k2view

Alpinist

LUI Sync Process - Part 1

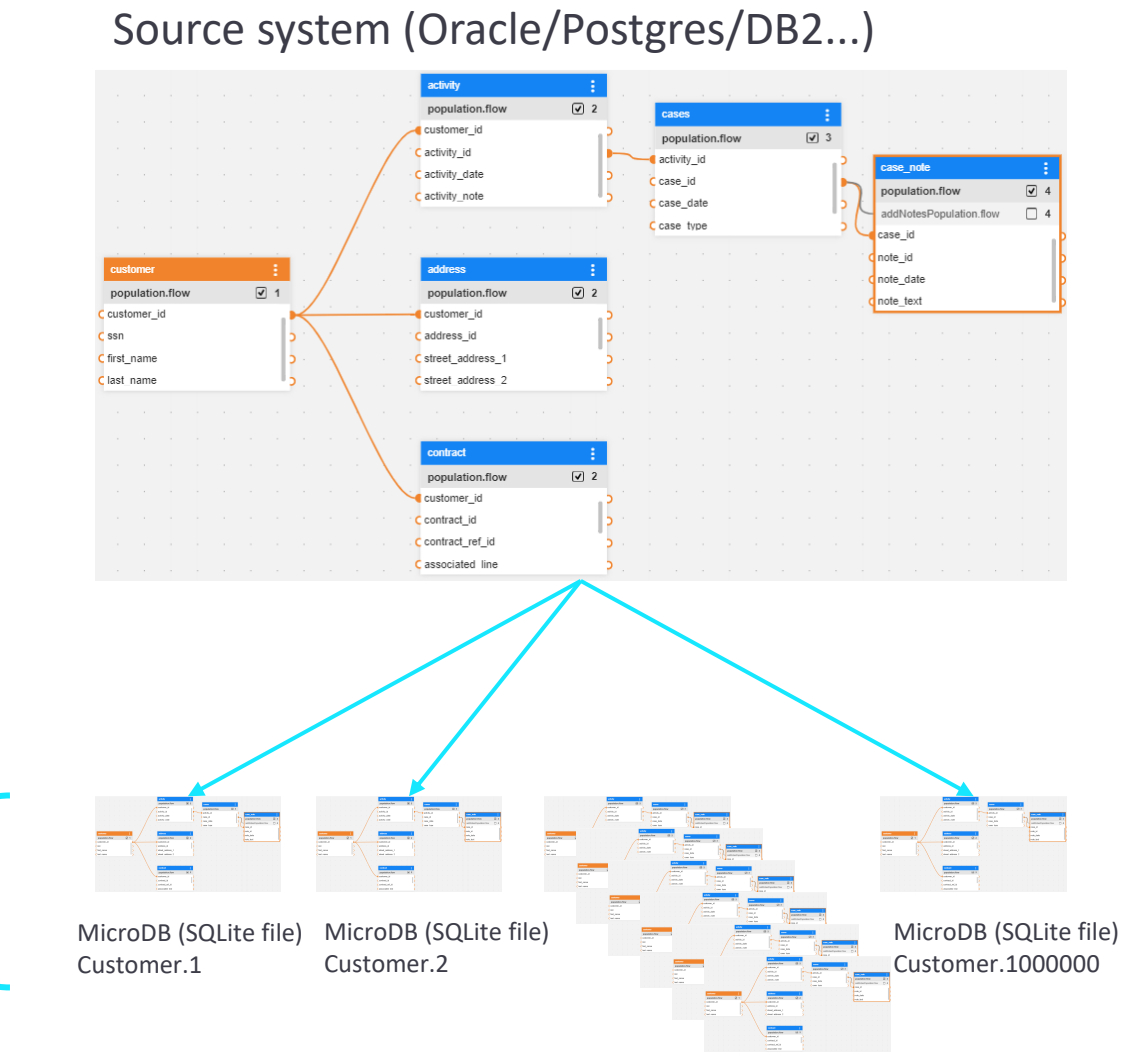
WELCOME

Agenda

- What happens when we execute GET?
- LU Storage
- System database
- Compression
- Vacuum
- LUI version
- Cache
- Transaction
- Sync timeout

What is an LUI?

1. LUI is an SQLite database file.
2. Each LUI contains all the tables defined on the source side.
3. Although each LUI contains all the tables, the data inside each LUI is relevant only for a single instance (e.g., Customer).
4. If we have 1 million customers on the source system, we will have 1 million LUI files in Fabric.
5. All the files are stored in Fabric storage (Cassandra is the default).
6. Each GET command is fetching the requested LUI from the storage to the memory and attach the SQLite to our session.



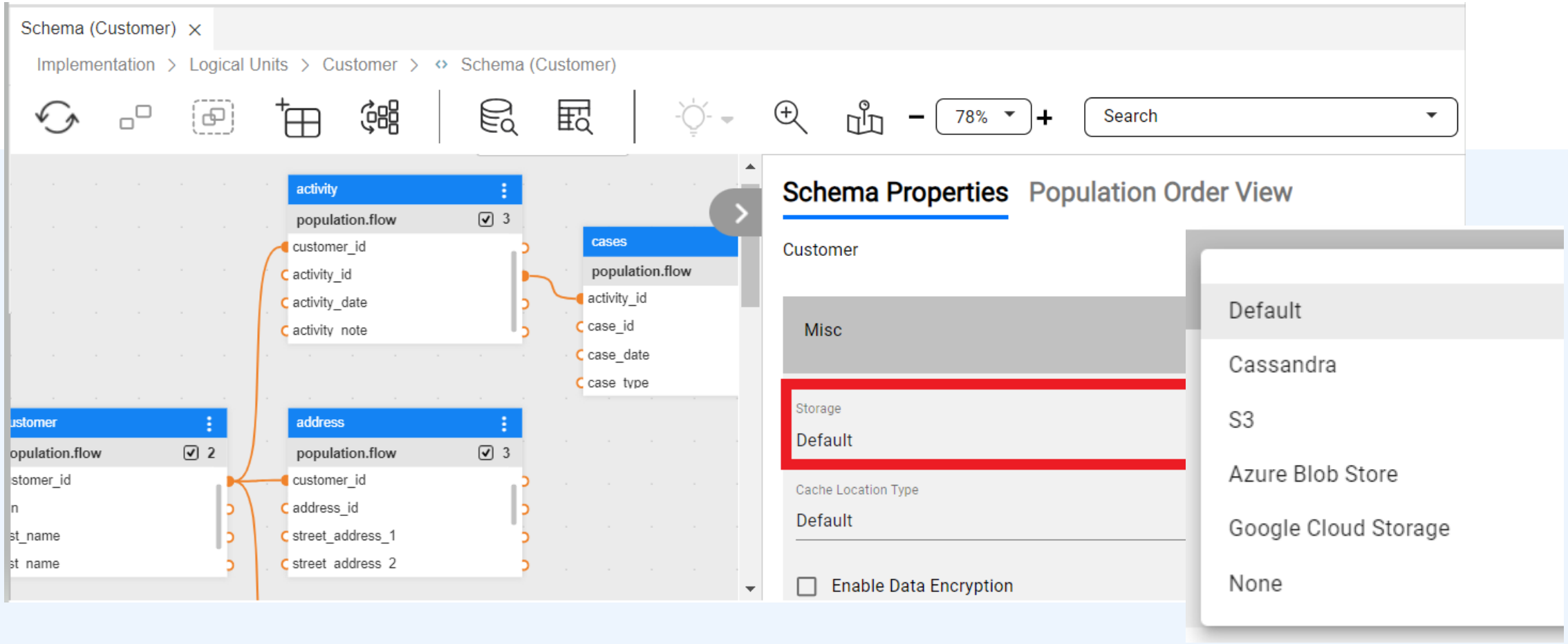
What happens when we execute a GET command?

Get Customer.123:

1. Validate user permissions for the LUI.
2. Check for any attached MDBs in the session that cannot be released due to an ongoing transaction (within the same LU type). If found, raise an error: "Attached LU cannot be detached while in transaction."
3. Extract the SQLite from storage. If not found - start from empty db.
4. Decrypt the file if encryption is applied.
5. Decompress the file.
6. Compare the schema to the LU type definition for any necessary upgrades and implement the schema changes accordingly. If the LUI is new - create the schema.
7. Attach the SQLite file and lock it for write.
   If another GET operation is underway for the same instance, on the same node, the current thread will wait up-to MDB_ATTACH_TIMEOUT ms.
8. If timeout exceeds - throw an error.
9. Begin syncing the LUI by executing table populations.
   1. *Execute all populations and enrichment functions. Each population establishes connections to its source DB as required (utilizing the connection pool).*
   2. *Update k2_objects_info after each population.*
   3. *If LUT sync timeout exceed – throw exception*
   4. *Commit changes to the SQLite.*
10. Apply compression.
11. Encrypt if needed.
12. Save the SQLite back into the storage.
13. Perform a resource cleanup.
    Note: Detach occurs only upon execution of a Release command or when a new instance ID (from the same LU type) needs to be attached.

LUI Storage

The location where to storage the SQLite files (MDBs)



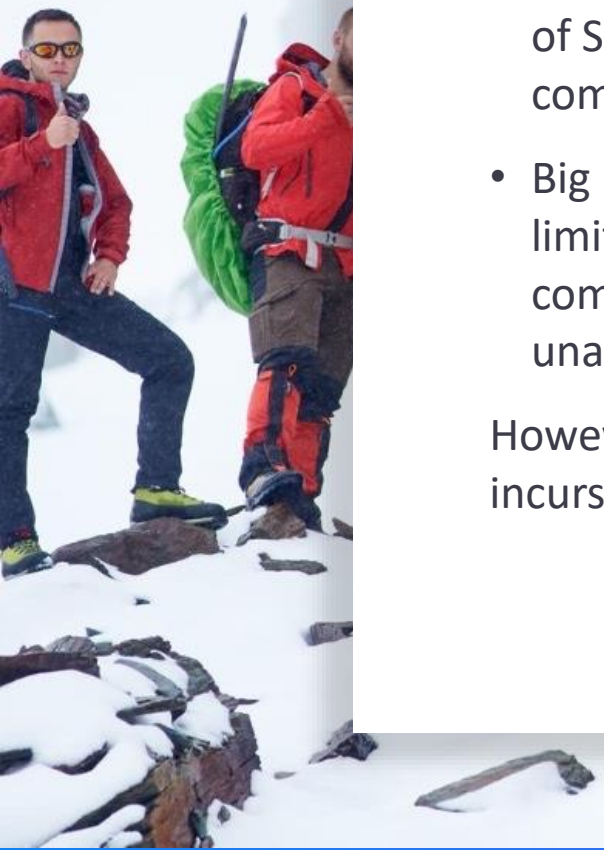
LUI Storage

Options:

- **Default** – as defined in MDB_DEFAULT_SCHEMA_CACHE_STORAGE_TYPE
  - **SYSTEM_DB -** [system_db]
  - **AWS S3 storage -** [s3_storage]
  - **Azure blob storage -** [azure_blob_storage]
  - **GCS – Google Cloud Storage -** [gcs_storage]
  - **NFS – shared storage.**
    Add Config.ini.[fabricdb].
    MDB_DEFAULT_STORAGE_PATH
  - **None** – LUIs are not stored
- **Cassandra** - [default_session]
- **S3** - [s3_storage]
- **Azure** blob storage - [azure_blob_storage]
- **GCS** - [gcs_storage]
- **None** – LUIs are not stored

```
[fabricdb]

FABRICDB_ENGINE=postgresql

## Time in millis to wait for a MicroDB to be released (read/write) by other threads
#MDB_ATTACH_TIMEOUT=10000

## Time in millis to wait for a fabricdb context to become available
#MDB_CONTEXT_POOL_GET_TIMEOUT_MILLIS=10000

## The number of concurrent fabricdb sessions
#MDB_CONTEXT_POOL_SIZE=200

## Cache size limit in bytes per Schema for MicroDB instances that are not currently in use
#MDB_DEFAULT_SCHEMA_CACHE_SIZE=10000000

## Defines the default storage for Micro Databases (can be changed for individual schemas from Studio)
## SYSTEM_DB/S3/AZURE_BLOB_STORE/GCS/NFS/NONE
#MDB_DEFAULT_SCHEMA_CACHE_STORAGE_TYPE=SYSTEM_DB
```

LUI Storage



Using cloud storage for LUIs is preferable over Cassandra due to several reasons:

- Frequent upserts of the LUI in Cassandra can lead to a high load due to the frequent creation of SSTables, which in turn requires constant compaction processes to run
- Big LUIs are stored in chunks due to Cassandra limitation, resulting in slower saving and fetching compared to cloud storage, which remains unaffected by blob size.

However, it's important to note that cloud storage incurs higher costs compared to Cassandra.

```
fabric>list lut storage='Y';
|LU_NAME |STORAGE|Project Version|
+--------+-------+---------------+
|Asset   |Default|1.0.0          |
|Customer|Default|1.0.0          |
```

LUI Storage - Cassandra

Entity table

- When the LU storage is set to Cassandra, the LUIs are stored, as a BLOB (Binary Large Object), in a table named “Entity” within the k2view_[LU_name] keyspace.

Entity table:

- Id = iid
- Batch_id – see Big LUIs section
- Chunks_count - see Big LUIs section
- Data – BLOB of the LUI SQLite file
- Key_desc_id - see Big LUIs section
- Schema_hash – Schema metadata hash. Used to identify schema change
- Sync_version – the version of the LUI

Entity table best practice:

- To count the number of instances, use Cassandra COPY command.
- In case resync is needed for the entire population, do not use ‘select id from entity’ for the batch command. That will bring the IIDs by partitions and therefore the load on the cluster will not be distributed.
  Instead – use the ‘reverse migration’ logic
- '*batch LU from fabric fabric_command="sync_instance LU.?" with ASYNC=true*' comman is running 'select id from entity'

SYSTEM_DB

Operational database for Fabric (cluster info, job mechanism, permissions…)

Options:

- NoSQL distributed database, such as Cassandra DB
- Relational database, such as PostgreSQL
- SQLite - development and single-node environments.

```
[system_db]

## System db to use for Fabric internal storage (SQLITE,POSTGRESQL,CASSANDRA). Default: CASSANDRA
SYSTEM_DB_TYPE=POSTGRESQL
SYSTEM_DB_HOST=localhost
SYSTEM_DB_PASSWORD=~encL0~Fg5TJ4AjjfKso6STHjSyMwMeGAB/1JSf+8GKcGUmZk4F7tUJ
SYSTEM_DB_USER=postgres
SYSTEM_DB_PORT=5432
SYSTEM_DB_DATABASE=k2_db
#SYSTEM_DB_CONNECTION_STRING=
```

SYSTEM_DB

NoSQL distributed database

Pros:

- Scalable
- Distributed
- Built-in TTL mechanism on row level.
- If Cassandra is used as a MicroDB storage, there is no need to introduce additional DBs.
- Managed services (such as AWS Keyspaces or Astra) are supported.
- Supported by the iidFinder solution.
- Built-in mechanism for managing parallel threads during a bulk instance loading.

Cons:

- Consistency
  Maintaining strong consistency often involves additional synchronization mechanisms, which can lead to slower reads and writes
- Not easy to operate and maintain.

Relational database

Pros:

- Consistency
- Compliance with services such as Cloud Spanner, AlloyDB.
- Easy to maintain.

Cons:

- Single point of failure
- Not supported by the iidFinder solution.

Move LUIs to a New Storage

Transfer LUIs to a new storage

To move LUIs between storages, use the following config.ini [fabricdb] settings:

- MDB_DEFAULT_SCHEMA_CACHE_STORAGE_TYPE= TRANSITION
- STORAGE_TRANSITION_FROM=CASSANDRA (the old DB)
- STORAGE_TRANSITION_TO=S3 (the new DB)

LUIs transfer process:

1. On GET, Fabric first checks (i.e., reads) STORAGE_TRANSITION_TO for data. If Fabric cannot find data there, it then reads STORAGE_TRANSITION_FROM for data.
2. On save, Fabric saves data in STORAGE_TRANSITION_TO.
   If the LUI was found in STORAGE_TRANSITION_FROM Fabric deletes the data that was found in STORAGE_TRANSITION_FROM.

If STORAGE_TRANSITION_FROM is set to blank, the system will stop reading STORAGE_TRANSITION_FROM (no need for a restart).

LUI Compression

Before storing the LUI in the storage, Fabric compress the MDB file, to occupy a smaller space and have faster save/extract.
The compression can be changed in config.ini.[fabricdb].MDB_DEFAULT_STORAGE_COMPRESSION

```
## The storage compression to use: LZ4/GZIP/NONE
#MDB_DEFAULT_STORAGE_COMPRESSION=LZ4
```

Options:

- LZ4 (default)
- GZIP
- NONE (no compression).

Best practice:

- GZIP – result Is 25% of the original file.
- LZ4 have better compression but is a bit slower.

LUI Vacuum

As an SQLite database, the below scenarios may occur in the LUIs:

- When content is deleted, it is not usually erased but rather the space used to hold the content is marked as available for reuse.

  When a large amount of data is deleted the database file might be larger than strictly necessary.

- Frequent inserts, updates, and deletes can cause the database file to become fragmented.

Running VACUUM reduces the size of the database file:

- Reclaims the “free” space
- Fix the fragmentations

Best practice:

Usually there is no need to enforce vacuum.

In case of an issue, and after consulting with R&D, you can force reclaim free space before storing the mdb using config.ini.[fabricdb]. MDB_VACUUM_THRESHOLD_KB: -1 is off, 0 always, >0 setting size threshold

LUI Version

Each time the LUI is saved back to the storage, it is assigned with a new version number.
The version number is constructed from the timestamp when the file is saved back

- When the storage is Cassandra, the version is kept in the Entity table.
- When it is stored in cloud, it is kept as property of the file (tag)

The version is used by Fabric in the below cases:

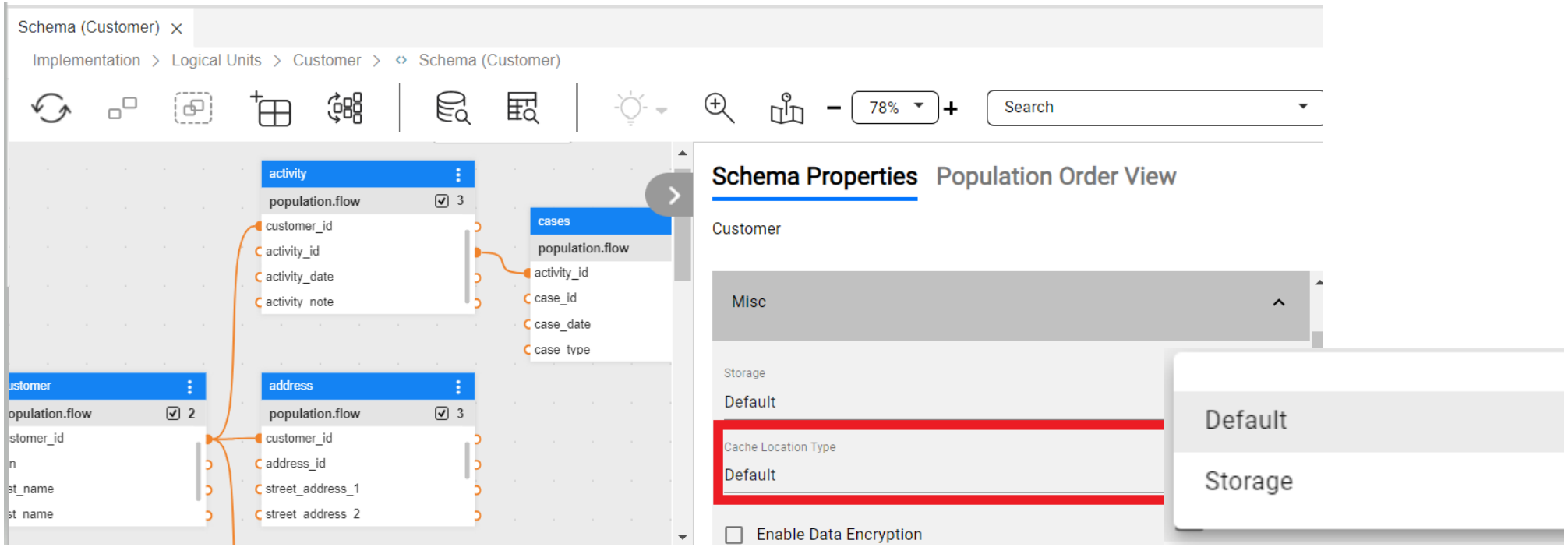
1. Validate LUI override
2. Validate cache is up to date

```
fabric>get Customer.1;
|luName  |iid|version      |action|notes|
+--------+---+-------------+------+-----+
|Customer|1  |1713091350631|ADD   |     |

(1 row)
fabric>select version("Customer");
|version("Customer")|
+-------------------+
|1713091350631      |
```

LUI Cache

To optimize the LUI retrieval process, Fabric uses a cache mechanism, which enables a faster loading of an instance into the memory.

The cache location is defined in the Cache Location property of the LUI Schema.



LUI Cache

Cache location property | Available options:

1. Default

- As configured in config.ini.[fabricdb]. MDB_DEFAULT_CACHE_PATH

```
## This is where fabricdb stores it's MDB cache.
MDB_DEFAULT_CACHE_PATH=${FABRIC_HOME}/storage/fdb_cache
```

- Default is /dev/shm/fdb_cache.
  If this path does not exist, ${FABRIC_HOME}/storage/fdb_cache/ will be used.
- Under the default path, a folder is created per each LUT.
- The /dev/shm directory is a special directory on Linux systems that is used for storing temporary files.
  The files in /dev/shm are stored in memory, rather than on disk, which makes them much faster to access (disk is mounted directly to the Memory)

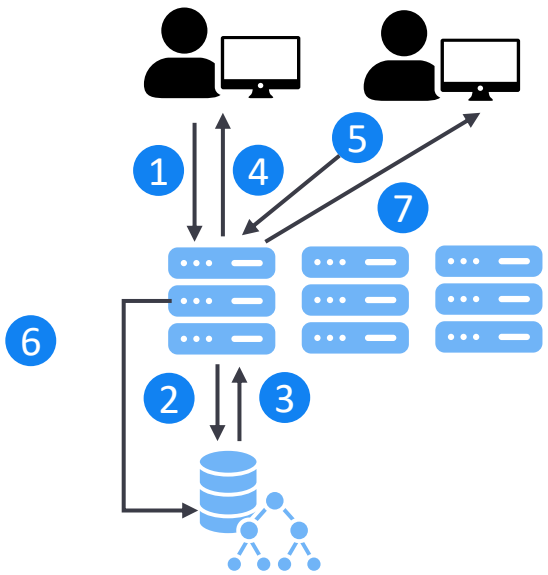
2. Storage

- MDB files will be stored in ${FABRIC_STORAGE}/storage/fdb_cache/ .
  If this location does not exist, store the cache in ${FABRIC_HOME}/storage/fdb_cache/.

Note:

Changing the default path in config.ini will result in ignoring this setting for all the LUTs.

LUI Cache



Fabric usage of the LUI cache

1. User 1 execute GET Customer.215 on node 1
2. Fabric is fetching the LUI (MDB) from Storage
3. Fabric save the MDB file on node 1 cache directory
4. User 1 can query the LUI
5. User 2 execute GET Customer.215 on node 1
6. Fabric is keeping a map in the memory to hold the list of instances IIDs that their MDB files are currently cached. The map also contains the LUI version and the Schema Hash
7. Prior to utilizing the cached file, Fabric validates whether it is the most recent version by querying the storage for MDB with the same IID but with version that is greater than cached one. If MDB is found – the cached file will be replaced
with the newer version.
8. If up-to-date, user 2 can query the file

LUI cache best practice:

1. **Always prioritize using the default path (/dev/shm) to optimize performance.**
2. For very large LUIs that exceed the cache size, consider configuring the cache to utilize another disk space.

LUI Cache

Cache storage size

- The catch storage size is restricted and is set per LUT in config.ini.[fabricdb]. MDB_DEFAULT_SCHEMA_CACHE_SIZE.
- Once the cache storage reaches the specified size:
  - Inactive files are removed from the cache by LRU (Least Recently Used) order.
  - If the size of the LUI file exceeds the remaining space it will be retained in the cache, potentially exceeding the maximum size defined, but it will not be stored in the directory once detached.
  - If the file size exceeds the total memory, Fabric will crash.

Note:

- *The cache is stateless - cached files are deleted upon Fabric restart.*
- *The cache is utilized best when the same LUI is accessed multiple times within a short period. Otherwise, it is possible for the file to be removed from the cache due to other files utilizing it.*

LUI transaction

The Sync process is managed as a single transaction that starts at the beginning of the Sync process and finishes at its end.

- If the Sync is completed successfully, the data is committed to the Fabric database.
- If an error occurs at any point during the Sync process, the transaction is rolled back.

The sync transaction can be managed from outside the sync process, when opening it by the calling session:

```
Db ci = db("fabric");
ci.beginTransaction();
ci.execute("get Customer.'" + IID + "'");
String SQL = "INSERT into CONTRACT_COPY
(CUSTOMER_ID,CONTRACT_ID,CONTRACT_REF_ID) values (?, ?, ?)";
Object[] params = new Object[]{IID, contrID, contrRefID};
ci.execute(SQL, params);
ci.execute("commit");
```

Note:

There is no difference between db("fabric") and fabric()

LUI transaction

LUI transaction

In case the source system cannot be accessed, you may prefer to roll back the Sync without getting an error (exception).
In that case, use the ignore_source_exception command set to ‘true’ on the session level.

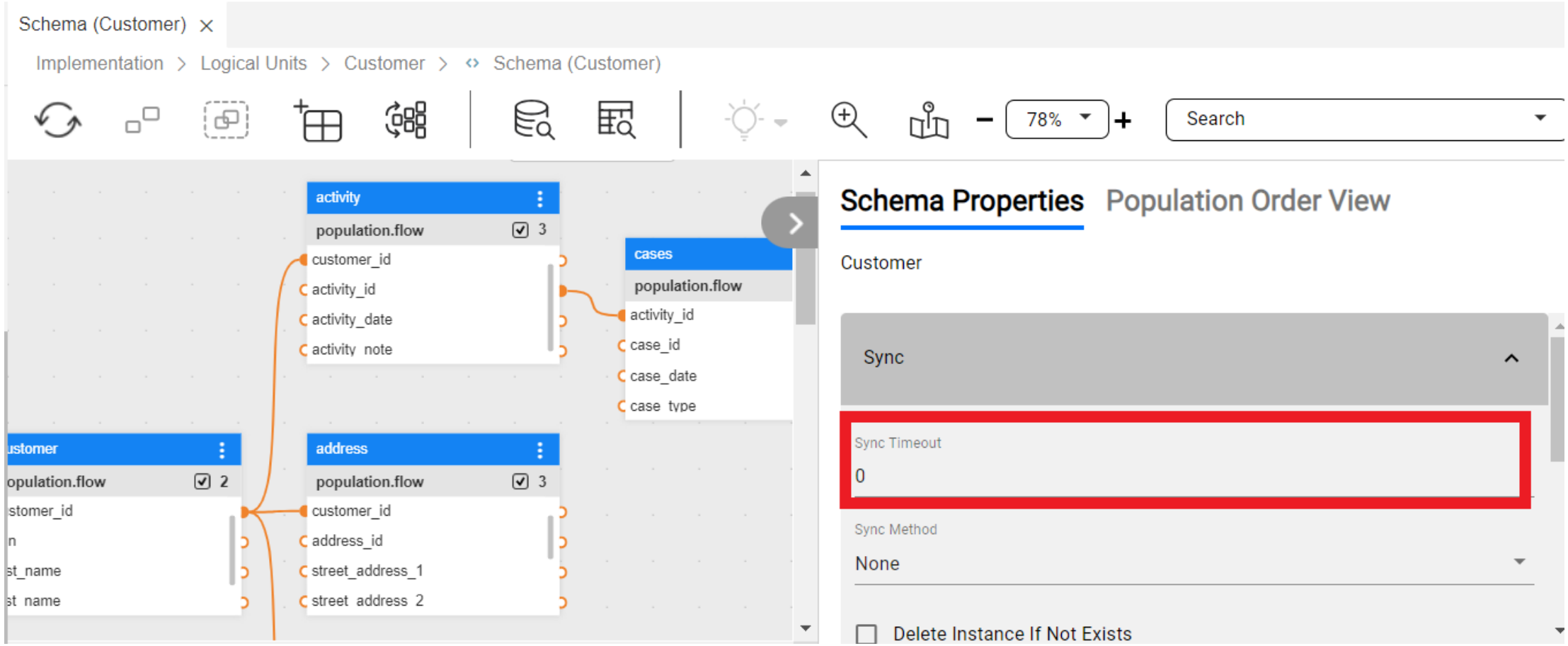
```
fabric>set ignore_source_exception = true;
(1 row affected)
fabric>get Customer.215;
```

Note:

If the instance is not yet in Fabric, the GET command will throw an exception.

LUI sync timeout

Timeout for the Sync process



LUI sync timeout

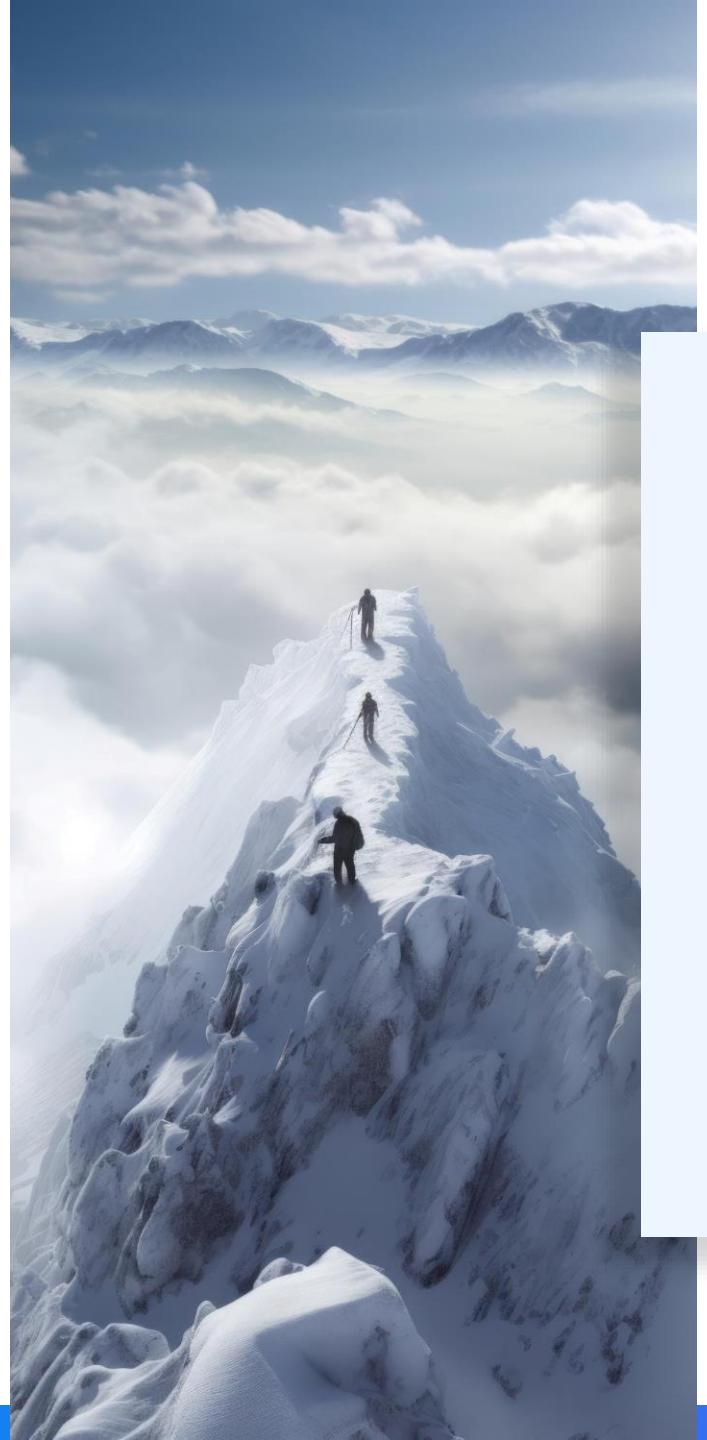
By default, LUI sync time is not limited by time. Nevertheless, it is recommended to limit the sync time to avoid bottlenecks and stuck instances.

If a timeout is set and the sync exceeds the predefined timeout, Fabric rollbacks the changes and throws the following exception: Timeout occurred.

A sync timeout can be defined either on the LUT level or per session:

- LUT Schema level – set the timeout for all the instances of the LUT.
- Session level – override the LUT setting on a session level, using **“set sync_timeout”** command.

```
fabric>set sync_timeout = 10000;
(1 row affected)
fabric>get Customer.215;
```



LUI sync timeout

Design best practice:

- Always set the timeout on the LUT schema level.
- For instances that exceed the timeout, it is recommended to have a retry process (log the failure and create a retry process).
  The retry process can dynamically adjust the sync timeout at the session level using the set sync_timeout command.

Note: when creating a different process, consider the limitations described in the Parallel GETs section.