STORAGE DEVELOPER CONFERENCE
SDC 23
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net use //samba/cloud: Scaling Samba

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2023-09-20

Outline

Scaling Samba in the Cloud

Distributed DB: ctdb or what?

Benchmarks

Results and Conclusions

Q&A

Scaling Samba in the Cloud

Samba in the Cloud

Dreaming of a scalable Samba Cloud SMB server

- Highly scalable Opensource Cloud SMB with Samba
  - hundreds of nodes
  - hundreds of thousands of clients
- Elasticity: adding/removing nodes must be cheap
- Availability: multi-datacenter, multi-region support
- Migrate data to the cloud while keeping applications working

The problem

- Samba's `ctdb` has consistency, scalability and elasticity limitations
  - data is not replicated, required for SMB3 Persistent Handles
  - usecase is high-performance NAS in a single DC
  - Suitable for cloud SMB at scale?
- Real world scalability: production max 16 nodes, 50k clients
- Elasticity: changing node count causes an expansive database redistribution

Building Blocks

Building blocks of a scalable Samba Cloud SMB server

- Clustered Filesystem
  - CephFS, GPFS, GlusterFS, Lustre, S3, . . . ?
- Distributed Database for session and handle state
  - `ctdb`, . . . ?
- This time we only look at the database component

Distributed DB: ctdb or what?

ctdb

ctdb **features**

- fast, fast, fast
- I've seen 66k ops/s in the open/close benchmark

ctdb **limitations**

- ctdb has consistency, scalability and elasticity limitations
  - data is not replicated, required for SMB3 Persistent Handles
  - usecase is high-performance NAS in a single DC
  - not suitable for cloud SMB at scale
- Real world scalability: production max 16 nodes, 50k clients
- Elasticity: changing node count causes an expansive database redistribution
- Availability: no support for mulit-DC and AZ

Fix ctdb? Are there alternatives?

- There are many scalable Open Source distributed databases out there
- Can any of those fit the bill?

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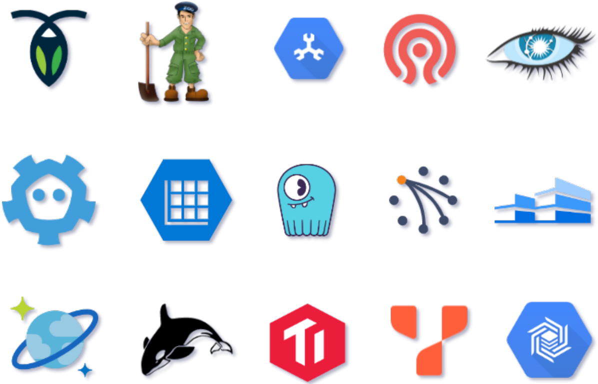
Zoo of Distributed Databases



CockroachDB, Zookeeper, Google Spanner, Ceph, Cassandra
etcd, Azure Table, Scylla, Riak, FoundationDB

Azure CosmosDB, Apache Hbase, TiKV, Yugabyte, Google Bigtable

Requirements: Consistency

Consistency

- Samba needs a database with strong consistency quarantees
  - for a non-transactional key/value store this means linearizability
  - for a transactional databases this means strict serializability
- low the database behaves like a single copy and all operation appear in real-time order

Distributed Locking

- locking is needed to serialize and isolate access to two resources: filesystem and database with file-handle state
- To implement locking we need either: transactions or atomic compare-and-set

Requirements: Performance

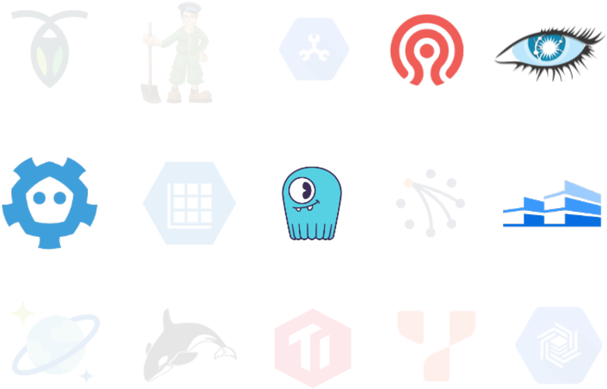
Performance

- Due to its non-replicating design `ctdb` has a very high throughput and low latency
- For many workloads low latency is not first priority:
  - remote office collaboration opening an .doc file:
    takes 200 ms longer to open? Probably doesn't matter!

Assume SMB workload with mostly non-concurrent file access

- the resulting database access pattern is also non-concurrent
- this allows good horizontal scalability

Distributed Databases Tested



dbwrap_py

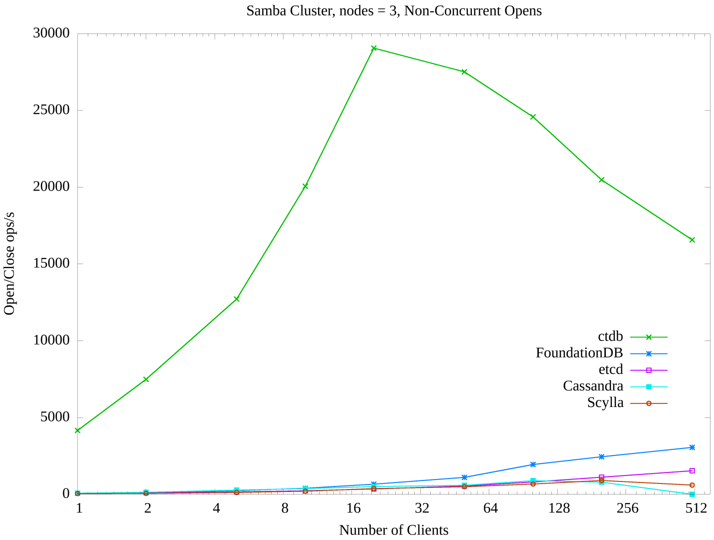
dbwrap_py

- Simplify database adapter development: use Python
- Just 1000 lines of C code (without txn support)
- Using Python for the backend allows rapid prototyping and testing

```
$ wc -l python/samba/samba3/dbwrap_py_*
  338 python/samba/samba3/dbwrap_py_cassandra.py
  414 python/samba/samba3/dbwrap_py_etcd3.py
  303 python/samba/samba3/dbwrap_py_fdb.py
   47 python/samba/samba3/dbwrap_py_tdb.py
```

Benchmarks

Performance: initial evaluation at SambaXP 2023



FoundationDB

And the winner was: FoundationDB

- Key-value store with transaction support
- Supposed to be highly scalable, used by Apple and Snowflake for cloud workloads
- One of the very few open source distributed DBs with a C client
- . . . and Python which we're using for rapid prototyping

Testing with larger FoundationDB cluster

- At SambaXP 2023 I concluded with "we need tests on larger clusters"
- Here are the results. . .

Benchmark

Before the results: how did we test?

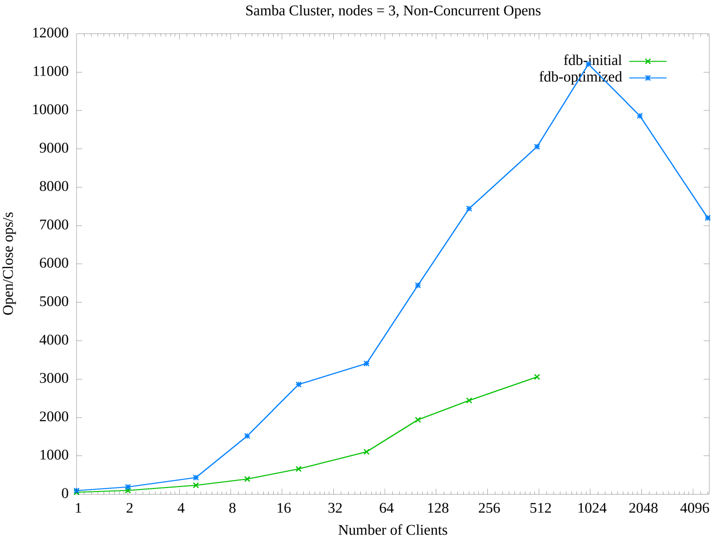
Server: deploy with terraform

- Deploy Samba ctdb cluster and FoundationDB cluster in Azure with terraform
- 1 client VM, 3 ctdb nodes, 1-32 FoundationDB nodes
- thanks to Jule Anger for working on the terraform tooling!

Client: open/close in a loop

```
$ smbtorture //172.18.111.10/test -U slow%x \
  smb2.bench.path-contention-shared \
  --unclist unclist-test.txt \
  --option=torture:timelimit=10 \
  --option=torture:nprocs=[1-500]
```

Performance: ctdb vs FoundationDB



Results and Conclusions

Results

Mixed bag. . .

- 44,000 write (!) txn/s on cloud VMs (`Azure Standard_D3_v2`) with IOPS capped disks
- But it still achieves only 10% max throughout compared to `ctdb`

Conclusions

And the winner is. . .

- FoundationDB for performance and features
- Simple PAXOS or RAFT based databases do not scale well
- Databases which avoid a leader bottleneck scale better
- FoundationDB scales significantly better then any other tested DB

Or write our own?

- Writing a scalable distributed database is very hard
- Single shard PAXOS and RAFT are trivially implemented but do not scale
- using a consensus group per shard solves this but:
  - now you need consensus key ranges
  - changing the ranges when adding or removing nodes becomes a hard problem
- TiKV does this, so it's doable
  (unfortunately TiKV has neither C nor Python bindings)
- Advanced features like multi DC / AZ support doesn't make it easier. . .

Outlook

Outlook

- Highly anticipating the release of Apache Cassandra 5.0
- Cassandra is kind of the Open Source industry standard for eventually consistent databases
- 5.0 ships with strong consistency based on a new consensus protocol ACCORD

QUIC support becomes more important

- Candidate library to add QUIC support to Samba: https://github.com/litespeedtech/lsquic/

Summary

tl;dr

- Still a lot to investigate
- Interested? Join the effort!

Q&A

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Thank you!
Questions?

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