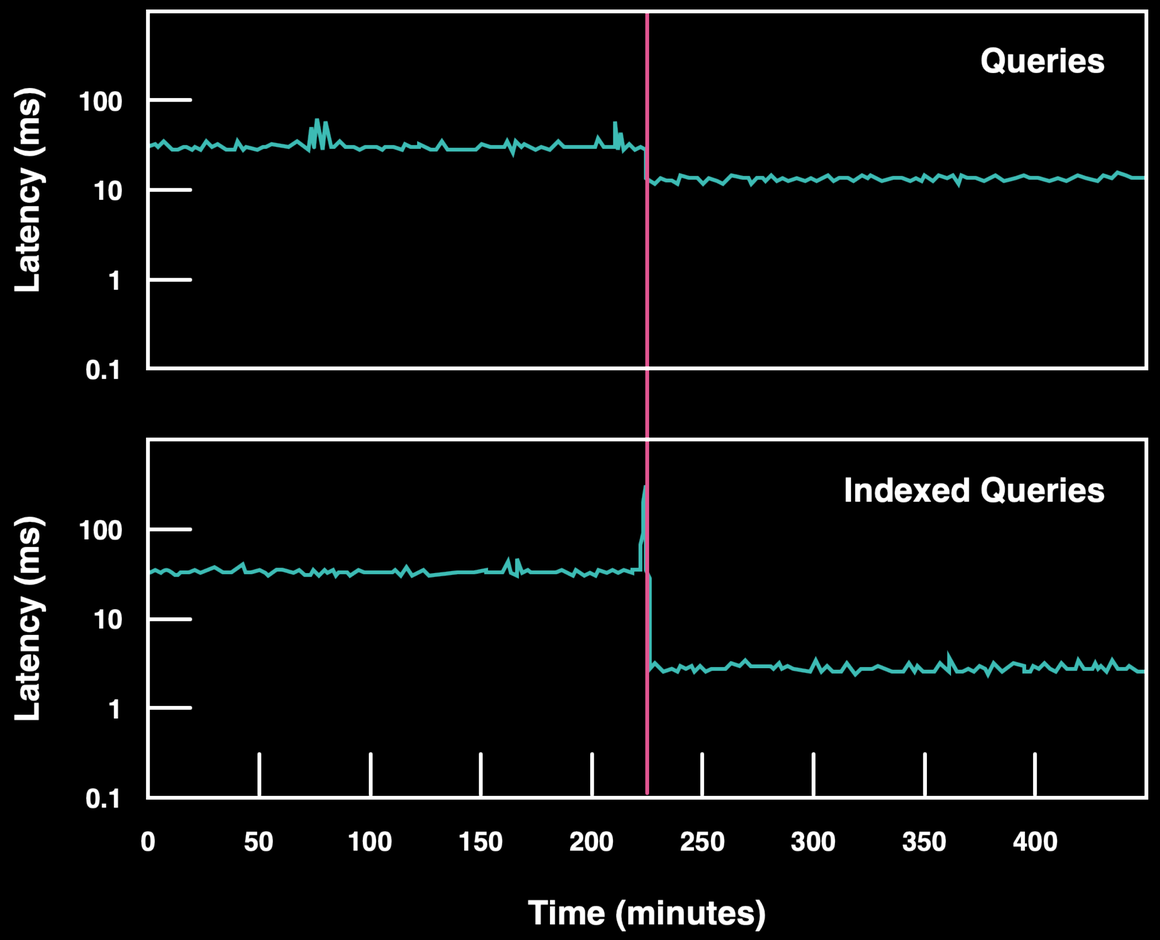
4 fault-tolerant seal

switching logs mid-flight





deploying Loglets: converged vs. disaggregated

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log+DB on each server:

- fast local log reads
- fate-sharing

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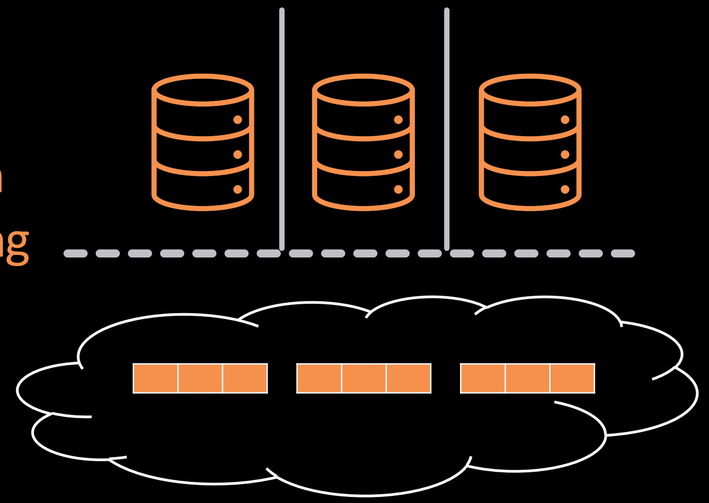

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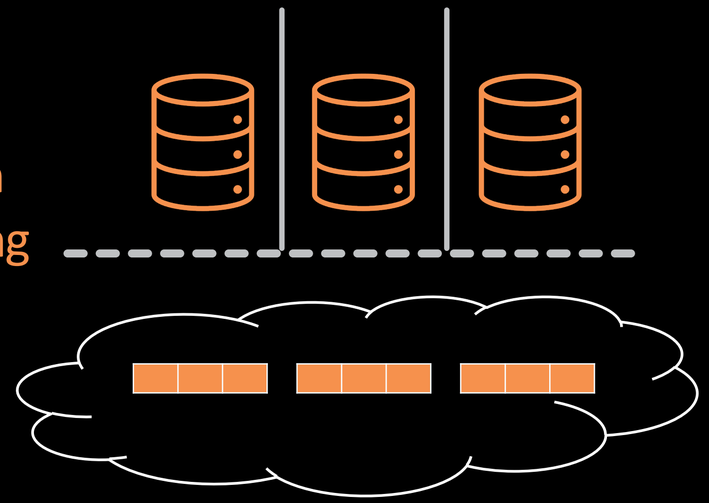

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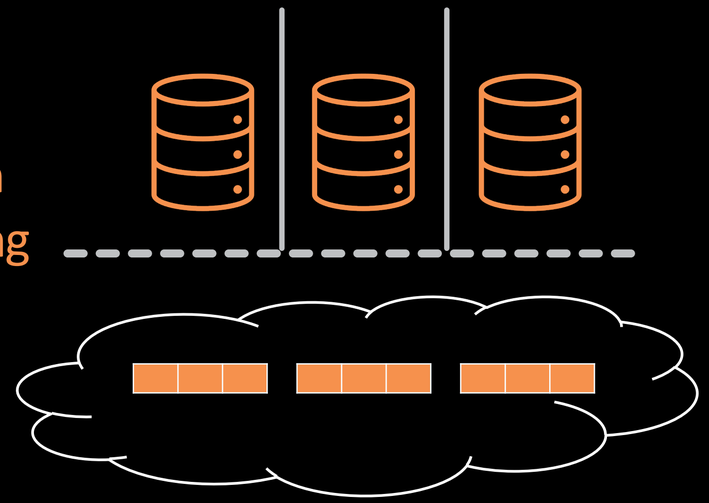

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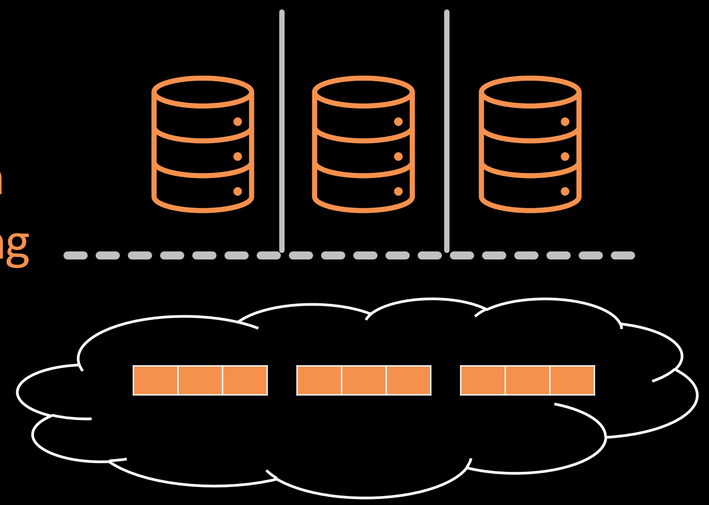

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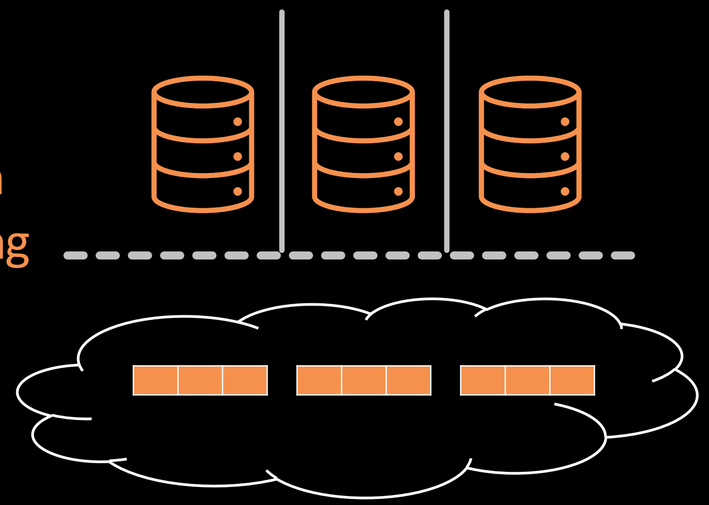

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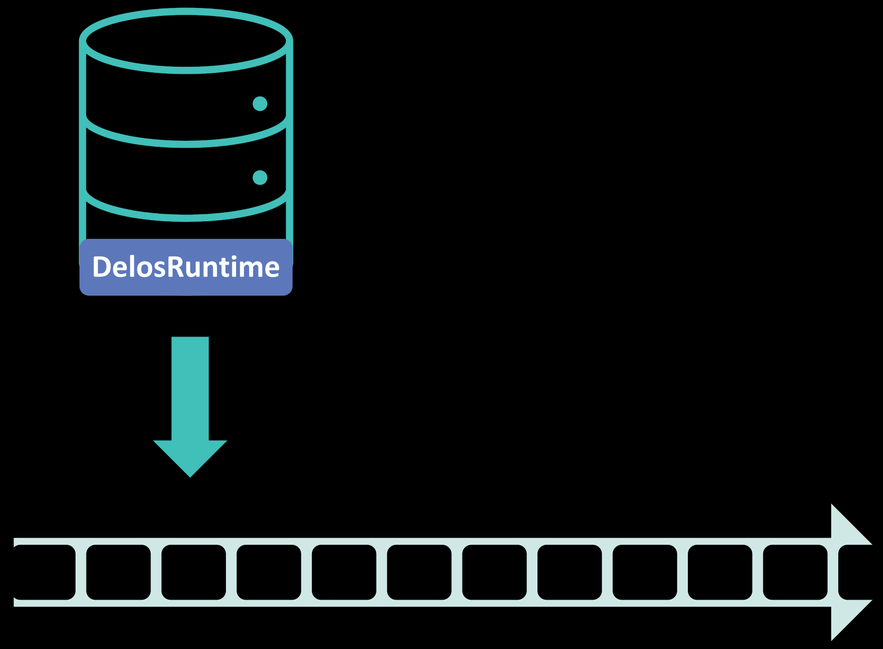
10X

higher throughput via disaggregation

composing Loglets: the StripedLoglet



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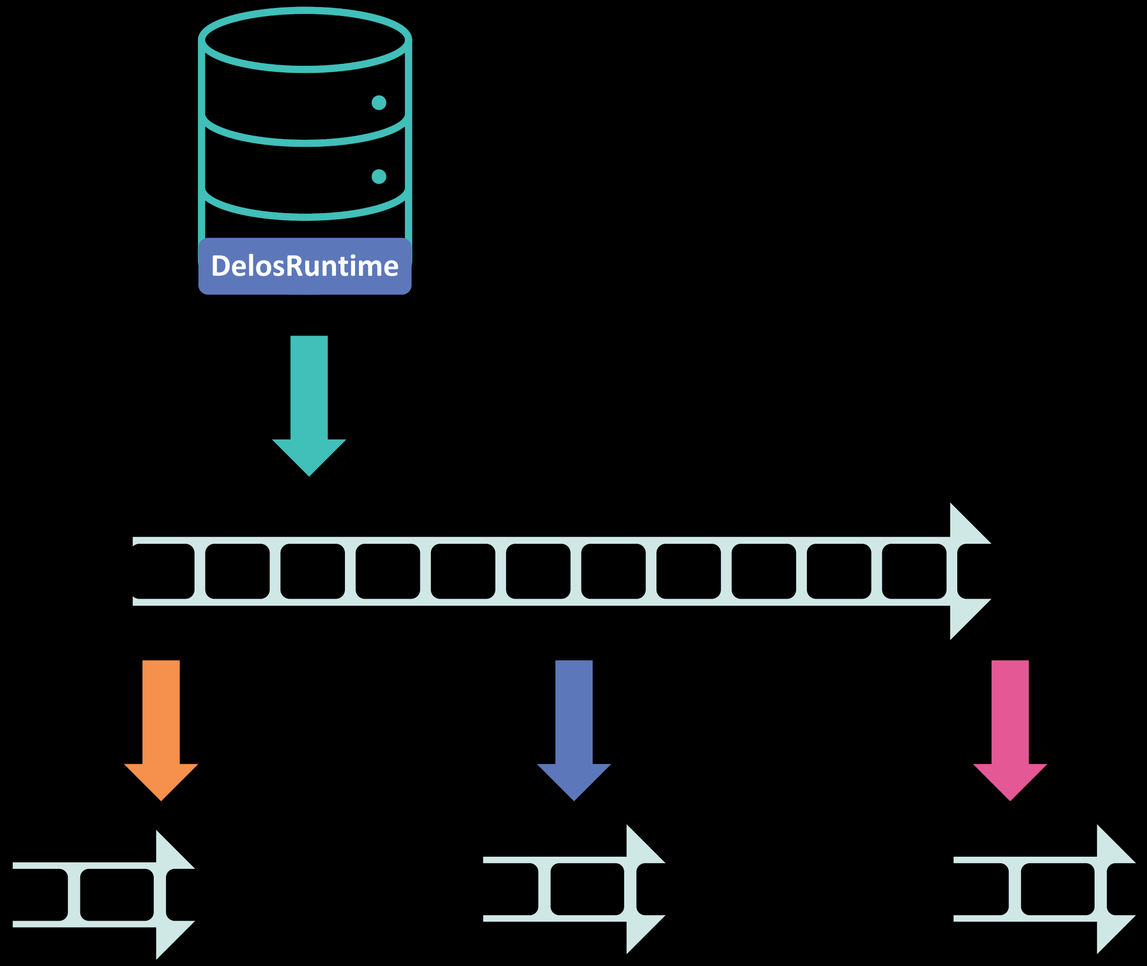
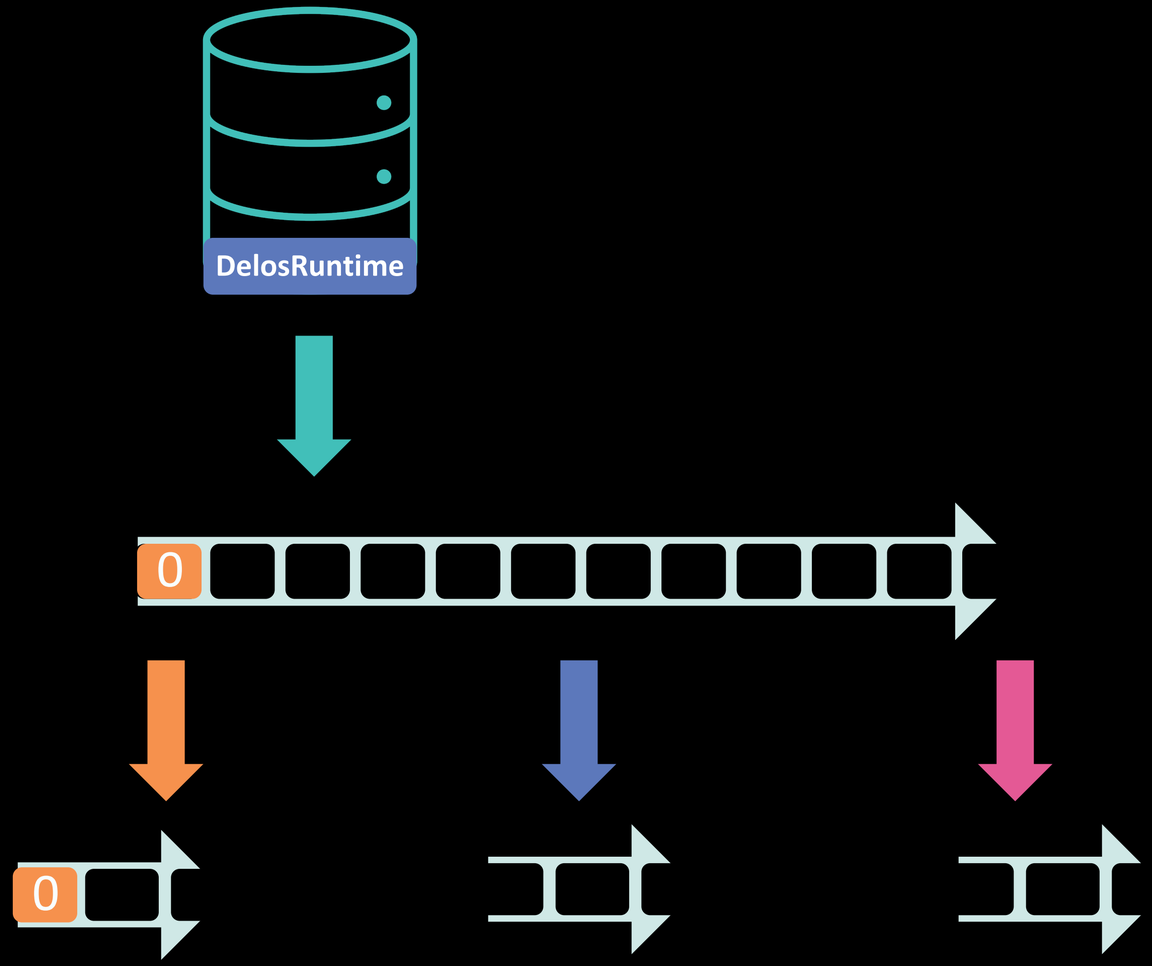


composing Loglets: the StripedLoglet



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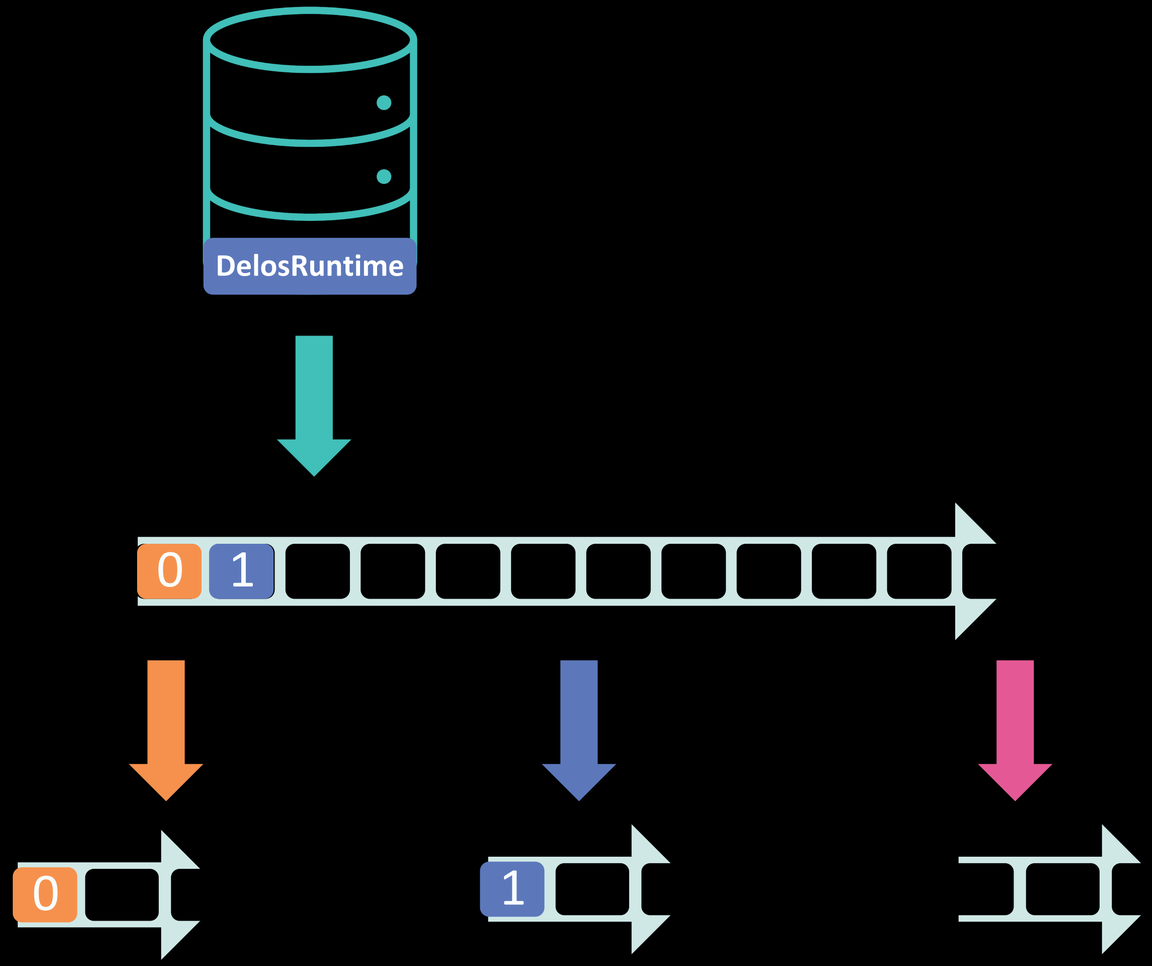

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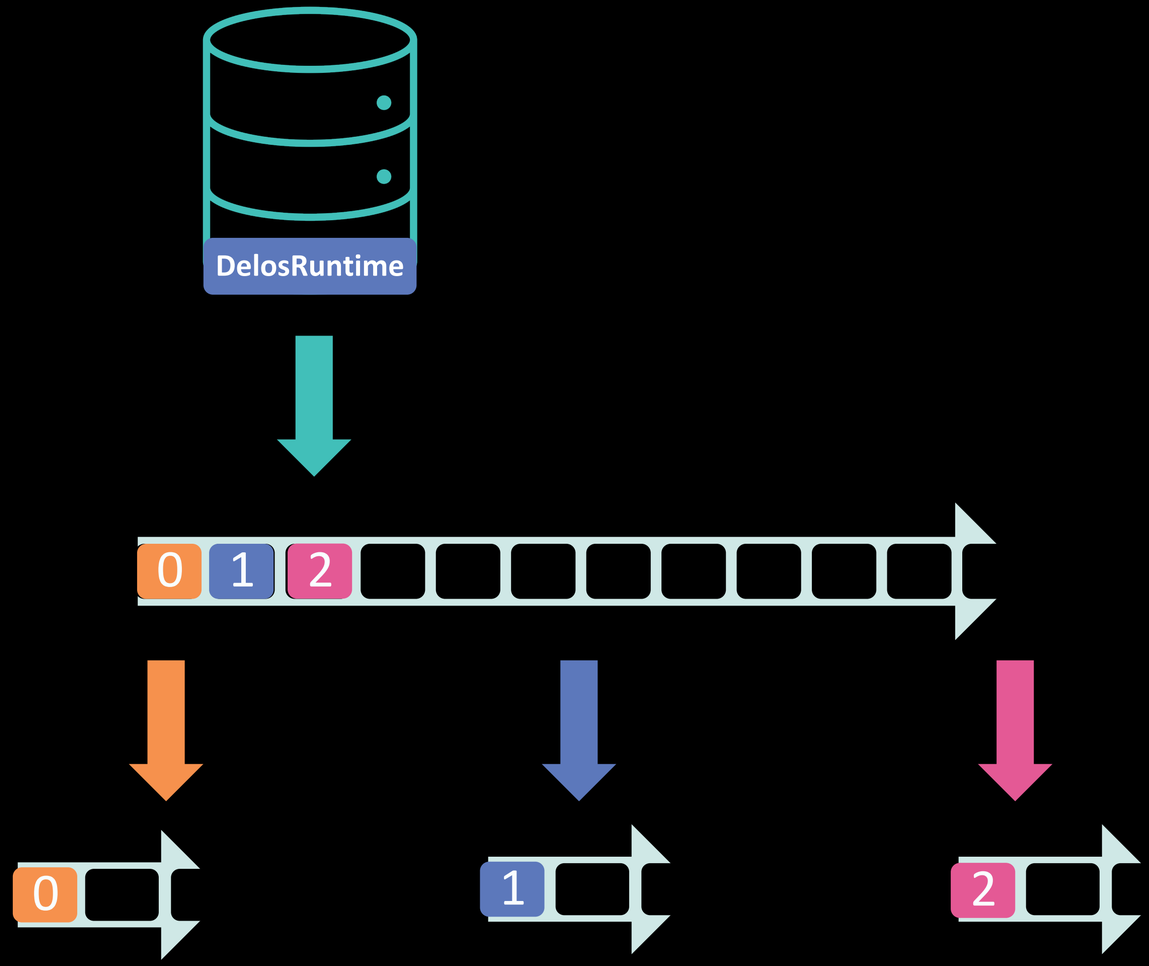

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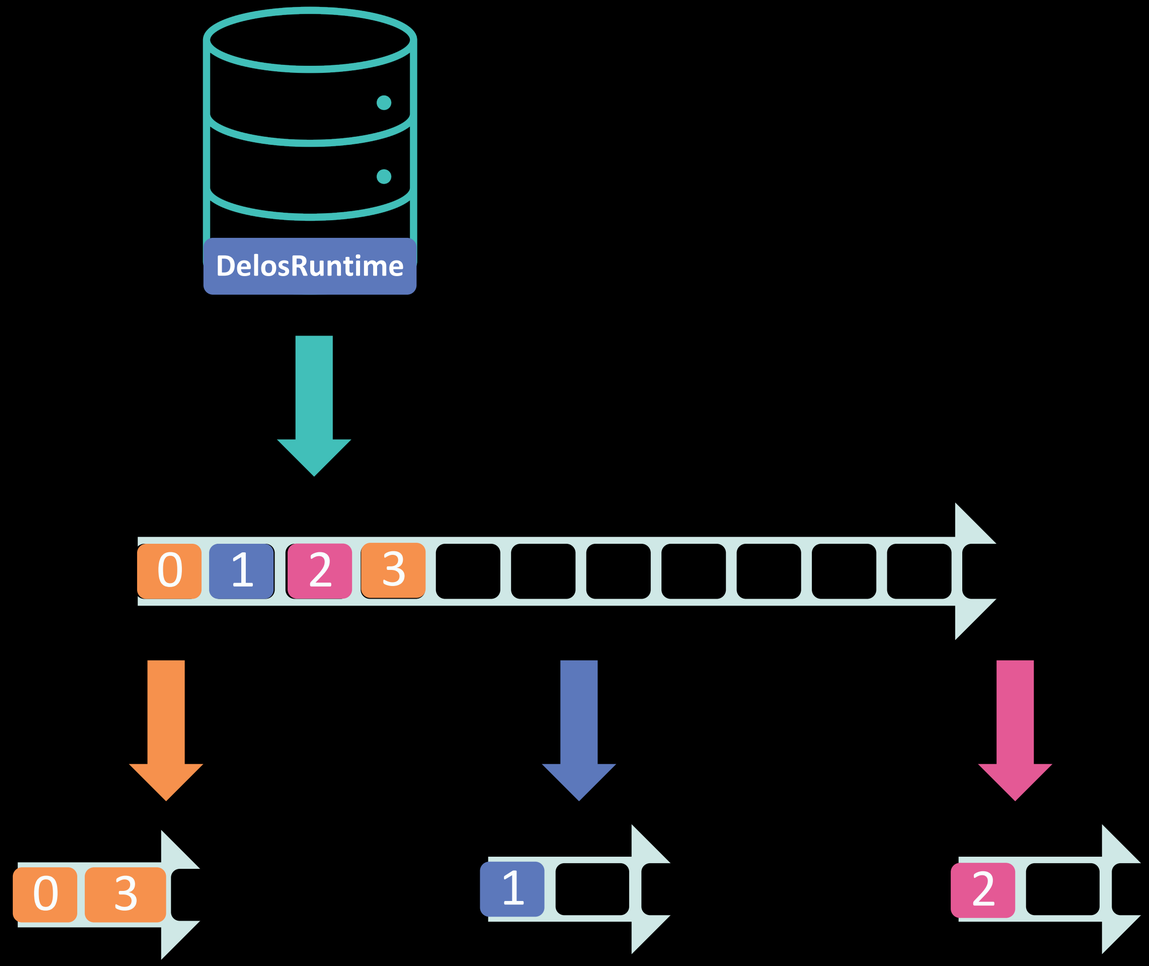

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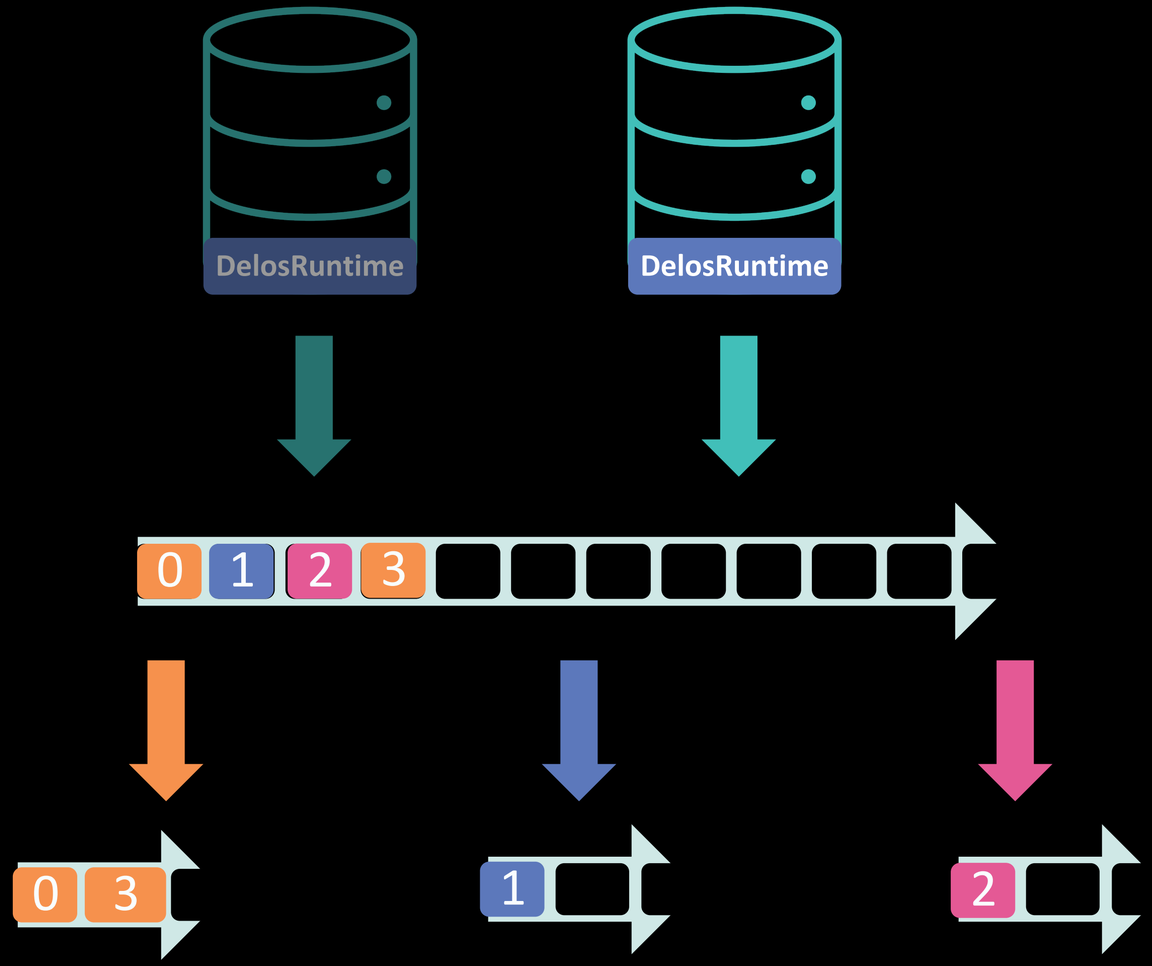

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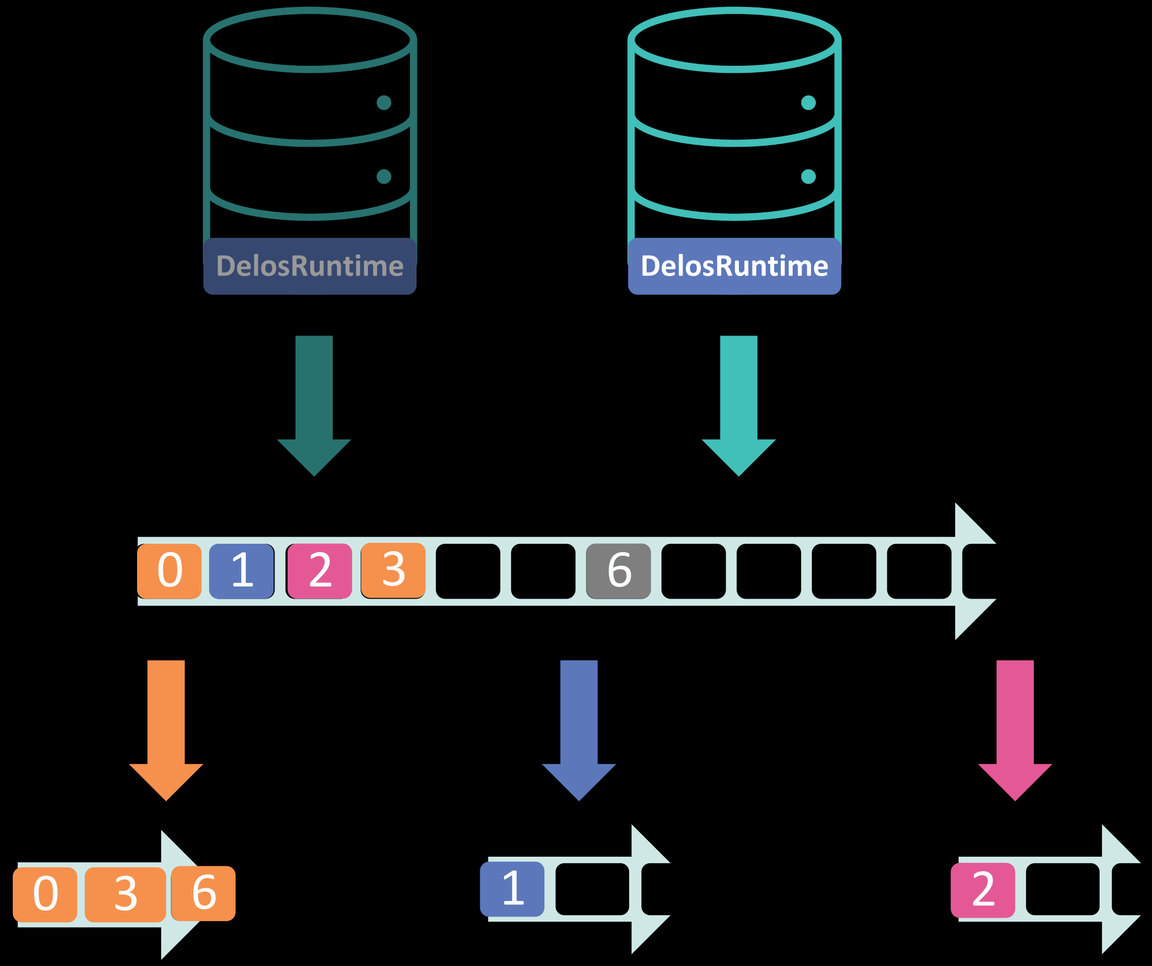

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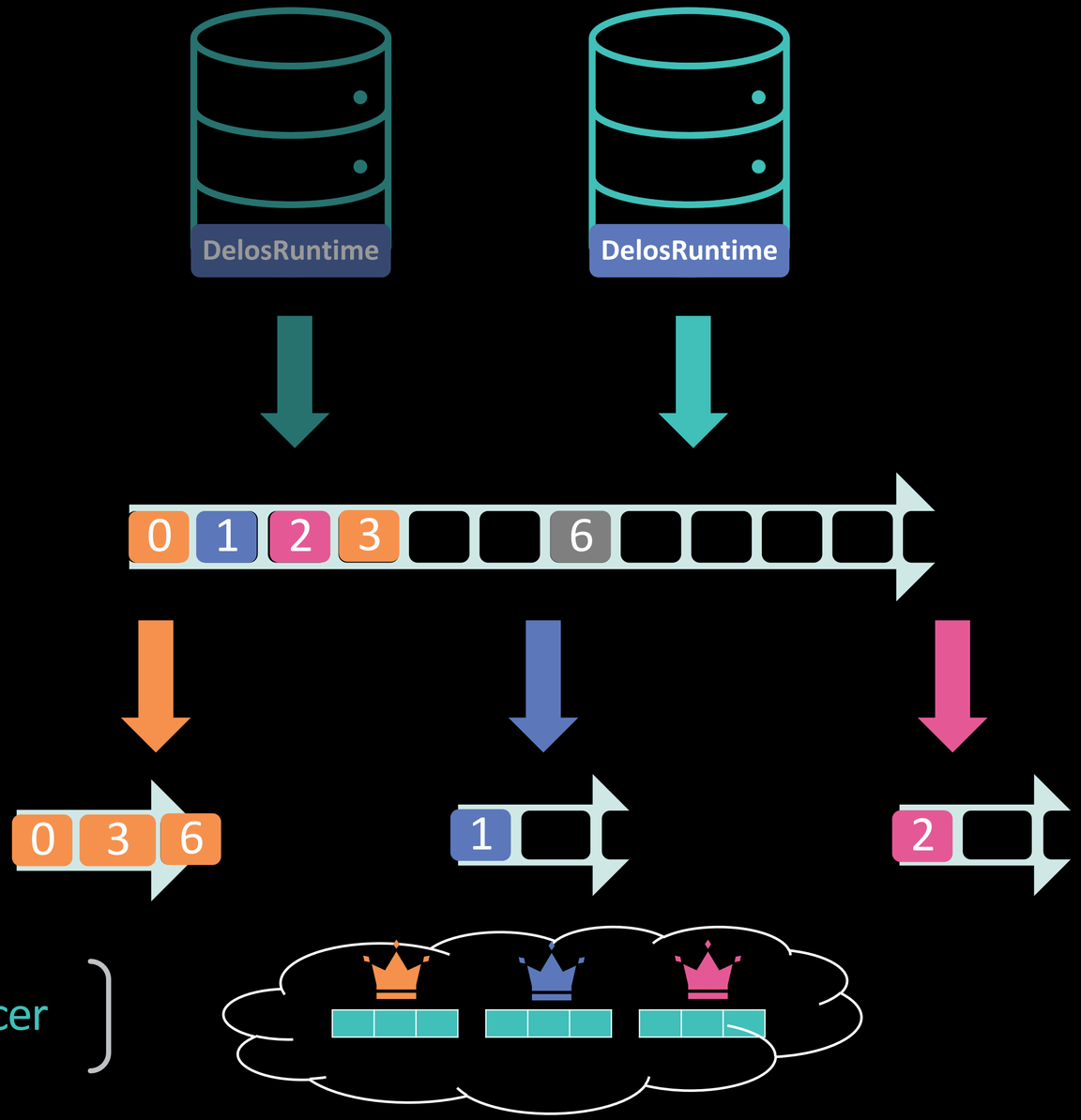

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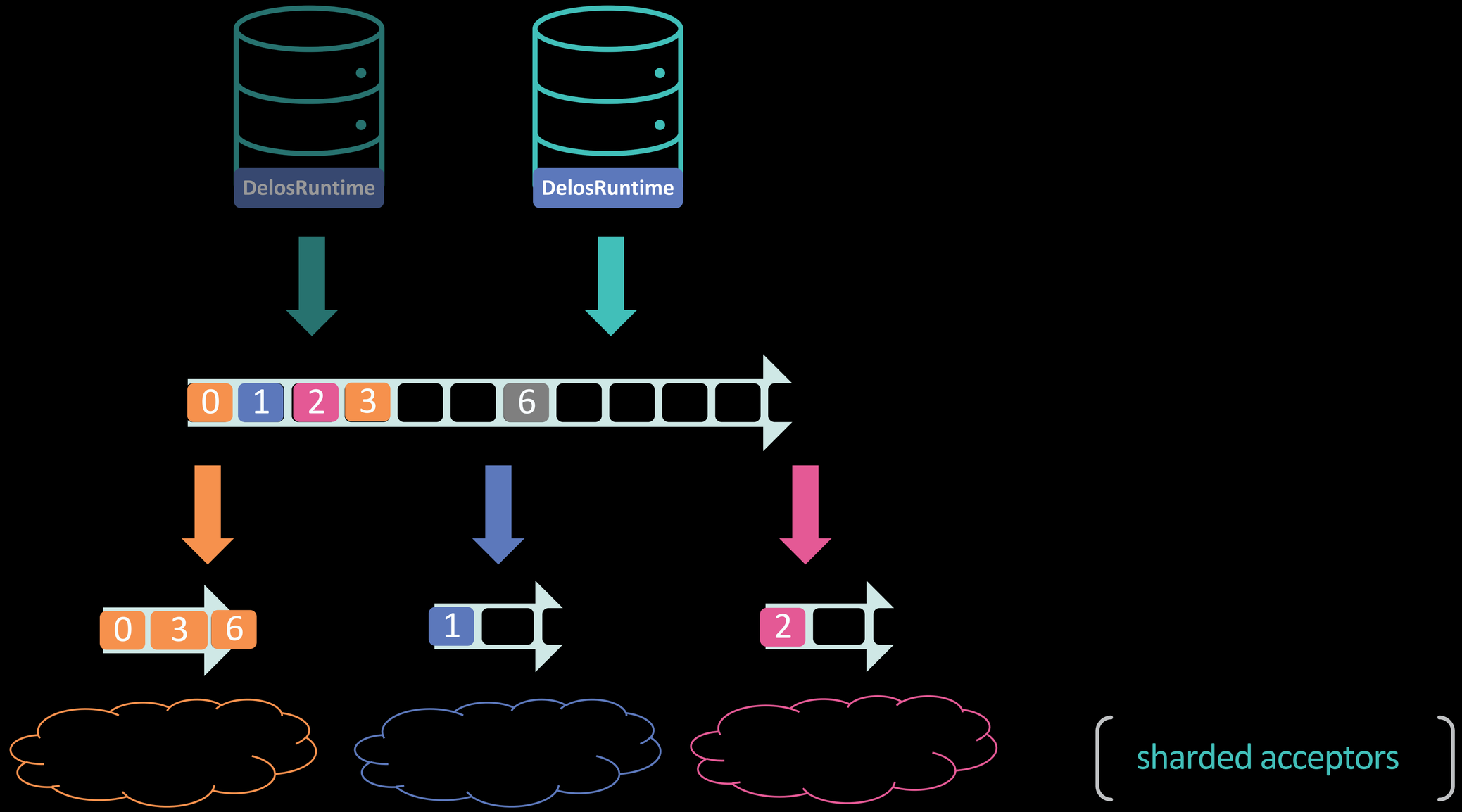

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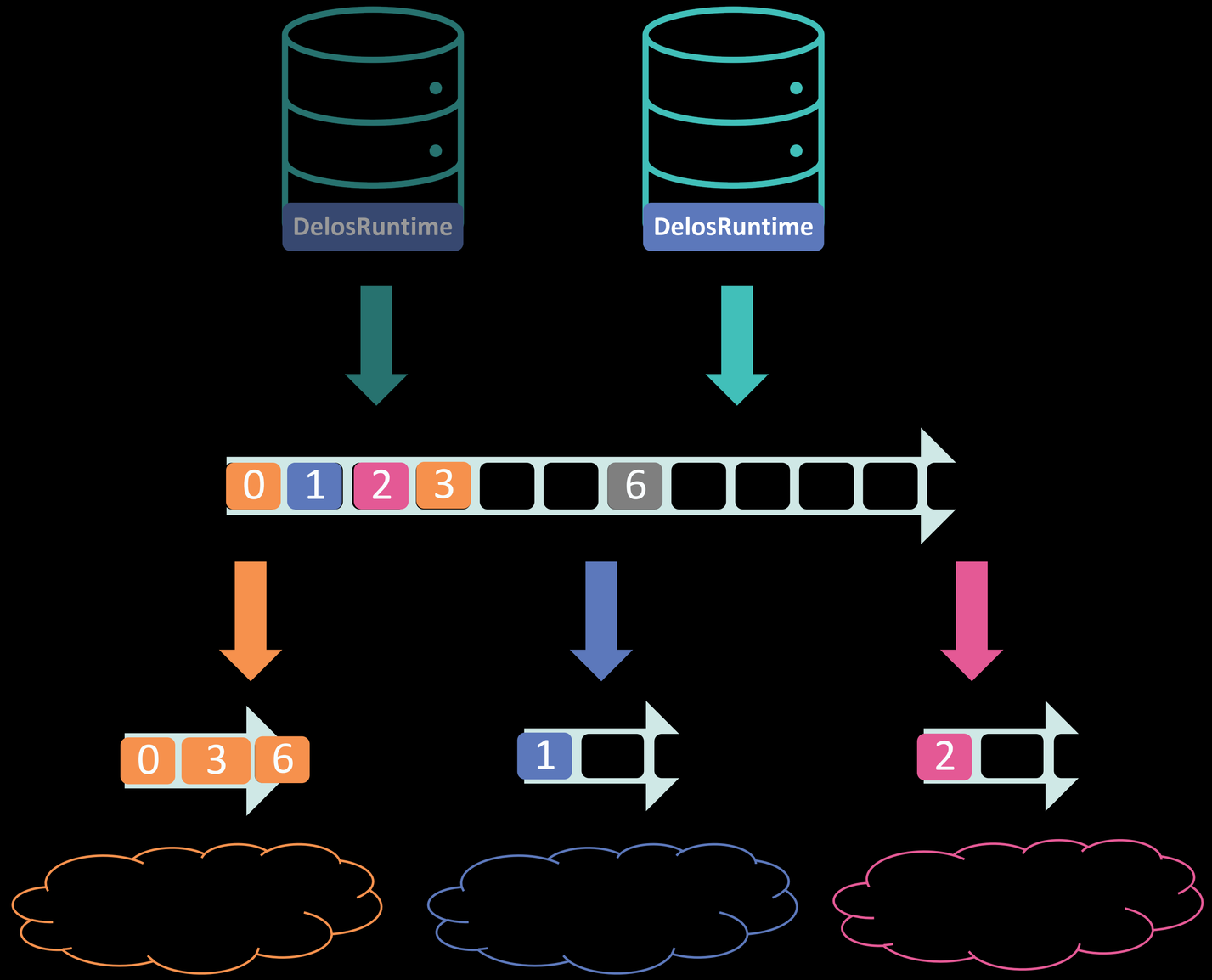
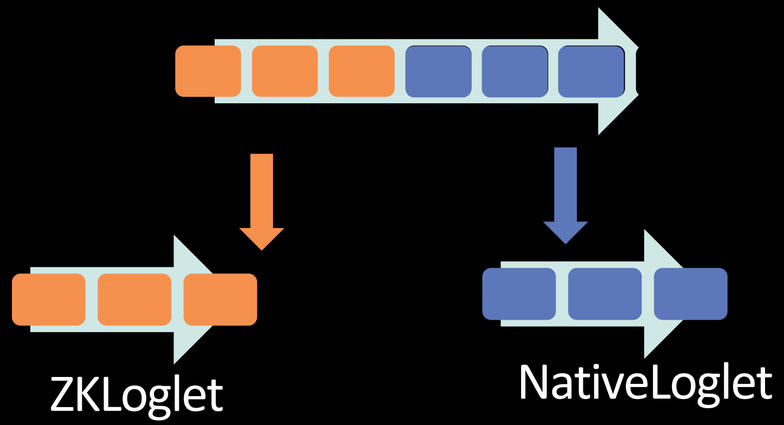


1M+

1KB appends/s with 30 stripes

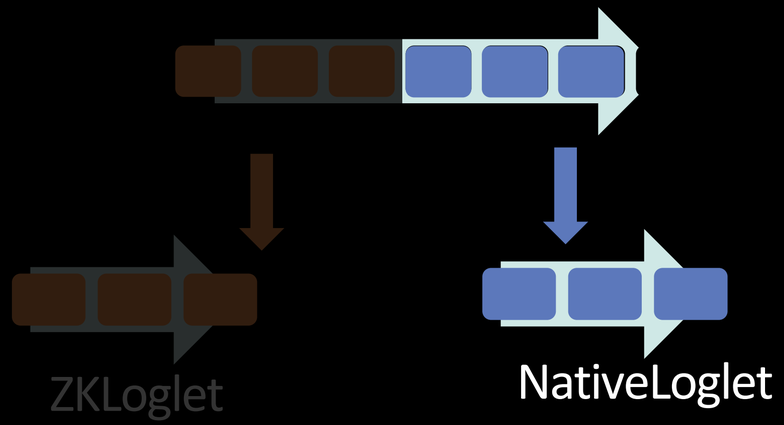
sharded acceptors

trimming the VirtualLog

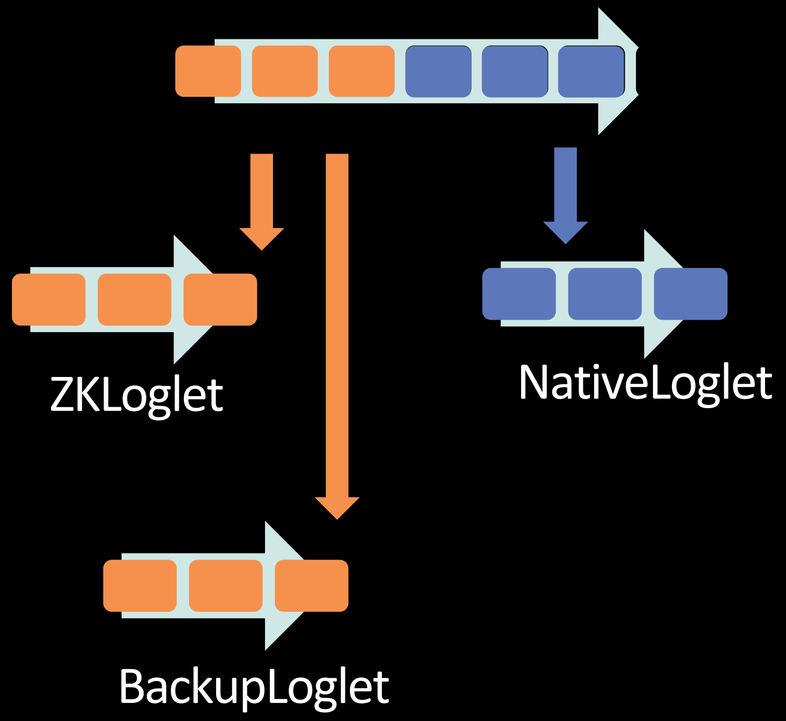


trimming the VirtualLog

trim cold segments



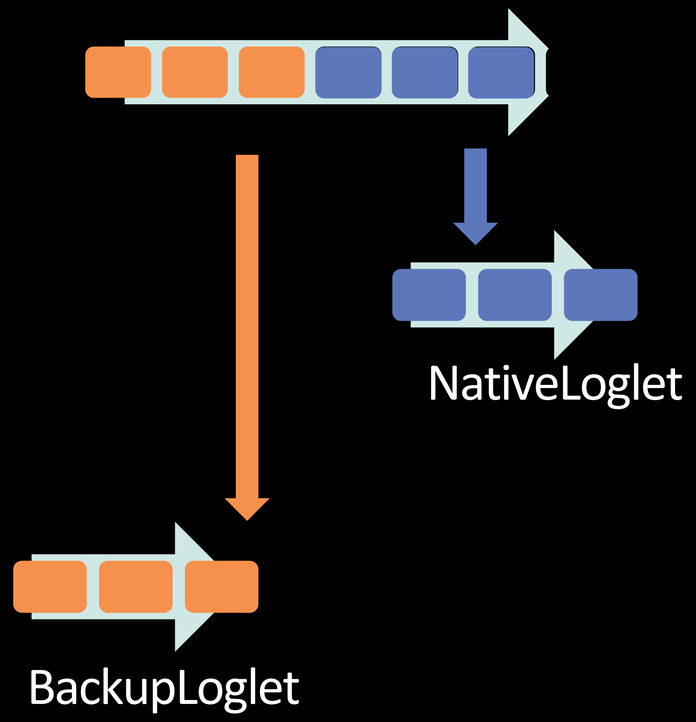
trimming the VirtualLog



trim cold segments

remap cold segments
- InfiniteLog → PiT restore
- more durability

trimming the VirtualLog



trim cold segments

remap cold segments
- InfiniteLog → PiT restore
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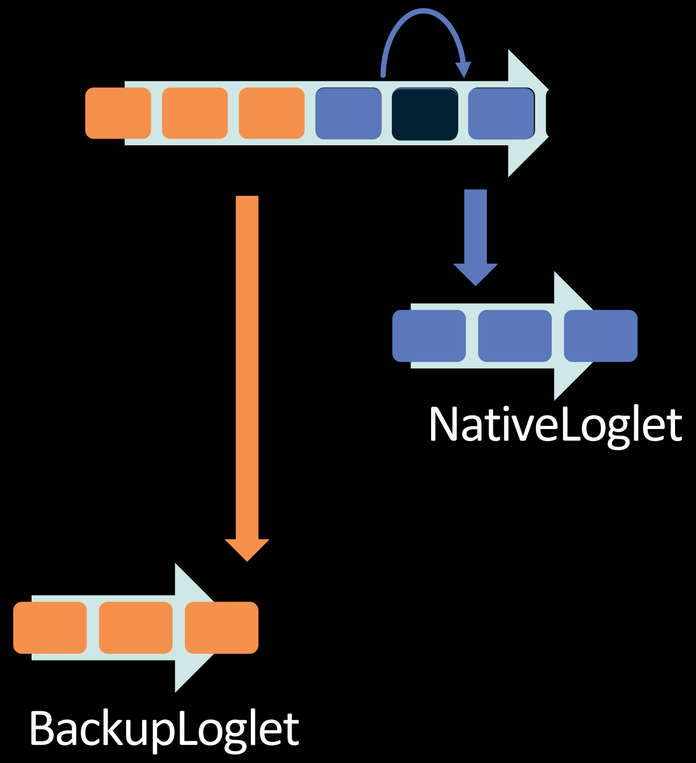
trimming the VirtualLog



trim cold segments

remap cold segments
- InfiniteLog → PiT restore
- more durability

remap single slots
- delete poison pill entries
- less durability

Delos as a platform

original goal: can we build a zero-dependency, fault-tolerant system with a rich API… *in months?*

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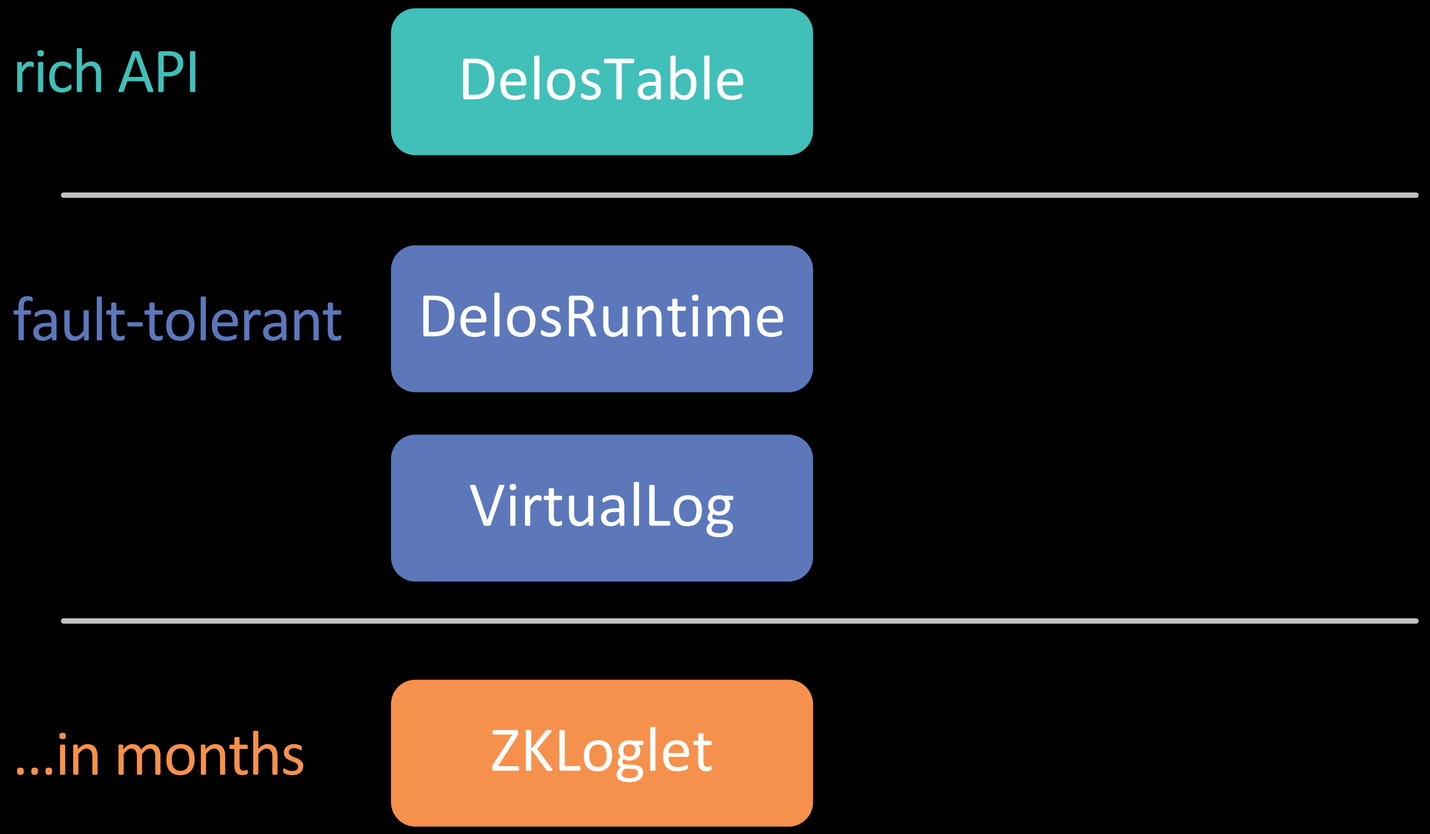

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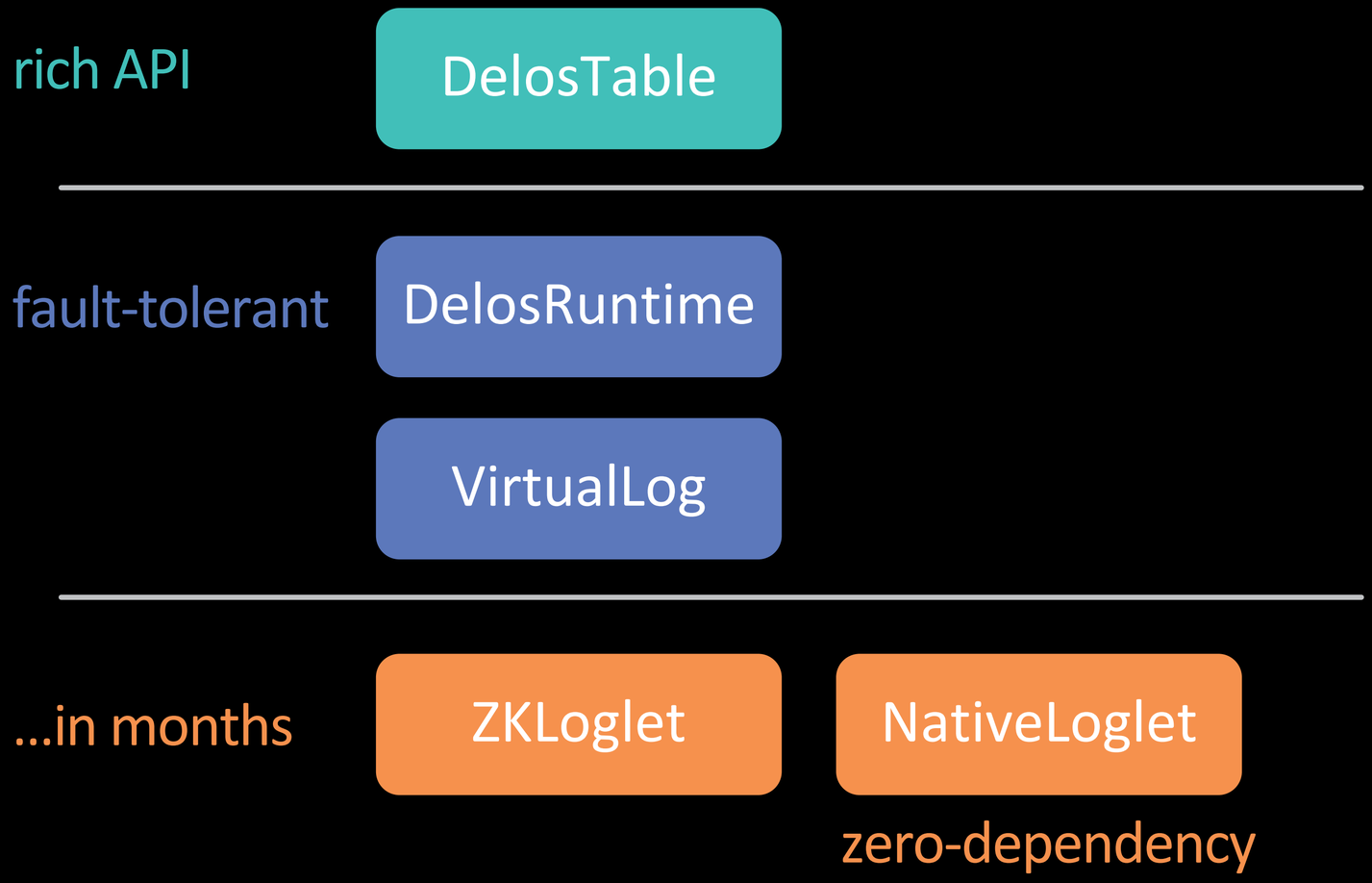

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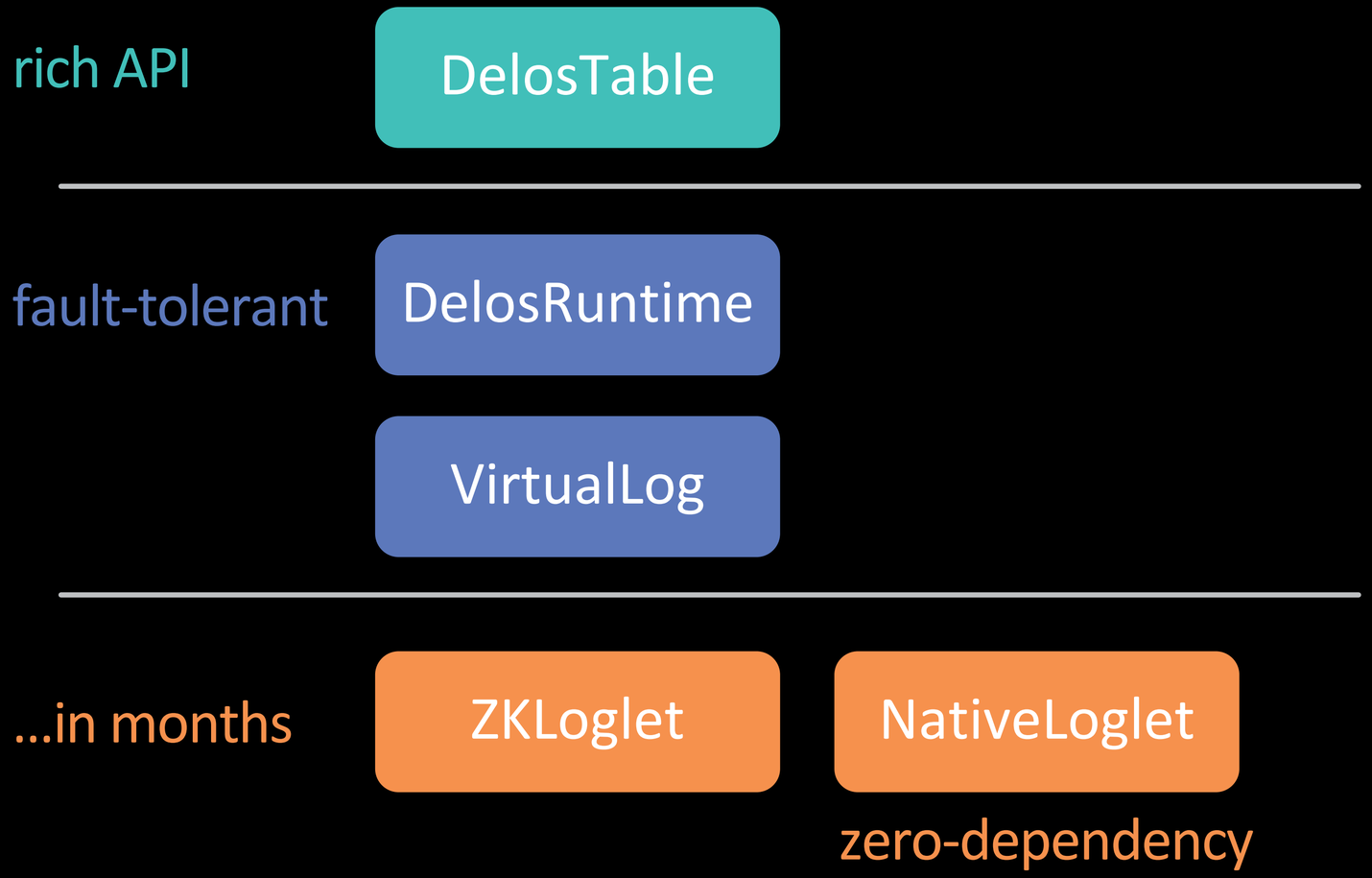

2
years in production

1.8B
TXes per day

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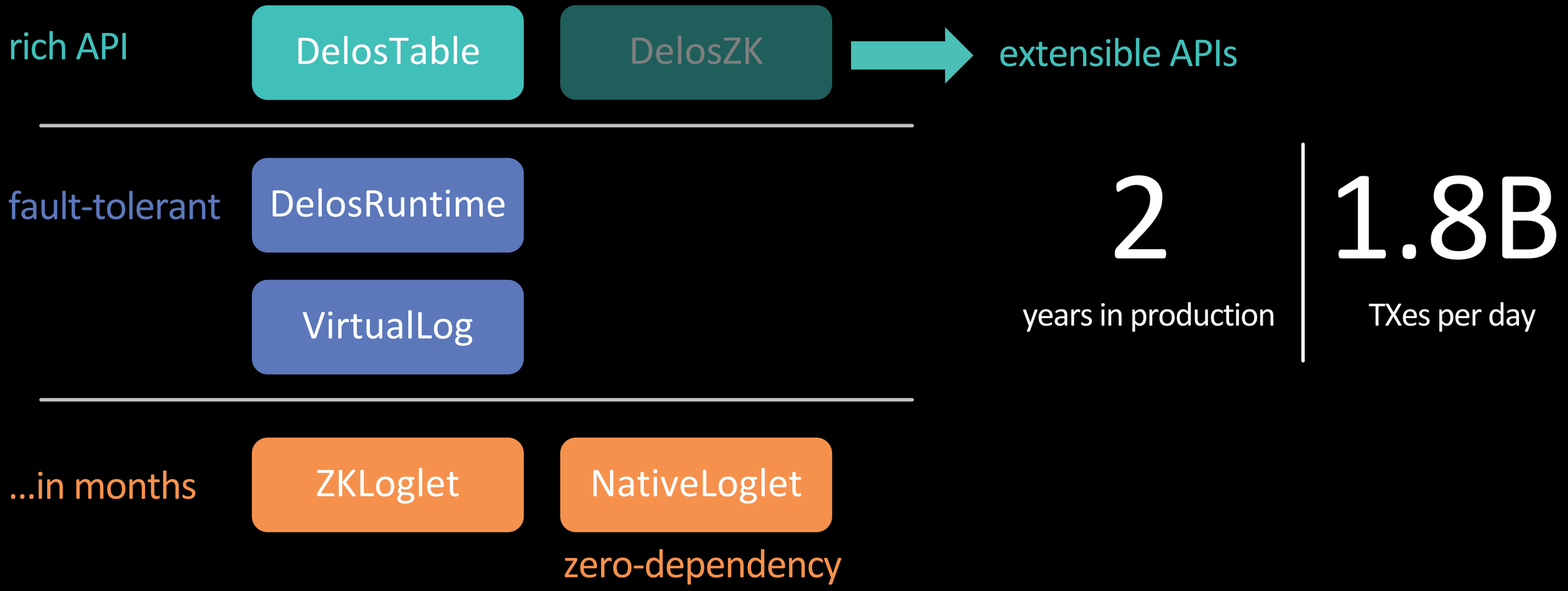

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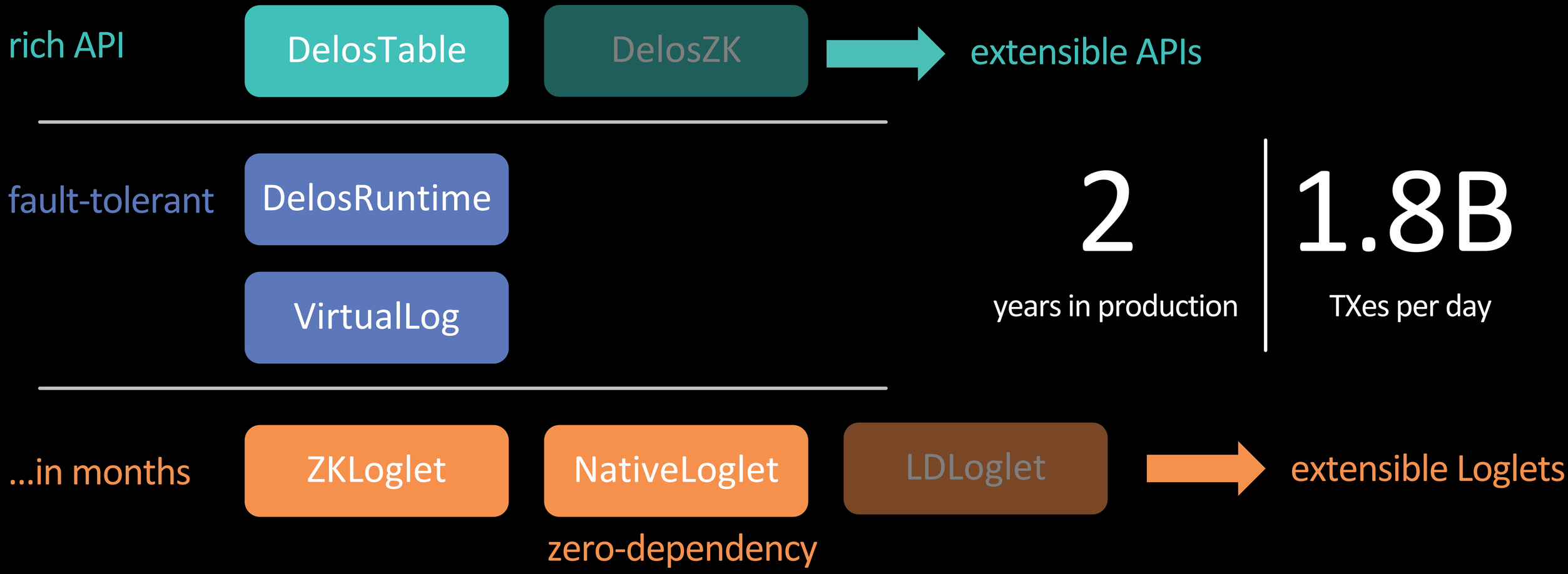

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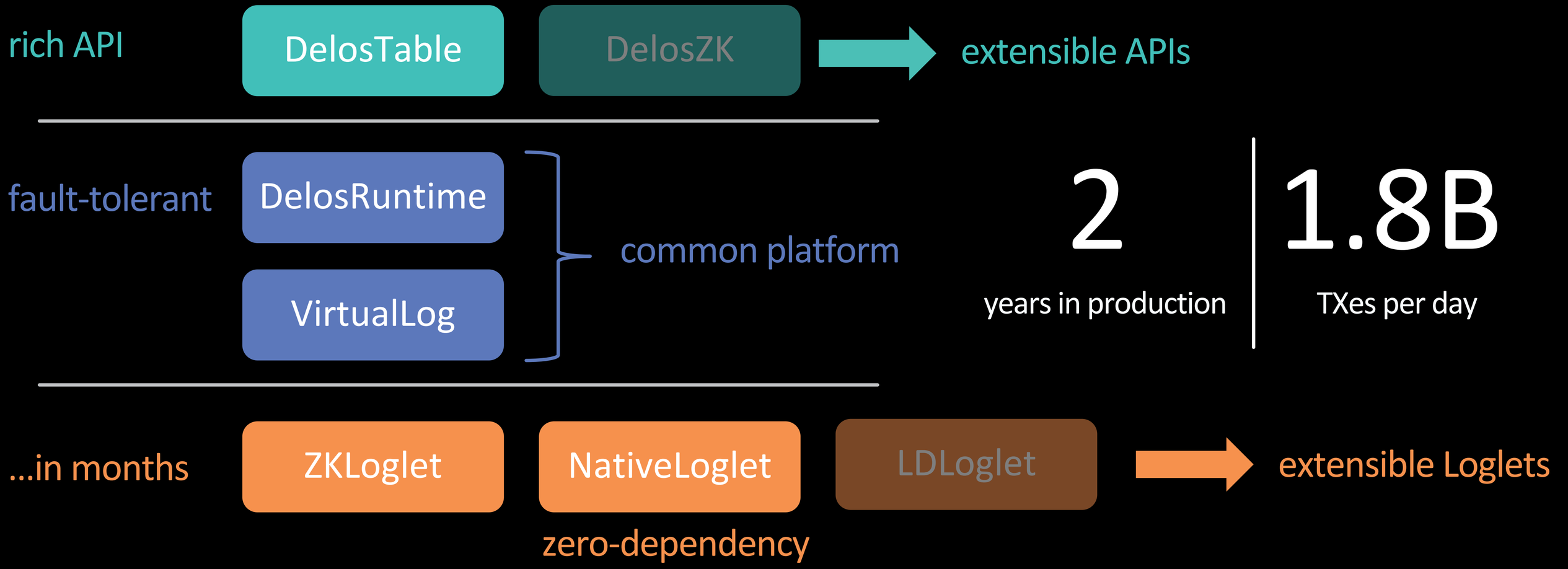


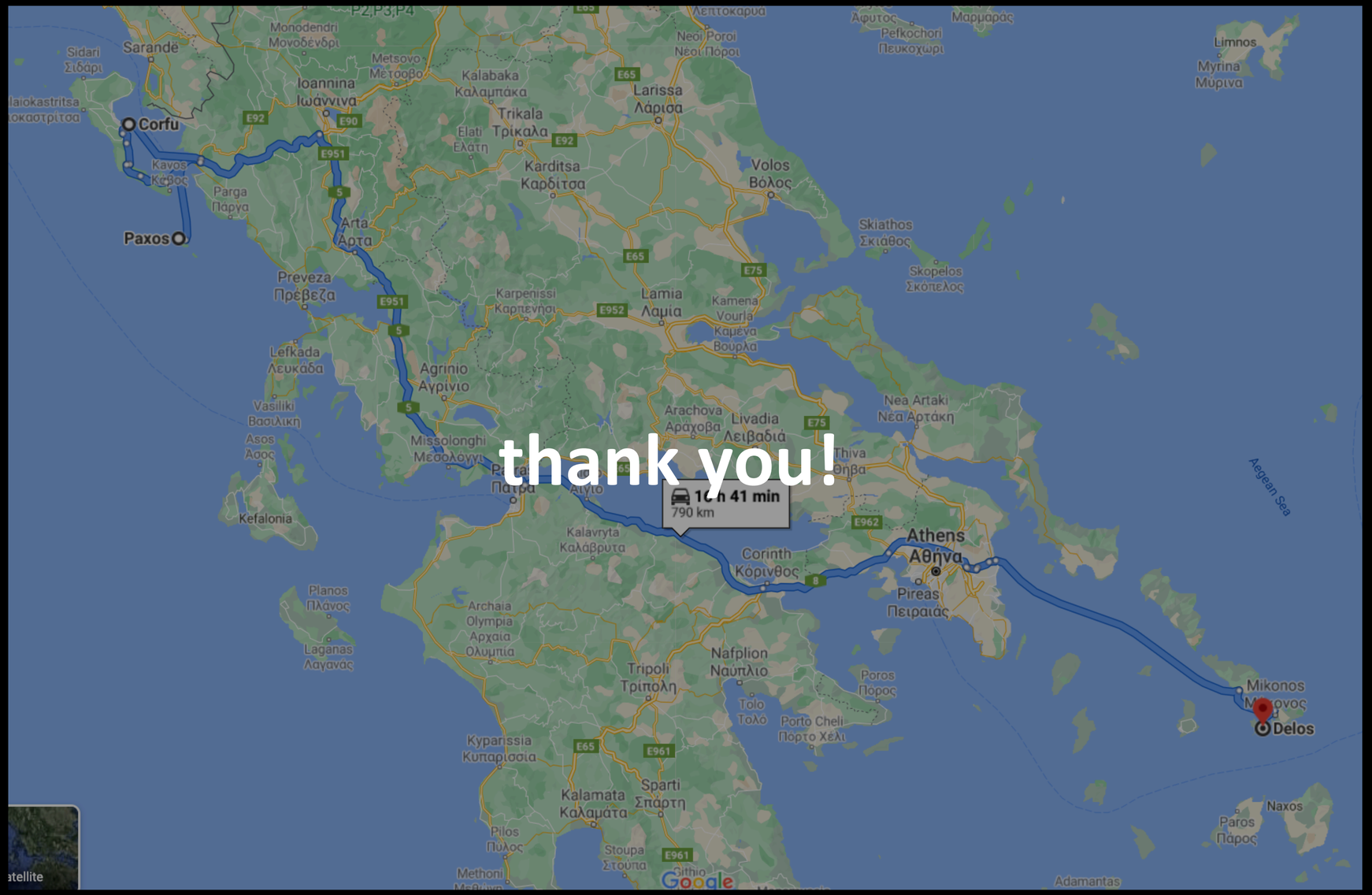
conclusion

Delos is a new storage system at the bottom of the Facebook stack

virtualizing consensus allowed us to develop and deploy new protocols

production benefits immediately from new research…

…new research can reach production quickly



contact: mbalakrishnan at fb.com