Caching At Twitter and moving towards a persistent, in-memory key-value store

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Outline

- Caching System Architecture
- Twemcache
- Twemproxy
- Learnings
- in-memory persistent store

Cache In Production

~30 TB of cache

> 2000 instances of caches

~500 machines

Average cache instance is **15G**

~2 trillion queries/day

23 million queries/sec

Cache Systems

Cache is an Optimization for

CPU

Disk (write through / write back)

Cache API

CRUD API (memcache)

set("key", "value")
get("key")
delete("key")
....

DS API (redis)

push("key", "element-1")
pop("key")
get("key", "index")
....

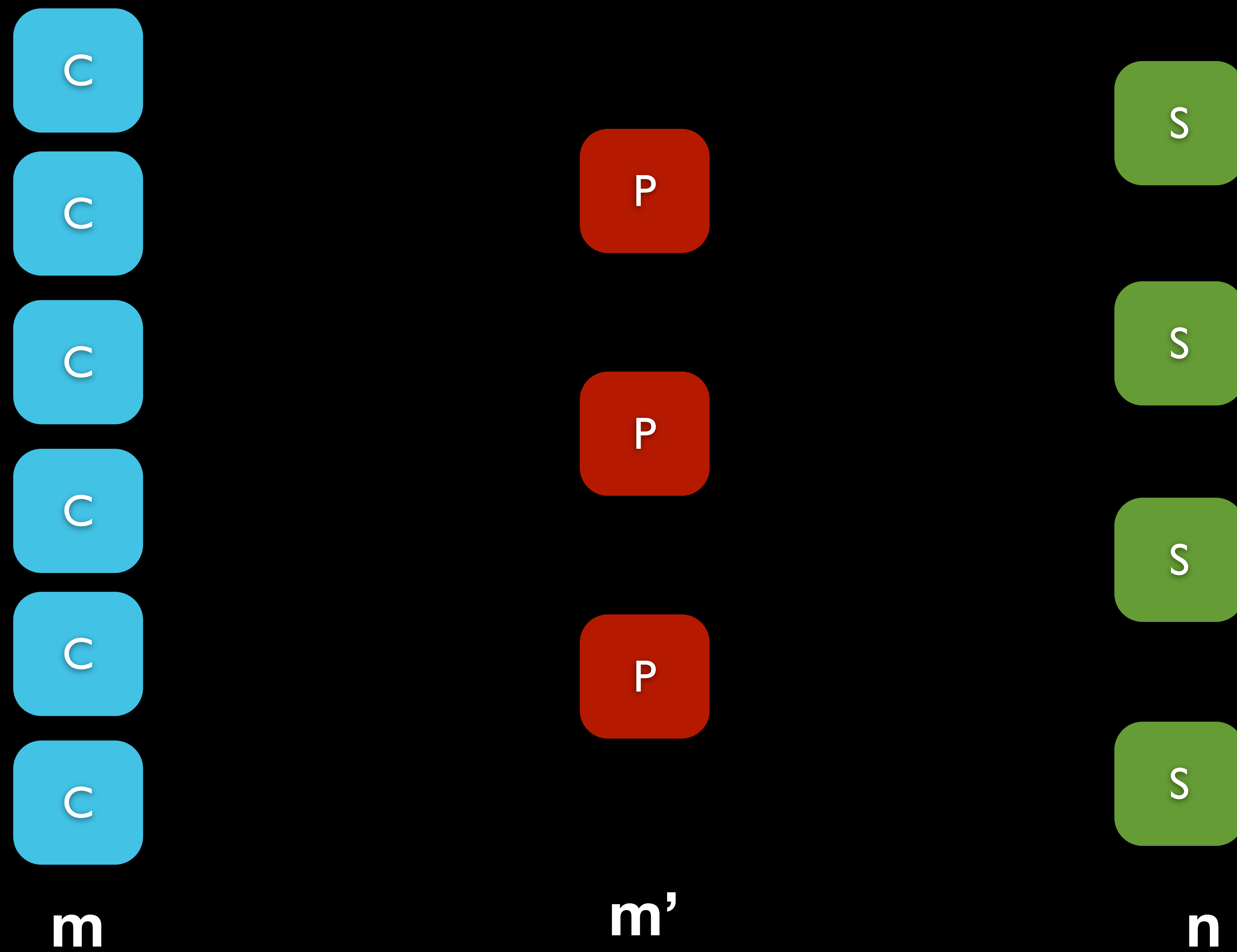
Caching System: Components

Simple distributed components

- Client
- Proxy
- Server

- Routing / Sharding
- Heartbeating / Liveness
- Protocol Encoder / Decoder
- Object Store

Client, Proxy & Server



m >> n
m’ < n

Twemcache

Based on memcached 1.4.4

Running in production since Jan ’11

code: github.com/twitter/twemcache

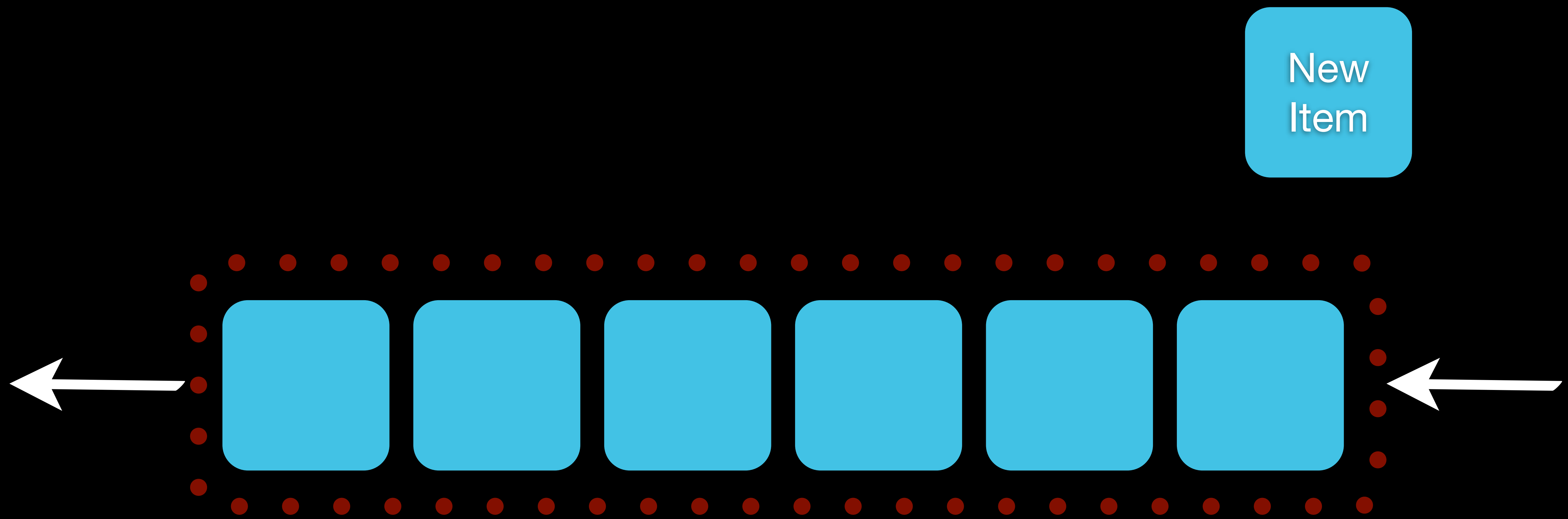
Features

Custom Eviction Algorithm

Thread-local stats collector

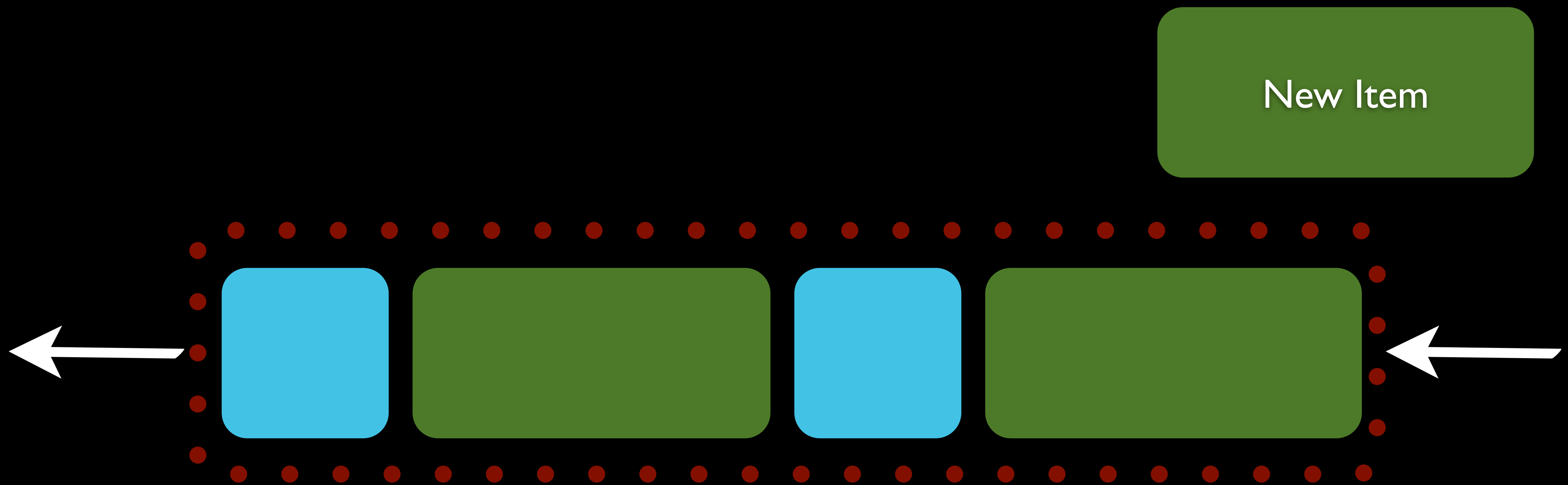
Command Logger

Eviction (1)



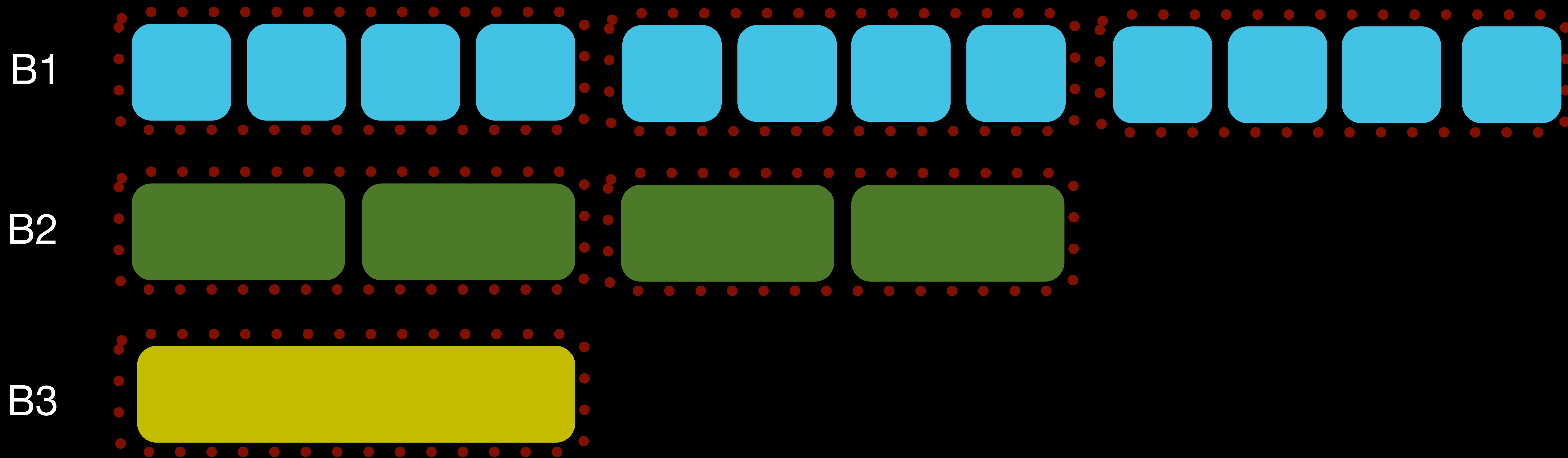
LRU Eviction

Eviction (2)



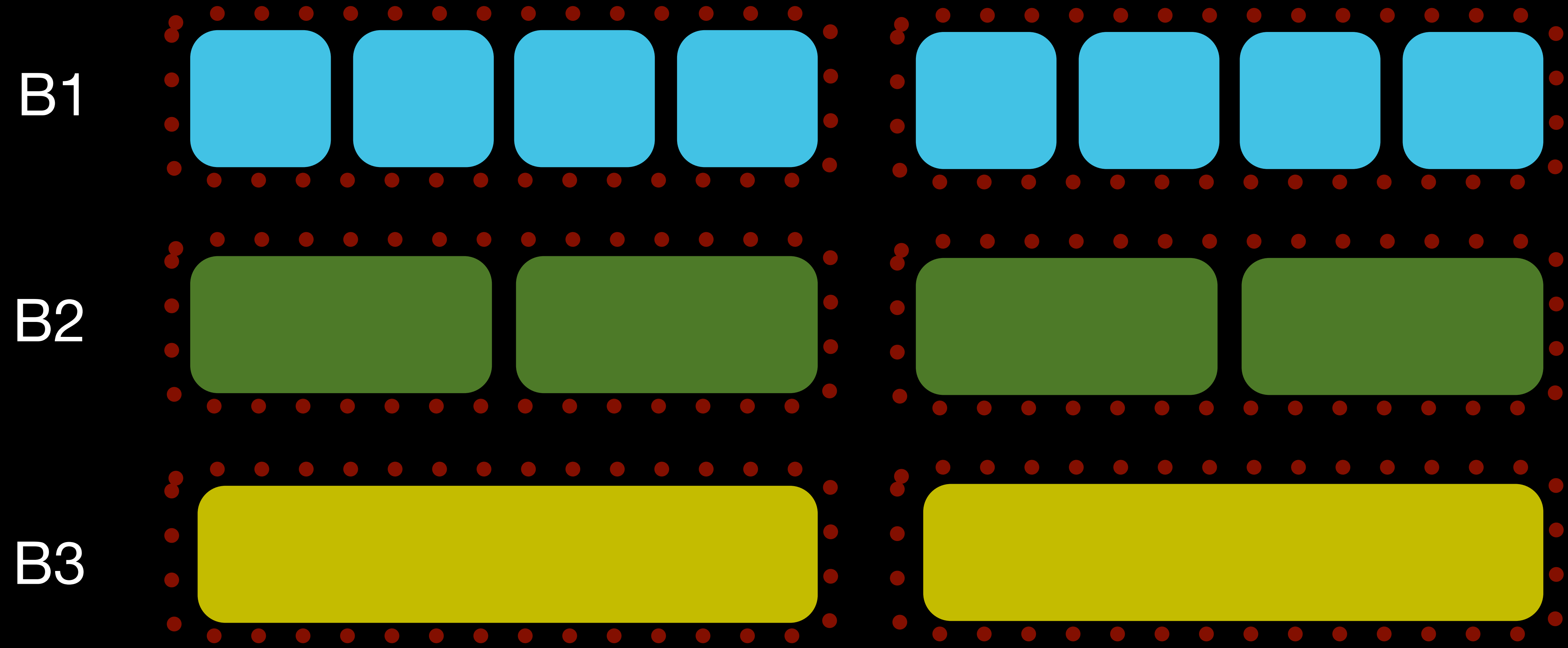
Items of different sizes

Eviction (3)



Per Slabclass LRU Eviction = calcification, pseudo OOM

Slab Eviction



Slab Eviction = deterministic behavior

Motivation

Keys accessed/updated/retrieved in the past 24hrs

- What data is hot and what is not?

- What should the heap size be to cache for 24 hours worth of data?

How many times and when is a key retrieved/updated after insertion?

- Explains why hit rate is so

- Determine a reasonable TTL

- Helps construct a heat map to decide cache size / hit rate trade off

What's the stats per namespace? ("foo:" vs "bar:")

- Does co-habitat make sense?

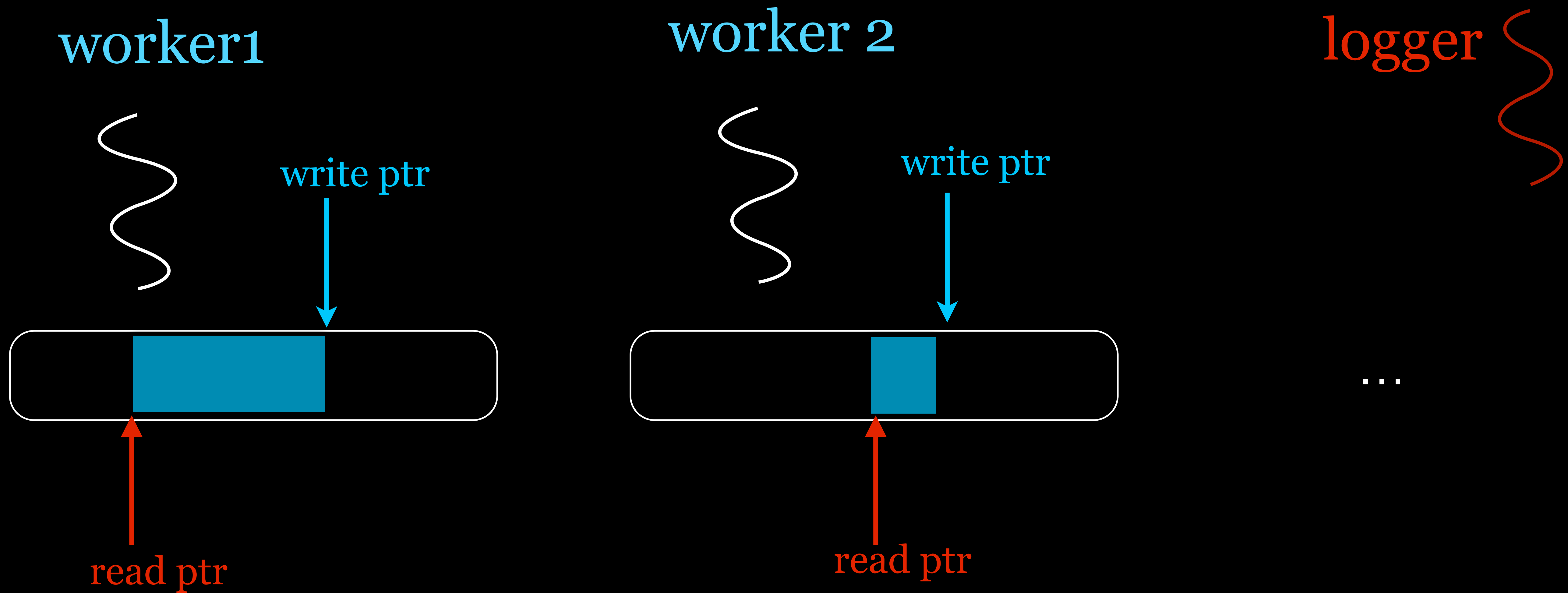
Async Command Logger

Log Format

```
172.25.135.205:55438 - [09/Jul/2012:18:15:45 -0700] "set foo 0 0 3" 1 6
172.25.135.205:55438 - [09/Jul/2012:18:15:46 -0700] "get foo" 0 14
172.25.135.205:55438 - [09/Jul/2012:18:15:57 -0700] "incr bar 1" 3 9
172.25.135.205:55438 - [09/Jul/2012:18:16:05 -0700] "set bar 0 0 1" 1 6
172.25.135.205:55438 - [09/Jul/2012:18:16:09 -0700] "incr bar 1" 0 1
172.25.135.205:55438 - [09/Jul/2012:18:16:13 -0700] "get bar" 0 12
....
```

Client IP	Timestamp	Type	Key	Status	Size

single producer, consumer



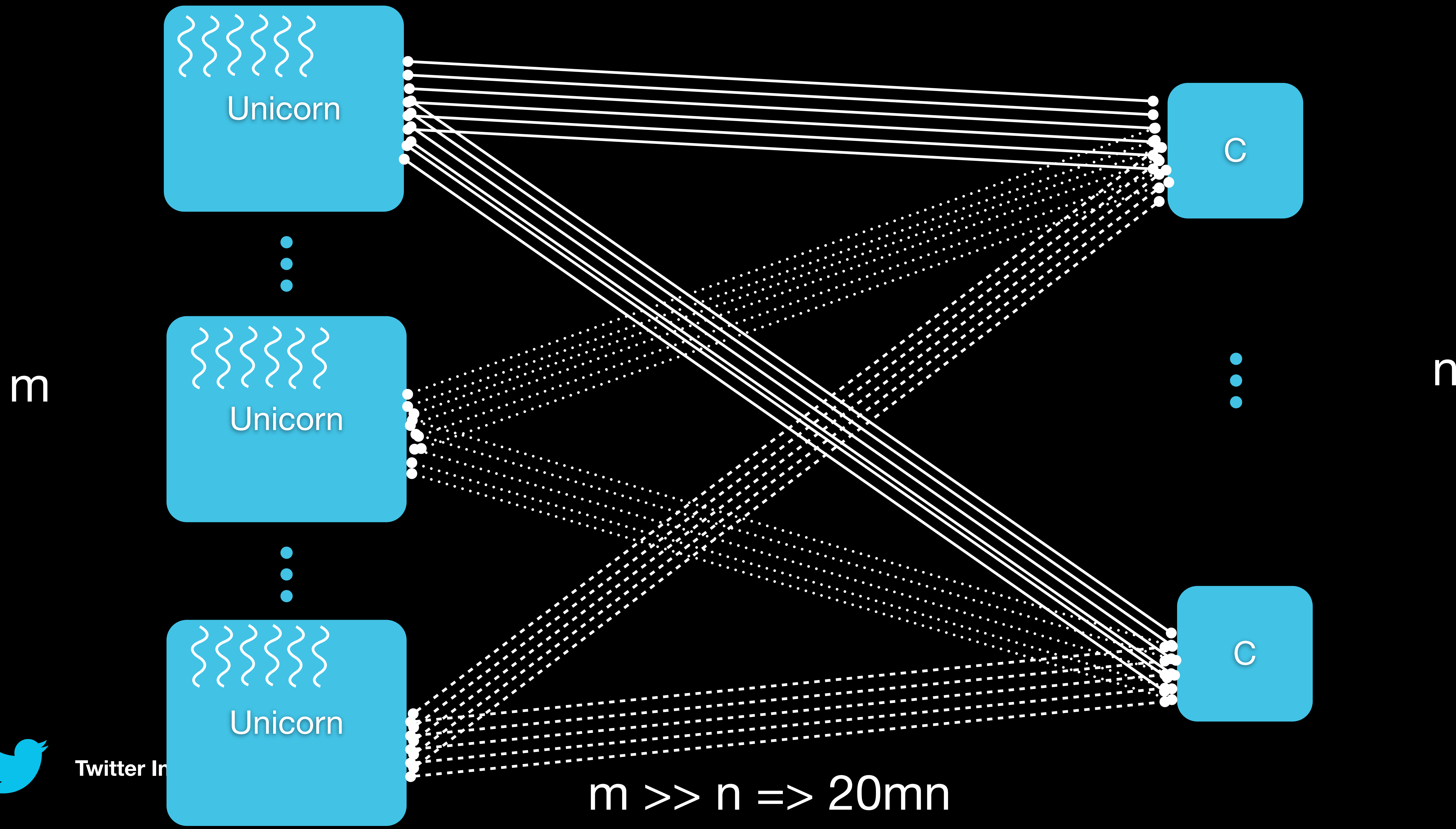
Twemproxy (nutcracker)

Running in production since Nov '11

Supports memcached and redis

code: github.com/twitter/twemproxy

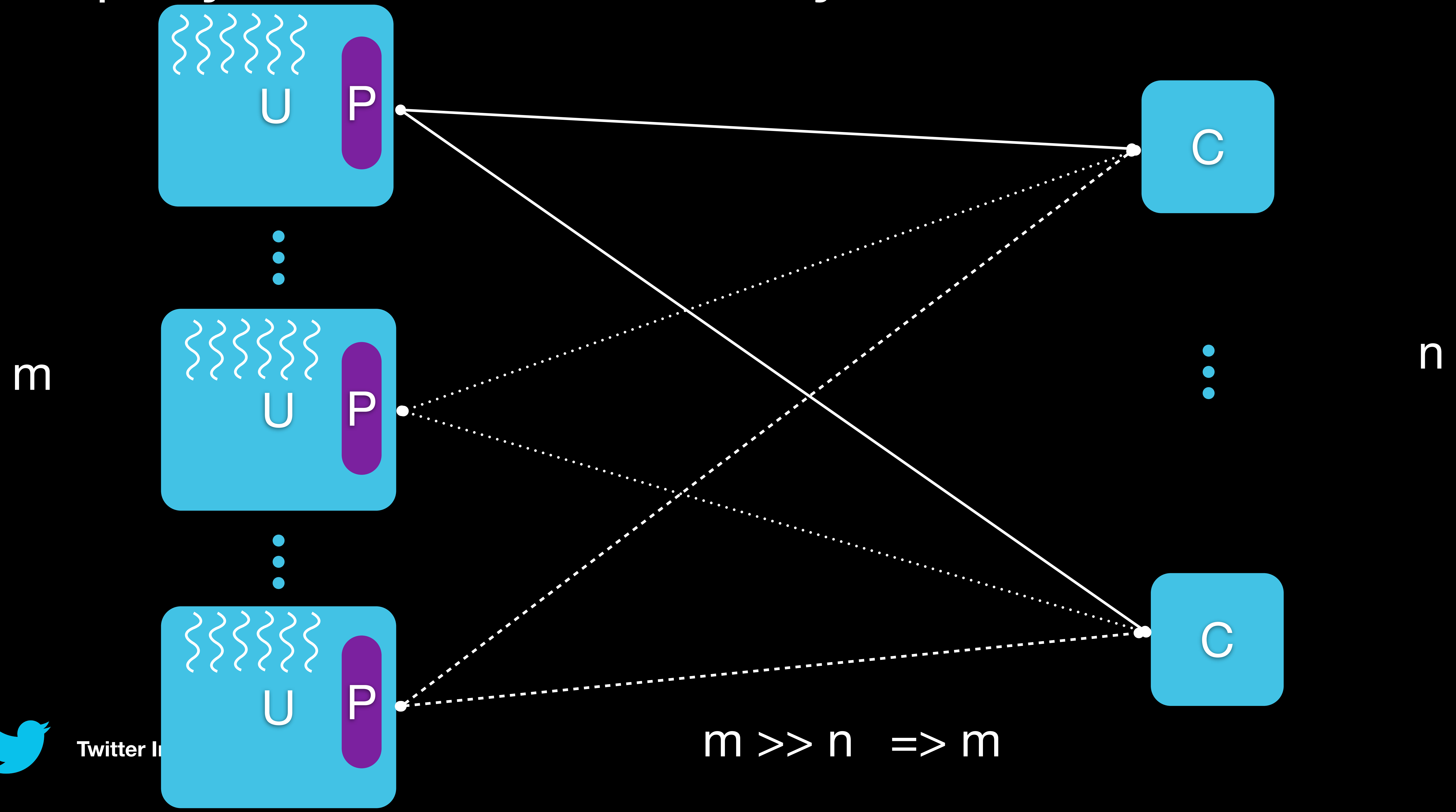
Motivation



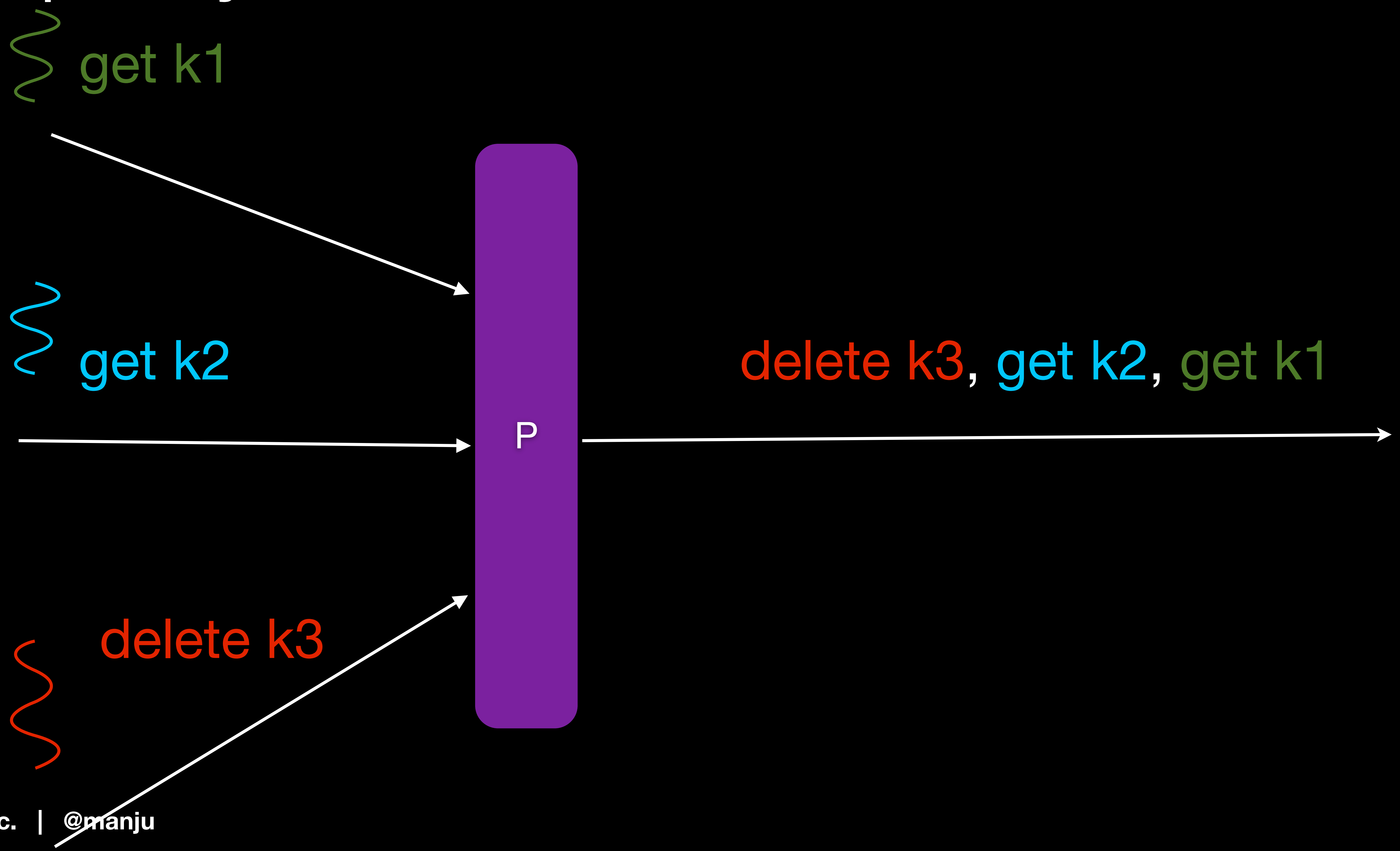
Twitter In

m >> n => 20mn

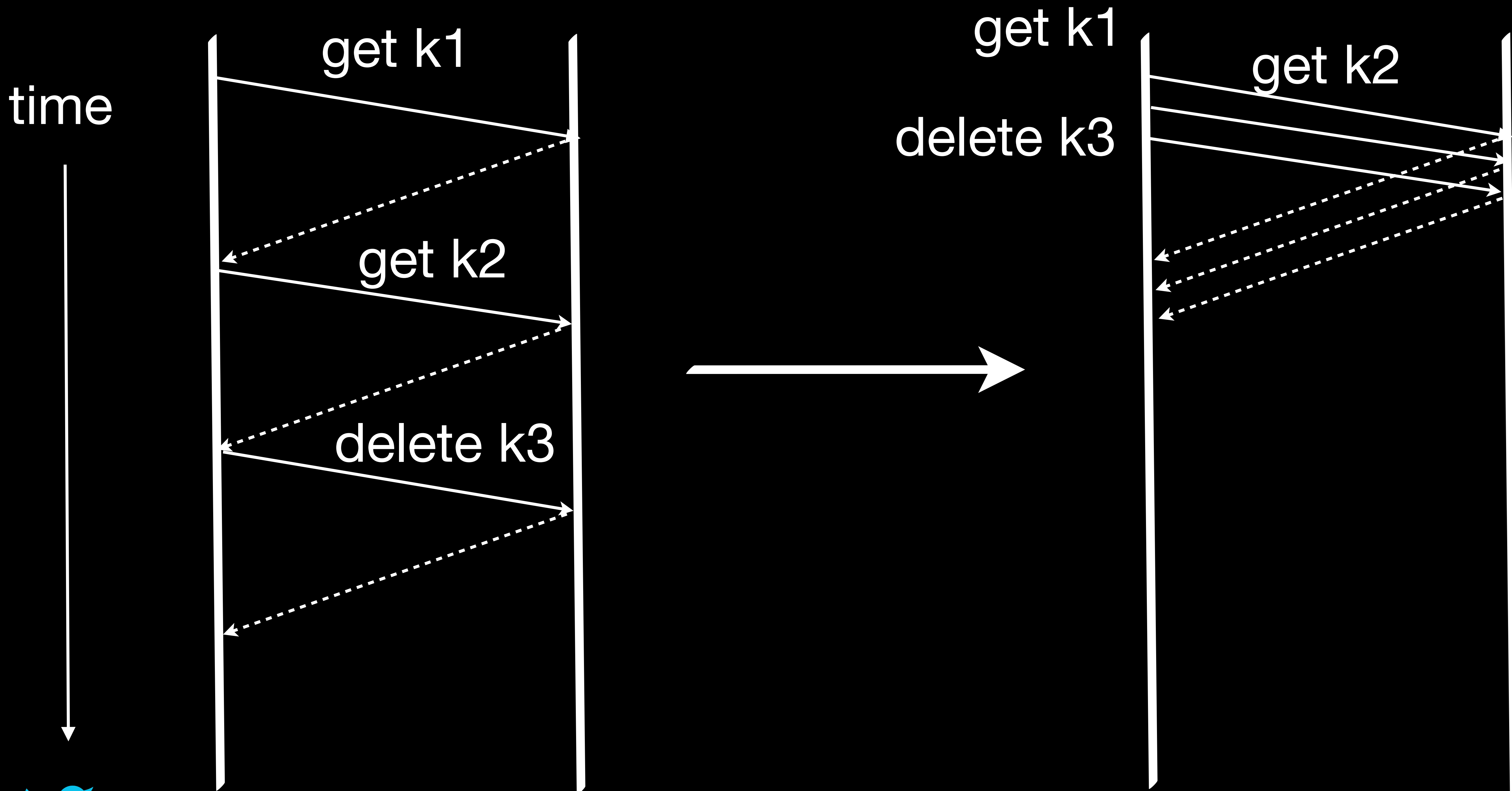
Deployed as Local Proxy



Twemproxy



Pipelining



Twemproxy in Production

Many thousands machines

10 - 20 server pools per instance

Each instance typically handles:

few hundred client connections

proxies to few thousands servers

Eg: 60K -> 3K connections

~2K rps, 200 KB/sec (req), 1MB/sec (rsp)

Why Proxy?

Persistent server connections

faster client restarts

filter close from client

Protocol pipelining

Enables simple and dumb clients

Hides semantics of underlying cache pool

Dynamic configuration

Why not Proxy?

Extra network hop

Tradeoff latency for throughput

Pipelining is your friend

What did we learn?

Hide caches behind abstraction layer

Indirection (proxies) enables horizontal scaling

Proxies add overhead and extra network hop

Minimize network hops by colocating proxies next to server / clients

Use pipelining to overcome additional overhead

New System Characteristics

Predictable worst case latency

Replicated

Read my Write

Eventually consistent

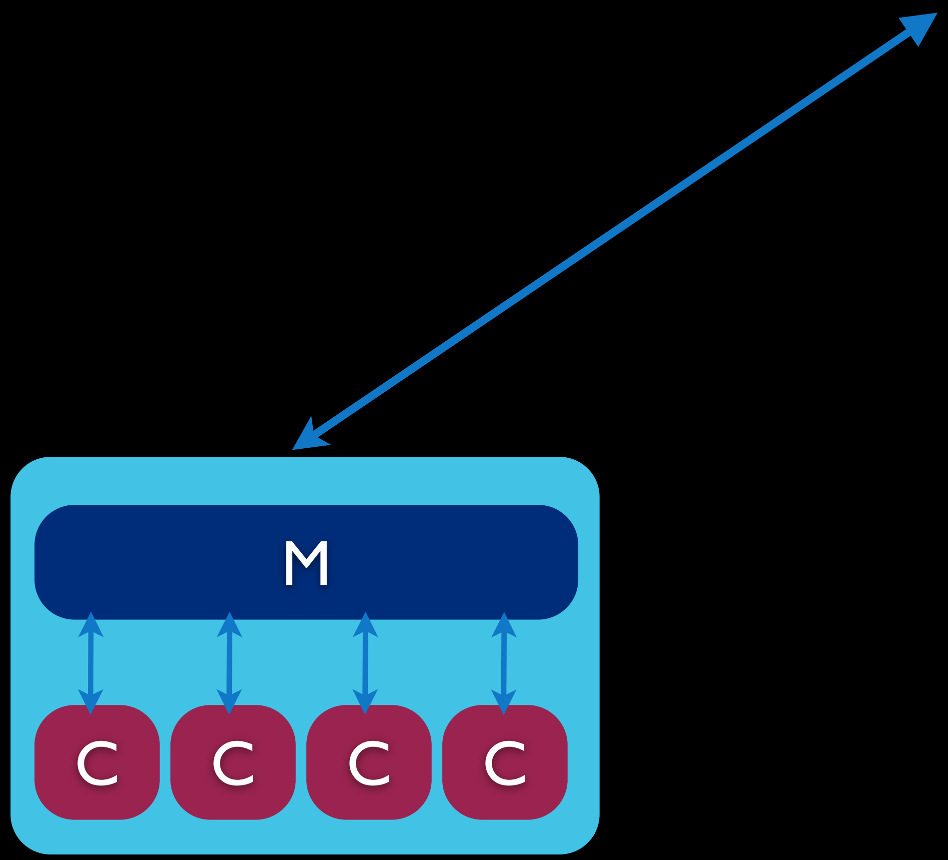
Use case: read volume >> write volume

key/value scheme

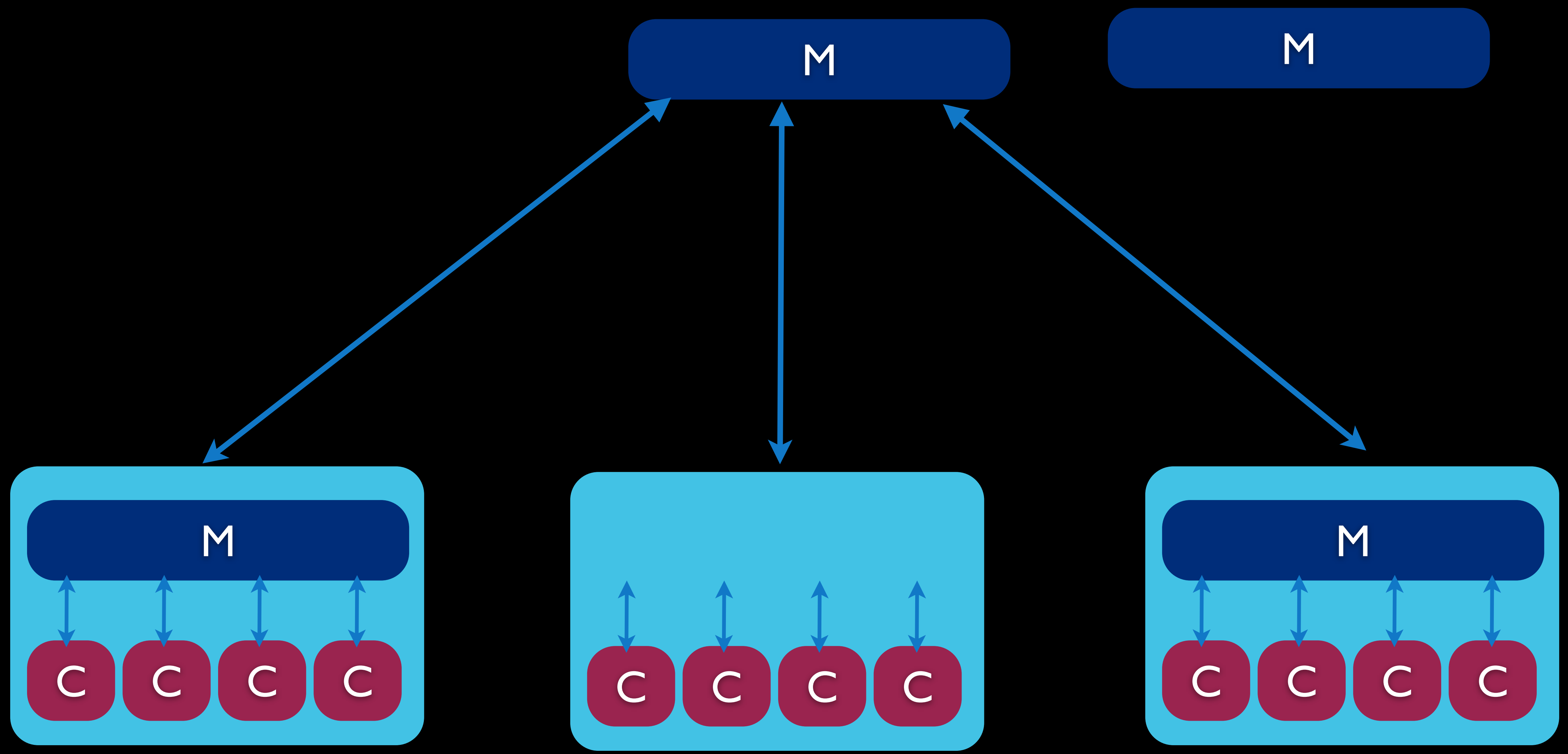
```
key = (outer-key, inner-key)

struct value {
    map<short, binary> fields = {}
    map<short, long> fieldTimestamps = {}
}
```

Indirection and Colocation

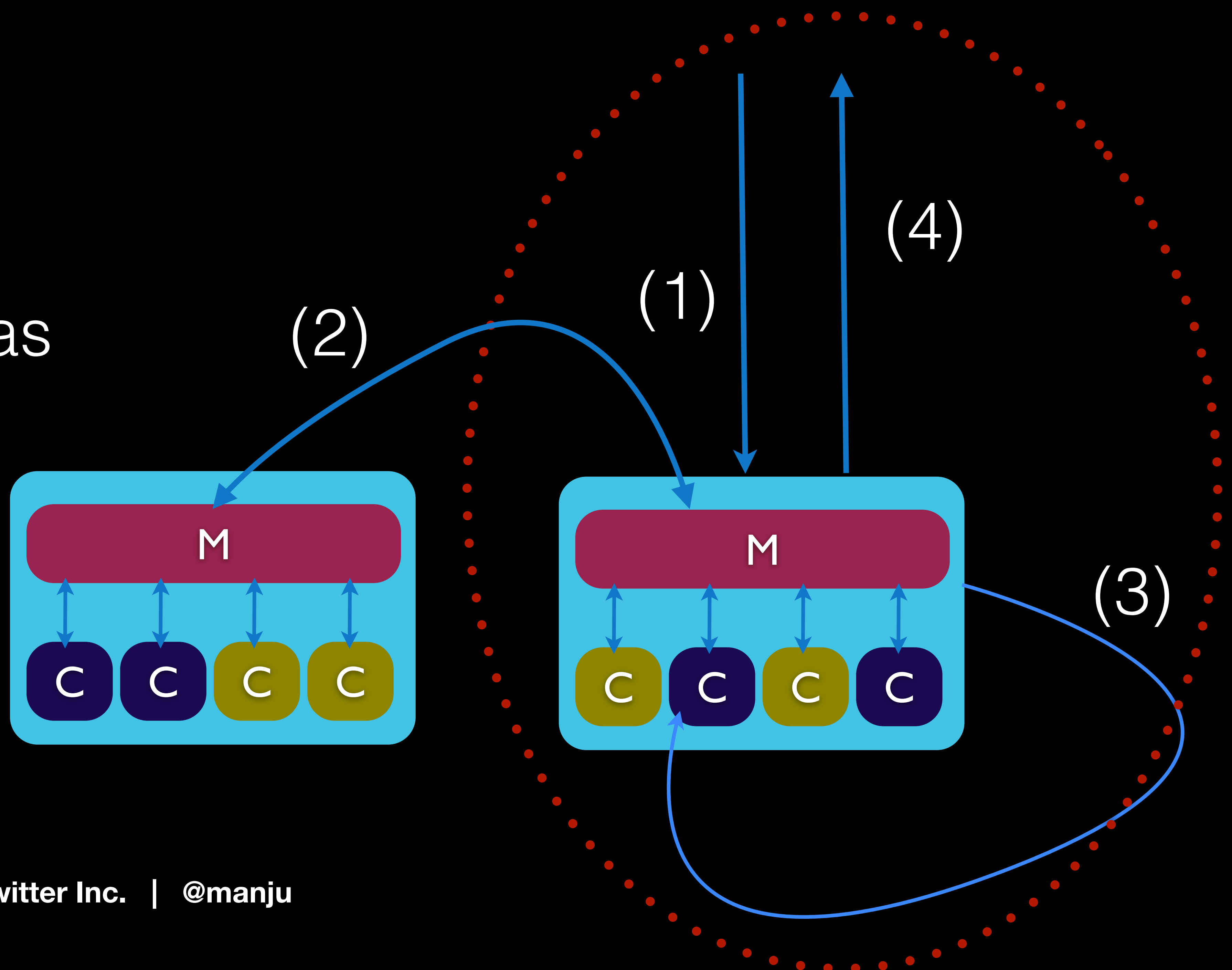


Horizontal Scaling



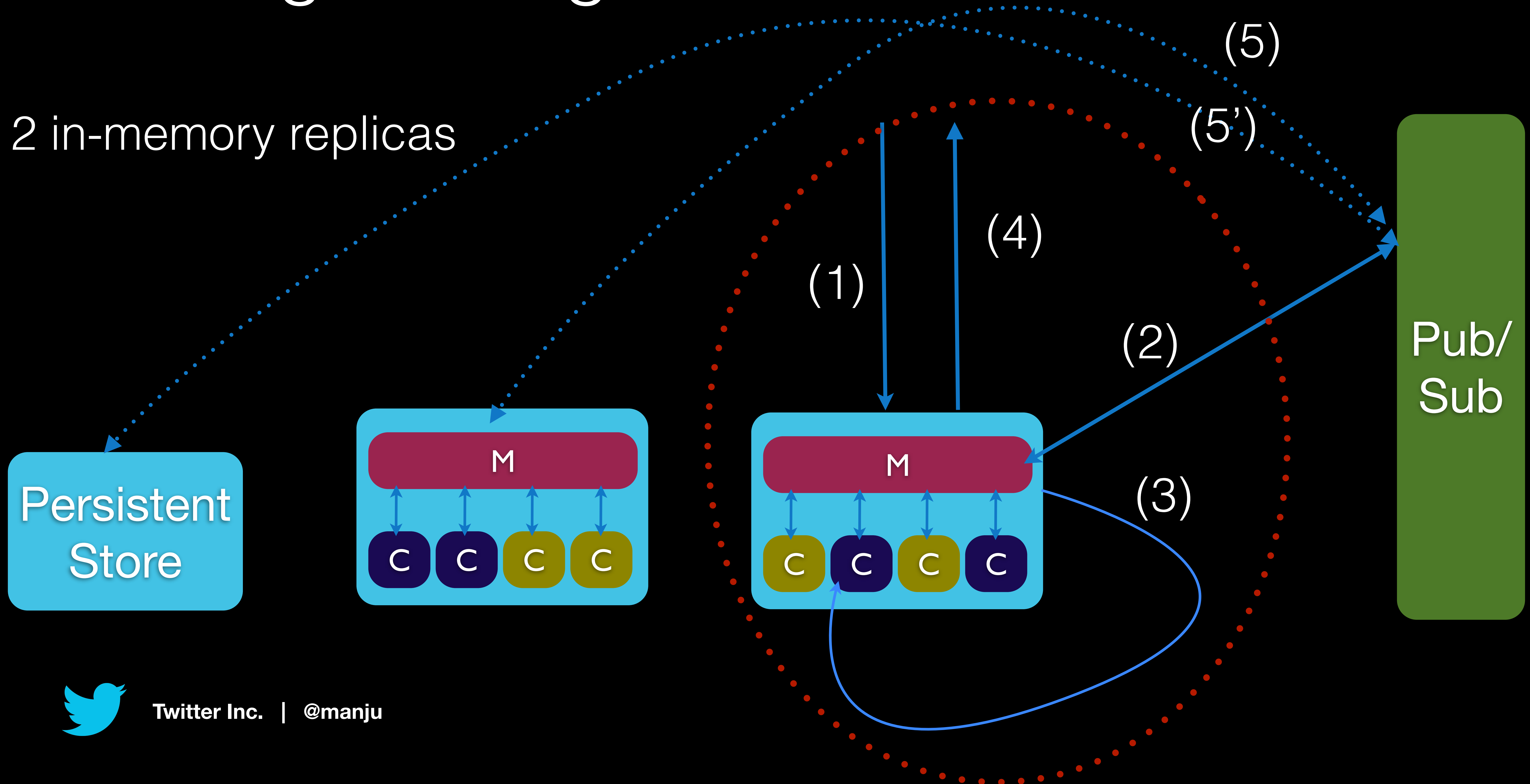
Putting it all together

2 replicas



Putting it all together

2 in-memory replicas



Questions?