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Facebook Tao

Distributed Data Store for the Social Graph

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Introduction

What is TAO?

TAO is a geographically distribute store

- deployed at Facebook
- with efficient and timely access to social graph
- using a fixed set of query
- replacing memcache
- running on thousands of machines
- provide access to many PB of data
- process a billion reads ad millions of writes each second!

The social graph

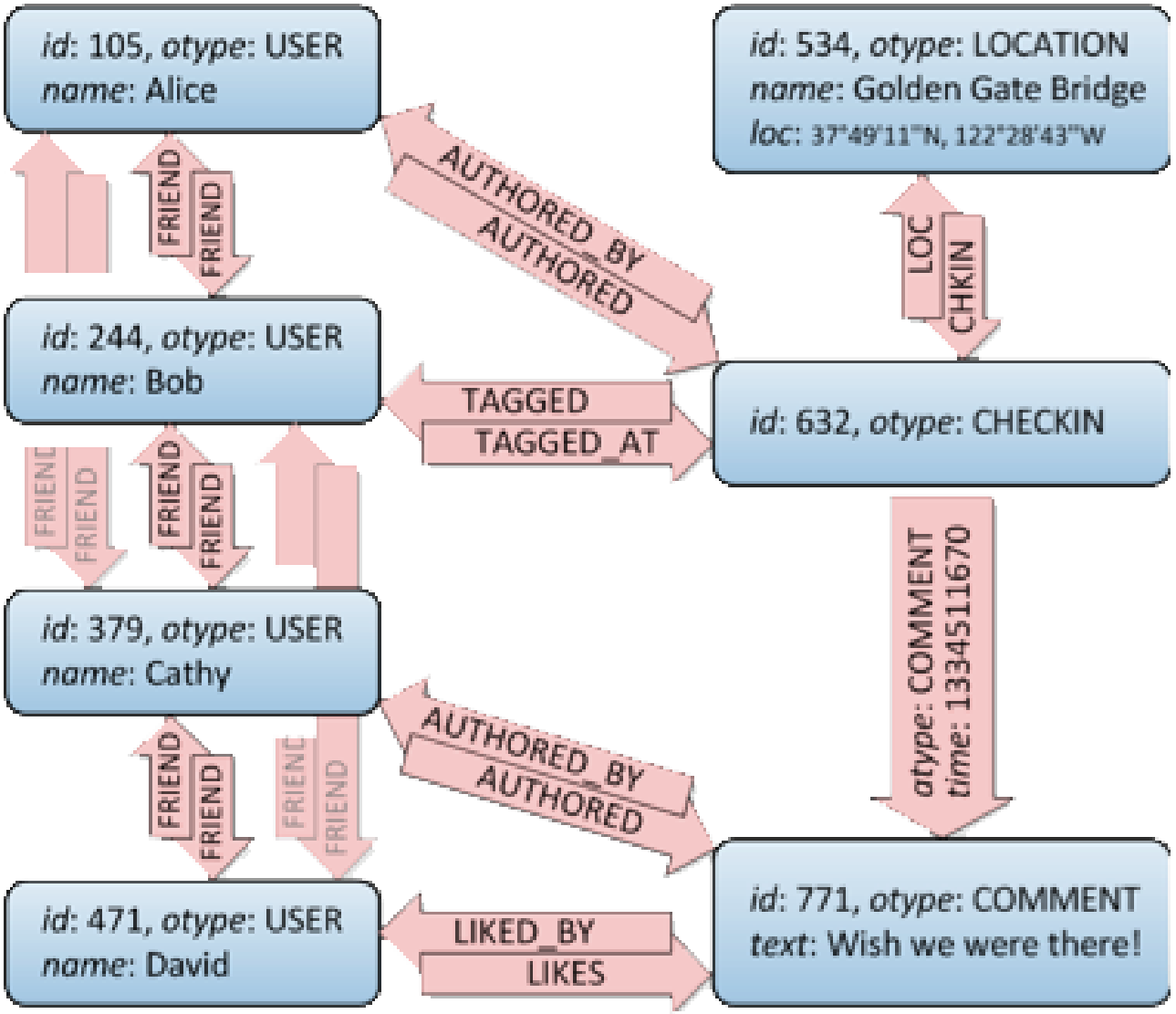
Facebook has more than 1 billion active user

- recording relationships,
- sharing interests,
- uploading pictures and …

The user experience of Fb comes from rapid, efficient and scalable access to the *social graph*

What's behind an entry in yours Fb page?

A single Fb page aggregate and filter hundreds of items from the social graph.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name: Alice
id: 534, otype: LOCATION
name: Golden Gate Bridge
loc: 37°49'11"N, 122°28'43"W
AUTHORED_BY
AUTHORED
LOC
CHKIN
FRIEND
FRIEND
id: 244, otype: USER
name: Bob
TAGGED
TAGGED_AT
id: 632, otype: CHECKIN
FRIEND
FRIEND
FRIEND
FRIEND
atype: COMMENT
time: 1334511670
id: 379, otype: USER
name: Cathy
AUTHORED_BY
AUTHORED
FRIEND
FRIEND
FRIEND
FRIEND
id: 771, otype: COMMENT
text: Wish we were there!
id: 471, otype: USER
name: David
LIKED_BY
LIKES

Before Tao

- Facebook was storing the social graph to MySql
  - Quering it from PHP
  - Storing result in memcache

Over time Fb deprecated direct access to MySQL in favor of a graph (associations, nodes) abstraction

Limits

- Operations on lists are inefficient in memcache (update whole list)
- Complexity on clients managing cache
- Hard to offer read-after-write consistency

Also they want to access social graph from non-PHP services

TAO's Goals

- Efficiency at Scale
- Low read latency
- Timeliness of writes
- High read availability

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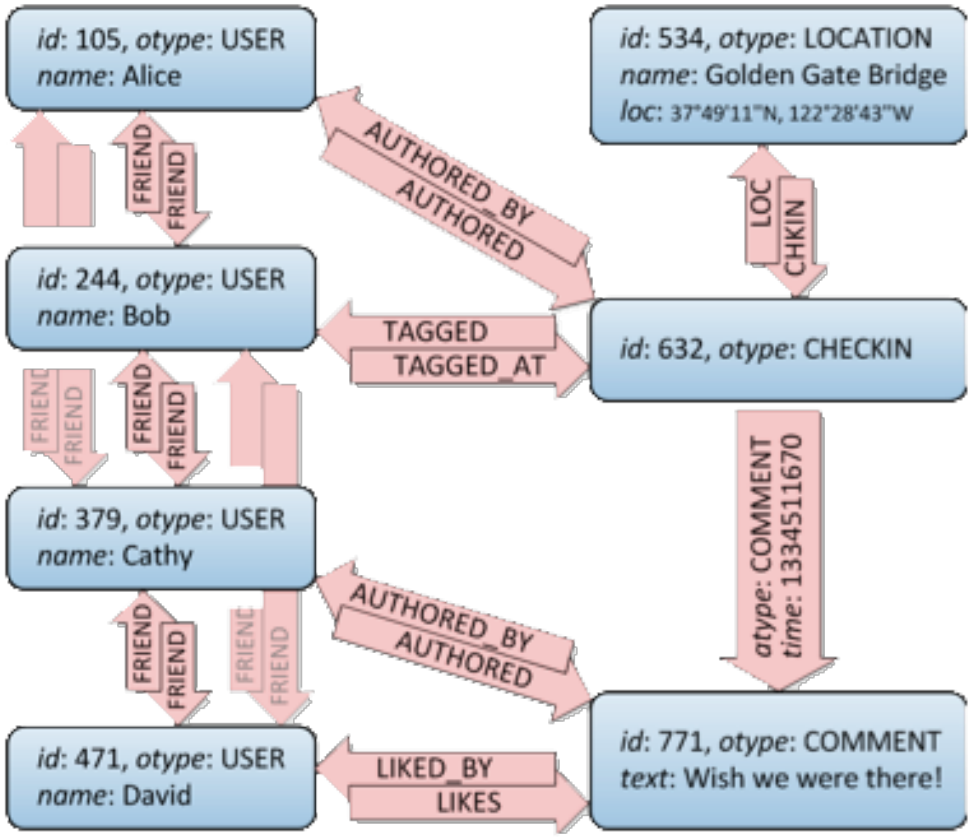
Tao Data Model

T.A.O. stands for “The Associations and Objects”



Objects

- Typed nodes (type is denoted by `otype`)
- Identified by 64-bit integers (unique)
- Contains data in the form of key-value pairs
- Models users and repeatable actions (e.g. comments)

API for objects:

- Allocate new object
- retrieve
- update
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Associations

- Typed directed edges between objects (type is denoted by `atype`)
- Identified by source object `id1`, `atype` and destination object `id2`
- Contains data in the form of key-value pairs.
- Contains a 32-bit `time` field.
- Models actions that happen at most once or records state transition (e.g. like)
- Often inverse association is also meaningful (eg like and liked by).

Associations API

- Add new
- Delete
- Change type

Also inverse association is created or modified automatically

Querying TAO

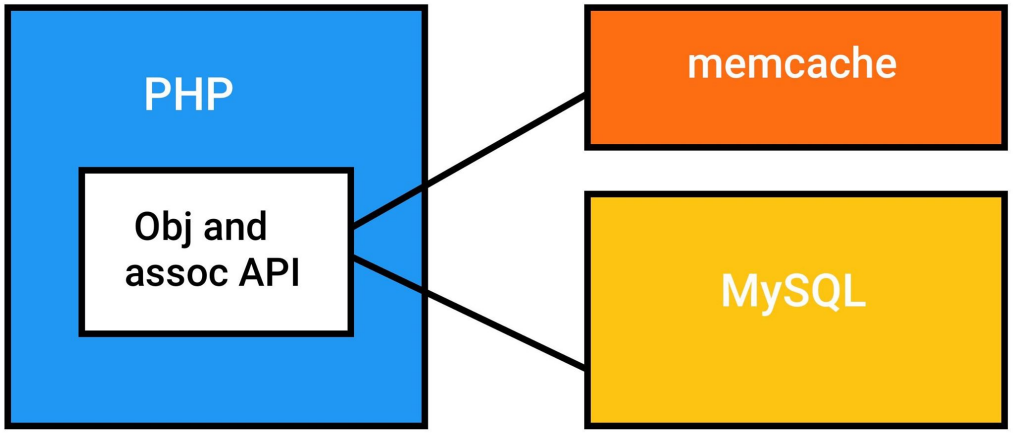
TAO's associations queries are organized around *associations list*

- `assoc_get(id1,atype, id2set, high?, low?)`
- `assoc_count(id1,atype)`
- `assoc_range(id1, atype, pos, limit)`
- `assoc_time_range(id1,atype, high, low, limit)`

Query results are bounded to 6000 results

Architecture

Before Tao

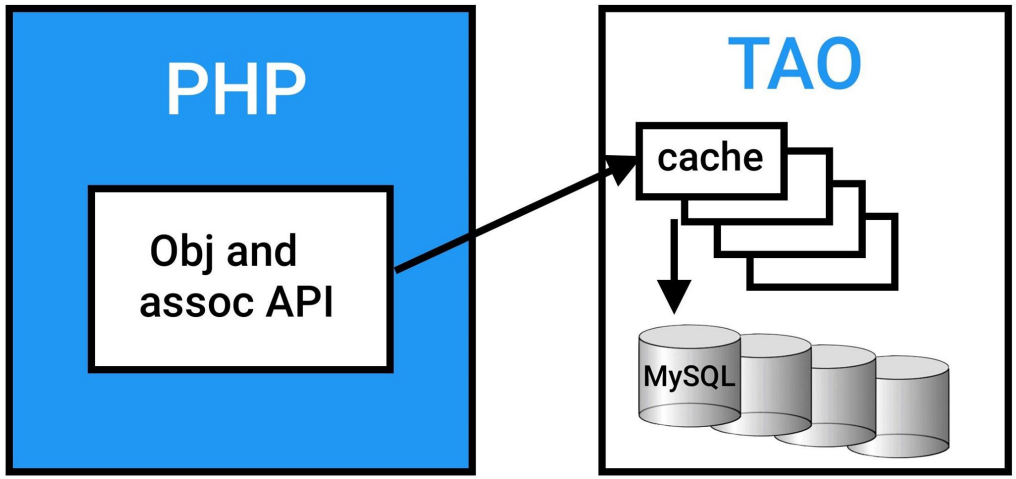


After Tao

Architecture

Before Tao

After Tao



Storage Layer

- Object and Associations are stored in MySql (before & with TAO)
- TAO API is mapped to a small set of SQL queries
- A single MySql server can’t handle TAO volumes of data
  - We divide data into logical *shards*
  - *shards* are mapped to db
  - different servers are responsible for multiple shards
  - mapping is adjusted for load balancing
- Object are bounded to a *shard* for their entire lifetime
- Associations are stored in the *shard* of its `id1`

Cache Layer

TAO cache

- contains: Objects, Associations, Associations counts
- implement the complete API for clients
- handles all the communication with storage layer
- it's filled on demand end evict the least recently used items
- Understand the semantic of their contents

It consists of multiple servers forming a *tier*

- Request are forwarded to correct server by a *sharding* scheme as dbs
- For cache miss and write request, the server contacts other caches or db

Yet Another caching layer

Problem: A single caching layer divided into a *tier* is susceptible to *hot spot*

Solution: Split the caching layer in two levels

- A *Leader* tier
- Multiple *Followers* tiers

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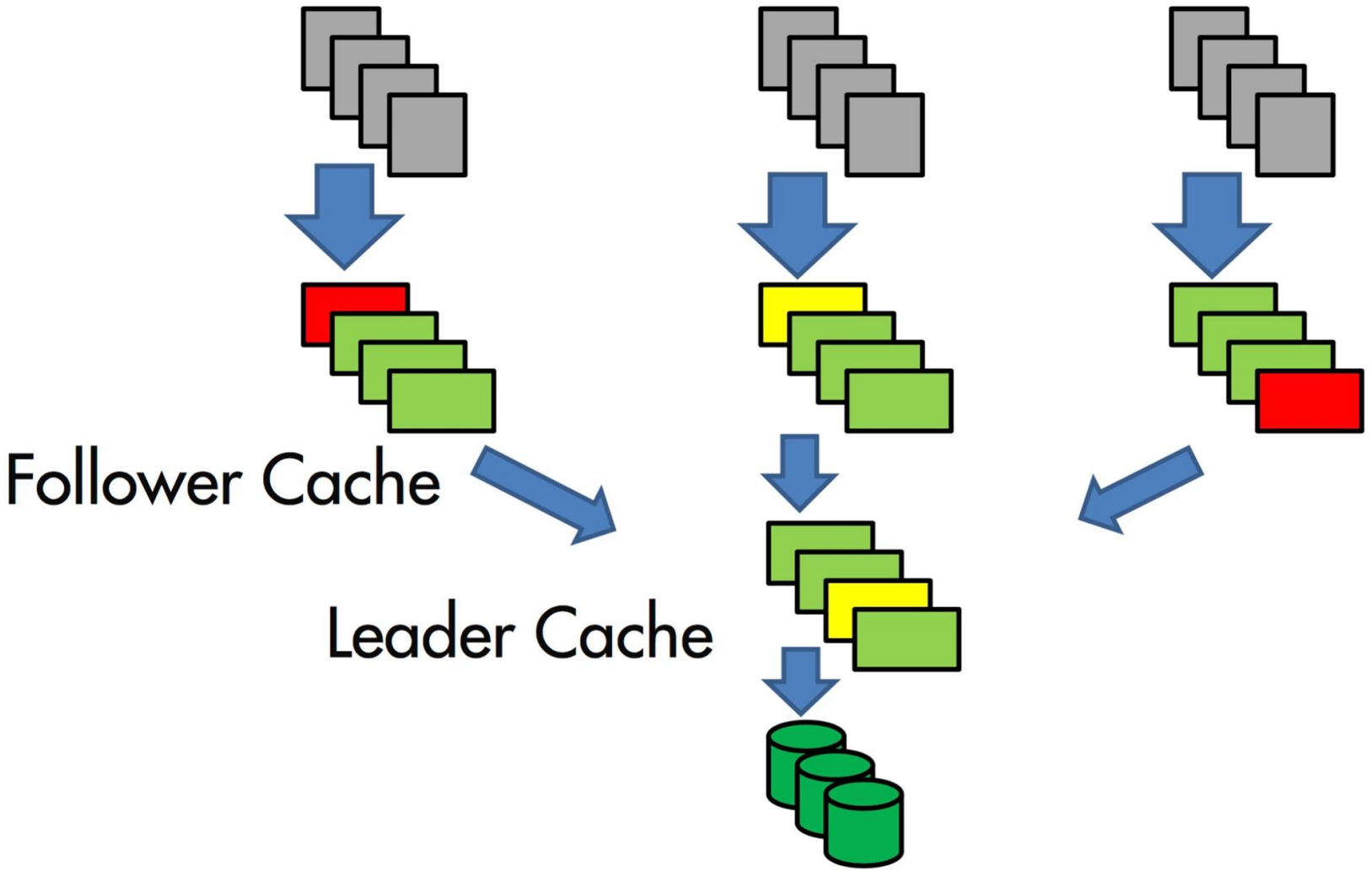
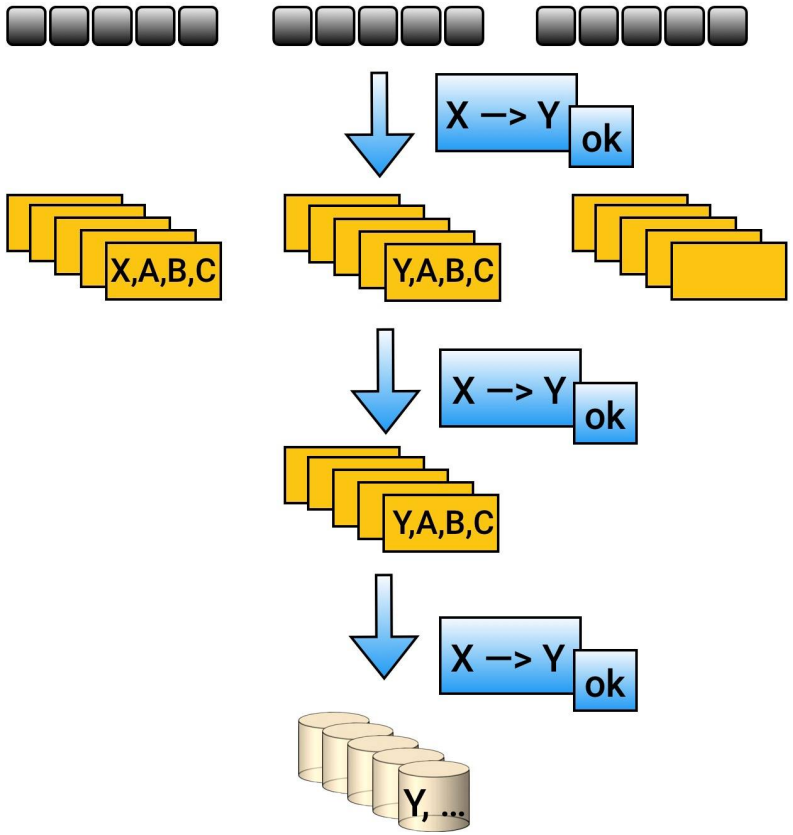
Leaders & Followers



Leaders & Followers

- Followers forward all writes and read cache misses to the leader tier
- Leader sends async cache maintenance messages to follower tier
  - Eventually Consistent
- If a follower issues a write, the follower's cache is updated synchronously
- Each update message has a version number
- Leader serializes writes

Leaders & Followers



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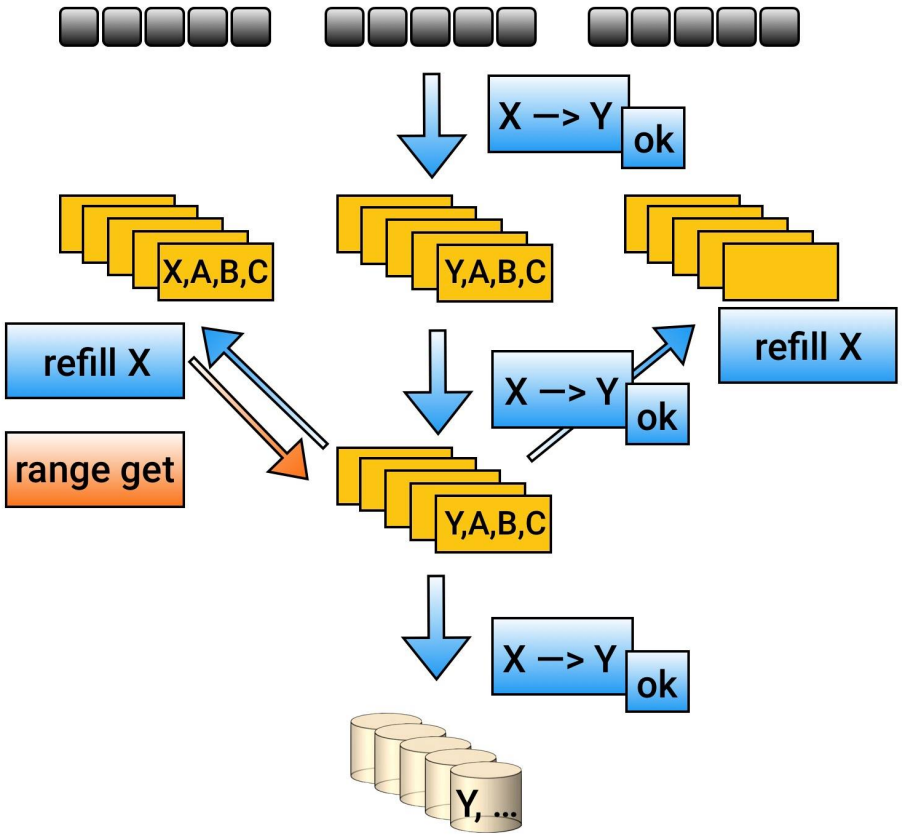

Scaling Geographically

Problem: Network latencies are not low in a multi Data Centers environment

Considering that read misses are more common than writes in the follower tier

Solution: Handles read cache miss locally

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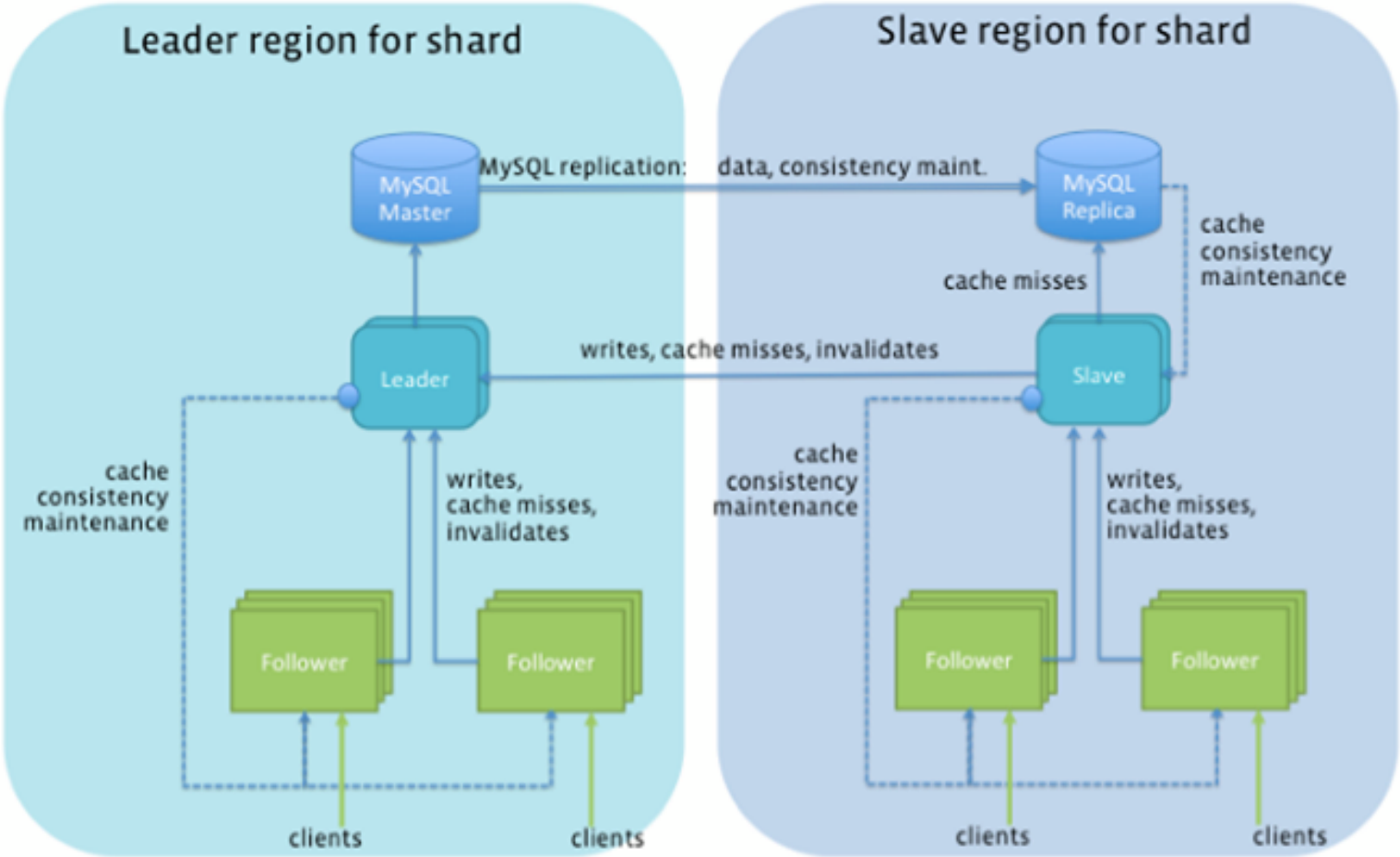
Master & Slave Regions

Fb cluster together DC in regions (with low intra region latency)

- Each region have a full copy of the social graph
- Region are defined master or slave for each shard
- Followers send read misses and write requests to the local leader
- Local leaders service read misses locally
- Slave leaders forward writes to the master shard
- The slave leader will update it’s cache ahead of the async updates to the persistent store

Overall Architecture



Implementation

Consistency

title