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MyTile

A Cloud-Native Storage Engine based on TileDB

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Outline

- What is TileDB
- MyTile Overview
- Use Cases of MyTile
- Internal Usage of MyTile At TileDB, Inc.

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What is TileDB?

What is TileDB?

TileDB the universal data engine

It is built upon built on **multi-dimensional arrays**

This enables storing and accessing:

- Dense arrays (e.g., satellite images)
- Sparse arrays (e.g., LiDAR, genomics)
- Dataframes (any data in tabular form)
- Key-values (mappings between keys and values)

TileDB: Universal Data Engine

Efficient integration

Open Source

Store all your Data

Model any structured data and slice any segment or region directly from the cloud

Analyze with any tool

Seamlessly access data with any data science tool and perform ML & analytics at scale

TileDB Cloud

Share at planet-scale

Share data sets+ code within & beyond organizational boundaries. Manage access & audit activities.

Eliminate deployment hassles

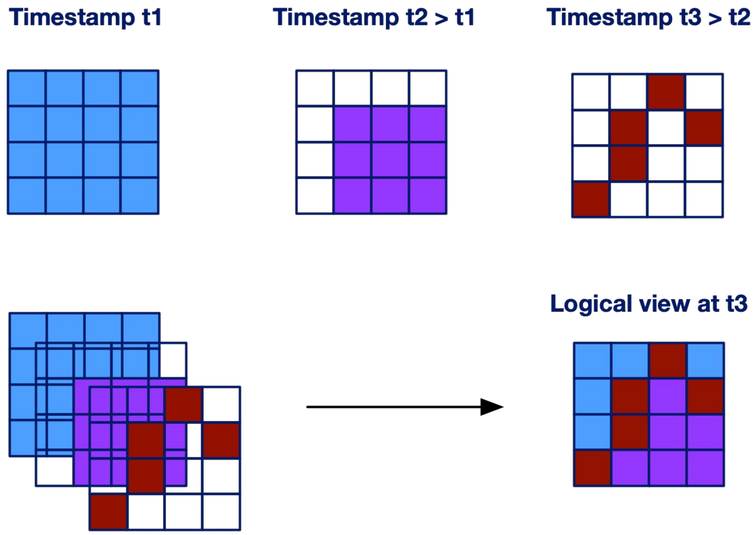
Spin up a Jupyter notebook and scale out computations - all serverless

TileDB Core Features

- Cloud storage (AWS S3, Google Cloud Storage, Azure Blob Storage)
- Tiling (i.e., chunking) for fast slicing
- Columnar
- Multiple compression, encryption and checksum filters
- Fully multi-threaded implementation
- Parallel IO
- Data versioning (rapid updates, time traveling)
- Array metadata
- Array groups
- Embeddable C++ library

TileDB Features (Contd.)

- Time Traveling is native due to MVCC Design
- Every write is immutable
  - Updates are treated as writes
  - Crash safe with object immutability
- Consolidation mechanism supported
  - Combine fragments, purge history
  - Reduced disk space
  - Can improve performance



Immutability is important for cloud object-stores

TileDB Features (Contd.)

ACID support:

- All writes in TileDB are atomic
- Consistency is determined by the storage location
  - Eventual consistency of cloud object stores is natively handled
  - TileDB always returns valid results, never corrupt or invalid results
- Isolation and durability are inherent in the MVCC design
  - Every write gets its own fragment (folder) with a unique with a timestamp + uuid
  - Transactions and locking are not needed
    - conflicting writes at the same timestamp are handled by the UUID of the write

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MyTile Overview

MyTile is a MariaDB Storage Engine based on TileDB Embedded

It inherits all functionality of TileDB

- Uses the TileDB Embedded C++ Library
- TileDB Arrays can be on remote cloud object store (S3, GCS, Azure)
- Fully dynamic discovery of existing arrays
  - SELECT * from `s3://my-bucket/my-array`. *It just works!*
  - Complete interoperability with existing arrays and other APIs
- Current maintained outside MariaDB source, hope to upstream soon

Query Optimizations

- Fully supports condition pushdown
  - Increased performance for large number of query types
  - Predicates on dimensions are intercepted and pushed to TileDB
- Multi-range read optimization built in
  - High performance joins between TileDB and any other tables!
  - Supports bulk key access for MRR optimization for joins

Transactions and Locking

- Completely lock free multi-reader/multi-writer design
  - TileDB storage engine and format natively handle conflicts
  - No need for any locking inside MariaDB
- ACID-like support without any locking or transactions
  - Eventual consistency of cloud object stores main limitation
- Transactions only supported for bulk insertion of data
  - No general transaction support at this time
  - TileDB itself does not have transactions
  - On roadmap for development to support only single mariadb server transactions

Embedded Usage

- MyTile is able to be built and bundled into a embedded MariaDB instance
- Customers use this for data exploration and manipulation
  - Works great to showcase sql in a jupyter notebook without a server
- Embedded MariaDB can be used by any client that links against mariadb c connector
  - Opens the door for anyone to run sql queries on remote datasets without needing a server setup

Backups

- TileDB arrays are self contained, simply copy the folder of the array
  - An array is always in a consistent state even in the middle of a write
- Hot backups and incremental backups are simple
  - Consistent and straightforward structure means its easy to copy only parts of an array after a given timestamp (last backup)
  - Rsync or aws s3 sync commands work great with TileDB arrays

What MyTile Is Not

- A general replacement for InnoDB
- Designed for highly transactional datasets
- Designed for full text searching and indexing (Mroonga)

Storage Engine Comparison - InnoDB

Advantages compared to InnoDB

- Cloud Native, store data on S3, Azure, GCS and more
- Many more compressors (zstd, lz4, RLE and more)
- Significantly reduced write amplification
- Supports time traveling
- Better performance at terabyte scale

Disadvantages:

- InnoDB is a very mature and battle tested storage engine
- InnoDB has great support for replication and backups through tools like mariabackup/xtrabackup
- InnoDB has significantly better single record insert performance

Storage Engine Comparison - MyRocks

Advantages compared to MyRocks

- Cloud Native, store data on S3, Azure, GCS and more
- Interops with any TileDB Integration or API
  - no special format or semantics
- Additional compressors such as run length encoding, double delta and more

Disadvantages:

- MyRocks is more mature, with additional MariaDB statistics and parameters
- MyRocks has support for MariaDB transactions and checkpoints

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Use Cases

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Use Case: #1 Geospatial - AIS

- AIS ship location data
- Data is stored as a Sparse TileDB Array
- Employees access data via:
  - Python
  - MariaDB
  - Embedded MariaDB
- Use the best tool for the job
- Efficient SQL pushdown of bounding box

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Use Case: #2 Time Series

- Common datasets
  - Stock market, asset trading
  - Stored as sparse TileDB array
- Customer uses embedded mariadb
  - Allows fast and easy data exploration
- Uses spark, dask and other for large production jobs
  - Experimenting with distributed SQL via a "cluster" of independent MariaDB servers with custom query sharding.

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Use of MyTile Internally

TileDB, Inc Offerings

Open-source

1. TileDB Embedded

A powerful open-source storage engine that works with all data science tools

- Captures all data via arrays
- Fast and cloud-optimized
- Data versioning built-in

Commercial product

2. TileDB Cloud

A scalable and easy-to-use collaboration and data analytics platform

- Serverless SQL and lambdas
- Jupyter notebooks
- Sharing with access control

Solve the **storage and data management pains** and enable **scalable compute**

Serverless SQL

MyTile is used to power TileDB Cloud's serverless SQL offering

- We run MariaDB servers in an autoscale cluster
- Allow users to dynamically access with their data with a simple query string

```
tiledb.cloud.sql.exec("select avg(a) FROM `tiledb://TileDB-Inc/quickstart_dense`")
```

- Returns data directly as a pandas dataframe (python) or JSON (any language)

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Thank you!

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