CONFLUENT

🚀 Deep Dive Operations: Oracle XStream CDC Connector Maintenance and Operation

Carsten Mützlitz and team
ATG

Document is work in progress.

Agenda

01 Cases

02 DB and DBA

03 Create Outbound Server

04 Administration

05 Offset Management

06 Tuning / Performance

07 Recovery

08 Best Practices

Which use-cases work well with the new connector?

Real-time data synchronization

Enable near real-time synchronization between databases and other systems.

Microservices architectures

Facilitate event-driven architectures and microservices communication.

Better BI/Analytics

Maintain accurate and consistent data across analytical platforms.

Note: **Oracle to Oracle Data Replication** is not a priority use-case for the XStream CDC Connector Roadmap, as this use-case requires additional features like, XStream In Server, data validation, transaction IDs, transaction boundaries and so on.

DB and DBA

CONFLUENT

CDC Source

Oracle XStream
API Connector
for Oracle RDBMS EE

Oracle Database Restrictions / Limitations

- The XStream License is included into Confluent Source XStream CDC Connector
  - The XStream API is **only for Oracle Enterprise Editions**, so Xstream is in EE only
- Run connectors to Oracle requires **a full-license** from Oracle DB. See Oracle License Guide basics
  - This mean **no SaaS** service from Oracle or ASFU licenses (e.g. with SAP) are covered here.
  - Only with **a full license** customers are allowed to connect the database (Royalty)

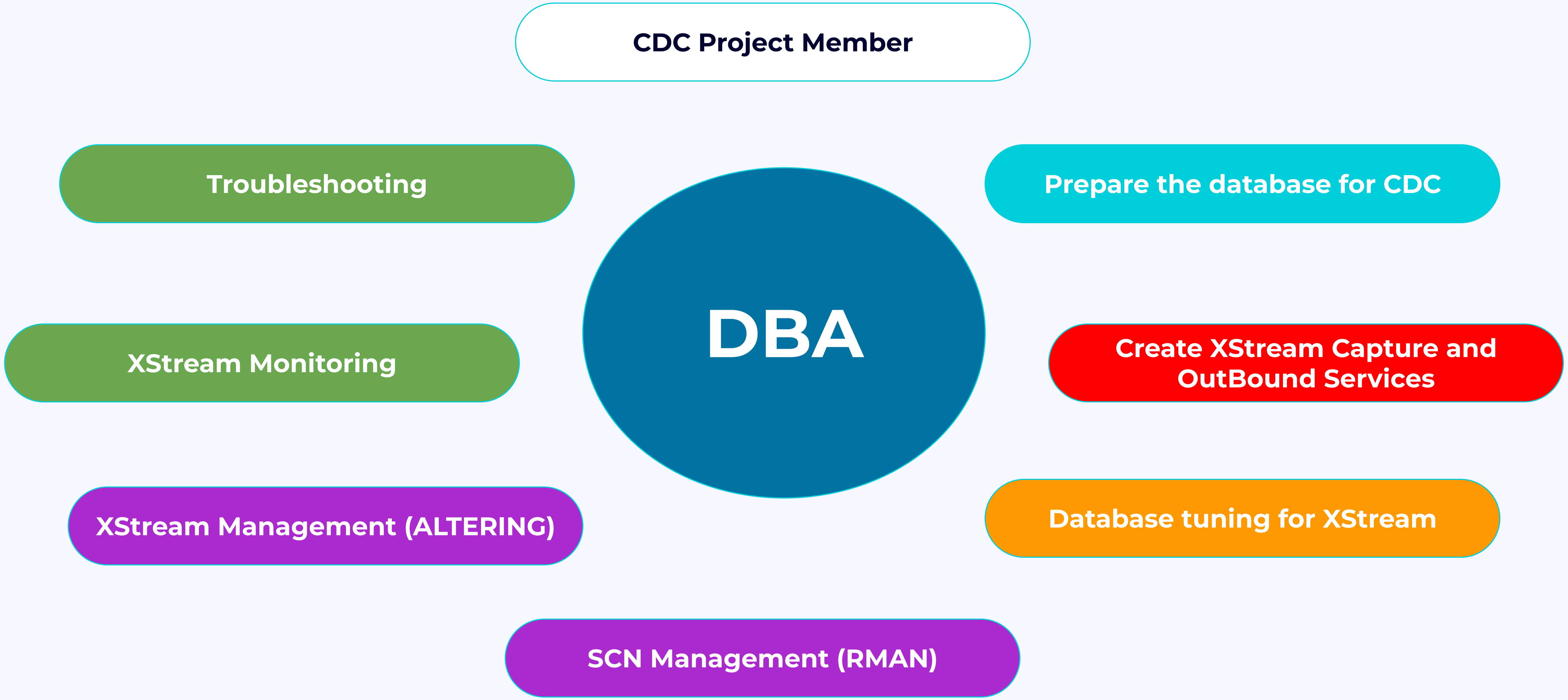
Confluent Documentation:

- Self-managed Confluent Oracle XStream CDC Source Connector
- Fully-managed Confluent Oracle XStream CDC Source Connector

Oracle Documentation:

- Oracle XStream Out Concepts
- DBMS_XSTREAM_ADM PL/SQL Admin Package
- DBMS_CAPTURE_ADM PL/SQL Admin Package

The DBA is an important part of the CDC Project Team


CDC Project Member
Troubleshooting
Prepare the database for CDC
DBA
XStream Monitoring
Create XStream Capture and OutBound Services
XStream Management (ALTERING)
Database tuning for XStream
SCN Management (RMAN)

Without a DBA on board the project will fail! Most of the work will happening in the database!

Common DBA tasks and tool

XStream Tasks are

- **Configure XStream**
  Configuring XStream involves preparing an Oracle Database for XStream, creating the Oracle Database components used by XStream, and creating one or more client applications that communicate with the Oracle Database.
- **Administer XStream**
  Administering XStream involves managing the Oracle Database components used by XStream. It also involves managing the rules and rule sets used by these components. It might also require modifications to a client application.
- **Monitor XStream**
  Monitoring XStream involves viewing Oracle Enterprise Manager Cloud Control pages related to XStream and querying data dictionary views related to XStream.

Main Tools are

- **SQL and PL/SQL**
  You can use SQL and PL/SQL to configure, administer, and monitor XStream. SQL enables you to create an XStream administrator and monitor XStream using data dictionary views. Several Oracle-supplied PL/SQL packages enable you to configure and manage XStream.
- **Oracle Enterprise Manager Cloud Control**
  You can use OEMCC to manage and monitor XStream components. You can also use Oracle Enterprise Manager Cloud Control to view information about the LCRs that are streaming in an XStream configuration.
- **The OCI API and Java API**
  You can use the XStream OCI API and XStream Java API to create client application that communicate with XStream. These applications can work with XStream Out to stream LCRs out of an Oracle Database

Support for Cloud@customer for NON-ADB

Supported Oracle versions
The connector is compatible with the following Oracle versions:

- Oracle 19c Enterprise Edition
- Oracle 21c Enterprise Edition

NON-CDBs and CDB/PDB

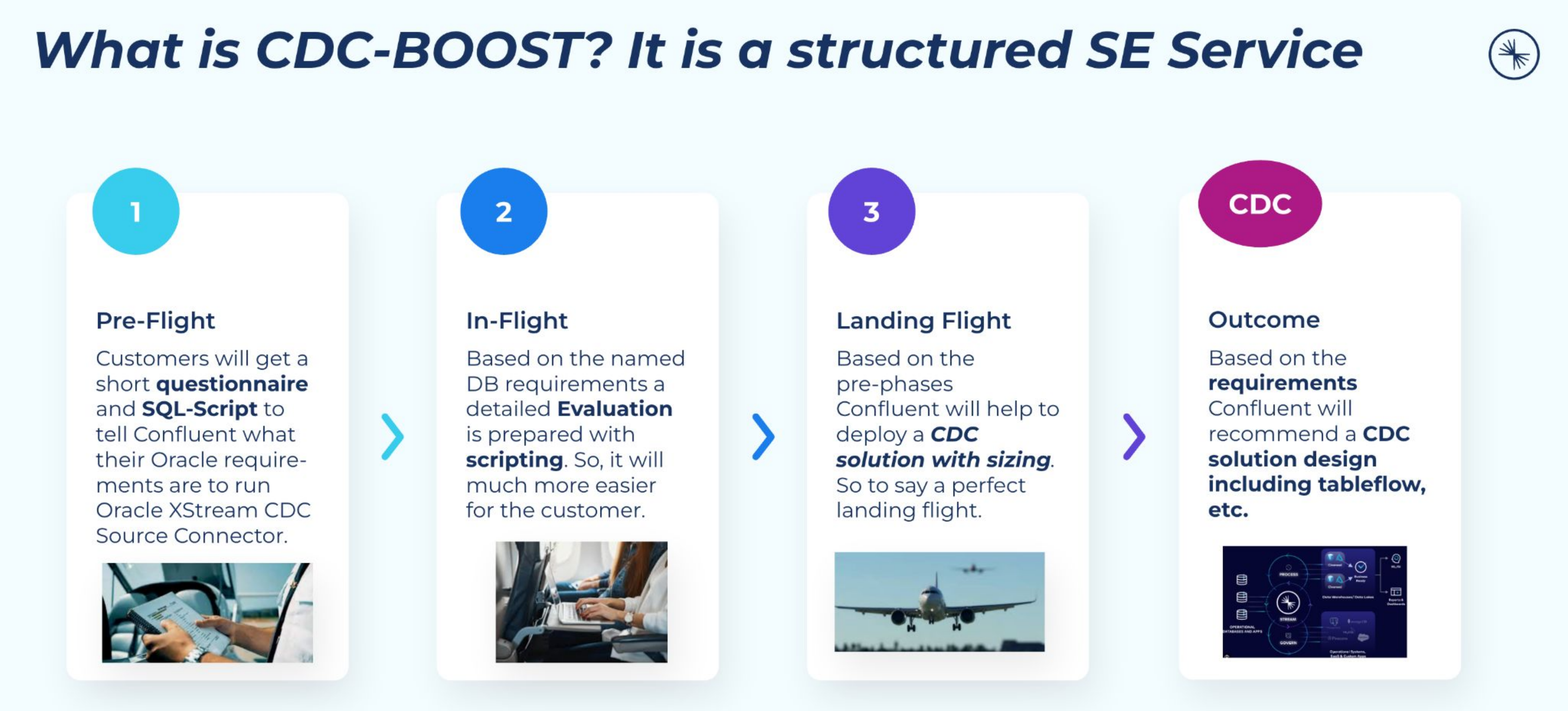
Java versions
The connector requires Java version 17 or higher.

Not supported

- Autonomous DB support -> NO SUPPORT
  - No support for XStream on dedicated ADB see Oracle
  - No support for XStream on serverless ADB see Oracle

Creation / Installation

Before going into detail, you can run Boost-Service from Confluent



What is CDC-BOOST? It is a structured SE Service

1

Pre-Flight

Customers will get a short **questionnaire** and **SQL-Script** to tell Confluent what their Oracle requirements are to run Oracle XStream CDC Source Connector.

2

In-Flight

Based on the named DB requirements a detailed **Evaluation** is prepared with **scripting**. So, it will much more easier for the customer.

3

Landing Flight

Based on the pre-phases Confluent will help to deploy a ***CDC solution with sizing***. So to say a perfect landing flight.

CDC

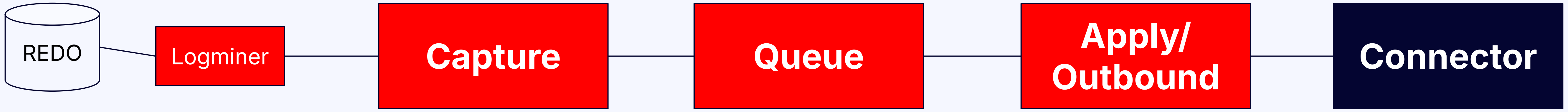
Outcome

Based on the **requirements** Confluent will recommend a **CDC solution design including tableflow, etc.**

A Stream Path Topology

A stream path begins with a capture process or XStream In client application. A stream path ends where an apply process, outbound server, or inbound server receives the LCRs. The stream path might flow through multiple source and destination components before it reaches an apply process, outbound server, or inbound server. Therefore, a single stream path can consist of multiple source/destination component pairs before it reaches last component.

The Oracle Replication topology only gathers information about a stream path if the stream path ends with an apply process, an outbound server, or an inbound server.



REDO

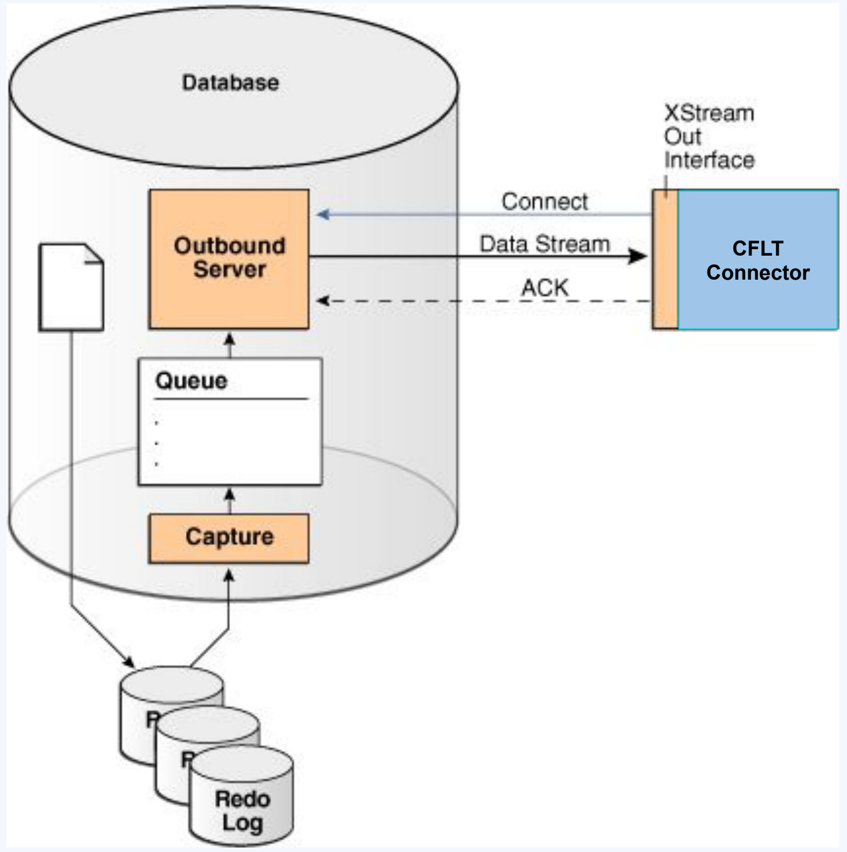
Logminer

Capture

Queue

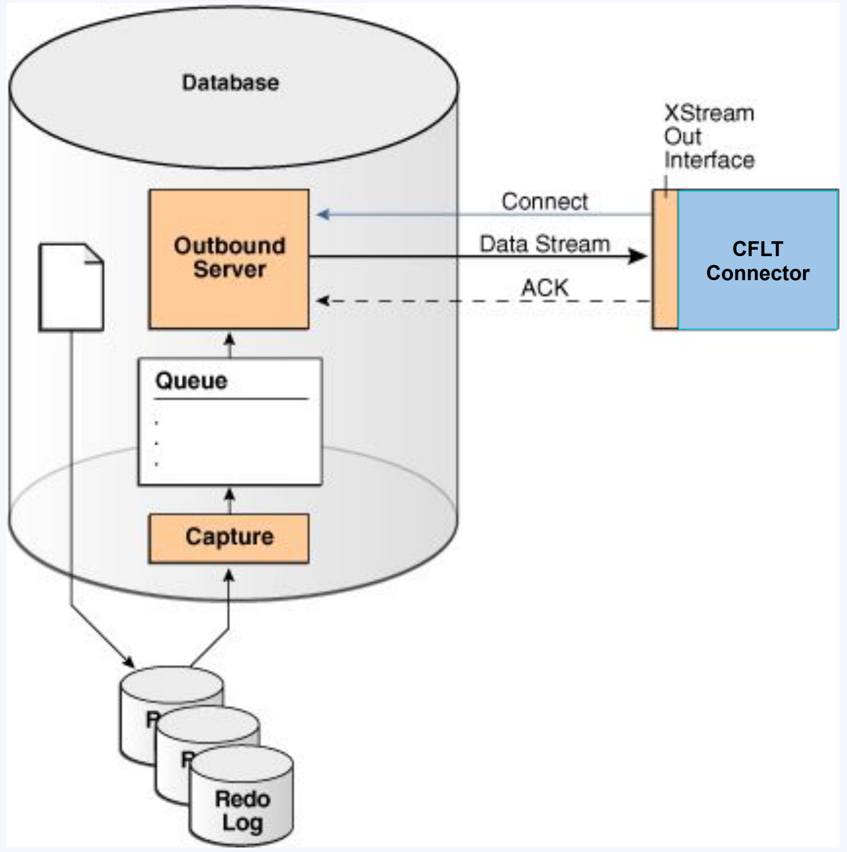
Apply/ Outbound

Connector



Creation process of Outbound Server

1. Enable all prereqs first
   a. Follow the instructions from Confluent Documentations: Prereqs
2. Create Outbound Server as XStream Admin in Oracle DB
   a. the table include list indicates which tables should be captured for changes.
   b. if table includes CLOB columns you can check how big the entries are. This is important because Kafka has a limit of message size. See script.
3. Configure the correct Stream Pools Size based on the workload
4. Set capture retention time as needed see Oracle Documentation
5. Adapt the amount of processes and sessions in your DB
6. Adapt storage in SYSAUX Tablespace to your need, depends also on retention time in Step 4
7. If you run RAC, please be aware of specific setting `use_rac_service=YES`. More information you will find here
8. You can check if all is set with the Confluent readiness check
9. If you have problems you can run the diagnostic tool from Confluent.
10. The Create Outbound Server will create each components / Logminer reader, Queue, Capture etc. at once.
11. If the database is ready you can start the Confluent connector
12. The connector will attached to the Outbound Server



DML Changes Captured by Capture Processes

- INSERT
- UPDATE
- DELETE

If you configure capture at the source database, the following actions start

- The **DBMS_CAPTURE_ADM.BUILD** procedure is run to extract (or build) the data dictionary to the redo log.
- **Supplemental logging at the source database places additional information** in the redo log. This information might be needed when captured changes are processed by an XStream client application.
- The first time a capture process is started at the database, Oracle Database **uses the extracted data dictionary information in the redo log to create a LogMiner data dictionary**, which is separate from the primary data dictionary for the source database. Additional capture processes can use this existing LogMiner data dictionary, or they can create new LogMiner data dictionaries.
- A capture process s**cans the redo log** for changes using LogMiner.
- **The rules engine evaluates changes** based on the rules in one or more of the capture process rule sets.
- The capture process **enqueues changes** that satisfy the rules in its rule sets into a local ANYDATA queue.
- If the captured changes are shared with one or more outbound servers on other databases, then one or more propagations propagate these changes from the source database to the other databases.

RAC Setup, see documentation and my collection

database.hostname	Oracle RAC database SCAN address If a SCAN address is unavailable, configure the database.hostname property to the hostname of the instance where the XStream components are running. You will need to manually reconfigure the connector whenever the instance running the XStream components changes.
database.service.name	to the auto-created Oracle XStream service

When using the SCAN address with the XStream service name, the client connection is established to the instance running the XStream components. If the instance running the XStream components becomes unavailable, the components automatically move to another available instance without requiring user intervention.

Roles and Privs

Database and account-level privileges

System roles and privileges

Preparing the database (1 of 7)

Enable Oracle XStream

```
ALTER SYSTEM SET enable_goldengate_replication=TRUE SCOPE=BOTH
```

Configure ARCHIVELOG mode

```
SHUTDOWN IMMEDIATE;
STARTUP MOUNT;
```

```
ALTER DATABASE ARCHIVELOG;
ALTER DATABASE OPEN;
```

Preparing the database (2 of 7)

Configure supplemental logging

There are two levels of supplemental logging:

1. Database supplemental logging: This enables supplemental logging for the entire database.
2. Table supplemental logging: This enables supplemental logging of specific tables using log groups.

Prerequisite: Enable minimal supplemental logging

```
ALTER SESSION SET CONTAINER = CDB$ROOT;
ALTER DATABASE ADD SUPPLEMENTAL LOG DATA;
```

Option 1: Enable supplemental logging for specific tables (*recommended*)

```
ALTER SESSION SET CONTAINER = <pdb name>;
ALTER TABLE <schema name>.<table name> ADD SUPPLEMENTAL LOG DATA (ALL) COLUMNS;
```

Option 2: Enable supplemental logging for the entire database

```
ALTER SESSION SET CONTAINER = CDB$ROOT;
ALTER DATABASE ADD SUPPLEMENTAL LOG DATA (ALL) COLUMNS;
```

Preparing the database (3 of 7)

Configure database users

XStream Out defines two users:

1. Capture user: This user will be responsible for administering the XStream components and capturing changes from the redo log
2. Connect user: This user will be used for connecting to the XStream outbound server and receiving changes in the form of LCRs

Configure an XStream administrator

Create a new tablespace for the XStream administrator

```
CREATE TABLESPACE xstream_adm_tbs DATAFILE
'/opt/oracle/oradata/ORCLCDB/xstream adm tbs.dbf'
  SIZE 25M REUSE AUTOEXTEND ON MAXSIZE UNLIMITED;
```

You must create the tablespace in all of the containers in the CDB, including the CDB root, all pluggable databases (PDBs), all application roots, and all application containers.

Preparing the database (4 of 7)

Create a new common user for the XStream administrator

```
CREATE USER c##cfltadmin IDENTIFIED BY password
  DEFAULT TABLESPACE xstream adm tbs
  QUOTA UNLIMITED ON xstream_adm_tbs
  CONTAINER=ALL;
```

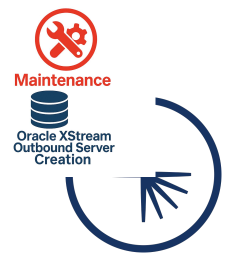
Grant the CREATE SESSION and SET CONTAINER privileges

```
GRANT CREATE SESSION, SET CONTAINER TO c##cfltadmin CONTAINER=ALL;
```

Run the GRANT_ADMIN_PRIVILEGE procedure in the DBMS_XSTREAM_AUTH package.

```
BEGIN
  DBMS XSTREAM AUTH.GRANT ADMIN_PRIVILEGE(
    grantee                 => 'c##cfltadmin',
    privilege type          => 'CAPTURE',
    grant select privileges => TRUE,
    container               => 'ALL');
END
```

Preparing the database (5 of 7)



Configure an XStream connect user

Create a new tablespace for the XStream connect user

```
CREATE TABLESPACE xstream tbs DATAFILE '/opt/oracle/oradata/ORCLCDB/xstream_tbs.dbf'
  SIZE 25M REUSE AUTOEXTEND ON MAXSIZE UNLIMITED;
```

You must create the tablespace in all of the containers in the CDB, including the CDB root, all pluggable databases (PDBs), all application roots, and all application containers.

Create a new common user for the XStream connect user

```
CREATE USER c##cfltuser IDENTIFIED BY password
  DEFAULT TABLESPACE xstream tbs
  QUOTA UNLIMITED ON xstream_tbs
  CONTAINER=ALL;
```

Preparing the database (6 of 7)

Grant the CREATE SESSION and SET CONTAINER privileges

```
GRANT CREATE SESSION, SET CONTAINER TO c##cfltuser CONTAINER=ALL;
```

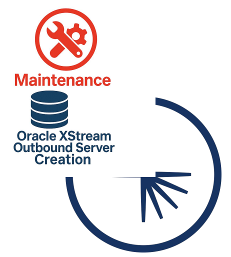
Grant the SELECT_CATALOG_ROLE role

```
GRANT SELECT_CATALOG_ROLE TO c##cfltuser CONTAINER=ALL;
```

Grant privileges to snapshot tables and capture schema

```
ALTER SESSION SET CONTAINER = <pdb_name>;
GRANT FLASHBACK ON <schema>.<table> TO c##cfltuser;
GRANT SELECT ON <schema>.<table> TO c##cfltuser;
```

Preparing the database (7 of 7)



Creating XStream Out

```
DECLARE
  tables  DBMS_UTILITY.UNCL_ARRAY;
  schemas DBMS_UTILITY.UNCL_ARRAY;
BEGIN
  tables(1)  := 'sample.employees';
  schemas(1) := NULL;
  DBMS_XSTREAM_ADM.CREATE_OUTBOUND(
    server_name           =>  'xout',
    source_container_name =>  'ORCLPDB1',
    table_names           =>  tables,
    schema_names          =>  schemas);
END;
```

```
BEGIN
  DBMS_XSTREAM_ADM.ALTER_OUTBOUND(
    server_name   => 'xout',
    connect_user => 'c##cfltuser');
END;
```

For detailed information about the CREATE_OUTBOUND procedure and additional configuration options, refer to the official Oracle documentation.

Before Images

Before Images for inserts and deletions

New topic and schema Structure

Logminer Connector (old)

- You have the redolog topic structure (same as v$logmnr_contents)

ORCLPDB1.ORDERMGMT.REDOLOG

- Table topics same structure like corresponding tables (flat structure)

ORCLPDB1.ORDERMGMT.CUSTOMERS

XStream Connector (new)

- Table topics only with
  - Before and After values
  - metadata structure
- No flat structure, if you would like to have like old table topics you need to run ExtractNewRecordState SMT by Debezium
  - SMT is available in CCloud
  - Included in CP Connect as well, see List

Maintenance
Oracle XStream Outbound Server Creation

Transform new structure back to flat (with SMT)

From:

```
{
    "after": {
        "cflt_3mar_3pm.ORDERMGMT.CUSTOMERS.Value": {
            "ADDRESS": {
                "string": "701 Seneca St, Buffalo, NY"
            },
            "CREDIT_LIMIT": {
                "bytes.decimal": "5000"
            },
            "CUSTOMER_ID": 174,
            "NAME": "Name_006",
            "WEBSITE": {
                "string": "http://www.oracle.com"
            }
        }
    },
    "before": {
        "cflt_3mar_3pm.ORDERMGMT.CUSTOMERS.Value": {
            "ADDRESS": {
                "string": "701 Seneca St, Buffalo, NY"
            },
            "CREDIT_LIMIT": {
                "bytes.decimal": "5000"
            },
            "CUSTOMER_ID": 174,
            "NAME": "Name_005",
            "WEBSITE": {
                "string": "http://www.oracle.com"
            }
        }
    },
    "op": "u",
    "source": {
        "connector": "Oracle XStream CDC",
        "db": "ORCLPDB1",
        "lcr_position": {
            "string": "000000000081e7f60000000100000001000000000081e7f500000001000000102"
        },
…
```

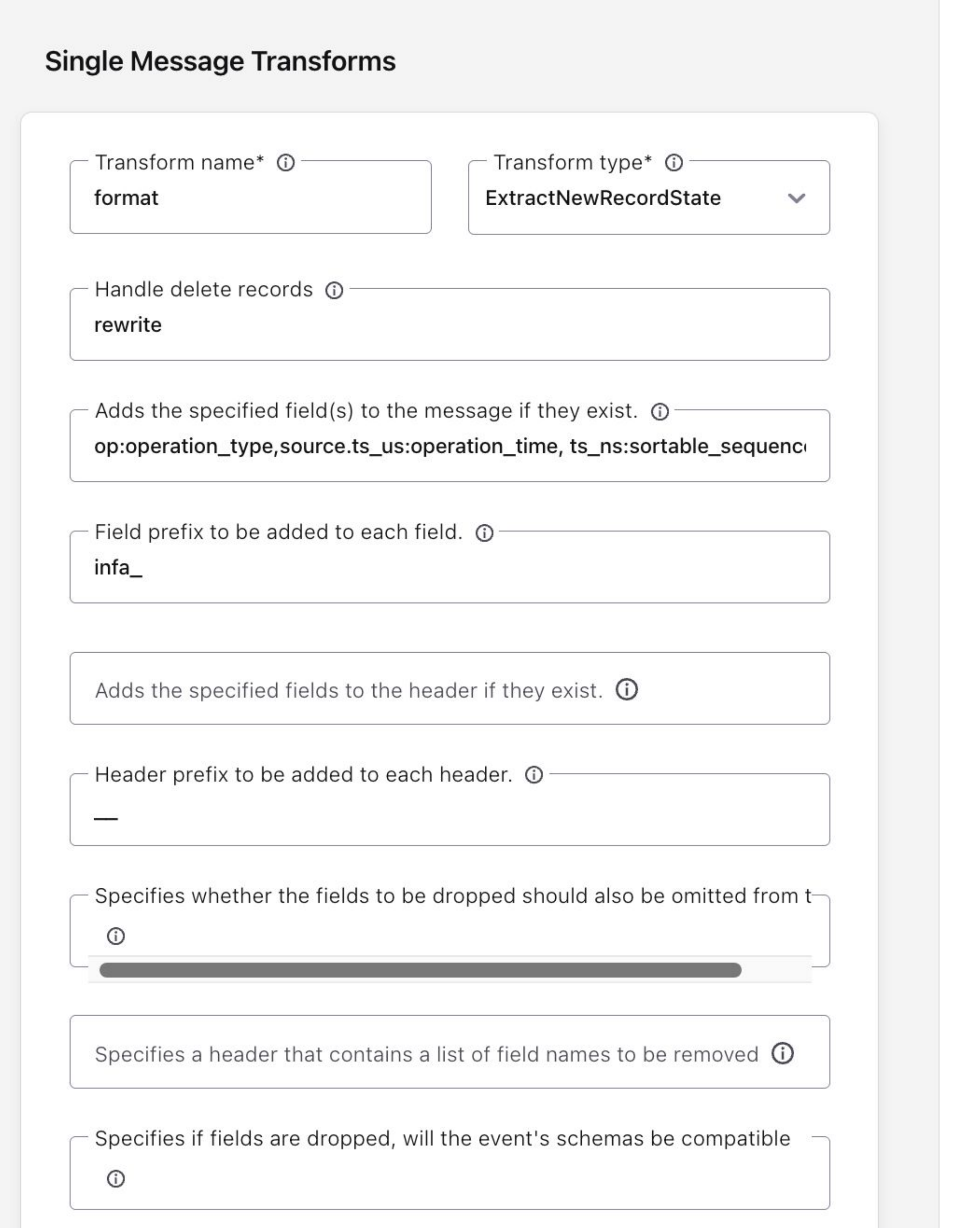
to flat structure:

```
{
    "ADDRESS": {
        "string": "2115 N Towne Ln Ne, Cedar Rapids, IA"
    },
    "CREDIT_LIMIT": {
        "bytes.decimal": "500"
    },
    "CUSTOMER_ID": 39,
    "NAME": "Lear",
    "WEBSITE": {
        "string": "http://www.lear.com"
    },
    "__deleted": {
        "string": "false"
    },
    "__op": {
        "string": "r"
    },
    "__source_ts_us": {
        "long": 1741344089000000
    },
    "__ts_ns": {
        "long": 1741344101041460676
    }
}
```

renaming would also work

Before only for updates

SMT Sample



Single Message Transforms

Transform name* ⓘ
format

Transform type* ⓘ
ExtractNewRecordState

Handle delete records ⓘ
rewrite

Adds the specified field(s) to the message if they exist. ⓘ
op:operation_type,source.ts_us:operation_time, ts_ns:sortable_sequenc

Field prefix to be added to each field. ⓘ
infa_

Adds the specified fields to the header if they exist. ⓘ

Header prefix to be added to each header. ⓘ
__

Specifies whether the fields to be dropped should also be omitted from t ⓘ

Specifies a header that contains a list of field names to be removed ⓘ

Specifies if fields are dropped, will the event's schemas be compatible ⓘ

Administration / Maintenance

Monitoring

- The DBA will include XStream components into the existing monitoring concept
- Oracle described monitoring here.
- I have developed a simple XStream Report Script and collect monitoring queries in this script.
- DB Memory (SGA) Check Script can be found here

Alert Logs

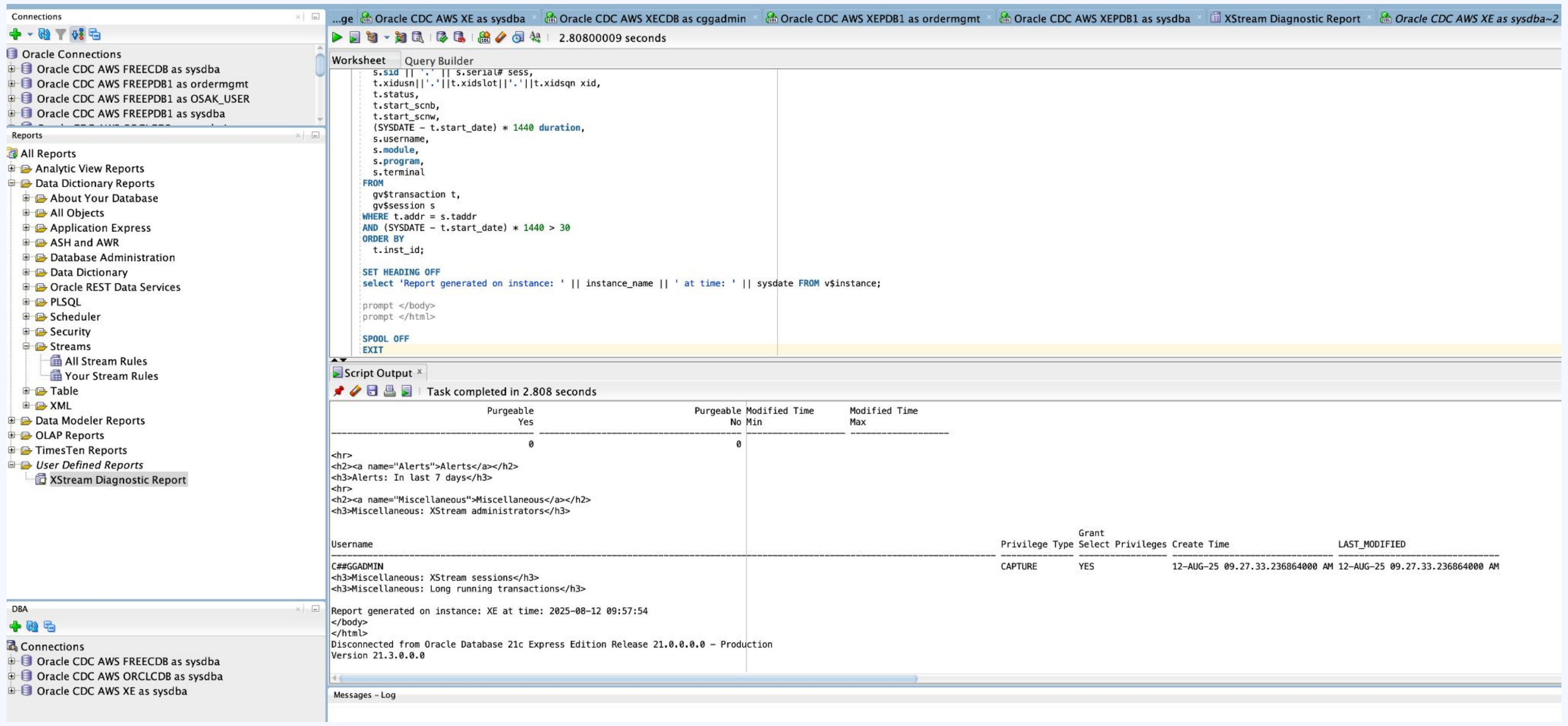
- Please also include the alert logs into your monitoring concept. It is sometimes very useful to have a combined look on the alert logs and connector logs

This monitoring should prevent trouble.

Oracle described troubleshooting here.
Confluent described troubleshooting here. (Run the diagnostic script and work together with the Confluent Support)

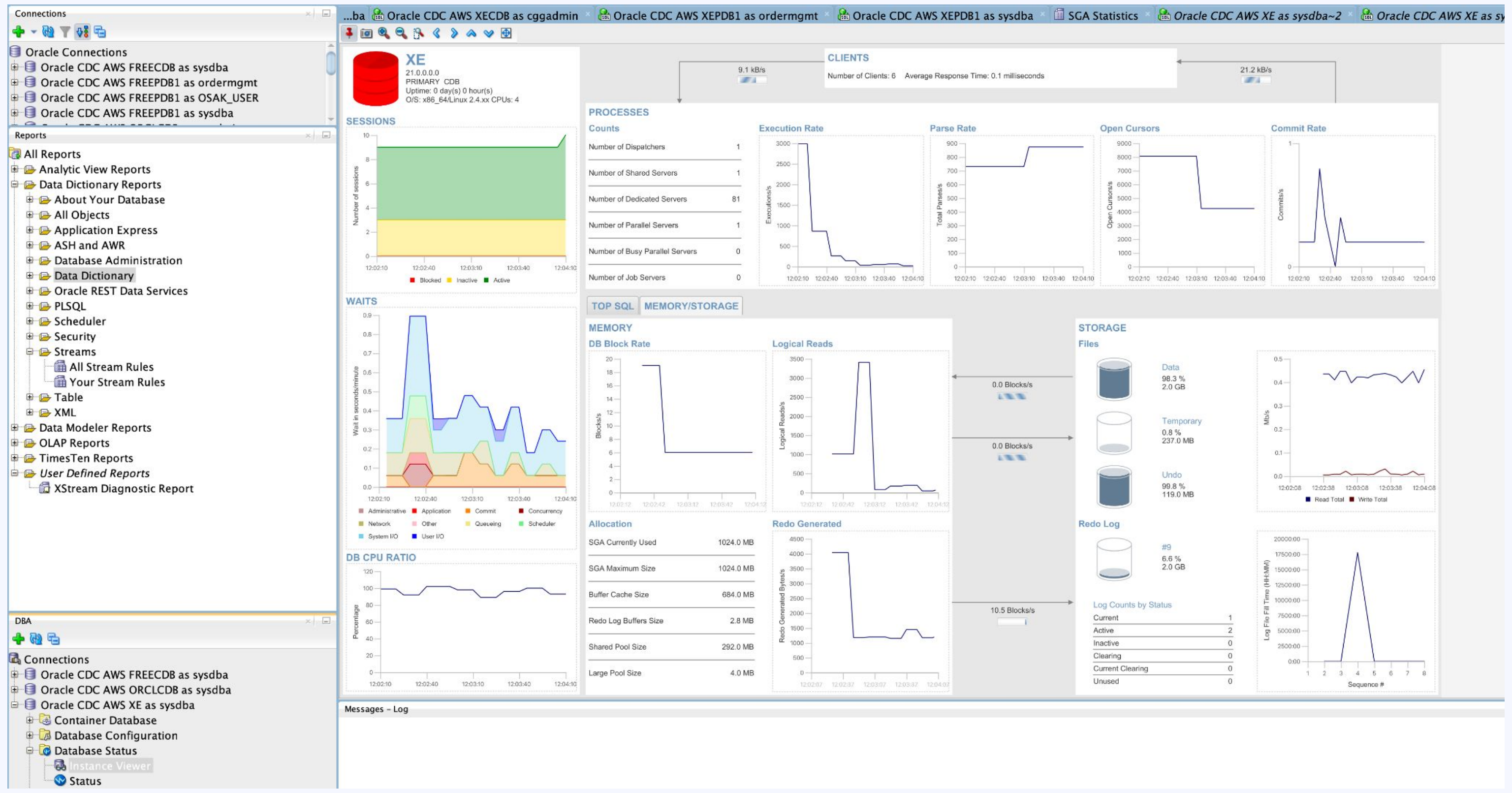
Monitoring: Use SQL Developer

- add yourself the diagnostic Report from CONFLUENT into SQL Developer
- and use existing tools in SQL Developer like Instance Viewer, AWR Reports


Connections
Oracle Connections
Oracle CDC AWS FREECDB as sysdba
Oracle CDC AWS FREEPDB1 as ordermgmt
Oracle CDC AWS FREEPDB1 as OSAK_USER
Oracle CDC AWS FREEPDB1 as sysdba
Reports
All Reports
Analytic View Reports
Data Dictionary Reports
About Your Database
All Objects
Application Express
ASH and AWR
Database Administration
Data Dictionary
Oracle REST Data Services
PLSQL
Scheduler
Security
Streams
All Stream Rules
Your Stream Rules
Table
XML
Data Modeler Reports
OLAP Reports
TimesTen Reports
User Defined Reports
XStream Diagnostic Report
DBA
Connections
Oracle CDC AWS FREECDB as sysdba
Oracle CDC AWS ORCLCDB as sysdba
Oracle CDC AWS XE as sysdba
...ge
Oracle CDC AWS XE as sysdba
Oracle CDC AWS XECDB as cggadmin
Oracle CDC AWS XEPDB1 as ordermgmt
Oracle CDC AWS XEPDB1 as sysdba
XStream Diagnostic Report
Oracle CDC AWS XE as sysdba~2
2.80800009 seconds
Worksheet
Query Builder
Script Output
Task completed in 2.808 seconds
Messages – Log

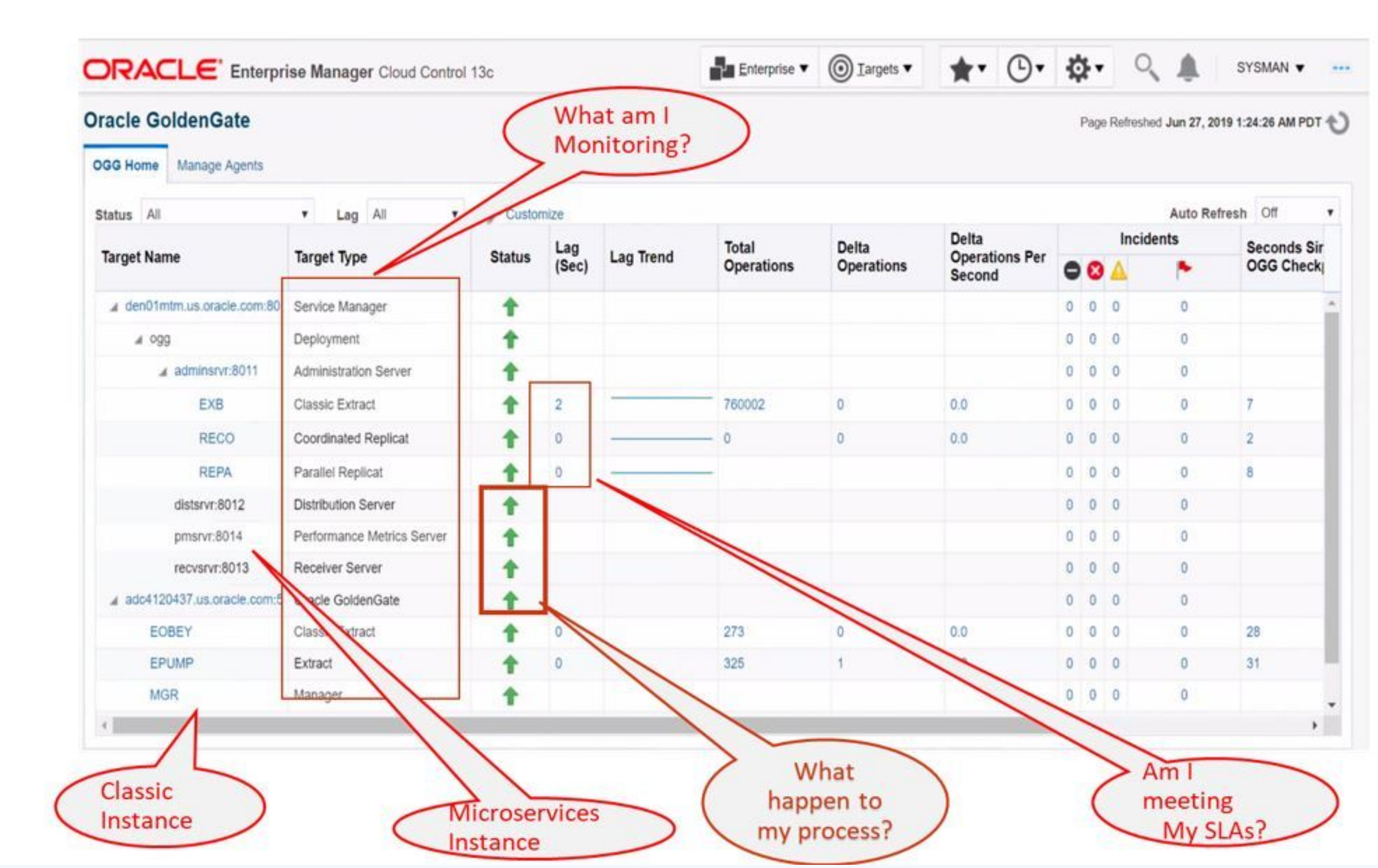
```
    s.sid || '.' || s.serial# sess,
    t.xidusn||'.'||t.xidslot||'.'||t.xidsqn xid,
    t.status,
    t.start_scnb,
    t.start_scnw,
    (SYSDATE - t.start_date) * 1440 duration,
    s.username,
    s.module,
    s.program,
    s.terminal
  FROM
    gv$transaction t,
    gv$session s
  WHERE t.addr = s.taddr
  AND (SYSDATE - t.start_date) * 1440 > 30
  ORDER BY
    t.inst_id;

  SET HEADING OFF
  select 'Report generated on instance: ' || instance_name || ' at time: ' || sysdate FROM v$instance;

  prompt </body>
  prompt </html>

  SPOOL OFF
  EXIT
```

```
                            Purgeable                       Purgeable Modified Time    Modified Time
                                  Yes                              No Min              Max
------------------------------------- ------------------------------- ---------------- ----------------
                                    0                               0
<hr>
<h2><a name="Alerts">Alerts</a></h2>
<h3>Alerts: In last 7 days</h3>
<hr>
<h2><a name="Miscellaneous">Miscellaneous</a></h2>
<h3>Miscellaneous: XStream administrators</h3>

                                                                                                                    Grant
Username                                                                                             Privilege Type Select Privileges Create Time                  LAST_MODIFIED
---------------------------------------------------------------------------------------------------- -------------- ----------------- ---------------------------- ----------------------------
C##GGADMIN                                                                                           CAPTURE        YES               12-AUG-25 09.27.33.236864000 AM 12-AUG-25 09.27.33.236864000 AM
<h3>Miscellaneous: XStream sessions</h3>
<h3>Miscellaneous: Long running transactions</h3>

Report generated on instance: XE at time: 2025-08-12 09:57:54
</body>
</html>
Disconnected from Oracle Database 21c Express Edition Release 21.0.0.0.0 - Production
Version 21.3.0.0.0
```



Monitoring in Enterprise Manager Cloud Control

- Oracle Enterprise Manager (OEM) is the Tool for DBAs.
- OEM does help DBAs to monitor and maintain the databases.
- DBAs can add own custom reports into OEM, e.g. the Confluent Diagnostic Script
- OEM delivers everything you need for diagnostic and tuning



Oracle GoldenGate

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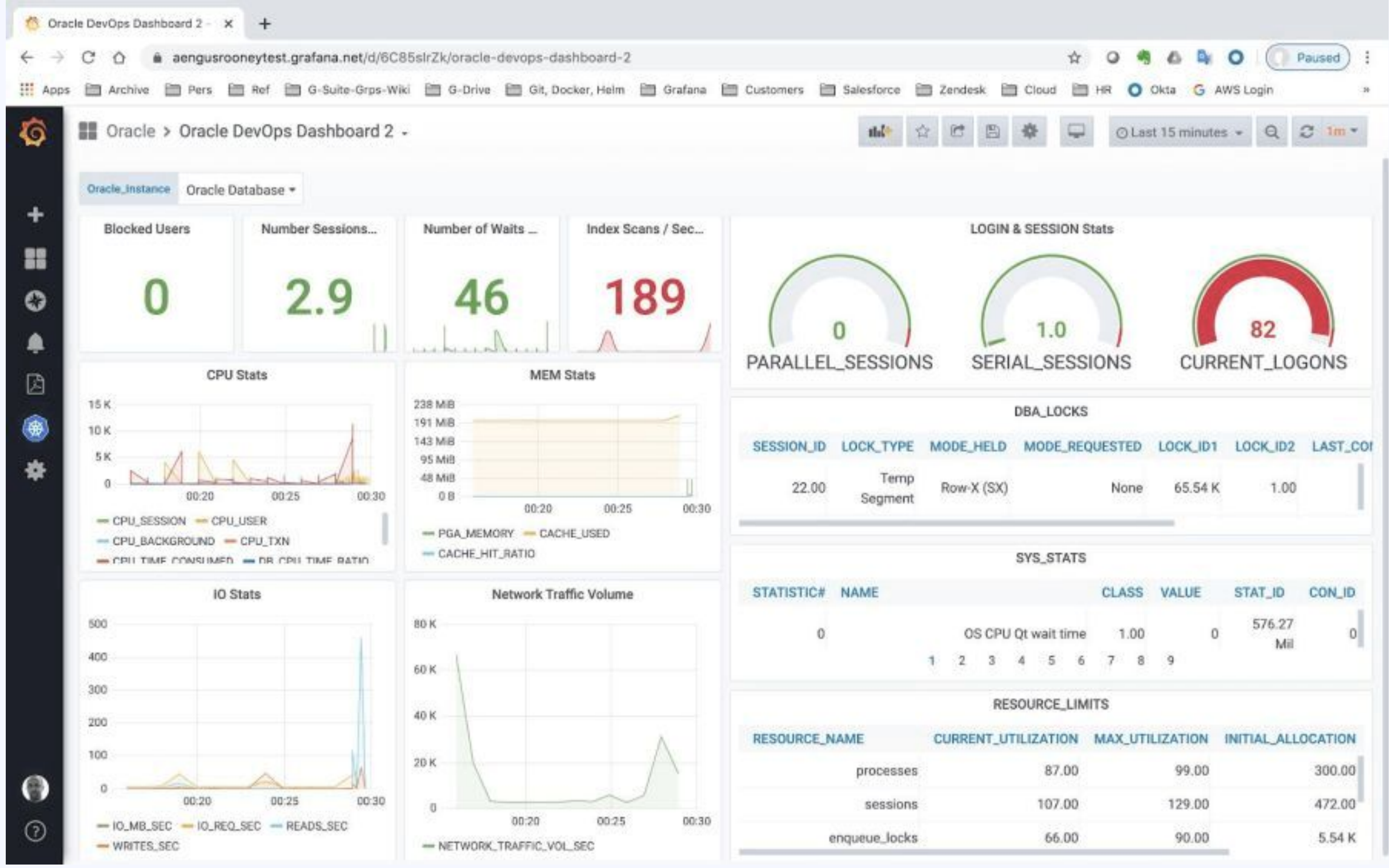
Status All ▾ Lag All ▾ Auto Refresh Off ▾

Target Name	Target Type	Status	Lag (Sec)	Lag Trend	Total Operations	Delta Operations	Delta Operations Per Second	Incidents				Seconds Sir OGG Check
								⊖	⊗	⚠	⚑	
den01mtm.us.oracle.com:80	Service Manager	↑						0	0	0	0	
ogg	Deployment	↑						0	0	0	0	
adminsrvr:8011	Administration Server	↑						0	0	0	0	
EXB	Classic Extract	↑	2	—	760002	0	0.0	0	0	0	0	7
RECO	Coordinated Replicat	↑	0	—	0	0	0.0	0	0	0	0	2
REPA	Parallel Replicat	↑	0	—				0	0	0	0	8
distsrvr:8012	Distribution Server	↑						0	0	0	0	
pmsrvr:8014	Performance Metrics Server	↑						0	0	0	0	
recvsrvr:8013	Receiver Server	↑						0	0	0	0	
adc4120437.us.oracle.com:5	cle GoldenGate	↑						0	0	0	0	
EOBEY	Class xtract	↑	0		273	0	0.0	0	0	0	0	28
EPUMP	Extract	↑	0		325	1	[illegible]	0	0	0	0	31
MGR	Manager	↑						0	0	0	0	

Xstream Monitoring with Grafana

- Use Grafana Lab with Grafana Cloud pro Account (Plugin for Oracle) and ready to use dashboard.
- Or you could add metrics from Oracle to Grafana via prometheus_oracle_exporter manually. Your will add customer queries and build your own Xstream Dashboard



DBA_LOCKS

SESSION_ID	LOCK_TYPE	MODE_HELD	MODE_REQUESTED	LOCK_ID1	LOCK_ID2	LAST_COI
22.00	Temp Segment	Row-X (SX)	None	65.54 K	1.00	

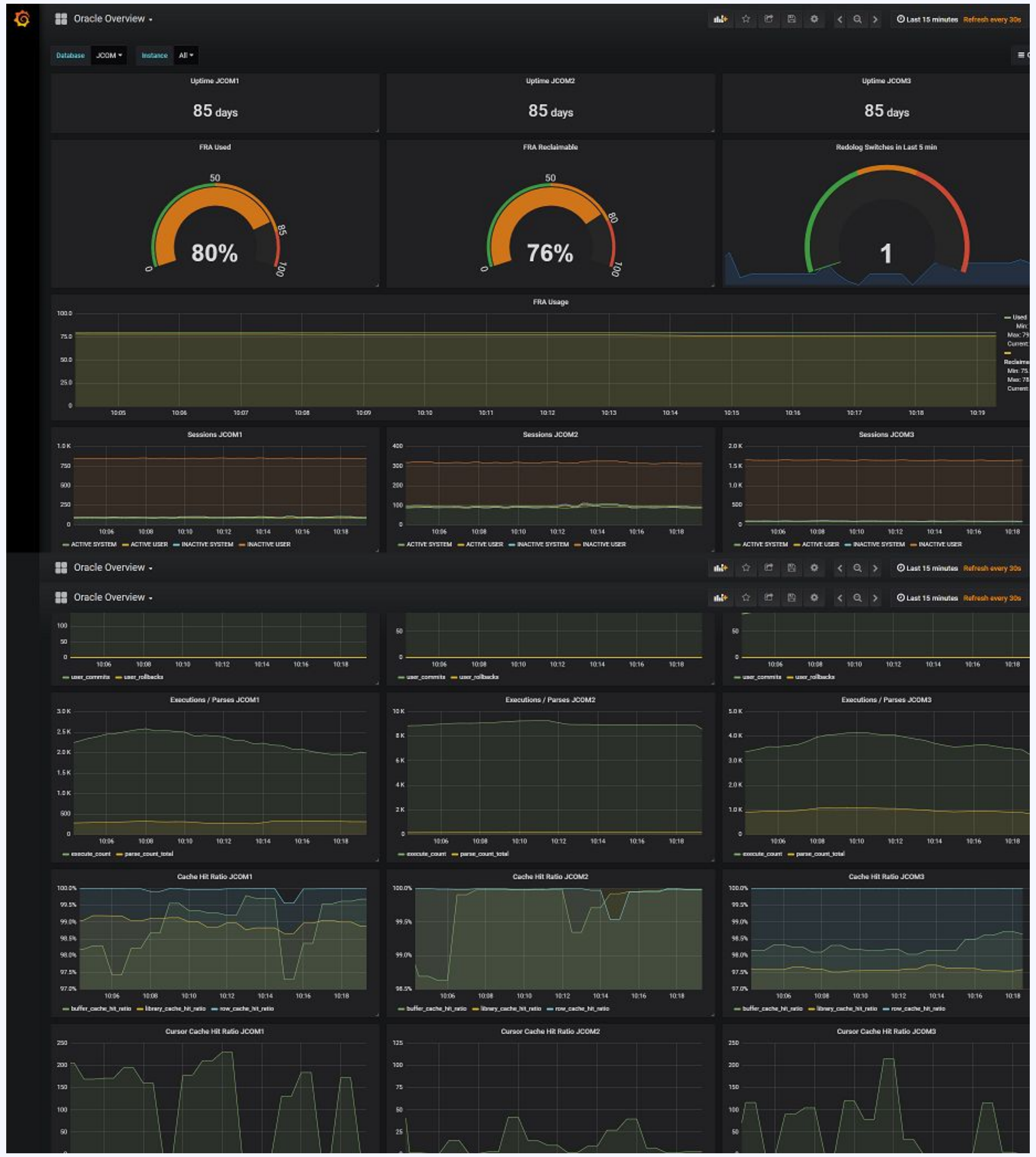
SYS_STATS

STATISTIC#	NAME	CLASS	VALUE	STAT_ID	CON_ID
0	OS CPU Qt wait time	1.00	0	576.27 Mil	0

1 2 3 4 5 6 7 8 9

RESOURCE_LIMITS

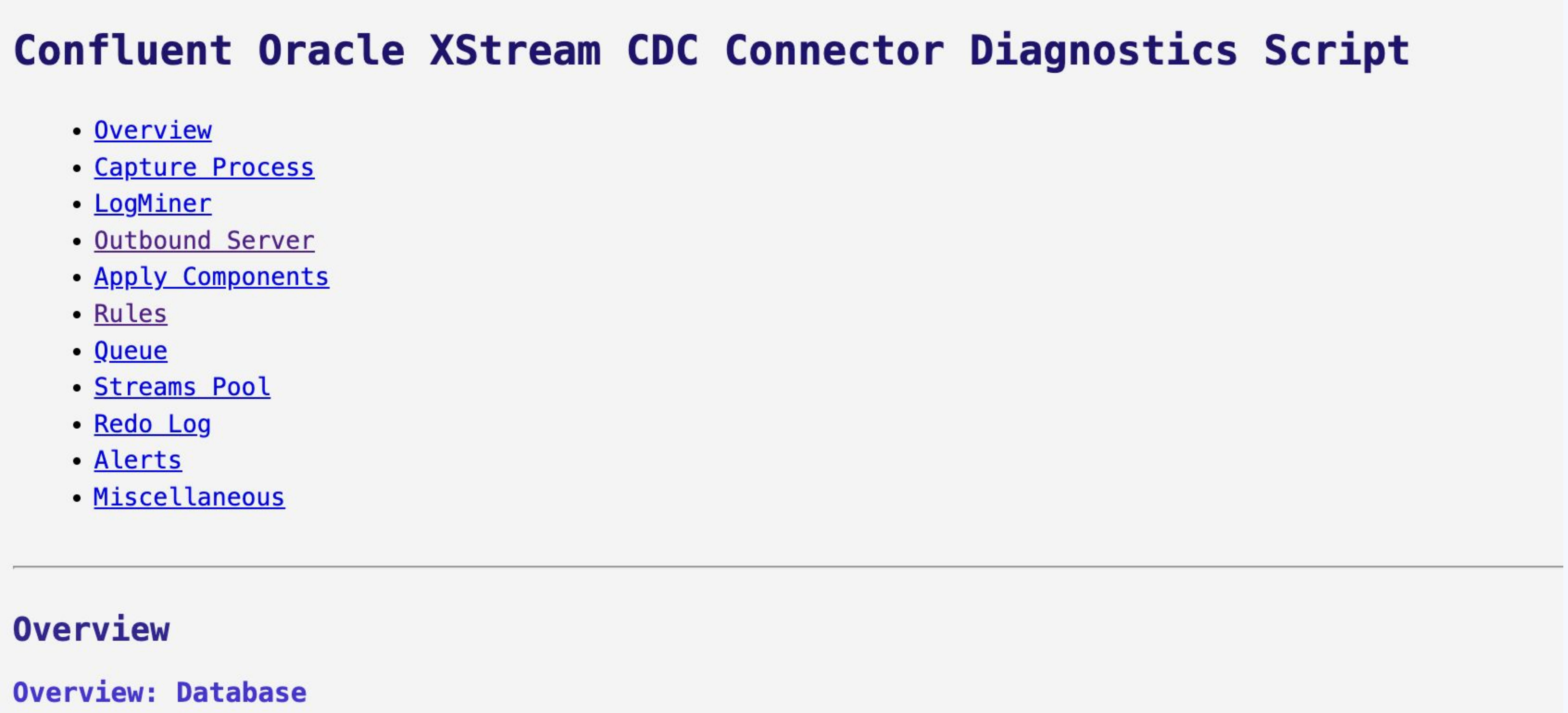
RESOURCE_NAME	CURRENT_UTILIZATION	MAX_UTILIZATION	INITIAL_ALLOCATION
processes	87.00	99.00	300.00
sessions	107.00	129.00	472.00
enqueue_locks	66.00	90.00	5.54 K



Guide how to monitor Oracle with Grafana in German

Healthcheck

Oracle has documented an Change Data Capture CDC Healthcheck (you need Oracle support Knowledge base access), this was for Streams and is very old. Most of the queries do not work anymore. Confluent has developed something similar see slide



Confluent Oracle XStream CDC Connector Diagnostics Script

- Overview
- Capture Process
- LogMiner
- Outbound Server
- Apply Components
- Rules
- Queue
- Streams Pool
- Redo Log
- Alerts
- Miscellaneous

Overview

Overview: Database

Adding Tables

- Follow Confluent documentation for adding tables.
- You can monitor the connector include list with a capture table rules query to prevent that only those tables are captured you are looking for (no wasted resources). See this sample

- Current Limitation: After initial snapshot, newly added tables in i`nclude.list` only stream CDC, no snapshot.
  - Requested Feature: Blocking ad hoc snapshot for added tables (similar to Debezium ad hoc snapshot) — Feature **Request FF-23314**.

Typical prod cases and test with Confluent Connector

Maintenance
Oracle XStream Outbound Server Administration

I did collect a couple of real customer cases here

1. Setting up xstream from oracle to gcp kafka Non-cdc and cdc – db rac/non-rac.
2. After creation and initial load make changes to the table (DML operations) and validate if those changes reflect in the topic
3. Evaluate, if we can add multiple tables in single connector.
4. Evaluate, if we can add multiple tables with different owner’s in the single connector
5. Include multiple tables for capture whether multiple capture process/xstream outbound servers are required.
6. Pause/stop capture/xstream outbound server.
7. Switch redo logs to generate archives and try resume/start capture/xstream server and see if it picks from archives.
8. Alter capture to start from specific scn/time
9. Alter connector to pick from prior time/scn.
10. Stop db/disable/enable archives and steps to restart capture/xstream outbound server and connector required during maintenance.
11. Test case, for long running transactions where we won’t commit and then we move or delete archives from the source and then commit. Check the connector status and data.
12. Test case scenario, if we move the archives or delete (Since in prod huge number of archives gets generates and we move the archives regularly via cron) while capture process is running what will be the status and how to manage.
13. Abrupt or normal shut down of source database and check the connector.
14. Any parameter to set at capture level to make sure it doesn’t consume much memory while extract/replicate.
15. Need to explore the monitoring of sessions of those connectors and any specific monitoring which needs our attention need to specify by Confluent.
16. Playing with offset

Offset Management

Offset Management

- One of the most important things is how to deal with the Offset. In the language of Oracle it means SCN.

I have collected a couple of typical cases here

1. SCN Management (we have different meaning in XStream Out)
2. Get SCNs from Database
3. LCR Auditing is very difficult, a sample how you could track LCRs
4. Use case: Connector maintenance. Pause connector, and collect all missing transactions
5. Use case: DB aborted 45 minutes ago, DBA would like to go back for 1 hour with Connector
6. Shutdown abort the database

Tuning / Performance

Snapshot

snapshot.fetch.size	10000
max.queue.size	65536
max.batch.size	16384
producer.override.batch.size	204800
producer.override.linger.ms	50
snapshot.max.threads	1 - 4
query.fetch.size	10000

Our internal test achieved a throughput of more than 30 MB/s processed data (and more 25 MB/s raw data).

Streaming DB (Performance Sample)

SGA: Set SGA_TARGET, SGA_MAX_SIZE	42GB (high enough)
PGA: Set PGA_AGGREGATE_TARGET	14GB (high enough)
Redo log file size	2Gb or bigger
Commit: COMMIT_LOGGING=BATCH, COMMIT_WAIT=NOWAIT	Batch, NOWAIT
SYSAUX, UNDO tablespace size (keep an eye on)	Re-size if necessary
DBMS_XSTREAM_ADM.CREATE_OUTBOUND include_ddl	true (if you want DDL support)

Streaming Connector (Performance Sample)

Maintenance

Oracle XStream Outbound Server Tuning

query.fetch.size	10000
heartbeat.interval.ms	300000
database.tls.mode	one-way (if you use TLS)*

*if you use self-signed Certificates you need to add the CA Cert into CA Certificate Store of OS

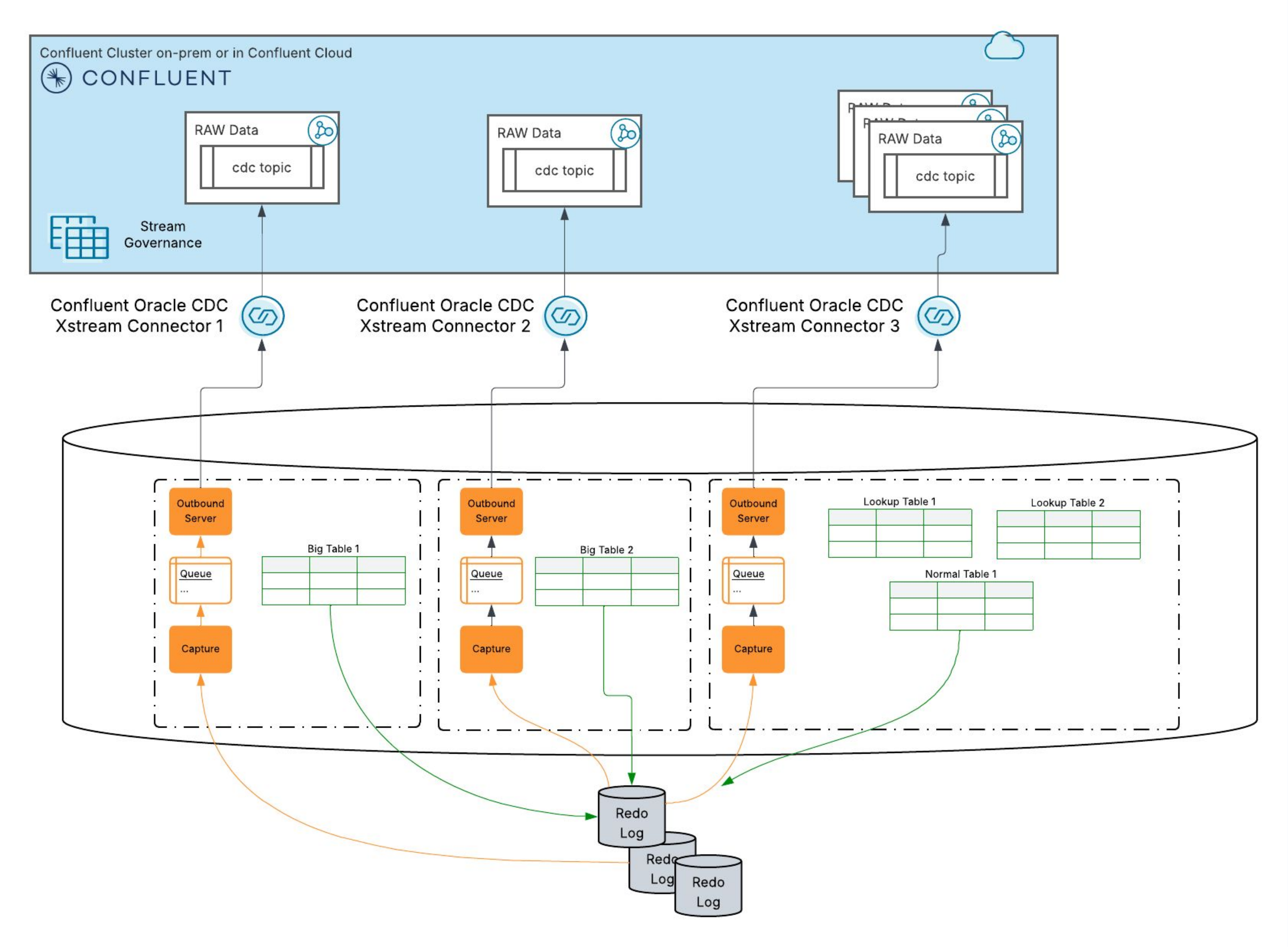
Self-managed Connector (heap size for long running transactions)

KAFKA_OPTS	
Heapsize for long running transaction	5 millions records per transaction
Max	-Xmx12G
Min	Xms512M

In general scale connector for bigger tables

You can scale the connector on tables

- If you have big tables (millions of entries)
  run one connector per big table
  and one connector for all the lookup tables



Monitoring

- Monitoring on connector should be enabled first.
- Monitoring the Xstream Components should be enabled as well.
  - Monitoring Outbound Server
  - Monitoring Capture Process

See sample scripts here

- Monitor Undo Usage and Flashback Performance
- Regular monitoring ensures quick identification of bottlenecks:
  - Check Undo tablespace usage:

```
SELECT tablespace_name, status, SUM(bytes)/1024/1024 AS MB
FROM dba_undo_extents
GROUP BY tablespace_name, status;
```

  - Check longest queryable flashback time available:

```
SELECT TO_CHAR(begin_time, 'DD-MON-YYYY HH24:MI:SS') AS begin_time,
       TO_CHAR(end_time, 'DD-MON-YYYY HH24:MI:SS') AS end_time, undotsn
FROM v$undostat
ORDER BY begin_time DESC;
```

Manage stream pool size

Please follow the knowledge base Article from Oracle.
STREAM_POOL_SIZE is used for XStream Out, Set parameter MAX_SGA_SIZE to limit Streams Pool utilization

The size of Streams Pool size should be 25% higher than the sum of the MAX_SGA_SIZE settings of XStream processes:
Capture process 1G MAX_SGA_SIZE
POOL SIZE need to be 25% higher of all MAX_SGA_SIZE settings

XStream-Out
Set parameter MAX_SGA_SIZE to limit Streams Pool utilization.

- With Automatic (Shared) Memory Management enabled (recommended), no minimum memory is needed for the Streams Pool
- Without Automatic (Shared) Memory Management enabled,
- the Streams Pool can allocate up to 10% of the Shared Pool if the STREAMS_POOL_SIZE is not set and Root-Level Extract, Integrated Replicat or XStream are in use.
- ⟹ Shared pool size need to be higher

For Snapshot Flashback Query

The connector uses Oracle Flashback Query to perform snapshot operations. The snapshot query may fail with a "snapshot too old" error (ORA-01555) if the undo data required for a consistent view has been overwritten and is no longer available in the undo segments. If this happens, consider increasing the **UNDO_RETENTION parameter** so that undo data is retained for a duration longer than the longest expected snapshot operation. Also, ensure that the undo tablespace has enough space to support the configured undo retention.

Flashback Query retrieves historical data from the Undo tablespace:

- Size Undo tablespace adequately:
- Set Undo tablespace large enough to hold transaction data for your required flashback duration:

```
ALTER DATABASE DATAFILE 'undotbs01.dbf' RESIZE 20G;
```

- Increase Undo Retention: For predictable and longer history retention, set a higher undo retention period:

```
ALTER SYSTEM SET UNDO_RETENTION=21600; -- 6 hours, for example
```

- Enable Automatic Undo Management (AUM): (Recommended & default) ensures Oracle dynamically manages undo segments efficiently
- Think about using Flashback Data Archives instead: FDA drastically improves historical query performance and reduces undo load on standard Undo segments.

Database Parameter for UNDO Performance

- Ensure UNDO_MANAGEMENT=AUTO.
- Adjust undo retention (UNDO_RETENTION) based on usage.
- Ensure sufficient database buffer cache and efficient I/O for the Undo tablespace files.

Optimize Redo Log Setup

- Use large redo log files to minimize frequent log switches:

```
ALTER DATABASE ADD LOGFILE GROUP 4 ('+REDO') SIZE 8G;
```

- Place redo logs on the fastest available storage (SSD/NVMe).
- Ensure archiving is fast enough, with multiple archiver processes configured:

```
ALTER SYSTEM SET LOG_ARCHIVE_MAX_PROCESSES=4;
```

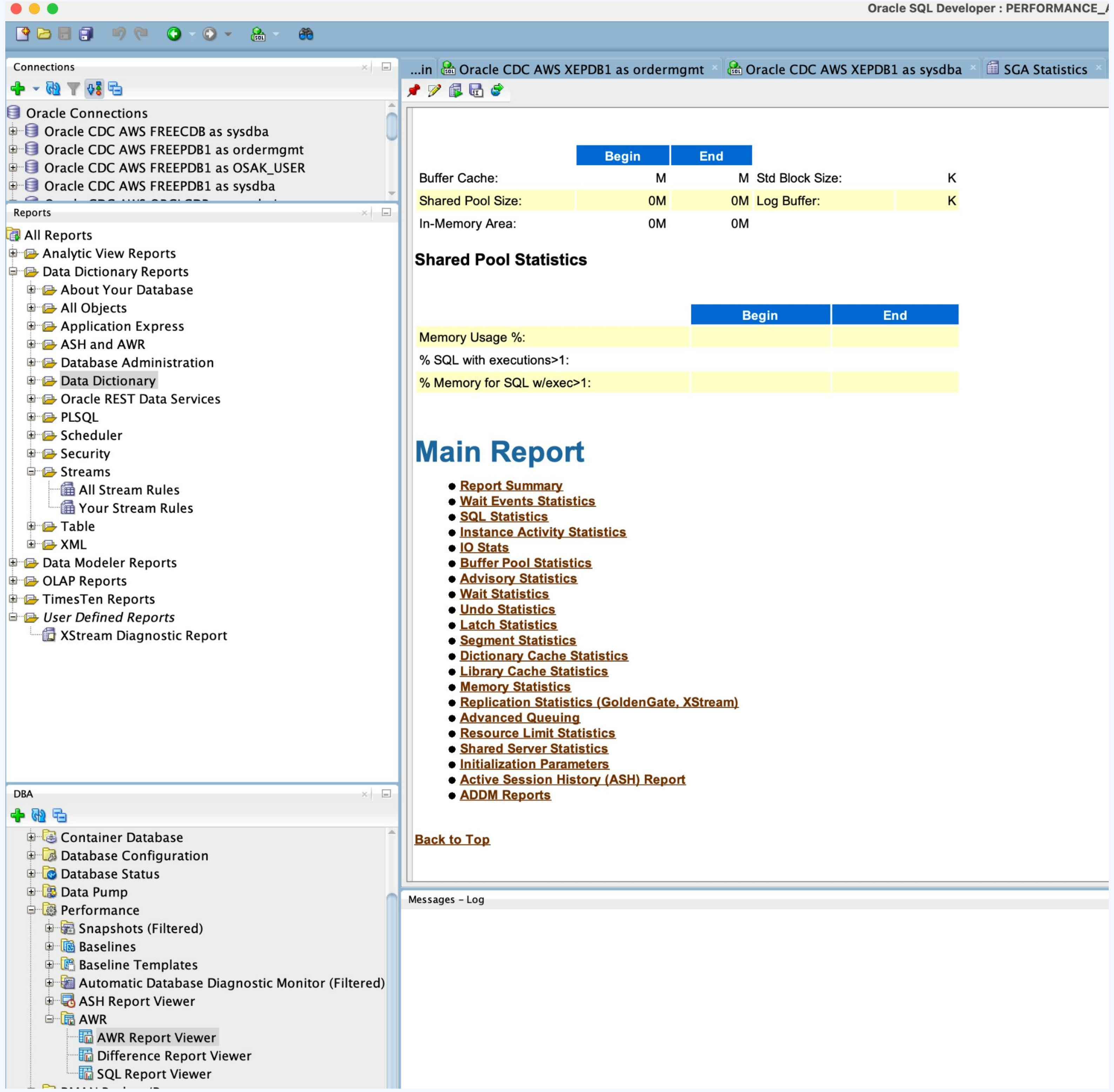
Using AWR and ADDM for Performance Tuning (License)

Oracle’s Automatic Workload Repository (AWR) and Automatic Database Diagnostic Monitor (ADDM) are invaluable for diagnosing performance bottlenecks in a high-throughput XStream environment. Here we outline a step-by-step process to leverage AWR/ADDM to identify issues and guide tuning:

- **Step 1:** Capture AWR Snapshots during Peak CDC Workload. Ensure AWR is enabled (it is by default on Enterprise Edition) and configured with a retention long enough to cover your analysis window. During a period of heavy CDC activity (e.g. when streaming ~100 GB/hour), take an AWR snapshot at the beginning and end of the interval.
- **Step 2:** Generate an AWR Report. Use Oracle’s awrrpt.sql script or Oracle Enterprise Manager (OEM) to generate a report for the snapshot interval. The AWR report will show the Top Wait Events, SQL statistics, Instance activity, Memory use, etc., for that period. Focus on sections relevant to log writer, LogMiner, and streams
- **Step 3: Review ADDM Analysis.** After an AWR snapshot, ADDM automatically analyzes the period and pinpoints the largest performance issues. that’s not the case).
- **Step 4:** Implement and Monitor Changes. Based on AWR/ADDM, implement changes.
- **Step 5:** Specific AWR Metrics for XStream: You can create a custom AWR Baseline for the CDC process. For instance, when the CDC is running, capture an AWR baseline and label it. This can help compare before/after metrics when you adjust settings. Key metrics to watch between runs:
  - Redo size per second (in AWR this is “redo size” statistic).
  - Streams pool usage – if you query at peak, SELECT SGA_USED, SGA_ALLOCATED FROM V$STREAMS_CAPTURE and compare to Streams pool size.
  - Capture latency – not directly in AWR, but you can infer by checking the last SCN/time mined vs current time (we’ll cover direct queries in Monitoring section).
  - Apply (outbound) idle time – AWR might show that the apply (outbound) was waiting on “Streams AQ: waiting for messages” or “SQL*Net more data to client” indicating it’s mostly waiting on the network/client, which could mean the bottleneck is outside the DB.

AWR and ADDR in SQL Developer

You can run AWR and will have in Report a section for GG, Xstream Statistics. Be aware that you need a special Oracle license for running AWR and ADDR, please contact your Oracle support



	Begin	End		
Buffer Cache:	M	M	Std Block Size:	K
Shared Pool Size:	0M	0M	Log Buffer:	K
In-Memory Area:	0M	0M		

Shared Pool Statistics

	Begin	End
Memory Usage %:		
% SQL with executions>1:		
% Memory for SQL w/exec>1:		

Main Report

- Report Summary
- Wait Events Statistics
- SQL Statistics
- Instance Activity Statistics
- IO Stats
- Buffer Pool Statistics
- Advisory Statistics
- Wait Statistics
- Undo Statistics
- Latch Statistics
- Segment Statistics
- Dictionary Cache Statistics
- Library Cache Statistics
- Memory Statistics
- Replication Statistics (GoldenGate, XStream)
- Advanced Queuing
- Resource Limit Statistics
- Shared Server Statistics
- Initialization Parameters
- Active Session History (ASH) Report
- ADDM Reports

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Oracle Replication Performance Advisor

The Oracle Replication Performance Advisor consists a collection of data dictionary views.
The Performance Advisor tracks the following types of components in an XStream environment:

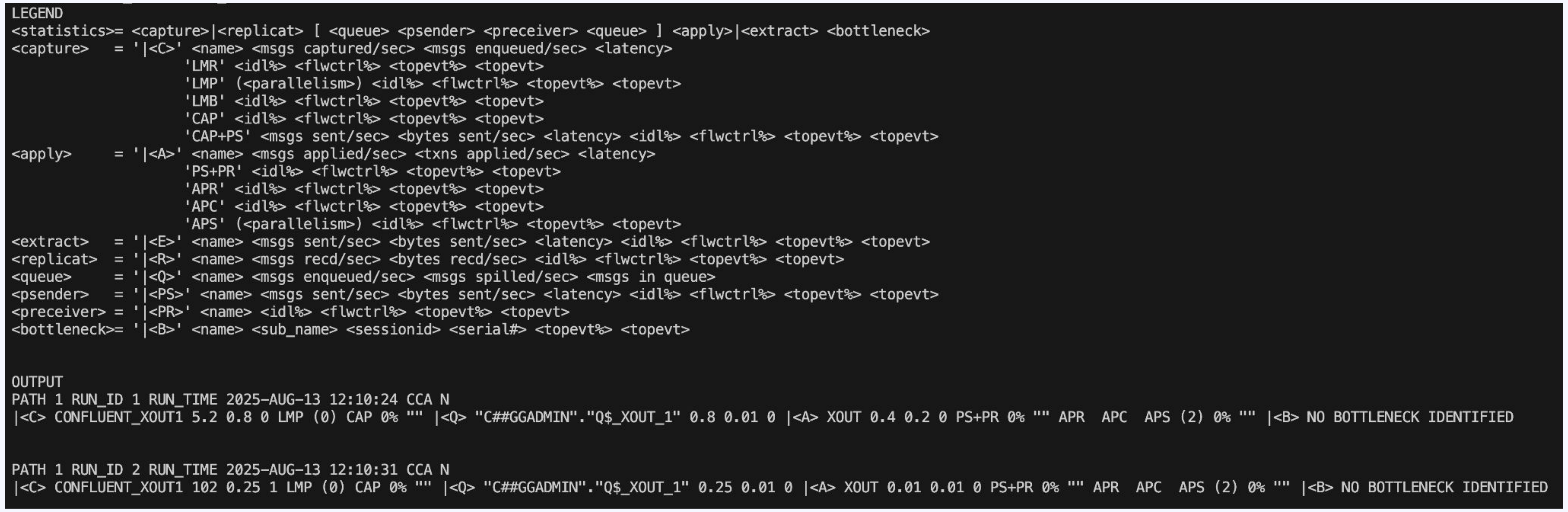
- QUEUE
- CAPTURE
- PROPAGATION SENDER
- PROPAGATION RECEIVER
- APPLY

In addition, the Performance Advisor identifies a bottleneck component as the busiest component or the component with the least amount of idle time. In an XStream configuration, the XStream client application might be the bottleneck when EXTERNAL appears in the ACTION_NAME column of the **DBA_STREAMS_TP_PATH_BOTTLENECK** view.

RUN Performance Advisor in Oracle, see utlrpadv

```
-- Start advisor, how to run documented here
cd $ORACLE_HOME/rdbms/admin
-- login as GG Admin
sqlplus c##ggadmin@XE
-- Load Advisor
SQL> @utlrpadv.sql
-- To collect the current XStream performance statistics once
SQL> exec UTL_RPADV.COLLECT_STATS;
-- To monitor continually start
-- SQL> exec UTL_RPADV.START_MONITORING
SQL> set serveroutput on
SQL> exec UTL_RPADV.SHOW_STATS;
```

Outcome: No Bottlenecks



```
LEGEND
<statistics>= <capture>|<replicat> [ <queue> <psender> <preceiver> <queue> ] <apply>|<extract> <bottleneck>
<capture>   = '|<C>' <name> <msgs captured/sec> <msgs enqueued/sec> <latency>
                    'LMR' <idl%> <flwctrl%> <topevt%> <topevt>
                    'LMP' (<parallelism>) <idl%> <flwctrl%> <topevt%> <topevt>
                    'LMB' <idl%> <flwctrl%> <topevt%> <topevt>
                    'CAP' <idl%> <flwctrl%> <topevt%> <topevt>
                    'CAP+PS' <msgs sent/sec> <bytes sent/sec> <latency> <idl%> <flwctrl%> <topevt%> <topevt>
<apply>     = '|<A>' <name> <msgs applied/sec> <txns applied/sec> <latency>
                    'PS+PR' <idl%> <flwctrl%> <topevt%> <topevt>
                    'APR' <idl%> <flwctrl%> <topevt%> <topevt>
                    'APC' <idl%> <flwctrl%> <topevt%> <topevt>
                    'APS' (<parallelism>) <idl%> <flwctrl%> <topevt%> <topevt>
<extract>   = '|<E>' <name> <msgs sent/sec> <bytes sent/sec> <latency> <idl%> <flwctrl%> <topevt%> <topevt>
<replicat>  = '|<R>' <name> <msgs recd/sec> <bytes recd/sec> <idl%> <flwctrl%> <topevt%> <topevt>
<queue>     = '|<Q>' <name> <msgs enqueued/sec> <msgs spilled/sec> <msgs in queue>
<psender>   = '|<PS>' <name> <msgs sent/sec> <bytes sent/sec> <latency> <idl%> <flwctrl%> <topevt%> <topevt>
<preceiver> = '|<PR>' <name> <idl%> <flwctrl%> <topevt%> <topevt>
<bottleneck>= '|<B>' <name> <sub_name> <sessionid> <serial#> <topevt%> <topevt>


OUTPUT
PATH 1 RUN_ID 1 RUN_TIME 2025-AUG-13 12:10:24 CCA N
|<C> CONFLUENT_XOUT1 5.2 0.8 0 LMP (0) CAP 0% "" |<Q> "C##GGADMIN"."Q$_XOUT_1" 0.8 0.01 0 |<A> XOUT 0.4 0.2 0 PS+PR 0% "" APR  APC  APS (2) 0% "" |<B> NO BOTTLENECK IDENTIFIED


PATH 1 RUN_ID 2 RUN_TIME 2025-AUG-13 12:10:31 CCA N
|<C> CONFLUENT_XOUT1 102 0.25 1 LMP (0) CAP 0% "" |<Q> "C##GGADMIN"."Q$_XOUT_1" 0.25 0.01 0 |<A> XOUT 0.01 0.01 0 PS+PR 0% "" APR  APC  APS (2) 0% "" |<B> NO BOTTLENECK IDENTIFIED
```

The parallelism capture process parameter controls capture process parallelism

The parallelism capture process parameter controls capture process parallelism. When capture process parallelism is 0 (zero), the default for XStream Out, the capture process does not use subcomponents to perform its work. Instead, the CPnn process completes all of the tasks required to capture database changes.

When capture process parallelism is greater than 0, the capture process uses the underlying LogMiner process name is MSnn, where nn can include letters and numbers. When capture process parallelism is 0 (zero), the capture process does not use this process. The process consists of

- One reader server that reads the redo log and divides the redo log into regions.
- One or more preparer servers that scan the regions defined by the reader server in parallel and perform prefiltering of changes found in the redo log. **You can control the number of preparer servers using the parallelism capture process parameter.**
- One builder server that merges redo records from the preparer servers. The builder server preserves the system change number (SCN) order of these redo records and passes the merged redo records to the capture process.

Recovery

Dealing with ORA-021560 if you want to go back in past

See Offset Management Trails

This mostly has to do with Kafka and XOUT offset SCNs getting "out of sync", for whatever reason(s).
To reset XOUT, you can always DROP_OUTBOUND and ADD_OUTBOUND, but you can also ALTER_OUTBOUND

1. Extract the offset from the schema topic via your fave method, Inspect via C3 or

```
kafka-console-consumer --bootstrap-server localhost:9092 --topic __oracle-schema-changes.cflt
--from-beginning --max-messages 1|more
  "position" : {
    "snapshot" : "INITIAL",
    "scn" : "9268080",
    "snapshot_completed" : false
  },
```

2. Either edit &new_scn or call this sample reset_scn.sql and pass in the new scn (9268080 in this case)

```
$ sqlplus connect / as dba  reset_scn.sql
-- Reset the OUTBOUND SCN when you get ORA-21560
BEGIN
  DBMS_XSTREAM_ADM.ALTER_OUTBOUND(
    server_name => 'xout',
    start_scn    => &new_scn);
END;
/
```

3. Check to see START_SCN (set to a log boundary) has been adjusted

```
COL capture_name format a20
SELECT capture_name,applied_scn
FROM all_capture;
```

4. Restart CDCv2 and stream mode should be OK again (edited)

When will ORA-21560 be triggered

* Trigger Scenarios:
  * Connector downtime while outbound advances.
  * Offset resets/manual changes.
  * Potential race in commit order (offset commit before DB low watermark update).
* Discussion Points:
  * Confirm precise conditions that cause this misalignment.
  * Is pushing PROCESSED_LOW_POSITION to offset ever safe? How to validate no data loss?
  * Is there a supported “fast recovery” procedure without resnapshot?
  * How to proactively detect pending misalignment before restart?
  * Log/debug configurations to capture pre-failure state.

Why the CDC is interested in the redo-logs that are more than x days old?

Why does it need to look back to the past? See slides 59 and more

Best Practices

Adding to much tables

see adding_tables.md

Avoid deleting Archive Logs

- See my collected information here

Waiting for REDO

WAITING FOR REDO - This state shows the Outbound Server is waiting on redo logs to continue its work. If redo/archivelogs are missing then the Outbound Server will wait, without throwing errors until the missing redo is available

If the state is WAITING FOR REDO request the user to query the REQUIRED_CHECKPOINT_SCN column in the ALL_CAPTURE data dictionary view to verify if the capture process is made available the archived redo log file containing required checkpoint SCN. If the REQUIRED_CHECKPOINT_SCN is not available to the capture process, then the capture process is most likely not recoverable and the customer should be advised to create a new outbound server and drop the existing one. This should be followed by creation of a new connector with the new outbound server. Changing outbound server in existing connector is not advised.

Waiting for new redo log files to be added to the capture process session. The capture process has finished processing all of the redo log files added to its session. This state is possible if there is no activity at a source database

See my collection. You can also check with diagnostic script from Confluent.

Waiting for REDO: REQUIRED_CHECKPOINT_SCN

REQUIRED_CHECKPOINT_SCN (RCS)
If the required Checkpoint SCN is not available in logs, Capture process is waiting for REDO
Why?

- RSC not updated because of inactive session. See KB
- RSC not updated because of long running transaction, See KB
- Capture restart from old archive log, see KB

Why WAITING FOR REDO?

Primary Note from Oracle.
The nature of the problem could be :

- a missing logfile; or
- a logfile is not registered; or
- a logfile is corrupted; or
- Capture is verifying/prechecking logfiles

The process will remain in this state until the log is located, it is registered, the corruption is resolved in which case it will also be necessary to reregister the log or the Capture process has checked the logfiles on disk

CAUSE
Common issues which can cause Capture to stop in this state are :
1.Incorrect use of RMAN backup command or RMAN Issue
2.Logs Stored in FRA - Flash Recovery Area
3.Logs not registered in dba_registered_archived_log
4.Logs marked as corrupted in system.logmnr_log$
5.required_checkpoint_scn issues
6.Capture Prevalidation of Logs in dba_registered_archived_log
7.Logs deleted in error or damaged due to OS/Storage issues
8.Capture can stuck due to missing archive logs

Capture Process Checkpoint Retention Time

Set the checkpoint retention time for each capture process.

Periodically, a capture process **takes a checkpoint to facilitate quicker restart.** These checkpoints are **maintained in the SYSAUX tablespace** by default.

Do not forget to **manage SYSAUX Tablespace**

The **checkpoint retention time for a capture process controls the amount of checkpoint data it retains.** The checkpoint retention time s**pecifies the number of days before the required checkpoint SCN to retain checkpoints**. When a **checkpoint is older than the specified time period, the capture process purges the checkpoint.**

When **checkpoints are purged, the first SCN for the capture process moves forward,** and Oracle Database writes a message including the text "f**irst scn changed" to the alert log**. The first SCN is the lowest possible SCN available for capturing changes.

Capture Process and Build Dictionary

If you run DBMS_XSTREAM_ADM.CREATE_OUTBOUND Procedure all components like Capture Process, Queue etc. are created.

You need to execute at least one a Build call.
When the new capture process is started for the first time, it creates a new LogMiner data dictionary using the data dictionary information in the redo log. If the BUILD procedure has not been run at least once on the source database, then an error is raised when the capture process is started.
In some situations the build process is not started.

A table in oracle documentation described when a dictionar is not build.

Oracle Error: ORA-04031: unable to allocate BYTES

- If you don’t care abount STREAM_POOL_SIZE you will get some day ORA-04031.
- I did document a summary of information for you here.

The two main problems occur:
Problem 1: Streams Pool Size Is Too Small and
Problem 2: The Maximum SGA Size for the Capture Process Is Too Small

Do not change DB Global Names

Both row LCRs and DDL LCRs contain the source database name of the database where a change originated. To avoid problems, **Oracle recommends that you do not change the global name** of the source database after a capture process has started capturing changes.

Data Transformation in Oracle database

Transformation in Database, is a real Shift-Left scenario, anyway remember

- We can transform data in connector, see SMT Sample (still shift-Left)
- We can transform data in Kafka e.g. with Flink SQL (still shift-Left)
- We can transform data later in target e.g. the new modern Data warehouse like databricks (no shift-left anymore)

BUT,
you also can **transform in the source database before sending**.
XStream uses rules and rule sets.
A rule is a database object that enables a client to perform an action when an event occurs and a condition is satisfied. In our case we are using table and schema rules only. Y**ou can create declaratives rule-based information to add column, delete column and more simple transformations like renaming**. You can transform the data in Oracle DB before sending.
One limit is that DDL rules should not be specified otherwise add_column would not work.

Another consideration is that transformation in DB slow down the throughput.

Be aware, that in general, it is best for the client application to perform transformations of the data. So, in Kafka.

CONFLUENT