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# SAP BW Query Performance Troubleshooting

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**Abstract**

**SAP BW Query is a key object in the Reporting Architecture. BW Queries can be used irrespective of the data modeling landscape. They are suitable to be used for S/4 HANA system reporting using Embedded Analytics and BW/4 HANA system Reporting architecture as well. Query performance is a key aspect for any development done in SAP and it is very common to have performance issues when the data size grows in the system. SAP offers effective tools and techniques for developers to make sure the query is optimized. This paper discusses in detail the available tools and techniques for BW Query performance troubleshooting and optimization.**

**Keywords: SAP BW/4 HANA, BW Query, RSRT, Performance Optimization, DB02, RSRV**

**1 Introduction:** To analyze a dataset in SAP BW/4HANA, you define queries on top of InfoProviders. By selecting and combining InfoObjects such as characteristics and key figures, or reusable query elements such as restricted and calculated key figures in a query, you define how you want to evaluate the data that comes from the selected InfoProvider. Query performance depends on overall design, data model maintenance, and query design, and there are measures you can take to discover the reasons for long query runtimes and to improve performance. Following are the key aspects to check a Query performance:

- Check layout and filter settings in the query definition
- Use query performance monitoring tools
- Ensure that read mode is set appropriately
- Ensure that the query execution mode is set appropriately
- Check the data model
- Improve performance on the database level

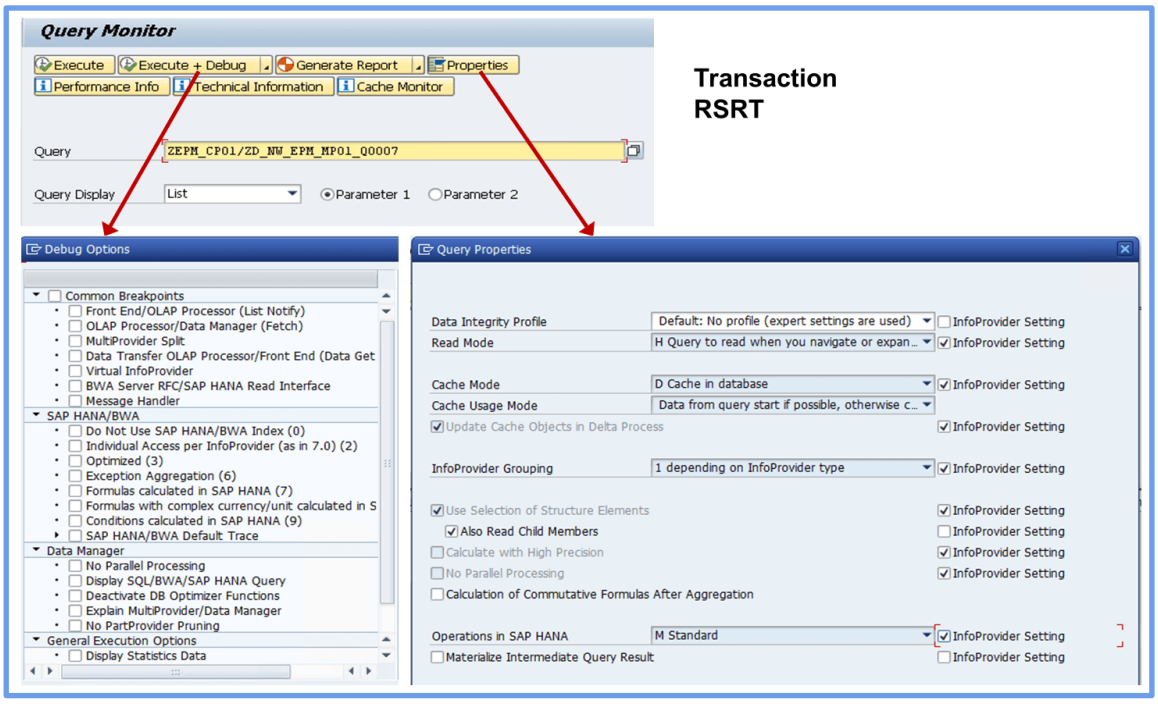
**2 Query Performance Monitoring Tools:**

We will now take a look at the tools available to troubleshoot and monitor the query performance.

**2.1 Query Monitor:**

Transaction RSRT & RSRT1 provide the Query monitor tool. It is useful for analyzing the query runtime and the operations that are performed while the query is loaded. We can test, check, and manage SAP BW queries using this tool.

In the query monitor, we enter the technical name of the query. To perform detailed analysis, we choose Execute + Debug. We can execute the query using the settings Display Statistics Data and Do not use cache to get an overview of the different steps performed and the runtime of each step.




**2.2 Read Mode:**

Query Read Mode determines how the OLAP processor reads data when executing a query and also during query navigation. They can be managed on InfoProvider level (Runtime Profile Properties) as default values for the queries or individually for each query in the BW Query Monitor(transaction RSRT) or in BW Query Designer (Runtime Properties). It is very important to understand the read modes available and how they work so that the most suitable one can be defined for the query as per the design. Following are the details on each mode.

**Read Mode H:**

The OLAP processor only requests the data required for each query navigation status of the query. Data across the hierarchy is aggregated by the database and transferred to the OLAP processor on the hierarchy level that is the lowest in the start list. This means the Query is read when you Navigate or Expand Hierarchies every time. When expanding a hierarchy node, the system intentionally must read this node's children from the database.

It transfers the smallest amount of data from the database to the OLAP processor and has the highest number of read processes. This mode significantly improves performance for the initial execution in almost all cases, compared to the other two read modes, because only data that the user initially wants to see is requested.

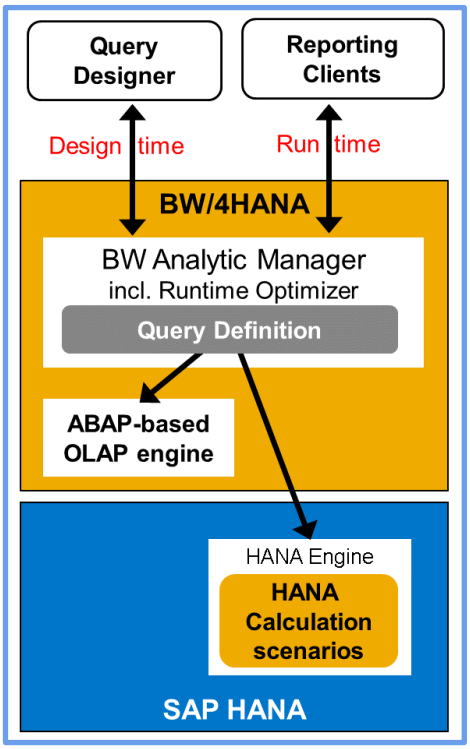
**Read Mode X:**

The OLAP processor only requests the data required for each query navigation status of the query. However the Hierarchies are always imported completely at leaf level.

It only has an effect on performance for queries with presentation hierarchies.

**Read Mode A:**
This mode has only one read process. It reads all the data in the cache of the OLAP processor that is needed for all possible navigational steps of the executed query. Hence, as per the user action, it aggregates and calculates all new navigational states from the data from the cache during the navigation.

**Analytic Manager:** Since SAP HANA became the database to power SAP BW/4HANA, a new component called the Analytic Manager was introduced. This acts as a broker to define the most efficient execution path for processing the query runtime. This means it synchronizes processing on the SAP HANA platform with processing on the SAP BW/4HANA ABAP Application Server with the purpose of pushing as many calculations as possible down to SAP HANA to achieve the best performance. The analytic manager converts existing SAP BW OLAP queries to SAP HANA optimized scripts that use SAP ABAP functions to enable push-down processing that exploits SAP HANA performance capabilities. This includes support of advanced SAP BW features, such as exception aggregation for count and currencies key figures, hierarchies, restricted key figures, or non-cumulative key figures.




**Runtime Optimizer:**
Runtime Optimizer selects the best suited operations mode. When we execute a query, the optimizer decides whether the query is executed with less code push-down (negative decision) or using an enhanced expert mode (positive decision). If an enhanced expert mode is used, we get a smaller result set in the database (DBTRANS). This shortens the processing time of the result set in the analytic manager. The Runtime Optimizer estimates the number of rows in the result set in the database for the positive decision [EST_DBTRANS_POSITIVE_DECISION] and for the negative decision

[EST_DBTRANS_NEGATIVE_DECISION]. The estimation only includes those parts of the query that are executed differently with a positive or negative decision. The estimation takes global filters into account and calculates a reduction factor by which the result set in the database is smaller with a positive decision.

**3 Operations in SAP HANA - Runtime Modes:**

SAP BW/4HANA introduces the Runtime Optimizer with new relative runtime modes to enhance SAP HANA processing flexibility by managing code push-down efficiently. These modes replace the previous absolute expert modes.

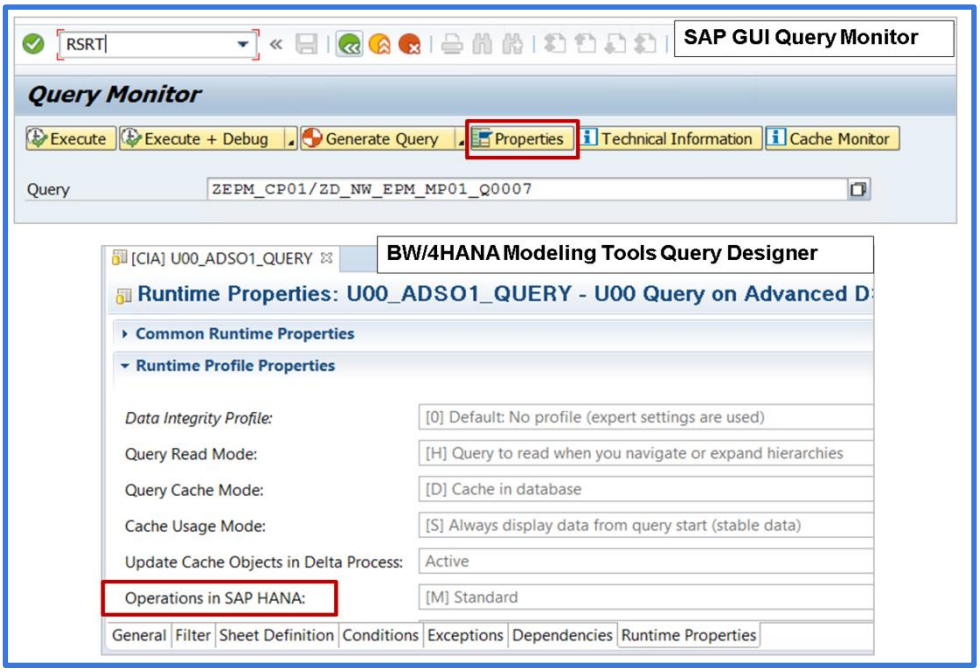
- **J (Defensive):** Maps to the old expert mode (3).
- **M (Standard):** The default for new CompositeProviders, InfoObjects, and queries, dynamically selecting mode (8) or (3).
- **P (Offensive):** Dynamically selects mode (9) or (3).

The system automatically maps previous fixed modes to these new relative modes. Modes 0, 2, or 3 map to J; Modes 6, 7, or 8 map to M; and Mode 9 maps to P. This transition ensures optimized query execution and better flexibility in runtime decisions.

However, we can go back to the former absolute runtime modes by setting the RSROA_TREXOPS_EXPERT switch for all users through an entry in the RSADMIN table. The switch enables all Operations in SAP HANA modes as below.

- ON: All Operations in SAP HANA modes (relative and absolute) are shown.
- OFF: Only the relative Operations in SAP HANA modes are shown.

The absolute modes (expert modes) having seven different runtimes as below:




**Mode 0: No Operations in SAP HANA**

- SAP HANA optimization is not utilized.
- Each InfoProvider is accessed individually via SQL statements, executed in parallel (up to six at a time).

- Suitable for queries with virtual characteristics or key figures requiring specific aggregation levels.

**Mode 2: Individual PartProvider Access**

- Accesses each InfoProvider via SAP HANA API against the generated InfoProvider ColumnView.
- Supports pushing down filters and optimized handling of hierarchy aggregation/filtering.
- Access occurs in parallel (up to six calls at once).

**Mode 3: Optimized Access:**

- Joint optimized access for CompositeProviders.
- Clusters homogenous InfoProviders and creates a CalculationScenario in SAP HANA.
- UNION operations in CompositeProviders are pushed down into SAP HANA.

**Mode 6: Exception Aggregation**

- Pushes all OLAP/calculation operations, including exception aggregation, into SAP HANA.
- Creates a CalculationScenario for OLAP operations, supporting definitions like NO1, NO2, STD, and VAR aggregations.

**Mode 7: Formulas Calculated in SAP HANA**

- Supports exception aggregation of formulas without currency or unit, or where the currency/unit is derived from operands.
- Available from SAP HANA 1.0 SP11 and BW/4HANA 1.0.

**Mode 8: Formulas Calculated in SAP HANA with Complex Currency or Unit**

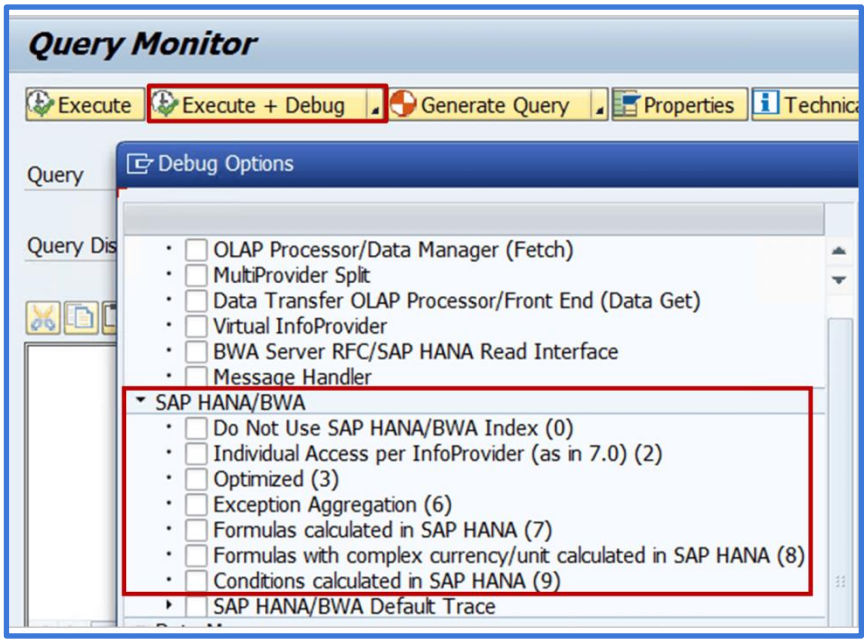
- Extends Mode 7 by supporting formulas with complex currency or unit calculations.
- Introduced in SAP BW/4HANA 1.0 SP08.

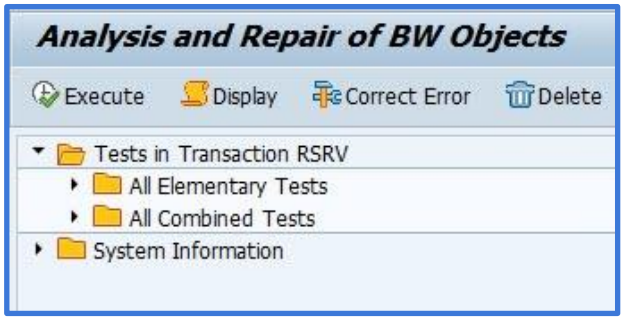
**Mode 9: Conditions Calculated in SAP HANA**

- Supports condition calculations like TopN, BottomN, TopSUM, and BottomSUM.
- Introduced in SAP BW/4HANA 2.0.
- Includes having operators like EqualTo, NotEqualTo, LessThan, GreaterThan, and more.

In general, not all BW queries will benefit from a pushdown; it depends on the exact query definition and the data in the providers. Therefore, it might be necessary to check the impact of this feature on the performance of every single query where the runtime is crucial to be able to exactly choose the proper setting for HANA operations.

This property can be altered for BW Queries, CompositeProviders, and InfoObjects in the BW Modeling Tools. For BW Queries, there is still the old option to set this parameter in the Query Monitor (transaction RSRT). In the Query Monitor (transaction RSRT), besides setting permanent parameters, we can also use the Execute+Debug functions. Here, it is possible to switch the SAP HANA optimization temporarily on or off, for simulation and testing purposes only.




**4 RSRV check:**

The RSRV (Analysis and Repair of BW Objects) tool is primarily used to check and repair inconsistencies in SAP BW metadata and data objects. While it is not directly a query performance tool, it plays a crucial role in ensuring the integrity of the underlying data and metadata, which can significantly impact query performance.

- Open transaction RSRV and select relevant checks for InfoProviders, aggregates, master data, and indexes.
- Review the results for inconsistencies or warnings that might impact performance.
- Use the repair options provided by RSRV to fix identified problems.
- After repairs, test the query to confirm improved performance.

**DB02 check:**

The DB02 transaction in SAP is primarily used for database monitoring and management. While it is not specifically designed for direct query performance analysis, it provides crucial insights into database-level aspects that can significantly influence SAP BW query performance.

- Ensures that indexes are properly maintained for faster query execution.

- Verifies proper partitioning of large fact tables to improve query performance. Poor partitioning strategies can lead to full table scans, slowing query execution.
- Expensive statements can be checked to see if the Query SQL statement appears in the expensive statement and also provides the runtime and database memory consumption statistics. These are helpful in analysis as well as testing when performance tuning is being done to the query.

**Conclusion:**

There could be a variety of reasons for a poor query performance and hence it is necessary to have the right tools to check and troubleshoot the performance issue. Query monitoring tool in RSRT helps simulate the query performance with different modes and provides developers with key information to make informed decisions. RSRV tool can help check the inconsistencies which can affect performance. Database monitoring tool DB02 helps identify database related issues and expensive statement memory consumption details.

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