Performance Optimization with SAP on IBM DB2 for Linux, UNIX and Windows - SAP NetWeaver BW

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Overview and recommendations for usage of IBM DB2 for LUW Features exploited in SAP NetWeaver BW

- Database Partitioning Feature (DPF)
- Multi-dimensional Clustering (MDC)
- Row Compression
- Self-tuning Memory (STMM)
- BLU
Agenda

- Overview and recommendations for usage of IBM DB2 for LUW Features exploited in SAP NetWeaver BW
  - Database Partitioning Feature (DPF)
  - Multi-dimensional Clustering (MDC)
  - Row Compression
  - Self-tuning Memory (STMM)
  - BLU
DB2 for LUW Database Partitioning Feature (DPF)

- One database can be divided into database partitions which can reside on several separate computers
- Each partition has its own Buffer Pools, Sort Areas and Logging.

- Shared nothing data distribution
  - Each Partition accesses only its local Data
  - Hash function is used to distribute table records horizontally on database partitions

- Several logical partitions can be on the same machine
  - Physical or Logical Partitioning is transparent to the database.

- Fast communication needed

Parallel Processing: Queries, Backup, …
Parallel Query Processing with DPF Feature

- The coordinator partition (Partition, to which the client is connected) prepares the SQL statement and distributes the access plan parts (blue) to all other partitions involved in answering the query.

- Each partition computes its results. Maybe data has to be shipped between partitions in that process.

- Finally the local result is sent back to the coordinator partition, summarized there and then returned to the client.
Advantages of DPF Feature

- Near-linear scalability
  - Start with small database server, add additional CPU resources and memory when needed
  - Or start with one database server and add additional database servers later when needed
- Better CPU utilization through parallel execution of SQL queries
  - Faster query execution
- Reduction of time spent for maintenance
  - Parallel backup of database partitions
  - Parallel creation for indexes on all partitions where table resided
  - Parallel table reorganization on all partitions where table resides
  - Statistics are only collected on the first partition where table resides
Data Structures in SAP NW BW

SAP NW BW specific tablespaces

Multidimensional Model

InfoCube

Fact

Customer

Multidimensional models (InfoCubes and Aggregates)

Operational DataStore (DataStore)

Persistent Staging Area (PSA)

Master Data (InfoObjects)

Any Source

Information Access

SAP Basis Tablespaces

<SID>#STABD
<SID>#STABI

<SID>#ODSD
<SID>#ODSI

<SID>#FACTD
<SID>#FACTI

<SID>#DIMD
<SID>#DIMI
SAP Application Servers connected to DB partition 0
- Fast access to SAP Basis, master data and dimension tables
- Large SAP NetWeaver BW tablespaces distributed over several additional DB partitions
  - Distribution Key generated automatically
  - Uniform data distribution

- SAP Application Server
- SAP Application Server

Partition 0 (Administration Part.)
- SAP Basis Tables
  - Master Data Tables
  - SAPNODEGRP_<SID>
- Dimension Tables
  - NGRP_DIM_<SID>

Partition 1 (Data Part.)
- PSA and DataStore Tables
  - (<SID>#ODSD, <SID>#ODSI)
  - NGRP_ODS_<SID>
- Fact Tables
  - (<SID>#FACTD, <SID>#FACTI)
  - NGRP_FACT_<SID>

Partition 2 (Data Part.)

Partition <n> (Data Part.)

Fast Communication Manager
Ca. 80% der Daten des BW liegen in DODS und DFACT
DPF Integration into SAP NW BW

- Installation program SAPinst
  - Add new database partitions

- SAP NW BW
  - Distribution of InfoCube fact, DataStore object (DSO) and PSA tables by assigning a data class which is mapped to a distributed tablespace
  - Automatic generation of distribution keys ensures even distribution of data over the database partitions
  - Functions for checking distribution keys (SAP note 648432)

- DBA Cockpit
  - Administration and monitoring of database partitions

- SAP Database Performance Warehouse (SAP Solution Manager 7.0 EhP 1)
  - Performance monitoring of database partitions including history
Table Distribution via Selection of Data Class
DB Partition Overview in DBA Cockpit
Reporting over DB Partitions in SAP Database Performance Warehouse
Enhancements for DPF since DB2 V9.1

- Automatic Storage support for DPF (DB2 V9.1)
  - Default for new SAP NW BW installations (7.0 SR3)
- New Fast Communication Manager implementation with improved performance (DB2 V9.1)
- Single-system view backup (DB2 V9.5)
  - Capability to create a backup of all database partitions with one command including support for “INCLUDE LOGS”
  - SAP Planning Calendar can now provide backups for DPF systems
- Single-system database configuration update (DB2 V9.5)
  - Updates of database configuration parameters can be distributed to all partitions
  - Eases the handling of SAP NW BW systems with many partitions
- Faster redistribute (DB2 V9.5 FixPack 1)
SAP NW BW Operations that Benefit from DPF

- Reporting – parallel execution of queries processing large amounts of data
- InfoCube compression
- Aggregate rollup
- InfoPackage deletion and selective deletion
- Recreation of InfoCube indexes after data load
- Statistics collection
- **New in SAP NW BW 7.3**: DataStore object data activation optimized for DPF parallel processing (1645327)
  - Parallelization at database level instead of SAP application server level
DPF-Optimized DSO Data Activation in SAP NW BW 7.3

- **Restrictions**
  - Standard DSOs only
  - Unique Data Records flag not set for DSO
  - DSO distributed over at least 4 database partitions
  - Only applies to records in activation queue the semantic key of which occurs only once
  - Duplicate keys are processed separately in the standard way

**Performance improvement up to factors compared to SAP NW BW 7.0/7.01**
DPF Recommendations for SAP NW BW

- Use DPF for BW systems > 500 GB and with fact tables, DataStore object tables and PSA tables with more than 2 million records
  - Take growth within next 1-4 years into account
- Use SAP sizing process or customer specific benchmark to determine CPU and memory resources for the SAP system
- Reserve about 20% of CPU and memory for the database for the administration partition
  - Contains SAP basis, master data and dimension tables
  - All SAP application servers connect to partition 0
- 1 to 4 CPU cores for each data partition
- Avoid over-partitioning
  - 24 to 32 database partitions + administration partition enough even for very large databases > 30 TB
DPF Recommendations for SAP NW BW (cont.)

- Distribution of large tables (> 2 million records) with following restrictions:
  - E and F fact tables of InfoCubes in the same tablespace
  - Aggregate fact tables in the same tablespace
  - DataStore object active and change log table in the same tablespace

- Distribution proposal

<table>
<thead>
<tr>
<th>Number of Data Partitions</th>
<th>Table Size</th>
<th>Database Partitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>&lt; 2 million records</td>
<td>DB partition 0</td>
</tr>
<tr>
<td></td>
<td>&gt;= 2 million records</td>
<td>On all DB partitions</td>
</tr>
<tr>
<td>8</td>
<td>&lt; 2 million records</td>
<td>DB partition 0</td>
</tr>
<tr>
<td></td>
<td>&gt;= 2 million records</td>
<td>On all DB partitions</td>
</tr>
<tr>
<td>12</td>
<td>&lt; 2 million records</td>
<td>DB partition 0</td>
</tr>
<tr>
<td></td>
<td>&gt;= 2 million records</td>
<td>On all DB partitions</td>
</tr>
<tr>
<td>16</td>
<td>&lt; 2 million records</td>
<td>DB Partition 0</td>
</tr>
<tr>
<td></td>
<td>2-16 million records</td>
<td>On 8 data partitions</td>
</tr>
<tr>
<td></td>
<td>&gt; 16 million records</td>
<td>On all data partitions</td>
</tr>
<tr>
<td>24 or 32</td>
<td>&lt; 2 million records</td>
<td>DB Partition 0</td>
</tr>
<tr>
<td></td>
<td>2-16 million records</td>
<td>On 8 data partitions</td>
</tr>
<tr>
<td></td>
<td>&gt; 16 million records</td>
<td>On all data partitions</td>
</tr>
</tbody>
</table>
Recommended Layout on 8 Data Partitions

Partition 0 (Administration Partition)
- SAP Basis Tables
- BW Master Data Tables
- BW Dimension Tables
- Small BW Fact, DSO, PSA Tables

Partition 1 (Data Partition)
- BW InfoCube and Aggregate Fact Tables

Partition 2 (Data Partition)
- BW DataStore Tables

Partition 7 (Data Partition)
- BW PSA Tables

Partition 8 (Data Partition)
Recommended Layout on 16 Data Partitions

Partition 0 (Administration Partition)
- SAP Basis Tables
- BW Master Data Tables
- BW Dimension Tables
- Small BW Fact, DSO, PSA Tables

Partition.1 (Data Partition)
- Large BW InfoCube and Aggregate Fact Tables
- Large BW DataStore Tables
- Large BW PSA Tables

Partition.2 (Data Partition)
- Medium-Sized Fact, DataStore, PSA Tables

Partition.3 (Data Partition)
- Medium-Sized Fact, DataStore, PSA Tables

Partition.4 (Data Partition)

Partition.15 (Data Partition)

Partition.16 (Data Partition)
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Problem with RID Indexes – Not optimized for multiple Key Access

- Database systems try to store the records of a table in a particular order
  - Called „data clustering“
  - Improves query performance for a single key column
  - Query performance for other keys could degrade

- Example

SELECT * FROM Sales WHERE Region = WEST
  - Usually do not require a page I/O when reading the next record (because it’s usually on same page as previous record)
  - The page I/Os that are required, are sequential (efficient)

SELECT * FROM Sales WHERE Year = 2005
  - Usually do require a page I/O when reading the next record (because it’s usually on a different page than the previous record)
  - Each of these page I/Os is random (inefficient)
Solution: Multi-Dimensional Clustering (MDC)

- MDC organizes table data along one or more columns defined as MDC dimensions
  - Records with the same values in one or more columns are stored physically together in blocks of pages
  - Blocks correspond to tablespace extents
  - MDC block indexes point to blocks instead of single rows
  - Improves query performance for more than one key column (MDC dimensions)

- Example

```
SELECT * FROM Sales WHERE Region = WEST
```
- 2 big block I/Os to retrieve pages containing region WEST
- All sequential I/O (efficient)

```
SELECT * FROM Sales WHERE Year = 2005
```
- 2 big block I/Os to retrieve pages containing year 2005
- All sequential I/O (efficient)
MDC Fast Insert / Fast Delete

- **MDC fast insert: Reduced locking**
  - Enabled by setting LOCKSIZE parameter of an MDC table to BLOCKINSERT (during table creation or by ALTER TABLE)
  - Locks MDC blocks instead of single rows

- **MDC fast delete (MDC Rollout)**
  - Mark pages as deleted instead of single rows
  - Synchronous cleanup of additional secondary indexes in the standard way in DB2 V9.1
  - **Asynchronous index cleanup in DB2 V9.5 (like for range-partitioning) ➔ large delete operations return much faster**
MDC Advantages

- Clustering is always guaranteed, no table reorganization necessary to preserve clustering order
- Significant performance improvement for queries with restrictions on the MDC dimensions
- Reduced maintenance overhead: block indexes are smaller and easier to maintain than row indexes
- Support for fast data insertion and deletion (roll-in and roll-out)

To be considered:
- Risk of high disk space consumption if wrong MDC dimensions are chosen (too many, too high cardinality)
- DB2 V9.1 and DB2 V9.5: Online REORG not supported
- Solution in DB2 9.7: free MDC blocks can be returned to tablespace online (see SAP note 1546414)

```sql
REORG TABLE <mdc-table-name> RECLAIM EXTENTS ONLY ALLOW WRITE ACCESS
```
MDC Support in SAP NW BW

- MDC is supported for PSA, DSOs, InfoCubes and Aggregates
  - MDC can be combined with DPF
  - PSA, DSO Activation Queue and Change Log tables: Enabled via RSADMIN parameter DB6_MDC_FOR_PSA=YES
  - InfoCube Fact tables, DSO Active Table: Manual selection of MDC dimensions during InfoCube/DSO creation
- "MDC Advisor" in DBA Cockpit (SAP NW BW 7.0 EhP 1)
- Re-clustering tool to convert existing InfoCubes / DSOs to MDC
  - Can be combined with compression
- Disk space consumption test in SAP NW BW transaction RSRV
- RSADMIN configuration parameters
  - DB6_MDC_FOR_PSA
    MDC for PSA and PSA-like tables (Default NO, changed to YES starting with SAP note 1481572)
  - DB6_MDC_FOR_AGGREGATES
    Aggregates inherit MDC settings from InfoCube if possible (Default YES)
  - DB6_MAX_MDC_COLS
    Maximum number of MDC dimensions that can be selected (Default 3)
Define MDC for InfoCubes

Edit InfoCube: Extras – DB Performance - Clustering

Select Type of Clustering
- Index Clustering
- Multi-Dimensional Clustering
MDC Advisor (SAP NW BW 7.0 EhP 1)

- Tool in DBA COCKPIT that calls the DB2 MDC Design Advisor to recommend MDC dimensions for InfoCubes and DSOs
- User can store queries executed on one or several InfoCubes/DSOs in a workload table
- MDC Advisor can be called to analyze workload
  - Generates recommendations for MDC dimensions that improve performance of queries in the workload
  - Estimates percentage of performance improvement and disk space consumption
- MDC recommendations can be implemented with re-clustering function
MDC Advisor in DBA Cockpit – Input Page

BW Administration: MDC Advisor

Input

<table>
<thead>
<tr>
<th>Database Provider</th>
<th>Tablespace</th>
<th>Number of Database(s)</th>
<th>Start</th>
<th>Stop</th>
<th>Used</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZOL_MDC1</td>
<td>SAPOOLS</td>
<td>2</td>
<td>13:35:26</td>
<td>2008/09/03 14:35:31</td>
<td></td>
<td>ANALYZED</td>
</tr>
<tr>
<td>ZOL_MDC2</td>
<td>SAPOOLS</td>
<td>6</td>
<td>13:35:26</td>
<td>2008/09/03 14:35:31</td>
<td></td>
<td>COLLECTED</td>
</tr>
<tr>
<td>ZOL_MDC3</td>
<td>SAPOOLS</td>
<td>1</td>
<td>13:35:26</td>
<td>2008/09/03 14:35:31</td>
<td></td>
<td>ANALYZING</td>
</tr>
<tr>
<td>ZOL_MDC4</td>
<td>SAPOOLS</td>
<td>1</td>
<td>13:35:26</td>
<td>2008/09/03 14:35:31</td>
<td></td>
<td>RUNNING</td>
</tr>
<tr>
<td>ZOL_MDC5</td>
<td>SAPOOLS</td>
<td>1</td>
<td>13:35:26</td>
<td>2008/09/03 14:35:31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MDC Advisor – Füge InfoProvider hinzu

Specify the following:

- The InfoProvider that you want to analyze.
- The user who has the required authorizations to collect BW reporting queries.
  If you want BW reporting queries to be collected for more than one user, enter "*".
- The tablespace where you want to store temporary BW tables.

We recommend that you create a new tablespace.

InfoProvider: CREDIL1

User: 

Tablespace: SYSTOOLS

Add  Cancel
MDC Advisor - Grenzwerte

BW Administration: MDC Advisor

Change Thresholds for Collecting Process

Specify the thresholds for the collecting process of the MDC Advisor:

- "Query Threshold" limits the number of stored BW reporting queries.
- "Temporary BW Table Threshold" limits the number of stored temporary BW tables.

⚠️ The stored BW reporting queries and the stored temporary BW tables can consume a lot of disk space. Therefore, be careful when you change the thresholds.

Query Threshold: 1.000

Temporary BW Table Threshold: 1.000
MDC Advisor – Status des Analyse-Prozesses
MDC Advisor in DBA Cockpit – Result Page
MDC Advisor – SAP NetWeaver BW 7.30

MDC Reclustering of InfoProviders

- **InfoCube**: ZGL_MDC4
- **DataStore Object**

**DB Storage Parameters**
- **Target Data Class**
- **Target Data Class for Aggregates (InfoCube Only)**

**Row Compression**
- Compress InfoCube FactTables / DataStore Active Tables
- Number of inserted lines before compression
- Recompress after inserting all data

**Logging Parameter**
- Commit Size (MB): 380

**Reclustering Request**
- Initialize
- Monitor

**Multidimensional Clustering**
- **Package Dimension**
  - Package Dimension on Fact Table
- **Time Dimension**
  - Selected Column
  - Status Number: 0
- **Char Dimension**
  - Dimension: ZGL_MDC4 (Customer), ZGL_MDC4 (Material), ZGL_MDC4 (Sales Area), ZGL_MDC4 (Version), ZGL_MDC4 (Value Type)

Choose column of time dimension for NO Clustering and additional dimensions (specification of a status Number)
- Execute Space Check
Potential Performance Improvements with MDC in SAP NW BW

- DSO Change Log, PSA tables
  - Fast deletion of InfoPackages
  - Fast deletion of activated requests from DSO change log in case of DSO request rollback
  - Only minor insert performance improvement because MDC index is created in addition to primary key index

- DSO Active Table, InfoCubes
  - Faster reporting for queries that restrict on MDC dimension columns
  - Fast deletion of InfoPackages from fact table
  - Faster selective deletion of data from DSO and InfoCube if selection of data to be deleted is along MDC dimensions
  - InfoCubes: Faster index recreation because RID indexes are replaced by MDC block indexes which are much smaller
Examples of MDC Rollout

- InfoCube on 8 database partitions: Deletion of an InfoPackage of 5 million rows

<table>
<thead>
<tr>
<th>Without MDC (sec.)</th>
<th>With MDC on package and calendar month (sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>160</td>
<td>6</td>
</tr>
</tbody>
</table>

- DSO Rollback on 8 database partitions: MDC speeds up deletion from change log
  - BUT: deletion from change log only small part of DSO request rollback process

<table>
<thead>
<tr>
<th>InfoPackage (#rows)</th>
<th>Without MDC (sec.)</th>
<th>With MDC (sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>950.000</td>
<td>203</td>
<td>179</td>
</tr>
<tr>
<td>1.500.000</td>
<td>503</td>
<td>406</td>
</tr>
<tr>
<td>4.750.000</td>
<td>1.220</td>
<td>1.034</td>
</tr>
</tbody>
</table>
MDC Recommendations

- Create MDC tables in tablespaces with EXTENTSIZExE 2
  - Each MDC block has 32 KB (page size 16 KB * EXTENTSIZExE)
  - Avoid high disk space consumption
- DB2 9.7
  - Use MDC for PSA and PSA-like tables: set RSADMIN parameter DB6_MDC_FOR_PSA=YES
- Default in SAP NW BW 7.3 for DB2 9.7 and with SAP note 1481572 for SAP NW BW 7.0x
- InfoCubes
  - MDC on package dimension if you use InfoCube compression
  - MDC on time characteristic (0CALMONTH, 0FISCPER) or on time dimension column (if not too granular ➔ space check)
- For more fine-granular MDC settings use the MDC Advisor
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DB2 for LUW Compression in SAP NW BW

- All features for general SAP applications are supported
  - Including BW system installation with all tables compressed

- RSADMIN Parameter DB6_ROW_COMPRESSION
  - When DB6_ROW_COMPRESSION=YES all new PSA, DSO and fact tables are created with compression enabled (default with SAP note 1481572)
  - Option to compress new master data tables and dimension tables available with SAP note 1596244
  - For heterogeneous system copy
    In new versions of R3LOAD options overrule SQL files

- Global compression variable
  - Option to compress new tables controlled by DBSL. with SAP note 1690077
  - VARIABLE <schema>.GLOBAL_COMPRESSION_OPTION
Common Storage Optimization in DB2

- Provides storage compression services to optimize the performance and footprint of your data
- Basic compression features included in several editions
- Advanced compression features bundled as DB2 Storage Optimization Feature, included in Advanced Enterprise Server edition (and SAP DB2 OEM license)
DB2 for LUW Compression in SAP NW BW

- Two tests for PSA tables and InfoProviders in BW transaction RSRV (mainly for DB2 V9.1)
  - Check whether a compression dictionary exists for tables that have been created with COMPRESS YES and contain data
  - „Repair“ function allows to schedule a job that creates a compression dictionary and optionally compresses the existing data (REORG or INSPECT)
DB2 for LUW Data Compression – SAP NW BW 60TB PoC Read I/O

I/O read operations uncompressed

Significantly less I/O with compression enabled!
DB2 for LUW Compression in SAP NW BW

- Recommendation
  - DB6_ROW_COMPRESSION=YES
  - SAP NW BW 7.3 and SAP NW BW 7.0x with SAP note 1481572: DB6_ROW_COMPRESSION=YES is default if DB2 Storage Optimization Feature is licensed and DB2 version is DB2 V9.5 or higher
  - Set Global compression option additionally
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Usage of STMM in a DPF Environment

- STMM tuner runs on one partition and propagates parameter changes to the other partitions where STMM is active
- SAP NW BW
  - Workload on Administration Partition different from Workload on Data Partitions
  - Workload on Data Partitions often uniform
- Recommendation (based on customer experiences):
  - Use STMM on Administration Partition
  - Tune Data Partitions manually
Overview and recommendations for usage of IBM DB2 for LUW Features exploited in SAP NetWeaver BW

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BLU

Introduction
Test szenario
Results
SAP Adaption for DB2 10.5

Overview
- DB2 10.5 support for applications based on SAP NetWeaver 7.00 and higher
- Release date: August 2013
- Support for SL Toolset 1.0 SP08 and higher
- Minimum support package levels and kernel patch levels will be required

SAP code adaptations/enhancements for BLU in the following areas
- DB2 BLU support with additional features
- Release date: 3.Dec 2013
- DB6CONV, R3load, ABAP Dictionary
- BW and BW Nearline Storage
- DBA Cockpit
- db6_update_db
SAP BW Adoption for DB2 BLU Feature

Support of SAP Applications
- SAP NetWeaver BW 7.00 and higher
  - Support started with DB2 10.5 FP1
  - DB2 10.5 BLU extensions are delivered with SAP BW support packages in

<table>
<thead>
<tr>
<th>SAP NW Release</th>
<th>SAP Basis Support Package</th>
<th>SAP BW Support Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.00</td>
<td>SP29</td>
<td>SP31</td>
</tr>
<tr>
<td>7.01</td>
<td>SP14</td>
<td>SP14</td>
</tr>
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<td>7.02</td>
<td>SP14</td>
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<td>7.11</td>
<td>SP12</td>
<td>SP12</td>
</tr>
<tr>
<td>7.30</td>
<td>SP10</td>
<td>SP10</td>
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<tr>
<td>7.31, 7.03</td>
<td>SP09</td>
<td>SP09</td>
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<tr>
<td>7.40</td>
<td>SP04</td>
<td>SP04</td>
</tr>
</tbody>
</table>

- SAP Notes for DB2 10.5 for details
  - Note 1819734 - DB6: Support for DB2 10.5 BLU Acceleration
  - Note 1825340 - DB6: Support for DB2 10.5 BLU Acceleration in SAP NW BW
  - Note 1889656 - DB6: Mandatory Corrections for SAP NW BW on DB2 10.5 BLU Acceleration