Justifications for the optimization part

This document provides a detailed justification for the optimization strategies applied to the database schema. The proposed SQL queries and the data access structures are at the end of this document.

Implementing a star schema enhances the efficiency of handling analytical queries while simplifying database design. The schema's clear separation of fact and dimension tables allows for faster joins and streamlined aggregations, making it well-suited for our analytical needs.

We defined AircraftID as the primary key in the AircraftUtilization fact table because it is essential for the index-based joins required in later queries. Adding additional primary keys would provide minimal optimization benefits while increasing block usage. Therefore, we opted for a single primary key to maintain a balance between performance and resource utilization.

Our queries involve filtering and aggregating data over attributes like AircraftID, MonthID, and Model. Bitmap indexes significantly simplify and accelerate these operations by enabling fast subset selection and efficient access paths, thereby reducing the need for full table scans. To support this, we created two bitmap indexes: one on AircraftID in the AircraftUtilization table, which optimizes query performance across all KPIs, and another on PersonID in the LogBookReporting table, which specifically reduces costs for KPI 3 and KPI 4.

Additionally, we implemented two join indexes:

1. AircraftUtilization_Join: This index maps aircraft models to utilization records, optimizing the cost of queries that group or filter by model.
2. LogBookReporting_Join: This index facilitates filtering and aggregation by aircraft model directly within the logbook data, further enhancing query performance.

While additional indexes could further reduce query costs, our optimization is constrained by a limit of 1,900 disk blocks. Within these constraints, we have achieved the maximum possible optimization for our workload.

INDEXES

```
-- Star schema
ALTER SESSION SET star_transformation_enabled = TRUE;
COMMENT ON TABLE AIRCRAFTUTILIZATION IS 'star_transformation_enabled';
COMMENT ON TABLE LOGBOOKREPORTING IS 'star_transformation_enabled';

-- PK
ALTER TABLE AircraftDimension ADD PRIMARY KEY (ID) USING INDEX PCTFREE 33;

------- AircraftUtilization ------------------------

CREATE BITMAP INDEX idx_utilization_aircraftID ON AircraftUtilization (AIRCRAFTID)
PCTFREE 0;
-- join index
CREATE BITMAP INDEX AircraftUtilization_Join
ON    AIRCRAFTUTILIZATION(AIRCRAFTDIMENSION.model)
FROM  AIRCRAFTUTILIZATION, AIRCRAFTDIMENSION
WHERE AIRCRAFTUTILIZATION.AIRCRAFTID = AIRCRAFTDIMENSION.ID PCTFREE 0;



------- LogBookReporting ------------------------
CREATE BITMAP INDEX idx_logbook_personID ON LogBookReporting (personid) PCTFREE 0;
-- join index
CREATE BITMAP INDEX LogBookReporting_Join
ON    LogBookReporting(AIRCRAFTDIMENSION.model)
FROM  LogBookReporting, AIRCRAFTDIMENSION
WHERE LogBookReporting.AIRCRAFTID = AIRCRAFTDIMENSION.ID PCTFREE 0;
```

KPIs

```
---- KPI 1: Give me FH and FC per month, filtered by the aircraft model (e.g.,
"777").
SELECT
   SUM(a.FLIGHTHOURS) AS FLIGHTHOURS,
   SUM(a.FLIGHTCYCLES) AS FLIGHTCYCLES,
   t.monthID,
   ad.MODEL
FROM
   AIRCRAFTUTILIZATION a
JOIN
   TEMPORALDIMENSION t ON a.TIMEID = t.ID
JOIN
   AIRCRAFTDIMENSION ad ON a.AIRCRAFTID = ad.ID
WHERE ad.MODEL = '777'
GROUP BY
   t.monthID,
   ad.model
```

```
--- KPI 2 Give me ADOSS, ADOSU per year, filtered by the aircraft from the fleet
(e.g., "XY-WTR").

SELECT sum(AAM.ADOSS), sum(AAM.ADOSU), m.Y, aam.AIRCRAFT
FROM AIRCRAFTUTILIZATION_A_M aam, MONTHS m
WHERE aam."MONTH" = m.ID AND
     aam.AIRCRAFT = 'XY-WTR'
GROUP BY m.Y, AIRCRAFT

--- KPI 3: Give me the RRh, RRc, PRRh, PRRc, MRRh and MRRc per month, filtered by
the aircraft model (e.g., "777").

SELECT
   1000 * (SUM(l.COUNTER) / SUM(a.FLIGHTHOURS)) AS RRh,
   100  * (SUM(l.COUNTER) / SUM(a.FLIGHTCYCLES)) AS RRc,
   1000 * (SUM(CASE WHEN p.role = 'P' THEN l.COUNTER ELSE 0 END) /
SUM(a.FlightHours)) AS PRRh,
   100 * (SUM(CASE WHEN p.role = 'P' THEN l.COUNTER ELSE 0 END) /
SUM(a.FLIGHTCYCLES)) AS PRRc,
   1000 * (SUM(CASE WHEN p.role = 'M' THEN l.COUNTER ELSE 0 END) /
SUM(a.FlightHours)) AS MRRh,
   100 * (SUM(CASE WHEN p.role = 'M' THEN l.COUNTER ELSE 0 END) /
SUM(a.FLIGHTCYCLES)) AS MRRc,
   t.monthID,
   ad.model AS AircraftModel
FROM
   LOGBOOKREPORTING l
JOIN
   MONTHS m ON m.ID = l.MONTHID
JOIN
   TEMPORALDIMENSION t ON t.monthID = m.ID
JOIN
   AIRCRAFTDIMENSION ad ON ad.ID = l.AIRCRAFTID
JOIN
   AIRCRAFTUTILIZATION a ON a.AIRCRAFTID = ad.ID AND a.TIMEID = t.ID
JOIN
    PEOPLEDIMENSION p ON p.ID = l.personID
WHERE ad.model = '777'
GROUP BY
   t.monthID, ad.model
ORDER BY
   t.monthID ASC;
```

```
-- KPI 4:  Give me the MRRh and MRRc per aircraft model, filtered by the airport of
the reporting person (e.g., "KRS"). 1749
SELECT a.MODEL AS aircraftModel,
   SUM(LAMP.MAREP)/SUM(aam.FH) * 1000 AS MMRh,
   SUM(LAMP.MAREP)/ SUM(aam.FC)*100 AS MMRc
FROM LOGBOOKREPORTING_A_M_P lamp,
   AIRCRAFTUTILIZATION_A_M aam,
   PEOPLEDIMENSION p,
   AIRCRAFTDIMENSION a
WHERE LAMP.AIRCRAFT = AAM.AIRCRAFT
   AND LAMP.PERSON = p.ID
   AND LAMP.AIRCRAFT = a.ID
   AND p.AIRPORT = 'KRS'
GROUP BY a.model
```