Loading with Redpanda to StarRocks using shared-data storage

About Routine Load

Routine load is a method using Apache Kafka, or in this lab, Redpanda, to continuously stream data into StarRocks. The data is streamed into a Kafka topic, and a Routine Load job consumes the data into StarRocks. More details on Routine Load are provided at the end of the lab.

About shared-data

In systems that separate storage from compute, data is stored in low-cost reliable remote storage systems such as Amazon S3, Google Cloud Storage, Azure Blob Storage, and other S3-compatible storage like MinIO. Hot data is cached locally and when the cache is hit, the query performance is comparable to that of storage-compute coupled architecture. Compute nodes (CN) can be added or removed on demand within seconds. This architecture reduces storage costs, ensures better resource isolation, and provides elasticity and scalability.

This tutorial covers:

- Running StarRocks, Redpanda, and MinIO with Docker Compose
- Using MinIO as the StarRocks storage layer
- Configuring StarRocks for shared-data
- Adding a Routine Load job to consume data from Redpanda

The data used is synthetic.

There is a lot of information in this document, and it is presented with step-by-step content at the beginning, and the technical details at the end. This is done to serve these purposes in this order:

1. Configure Routine Load.
2. Allow the reader to load data in a shared-data deployment and analyze that data.
3. Provide the configuration details for shared-data deployments.

Prerequisites

Docker

- Docker
- 4 GB RAM assigned to Docker
- 10 GB free disk space assigned to Docker

SQL client

You can use the SQL client provided in the Docker environment, or use one on your system. Many MySQL-compatible clients will work, and this guide covers the configuration of DBeaver and MySQL WorkBench.

curl

`curl` is used to download the Compose file and the script to generate the data. Check to see if you have it installed by running `curl` or `curl.exe` at your OS prompt. If curl is not installed, get curl here.

Python

Python 3 and the Python client for Apache Kafka, `kafka-python`, are required.

- Python
- `kafka-python`

Terminology

FE

Frontend nodes are responsible for metadata management, client connection management, query planning, and query scheduling. Each FE stores and maintains a complete copy of metadata in its memory, which guarantees indiscriminate services among the FEs.

CN

Compute Nodes are responsible for executing query plans in shared-data deployments.

BE

Backend nodes are responsible for both data storage and executing query plans in shared-nothing deployments.

> **NOTE**
>
> This guide does not use BEs, this information is included here so that you understand the difference between BEs and CNs.

Launch StarRocks

To run StarRocks with shared-data using Object Storage you need:

- A frontend engine (FE)
- A compute node (CN)
- Object Storage

This guide uses MinIO, which is S3 compatible Object Storage provider. MinIO is provided under the GNU Affero General Public License.

Download the lab files

`docker-compose.yml`

```
mkdir routineload
cd routineload
curl -O
https://raw.githubusercontent.com/StarRocks/demo/master/documentation-
samples/routine-load-shared-data/docker-compose.yml
```

`gen.py`

`gen.py` is a script that uses the Python client for Apache Kafka to publish (produce) data to a Kafka topic. The script has been written with the address and port of the Redpanda container.

```
curl -O
https://raw.githubusercontent.com/StarRocks/demo/master/documentation-
samples/routine-load-shared-data/gen.py
```

Start StarRocks, MinIO, and Redpanda

```
docker compose up --detach --wait --wait-timeout 120
```

Check the progress of the services. It should take 30 seconds or more for the containers to become healthy. The `routineload-minio_mc-1` container will not show a health indicator, and it will exit once it is done configuring MinIO with the access key that StarRocks will use. Wait for `routineload-minio_mc-1` to exit with a `0` code and the rest of the services to be `Healthy`.

Run `docker compose ps` until the services are healthy:

```
docker compose ps
```

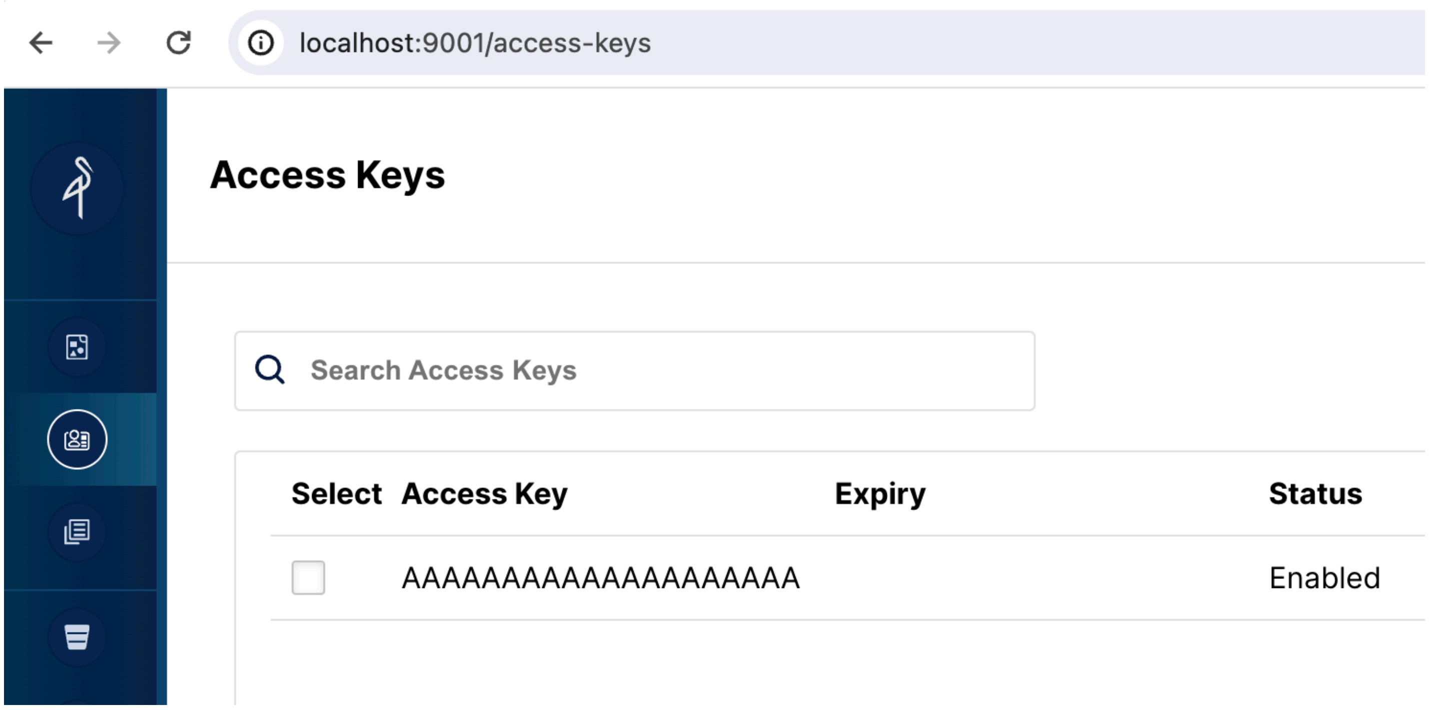
```
WARN[0000] /Users/droscign/routineload/docker-compose.yml: `version` is
obsolete
[+] Running 6/7
 ✔ Network routineload_default       Crea...         0.0s
 ✔ Container minio                   Healthy         5.6s
 ✔ Container redpanda                Healthy         3.6s
 ✔ Container redpanda-console        Healt...        1.1s
 ⠸ Container routineload-minio_mc-1  Waiting          23.1s
 ✔ Container starrocks-fe            Healthy          11.1s
 ✔ Container starrocks-cn            Healthy          23.0s
container routineload-minio_mc-1 exited (0)
```

Examine MinIO credentials

In order to use MinIO for Object Storage with StarRocks, StarRocks needs a MinIO access key. The access key was generated during the startup of the Docker services. To help you better understand the way that StarRocks connects to MinIO you should verify that the key exists.

Open the MinIO web UI

Browse to http://localhost:9001/access-keys The username and password are specified in the Docker compose file, and are `miniouser` and `miniopassword`. You should see that there is one access key. The Key is `AAAAAAAAAAAAAAAAAAAA`, you cannot see the secret in the MinIO Console, but it is in the Docker compose file and is `BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB`:



Select	Access Key	Expiry	Status
☐	AAAAAAAAAAAAAAAAAAAA		Enabled

SQL Clients

These three clients are tested with this tutorial, you only need one:

- mysql CLI: You can run this from the Docker environment or your machine.
- DBeaver is available as a community version and a Pro version.
- MySQL Workbench

Configuring the client

mysql CLI **DBeaver** **MySQL Workbench**

The easiest way to use the mysql CLI is to run it from the StarRocks container `starrocks-fe`:

```
docker compose exec starrocks-fe \
mysql -P 9030 -h 127.0.0.1 -u root --prompt="StarRocks > "
```

TIP

All `docker compose` commands must be run from the directory containing the `docker-compose.yml` file.

If you would like to install the mysql CLI expand **mysql client install** below:

▸ mysql client install

StarRocks configuration for shared-data

At this point you have StarRocks, Redpanda, and MinIO running. A MinIO access key is used to connect StarRocks and Minio. When StarRocks started up, it established the connection with MinIO and created the default storage volume in MinIO.

This is the configuration used to set the default storage volume to use MinIO (this is also in the Docker compose file). The configuration will be described in detail at the end of this guide, for now just note that the `aws_s3_access_key` is set to the string that you saw in the MinIO Console and that the `run_mode` is set to `shared_data`.

```
# enable shared data, set storage type, set endpoint
run_mode = shared_data
cloud_native_storage_type = S3
aws_s3_endpoint = minio:9000

# set the path in MinIO
aws_s3_path = starrocks

# credentials for MinIO object read/write
aws_s3_access_key = AAAAAAAAAAAAAAAAAAAA
aws_s3_secret_key = BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
aws_s3_use_instance_profile = false
aws_s3_use_aws_sdk_default_behavior = false

# Set this to false if you do not want default
# storage created in the object storage using
# the details provided above
enable_load_volume_from_conf = true
```

TIP

To see the full configuration file you can run this command:

```
docker compose exec starrocks-fe cat fe/conf/fe.conf
```

Run all `docker compose` commands from the directory containing the `docker-compose.yml` file.

Connect to StarRocks with a SQL client

TIP

Run this command from the directory containing the `docker-compose.yml` file.

If you are using a client other than the mysql CLI, open that now.

```
docker compose exec starrocks-fe \
mysql -P9030 -h127.0.0.1 -uroot --prompt="StarRocks > "
```

Examine the storage volume

```
SHOW STORAGE VOLUMES;
```

```
+------------------------+
| Storage Volume         |
+------------------------+
| builtin_storage_volume |
+------------------------+
1 row in set (0.00 sec)
```

```
DESC STORAGE VOLUME builtin_storage_volume\G
```

TIP

Some of the SQL in this document, and many other documents in the StarRocks documentation, and with `\G` instead of a semicolon. The `\G` causes the mysql CLI to render the query results vertically.

Many SQL clients do not interpret vertical formatting output, so you should replace `\G` with `;`.

```
*************************** 1. row ***************************
     Name: builtin_storage_volume
     Type: S3
IsDefault: true
 Location: s3://starrocks
   Params:
{"aws.s3.access_key":"******","aws.s3.secret_key":"******","aws.s3.endpoint"
  Enabled: true
  Comment:
1 row in set (0.03 sec)
```

Verify that the parameters match the configuration.

> **NOTE**
>
> The folder `builtin_storage_volume` will not be visible in the MinIO object list until data is written to the bucket.

Create a table

These SQL commands are run in your SQL client.

```
CREATE DATABASE quickstart;
```

```
USE quickstart;
```

```
CREATE TABLE site_clicks (
    `uid` bigint NOT NULL COMMENT "uid",
    `site` string NOT NULL COMMENT "site url",
    `vtime` bigint NOT NULL COMMENT "vtime"
)
DISTRIBUTED BY HASH(`uid`)
PROPERTIES("replication_num"="1");
```

Open the Redpanda Console

There will be no topics yet, a topic will be created in the next step.

http://localhost:8080/overview

Publish data to a Redpanda topic

From a command shell in the `routineload/` folder run this command to generate data:

```
python gen.py 5
```

TIP

On your system, you might need to use `python3` in place of `python` in the command.

If you are missing `kafka-python` try:

```
pip install kafka-python
```

or

```
pip3 install kafka-python
```

```
b'{ "uid": 6926, "site": "https://docs.starrocks.io/", "vtime": 1718034793
} '
b'{ "uid": 3303, "site": "https://www.starrocks.io/product/community",
"vtime": 1718034793 } '
b'{ "uid": 227, "site": "https://docs.starrocks.io/", "vtime": 1718034243
} '
b'{ "uid": 7273, "site": "https://docs.starrocks.io/", "vtime": 1718034794
} '
b'{ "uid": 4666, "site": "https://www.starrocks.io/", "vtime": 1718034794
} '
```

Verify in the Redpanda Console

Navigate to http://localhost:8080/topics in the Redpanda Console, and you will see one topic named `test2`. Select that topic and then the **Messages** tab and you will see five messages matching the output of `gen.py`.

Consume the messages

In StarRocks you will create a Routine Load job to:

1. Consume the messages from the Redpanda topic `test2`
2. Load those messages into the table `site_clicks`

StarRocks is configured to use MinIO for storage, so the data inserted into the `site_clicks` table will be stored in MinIO.

Create a Routine Load job

Run this command in the SQL client to create the Routine Load job, the command will be explained in detail at the end of the lab.

```
CREATE ROUTINE LOAD quickstart.clicks ON site_clicks
PROPERTIES
(
    "format" = "JSON",
    "jsonpaths" ="[\"$.uid\",\"$.site\",\"$.vtime\"]"
)
FROM KAFKA
(
    "kafka_broker_list" = "redpanda:29092",
    "kafka_topic" = "test2",
    "kafka_partitions" = "0",
    "kafka_offsets" = "OFFSET_BEGINNING"
);
```

Verify the Routine Load job

```
SHOW ROUTINE LOAD\G
```

Verify the three highlighted lines:

1. The state should be `RUNNING`
2. The topic should be `test2` and the broker should be `redpanda:2092`
3. The statistics should show either 0 or 5 loaded rows depending on how soon you ran the `SHOW ROUTINE LOAD` command. If there are 0 loaded rows run it again.

```
*************************** 1. row ***************************
                  Id: 10078
                Name: clicks
          CreateTime: 2024-06-12 15:51:12
           PauseTime: NULL
             EndTime: NULL
              DbName: quickstart
           TableName: site_clicks
               State: RUNNING
      DataSourceType: KAFKA
      CurrentTaskNum: 1
       JobProperties:
{"partitions":"*","partial_update":"false","columnToColumnExpr":"*","maxBatc
[\"$.uid\",\"$.site\",\"$.vtime\"]","taskConsumeSecond":"15","desireTaskConc
DataSourceProperties: {"topic":"test2","currentKafkaPartitions":"0","brokerL
    CustomProperties: {"group.id":"clicks_ea38a713-5a0f-4abe-9b11-ff4a241ccb
           Statistic: {"receivedBytes":0,"errorRows":0,"committedTaskNum":0,
            Progress: {"0":"OFFSET_ZERO"}
   TimestampProgress: {}
ReasonOfStateChanged:
        ErrorLogUrls:
         TrackingSQL:
            OtherMsg:
LatestSourcePosition: {}
1 row in set (0.00 sec)
```

```
SHOW ROUTINE LOAD\G
```

```
*************************** 1. row ***************************
                  Id: 10076
                Name: clicks
          CreateTime: 2024-06-12 18:40:53
           PauseTime: NULL
             EndTime: NULL
              DbName: quickstart
           TableName: site_clicks
               State: RUNNING
      DataSourceType: KAFKA
      CurrentTaskNum: 1
       JobProperties:
{"partitions":"*","partial_update":"false","columnToColumnExpr":"*","maxBatc
```

```
[\"$.uid\",\"$.site\",\"$.vtime\"]","taskConsumeSecond":"15","desireTaskConc
DataSourceProperties: {"topic":"test2","currentKafkaPartitions":"0","brokerL
    CustomProperties: {"group.id":"clicks_a9426fee-45bb-403a-a1a3-b3bc6c7aa6
           Statistic: {"receivedBytes":372,"errorRows":0,"committedTaskNum":
            Progress: {"0":"4"}
   TimestampProgress: {"0":"1718217035111"}
ReasonOfStateChanged:
        ErrorLogUrls:
         TrackingSQL:
            OtherMsg:
LatestSourcePosition: {"0":"5"}
1 row in set (0.00 sec)
```

Verify that data is stored in MinIO

Open MinIO http://localhost:9001/browser/ and verify that there are objects stored under `starrocks`.

Query the data from StarRocks

```
USE quickstart;
SELECT * FROM site_clicks;
```

```
+------+--------------------------------------------+------------+
| uid  | site                                       | vtime      |
+------+--------------------------------------------+------------+
| 4607 | https://www.starrocks.io/blog              | 1718031441 |
| 1575 | https://www.starrocks.io/                  | 1718031523 |
| 2398 | https://docs.starrocks.io/                 | 1718033630 |
| 3741 | https://www.starrocks.io/product/community | 1718030845 |
| 4792 | https://www.starrocks.io/                  | 1718033413 |
+------+--------------------------------------------+------------+
5 rows in set (0.07 sec)
```

Publish additional data

Running `gen.py` again will publish another five records to Redpanda.

```
python gen.py 5
```

Verify that data is added

Since the Routine Load job runs on a schedule (every 10 seconds by default), the data will be loaded within a few seconds.

```
SELECT * FROM site_clicks;
```

```
+------+--------------------------------------------+------------+
| uid  | site                                       | vtime      |
+------+--------------------------------------------+------------+
| 6648 | https://www.starrocks.io/blog              | 1718205970 |
| 7914 | https://www.starrocks.io/                  | 1718206760 |
| 9854 | https://www.starrocks.io/blog              | 1718205676 |
| 1186 | https://www.starrocks.io/                  | 1718209083 |
| 3305 | https://docs.starrocks.io/                 | 1718209083 |
| 2288 | https://www.starrocks.io/blog              | 1718206759 |
| 7879 | https://www.starrocks.io/product/community | 1718204280 |
| 2666 | https://www.starrocks.io/                  | 1718208842 |
| 5801 | https://www.starrocks.io/                  | 1718208783 |
| 8409 | https://www.starrocks.io/                  | 1718206889 |
+------+--------------------------------------------+------------+
10 rows in set (0.02 sec)
```

Configuration details

Now that you have experienced using StarRocks with shared-data it is important to understand the configuration.

CN configuration

The CN configuration used here is the default, as the CN is designed for shared-data use. The default configuration is shown below. You do not need to make any changes.

```
sys_log_level = INFO

# ports for admin, web, heartbeat service
be_port = 9060
be_http_port = 8040
heartbeat_service_port = 9050
brpc_port = 8060
starlet_port = 9070
```

FE configuration

The FE configuration is slightly different from the default as the FE must be configured to expect that data is stored in Object Storage rather than on local disks on BE nodes.

The `docker-compose.yml` file generates the FE configuration in the `command` section of the `starrocks-fe` service.

```
# enable shared data, set storage type, set endpoint
run_mode = shared_data
cloud_native_storage_type = S3
aws_s3_endpoint = minio:9000

# set the path in MinIO
aws_s3_path = starrocks

# credentials for MinIO object read/write
aws_s3_access_key = AAAAAAAAAAAAAAAAAAAA
aws_s3_secret_key = BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
aws_s3_use_instance_profile = false
aws_s3_use_aws_sdk_default_behavior = false

# Set this to false if you do not want default
# storage created in the object storage using
# the details provided above
enable_load_volume_from_conf = true
```

> **NOTE**
>
> This config file does not contain the default entries for an FE, only the shared-data configuration is shown.

The non-default FE configuration settings:

> **NOTE**
>
> Many configuration parameters are prefixed with `s3_`. This prefix is used for all Amazon S3 compatible storage types (for example: S3, GCS, and MinIO). When using Azure Blob Storage the prefix is `azure_`.

`run_mode=shared_data`

This enables shared-data use.

`cloud_native_storage_type=S3`

This specifies whether S3 compatible storage or Azure Blob Storage is used. For MinIO this is always S3.

`aws_s3_endpoint=minio:9000`

The MinIO endpoint, including port number.

`aws_s3_path=starrocks`

The bucket name.

`aws_s3_access_key=AAAAAAAAAAAAAAAAAAAA`

The MinIO access key.

`aws_s3_secret_key=BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB`

The MinIO access key secret.

`aws_s3_use_instance_profile=false`

When using MinIO an access key is used, and so instance profiles are not used with MinIO.

`aws_s3_use_aws_sdk_default_behavior=false`

When using MinIO this parameter is always set to false.

`enable_load_volume_from_conf=true`

When this is true, a StarRocks storage volume named `builtin_storage_volume` is created using MinIO object storage, and it is set to be the default storage volume for the tables that you create.

Notes on the Routine Load command

StarRocks Routine Load takes many arguments. Only the ones used in this tutorial are described here, the rest will be linked to in the more information section.

```sql
CREATE ROUTINE LOAD quickstart.clicks ON site_clicks
PROPERTIES
(
    "format" = "JSON",
    "jsonpaths" ="[\"$.uid\",\"$.site\",\"$.vtime\"]"
)
FROM KAFKA
(
    "kafka_broker_list" = "redpanda:29092",
    "kafka_topic" = "test2",
    "kafka_partitions" = "0",
    "kafka_offsets" = "OFFSET_BEGINNING"
);
```

Parameters

```
CREATE ROUTINE LOAD quickstart.clicks ON site_clicks
```

The parameters for `CREATE ROUTINE LOAD ON` are:

- database_name.job_name
- table_name

`database_name` is optional. In this lab, it is `quickstart` and is specified.

`job_name` is required, and is `clicks`

`table_name` is required, and is `site_clicks`

Job properties

Property `format`

```
"format" = "JSON",
```

In this case, the data is in JSON format, so the property is set to `JSON`. The other valid formats are: `CSV`, `JSON`, and `Avro`. `CSV` is the default.

Property `jsonpaths`

```
"jsonpaths" ="[\"$.uid\",\"$.site\",\"$.vtime\"]"
```

The names of the fields that you want to load from JSON-formatted data. The value of this parameter is a valid JsonPath expression. More information is available at the end of this page.

Data source properties

`kafka_broker_list`

```
"kafka_broker_list" = "redpanda:29092",
```

Kafka's broker connection information. The format is `<kafka_broker_name_or_ip>:<broker_port>`. Multiple brokers are separated by commas.

`kafka_topic`

```
"kafka_topic" = "test2",
```

The Kafka topic to consume from.

`kafka_partitions` and `kafka_offsets`

```
"kafka_partitions" = "0",
"kafka_offsets" = "OFFSET_BEGINNING"
```

These properties are presented together as there is one `kafka_offset` required for each `kafka_partitions` entry.

`kafka_partitions` is a list of one or more partitions to consume. If this property is not set, then all partitions are consumed.

`kafka_offsets` is a list of offsets, one for each partition listed in `kafka_partitions`. In this case the value is `OFFSET_BEGINNING` which causes all of the data to be consumed. The default is to only consume new data.

Summary

In this tutorial you:

- Deployed StarRocks, Reedpanda, and Minio in Docker
- Created a Routine Load job to consume data from a Kafka topic
- Learned how to configure a StarRocks Storage Volume that uses MinIO

More information

StarRocks Architecture

The sample used for this lab is very simple. Routine Load has many more options and capabilities. learn more.

JSONPath