

# Discovering the Value of IBM InfoSphere Change Data Capture

*Lab Exercise*

*Content contributor:*

**Ronny Zakaria**  
Senior Information Architecture Tech Specialist  
IBM Data & AI - ASEAN  
[ronnyz@id.ibm.com](mailto:ronnyz@id.ibm.com)

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## IBM InfoSphere Change Data Capture hands-on lab overview

This workbook guides you through the IBM® InfoSphere™ Change Data Capture lab exercises. As you complete these exercises, you will be acting as an employee of our fictitious company JK Life & Wealth and take on a dedicated role that is responsible for the task at hand. Each lab will introduce you to the capabilities of IBM InfoSphere Change Data Capture and demonstrate how JK Life & Wealth is using this technology to solve their critical business problems.

### Scenario Overview

JK Life & Wealth is a large financial services company which is globally recognized as a brand leader in customer satisfaction. To that end, our core business includes delivering banking, investment and insurance services to our clients

In order to remain competitive, we have expanded JKLW's business not just through organic growth but through acquisitions as well. At JKLW, we understand that the challenge to stay competitive lies at the heart of our IT environment and is fed by our most strategic asset – the data.

Our growing banking and insurance business eventually effected our day to day operations.

To differentiate ourselves competitively, we need to integrate our data holistically across all our lines of business. This is crucial to enable the right marketing campaign and other customer value programs.

Our operational database systems were running at a high utilization rate during peak business hours. We had to take action to further ensure continuous uninterrupted and fast access. We needed to establish an efficient way to capture changes in our operational database system and align them with our data integration requirements without impacting the performance of our production systems.

We had particular requirements regarding system impact, latency, and data integrity in a heterogeneous relational database landscape.

Considering our options, we chose **IBM InfoSphere Change Data Capture**.

IBM InfoSphere Change Data Capture not only supports our requirements, it also integrates easily with our other IBM InfoSphere products (such as IBM InfoSphere DataStage®) that we already use at JKLW. Let's have a look at how InfoSphere Change Data Capture can help us simplify our data integration process and derive information in a trusted and consistent way.

## Logging on

Windows user / password:

*techzone/IBMDem0s*

Management Console user / password:

*Admin/passw0rd*

## Lab 1 Prepare the InfoSphere CDC Replication Environment

As the Database Administrator at JKLW, you are responsible for setting up and maintaining configurations to synchronize and integrate data between JKLW's disparate relational database systems.

We received a request from head office to continuously capture changes from an Oracle® database, which is used by a recently acquired insurance company, and deliver those changes in real-time to an IBM DB2 database.

You will be using IBM InfoSphere Change Data Capture to setup a heterogeneous replication environment which will be used in subsequent labs to replicate data in real-time between the JK Life & Wealth's Oracle and DB2 databases.

In this lab, you will:

- Verify the connection to the InfoSphere Change Data Capture Management Console
- Use the Access Manager to assign InfoSphere Change Data Capture Datastores to a user
- Validate the user and its access to the heterogeneous replication environment that has been created

**Important!**

Please make sure you start all CDC Services,

- Click Putty icon from window task bar 
- Double click **cdc01.de.ibm.com**



**Putty Configuration**

**Category:**

- Session
- Logging
- Terminal
- Keyboard
- Bell
- Features
- Window
- Appearance
- Behaviour
- Translation
- Selection
- Colours
- Connection
- Data
- Proxy
- SSH
- Serial
- Telnet
- Rlogin
- SUPDUP

**Basic options for your PuTTY session**

Specify the destination you want to connect to  
**Host Name (or IP address)**: cdc01.de.ibm.com  
**Port**: 22  
**Connection type:**  SSH  Serial  Other: Telnet  
 Load, save or delete a stored session  
**Saved Sessions**: Default Settings  
**Default Settings**: cdc01.de.ibm.com  
 Load  
 Save  
 Delete  
**Close window on exit:**  Always  Never  Only on clean exit

**About** **Open** **Cancel**

**- Login as root/passw0rd**

```
root@cdc01:~$ login as: root
root@cdc01.de.ibm.com's password:
Activate the web console with: systemctl enable --now cockpit.socket
```

**- Type cd /replication-scripts**

- Run [./start\\_all.sh](#)

```
[root@cdc01 ~]# cd replication-scripts/
[root@cdc01 replication-scripts]# ./start_all.sh
```

Wait until you saw below “**IBM Data Replication is running.**”

```
# Start CDC Engines

su cdcaccess -c '/opt/cdcaccess/bin/dmaccessserver &
++ su cdcaccess -c '/opt/cdcaccess/bin/dmaccessserver &
su cdcorax -c '/opt/cdcxstream/bin/dmts64 -I linux &
++ su cdcorax -c '/opt/cdcxstream/bin/dmts64 -I linux &
su cdcora -c '/opt/cdcoracle/bin/dmts64 -I linux &
++ su cdcora -c '/opt/cdcoracle/bin/dmts64 -I linux &
su cdcflat -c '/opt/cdcflat/bin/dmts64 -I linux &
++ su cdcflat -c '/opt/cdcflat/bin/dmts64 -I linux &
su cdckafka -c '/opt/cdckafka/bin/dmts64 -I linux &
++ su cdckafka -c '/opt/cdckafka/bin/dmts64 -I linux &
su db2inst1 -c '/opt/cdcdb2/bin/dmts64 -I linux &
++ su db2inst1 -c '/opt/cdcdb2/bin/dmts64 -I linux &
su informix -c '/opt/cdcifix/bin/dmts64 -I linux &
++ su informix -c '/opt/cdcifix/bin/dmts64 -I linux &
su postgres -c '/opt/cdcpsql/bin/dmts64 -I linux &
++ su postgres -c '/opt/cdcpsql/bin/dmts64 -I linux &
[root@cdc01 replication-scripts]# IBM Data Replication is running.

IBM Data Replication is running.
```

-Minimize the command window

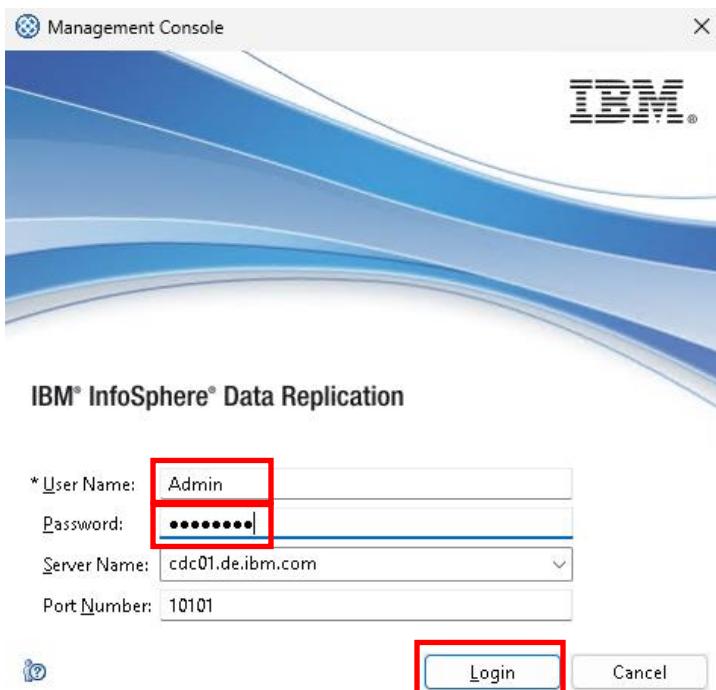
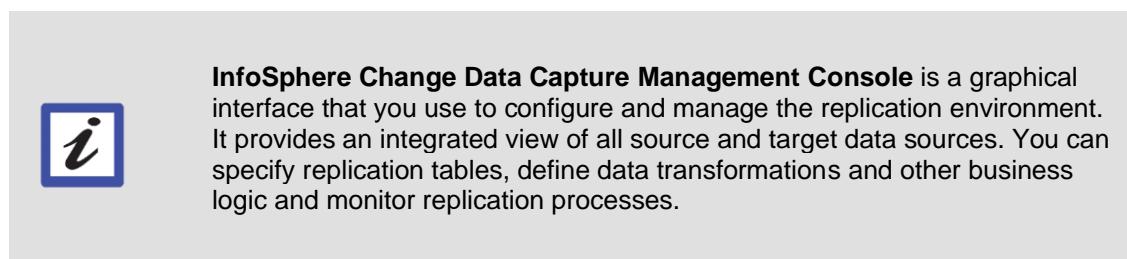
## 1.1 Review existing Datastores

In order to replicate data to and from a database, I need to have an InfoSphere Change Data Capture instance for each participating database and these have already been installed and configured. However, before I am able to configure replication, I need setup access to each InfoSphere CDC instance through the IBM InfoSphere Change Data Capture Management Console.

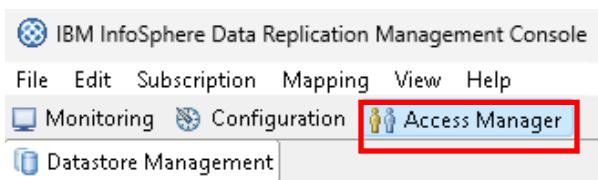
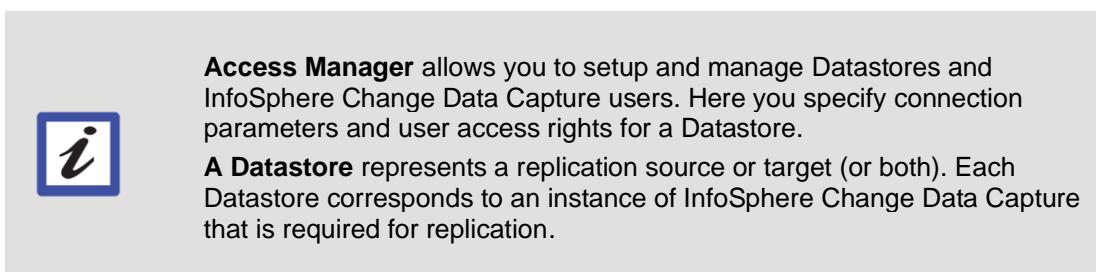
- \_\_1. Make sure you have done above command to start IBM Data Replication services.
- \_\_2. I will be using the InfoSphere Change Data Capture Management Console to manage our replication scenario. Start the InfoSphere Change Data Capture Management Console by clicking on ‘*Management Console*’ icon from windows task bar.



- 3. Authenticate with user name '**Admin**' and password '**passw0rd**' and click: '**Login**'. Leave the values for server name (cdc01.de.ibm.com) and port number (10101) unchanged.



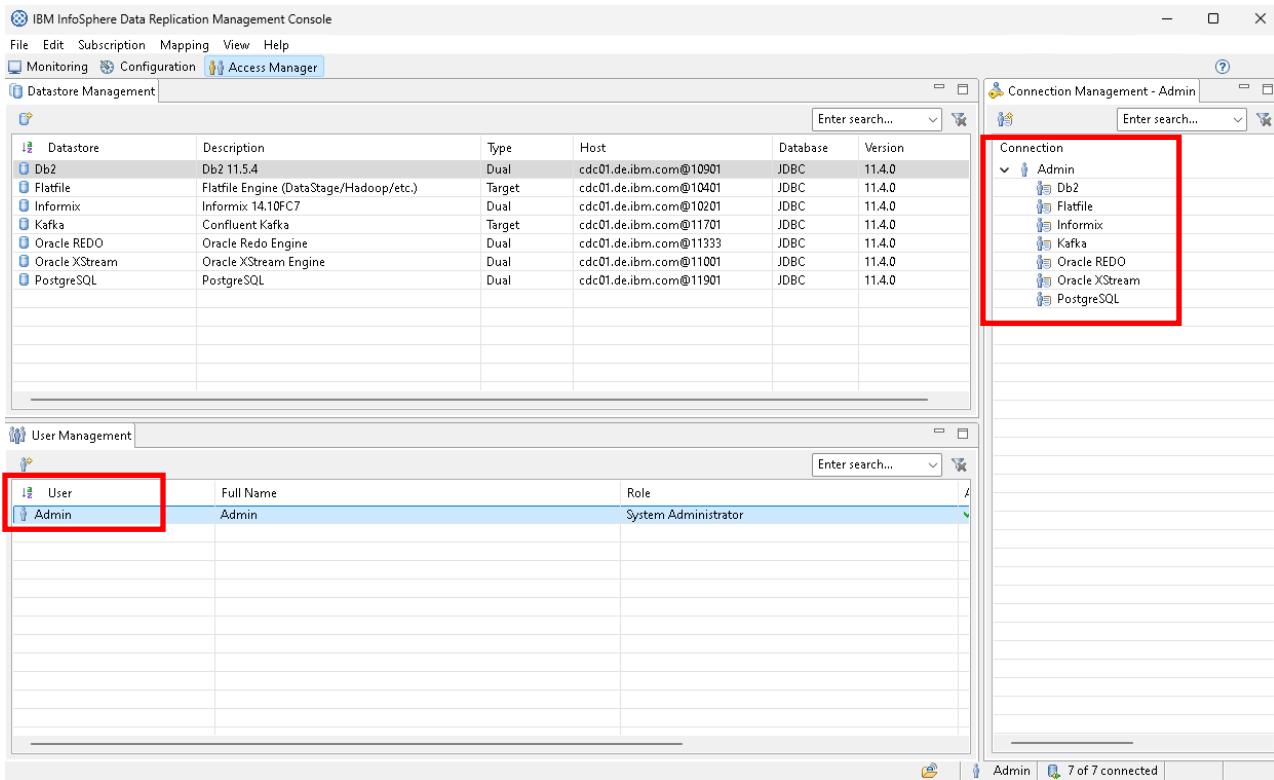
- 4. Click on the '**Access Manager**' perspective.



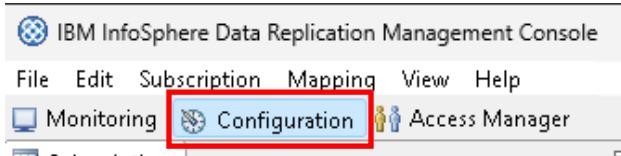
As a System Administrator for InfoSphere Change Data Capture I have access to the 'Access Manager' view. I can create new users, change users roles, assign Datastores to users and add new Datastores. I can see list of existing Datastores.

Each Datastore maps to one InfoSphere Change Data Capture instance.

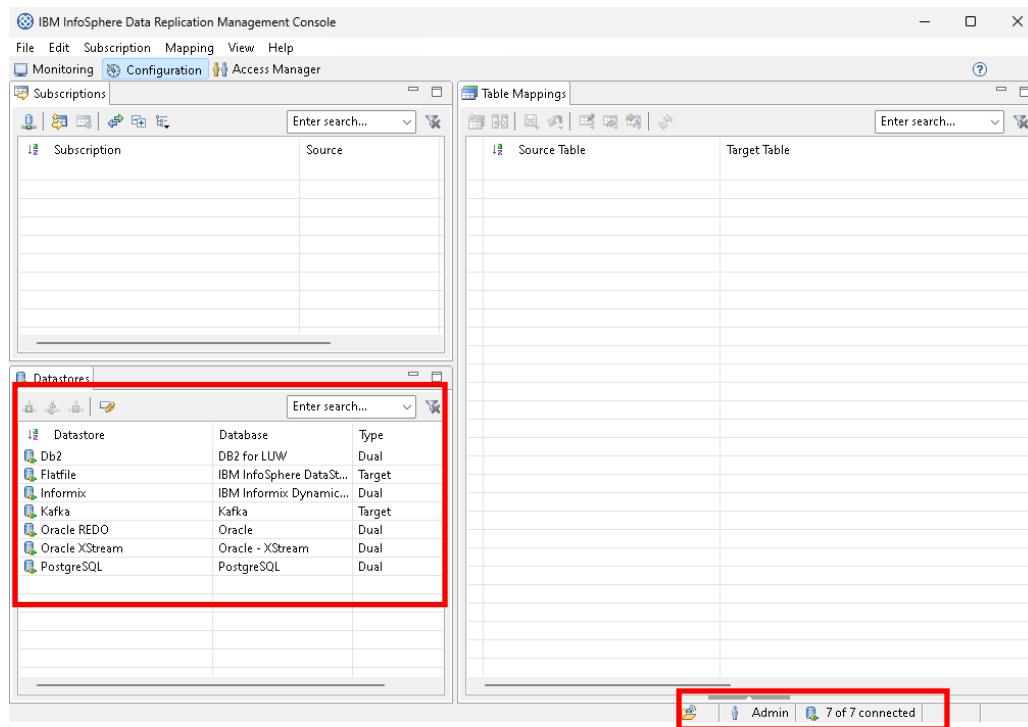
- 5. Under the 'User Management' tab at the bottom part, select the 'Admin' user and on the right side, under the 'Connection Management – Admin' tab, you can see all the Datastores already assigned to the 'Admin' user.



- 6. Click on the 'Configuration' perspective. This view allows you to configure replication for the Datastores that you have access to.



- 7. In the Datastores view you can see the Datastores that are available and the connection status for each. At the bottom right hand corner, you can see that you are connected as the 'Admin' user and the number of Datastores that are connected. There should be '**7 out of 7 connected**', if this is not the case then under then Datastores tab, right click on the Datastore that is not connected and select 'Connect'. The Subscriptions view and Table Mappings view are empty because we have not configured replication.



8. Do not close the InfoSphere Change Data Capture Management Console as it will be used in the subsequent labs.

## 1.2 Summary

At this point, you have used the IBM InfoSphere Change Data Capture Management Console to review access all the required Datastores and prepared the heterogeneous replication environment. You are now able to configure and manage replication between these Datastores and this will be explored in the next labs.

## Lab 2    Replicating Data from Oracle to DB2 using Standard Replication

At JKLW, in order to improve the visibility and timeliness of information into the different lines of business, one of the challenges is to integrate data from multiple sources into an operational data store (ODS) in real-time.

JKLW recently acquired an insurance company whose application system uses an Oracle database. The ODS at JKLW uses an IBM DB2 database. To gain insight into the recently acquired company, the goal is to continuously capture the changes made to customer and product data from their Oracle database and flow the information into the IBM DB2 ODS so that it contains up to date information.

Using IBM InfoSphere Change Data Capture, we are able to replicate data in near real-time between different relational database systems and platforms. It is a technology that uses 'log-based change data capture' to enable the continuous movement of data with minimal impact to mission critical systems.

**Please make sure all datastore in Lab 1 are already connected before doing this exercise**

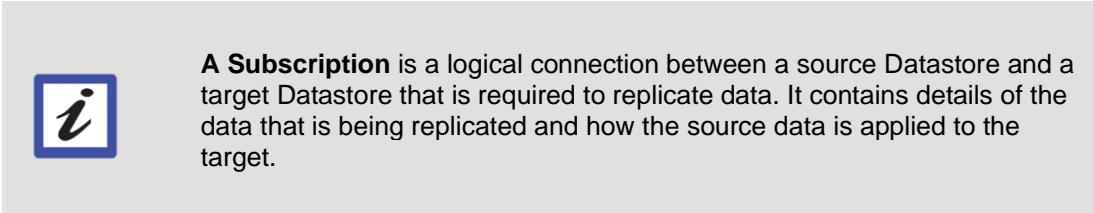
Now that you have access to the required IBM InfoSphere Change Data Capture Datastores, you are now able to configure replication for the customer and product data from the Oracle database into DB2.

In this lab, you will:

- Learn how to setup standard replication between Oracle and DB2 for user selected tables
- Continuously mirror changes between databases
- Monitor the status, event logs, latency and performance for the replication process

### 2.1    Configuring Replication from Oracle to DB2

The InfoSphere Change Data Capture Management Console is the central graphical user interface which we will use to create Subscriptions and manage the replication environment.

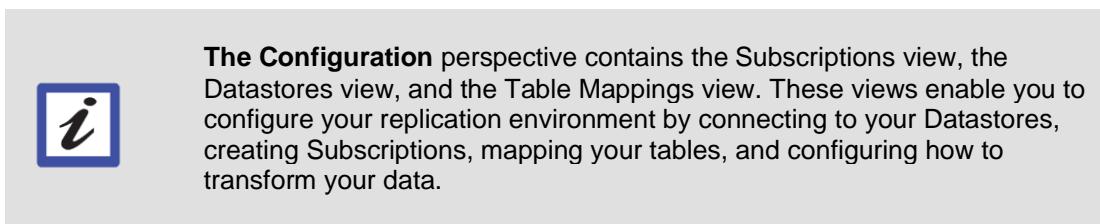


#### 2.1.1    Defining a Subscription from Oracle to DB2

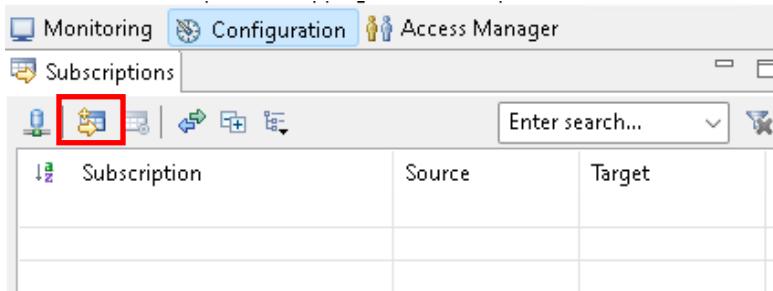
- \_\_1. If you have not already done so, start the InfoSphere Change Data Capture Management

Console by clicking the '*Management Console*' icon  on windows task bar.  
Authenticate with user name '**Admin**' and password '**passw0rd**' and click: '*Login*'.  
Leave the values for server name (cdc01.de.ibm.com) and port number (10101) unchanged.

- \_\_2. Select the '**Configuration**' perspective.



- \_\_3. Under the '**Subscription**' view, click on the icon to '**Create a new subscription**'.



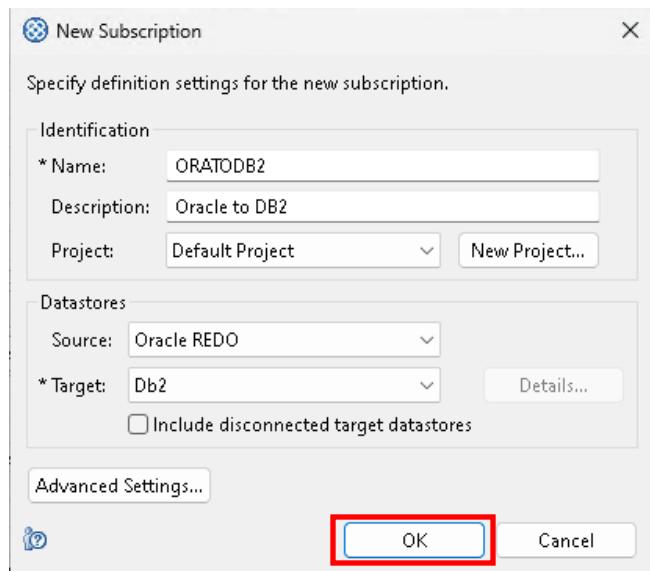
- \_\_4. Create a Subscription with:

Name: **ORATODB2**

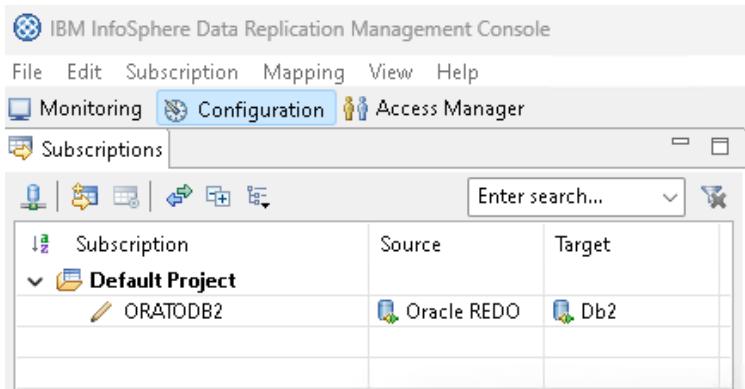
Description: **Oracle to DB2**

Source: **Oracle REDO**

Target: **Db2**

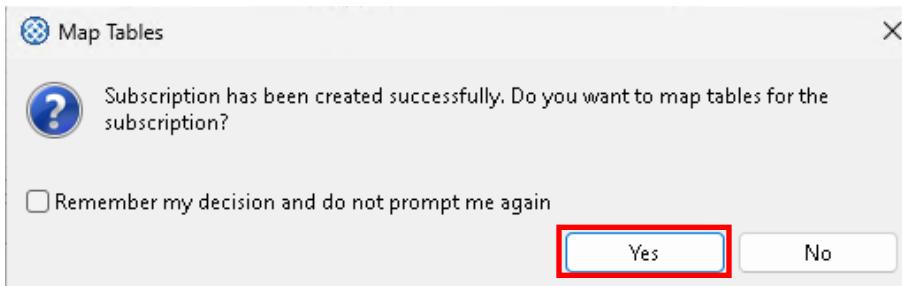


- \_\_5. Click '**OK**'. A new Subscription 'ORATODB2' is created.

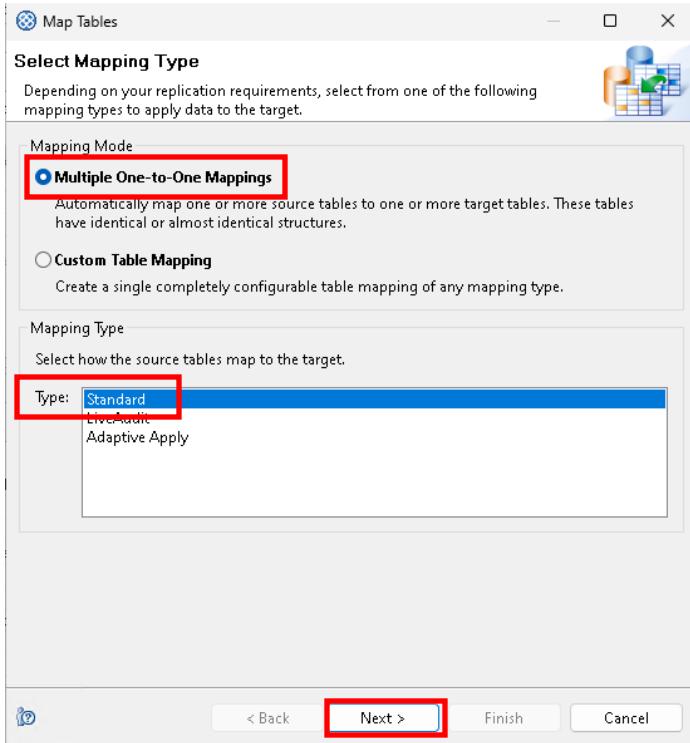


## 2.1.2 Mapping your Tables

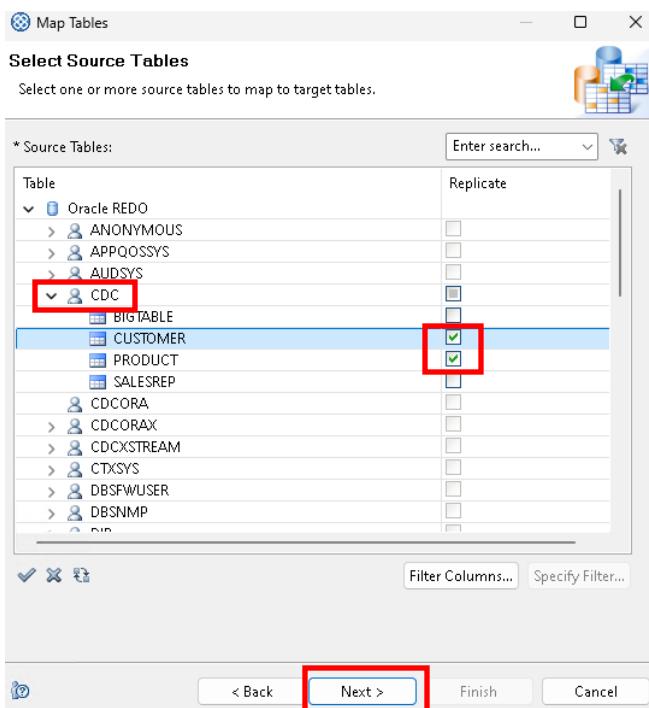
- 6. Click **Yes** on ‘Map Tables’ dialog box.



- 7. Select Automatic ‘**Multiple One-to-one Mappings**’, type **Standard** and click ‘**Next**’.

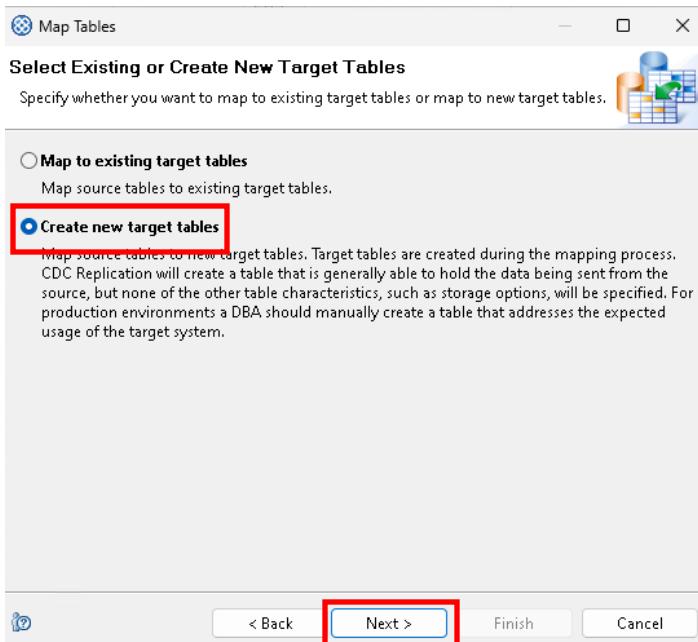


- 8. Next you will select the source tables that you will be replicating from. Expand the schema ‘CDC’ and select tables ‘CUSTOMER’ and ‘PRODUCT’. Note that InfoSphere Change Data Capture allows you to choose which tables to replicate.

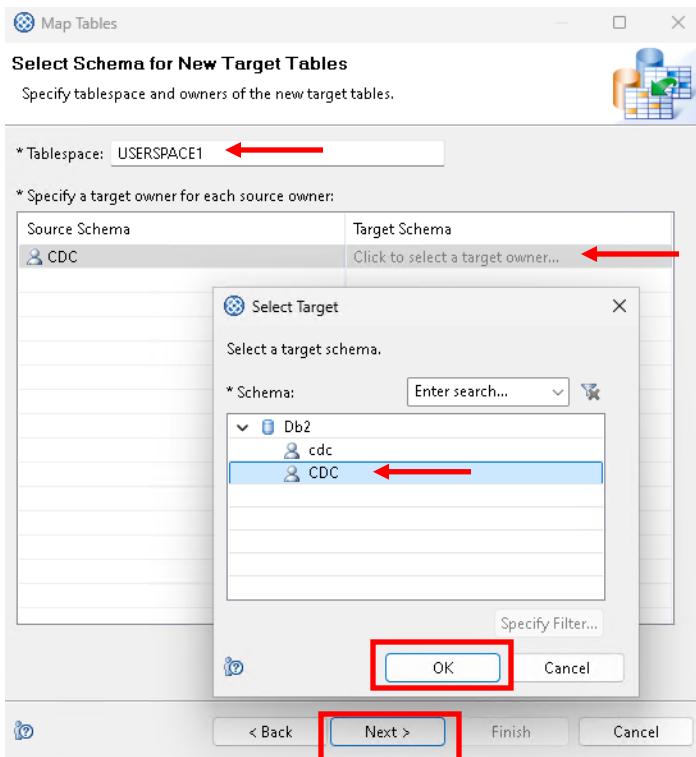


- 9. Click ‘**Next**’.

- 10. Now you are given the option to either select existing or create new target tables to map the source tables to. Select the option to ‘**Create new target tables**’ and click ‘**Next**’.



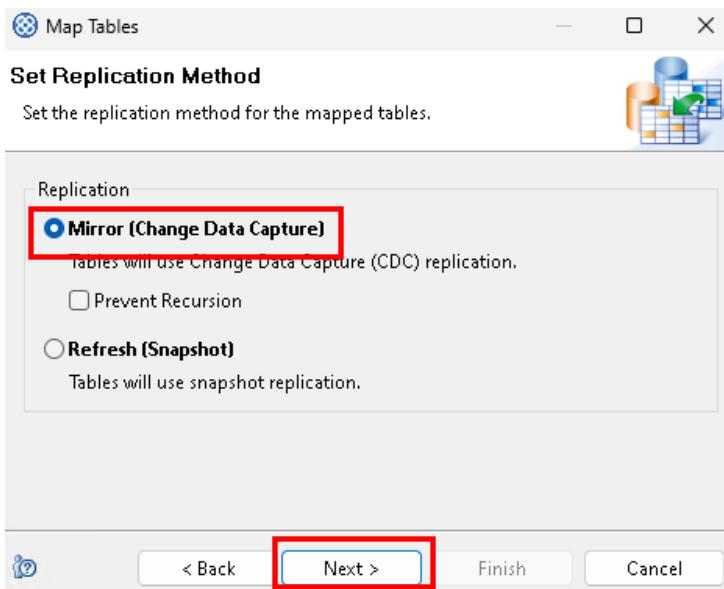
- \_\_11. For the Tablespace enter '**USERSPACE1**'. Under the Target Schema column, click the text '[Click to select a target owner](#)' and select '**CDC**'. (ALL CAPS)  
Click '**OK**' and then '**Next**'.



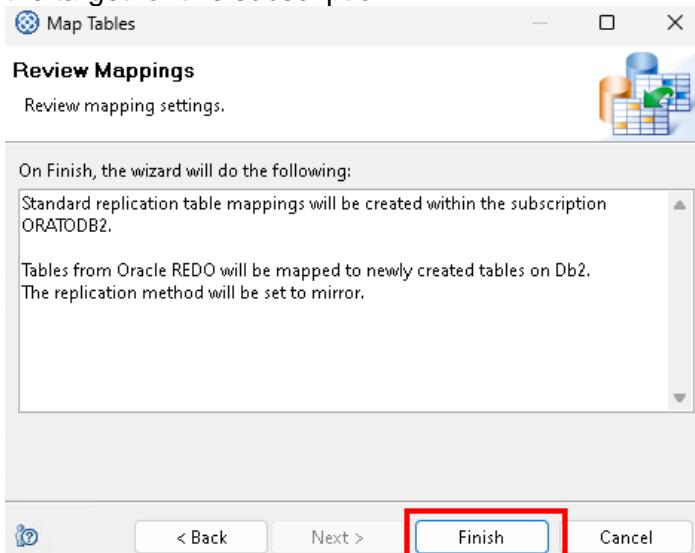
- \_\_12. Select the name of the target tables to be '**Source table names with prefixes and/or suffixes**'. Type in suffix "**\_TGT**" Then click '**Next**'



- \_\_13. Set the replication method to '**Mirror (Change Data Capture)**' and click '**Next**'.



- \_\_14. Review the mapping settings and click '**Finish**'. The tables will be mapped from the source to the target for this subscription.



- \_\_15. At this point, we have easily configured the '**CUSTOMER**' and '**PRODUCT**' Oracle tables to be replicated to DB2.

The screenshot shows the IBM InfoSphere Data Replication Management Console. On the left, the 'Subscriptions' tree view shows 'Default Project' expanded, with 'ORATODDB2' selected. On the right, the 'Table Mappings - ORATODDB2' table lists the mappings:

Source Table	Target Table	Mapping Type	Method	Status	Prevent Re...
CDC.CUSTOMER	CDC.CUSTOMER_TGT	Standard	Mirror	Refresh	No
CDC.PRODUCT	CDC.PRODUCT_TGT	Standard	Mirror	Refresh	No



**Note:** The status is set to '**Refresh**' by default in order to initially synchronize the source and target tables prior to mirroring the changes continuously. If the tables are already synchronized then this behavior can be overwritten so that the initial Refresh is skipped.

## 2.2 Review the Source and Target Table Contents

Before starting the data replication process, take a moment to review the data in both the source and target tables.

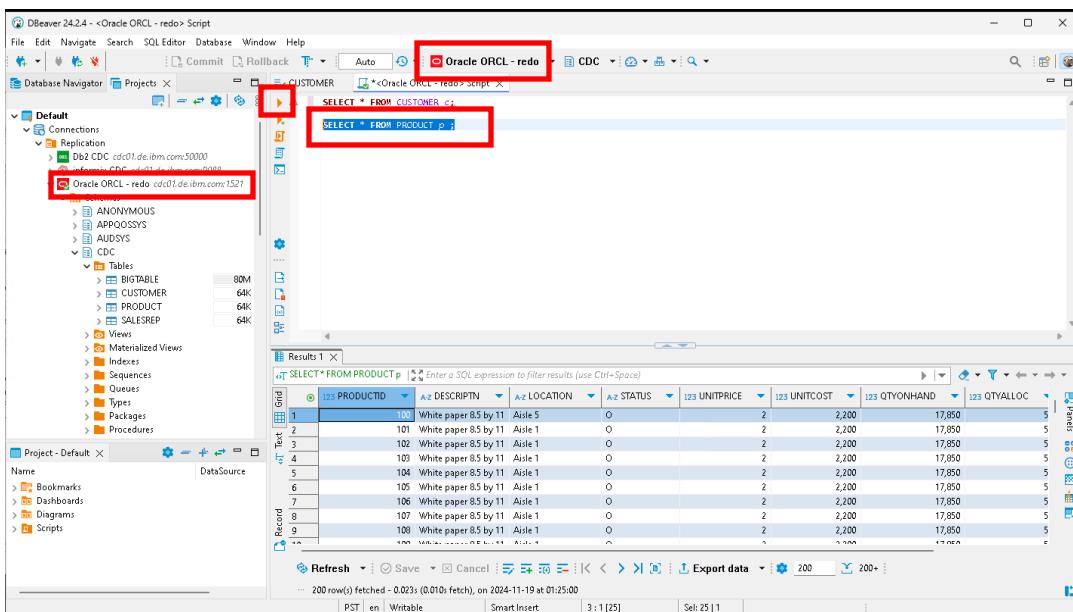
- 16. To view the source Oracle tables, click on taskbar icon 'DBeaver'. This will log you onto the Oracle database, and other database in the server, click **Oracle ORCL - redo** on the left side

Execute the following SQL commands to view the source table contents:

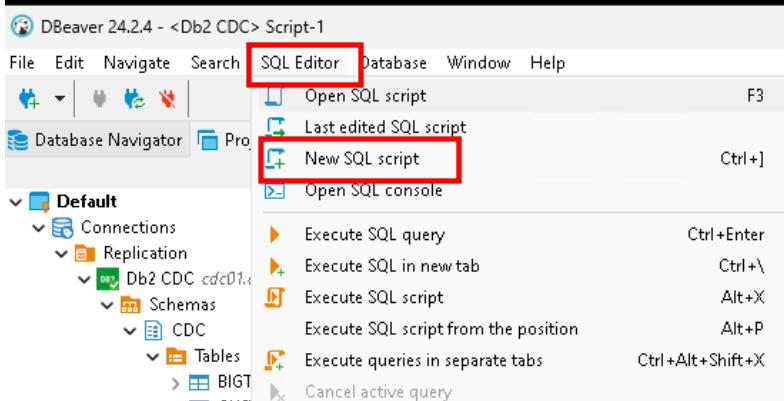
```
select * from customer;
```

CUSTNO	BRANCH	NAME1	NAME2	ADDRESS1	ADDRESS2	CITY	STATE	STATUS
555.072	11	DATAMIRROR		2500 DANFORTH AVE. SUITE 300		DES MOINES	IA	A
556.572	11	DATAMIRROR		2500 DANFORTH AVE. SUITE 300		DES MOINES	IA	A
556.672	11	DATAMIRROR		2500 DANFORTH AVE. SUITE 300		DES MOINES	IA	A
556.996	11	DATAMIRROR		403 CLEMENTS RD. W.		OAKLAND	CA	A
556.996	11	DATAMIRROR		346 NEWKIRK RD.		DULUTH	GA	A
557.007	11	DATAMIRROR		403 CLEMENTS RD. W.		OAKLAND	CA	A
557.096	11	DATAMIRROR		346 NEWKIRK RD.		DULUTH	GA	A
557.272	11	DATAMIRROR		2500 DANFORTH AVE. SUITE 300		DES MOINES	IA	A
557.372	11	DATAMIRROR		2500 DANFORTH AVE. SUITE 300		DES MOINES	IA	A

```
select * from product;
```

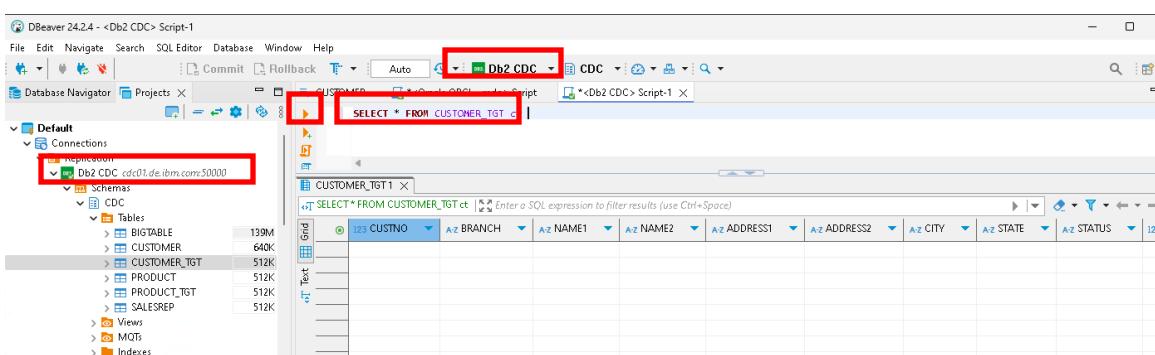


17. To view the target DB2 tables, click **Db2 CDC** from DBeaver Left panel, click **SQL Editor Menu**, then choose **New SQL script**

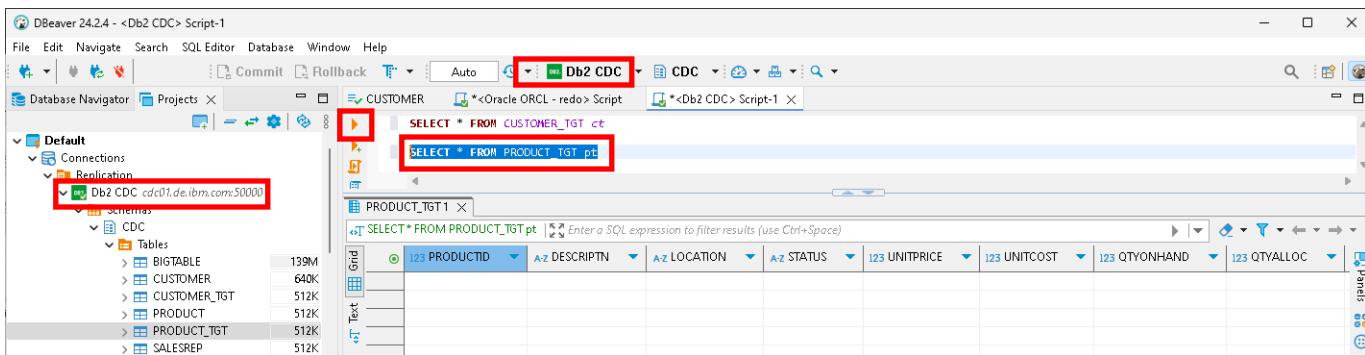


Execute the following SQL commands to view the target table contents (both target tables showing empty):

```
select * from customer_TGT
```



```
select * from product_TGT
```

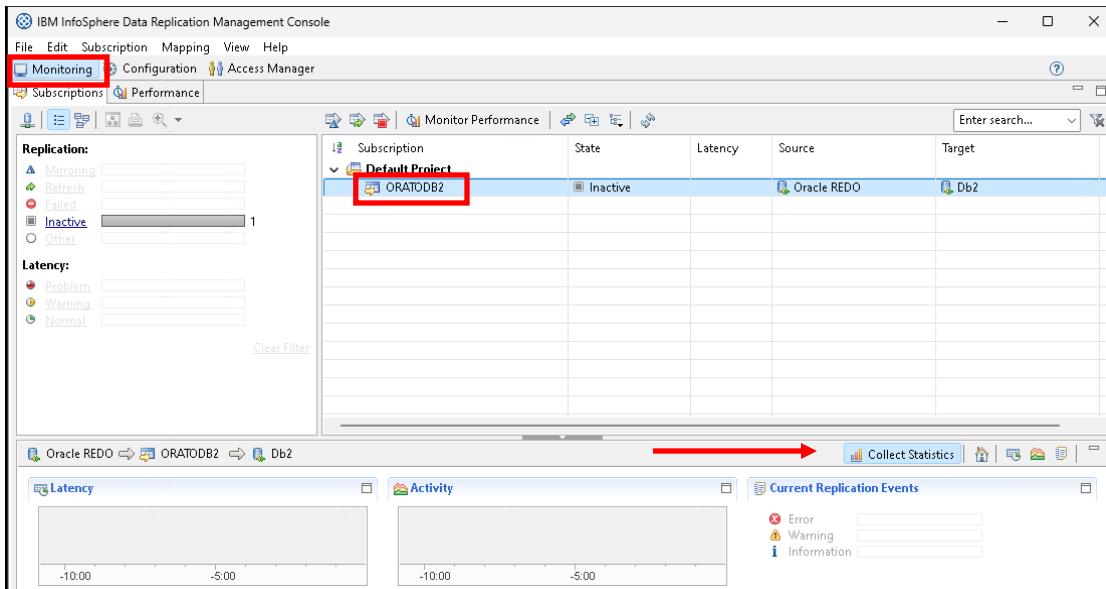


At this point the target DB2 tables are empty since replication has not yet been started.

- 18. Leave these windows opened as they will be used later to enter and verify data.

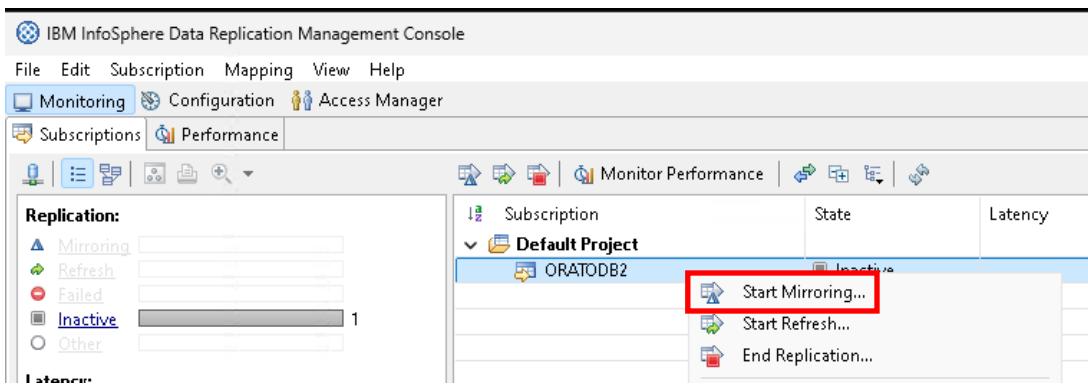
## 2.3 Starting Replication

- 19. Select the '**Monitoring**' perspective.  
Click on the '**ORATODB2**' Subscription and click the '**Collect Statistics**' button.



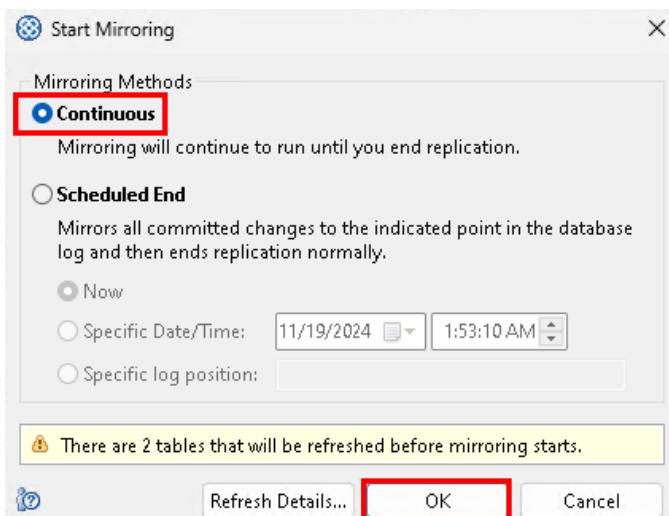
**The Monitoring** perspective contains the Subscriptions view and the Performance view. These views that allow you to initiate replication and monitor your replication activity.

- \_\_20. Right-click on the '**ORATODB2**' Subscription and select '**Start Mirroring...**'.



- \_\_21. Choose '**Continuous**' as the method.

Note that since the initial status of the table mappings were set to 'Refresh', when the Subscription starts, the data is first pulled from the source and loaded to the target table.



**The are two types of mirroring:**



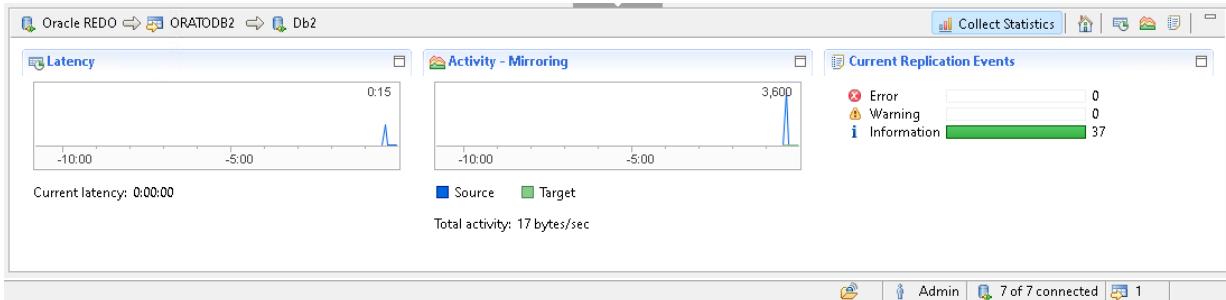
- **Continuous** mirroring replicates changes to the target on a continuous basis.
- **Scheduled End** mirroring replicates changes to the target up to a user-specified point in time or position in the source database logs and then ends replication.

- \_\_22. Click '**OK**'.

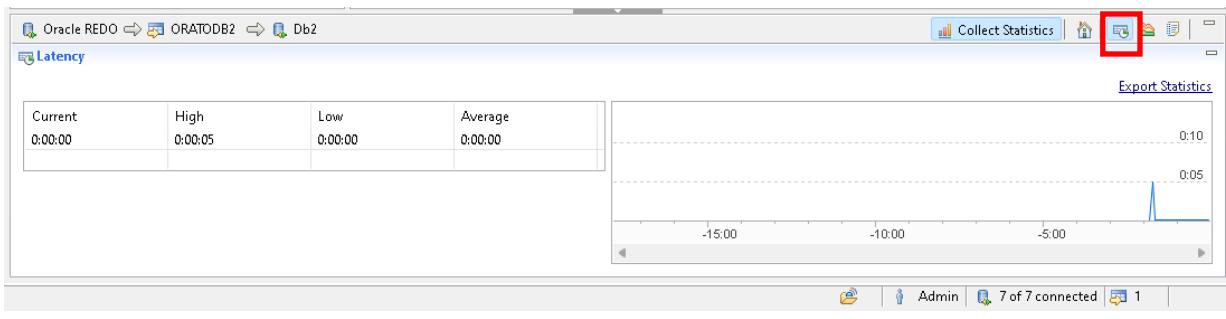
- \_\_23. Notice that the State changes from '*Inactive*' to '*Starting*' to '*Refresh Before Mirror*' to '*Mirror Continuous*'.

## 2.4 Monitoring Replication Latency, Activity, Events and Performance

- 24. In the bottom half of the ‘Monitoring’ perspective you can see a summary of the **Latency**, **Activity** and the **Current Replication Events**.

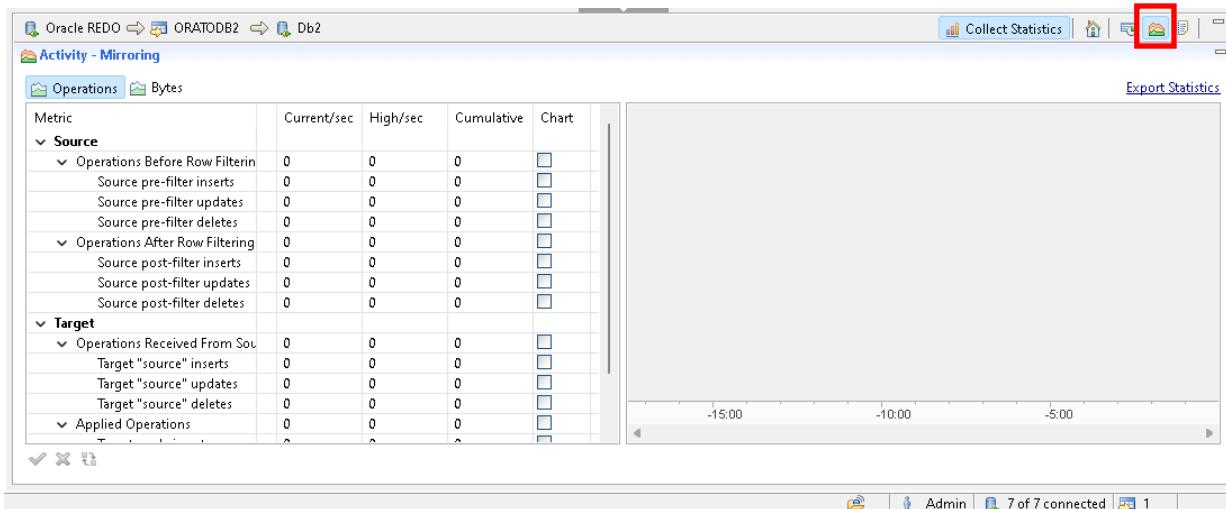


- 25. To view the latency, click on the **Latency** icon.



**Latency:** InfoSphere Change Data Capture measures latency as: the amount of time that passes between when data changes on a source table and when it changes on the target table.

- 26. To view the replication activity, click on the **Activity** icon.



This provides you with a more detailed view of the replication activity. You can choose to view the activities by either operations or bytes. The metrics, on the left, can be selected to plot the graph on the right.

27. To view the events, click on the **Events** icon.  
Click '**Retrieve Events** → **All Events**' to refresh all the replication events.

The screenshot shows the 'Events' view in the IBM InfoSphere Data Replication Management Console. The 'All Events' button in the toolbar is highlighted with a red box. The main area displays a list of replication events, with the first few rows shown below:

Type	Last 24 Hours	Event ID	Object	Time
i In	Last 7 Days	93	ORATODB2	Nov 8, 2024 3:43:52 PM
i In	Last 30 Days	1488	ORATODB2	Nov 8, 2024 3:43:52 PM
i In	All Events	1528	ORATODB2	Nov 8, 2024 3:43:52 PM
i In		111	ORATODB2	Nov 8, 2024 3:43:51 PM
i In		1582	ORATODB2	Nov 8, 2024 3:43:51 PM
i Information		1521	ORATODB2	Nov 8, 2024 3:43:51 PM
i Information		9750	ORATODB2	Nov 8, 2024 3:43:51 PM
i Information		110	ORATODB2	Nov 8, 2024 3:43:50 PM
i Information		1487	ORATODB2	Nov 8, 2024 3:43:50 PM
i Information		1561	ORATODB2	Nov 8, 2024 3:43:50 PM
i Information		1580	ORATODB2	Nov 8, 2024 3:43:50 PM
i Information		1520	ORATODB2	Nov 8, 2024 3:43:50 PM
i Information		92	ORATODB2	Nov 8, 2024 3:43:50 PM

At the bottom of the screen, there are error and warning counts: Errors 0 / 0, Warnings 0 / 0, and All 13 / 54. The status bar indicates 'Events since: Nov 8, 2024 3:43:50 PM'.

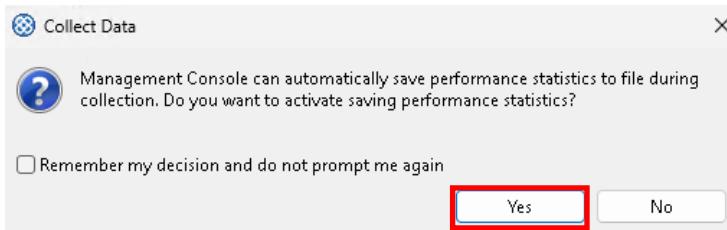
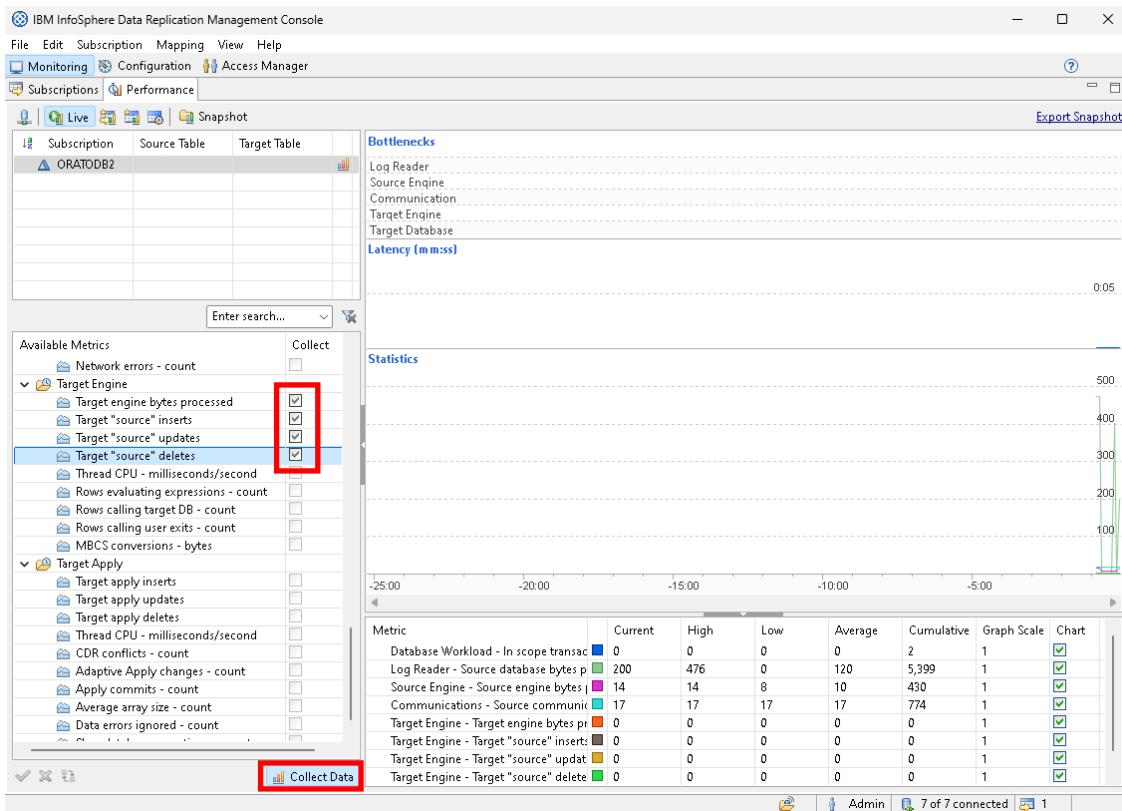
28. To view the performance, open the '**Performance**' view  
and click the icon to select a Subscription.  
Choose the '**ORATODB2**' Subscription and click '**OK**'.

The screenshot shows the 'Performance' view in the IBM InfoSphere Data Replication Management Console. The 'Performance' icon in the 'Subscriptions' tab is highlighted with a red box. A 'Select Subscriptions' dialog box is open, showing the 'ORATODB2' subscription selected and highlighted with a red box. The 'OK' button is also highlighted with a red box.

**The Performance** view allows you to diagnose the performance of a Subscription or tables within a Subscription by selecting metrics by which to gauge performance.  
The selected Subscription (and any selected tables) is displayed in the top left area of the view. Below it is a list of available metrics. This list will vary depending on the Subscription selected.

29. Select a few metrics (a maximum of ten are allowed) by checking the box and click the 'Collect Data' button. Click Yes on the window dialog box

The graphical display on the right is populated, with a statistics count area at the bottom.



#### The graphical display area contains three zones:



**Bottlenecks** - Displays a bar chart featuring the five components of the pipeline: Log Reader, Source Engine, Communication, Target Engine, and Target Database. The results of the bar chart will help you isolate which components are causing bottlenecks if there are any. Some engine, such as CDC i-series does not provide bottleneck information

**Latency** - Displays a graphical summary of latency for the selected Subscription.

**Statistics** - Displays a graph of the performance of the selected metrics.

## 2.5 Replicate Changes and Verify Data

- 30. Use DBeaver to make any number of data changes to the source Oracle ‘CUSTOMER’ and ‘PRODUCT’ tables. Make sure that you commit the changes. For example:

```
update customer set name1='<Your Name>' where custno=112378;
```

DBeaver interface showing the Oracle ORCL - redo tab selected. The SQL editor contains the following code:

```
SELECT * FROM CUSTOMER c
SELECT * FROM PRODUCT p;
update customer set name1='Ronny Zakaria' where custno=112378;
commit;
```

The Statistics tab shows the following results:

Name	Value
Updated Rows	1
Query	update customer set name1='Ronny Zakaria' where custno=112378
Start time	Tue Nov 19 02:32:10 PST 2024
Finish time	Tue Nov 19 02:32:10 PST 2024

- 31. Use the other Db2 Tab to verify the changes reflected in the DB2 target table by executing below SQL

```
SELECT * FROM CUSTOMER_TGT WHERE custno = 112378.
```

DBeaver interface showing the Db2 CDC tab selected. The SQL editor contains the following code:

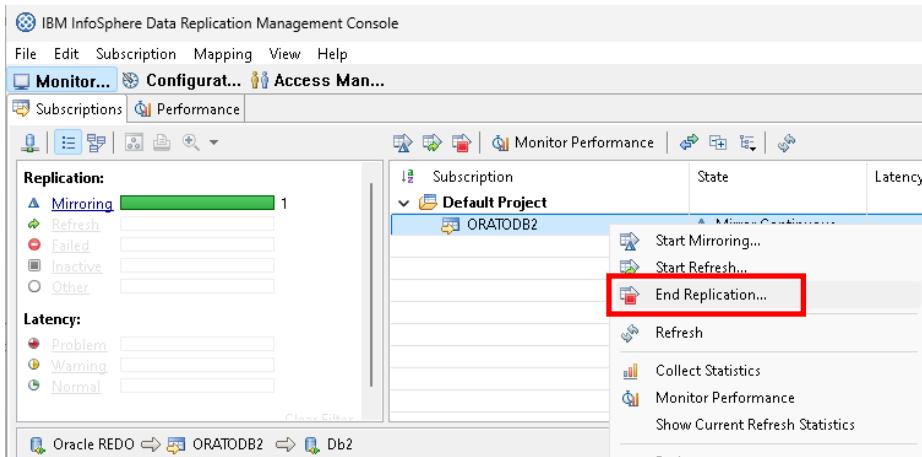
```
SELECT * FROM CUSTOMER_TGT ct
SELECT * FROM PRODUCT_TGT pt
SELECT * FROM CUSTOMER_TGT ct
WHERE custno = 112378
```

The results grid shows the following data:

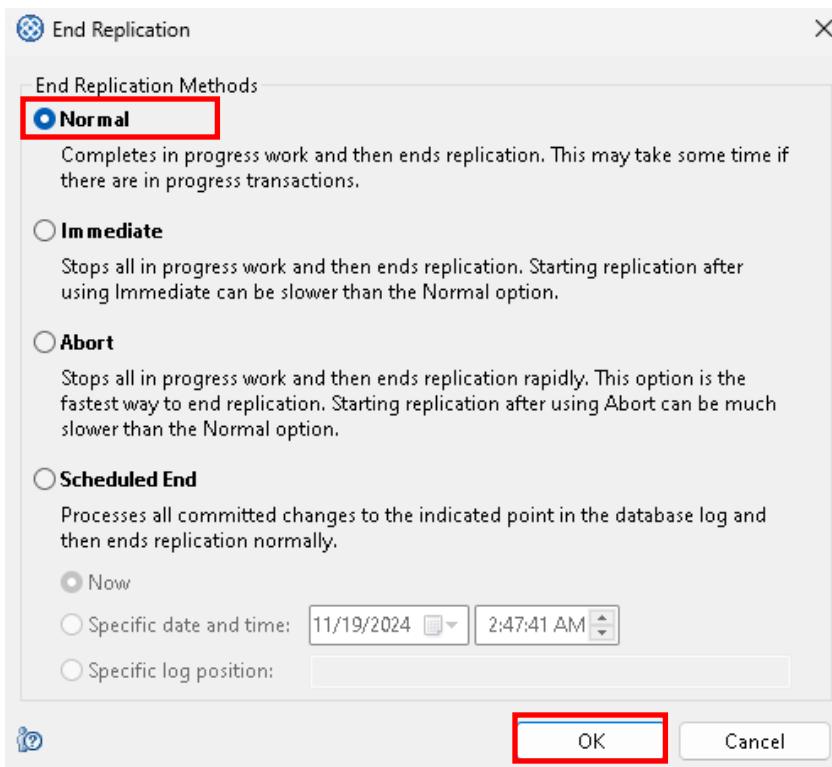
Grid	123 CUSTNO	AZ BRANCH	AZ NAME1	AZ NAME2	AZ ADDRESS1	AZ ADDRESS2	AZ CITY	AZ STATE
1	112,378	11	Ronny Zakaria		50 VALLEY WOOD DR.	SUITE 500	LAKE HAVASU CITY	AZ

## 2.6 Stopping Replication

- \_\_32. From the '**Monitoring**' perspective,  
Right-click on the 'ORATODB2' Subscription  
and select '**End Replication...**'.



- \_\_33. You are presented with a number of end replication methods. Review the options.



- \_\_34. Select '**Normal**' as the end replication method and click '**OK**'.

## 2.7 Summary

Using the InfoSphere Change Data Capture Management Console, you can easily configure, manage and monitor replication in a heterogeneous environment through a centralized graphical interface. The tool also allows you to visually gauge performance, latency and activity.

You have now setup a complete replication environment from Oracle to DB2 and replicated the required tables in real-time. The changes made to the customer and product data in the Oracle database are now captured and replicated in real-time to the IBM DB2 ODS. You have now made a truly dynamic ODS with more up to date information for better reporting and in turn, better business decisions.

## Lab 3 Bi-Directional Replication between Oracle and DB2

At JKLW, our growing insurance business eventually effected our day to day operations. Changes to operational data, residing on two different relational database systems across our different insurance branches, needed to be synchronized so that each branch had the same information. Since changes could be made on either database and potentially at the same time, we needed bi-directional synchronization that had multi-side update support with conflict detection and resolution.

Considering our options, we chose IBM InfoSphere Change Data Capture since it provides the flexibility to support a variety of replication topologies; it integrates data from a broad range of databases and platforms; and has built in conflict detection and resolution functionality.

In our environment, we have an Oracle database and an IBM DB2 database. Our goal is to setup bi-directional replication between the two databases so that changes to our product data, on either side, will be synchronized with each other.

**As a prerequisite, you will need to complete Lab 1 and 2 before doing this exercise.**

In this lab, you will:

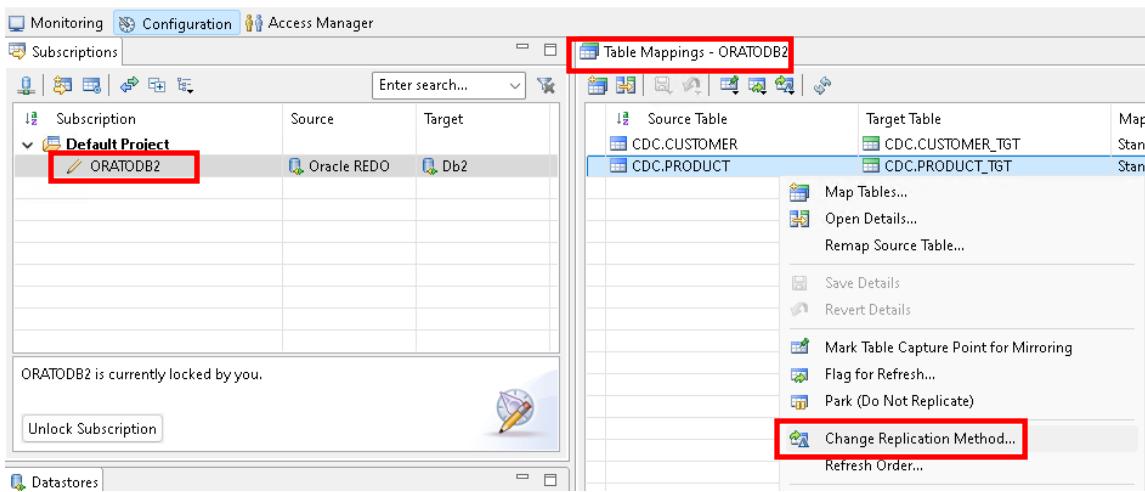
- Learn how to setup bi-directional replication between different relational database systems
- Setup conflict detection and resolution rules
- Continuously mirror changes bi-directionally between databases

### 3.1 Modifying the Existing Subscription

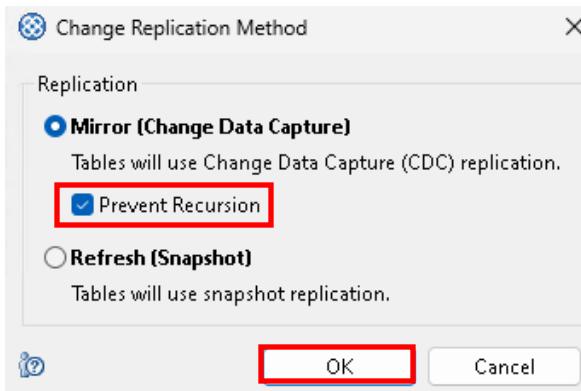
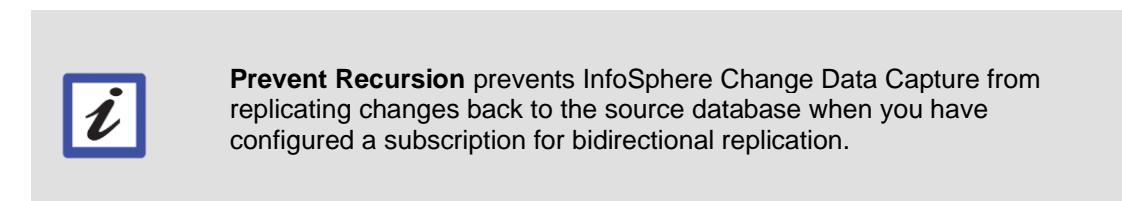
In Lab 2, we already setup replication for our product table from Oracle to DB2 using our 'ORATODB2' Subscription. We need to slightly modify that Subscription for bi-directional replication.

#### 3.1.1 Enable Subscription Parameter to Prevent Recursion

- 1. If you have not already done so, start the InfoSphere CDC Management Console by clicking the 'InfoSphere CDC Management Console' icon  from windows task bar.  
Login with user name '**Admin**' and password '**passw0rd**' and click: '**Login**'.  
Leave the values for server name (cdc01.de.ibm.com) and port number (10101) unchanged.
- 2. Ensure that **replication is stopped (Inactive)** for the '**ORATODB2**' Subscription by checking the status in the '**Monitoring**' perspective.
- 3. In the '**Configuration**' perspective, highlight the subscription '**ORATODB2**' and under the '**Table Mappings – ORATODB2**' view,  
Right-click on the mapping for the '**CDC.PRODUCT**' table  
and select '**Change Replication Method**'.



- 4. Check the box next to '**Prevent Recursion**' then click '**OK**'.

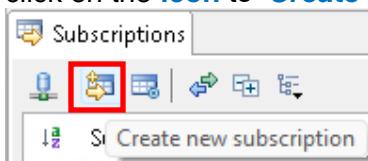


## 3.2 Configuring Replication from DB2 to Oracle

Now we will configure replication in the opposite direction from DB2 to Oracle.

### 3.2.1 Defining a Subscription from DB2 to Oracle

- 5. Under the '**Subscription**' view, click on the icon to '**Create a new subscription**'.



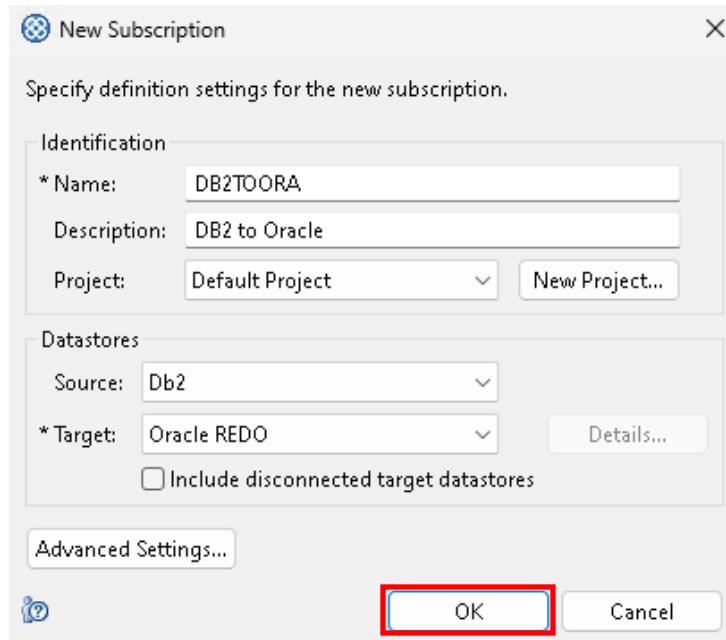
- \_\_6. Create a new Subscription with:

Name: **DB2TOORA**

Description: **DB2 to Oracle**

Source: **Db2**

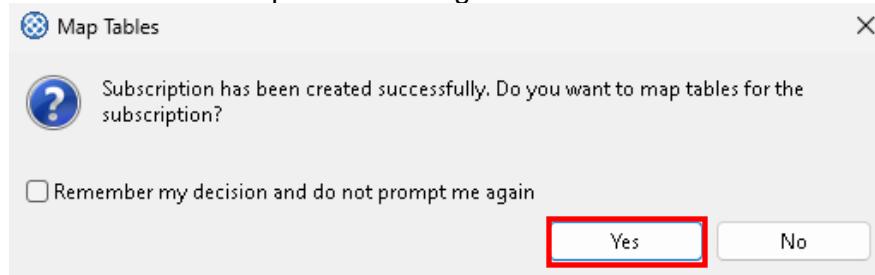
Target: **Oracle REDO**



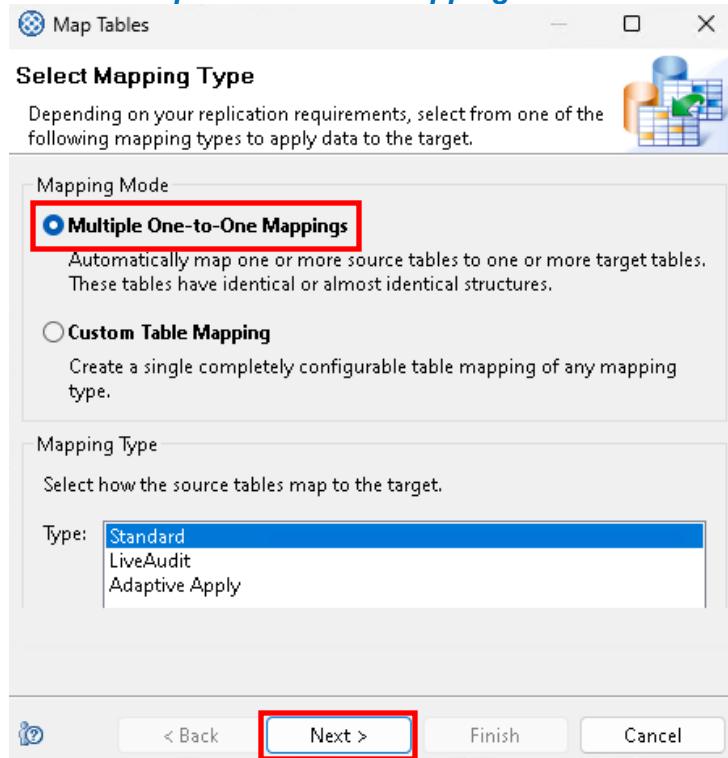
- \_\_7. Click '**OK**'. A new Subscription 'DB2TOORA' is created.

### 3.2.2 Mapping your Tables

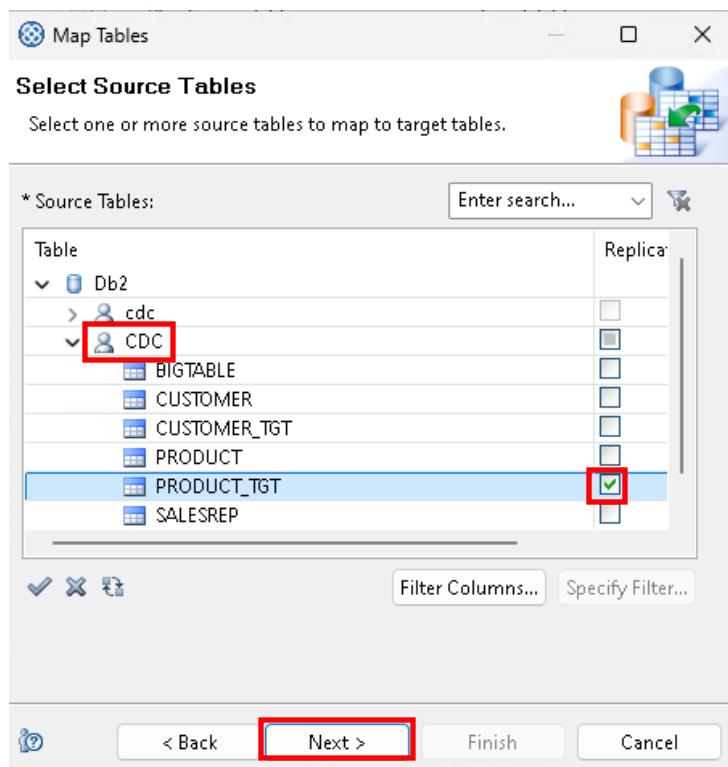
- \_\_8. Click **Yes** on the Map Tables dialog box



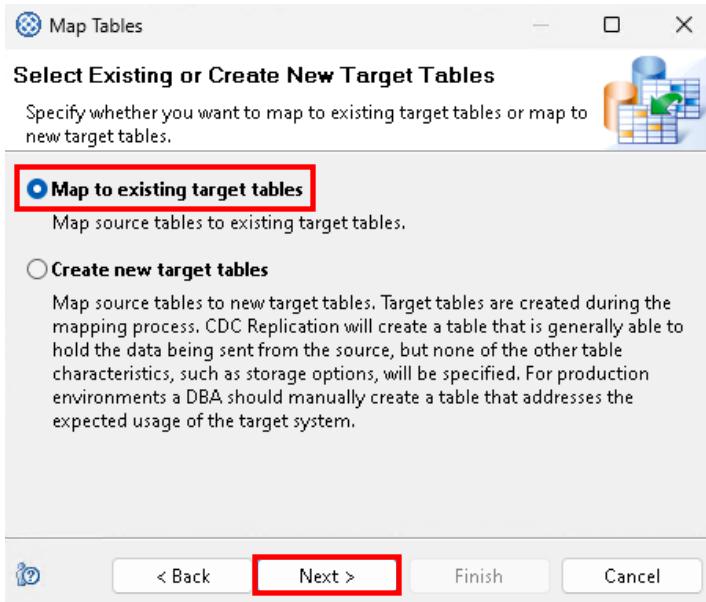
- 9. Select '**Multiple One-to-one Mappings**' and click '**Next**'.



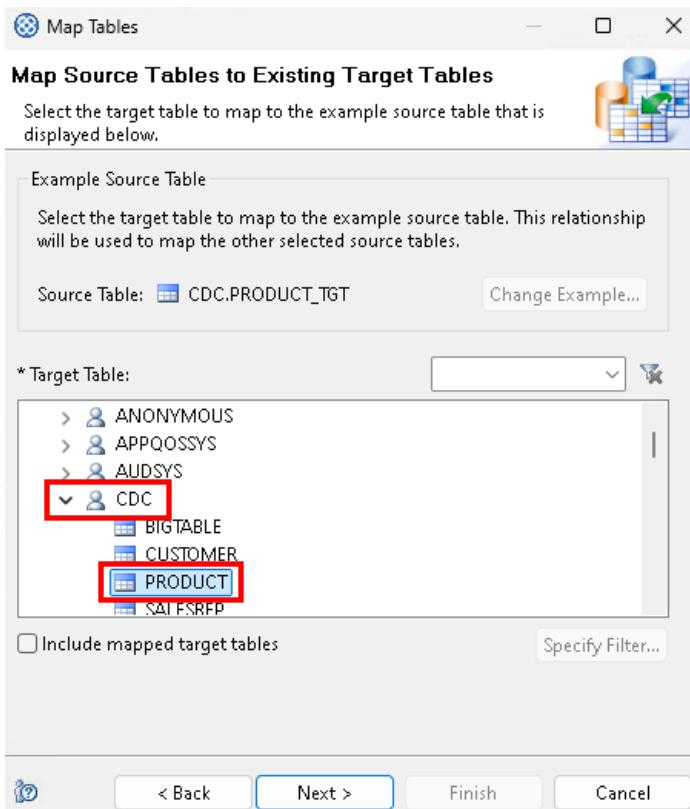
- 10. Select the source DB2 table that will be replicated back to Oracle. Expand the schema '**CDC** (Capital letter)', select only the '**PRODUCT\_TGT**' table. Click **Next**



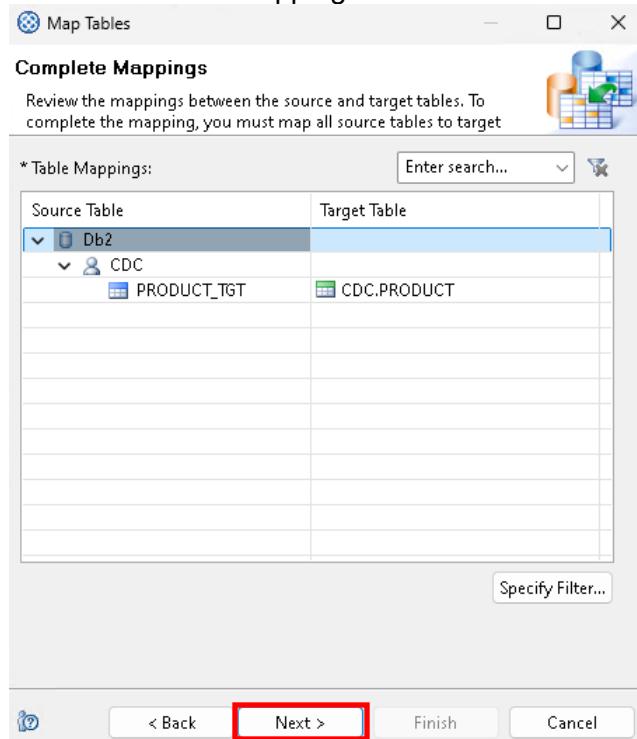
- \_\_11. You will map this table to the existing table on Oracle.  
Select the option to '**Map to existing target tables**' and click '**Next**'.



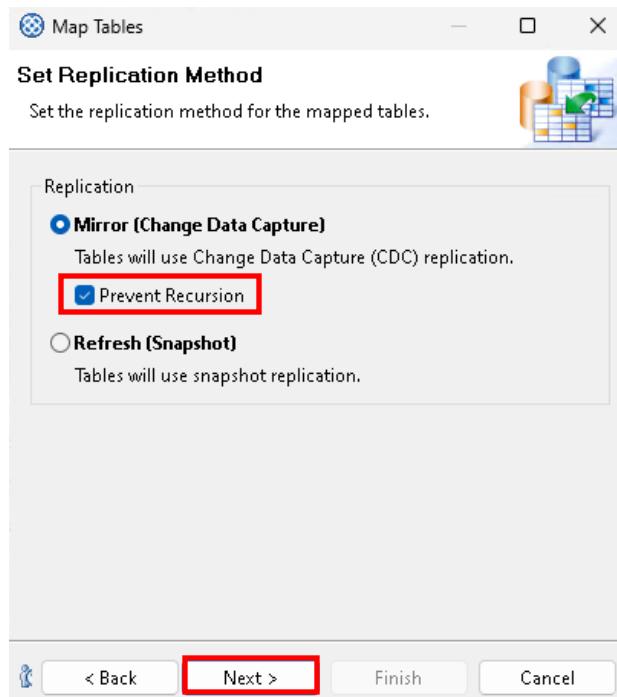
- \_\_12. Now pick the target table. Expand the schema '**CDC**' select '**PRODUCT**' and click '**Next**'.



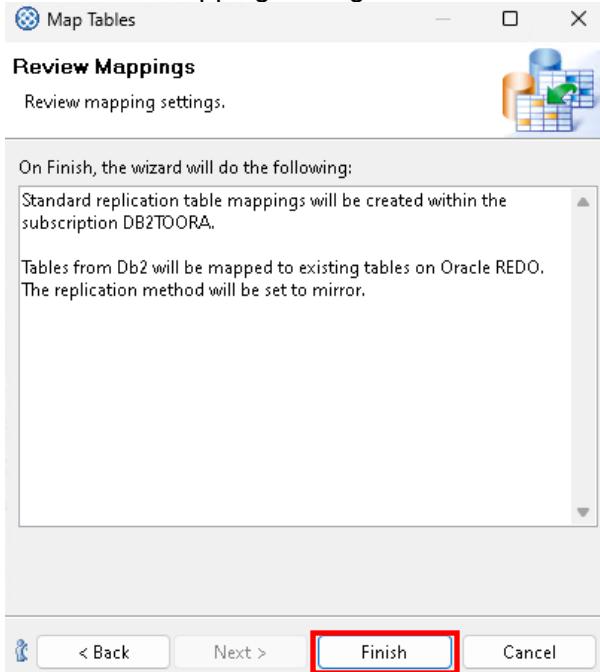
- \_\_13. Review the table mappings and click ‘**Next**’.



- \_\_14. Check the box next to ‘**Prevent Recursion**’ and click ‘**Next**’.

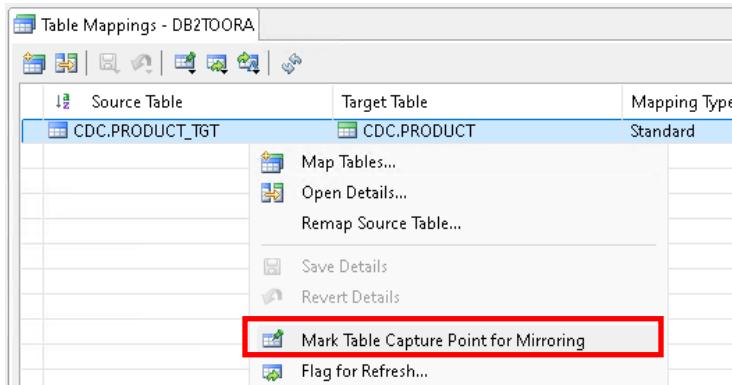


- 15. Review the mapping settings and click '**Finish**'.



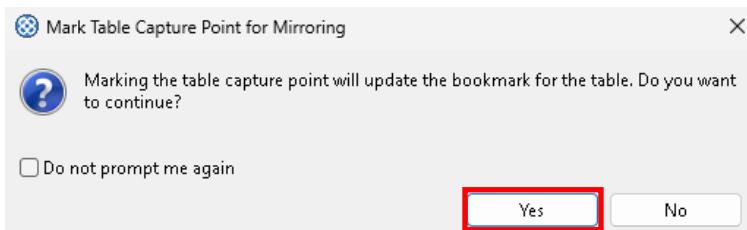
- 16. Note that by default the mapping shows the status as 'Refresh'.  
The tables are already synchronized so you do NOT want to refresh the tables at startup.

**Right-click** on the mapping for the '**CDC.PRODUCT\_TGT**' table and select '**Mark Table Capture Point for Mirroring**'.



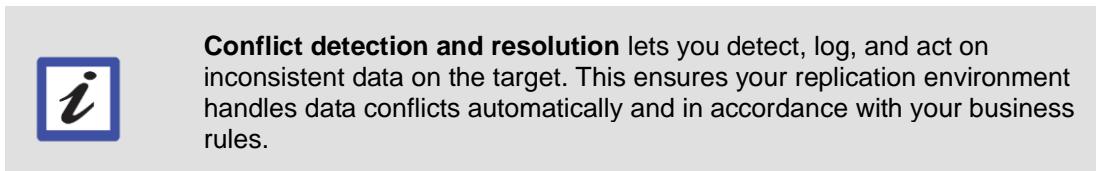
When prompted, click '**Yes**'.

This will set the status to 'Active' and sets the capture point to start processing logs for this table to the current time.



### 3.3 Setup the Conflict Detection and Resolution Rules

With the mappings defined as they are at this point, InfoSphere Change Data Capture would cause changes to the 'PRODUCT' and 'PRODUCT\_TGT' table to be replicated bi-directionally between Oracle and DB2, regardless of which side updated the table first and there could be data collisions. For instance, during updates, if the table rows did not match then the update would not be allowed. In order to handle conflicts, we need to setup the conflict detection and resolution rules for the table mappings.



- \_\_17. Highlight the Subscription '**DB2TOORA**' and under the '*Table Mappings – DB2TOORA*' view, Right-click on the mapping for the '*PRODUCT\_TGT*' table and select '**Open Details**'.

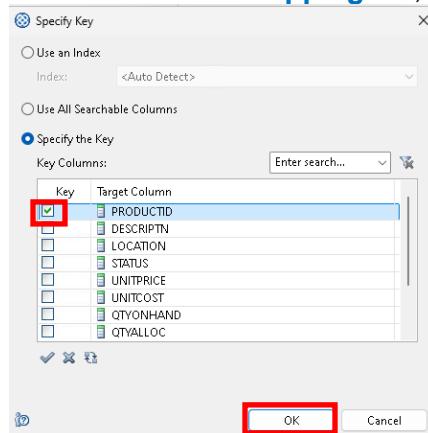
The screenshot shows two windows side-by-side. On the left is the 'Subscriptions' view, where the 'DB2TOORA' subscription is highlighted with a red box. On the right is the 'Table Mappings - DB2TOORA' view, showing a mapping between 'CDC.PRODUCT\_TGT' and 'CDC.PRODUCT'. The 'Open Details...' option in the context menu for the 'CDC.PRODUCT\_TGT' mapping is highlighted with a red box.

- \_\_18. For the '*CDC.PRODUCT\_TGT → CDC.PRODUCT*' mapping, select the '**Conflicts**' tab:

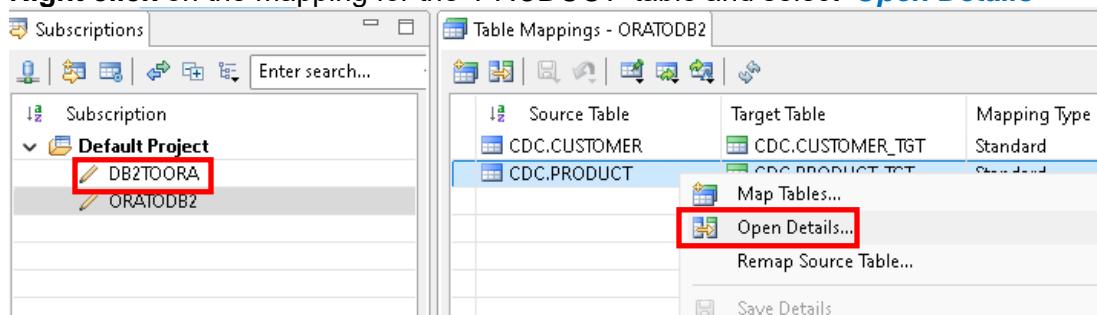
- \_\_a. Select all the columns to detect conflicts on
- \_\_b. Set the Conflict Resolution Method to '**Largest Value Wins**'
- \_\_c. Set the Value Comparison Column to '**UPDATETIME**'
- \_\_d. Click '**Save**'

The screenshot shows the 'Conflicts' tab of the 'Column Mappings' dialog for the 'CDC.PRODUCT\_TGT - CDC.PRODUCT' mapping. The 'Conflict Detection' section shows checkboxes for all columns (PRODUCTID, DESCRIPTN, LOCATION, STATUS, UNITPRICE, UNICOST, QTYONHAND, QTYALLOC, QTYMINORD, UPDATETIME) in the 'Target Column' list, with the 'Detect Conflicts' column also checked for all. The 'Conflict Resolution' section shows 'Largest Value Wins' selected for 'Conflict Resolution Method' and 'UPDATETIME' selected for 'Value Comparison Column'. The 'Save' button at the bottom is highlighted with a red box.

Click the **column mapping** tab, Click **Key columns** button, specify product ID as key, click **OK**

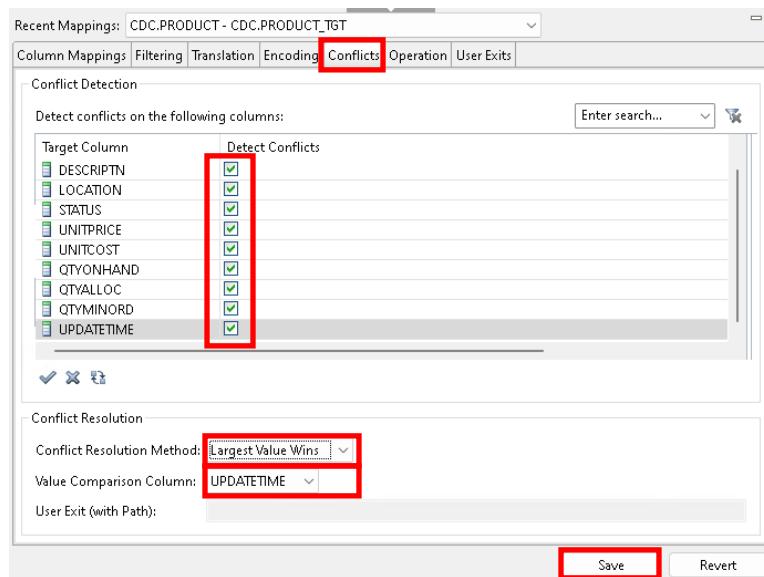


- \_\_19. Highlight the Subscription '**ORATODB2**' and under the '*Table Mappings – ORATODB2*' view, Right click on the mapping for the '**PRODUCT**' table and select '**Open Details**'

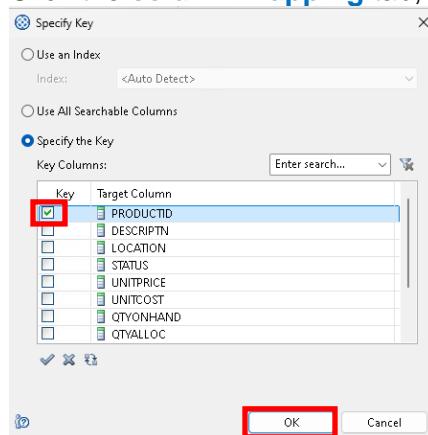


- \_\_20. Similarly, for the '**CDC.PRODUCT → CDC.PRODUCT\_TGT**' mapping, select the '**Conflicts**' tab:

- \_\_a. Select all the columns to detect conflicts on
- \_\_b. Set the Conflict Resolution Method to '**Largest Value Wins**'
- \_\_c. Set the Value Comparison Column to '**UPDATETIME**'
- \_\_d. Click '**Save**'

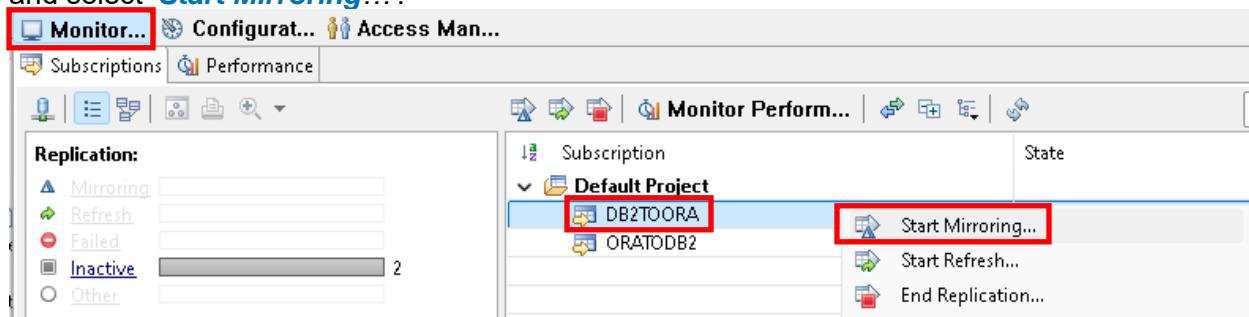


Click the **column mapping** tab, Click **Key columns** button, specify product ID as key, click **OK**

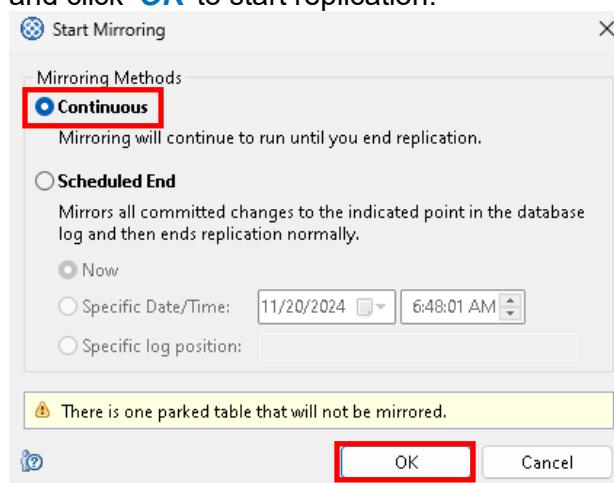


### 3.4 Starting Bi-Directional Replication

- 21. Under the '**Monitoring**' perspective,  
Right-click on the '**DB2TOORA**' Subscription  
and select '**Start Mirroring...**'.

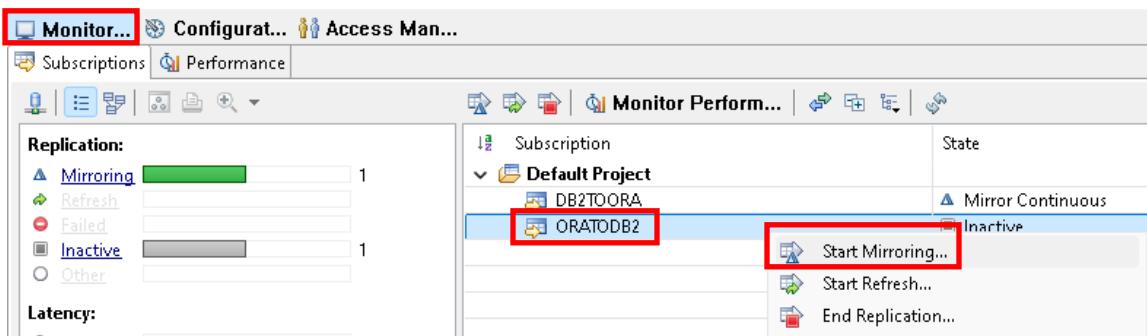


Choose '**Continuous**' as the method  
and click '**OK**' to start replication.



- \_\_22. Do the same for the '**ORATODB2**' subscription. → “**Start Mirroring...**”

At this point both Subscriptions should be running and replicating changes bi-directionally between Oracle and DB2 for the '*PRODUCT*' and '*PRODUCT\_TGT*' table.



### 3.5 Testing and Verifying Bi-Directional Changes

- \_\_23. Open the *DBeaver* tools

Make data changes to the Oracle '*PRODUCT*' table and note that they are replicated to the '*PRODUCT\_TGT*' DB2 table.

example: `UPDATE PRODUCT`

```
SET DESCRIPTN ='product update <your name> ORA',
    updatetime = sysdate
WHERE PRODUCTID =100
```

Name	Value
Updated Rows	1
Query	UPDATE PRODUCT SET DESCRIPTN ='product update Ronny Z ORA', updatetime = sysdate WHERE PRODUCTID =100
Start time	Wed Nov 20 07:35:48 PST 2024
Finish time	Wed Nov 20 07:35:49 PST 2024

- \_\_24. Still using *DBeaver* tools, now make data changes to the DB2 '*PRODUCT\_TGT*' table and note that they are also replicated to the Oracle '*PRODUCT*' table.

example: `UPDATE PRODUCT_TGT`

```
SET DESCRIPTN ='product update <your name> DB2',
    updatetime = current timestamp
WHERE PRODUCTID =101
```

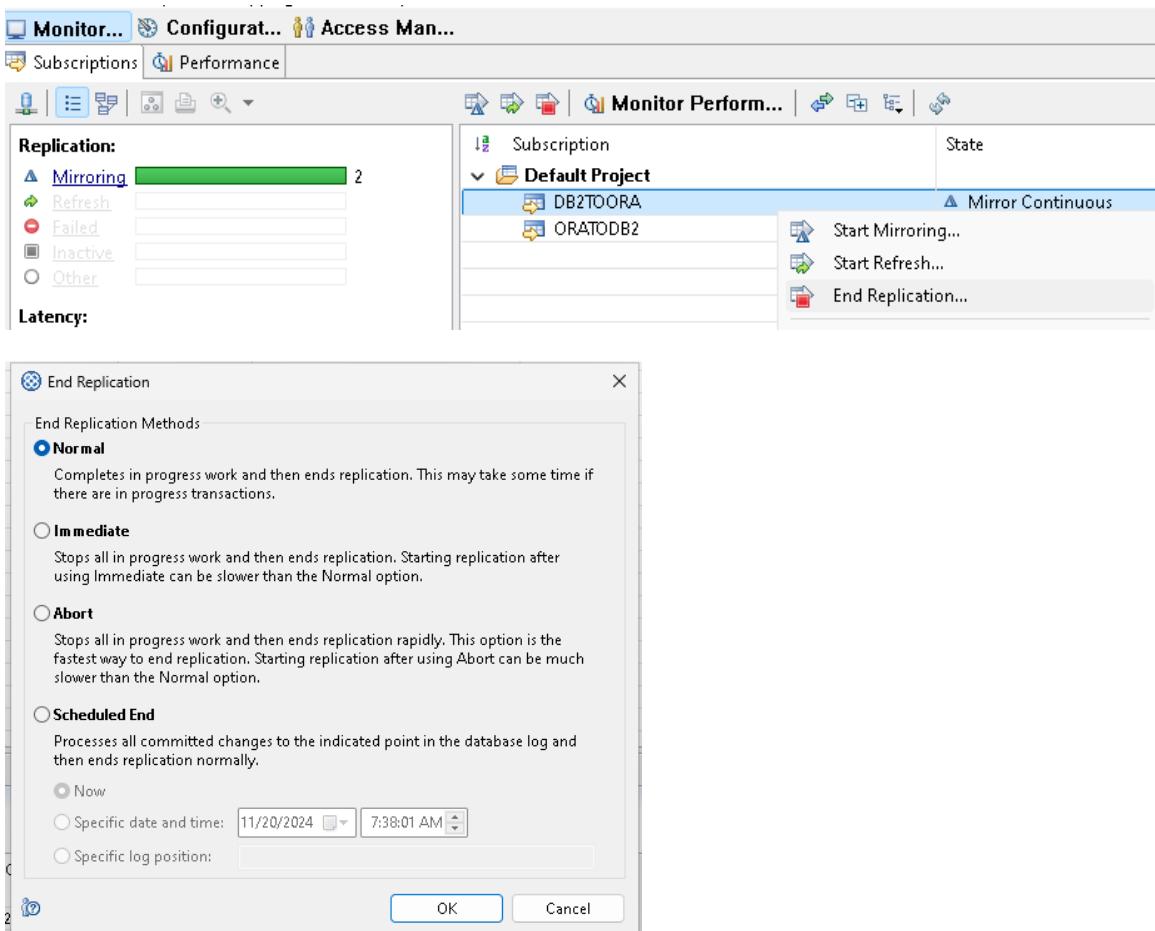
The screenshot shows a database client interface. In the top window, a query is being run:

```
UPDATE PRODUCT_TGT
SET DESCRIPTN ='product update Ronny DB2',
    updatetime = current_timestamp
WHERE PRODUCTID =101
```

In the bottom window, titled "Statistics 1", the results of the query are displayed:

Name	Value
Updated Rows	1
Query	UPDATE PRODUCT_TGT SET DESCRIPTN ='product update Ronny DB2', updatetime = current_timestamp WHERE PRODUCTID =101
Start time	Wed Nov 20 07:35:31 PST 2024
Finish time	Wed Nov 20 07:35:31 PST 2024

25. When you are finished,  
**end replication using the ‘Normal’ method for BOTH Subscription**  
the ‘DB2TOORA’ and ‘ORATODB2’ Subscriptions.



### **3.6 Summary**

You have now setup heterogeneous bi-directional replication between two different relational database systems. Changes made in either database are now synchronized with each other so that each branch has access to the same information.

InfoSphere Change Data Capture supports all the major relational database systems such as IBM DB2, Oracle, Sybase, IBM Informix®, PostgreSQL, Microsoft SQL Server for dual replication (source and target). It can be implemented in a number of different ways, including bi-directional replication, to address a wide range of data integration requirements.

Using the InfoSphere Change Data Capture Management Console, it is easy to configure replication from one environment to another, regardless of platform or database, making it a repeatable and sustainable solution.

---

## Lab 4 Filtering, Transformation and Data Translation Capabilities

As part of JKLW's recent acquisition of an insurance company, the human resource department requested that we capture and consolidate employee information into their central repository.

The employee information, from the acquired insurance company, resides in an Oracle database in a format that is different than the one that will be used in the human resource department's IBM DB2 database. The goal is to capture only actively employed individuals and to massage each record so that it conforms to the format that will be used at JKLW.

In particular, using the Oracle source table as defined in Table 1, the data will be mapped to the DB2 table format outlined in Table 2.

Please refer to next page detail

**Table 1: Source Table Structure**

Source Oracle Table	Column
EMP	EMPLOYEE_ID
	FIRST_NAME
	LAST_NAME
	HIRE_DATE
	SALARY
	BONUS_PCT
	MANAGER_ID
	DEPT_ID
	STAT

**Table 2: Target Table Structure and Table Mappings**

Target DB2 Table	Column	Maps To
EMPLOYEE	EMP_ID	Source Oracle column EMPLOYEE_ID
	FULL_NAME	Concatenation of the FIRSTNAME and LASTNAME columns from the source.
	HIRE_DATE	Source Oracle column HIRE_DATE
	SALARY	Source Oracle column SALARY
	BONUS_AMT	Bonus amount calculated: BONUS_PCT * SALARY
	STATUS	Source Oracle column STAT

As a robust data replication technology, InfoSphere Change Data Capture also provides Filtering, Transformation and data translation capabilities to meet the human resource's data replication requirements

As a prerequisite, you will need to complete Lab 1 and 2 before doing this exercise.

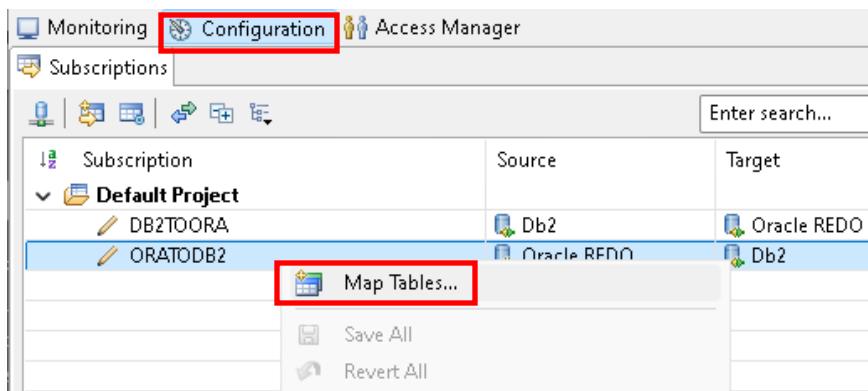
In this lab, you will:

- Learn how to filter information and map tables with different formats
- Include in-flight transformations to the replicated data
- Perform data translations for specific values

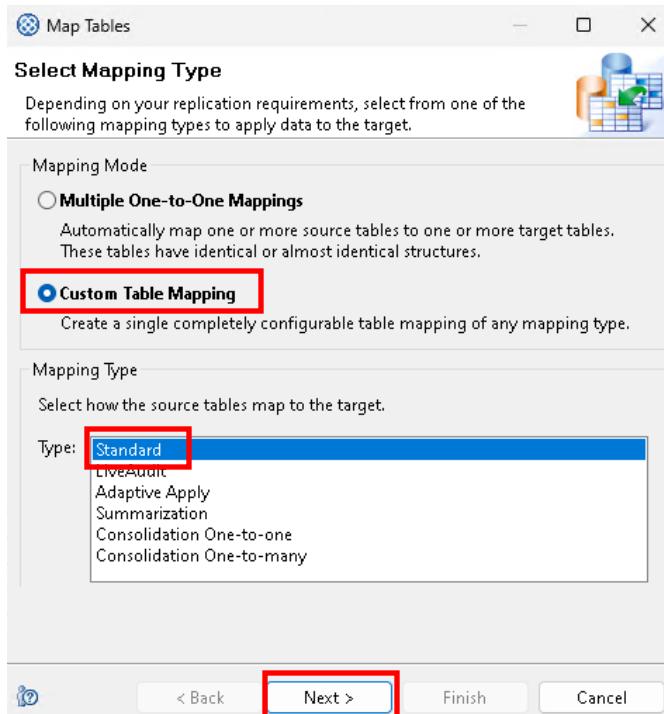
## 4.1 Create a Customized Table Mapping from Oracle to DB2

### 4.1.1 Mapping your Tables

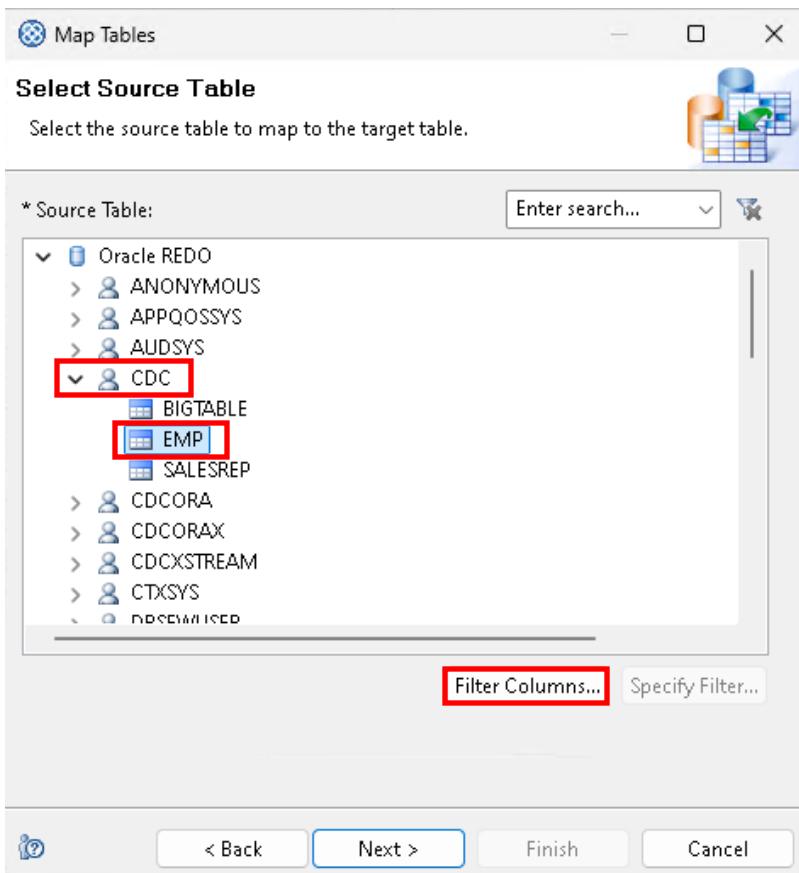
- 1. In the InfoSphere Change Data Capture Management Console, **ensure that replication is stopped (Inactive)** for the '**ORATODB2**' Subscription by checking the status in the '*Monitoring*' perspective.
- 2. In the '**Configuration**' perspective,  
**Right-click** on the '**ORATODB2**' Subscription and select '**Map Tables...**'.



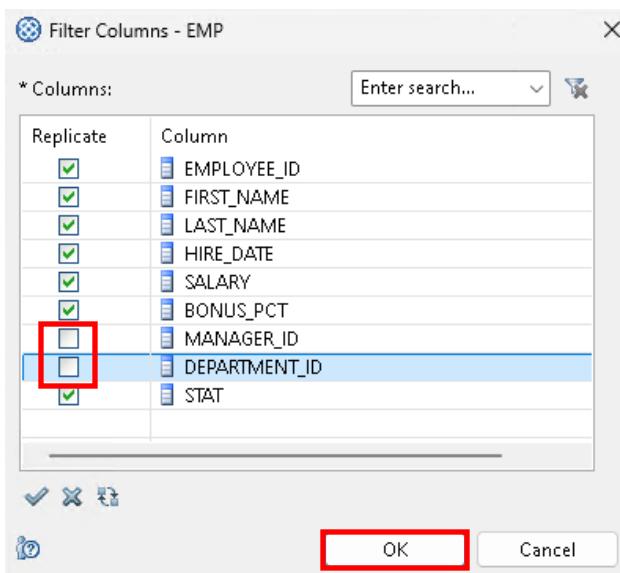
- 3. Select **Custom Table Mapping** and under the Mapping Type select **Standard**. Then click '**Next**'.



- 4. Select the source Oracle table that you will be replicating from. Expand the schema '**CDC**' and select the table '**EMP**'. Click the '**Filter Columns...**' button.

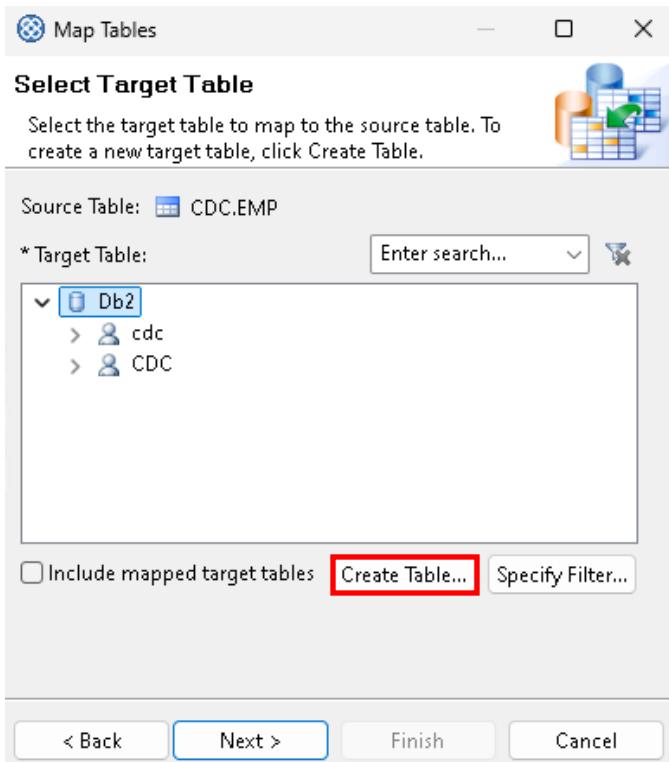


- 5. You have the option to filter out source columns which are not required for replication.  
Un-check the '**MANAGER\_ID**' and '**DEPARTMENT\_ID**' column.

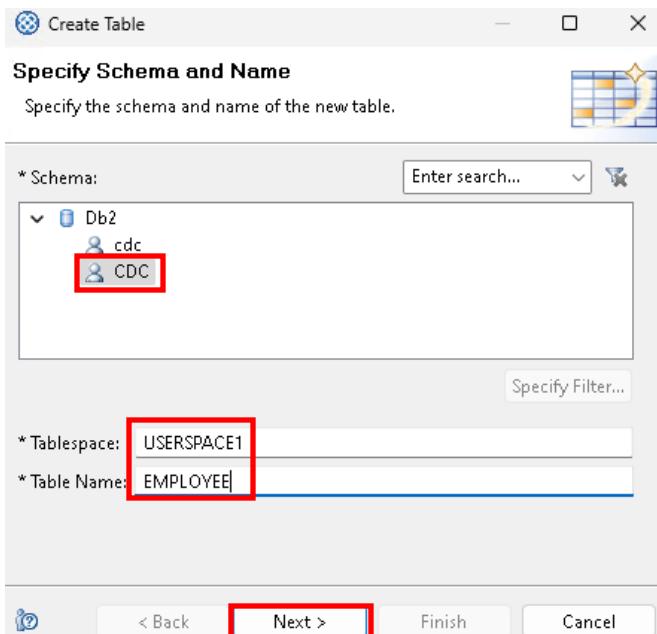


- 6. Click '**OK**' then '**Next**' to continue.

- 7. You will create a new target table in DB2 to map to the source Oracle table. Click the '**Create Table...**' button.



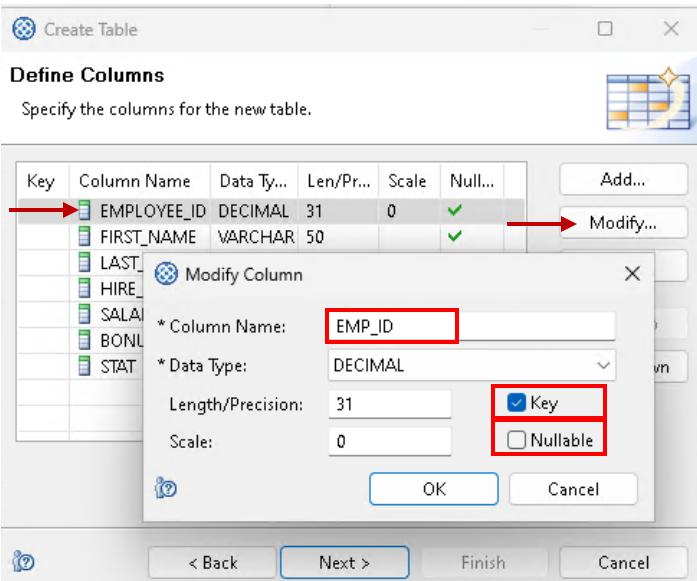
- 8. In the Create Table window, select the '**CDC**' (CAPITAL LETTER) schema. For the Tablespace enter '**USERSPACE1**' and for Table Name enter '**EMPLOYEE**'.



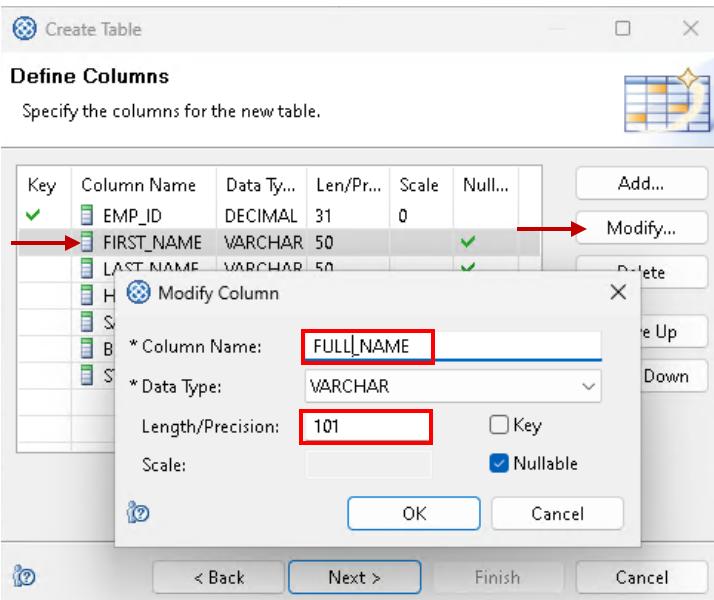
- 9. Click '**Next**'.

\_\_10. You will now customize the columns that will be created for the DB2 target table.

- \_\_a. Select the '**EMPLOYEE\_ID**' column and click the '**Modify...**' button.  
 Change the column name to '**EMP\_ID**',  
 select '**Key**' checkbox and **de-select 'Nullable'**. Then click '**OK**'.

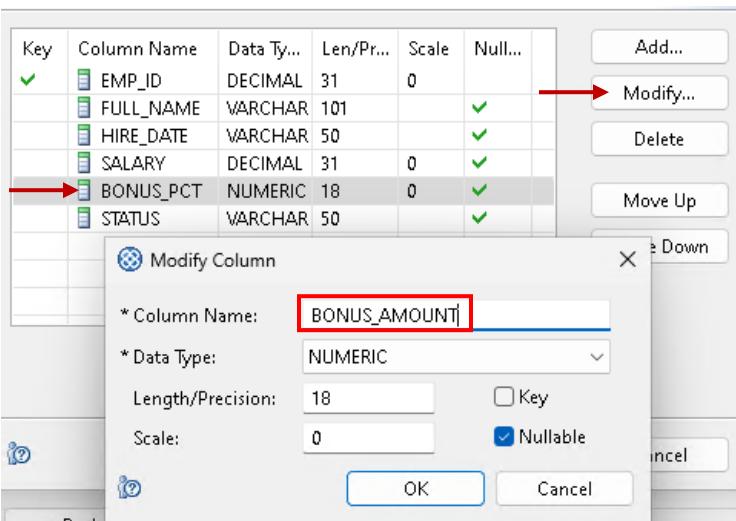


- \_\_b. Modify the '**FIRSTNAME**' column by changing the column name to '**FULL\_NAME**'.  
 This column will be used later to concatenate the FIRSTNAME and LASTNAME columns from Oracle. Change the length to '**101**' to accommodate the combined field lengths plus one for a space. Then click '**OK**'.

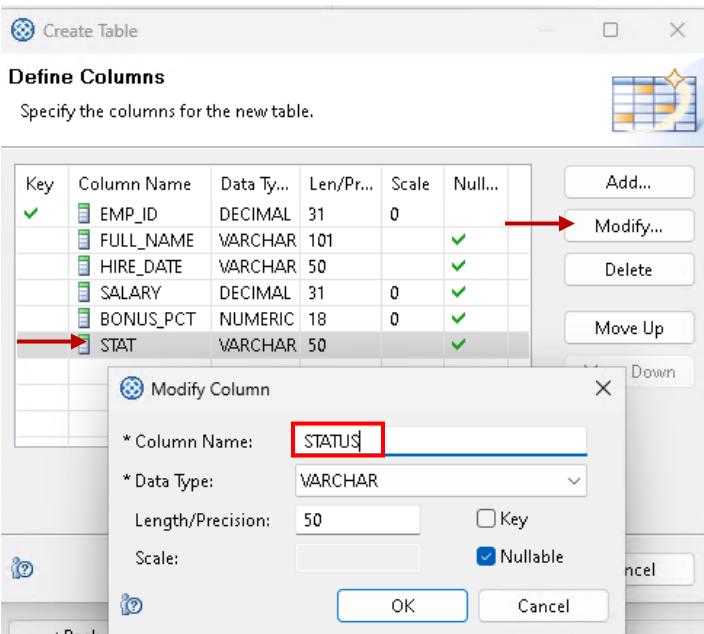


- \_\_c. Delete the '**LASTNAME**' column by selecting the column and then clicking the '**Delete**' button.

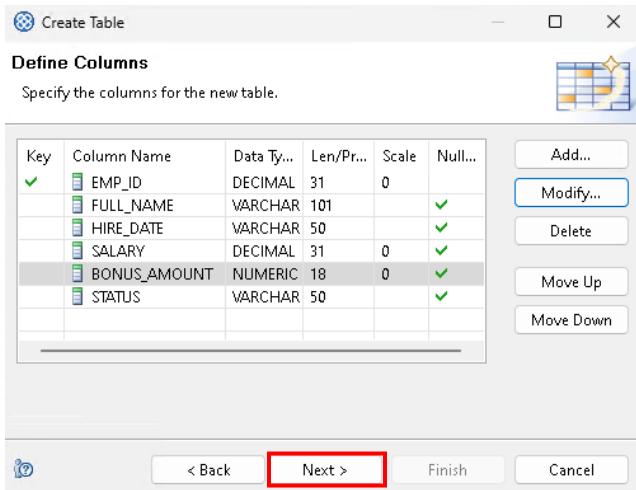
- \_\_d. Modify the '**BONUS\_PCT**' column by changing the column name to '**BONUS\_AMOUNT**'. Then click '**OK**'.



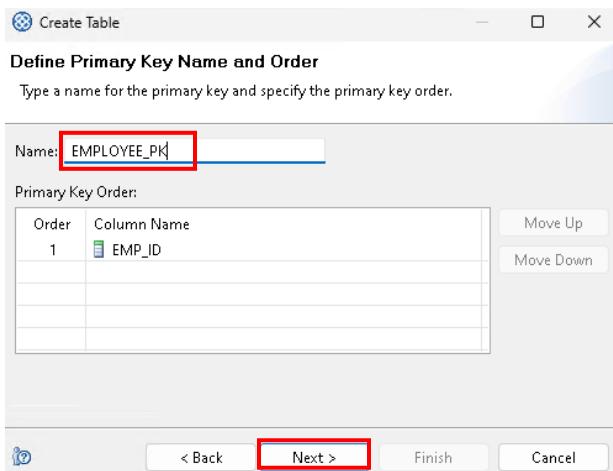
- \_\_e. Modify the '**STAT**' column by changing the column name to '**STATUS**'. Then click '**OK**'.



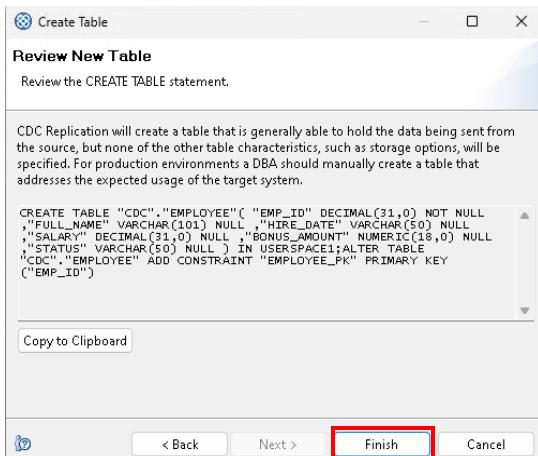
- \_\_11. When you are finished, it should look like below:



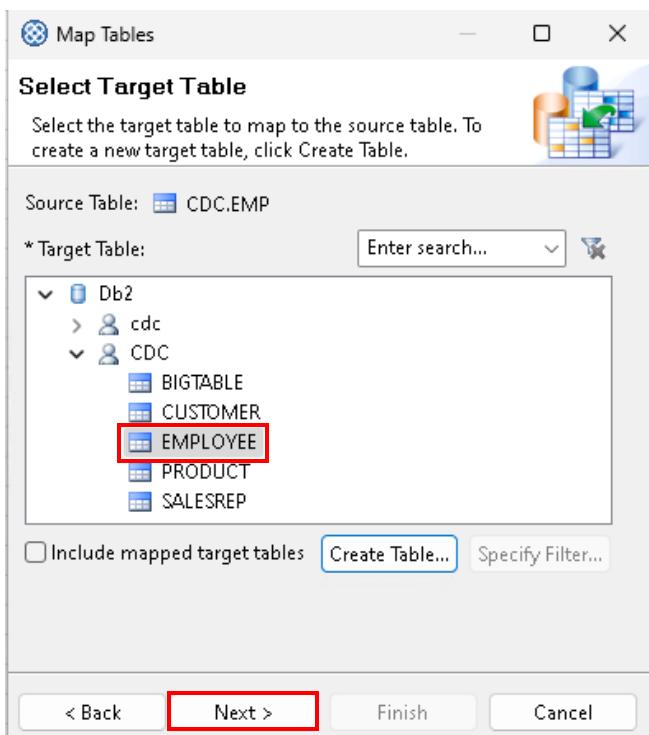
- 12. Click '**Next**'. The 'EMP\_ID' column will be used as a primary key. Specify the name of the primary key to be '**EMPLOYEE\_PK**'. Then click '**Next**'.



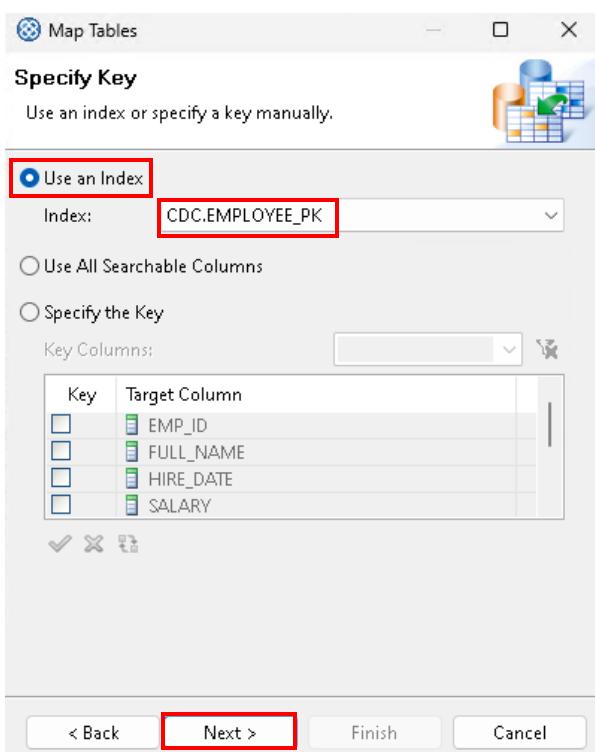
- 13. Review the CREATE TABLE statement and click '**Finish**' to start the table creation process on the target system. You have the option to view the table that was created.



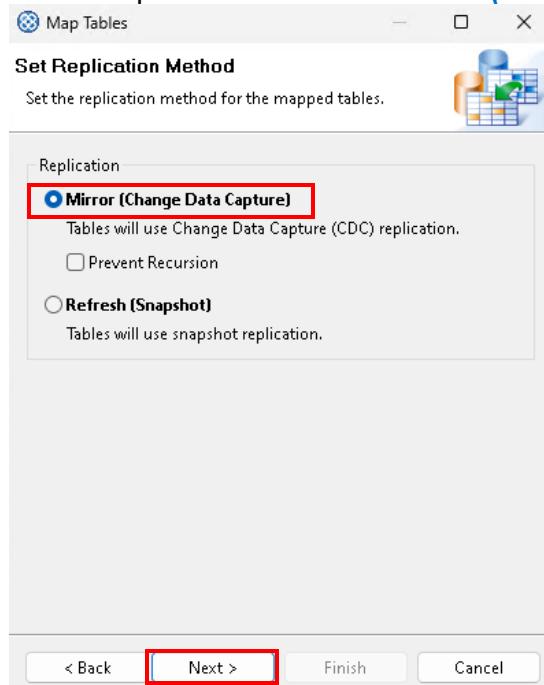
- \_\_14. The '**EMPLOYEE**' table should now be displayed under 'CDC' schema. Select it and click '**Next**'.



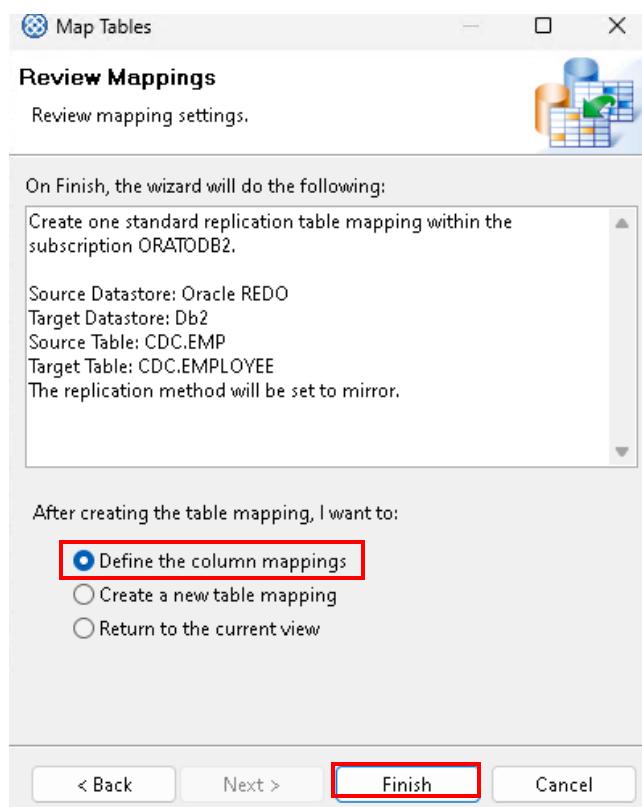
- \_\_15. Select '**Use an Index**' and choose the '**CDC.EMPLOYEE\_PK**' index from the drop down menu. Click '**Next**'.



- \_\_16. Set the replication method to '**Mirror (Change Data Capture)**' and click '**Next**'.



- \_\_17. Review the mapping settings and select '**Define the column mappings**' as the action to perform after mapping the tables. Click '**Finish**'.



#### 4.1.2 Configure the Column Mappings

- 18. You can view the mapping details in the bottom right panel of the ‘**Configuration**’ perspective. The details of the ‘**CDC.EMP → CDC.EMPLOYEE**’ mapping should be opened automatically.
- 19. Map the source column ‘**ID**’ to the target column ‘**EMP\_ID**’. To do this:
- a. Right click on the ‘**EMP\_ID**’ column and select ‘**Map Column...**’.

Source	Target Column	Initial Value
	<b>EMP_ID</b>	0
HIRE_DATE	FULL_NAME	
SALARY	HIRE_DATE	
	SALARY	
	BONUS_AMOUNT	
	STATUS	NULL

- b. A drop down menu will appear. Select the ‘**EMPLOYEE\_ID**’ column.

Source	Target Column
<b>EMPLOYEE_ID</b>	<b>EMP_ID</b>
BONUS_PCT	REAL
DEPARTMENT_ID	NUMBER (38)
<b>EMPLOYEE_ID</b>	<b>NUMBER (38)</b>
FIRST_NAME	VARCHAR2 (50)
HIRE_DATE	VARCHAR2 (50)
LAST_NAME	VARCHAR2 (50)
New Derived Column...	Ctrl D
New Expression...	Ctrl E

- 20. Similarly, map the source column ‘**STAT**’ to the target column ‘**STATUS**’.

Source	Target Column
EMPLOYEE_ID	EMP_ID
HIRE_DATE	FULL_NAME
SALARY	HIRE_DATE
STAT	<b>STATUS</b>
LAST_NAME	VARCHAR2 (50)
MANAGER_ID	NUMBER (38)
SALARY	NUMBER (38)
<b>STAT</b>	VARCHAR2 (50)
&CCID	

#### 4.1.3 Configure the Transformations

InfoSphere Change Data Capture has a number of built-in transformation functions and capabilities which allows you to perform in-flight transformations and translations on data as it is being replicated.

- \_\_21. The '**FULL\_NAME**' target column will be a concatenation of the '**FIRSTNAME**' and '**LASTNAME**' columns from the source. This will be accomplished using a Derived Expression.



**A Derived Expression** is an expression that defines the value placed in a column for each row inserted or updated in a target table.

To do this:

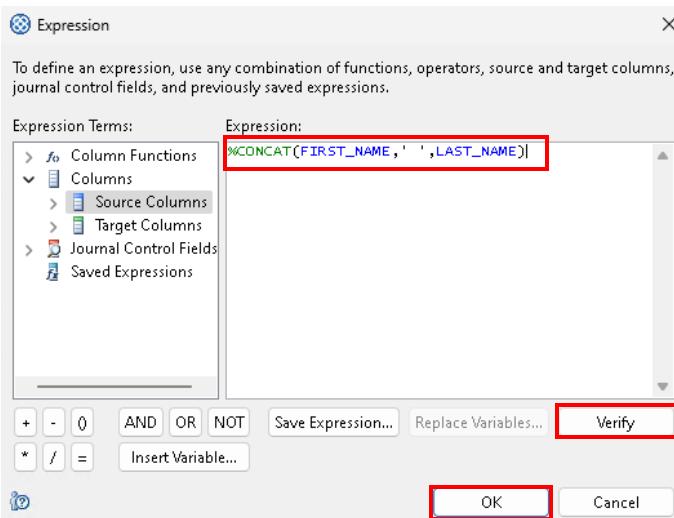
- \_\_a. Right-click on the '**FULL\_NAME**' column and select '**Map Column...**'.
- \_\_b. From the drop down, select '**New Expression**'.

Source-target column mappings:

Source	Target Column
EMPLOYEE_ID	EMP_ID
	FULL_NAME
BONUS_PCT	REAL
DEPARTMENT_ID	NUMBER (38)
EMPLOYEE_ID	NUMBER (38)
FIRST_NAME	VARCHAR2 (50)
HIRE_DATE	VARCHAR2 (50)
LAST_NAME	VARCHAR2 (50)
<b>New Derived Column...</b>	Ctrl D
<b>New Expression...</b>	Ctrl E

- \_\_c. Enter the following expression in the expression Field:

**%CONCAT(FIRST\_NAME, ' ', LAST\_NAME)**



- \_\_d. Click '**Verify**' to check the correctness of the expression. Click '**OK**' to accept the change.

\_\_22. The '**BONUS\_AMOUNT**' column will be a calculated value. This will be accomplished using a Derived Expression. To do this:

- \_\_a. Right-click on the '**BONUS\_AMOUNT**' column and select '**Map Column...**'.
- \_\_b. From the drop down, select '**New Expression**'.

Source-target column mappings:

Source	Target Column
EMPLOYEE_ID	EMP_ID
%CONCAT(FIRST_NAME,',LAST...	FULL_NAME
HIRE_DATE	HIRE_DATE
SALARY	SALARY
	BONUS_AMOUNT
<b>BONUS_PCT</b>	REAL
DEPARTMENT_ID	NUMBER (38)
EMPLOYEE_ID	NUMBER (38)
FIRST_NAME	VARCHAR2 (50)
HIRE_DATE	VARCHAR2 (50)
LAST_NAME	VARCHAR2 (50)
<b>New Derived Column...</b>	
<b>New Expression...</b>	

- \_\_c. Enter the following expression in the expression Field:

**BONUS\_PCT \* SALARY**

To define an expression, use any combination of functions, operators, source and target columns, journal control fields, and previously saved expressions.

Expression Terms:      Expression:

**BONUS\_PCT \* SALARY**

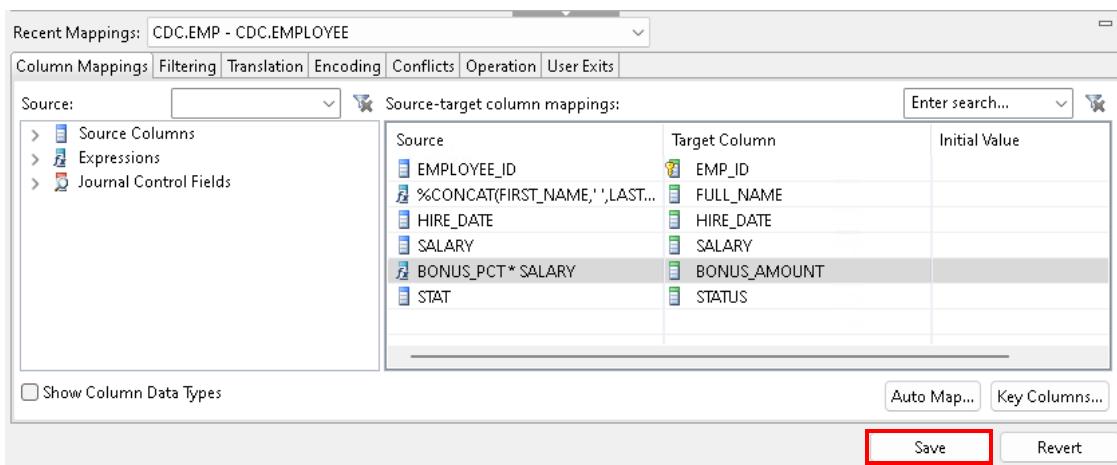
> **f0** Column Functions  
 < **Columns**  
   < **Source Columns**  
     EMPLOYEE\_ID  
     FIRST\_NAME  
     LAST\_NAME  
     HIRE\_DATE  
     **SALARY**  
     BONUS\_PCT  
     STAT  
   > **Target Columns**  
   > **Journal Control Fields**  
   > **Saved Expressions**

+ - 0 AND OR NOT Save Expression... Replace Variables... **Verify**  
 \* / = Insert Variable...

OK Cancel

- \_\_d. Click '**Verify**' to check the correctness of the expression. Click '**OK**'.

\_\_23. Your completed column mappings should look like below:



- \_\_24. Click the '**Save**' button to apply the changes.

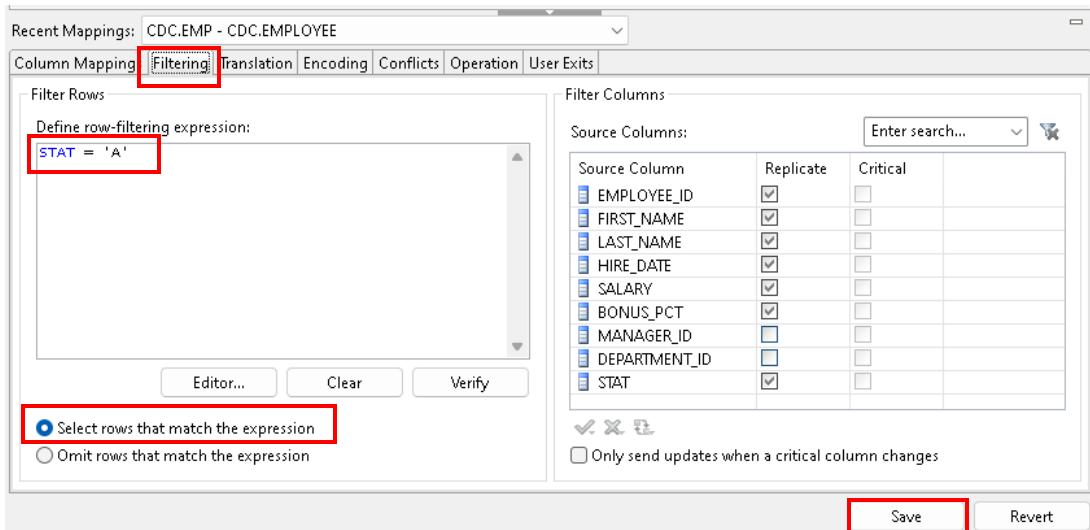
#### 4.1.4 Setup Filtering

InfoSphere Change Data Capture allows you to filter at the table, row and column level.

- \_\_25. In order to include or exclude particular rows for replication, we build a row-filtering expression. Select the '**Filtering**' tab. Under '**Filter Rows**' enter:

**STAT = 'A'**

Ensure that '**Select rows that match the expression**' is selected; this indicates that only active employee records will be replicated.

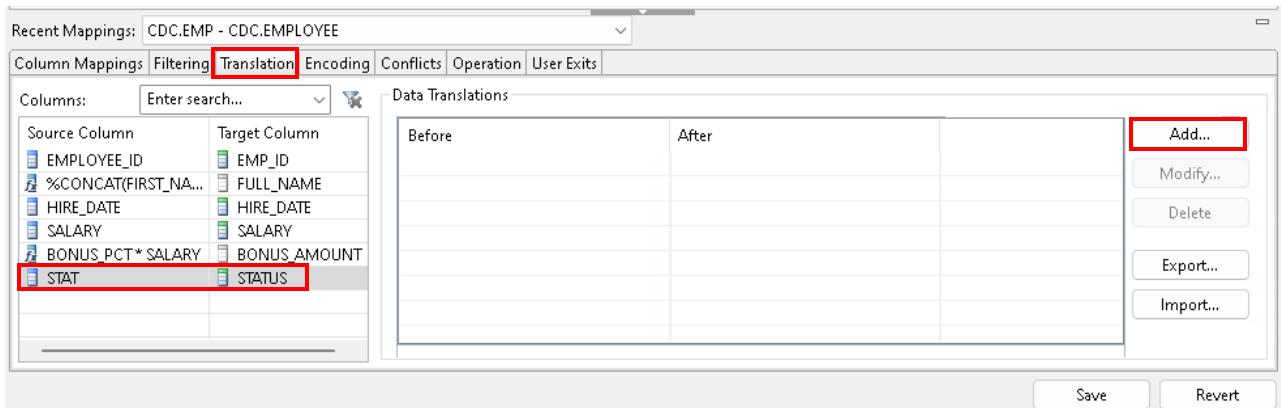


- \_\_26. Under '**Filter Columns**', notice that some columns such as '**MANAGER\_ID**' and '**DEPARTMENT\_ID**' column is de-selected. This column was de-selected earlier when mapping the table.

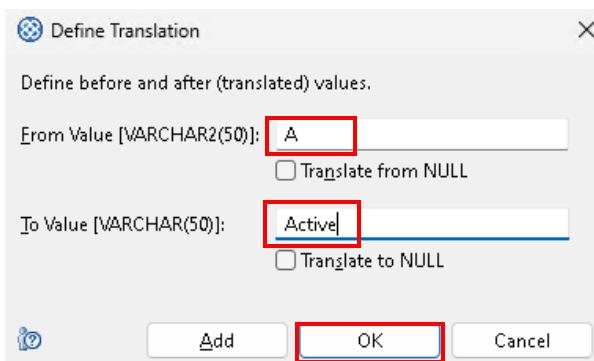
- \_\_27. Click the '**Save**' button to apply the changes.

#### 4.1.5 Setup Data Translations

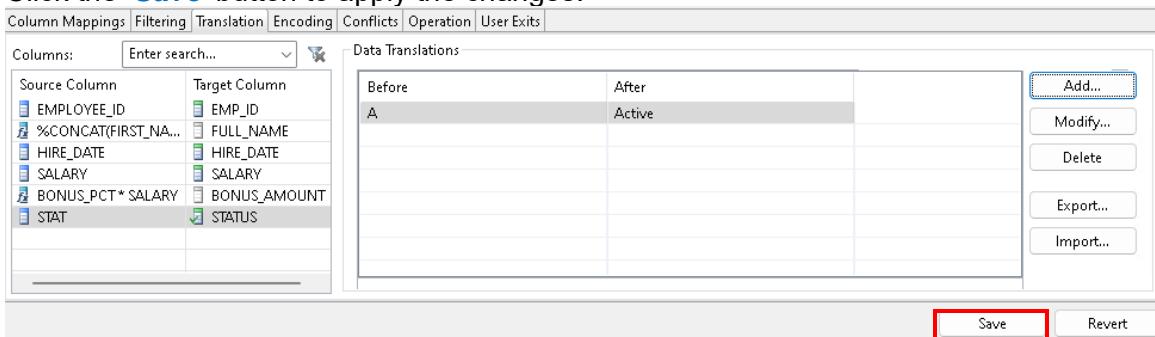
- 28. You can translate specific data in your source columns to new data in mapped target columns. Select the ‘**Translation**’ tab to view the data translation options.
- 29. We will translate the data in the source ‘STAT’ column to a more meaningful value when replicated to the target ‘STATUS’ column. Select the ‘**STAT**’ source column (‘**STATUS**’ target column) then click the ‘**Add...**’ button.



- 30. Enter From Value ‘**A**’ and To Value ‘**Active**’. Click ‘**OK**’.



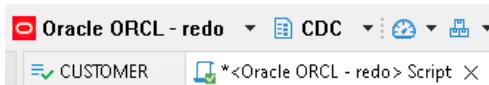
- 31. Click the ‘**Save**’ button to apply the changes.



## 4.2 Review the Source and Target Table Contents

Before starting the data replication process, take a moment to review the data in both the source and target tables

- \_\_32. Use the DBeaver tool to view the source Oracle tables. If you do not have it already opened then click on the Windows task bar icon . Make sure your SQL Query Script tab connected to **Oracle ORCL – redo** and **CDC** schema,

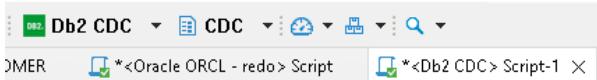


Execute the following SQL command to view the source table contents:

```
select * from emp;
```

	EMPLOYEE_ID	FIRST_NAME	LAST_NAME	HIRE_DATE	SALARY	BONUS_PCT	MANAGER_ID	DEPARTMENT_ID	STAT
1	145	John	Russell	10/1/2004	14,000	0.25	100	80	A
2	146	Karen	Partners	1/5/2005	13,500	0.3	100	80	A
3	147	Alberto	Errazuriz	3/10/2005	12,000	0.3	100	80	I
4	148	Gerald	Cambrault	10/15/2007	11,000	0.3	100	80	A
5	149	Eleni	Zlotkey	1/29/2008	10,500	0.2	100	80	A
6	150	Peter	Tucker	1/30/2005	10,000	0.3	145	80	I

- \_\_33. Use DBeaver to view the target DB2 tables using another SQL Query Script tab. Make sure your SQL Query Script tab connected to **Db2 CDC** and **CDC** Schema



Execute the following SQL command to view the target table contents:

```
select * from employee;
```

To run each command, highlight it and click the Execute icon  or press Ctrl+enter.

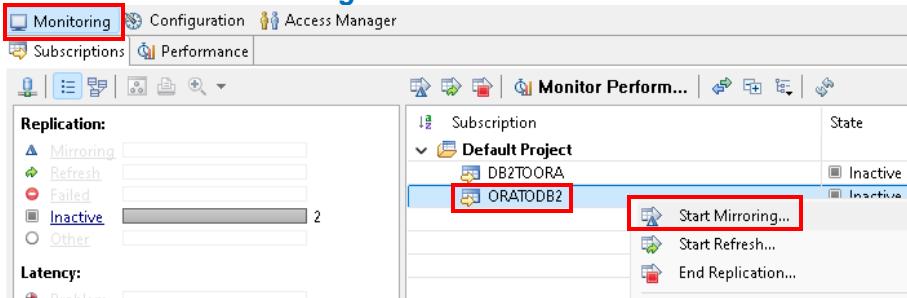
The Employee target table should be empty.

	EMP_ID	FULL_NAME	HIRE_DATE	SALARY	BONUS_AMOUNT	STATUS

- \_\_34. Leave these windows opened as they will be used later to enter and verify data.

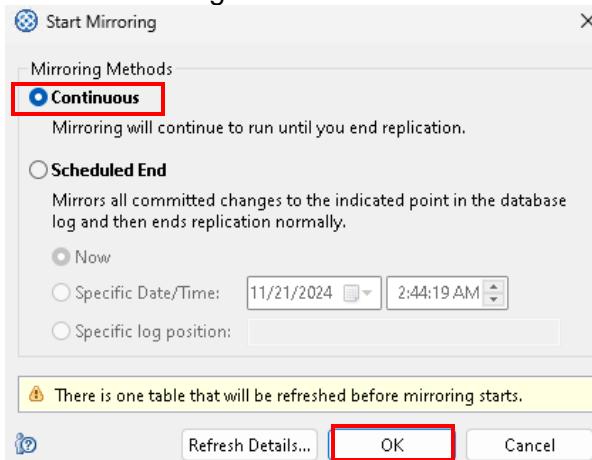
## 4.3 Starting Replication

- \_\_35. Under the '**Monitoring**' perspective, **Right-click** on the '**ORATODB2**' Subscription and select '**Start Mirroring...**'.



Choose '**Continuous**' as the method.'

Note that since the initial status of the '*EMP → EMPLOYEE*' table mapping was set to 'Refresh', when the subscription starts, the data is first pulled from the EMP source table and loaded to the EMPLOYEE target table. Click '**OK**' to start replication.



- \_\_36. Notice that the State changes from '*Inactive*' to '*Starting*' to '*Refresh Before Mirror*' to '*Mirror Continuous*'.

## 4.4 Testing Data Changes from Oracle to DB2

- \_\_37. Use DBeaver to verify the changes are replicated to the DB2 '*CDC.EMPLOYEE*' target table.

```
select * from employee
```

Your results should look like the following:

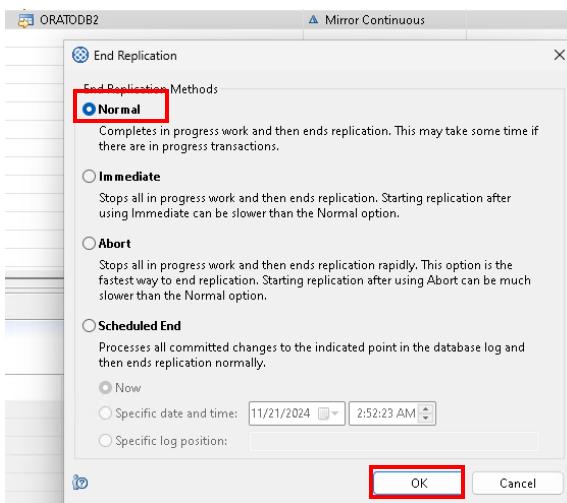
The screenshot shows the DBeaver interface. At the top, there is a SQL editor window with the query: `SELECT * FROM EMPLOYEE e`. Below it is a results grid titled "EMPLOYEE 1 X". The results grid displays the following data:

	EMP_ID	FULL_NAME	HIRE_DATE	SALARY	BONUS_AMOUNT	STATUS
1	145	John Russell	10/1/2004	14,000	3,500	Active
2	146	Karen Partners	1/5/2005	13,500	4,050	Active
3	148	Gerald Cambrault	10/15/2007	11,000	3,300	Active
4	149	Eleni Zlotkey	1/29/2008	10,500	2,100	Active
5	151	David Bernstein	3/24/2005	9,500	2,375	Active
6	152	Peter Hall	8/20/2005	9,000	2,250	Active

- 38. Now other tab of DBeaver to make changes to the source Oracle 'EMP' table.  
Make sure that you commit the changes.  
For example:

```
update emp set first_name='<Your Name>' where Employee_ID=145;
commit;
```

- 39. Verify that the changes are made to the target DB2 'EMPLOYEE' table.
- 40. When you are finished testing, please stop replication.  
From the '[Monitoring](#)' perspective,  
[Right-click on the 'ORATODB2' Subscription](#) and select '[End Replication...](#)'.  
Select '[Normal](#)' as the end replication method and Click '[OK](#)'.



## 4.5 Summary

You have now configured replication between two different table structures using a customized table mapping which includes filtering, transformations and data translations. This was all easily accomplished through the InfoSphere Change Data Capture Management Console with minimal effort so that you can reduce the time and effort it takes for implementation and deploy faster.

InfoSphere Change Data Capture has a rich set of features designed so that you can tailor your replication configuration to suit your business requirements and goals.

## Lab 5 Auditing Changes using LiveAudit™

With increasing government and industry regulations, JKLW cannot just hope that they comply with the rules. Rather, their existence depends on it. They require a complete, accurate, and up-to-date view of their company's critical data so they can detect and monitor critical data changes quickly and react accordingly. They need a surefire way to prove to internal or external auditors that their electronic records are reliable and accurate. They have to accomplish this even though corporate data is spread out across different databases.

As a requirement, we need to audit and monitor changes made to customer data which resides in an Oracle database at one of our insurance branches. With minimal impact to the source operational system, the audit trail needs to be replicated to our head office IBM DB2 database for monitoring, reporting and risk management.

IBM InfoSphere Change Data Capture has a built-in LiveAudit™ feature which captures additions, modifications or deletions of data generated by a source system and creates a real-time audit trail of these changes in a relational database.

As inserts, updates or deletes are detected on the source, through the database logs, the LiveAudit mode of replication will replicate these changes along with additional information about each record change. The additional information is optional and can include information such as the database user who made the change, the operation type, which will describe if the change was an insert, update or delete, the time of update on the source, among various other information. These changes will be replicated to a target audit table as inserts. Thus, a new row or rows will be inserted in the target audit table every time there is an insert, update or delete that occurs in the source table.

We will be using the LiveAudit mode of replication to capture changes made to a source Oracle table and create an audit trail in a target DB2 table.

**As a prerequisite, you will need to complete Lab 1 before doing this exercise.**

In this lab, you will:

- Understand and configure the LiveAudit mode of replication
- Learn how to use Journal Control fields to provide additional information about each record change

### 5.1 Configuring LiveAudit Replication from Oracle to DB2

#### 5.1.1 Defining a Subscription from Oracle to DB2

- 1. If you have not already done so, start the InfoSphere Change Data Capture Management

Console by clicking the '*InfoSphere CDC Management Console*' icon  on windows Task bar. Authenticate with user name '**Admin**' and password '**passw0rd**' and click: '**Login**'. Leave the values for server name (cdc01.de.ibm.com) and port number (10101) unchanged.

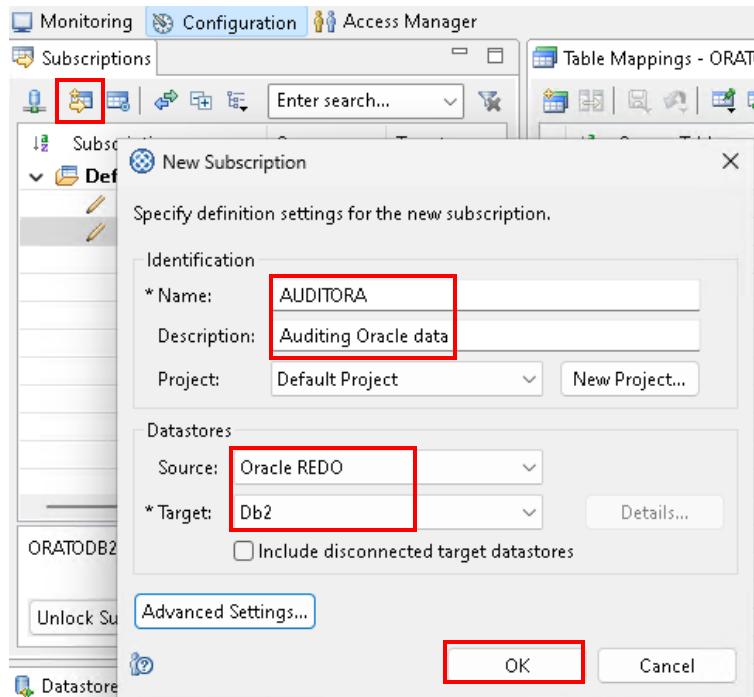
- \_\_2. Select the '**Configuration**' perspective. Under the '*Subscription*' view, click on the icon to '**Create a new subscription**'.
- \_\_3. Create a new Subscription with:

Name: **AUDITORA**

Description: **Auditing Oracle data**

Source: **Oracle REDO**

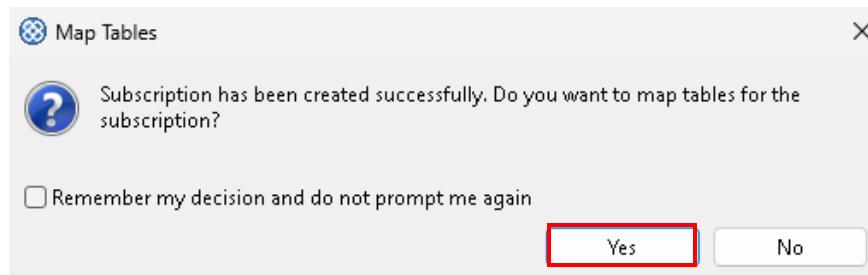
Target: **Db2**



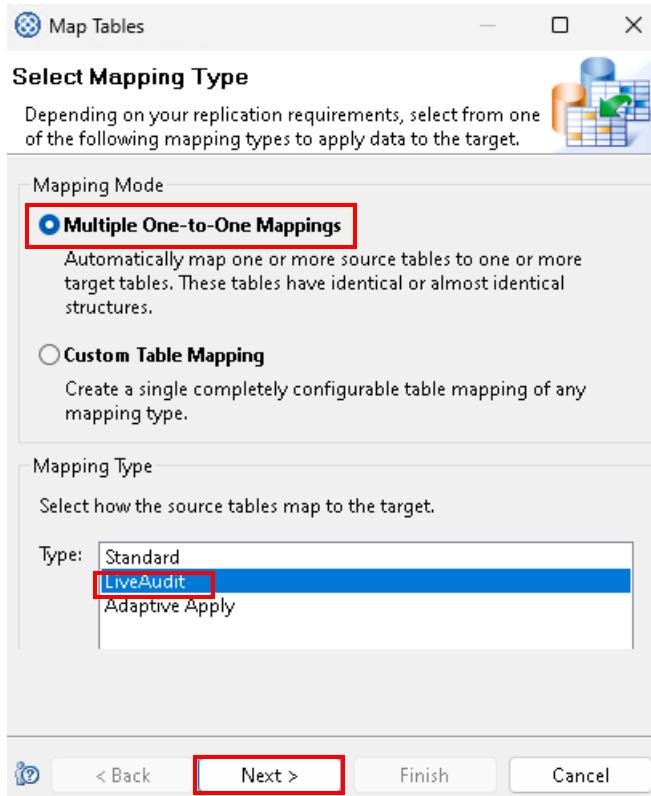
- \_\_4. Click '**OK**'. A new Subscription 'AUDITORA' is created.

### 5.1.2 Mapping your Tables

- \_\_5. Click **Yes** to Map '*Map Tables...*'.



- 6. Select **Multiple One-to-One Mappings**  
 Mapping Type '**LiveAudit**' and click '**Next**'.



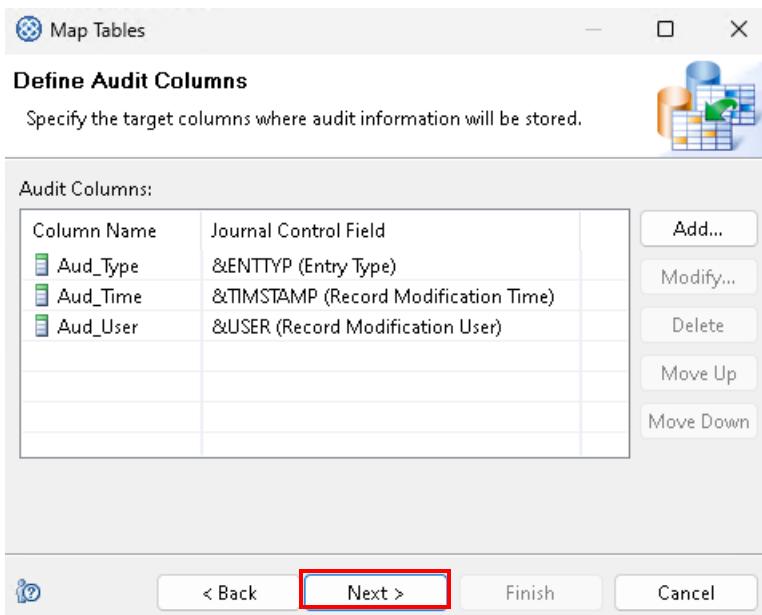
- 7. Here you can define additional audit columns that will be added to each record change.  
 These columns will include information from a variety of Journal Control fields.

**Journal Control Fields** are a set of fields that contain different information about the database log entry associated with a source table change.

i

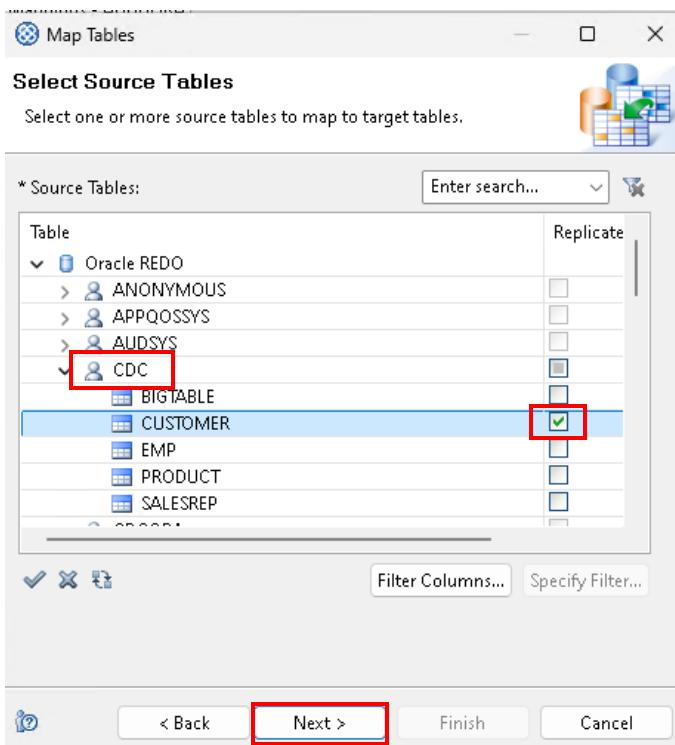
Journal control fields can be assigned to target columns, as database log entry information is replicated with source table data. In the Management Console, journal control fields are denoted with an ampersand (&) before the name of the field.

By default, the operation type (&ENTTYP), update time (&TIMESTAMP), and user (&USER) information are added as additional columns to each row.  
 This is additional information which can be used to further identify each source record change.

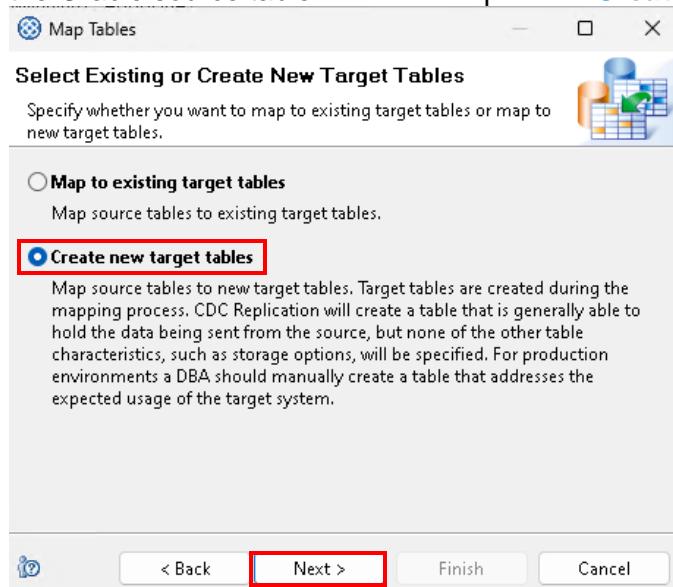


\_\_8. Click '**Next**'.

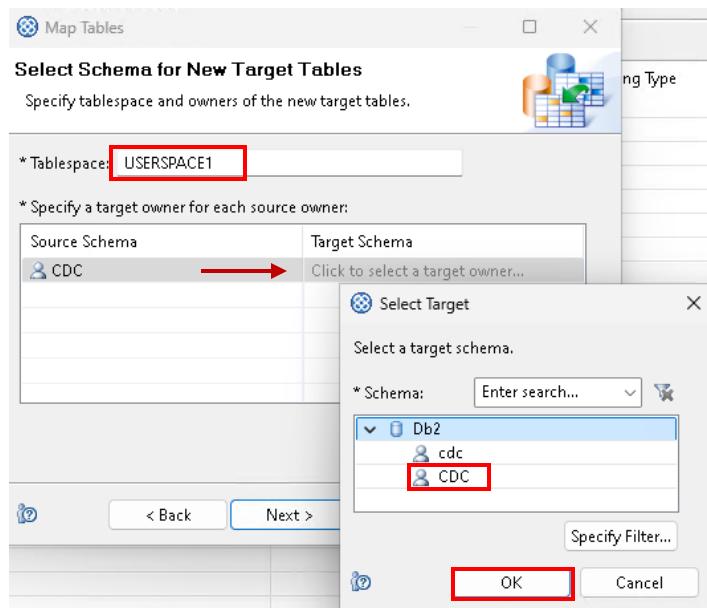
\_\_9. Select the source table that you will be replicating from. Expand the schema '**CDC**' and select table '**CUSTOMER**'. Click '**Next**'.



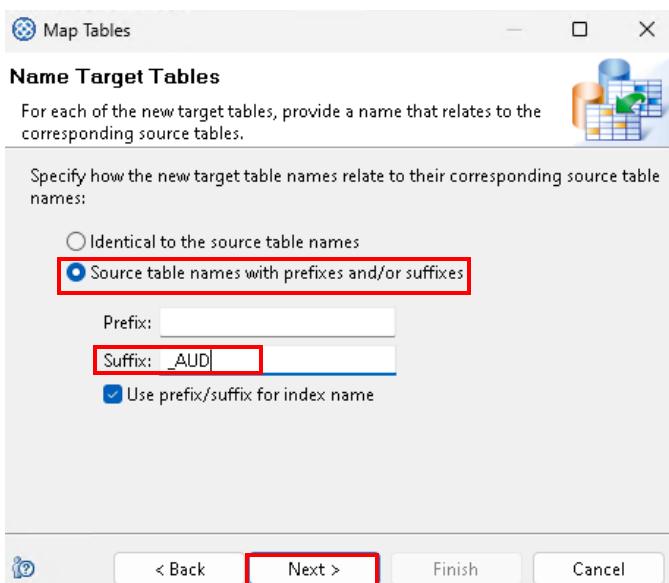
- \_\_10. You will be creating a new target table in DB2 which will be used to audit the changes made in the Oracle source table. Select the option to '[Create new target tables](#)' and click '[Next](#)'.



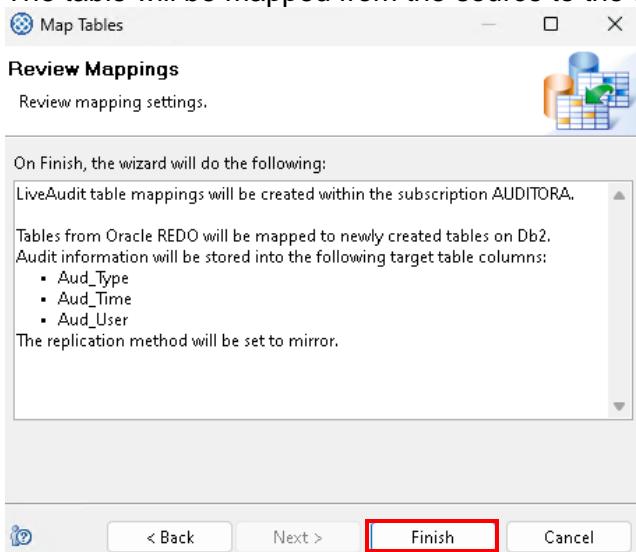
- \_\_11. For the Tablespace enter '[USERSPACE1](#)'. Under the Target Schema column, click the text '[Click to select a target owner](#)' and select '[CDC](#) (CAPITAL Letter). Click '[OK](#)' and then '[Next](#)'.



- \_\_12. For the new target table, we will use the source table name and add a suffix '[\\_AUD](#)'.



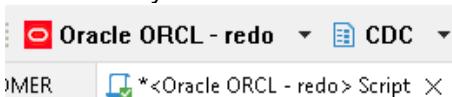
- 13. Click '**Next**'. Review the mapping settings and click '**Finish**'.  
The table will be mapped from the source to the target for this Subscription.



## 5.2 Review the Source and Target Table Contents

Before starting the data replication process, take a moment to review the data in both the source and target tables.

- 14. Use the DBeaver to view the source Oracle tables.  
Make sure you connected to Oracle database in the SQL Query script tab



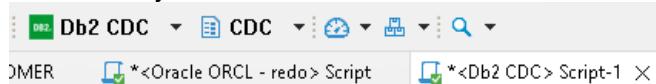
Execute the following SQL command to view the source table contents:

```
select * from customer;
```

	CUSTNO	BRANCH	NAME1	NAME2	ADDRESS1	ADDRESS2	CITY	STATE	STATUS	CRLIMIT	BALANCE
1	555,972	11	DATAMIRROR		2500 DANFORTH AVE.	SUITE 300	DES MOINES	IA	A	8,500	
2	556,572	11	DATAMIRROR		2500 DANFORTH AVE.	SUITE 300	DES MOINES	IA	A	8,500	
3	556,672	11	DATAMIRROR		2500 DANFORTH AVE.	SUITE 300	DES MOINES	IA	A	8,500	
4	556,907	11	DATAMIRROR		403 CLEMENTS RD. W.		OAKLAND	CA	A	4,500	4,
5	556,996	11	DATAMIRROR		346 NEWKIRK RD.		DULUTH	GA	A		500

- 15. Still use DBeaver to view the target DB2 tables.

Make sure you connected to DB2 database in the SQL Query script tab



Execute the following SQL command to view the target table contents (it should be empty)

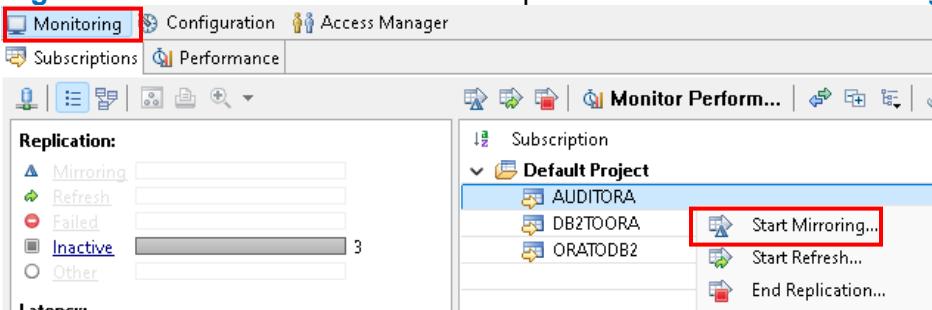
```
select * from customer_aud
```

	CUSTNO	BRANCH	NAME1	NAME2	ADDRESS1	ADDRESS2	CITY	STATE	STATUS	CRLIMIT	BALANCE

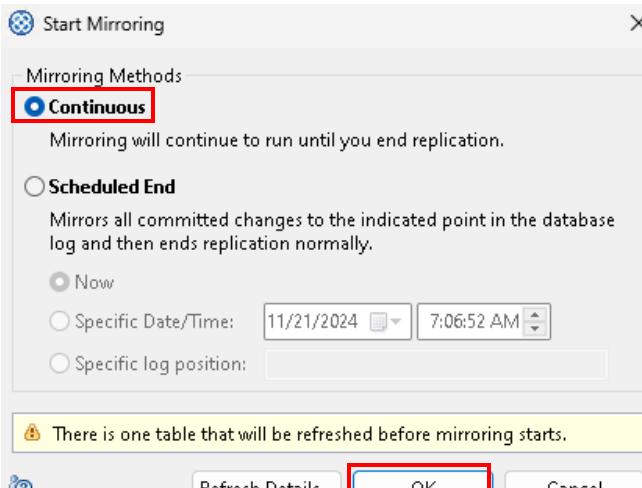
- 16. Leave these windows opened as they will be used later to enter and verify data.

## 5.3 Start Replication and Verify that Changes are Audited

- 17. Under the '**Monitoring**' perspective,  
**Right-click** on the '**AUDITORA**' Subscription and select '**Start Mirroring...**'.

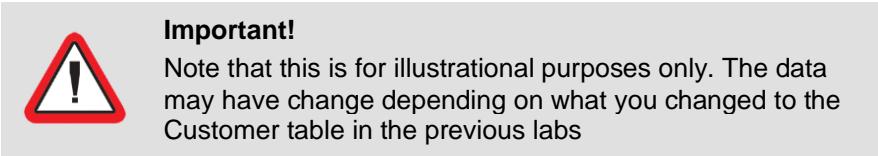


Choose '**Continuous**' as the method and click '**OK**' to start replication.



Note that since the initial status of the '*CUSTOMER → CUSTOMER\_AUD*' table mapping was set to 'Refresh', when the Subscription starts, the data is first pulled from the source and loaded to the target table.

- 18. Notice that the State changes from '*Inactive*' to '*Starting*' to '*Refresh Before Mirror*' to '*Mirror Continuous*'.
- 19. Go back to Dbeaver to verify the changes are replicated to the DB2 '*CUSTOMER\_AUD*' target table. The results should like something like the following:



Customer_Aud 1																
SELECT * FROM CUSTOMER_AUD c9																
Customer_Aud 1 X																
<input checked="" type="radio"/> 123 CUSTNO ▾ A-Z BRANCH ▾ A-Z NAME1 ▾ A-Z NAME2 ▾ A-Z ADDRESS1 ▾ A-Z ADDRESS2 ▾ A-Z CITY ▾ A-Z STATE ▾ A-Z STATUS ▾ 123 CRLIMIT ▾ 123 BALANCE ▾ 123 REPNO ▾ A-Z Aud_Type ▾ A-Z Aud_Time ▾ A-Z Aud_User																
1	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	2500 DANFORTH AVE SUITE 300	DES MOINES	IA	A	8,500	500	651	RR	1-21-16.08.28.041000	NOT SET	
2	555,972	11	DATAMIRROR									651	RR	1-21-16.08.28.041000	NOT SET	
3	556,572	11	DATAMIRROR			2500 DANFORTH AVE SUITE 300	DES MOINES	IA	A	8,500	500	651	RR	1-21-16.08.28.041000	NOT SET	
4	556,672	11	DATAMIRROR			2500 DANFORTH AVE SUITE 300	DES MOINES	IA	A	8,500	500	651	RR	1-21-16.08.28.041000	NOT SET	
5	556,907	11	DATAMIRROR			403 CLEMENTS RD. W	OAKLAND	CA	A	4,500	4,000	251	RR	1-21-16.08.28.041000	NOT SET	
6	556,996	11	DATAMIRROR			346 NEWGRK RD.	DULUTH	GA	A	500	0	651	RR	1-21-16.08.28.041000	NOT SET	

As a result of the initial Refresh operation, the 'CDC.CUSTOMER\_AUD' table should:

- Have the same structure as the source 'CUSTOMER' table plus three additional audit columns (Aud\_Type, Aud\_Time and Aud\_User) at the end
- Contain one record for the Refresh Start (Aud\_Type = 'RS') entry type
- Contain individual Refresh Records (Aud\_Type = 'RR") which have been refreshed from the source

\_\_20. Now use DBeaver to insert, update and delete records from the source Oracle 'CUSTOMER' table. Run below 3 syntax one by one, make sure that you commit the changes. For example:

```
Insert into CDC.customer
(CUSTNO, BRANCH, NAME1, NAME2, ADDRESS1, ADDRESS2, CITY, STATE, STATUS,
CRLIMIT, BALANCE, REPNO)
VALUES(111111, '11', '<your name>', 'AUDIT NAME', 'AUDIT Address',
'Street', 'Jakarta', 'NA', 'A', 0, 0, 0);

update CDC.customer set name1='IBM' where custno=111111;

delete from CDC.customer where custno=111111;

commit;

INSERT INTO CDC.CUSTOMER
(CUSTNO, BRANCH, NAME1, NAME2, ADDRESS1, ADDRESS2, CITY, STATE, STATUS, CRLIMIT, BALANCE, REPNO)
VALUES(111111, '11', 'Ronny', 'AUDIT NAME', 'AUDIT Address', 'Street', 'Jakarta', 'NA', 'A', 0, 0, 0);

update CDC.customer set name1='IBM' where custno=111111;

delete from CDC.customer where custno=111111;

commit;
```

\_\_21. View that the changes are made to the target DB2 'CUSTOMER\_AUD' table. For example:

CUSTOMER_AUD 1																
SELECT * FROM CUSTOMER_AUD ca ORDER BY "Aud_Time" DESC																
Enter a SQL expression to filter results (use Ctrl+Space)																
①	CUSTNO	AZ BRANCH	AZ NAME1	AZ NAME2	AZ ADDRESS1	AZ ADDRESS2	AZ CITY	AZ STATE	I23 CRLIMIT	I23 BALANCE	I23 REPNC	Az Aud_Type	O Aud_Time	Az Aud_User		
1	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	[NULL]	NOT SET
2	111,111	11	IBM	AUDIT NAME	AUDIT Address	Street	Jakarta	NA	A	0	0	0	DL	2024-11-21-16.21.13.000000	SYSTEM	
3	111,111	11	Ronny	AUDIT NAME	AUDIT Address	Street	Jakarta	NA	A	0	0	0	UB	2024-11-21-16.20.25.000000	SYSTEM	
4	111,111	11	IBM	AUDIT NAME	AUDIT Address	Street	Jakarta	NA	A	0	0	0	UP	2024-11-21-16.20.25.000000	SYSTEM	
5	111,111	11	Ronny	AUDIT NAME	AUDIT Address	Street	Jakarta	NA	A	0	0	0	PT	2024-11-21-16.16.30.000000	SYSTEM	
6	555,972	11	DATAMIRROR		2500 DANFORTH AVE.	SUITE 300	DES MOINES	IA	A	8,500	500	651	RR	2024-11-21-16.08.28.841000	NOT SET	
7	556,672	11	DATAMIRROR		2500 DANFORTH AVE.	SUITE 300	DES MOINES	IA	A	8,500	500	651	RR	2024-11-21-16.08.28.841000	NOT SET	
8	556,672	11	DATAMIRROR		2500 DANFORTH AVE.	SUITE 300	DES MOINES	IA	A	8,500	500	651	RR	2024-11-21-16.08.28.841000	NOT SET	
9	556,907	11	DATAMIRROR		403 CLEMENTS RD. W.		OAKLAND	CA	A	4,500	4,000	251	RR	2024-11-21-16.08.28.841000	NOT SET	

**You will notice that all the insert, update and delete operations made in the source table were applied as inserts to the target table.** Also notice the following:

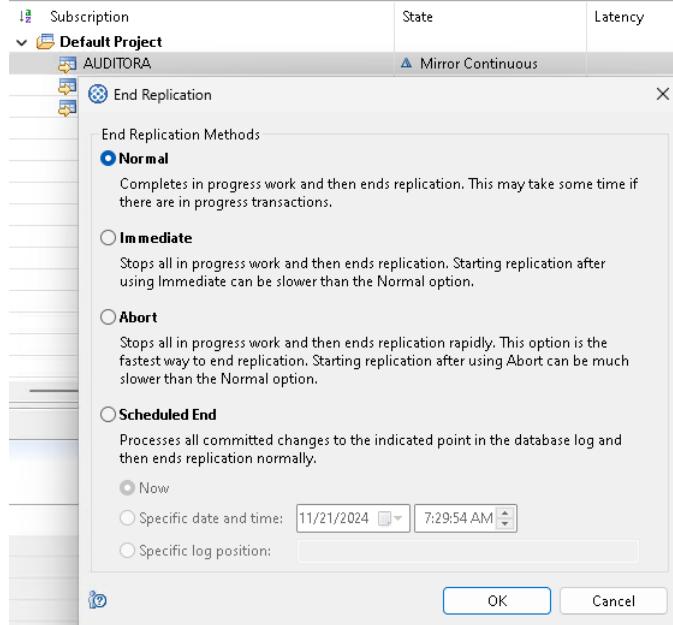
- There is one record for each insert operation and the entry type is identified by as Aud\_Type = 'PT'
- There are two records for each update operation, one for the update before image (Aud\_Type = 'UB') and one for the update after image (Aud\_Type = 'UP')
- There is one record for each delete operation (Aud\_Type = 'DL')
- The user (Aud\_User) that made the change was the Oracle 'SYSTEM' user that DBeaver automatically logged you on as
- The time (Aud\_Time) that the change was made on the source table

## 22. When you are finished testing, please stop replication.

From the '[Monitoring](#)' perspective,

Right-click on the '[AUDITORA](#)' Subscription and select '[End Replication...](#)'.

Select 'Normal' as the end replication method and click '[OK](#)'.



## 5.4 Summary

You have now configured LiveAudit replication to capture changes made in a source system and to produce an up-to-date audit trail of those changes.

The audit trail can be used to monitor suspicious activity, improve accountability and ensure compliance with industry regulations.

The audit trail could also be consumed by other processes and components of a solution.

For instance the audit trail can also be used to feed real-time changes to an ETL tool for further processing. This can add tremendous value for companies who are challenged with shrinking batch windows and resource intensive data extraction processes, because InfoSphere Change Data Capture is able to capture and audit just the changes from a source system into a staging table which can then be continuously read by any ETL tool with minimal impact to source production systems.

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## Lab 6 Replicating Data to Kafka in Real Time

At JKLW, our high transactional operational database systems are faced with significant data volume growth and we are challenged with our existing batch oriented data extraction process and changed data delivery requirements to our enterprise data warehouse (EDW). Using our traditional means of data extraction, we need to quiesce the source operational database, extract all the information and compare it with a previous copy to find the changed data and this takes a significant amount of time which contributes to an already 6 hours batch window. In addition, the operational database is not available during the extraction process; this impacts the timeliness of reporting; we are missing service level agreements to our lines of business and impacting the resource utilization of critical systems.

We need to reduce the batch window and simplify the current EDW data integration and delivery architecture. Changes to our source operational data system need to be captured in real-time with minimal impact and delivered in a format which can be easily consumed by any ETL tool which can further enhance and enrich the data that will be populated to our EDW.

Using IBM InfoSphere Change Data Capture, I am able to capture changes from any number of relational database systems and deliver those changes not only to other relational databases, but also to Kafka, message queues or flat files which can be consumed by ETL Tools such as IBM DataStage

In this Lab, you will only be responsible for capturing changes to the SALESREP table from the operational system and replicating those changes to Kafka. It can then be potentially consumed by any downstream business process or ETL tool for further processing.

In this lab, you will:

- Learn how to configure replication to Kafka topic
- Continuously mirror changes from a table to Kafka topic

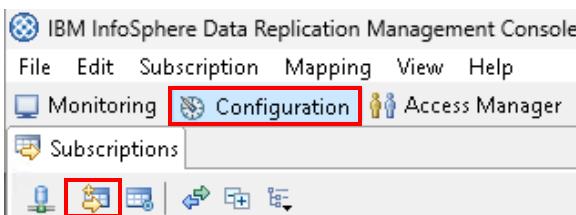
## 6.1 Configuring Replication to Kafka

### 6.1.1 Defining a Subscription from DB2 to Kafka

- 1. If you have not already done so, start the InfoSphere Change Data Capture Management Console by clicking the '*InfoSphere CDC Management Console*' icon  on the Windows Task bar. Authenticate with user name '**Admin**' and password '**passw0rd**' and click: '**Login**'. Leave the values for server name (cdc01.de.ibm.com) and port number (10101) unchanged.
- 2. Once connected, notice that the user Admin also has access to the '*Kafka*' Datastore. This Datastore will be used as a target of replication and, as changes are replicated to it, it will apply the changes to kafka topic. The '*Db2*' Datastore, will be used as a source of replication.

Datastores		
	Database	Type
Db2	DB2 for LUW	Dual
Flatfile	IBM InfoSphere DataStage	Target
Informix	IBM Informix Dynamic Server	Dual
Kafka	Kafka	Target
Oracle REDO	Oracle	Dual
Oracle XStream	Oracle - XStream	Dual
PostgreSQL	PostgreSQL	Dual

- \_\_3. Click on the '**Configuration**' perspective.  
Under the '**Subscription**' view,  
click on the icon to '**Create a new subscription**'.



- \_\_4. Create a new Subscription with:

Name: **DB2TOKFK**

Description: **DB2 to Kafka**

Source: **Db2**

Target: **Kafka**

The screenshot shows the 'New Subscription' dialog box. The 'Identification' section has 'Name' set to 'DB2TOKFK' and 'Description' set to 'DB2 to Kafka'. The 'Datastores' section has 'Source' set to 'Db2' and 'Target' set to 'Kafka'. The 'OK' button at the bottom right is highlighted with a red box.

Identification	
* Name:	DB2TOKFK
Description:	DB2 to Kafka
Project:	Default Project

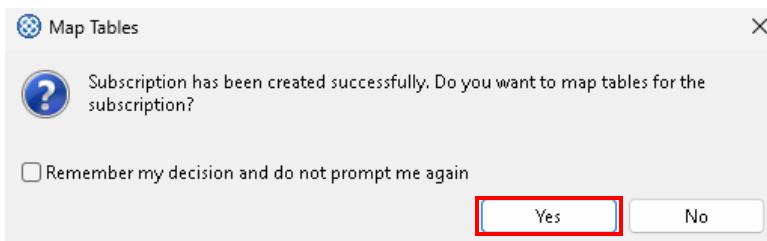
Datastores	
Source:	Db2
* Target:	Kafka
<input type="checkbox"/> Include disconnected target datastores	

OK Cancel

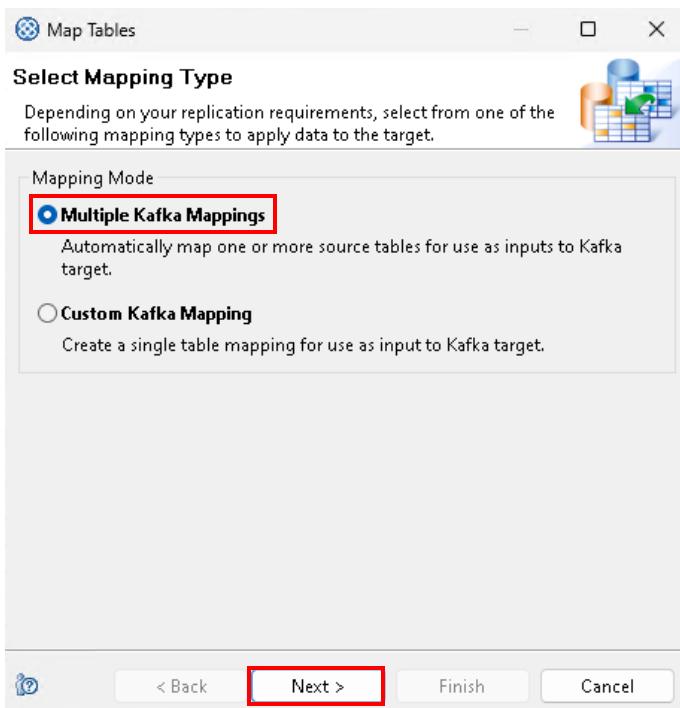
- \_\_5. Click '**OK**'. A new Subscription '**DB2TOKFK**' is created.

### 6.1.2 Mapping your Tables to Kafka

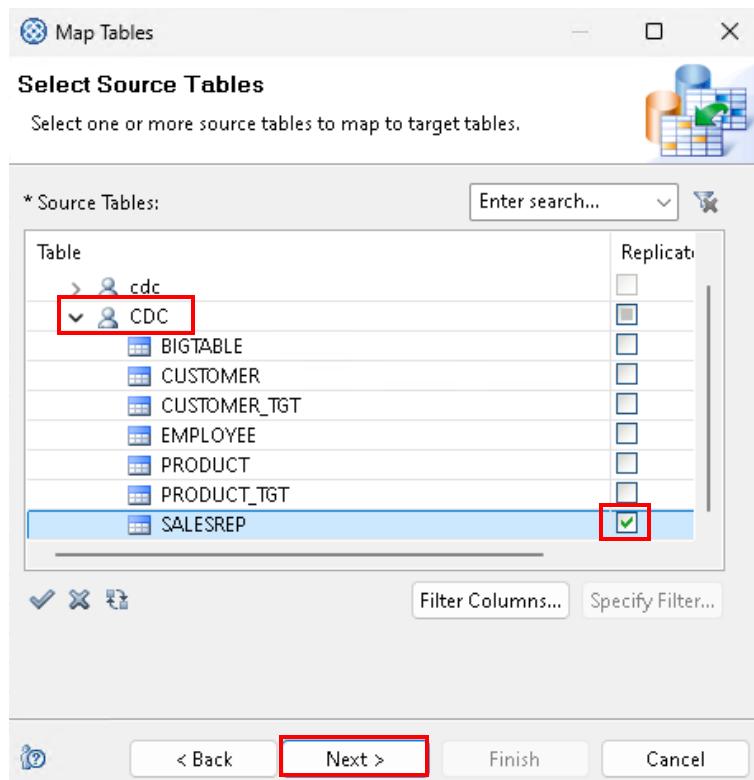
- 6. Click **Yes** on the dialog box to ‘Map Tables…’.



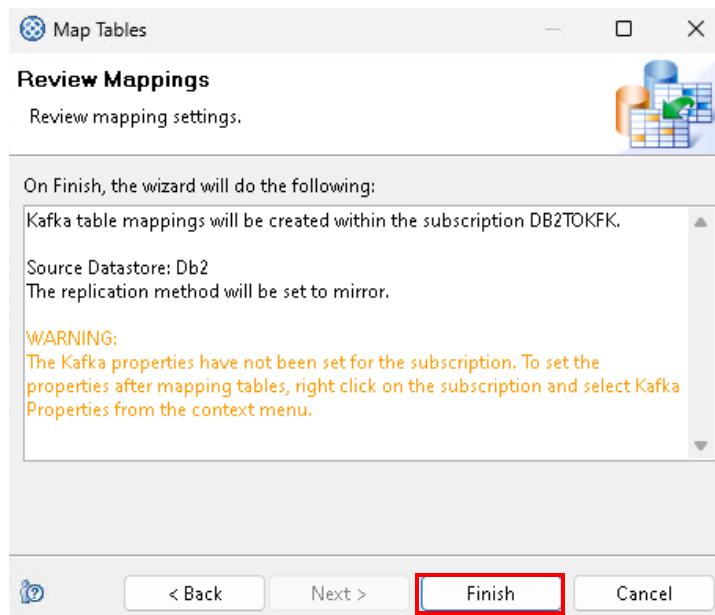
- 7. Select ‘**Multiple Kafka Mappings**’ and click ‘**Next**’.



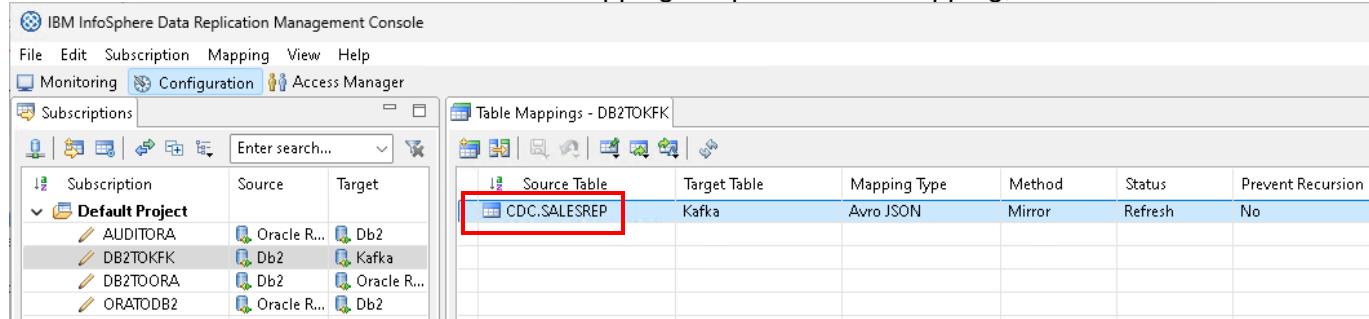
- 8. Select the source DB2 table that you will be replicating from. Expand the schema ‘**CDC**’ (CAPITAL LETTER) and select the table ‘**SALESREP**’ and then click ‘**Next**’.



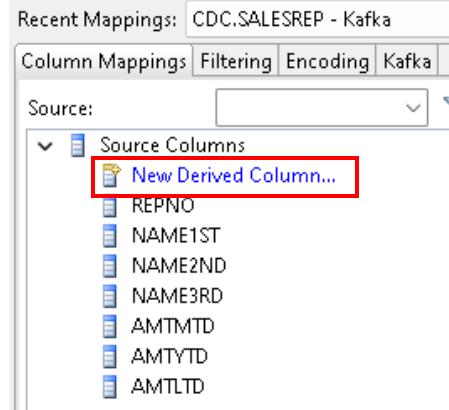
- 9. Review the mappings, notice that there is a warning shown that we need to setup the Kafka properties, we will set this up in the next step, for now just click '[Finish](#)'.



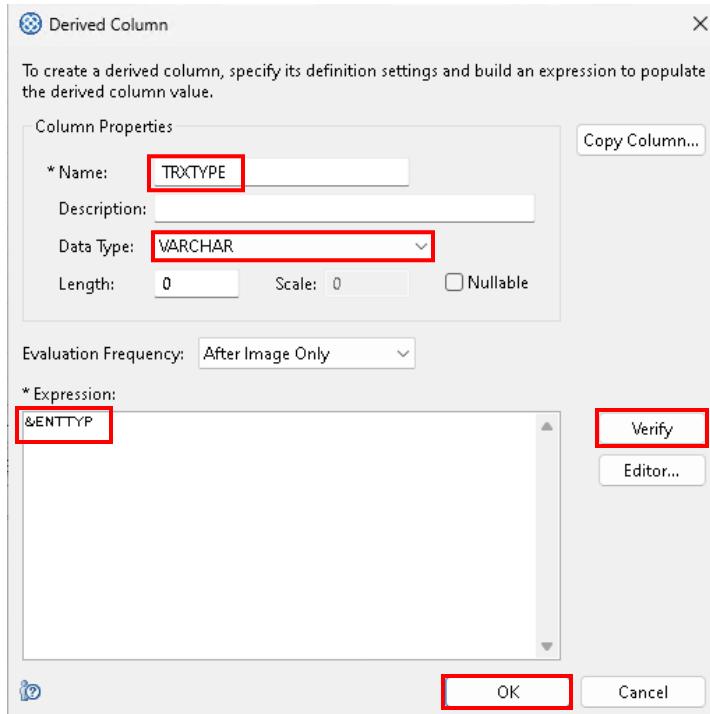
10. Double click the CDC.SALESREP Table mapping to open column mapping,



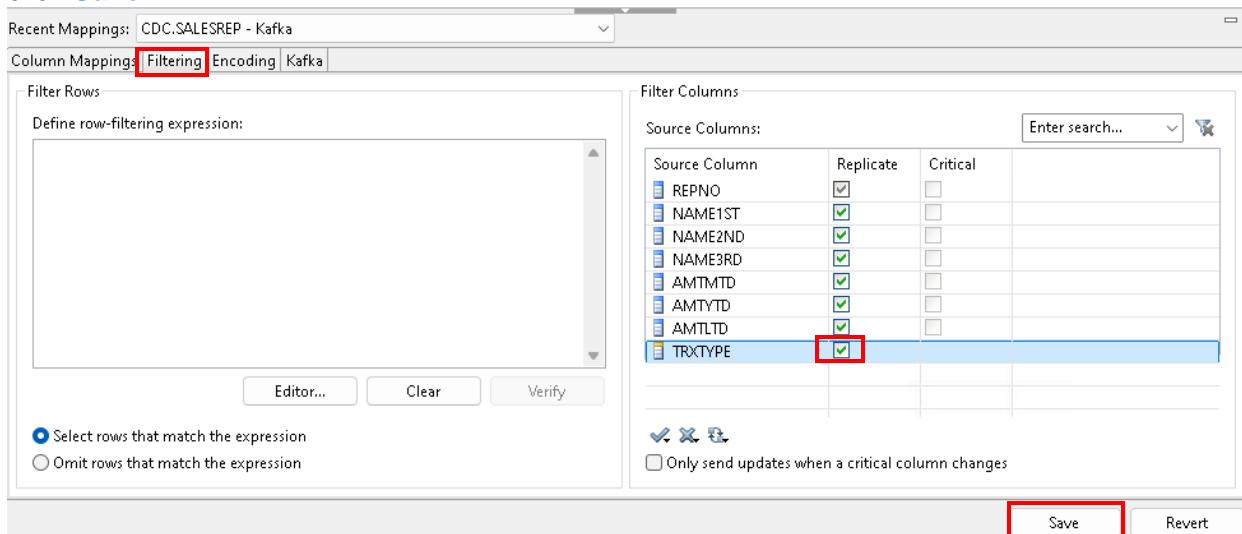
11. Double Click New Derived Column



- \_\_12. When Derived Column dialog box open,  
 fill the name with **TRXTYPE**  
 Data Type select **VARCHAR**  
 input **&ENTTYP** (*this is journal entry types that provide information about the entry*).  
 Click **Verify**, and Click **OK**



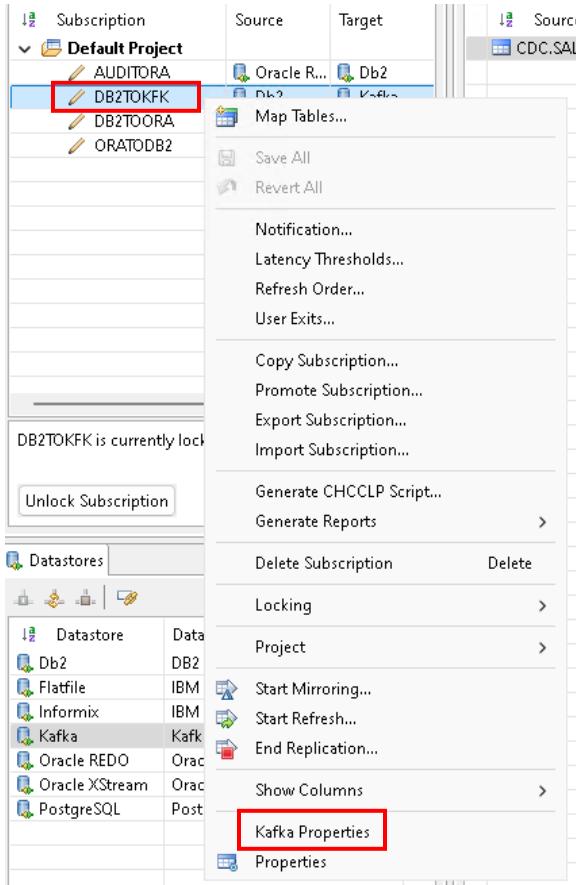
- \_\_13. Now make sure that the new derived column will be replicated  
 click **Filtering** tab  
**check the new TRXTYPE derived column** to be replicated  
 click **Save**



- \_\_14. At this point, we have created subscription from the 'CDC.SALESREP' table to Kafka.

### 6.1.3 Configure the Kafka Properties

- 15. To set the Kafka properties,  
**Right-click** the Subscription ‘**DB2TOKFK**’  
and select ‘**Kafka Properties**’.



- 16. Kafka Properties dialog box will pop up, fill below information

#### ZooKeeper Server

Host Name: **cdc01.de.ibm.com**

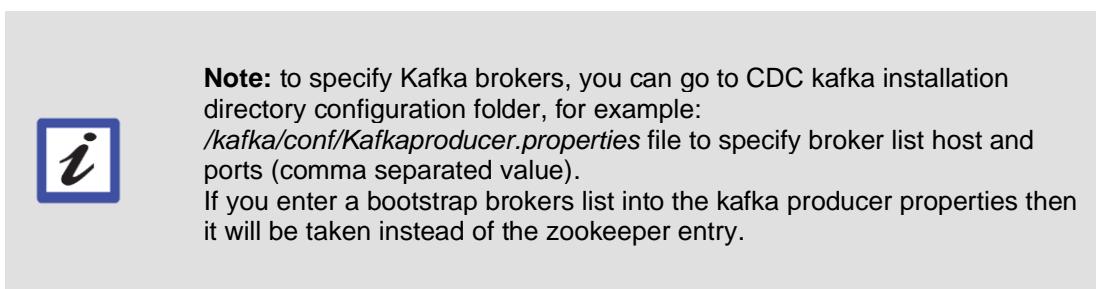
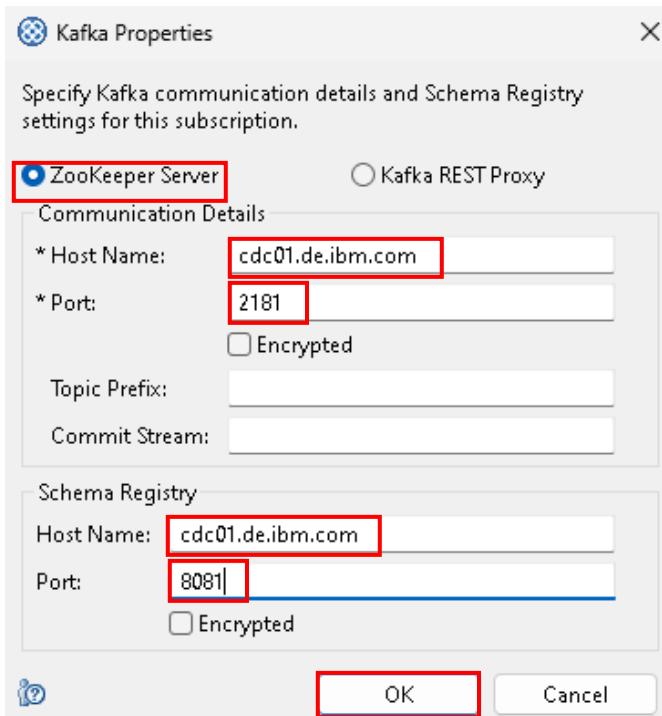
Port: **2181**

#### Schema Registry

Host Name: **cdc01.de.ibm.com**

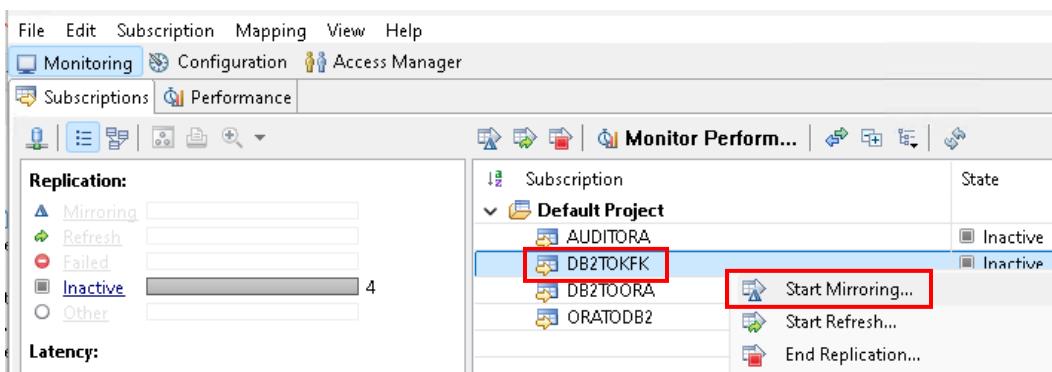
Port: **8081**

Then Click '**OK**'

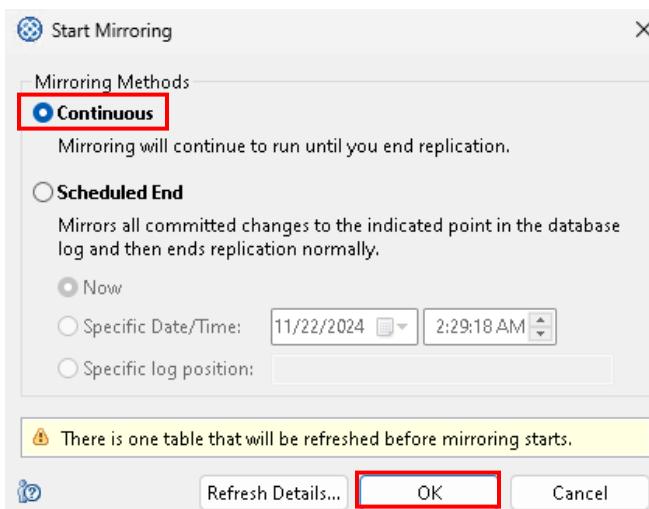


## 6.2 Starting Replication

- 17. Under the '**Monitoring**' perspective, Right-click on the '**DB2TOKFK**' Subscription and select '**Start Mirroring...**' .



Choose '**Continuous**' as the method and click '**OK**' to start replication.  
notice a note that the table will be refreshed before mirroring starts



## 6.3 Review Topics created in Kafka

- 18. Click Mozilla Firefox icon  from Windows Task bar
- 19. Click **UI for Apache Kafka** Tab,  
Click **Topics** menu on the left, you will see that 2 topics created:

**linux.db2tokfk.sourcedb.cdc.salesrep**  
**linux-DB2TOKFK-commitstream**

Topic Name	Partitions	Out of sync replicas	Replication Factor	Number of messages	Size
IN __consumer_offsets	50	0	1	1	524 Bytes
_schemas	1	0	1	4	2 KB
linux-DB2TOKFK-commitstream	1	0	1	2	363 Bytes
linux.db2tokfk.sourcedb.cdc.salesrep	1	0	1	216	12 KB

**Note:** The topic name uses this structure:  
*instanceName.subscriptionName.sourcedb.tableSchema.tableName,*

and the commit stream metadata topic name is  
*instanceName-subscriptionName-commitstream.*



By default the commit stream is not used and the bookmark of the target Kafka agent is stored in the CDC metadata in the internal **Pointbase database dm.dbn** in the conf directory of the instance. However if customers uses the Transactionally Consistent Consumer (TCC) APIs in their code ingesting the Kafka data deposited by CDC, then the commit stream is used instead to store the bookmark as this is fundamental to the TCC functionality

To configure a user-specified topic name, refer to  
[Enabling a KCOP to specify topic names and map multiple source tables.](#)

## 6.4 Testing Real-Time Data Changes to Kafka

- 20. Open DBeaver.
- 21. Open Db2 SQL Script Tab, Make sure you are connected to Db2 CDC and CDC Schema

- 22. Run below command from DBeaver to test Insert and Update

```
INSERT INTO CDC.SALESREP
  (REPNO, NAME1ST, NAME2ND, NAME3RD, AMTMTD, AMTYTD, AMTLTD)
VALUES(999, '<your First name>', '', '<your last name>', 100, 100, 100);
```

The screenshot shows a database interface with a query editor and a statistics panel. The query editor contains the following SQL code:

```
INSERT INTO CDC.SALESREP
  (REPNO, NAME1ST, NAME2ND, NAME3RD, AMTMTD, AMTYTD, AMTLTD)
VALUES(999, 'Ronny', '', 'Zakaria', 100, 100, 100);
```

The statistics panel, titled "Statistics 1", displays the following information:

Name	Value
Updated Rows	1
Query	INSERT INTO CDC.SALESREP (REPNO, NAME1ST, NAME2ND, NAME3RD, AMTMTD, AMTYTD, AMTLTD) VALUES(999, 'Ronny', '', 'Zakaria', 100, 100, 100)
Start time	Fri Nov 22 03:06:44 PST 2024
Finish time	Fri Nov 22 03:06:44 PST 2024

```
UPDATE CDC.SALESREP
SET NAME3RD = 'IBM'
WHERE REPNO = 999;
```

The screenshot shows a database interface with a query editor and a statistics panel. The query editor contains the following SQL code:

```
UPDATE CDC.SALESREP
SET NAME3RD = 'IBM'
WHERE REPNO = 999;
```

The statistics panel, titled "Statistics 1", displays the following information:

Name	Value
Updated Rows	1
Query	UPDATE CDC.SALESREP SET NAME3RD = 'IBM' WHERE REPNO = 999
Start time	Fri Nov 22 03:11:41 PST 2024
Finish time	Fri Nov 22 03:11:41 PST 2024

Above command will insert one new records,  
and update the new record name3rd column value to IBM

23. To view the replicated changes in Kafka, open [UI for Apache Kafka](#) from Mozilla firefox,  
Click **Topics** on the left menu,  
Click **linux.db2tokfk.sourcedb.cdc.salesrep** topic  
then click **Messages** tab  
Click **Newest first** on the top right

You will see that 2 new messages as a result of your transaction appear

Offset	Partition	Timestamp	Key	Preview
217	0	11/22/2024, 03:11:32	{"REPNO":999}	{"REPNO":999,"NAME1ST":"Ronny","NAME2ND":" ","NAME3I
216	0	11/22/2024, 03:06:34	{"REPNO":999}	{"REPNO":999,"NAME1ST":"Ronny","NAME2ND":" ","NAME3I
215	0	11/22/2024, 02:36:28	{"REPNO":249}	{"REPNO":249,"NAME1ST":"LEW","NAME2ND":" ","NAME3R
214	0	11/22/2024, 02:36:28	{"REPNO":248}	{"REPNO":248,"NAME1ST":"DAWN","NAME2ND":" ","NAME3R

- 24. Additionally, you may make more updates to the 'CDC.SALESREP' DB2 table and verify the results in the Kafka UI.
- 25. When you are finished testing, please stop replication.  
From the '[Monitoring](#)' perspective,  
Right-click on the '[DB2TOKFK](#)' Subscription  
and select '[End Replication...](#)'.  
Select '[Normal](#)' as the end replication method  
and click '[OK](#)'.
- 26. Exit from the InfoSphere Change Data Capture Management Console by selecting '[File → Exit](#)' from the menu bar.

## 6.5 Summary

You have now optimized the batch window process by capturing the changes from the operational database system and replicating those changes directly to Kafka. You are minimizing the impact to the operational system by only capturing the changed data in real-time, without any downtime. This process does not affect the availability to end-users and eliminates the need to perform a full extract and comparison of the data to determine the changes.

The Kafka topic can be consumed by other processes and components of a solution. For instance to feed real-time changes to an ETL tool for further processing. This can add tremendous value for companies who are challenged with shrinking batch windows and resource intensive data extraction processes, because InfoSphere Change Data Capture is able to capture and audit just the changes from a source system into Kafka topic which can then be continuously read by any ETL tool with minimal impact to source production systems.

**Congratulations, you have finished IBM CDC Proof Technology Hands on Lab !**

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## **NOTES**

## **NOTES**





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