Red Hat Integration 2020.Q1

Getting Started with Debezium

For use with Debezium 1.0

Last Updated: 2021-02-19

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Legal Notice

Abstract

This guide describes how to get started using Debezium.

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PREFACE

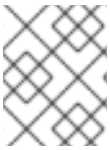
This tutorial demonstrates how to use Debezium to monitor a MySQL database. As the data in the database changes, you will see the resulting event streams.

In this tutorial you will start the Debezium services in OpenShift, run a MySQL database server with a simple example database, and use Debezium to monitor the database for changes.

Prerequisites

Before you can use Debezium to monitor a MySQL database, you must have:

- Access to an OpenShift Container Platform 4.x cluster with **cluster-admin** privileges
- The AMQ Streams 1.4 OpenShift installation and example files
  You can download these files from the AMQ Streams download site .
- The Debezium 1.0.0 MySQL Connector
  You can download these files from the Red Hat Integration download site .



NOTE

These prerequisites apply to the MySQL connector. Other Debezium connectors may have different prerequisites.

CHAPTER 1. INTRODUCTION TO DEBEZIUM

Debezium is a distributed platform that turns your existing databases into event streams, so applications can see and respond immediately to each row-level change in the databases.

Debezium is built on top of Apache Kafka and provides Kafka Connect compatible connectors that monitor specific database management systems. Debezium records the history of data changes in Kafka logs, from where your application consumes them. This makes it possible for your application to easily consume all of the events correctly and completely. Even if your application stops unexpectedly, it will not miss anything: when the application restarts, it will resume consuming the events where it left off.

Debezium includes multiple connectors. In this tutorial, you will use the MySQL connector.

CHAPTER 2. STARTING THE SERVICES

Using Debezium requires AMQ Streams and the Debezium connector service. To start the services needed for this tutorial, you must:

1. Use AMQ Streams to set up a single-node Kafka cluster in OpenShift
2. Deploy Kafka Connect with the Debezium MySQL Connector plugin
3. Deploy a MySQL database

2.1. SETTING UP A KAFKA CLUSTER

You use AMQ Streams to set up a Kafka cluster. This procedure deploys a single-node Kafka cluster.

Procedure

1. In your OpenShift 4.x cluster, create a new project:

```
$ oc new-project cdc-tutorial
```

2. Change to the directory where you downloaded the AMQ Streams 1.4 OpenShift installation and example files.

3. Deploy the AMQ Streams Cluster Operator.
The Cluster Operator is responsible for deploying and managing Kafka clusters within an OpenShift cluster. This command deploys the Cluster Operator to watch just the project that you created:

```
$ sed -i 's/namespace: .*/namespace: cdc-tutorial/' install/cluster-operator/*RoleBinding*.yaml

$ oc apply -f install/cluster-operator -n cdc-tutorial
```

4. Verify that the Cluster Operator is running.
This command shows that the Cluster Operator is running, and that all of the Pods are ready:

```
$ oc get pods
NAME                                        READY   STATUS    RESTARTS   AGE
strimzi-cluster-operator-5c6d68c54-l4gdz    1/1     Running   0          46s
```

5. Deploy the Kafka cluster.
This command uses the **kafka-ephemeral-single.yaml** Custom Resource to create an ephemeral Kafka cluster with three ZooKeeper nodes and one Kafka node:

```
$ oc apply -f examples/kafka/kafka-ephemeral-single.yaml
```

6. Verify that the Kafka cluster is running.
This command shows that the Kafka cluster is running, and that all of the Pods are ready:

```
$ oc get pods
NAME                                          READY   STATUS    RESTARTS   AGE
my-cluster-entity-operator-5b5d4f7c58-8gnq5   3/3     Running   0          41s
my-cluster-kafka-0                            2/2     Running   0          70s
```

```
my-cluster-zookeeper-0                        2/2     Running   0          107s
my-cluster-zookeeper-1                        2/2     Running   0          107s
my-cluster-zookeeper-2                        2/2     Running   0          107s
strimzi-cluster-operator-5c6d68c54-l4gdz      1/1     Running   0          8m53s
```

2.2. DEPLOYING KAFKA CONNECT

After setting up a Kafka cluster, you deploy the Kafka Connect Source-to-Image (S2I) service. This service provides a framework for managing the Debezium MySQL connector.

Procedure

1. Deploy the Kafka Connect Source-to-Image (S2I) service:
   This command deploys the Kafka Connect S2I service using the example YAML file for a single-node Kafka cluster:

   ```
   $ oc apply -f examples/kafka-connect/kafka-connect-s2i-single-node-kafka.yaml
   ```

2. Verify that the Kafka Connect service is running.
   This command shows that the Kafka Connect service is running, and that the Pod is ready:

   ```
   $ oc get pods -l strimzi.io/name=my-connect-cluster-connect
   NAME                                     READY   STATUS    RESTARTS   AGE
   my-connect-cluster-connect-1-dxcs9       1/1     Running   0          7m
   ```

3. Start a new build of the Kafka Connect image using the Debezium MySQL Connector plugin.
   This command uses the Debezium MySQL Connector plugin that you previously downloaded:

   ```
   $ oc start-build my-connect-cluster-connect --from-dir ./my-plugins/
   ```

4. Verify that the build has completed.
   This command shows that the new build is complete (**my-connect-cluster-connect-2**). The Debezium MySQL Connector is installed:

   ```
   $ oc get build
   NAME                          TYPE     FROM     STATUS     STARTED         DURATION
   my-connect-cluster-connect-1  Source            Complete   9 minutes ago   2m10s
   my-connect-cluster-connect-2  Source   Binary   Complete   4 minutes ago   2m2s
   ```

2.3. DEPLOYING A MYSQL DATABASE

At this point, you have deployed a Kafka cluster and the Kafka Connect service with the Debezium MySQL Database Connector. However, you still need a database server from which Debezium can capture changes. In this procedure, you will start a MySQL server with an example database.

Procedure

1. Start a MySQL database.
   This command starts a MySQL database server preconfigured with an example **inventory** database:

```
$ oc new-app --name=mysql debezium/example-mysql:1.0
```

2. Configure credentials for the MySQL database.
   This command updates the deployment configuration for the MySQL database to add the user name and password:

```
$ oc set env dc/mysql MYSQL_ROOT_PASSWORD=debezium  MYSQL_USER=mysqluser
MYSQL_PASSWORD=mysqlpw
```

3. Verify that the MySQL database is running.
   This command shows that the MySQL database is running, and that the Pod is ready:

```
$ oc get pods -l app=mysql
NAME           READY   STATUS    RESTARTS   AGE
mysql-1-2gzx5   1/1     Running   1          23s
```

4. Open a new terminal and log into the sample **inventory** database.
   This command opens a MySQL command line client in the Pod that is running the MySQL database. It uses the user name and password that you previously configured:

```
$ oc exec mysql-1-2gzx5 -it -- mysql -u mysqluser -p mysqlpw inventory
mysql: [Warning] Using a password on the command line interface can be insecure.
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A

Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 7
Server version: 5.7.29-log MySQL Community Server (GPL)

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owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql>
```

5. List the tables in the **inventory** database.

```
mysql> show tables;
+--------------------+
| Tables_in_inventory |
+--------------------+
| addresses          |
| customers          |
| geom               |
| orders             |
| products           |
| products_on_hand   |
+--------------------+
6 rows in set (0.00 sec)
```

6. Explore the database and view the pre-loaded data.
   This example shows the customers table:

```
mysql> select * from customers;
+------+------------+-----------+-----------------------+
| id   | first_name | last_name | email                 |
+------+------------+-----------+-----------------------+
| 1001 | Sally      | Thomas    | sally.thomas@acme.com |
| 1002 | George     | Bailey    | gbailey@foobar.com    |
| 1003 | Edward     | Walker    | ed@walker.com         |
| 1004 | Anne       | Kretchmar | annek@noanswer.org    |
+------+------------+-----------+-----------------------+
4 rows in set (0.00 sec)
```

CHAPTER 3. CREATING A CONNECTOR TO MONITOR THE INVENTORY DATABASE

After starting the Kafka, Debezium, and MySQL services, you are ready to create a connector instance to monitor the **inventory** database.

In this procedure, you will create the connector instance by creating a **KafkaConnector** Custom Resource (CR) that defines the connector instance, and then applying it. After applying the CR, the connector instance will start monitoring the **inventory** database's **binlog**. The **binlog** records all of the database's transactions (such as changes to individual rows and changes to the schemas). When a row in the database changes, Debezium generates a change event.

NOTE

Typically, you would likely use the Kafka tools to manually create the necessary topics, including specifying the number of replicas. However, for this tutorial, Kafka is configured to automatically create the topics with just one replica.

Procedure

1. Open the **examples/kafka-connect/kafka-connect-s2i-single-node-kafka.yaml** file that you used to deploy Kafka Connect.
   Before you can create the MySQL connector instance, you must first enable connector resources in the **KafkaConnectS2I** Custom Resource (CR).

2. In the **metadata.annotations** section, enable Kafka Connect to use connector resources.
   This example adds an annotation to the **examples/kafka-connect/kafka-connect-s2i-single-node-kafka.yaml** example file:

   kafka-connect-s2i-single-node-kafka.yaml

   ```
   apiVersion: kafka.strimzi.io/v1beta1
   kind: KafkaConnectS2I
   metadata:
     name: my-connect-cluster
     annotations:
       strimzi.io/use-connector-resources: "true"
   spec:
     ...
   ```

3. Apply the updated **kafka-connect-s2i-single-node-kafka.yaml** file to update the **KafkaConnectS2I** CR.

   ```
   $ oc apply -f kafka-connect-s2i-single-node-kafka.yaml
   ```

4. Create a MySQL connector instance to monitor the **inventory** database.
   This example creates a **KafkaConnector** CR that defines the MySQL connector instance:

   inventory-connector.yaml

   ```
   apiVersion: kafka.strimzi.io/v1alpha1
   kind: KafkaConnector
   metadata:
   ```

```
  name: inventory-connector (1)
  labels:
    strimzi.io/cluster: my-connect-cluster
spec:
  class: io.debezium.connector.mysql.MySqlConnector
  tasksMax: 1 (2)
  config: (3)
    database.hostname: mysql (4)
    database.port: 3306
    database.user: debezium
    database.password: dbz
    database.server.id: 184054 (5)
    database.server.name: dbserver1 (6)
    database.whitelist: inventory (7)
    database.history.kafka.bootstrap.servers: my-cluster-kafka-bootstrap:9092 (8)
    database.history.kafka.topic: schema-changes.inventory (9)
```

(1) The name of the connector.

(2) Only one task should operate at any one time. Because the MySQL connector reads the MySQL server's **binlog**, using a single connector task ensures proper order and event handling. The Kafka Connect service uses connectors to start one or more tasks that do the work, and it automatically distributes the running tasks across the cluster of Kafka Connect services. If any of the services stop or crash, those tasks will be redistributed to running services.

(3) The connector's configuration.

(4) The database host, which is the name of the container running the MySQL server (**mysql**).

(5) (6) A unique server ID and name. The server name is the logical identifier for the MySQL server or cluster of servers. This name will be used as the prefix for all Kafka topics.

(7) Only changes in the **inventory** database will be detected.

(8) (9) The connector will store the history of the database schemas in Kafka using this broker (the same broker to which you are sending events) and topic name. Upon restart, the connector will recover the schemas of the database that existed at the point in time in the **binlog** when the connector should begin reading.

5. Apply the connector instance.

```
$ oc apply -f inventory-connector.yaml
```

The **inventory-connector** connector is registered and starts to run against the **inventory** database.

6. Verify that **inventory-connector** was created and has started to monitor the **inventory** database.
You can verify the connector instance by watching the Kafka Connect log output as **inventory-connector** starts.

   a. Display the Kafka Connect log output:

```
$ oc logs $(oc get pods -o name -l strimzi.io/name=my-connect-cluster-connect)
```

b. Review the log output and verify that the initial snapshot has been executed.
These lines show that the initial snapshot has started:

```
...
2020-02-21 17:57:30,801 INFO Starting snapshot for jdbc:mysql://mysql:3306/?
useInformationSchema=true&nullCatalogMeansCurrent=false&useSSL=false&useUnicode=
true&characterEncoding=UTF-8&characterSetResults=UTF-
8&zeroDateTimeBehavior=CONVERT_TO_NULL&connectTimeout=30000 with user
'debezium' with locking mode 'minimal' (io.debezium.connector.mysql.SnapshotReader)
[debezium-mysqlconnector-dbserver1-snapshot]
2020-02-21 17:57:30,805 INFO Snapshot is using user 'debezium' with these MySQL
grants: (io.debezium.connector.mysql.SnapshotReader) [debezium-mysqlconnector-
dbserver1-snapshot]
...
```

The snapshot involves a number of steps:

```
...
2020-02-21 17:57:30,822 INFO Step 0: disabling autocommit, enabling repeatable read
transactions, and setting lock wait timeout to 10
(io.debezium.connector.mysql.SnapshotReader) [debezium-mysqlconnector-dbserver1-
snapshot]
2020-02-21 17:57:30,836 INFO Step 1: flush and obtain global read lock to prevent
writes to database (io.debezium.connector.mysql.SnapshotReader) [debezium-
mysqlconnector-dbserver1-snapshot]
2020-02-21 17:57:30,839 INFO Step 2: start transaction with consistent snapshot
(io.debezium.connector.mysql.SnapshotReader) [debezium-mysqlconnector-dbserver1-
snapshot]
2020-02-21 17:57:30,840 INFO Step 3: read binlog position of MySQL master
(io.debezium.connector.mysql.SnapshotReader) [debezium-mysqlconnector-dbserver1-
snapshot]
2020-02-21 17:57:30,843 INFO   using binlog 'mysql-bin.000003' at position '154' and gtid
'' (io.debezium.connector.mysql.SnapshotReader) [debezium-mysqlconnector-dbserver1-
snapshot]
...
2020-02-21 17:57:34,423 INFO Step 9: committing transaction
(io.debezium.connector.mysql.SnapshotReader) [debezium-mysqlconnector-dbserver1-
snapshot]
2020-02-21 17:57:34,424 INFO Completed snapshot in 00:00:03.632
(io.debezium.connector.mysql.SnapshotReader) [debezium-mysqlconnector-dbserver1-
snapshot]
...
```

After completing the snapshot, Debezium begins monitoring the **inventory** database's **binlog** for change events:

```
...
2020-02-21 17:57:35,584 INFO Transitioning from the snapshot reader to the binlog
reader (io.debezium.connector.mysql.ChainedReader) [task-thread-inventory-connector-
0]
2020-02-21 17:57:35,613 INFO Creating thread debezium-mysqlconnector-dbserver1-
binlog-client (io.debezium.util.Threads) [task-thread-inventory-connector-0]
```

```
2020-02-21 17:57:35,630 INFO Creating thread debezium-mysqlconnector-dbserver1-
binlog-client (io.debezium.util.Threads) [blc-mysql:3306]
Feb 21, 2020 5:57:35 PM com.github.shyiko.mysql.binlog.BinaryLogClient connect
INFO: Connected to mysql:3306 at mysql-bin.000003/154 (sid:184054, cid:5)
2020-02-21 17:57:35,775 INFO Connected to MySQL binlog at mysql:3306, starting at
binlog file 'mysql-bin.000003', pos=154, skipping 0 events plus 0 rows
(io.debezium.connector.mysql.BinlogReader) [blc-mysql:3306]
...
```

CHAPTER 4. VIEWING CHANGE EVENTS

After deploying the Debezium MySQL connector, it starts monitoring the **inventory** database for data change events.

When you watched the connector start up, you saw that events were written to the following topics with the **dbserver1** prefix (the name of the connector):

dbserver1

The schema change topic to which all of the DDL statements are written.

dbserver1.inventory.products

Captures change events for the **products** table in the **inventory** database.

dbserver1.inventory.products_on_hand

Captures change events for the **products_on_hand** table in the **inventory** database.

dbserver1.inventory.customers

Captures change events for the **customers** table in the **inventory** database.

dbserver1.inventory.orders

Captures change events for the **orders** table in the **inventory** database.

For this tutorial, you will explore the **dbserver1.inventory.customers** topic. In this topic, you will see different types of change events to see how the connector captured them:

- Viewing a *create* event
- Updating the database and viewing the *update* event
- Deleting a record in the database and viewing the *delete* event
- Restarting Kafka Connect and changing the database

4.1. VIEWING A *CREATE* EVENT

By viewing the **dbserver1.inventory.customers** topic, you can see how the MySQL connector captured *create* events in the **inventory** database. In this case, the *create* events capture new customers being added to the database.

Procedure

1. Open a new terminal and use **kafka-console-consumer** to consume the **dbserver1.inventory.customers** topic from the beginning of the topic.
   This command runs a simple consumer (**kafka-console-consumer.sh**) in the Pod that is running Kafka (**my-cluster-kafka-0**):

   ```
   $ oc exec -it my-cluster-kafka-0 -- /opt/kafka/bin/kafka-console-consumer.sh \
     --bootstrap-server localhost:9092 \
     --from-beginning \
     --property print.key=true \
     --topic dbserver1.inventory.customers
   ```

   The consumer returns four messages (in JSON format), one for each row in the **customers** table. Each message contains the event records for the corresponding table row.

There are two JSON documents for each event: a *key* and a *value*. The key corresponds to the row's primary key, and the value shows the details of the row (the fields that the row contains, the value of each field, and the type of operation that was performed on the row).

2. For the last event, review the details of the *key*.
Here are the details of the *key* of the last event (formatted for readability):


```
{
  "schema":{
    "type":"struct",
     "fields":[
       {
         "type":"int32",
         "optional":false,
         "field":"id"
       }
     ],
    "optional":false,
    "name":"dbserver1.inventory.customers.Key"
  },
  "payload":{
    "id":1004
  }
}
```


The event has two parts: a **schema** and a **payload**. The **schema** contains a Kafka Connect schema describing what is in the payload. In this case, the payload is a **struct** named **dbserver1.inventory.customers.Key** that is not optional and has one required field (**id** of type **int32**).

The **payload** has a single **id** field, with a value of **1004**.

By reviewing the *key* of the event, you can see that this event applies to the row in the **inventory.customers** table whose **id** primary key column had a value of **1004**.

3. Review the details of the same event's *value*.
The event's *value* shows that the row was created, and describes what it contains (in this case, the **id**, **first_name**, **last_name**, and **email** of the inserted row).

Here are the details of the *value* of the last event (formatted for readability):


```
{
  "schema": {
    "type": "struct",
    "fields": [
      {
        "type": "struct",
        "fields": [
          {
            "type": "int32",
            "optional": false,
            "field": "id"
          },
          {
            "type": "string",
            "optional": false,
```

```
        "field": "first_name"
      },
      {
        "type": "string",
        "optional": false,
        "field": "last_name"
      },
      {
        "type": "string",
        "optional": false,
        "field": "email"
      }
    ],
    "optional": true,
    "name": "dbserver1.inventory.customers.Value",
    "field": "before"
  },
  {
    "type": "struct",
    "fields": [
      {
        "type": "int32",
        "optional": false,
        "field": "id"
      },
      {
        "type": "string",
        "optional": false,
        "field": "first_name"
      },
      {
        "type": "string",
        "optional": false,
        "field": "last_name"
      },
      {
        "type": "string",
        "optional": false,
        "field": "email"
      }
    ],
    "optional": true,
    "name": "dbserver1.inventory.customers.Value",
    "field": "after"
  },
  {
    "type": "struct",
    "fields": [
      {
        "type": "string",
        "optional": true,
        "field": "version"
      },
      {
        "type": "string",
        "optional": false,
```

```
        "field": "name"
      },
      {
        "type": "int64",
        "optional": false,
        "field": "server_id"
      },
      {
        "type": "int64",
        "optional": false,
        "field": "ts_sec"
      },
      {
        "type": "string",
        "optional": true,
        "field": "gtid"
      },
      {
        "type": "string",
        "optional": false,
        "field": "file"
      },
      {
        "type": "int64",
        "optional": false,
        "field": "pos"
      },
      {
        "type": "int32",
        "optional": false,
        "field": "row"
      },
      {
        "type": "boolean",
        "optional": true,
        "field": "snapshot"
      },
      {
        "type": "int64",
        "optional": true,
        "field": "thread"
      },
      {
        "type": "string",
        "optional": true,
        "field": "db"
      },
      {
        "type": "string",
        "optional": true,
        "field": "table"
      }
    ],
    "optional": false,
    "name": "io.debezium.connector.mysql.Source",
    "field": "source"
```

```
      },
      {
        "type": "string",
        "optional": false,
        "field": "op"
      },
      {
        "type": "int64",
        "optional": true,
        "field": "ts_ms"
      }
    ],
    "optional": false,
    "name": "dbserver1.inventory.customers.Envelope",
    "version": 1
  },
  "payload": {
    "before": null,
    "after": {
      "id": 1004,
      "first_name": "Anne",
      "last_name": "Kretchmar",
      "email": "annek@noanswer.org"
    },
    "source": {
      "version": "1.0.3.Final",
      "name": "dbserver1",
      "server_id": 0,
      "ts_sec": 0,
      "gtid": null,
      "file": "mysql-bin.000003",
      "pos": 154,
      "row": 0,
      "snapshot": true,
      "thread": null,
      "db": "inventory",
      "table": "customers"
    },
    "op": "c",
    "ts_ms": 1486500577691
  }
}
```


This portion of the event is much longer, but like the event's *key*, it also has a **schema** and a **payload**. The **schema** contains a Kafka Connect schema named **dbserver1.inventory.customers.Envelope** (version 1) that can contain five fields:

op

A required field that contains a string value describing the type of operation. Values for the MySQL connector are **c** for create (or insert), **u** for update, **d** for delete, and **r** for read (in the case of a non-initial snapshot).

before

An optional field that, if present, contains the state of the row *before* the event occurred. The structure will be described by the **dbserver1.inventory.customers.Value** Kafka Connect schema, which the **dbserver1** connector uses for all rows in the

inventory.customers table.

after

An optional field that, if present, contains the state of the row *after* the event occurred. The structure is described by the same **dbserver1.inventory.customers.Value** Kafka Connect schema used in **before**.

source

A required field that contains a structure describing the source metadata for the event, which in the case of MySQL, contains several fields: the connector name, the name of the **binlog** file where the event was recorded, the position in that **binlog** file where the event appeared, the row within the event (if there is more than one), the names of the affected database and table, the MySQL thread ID that made the change, whether this event was part of a snapshot, and, if available, the MySQL server ID, and the timestamp in seconds.

ts_ms

An optional field that, if present, contains the time (using the system clock in the JVM running the Kafka Connect task) at which the connector processed the event.

NOTE

The JSON representations of the events are much longer than the rows they describe. This is because, with every event key and value, Kafka Connect ships the *schema* that describes the *payload*. Over time, this structure may change. However, having the schemas for the key and the value in the event itself makes it much easier for consuming applications to understand the messages, especially as they evolve over time.

The Debezium MySQL connector constructs these schemas based upon the structure of the database tables. If you use DDL statements to alter the table definitions in the MySQL databases, the connector reads these DDL statements and updates its Kafka Connect schemas. This is the only way that each event is structured exactly like the table from where it originated at the time the event occurred. However, the Kafka topic containing all of the events for a single table might have events that correspond to each state of the table definition.

The JSON converter includes the key and value schemas in every message, so it does produce very verbose events.

4. Compare the event's *key* and *value* schemas to the state of the **inventory** database. In the terminal that is running the MySQL command line client, run the following statement:

```
mysql> SELECT * FROM customers;
+------+------------+-----------+-----------------------+
| id   | first_name | last_name | email                 |
+------+------------+-----------+-----------------------+
| 1001 | Sally      | Thomas    | sally.thomas@acme.com |
| 1002 | George     | Bailey    | gbailey@foobar.com    |
| 1003 | Edward     | Walker    | ed@walker.com         |
| 1004 | Anne       | Kretchmar | annek@noanswer.org    |
+------+------------+-----------+-----------------------+
4 rows in set (0.00 sec)
```

This shows that the event records you reviewed match the records in the database.

4.2. UPDATING THE DATABASE AND VIEWING THE *UPDATE* EVENT

Now that you have seen how the Debezium MySQL connector captured the *create* events in the **inventory** database, you will now change one of the records and see how the connector captures it.

By completing this procedure, you will learn how to find details about what changed in a database commit, and how you can compare change events to determine when the change occurred in relation to other changes.

Procedure

1. In the terminal that is running the MySQL command line client, run the following statement:

```
mysql> UPDATE customers SET first_name='Anne Marie' WHERE id=1004;
Query OK, 1 row affected (0.05 sec)
Rows matched: 1  Changed: 1  Warnings: 0
```

2. View the updated **customers** table:

```
mysql> SELECT * FROM customers;
+------+------------+-----------+-----------------------+
| id   | first_name | last_name | email                 |
+------+------------+-----------+-----------------------+
| 1001 | Sally      | Thomas    | sally.thomas@acme.com |
| 1002 | George     | Bailey    | gbailey@foobar.com    |
| 1003 | Edward     | Walker    | ed@walker.com         |
| 1004 | Anne Marie | Kretchmar | annek@noanswer.org    |
+------+------------+-----------+-----------------------+
4 rows in set (0.00 sec)
```

3. Switch to the terminal running **kafka-console-consumer** to see a *new* fifth event.
   By changing a record in the **customers** table, the Debezium MySQL connector generated a new event. You should see two new JSON documents: one for the event's *key*, and one for the new event's *value*.

   Here are the details of the *key* for the *update* event (formatted for readability):

```
{
  "schema": {
    "type": "struct",
    "name": "dbserver1.inventory.customers.Key"
    "optional": false,
    "fields": [
      {
        "field": "id",
        "type": "int32",
        "optional": false
      }
    ]
  },
  "payload": {
    "id": 1004
  }
}
```

This *key* is the same as the *key* for the previous events.

Here is that new event's *value*. There are no changes in the **schema** section, so only the **payload** section is shown (formatted for readability):

```
{
 "schema": {...},
 "payload": {
  "before": { 1
    "id": 1004,
    "first_name": "Anne",
    "last_name": "Kretchmar",
    "email": "annek@noanswer.org"
  },
  "after": { 2
    "id": 1004,
    "first_name": "Anne Marie",
    "last_name": "Kretchmar",
    "email": "annek@noanswer.org"
  },
  "source": { 3
    "name": "1.0.3.Final",
    "name": "dbserver1",
    "server_id": 223344,
    "ts_sec": 1486501486,
    "gtid": null,
    "file": "mysql-bin.000003",
    "pos": 364,
    "row": 0,
    "snapshot": null,
    "thread": 3,
    "db": "inventory",
    "table": "customers"
  },
  "op": "u", 4
  "ts_ms": 1486501486308 5
 }
}
```

1. The **before** field now has the state of the row with the values before the database commit.
2. The **after** field now has the updated state of the row, and the **first_name** value is now **Anne Marie**.
3. The **source** field structure has many of the same values as before, except that the **ts_sec** and **pos** fields have changed (the **file** might have changed in other circumstances).
4. The **op** field value is now **u**, signifying that this row changed because of an update.
5. The **ts_ms** field shows the time stamp for when Debezium processed this event.

By viewing the **payload** section, you can learn several important things about the *update* event:

- By comparing the **before** and **after** structures, you can determine what actually changed in the affected row because of the commit.

- By reviewing the **source** structure, you can find information about MySQL's record of the change (providing traceability).
- By comparing the **payload** section of an event to other events in the same topic (or a different topic), you can determine whether the event occurred before, after, or as part of the same MySQL commit as another event.

4.3. DELETING A RECORD IN THE DATABASE AND VIEWING THE *DELETE* EVENT

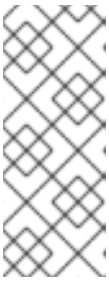
Now that you have seen how the Debezium MySQL connector captured the *create* and *update* events in the **inventory** database, you will now delete one of the records and see how the connector captures it.

By completing this procedure, you will learn how to find details about *delete* events, and how Kafka uses *log compaction* to reduce the number of *delete* events while still enabling consumers to get all of the events.

Procedure

1. In the terminal that is running the MySQL command line client, run the following statement:

```
mysql> DELETE FROM customers WHERE id=1004;
Query OK, 1 row affected (0.00 sec)
```



NOTE

If the above command fails with a foreign key constraint violation, then you must remove the reference of the customer address from the *addresses* table using the following statement:

```
mysql> DELETE FROM addresses WHERE customer_id=1004;
```

2. Switch to the terminal running **kafka-console-consumer** to see *two* new events.
   By deleting a row in the **customers** table, the Debezium MySQL connector generated two new events.

3. Review the *key* and *value* for the first new event.
   Here are the details of the *key* for the first new event (formatted for readability):

```
{
  "schema": {
    "type": "struct",
    "name": "dbserver1.inventory.customers.Key"
    "optional": false,
    "fields": [
      {
        "field": "id",
        "type": "int32",
        "optional": false
      }
    ]
  },
  "payload": {
```

```
    "id": 1004
  }
}
```

This *key* is the same as the *key* in the previous two events you looked at.

Here is the *value* of the first new event (formatted for readability):

```
{
 "schema": {...},
 "payload": {
  "before": { (1)
    "id": 1004,
    "first_name": "Anne Marie",
    "last_name": "Kretchmar",
    "email": "annek@noanswer.org"
  },
  "after": null, (2)
  "source": { (3)
    "name": "1.0.3.Final",
    "name": "dbserver1",
    "server_id": 223344,
    "ts_sec": 1486501558,
    "gtid": null,
    "file": "mysql-bin.000003",
    "pos": 725,
    "row": 0,
    "snapshot": null,
    "thread": 3,
    "db": "inventory",
    "table": "customers"
  },
  "op": "d", (4)
  "ts_ms": 1486501558315 (5)
 }
}
```

(1) The **before** field now has the state of the row that was deleted with the database commit.

(2) The **after** field is **null** because the row no longer exists.

(3) The **source** field structure has many of the same values as before, except the **ts_sec** and **pos** fields have changed (the **file** might have changed in other circumstances).

(4) The **op** field value is now **d**, signifying that this row was deleted.

(5) The **ts_ms** field shows the time stamp for when Debezium processes this event.

Thus, this event provides a consumer with the information that it needs to process the removal of the row. The old values are also provided, because some consumers might require them to properly handle the removal.

4. Review the *key* and *value* for the second new event.
   Here is the *key* for the second new event (formatted for readability):

```
{
  "schema": {
    "type": "struct",
    "name": "dbserver1.inventory.customers.Key"
    "optional": false,
    "fields": [
      {
        "field": "id",
        "type": "int32",
        "optional": false
      }
    ]
  },
  "payload": {
    "id": 1004
  }
}
```


Once again, this *key* is exactly the same key as in the previous three events you looked at.

Here is the *value* of that same event (formatted for readability):


```
{
  "schema": null,
  "payload": null
}
```


If Kafka is set up to be *log compacted*, it will remove older messages from the topic if there is at least one message later in the topic with same key. This last event is called a *tombstone* event, because it has a key and an empty value. This means that Kafka will remove all prior messages with the same key. Even though the prior messages will be removed, the tombstone event means that consumers can still read the topic from the beginning and not miss any events.

4.4. RESTARTING THE KAFKA CONNECT SERVICE

Now that you have seen how the Debezium MySQL connector captures create, update, and delete events, you will now see how it can capture change events even when it is not running.

The Kafka Connect service automatically manages tasks for its registered connectors. Therefore, if it goes offline, when it restarts, it will start any non-running tasks. This means that even if Debezium is not running, it can still report changes in a database.

In this procedure, you will stop Kafka Connect, change some data in the database, and then restart Kafka Connect to see the change events.

Procedure

1. Stop the Kafka Connect service.
   a. Open the deployment configuration for the Kafka Connect service.

      ```
      $ oc edit dc/my-connect-cluster-connect
      ```

      The deployment configuration opens:

      ■

```
apiVersion: apps.openshift.io/v1
kind: DeploymentConfig
metadata:
  ...
spec:
  replicas: 1
...
```

b. Change the **spec.replicas** value to **0**.

c. Save the deployment configuration.

d. Verify that the Kafka Connect service has stopped.
This command shows that the Kafka Connect service is completed, and that no Pods are running:

```
$ oc get pods -l strimzi.io/name=my-connect-cluster-connect
NAME                                READY   STATUS      RESTARTS   AGE
my-connect-cluster-connect-1-dxcs9          0/1     Completed   0          7h
```

2. While the Kafka Connect service is down, switch to the terminal running the MySQL client, and add a new record to the database.

```
mysql> INSERT INTO customers VALUES (default, "Sarah", "Thompson", "kitt@acme.com");
```

3. Restart the Kafka Connect service.

a. Open the deployment configuration for the Kafka Connect service.

```
$ oc edit dc/my-connect-cluster-connect
```

The deployment configuration opens:

```
apiVersion: apps.openshift.io/v1
kind: DeploymentConfig
metadata:
  ...
spec:
  replicas: 0
...
```

b. Change the **spec.replicas** value to **1**.

c. Save the deployment configuration.

d. Verify that the Kafka Connect service has restarted.
This command shows that the Kafka Connect service is running, and that the Pod is ready:

```
$ oc get pods -l strimzi.io/name=my-connect-cluster-connect
NAME                                READY   STATUS      RESTARTS   AGE
my-connect-cluster-connect-2-q9kkl          1/1     Running     0          74s
```

4. Switch to the terminal that is running **kafka-console-consumer** and review the messages.

You should see the record that you created when Kafka Connect was offline (formatted for readability):


```
{
  ...
  "payload":{
    "id":1005
  }
}
{
  ...
  "payload":{
    "before":null,
    "after":{
      "id":1005,
      "first_name":"Sarah",
      "last_name":"Thompson",
      "email":"kitt@acme.com"
    },
    "source":{
      "version":"{debezium-version}",
      "connector":"mysql",
      "name":"dbserver1",
      "ts_ms":1582581502000,
      "snapshot":"false",
      "db":"inventory",
      "table":"customers",
      "server_id":223344,
      "gtid":null,
      "file":"mysql-bin.000004",
      "pos":364,
      "row":0,
      "thread":5,
      "query":null
    },
    "op":"c",
    "ts_ms":1582581502317
  }
}
```

CHAPTER 5. NEXT STEPS

After completing the tutorial, consider the following next steps:

- Explore the tutorial further.
  Use the MySQL command line client to add, modify, and remove rows in the database tables, and see the effect on the topics. Keep in mind that you cannot remove a row that is referenced by a foreign key.

- Plan a Debezium deployment.
  You can install Debezium in OpenShift or on Red Hat Enterprise Linux. For more information, see the following:

  - Installing Debezium on OpenShift

  - Installing Debezium on RHEL