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Using Rust to Build a Distributed Transactional Key-Value Database

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About me

- Chief Architect at PingCAP
- TiDB and TiKV
- Open source projects
  - LedisDB
  - go-mysql
  - go-mysql-elasticsearch
  - rust-prometheus
  - ...

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Agenda

- Introduction
- Hierarchy
  - Storage
  - Raft
  - Transaction
  - RPC Framework
  - Monitor
  - Test
- Combine them all

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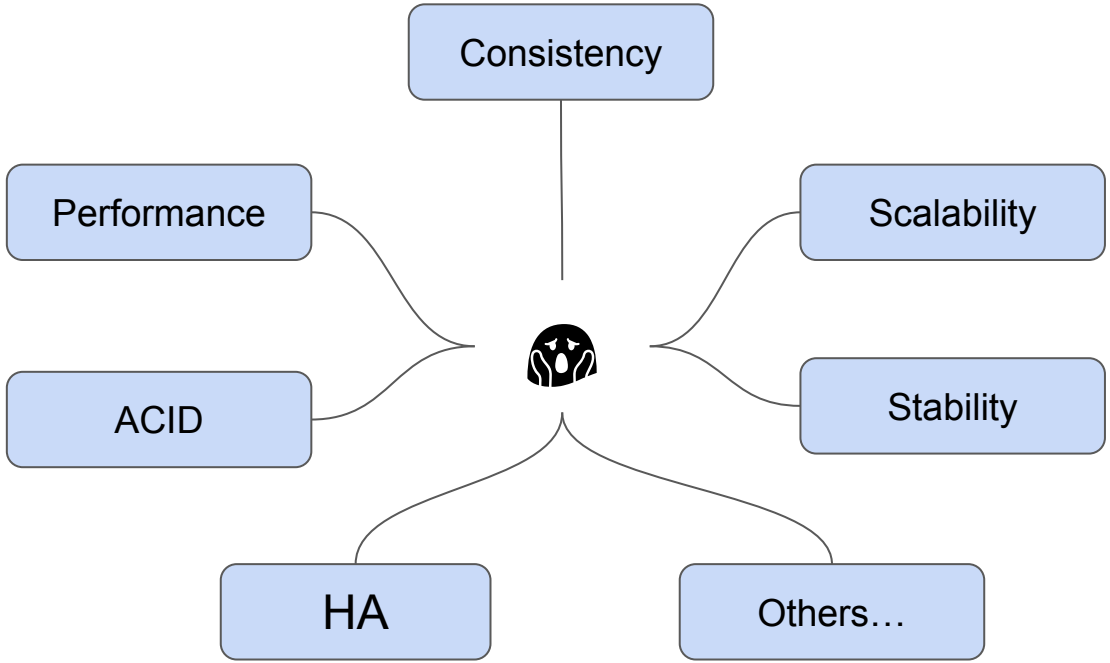
When we want to build a distributed transactional key-value database...


Consistency
Performance
Scalability
ACID
Stability
HA
Others…

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A High Building,
A Low Foundation

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Language

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Let’s start from scratch!!!

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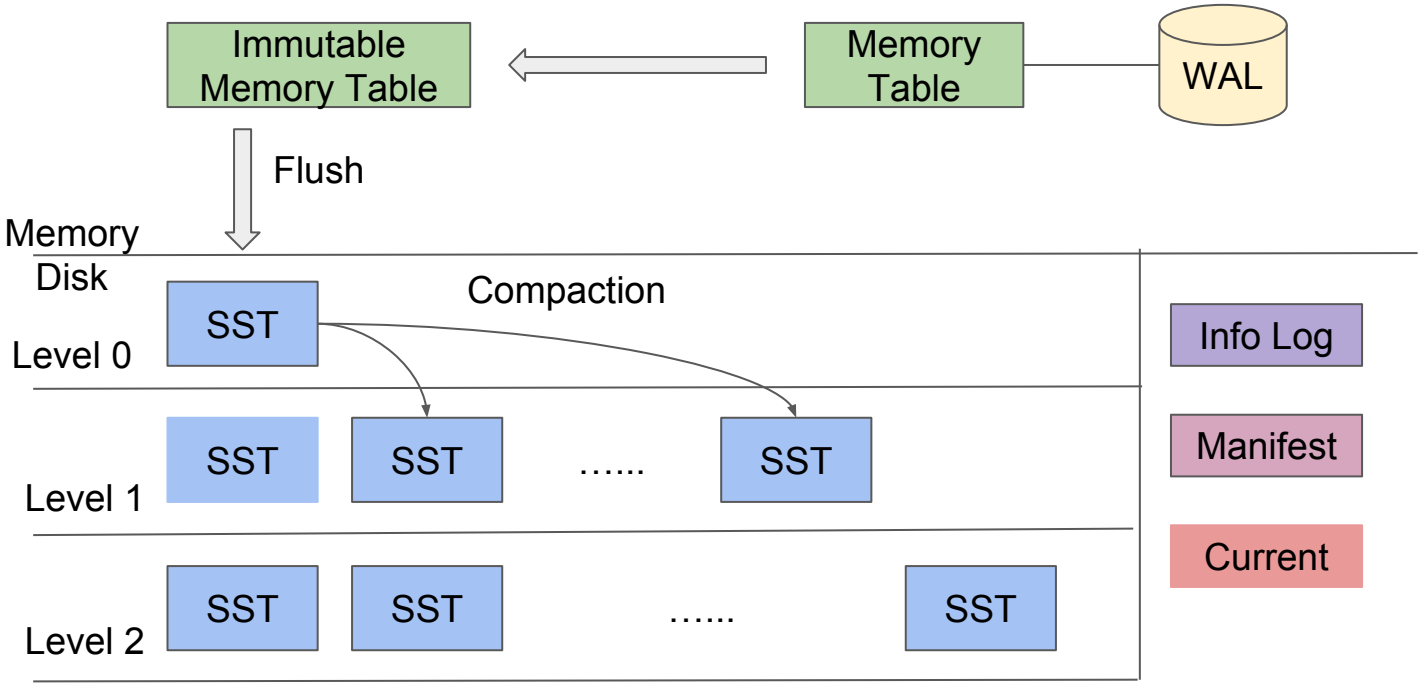
RocksDB



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https://github.com/pingcap/rust-rocksdb

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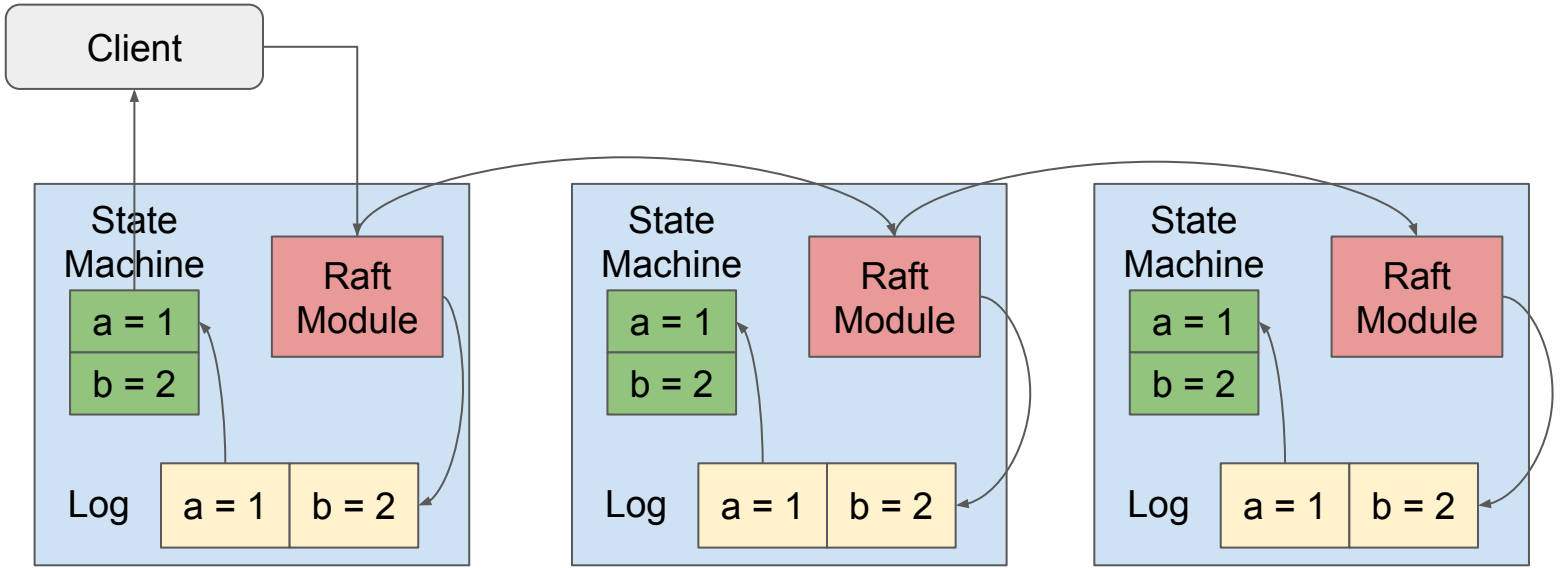
Raft



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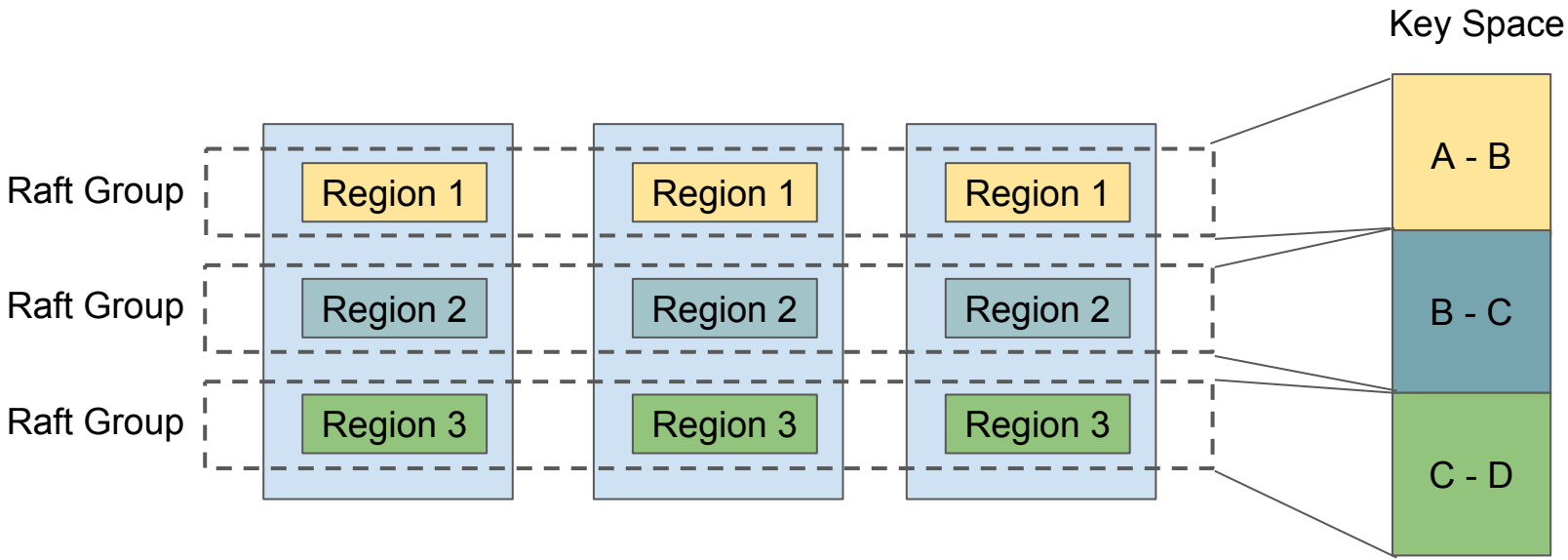
Multi-Raft



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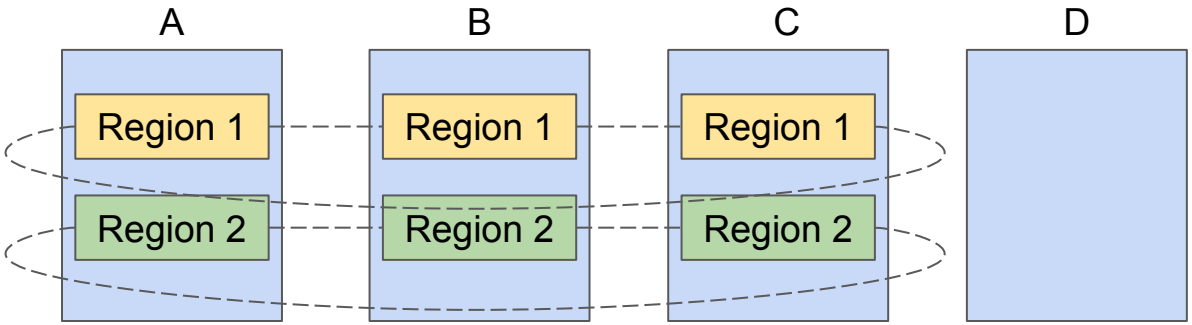
Multi-Raft - Scalability



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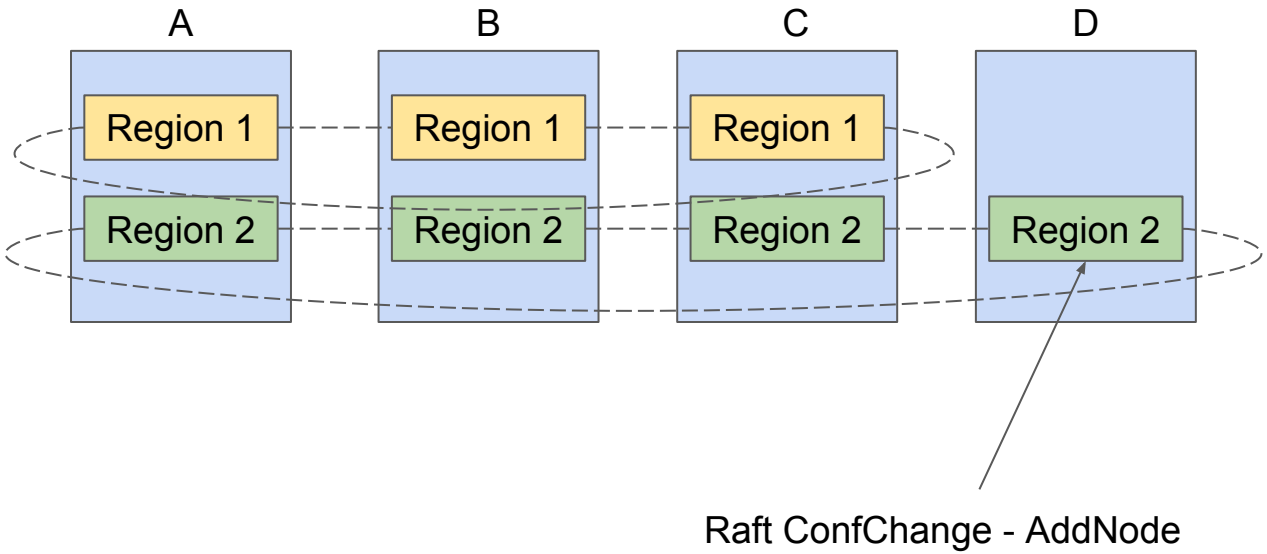
Multi-Raft - Scalability



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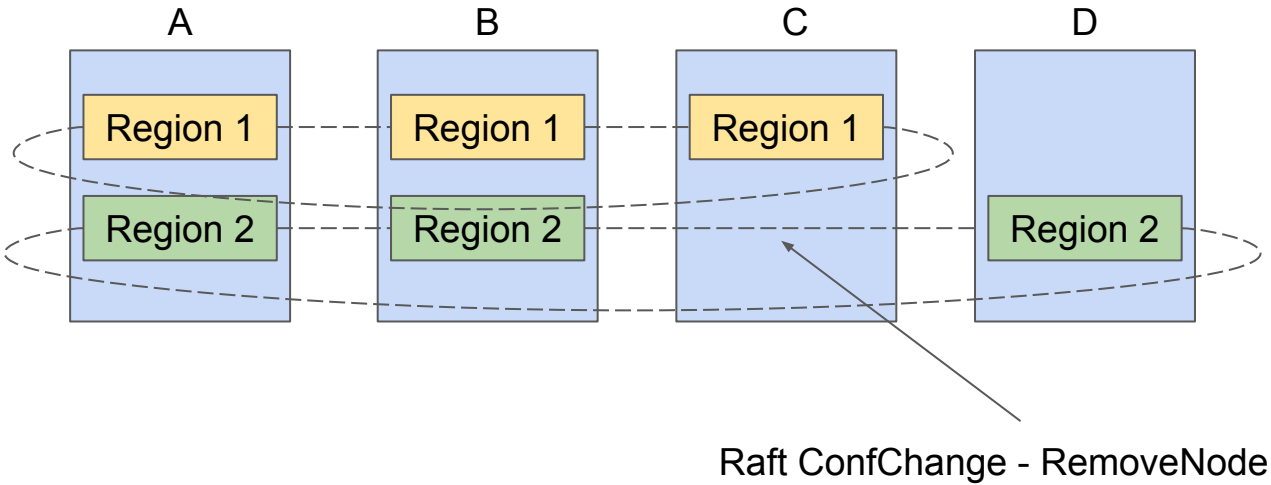
Multi-Raft - Scalability



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https://github.com/pingcap/raft-rs

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Transaction

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Transaction

```
let mut txn = store.begin()
let value1 = txn.get(region1_key)
let value2 = txn.get(region2_key)
// do something with value
txn.set(region1_key, new_value1)
txn.set(region2_key, new_value2)
txn.commit()
// or txn.rollback()
```

How to keep consistency crossing multi-Raft Groups?

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Transaction

1. Inspired by Google Percolator
2. Optimized Two Phase Commit (2 PC)
3. Multiversion Concurrency Control (MVCC)
4. Snapshot Isolation
5. Optimistic Transaction

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gRPC

- Mode
  - Unary
  - Client streaming
  - Server streaming
  - Duplex streaming

- Using Futures to wrap the asynchronous C gRPC API

```
let f = unary(service, method, request);
let resp = f.wait();
```

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https://github.com/pingcap/grpc-rs

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Prometheus

- Type
  - Counter
  - Gauge
  - Histogram

```
lazy_static! {
   static ref HTTP_COUNTER: Counter = register_counter!(
       "http_request_total",
       "Total number of HTTP request."
   ).unwrap();
}

HTTP_COUNTER.inc();
```

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https://github.com/pingcap/rust-prometheus

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Testing

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Testing - Failure Injection

```
// Ingest a failure
fn function_foo() {
    fail_point!("foo");
}


// Run and Trigger the failure
FAILPOINTS=foo=panic cargo run
```

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https://github.com/pingcap/fail-rs

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Architecture

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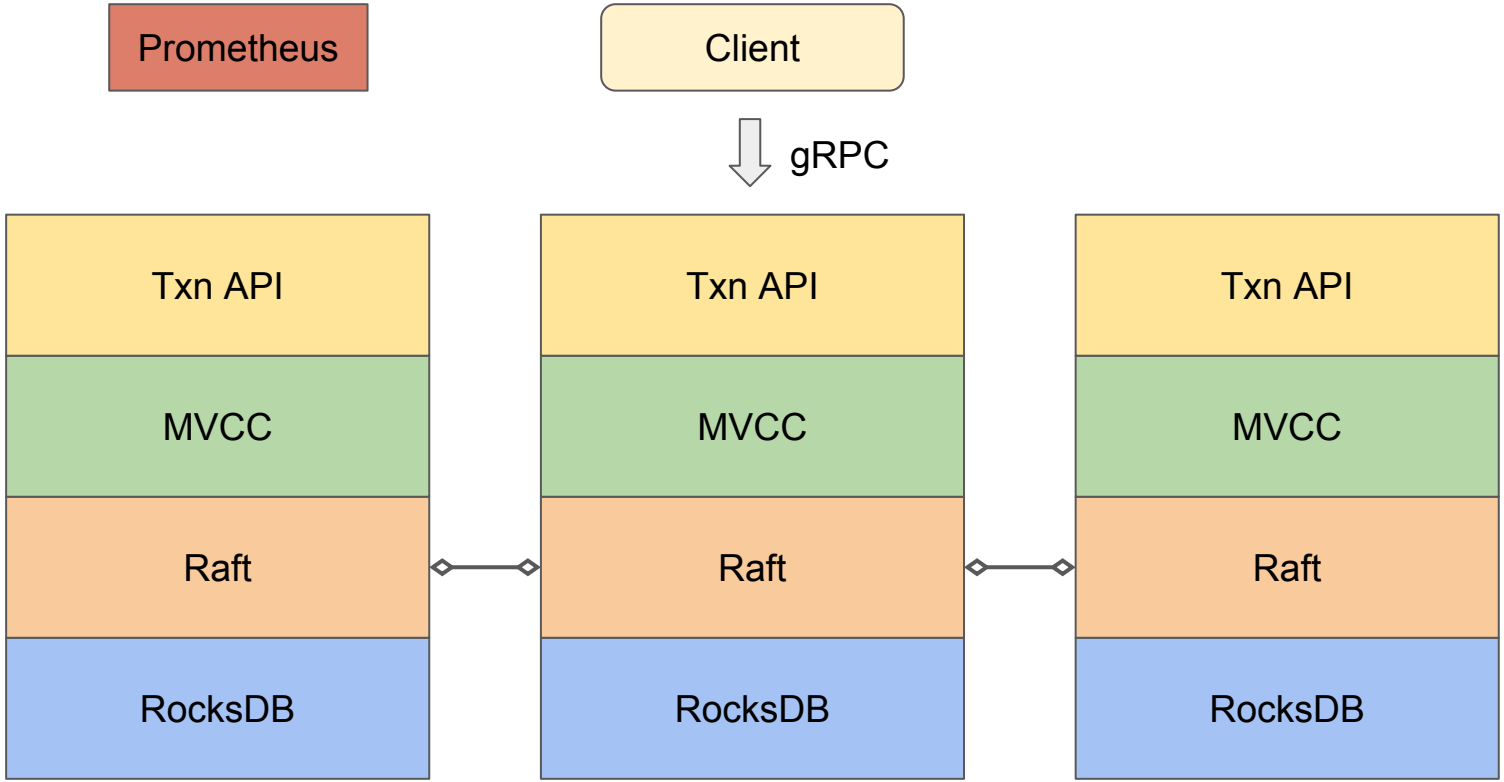
Architecture



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https://github.com/pingcap/tikv

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Beyond TiKV

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A Distributed Relational Database

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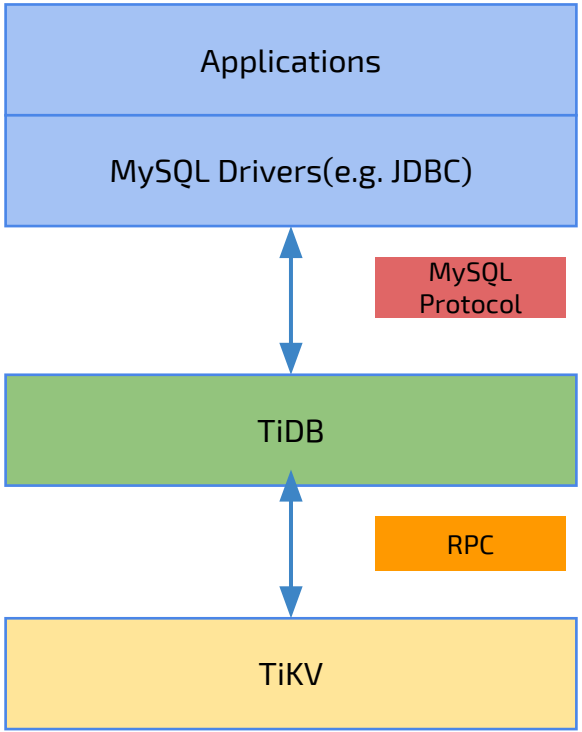
TiDB



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A Distributed Analytical Database

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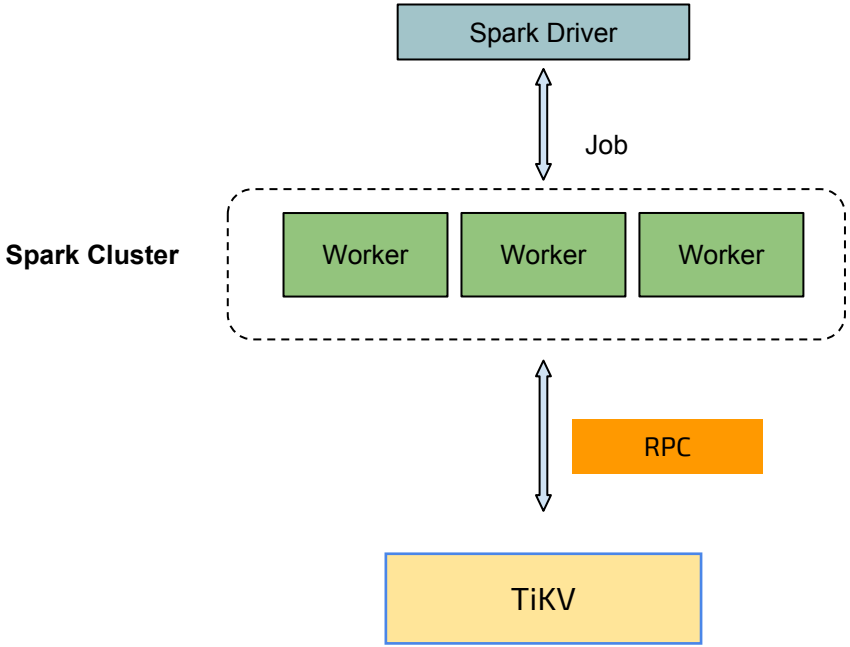
TiSpark



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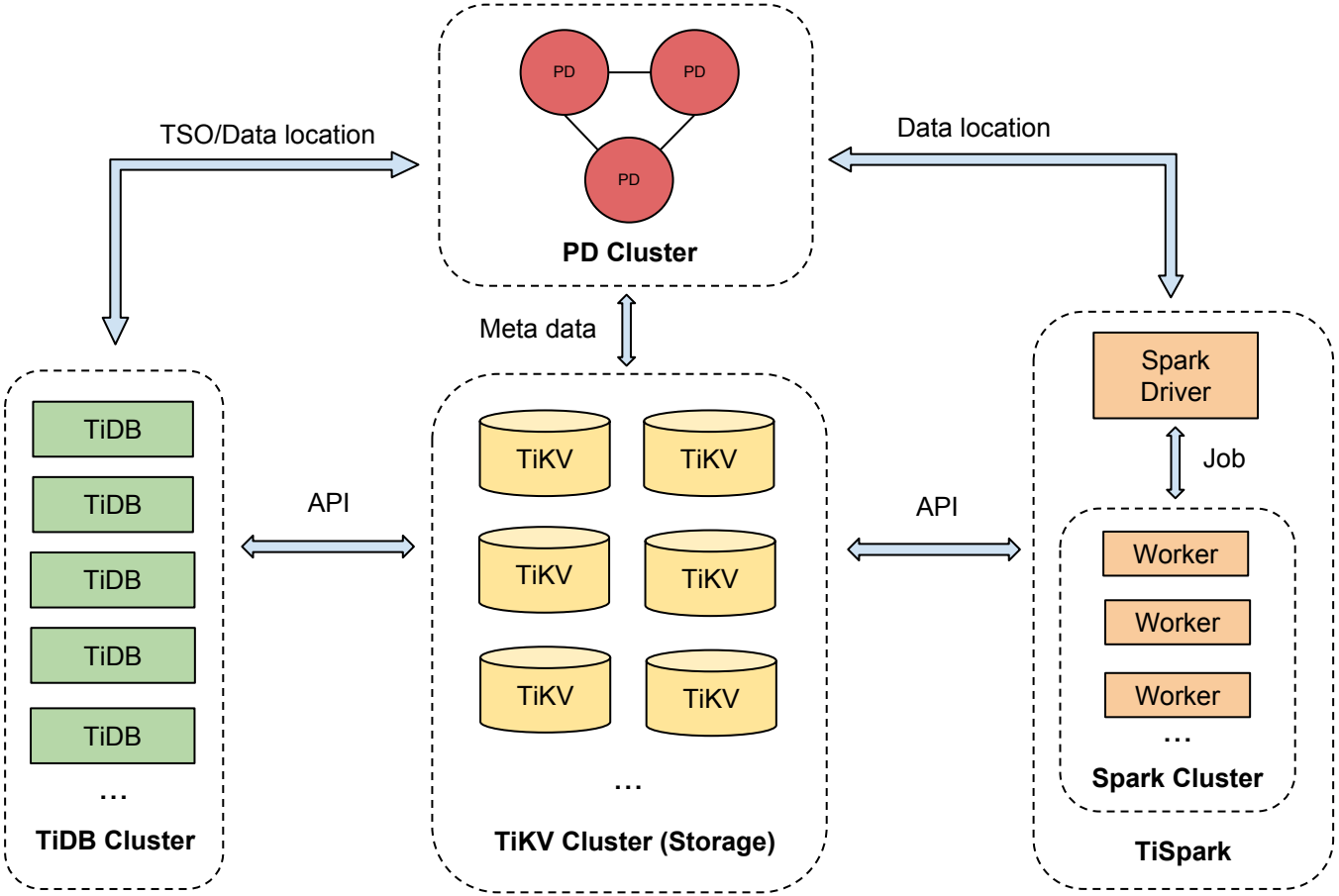
Hybrid Transactional/Analytical Processing Database


PD
PD
PD
PD Cluster
TSO/Data location
Data location
Meta data
TiDB
TiDB
TiDB
TiDB
TiDB
...
TiDB Cluster
API
TiKV
TiKV
TiKV
TiKV
TiKV
TiKV
...
TiKV Cluster (Storage)
API
Spark Driver
Job
Worker
Worker
Worker
...
Spark Cluster
TiSpark

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Thank you!

https://github.com/pingcap/tidb

https://github.com/pingcap/tikv

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