DBA Cockpit: Automatic Table Maintenance for SAP Adaptive Server Enterprise

Applies to:
SAP Business Suite as well as any other applications running on SAP Adaptive Server Enterprise (SAP ASE).

Summary
Maintaining tables, indexes and data partitions is crucial for productive database systems. Continuous insertion, update and deletion of data induce fragmentation, bad cluster ratios and inaccurate optimizer statistics. This article shows you how the DBA Cockpit and its automatic table maintenance for SAP ASE ensures good cluster ratios on tables and indexes, frees up unused space and ensures accurate optimizer statistics.

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**Introduction**

Sophisticated business applications like the SAP Business Suite execute millions of DML statements a day. In a data warehouse scenario, for example, reports are constantly being generated to determine whether business targets are being met while in the background tasks are executed to load collected data into data cubes or to delete obsolete data. This constant manipulation of data sets causes data fragmentation, leaves non-reusable free space behind, and, finally, invalidates optimizer statistics which can end up in poor query performance.

The SAP DBA Cockpit for SAP ASE introduces a flexible framework that allows you to set up and control automatic table maintenance (in the following referred to as ATM) on SAP ASE database systems. Considering the thousands of tables and indexes a typical SAP system creates on the database, this solution dramatically reduces manual administrative activities and thus significantly reduces the TCO of the SAP on ASE solution as well.

**Terminology Used in the Context of Automatic Table Maintenance**

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATM profile</td>
<td>An ATM profile defines the objects that ATM should monitor as well as the maintenance activities that should be executed once defined thresholds are violated.</td>
</tr>
<tr>
<td>ATM window</td>
<td>An ATM window defines a time frame within which ATM is allowed to evaluate and maintain objects. ATM profiles are assigned to ATM windows to control which objects are to be maintained in a certain time window and which are not.</td>
</tr>
<tr>
<td>ATM queue</td>
<td>Objects that require maintenance are stored in the ATM queue. ATM might not be able to maintain all identified objects before an ATM window expires. In this case, ATM will continue to process queued objects during the next ATM window.</td>
</tr>
<tr>
<td>ATM history</td>
<td>Objects that were maintained by ATM are dropped from the ATM queue, but, at the same time activities are logged in the ATM history. Thus, the ATM history allows monitoring of past ATM activities.</td>
</tr>
<tr>
<td>Job scheduler</td>
<td>ATM makes use of the job scheduler that is built into the SAP ASE DBMS.</td>
</tr>
</tbody>
</table>
Overview

The following graph provides a general overview of how ATM operates on an SAP ASE DBMS:

The SAP DBA Cockpit acts as the central point to:

- Set up ATM on any remote SAP ASE DBMS
- Configure ATM windows and ATM profiles
- Monitor the ATM queue and ATM history
- Monitor ATM execution

All objects of the ATM framework are thereby created in a private database named saptools, which is also used by the SAP DBA Cockpit to store historical performance data and space information.

The job scheduler (JS) executes a stored procedure that is created and scheduled by the SAP DBA Cockpit as defined by ATM windows. This stored procedure evaluates maintenance requirements that are defined by ATM profiles, and in a second step, this stored procedure also executes maintenance commands on identified objects.

ATM is part of the SAP DBA Cockpit as of Enhancement Package 2 for SAP NetWeaver 7.0 Support Package 9 as well as SAP Solution Manager 7.1 Support Package 4.

*Note:* ATM is not supported for ASE releases older than 15.5. In addition, system and proxy tables are excluded from automatic maintenance.
Setup and Maintenance of the ATM Framework

Deploying ATM on SAP ASE is very easy. All you need to do is make the system known to the SAP DBA Cockpit and initiate the setup process in the Configuration → ATM Configuration screen.

![ATM Configuration Screen](image)

The SAP DBA Cockpit detects that ATM has not yet been set up on the system. When you click the Setup ATM button, all required tables, routines and procedures are created in the saptools database. In addition, a default ATM configuration is created that immediately enables the system for automatic table maintenance.

Updates and fixes for ATM are provided through SAP Support Packages and SAP Notes. If the ATM framework that was already set up on a system requires an update, the SAP DBA Cockpit will recognize a version mismatch and will ask you to update ATM by choosing Repair ATM.

**Note:** The saptools database is available on every SAP system by default. If ATM is going to be deployed on a non-SAP system, the saptools database needs to be created manually (see SAP Note 1593987).

### Default ATM Configuration

The default ATM configuration that is created when you initially deploy ATM on an SAP ASE DBMS tries to automate table maintenance, without risking negative impact on the applications that are connected to ASE. This means objects only undergo lightweight maintenance activities on regular business days. More costly maintenance activities are executed during the weekend, with very large objects being excluded from such maintenance activities entirely. The default ATM configuration also ensures full availability of all objects at any time.

### Default ATM Profiles

**ATM profile Small Tables** for update statistics:

- Includes tables containing 100 up to 9999 rows.
- Triggers update of index statistics if data change exceeds 20%.
- Commands are executed with low priority.

**ATM profile Medium Tables for update statistics:**
- Includes tables containing 10000 up to 999999 rows.
- Triggers update of index statistics if data change exceeds 20%.
- Commands are executed with low priority.

**ATM profile Large Tables for update statistics:**
- Includes tables containing 1000000 up to 999999999999 rows.
- Triggers update of index statistics if data change exceeds 10%.
- Commands are executed with low priority.

**Note:** If an SAP application database is found on the DBMS, special objects in that database are excluded from getting updated statistics as known from best practices through additional exclusion profiles.

If an SAP application database is found on the DBMS, special objects in that database are excluded from getting updated statistics as known from best practices through additional exclusion profiles.

**ATM profile All Tables – Remove Row Forwarding for reorganization:**
- Includes all tables.
- Triggers reorganization using sub-command "compact" if the percentage of forwarded rows exceeds 10%.
- Commands are executed with low priority.

**ATM profile All Tables – Reclaim Space for reorganization:**
- Includes all tables.
- Triggers reorganization with sub-command "compact" if the space utilization falls below 90%.
- Commands are executed with low priority.

**ATM profile Small to Medium Tables – Rebuild Indexes for reorganization:**
- Includes tables with up to 10GB of reserved space.
- Triggers rebuild of all indexes that have an index page cluster ratio below 90%.
- Commands are executed with low priority.

**Default ATM Windows**

**ATM window 24 hours all day**
- Starts Monday at 00:00 and ends Sunday 23:30.
- ATM profiles are applied repeatedly on an hourly basis until the ATM window expires.
- Two ATM profiles are assigned by default:
  - Update statistics profile Small Tables
  - Update statistics profile Medium Tables

**ATM window “Weekend”**
- Starts Sunday at 02:00 and ends Monday 05:00.
- ATM profiles are applied only once or until the ATM window expires.
Four ATM profiles are assigned by default:
- Update statistics profile \textit{Large Tables}
- Reorganization profile \textit{All Tables – Remove Row Forwarding}
- Reorganization profile \textit{All Tables – Reclaim Space}
- Reorganization profile \textit{Small to Medium Tables – Rebuild Indexes}

Miscellaneous Settings

In the \textit{Miscellaneous} tab of the \textit{ATM Configuration} screen, you can configure options like the number of days the ATM history should span, or you can set the log level.

\textbf{ATM Profiles}

\textbf{ATM Profile Types}

ATM profiles are separated by the type of maintenance operation concerned, which is either update statistics or reorganization. For each of the two maintenance operations, there are in total three types of ATM profiles that can be defined:

\textbf{Standard ATM Profiles}

Tables are identified by a characteristic, such as row count or size. Standard ATM profiles are used to maintain all tables that do not require special care.

\textbf{ATM Profiles for Special Objects}

Tables are identified by a full, qualified name (supporting a wildcard at the right end of the table's name). This type of ATM profile is used for tables that do require special care- for example, due to the size of the table or its need for special maintenance options. Tables matching any active ATM profile of type \textit{ATM Profile for Special Objects} will be excluded from any \textit{Standard ATM Profile}.

\textbf{ATM Profiles for Excluding Objects from ATM}

Tables are identified by a full, qualified name (supporting a wildcard at the right end of the table's name). This type of ATM profile is used for tables that should be excluded from either update statistics or reorganization. This means that tables matching any active ATM profile of type \textit{ATM Profile to Exclude Objects from ATM} will be excluded from any \textit{Standard ATM Profile} or \textit{ATM Profile for Special Objects}. Examples are queue tables that are constantly undergoing a massive data change, causing continuously inaccurate statistics.

\textbf{Note:} A single object can qualify for multiple ATM profiles of the same type. You may for example want to define an ATM profile that initiates sampled statistics with low priority if data change exceeds 20%. But for the same set of objects, you are able to define another ATM profile that initiates full statistics with high priority if data change exceeds 50%.

\textbf{Maintaining ATM Profiles}

The \textit{Configuration} → \textit{ATM Configuration} screen allows you to

- Define new ATM profiles
- Change existing ATM profiles
- Delete existing ATM profiles
- Activate or deactivate ATM profiles
The following screenshot shows a dialog for creating an ATM profile of type *ATM Profile for Special Objects* for update statistics. The example shown will initiate sampled update statistics on all index columns once data change of table BEN.SAPSR3.REPOSRC has exceeded a value of 5%. Update statistics will be executed with standard ASE execution priority.

There are two types of priorities that can be configured for an ATM profile. With the so called maintenance priority, you define the importance the requested maintenance operation has compared to maintenance operations defined by other ATM profiles. With the so called ASE execution priority, you specify the amount of CPU resources that should be assigned to the maintenance operations while they are being executed.
The next example shows a dialog for changing an existing ATM profile of type Standard ATM Profile for reorganization. This ATM profile is limited to tables with a size of 0 to 10000MB. Indexes are rebuilt as soon as the index page cluster ratio falls below 90%, using a reduced ASE execution priority.

Some applications, especially data warehouse applications, make use of SAP ASE’s partitioning feature. Depending on the dimensions used to partition the data, some data partitions may undergo heavy data changes, while some other data partitions may remain mostly or completely unchanged. In such cases, it does not make sense to update statistics on all partitions or to reorganize the whole object. If you check Evaluate Threshold per Data Partition, ATM will evaluate thresholds for each data and index partition individually, and maintenance operations will also be executed individually as required by an individual data or index partition.

The final example shows an ATM profile that excludes table BEN.SAPSR3.VBDATA from getting any update of statistics.

ATM Windows

With ATM windows, you define what type of table maintenance requirements and operations are evaluated and executed on certain objects within a defined time frame. You may, for example, want to ensure accurate optimizer statistics on certain objects during regular business time, while update statistics on other, usually very large objects, should be maintained outside regular business time. You may also want to move table or index reorganization into the weekend, while wanting to run update statistics at any time.

Maintaining ATM Windows

The Configuration → ATM Configuration screen allows you to
- Define new ATM windows
- Change existing ATM windows
- Delete existing ATM windows
- Activate or deactivate ATM windows
- Assign ATM profiles to an ATM window or remove assigned ATM profiles from an ATM window

The following screenshot shows a dialog for changing an existing ATM window. In this example, ATM would kick in on Sunday 2am, and expire on Monday 5am. As shown in the screenshot above, maintenance operations that are evaluated (and possibly executed) during this ATM window are update statistics for any object that matches ATM profiles *Small Tables or Medium Tables.*
**Note:** ATM profiles of type *ATM Profiles for Excluding Objects from ATM* cannot be assigned to specific ATM windows. Those ATM profiles are valid for all ATM windows by definition.

ATM windows are scheduled jobs in the ASE job scheduler. Deactivation of an ATM window will unschedule the job for further executions and, if appropriate, cancel current executions. Changing an ATM window will reschedule the respective job.

ATM windows can be configured to repeatedly apply ATM profiles until the window expires. In this case, the ATM job will not complete execution after the evaluation of maintenance requirements has been finished and no objects remain in the ATM queue. Instead, the ATM job will go into sleep mode and wake up once every hour to re-evaluate and re-execute maintenance requirements continuously until the ATM window finally expires.

Temporal overlap between ATM windows is permitted. In addition, a single ATM profile can be assigned to multiple ATM windows. Details on how ATM windows and assigned ATM profiles are processed are given in the chapter entitled *Processing ATM Windows and Assigned ATM Profiles.*
Monitoring the ATM Queue

As described in chapter *Processing ATM Windows and Assigned ATM Profiles*, ATM is executed in two phases. Phase 1 will identify objects that require maintenance according to the defined ATM profile and put those objects into an ATM queue. Phase 2 will finally execute maintenance, as defined in the ATM queue until the ATM window has expired or no entry can be found in the ATM queue.

If the ATM windows are too short to process all identified maintenance requirement, the ATM queue will fill up and required maintenance operations will not be executed. The **Diagnostics → Automatic Table Maintenance → ATM Queue** screen allows you to monitor the current ATM queue:

![ATM Queue Screen](image)

By selecting one of the records shown, the maintenance command that is going to be executed is shown in the details section below, as well as the ATM profile that initiated maintenance of the object.

Monitoring the ATM History

The **Diagnostics → Automatic Table Maintenance → ATM History** screen shows all maintenance operations that have been executed by ATM in the past days and weeks. This information allows you to fine tune your ATM configuration and to ensure proper behavior of ATM in the respective application environment.
By selecting one of the records shown, the maintenance command that was executed is shown in the details section below, as well as the ATM profile that initiated maintenance of the object.

By default, the ATM history spans 8 weeks. A different ATM history size can be configured in the Miscellaneous tab of the Configuration → ATM Configuration screen.

**Note:** In addition to the ATM Queue and ATM History screen, details regarding ATM for a single table can also be reviewed using the Space → Tables and Indexes → Single Table Analysis screen.

**The ATM Log**

ATM writes its own message log while evaluating maintenance requirements and finally executing maintenance operations. While its main target group is SAP support, this message log can also help DBAs understand error conditions and performance related issues. You can access the ATM log by navigating into the Diagnostics → Automatic Table Maintenance → ATM Log screen of the SAP DBA Cockpit.
By default, ATM logs for the last 14 days are kept. This number of days as well as the number of messages being written into the ATM log can be configured in the Miscellaneous tab of the Configuration → ATM Configuration screen.

Processing ATM Windows and Assigned ATM Profiles

While configuration and monitoring of ATM is completely done from the SAP DBA Cockpit, actual execution of ATM activities is completely done through the job scheduler that is provided by SAP ASE. Jobs named \texttt{SAP\_ATM\_W<window\_ID>} are scheduled as defined by active ATM windows. Each job then crosses over into the phases described in the following subsections.

Preparation Phase

During this initial phase of an ATM window, ATM checks whether all configuration prerequisites are fulfilled and whether ATM profiles assigned to the ATM window are valid. In addition, configuration options are read for the ATM window (like, for example, its expiration time or whether the evaluation and cleanup phase are going to be executed with low execution priority).
Evaluation Phase

A standard installation of SAP ERP 6 including Enhancement Package 5 creates around 75000 tables and around 90000 indexes on the database. Nevertheless, as usually only certain scenarios of the SAP ERP are exploited in a specific installation, only a small amount of these objects is accessed.

The first thing ATM does is to restrict the amount of tables, indexes and partitions that are going to be evaluated for maintenance. This is done in the following way:

1. Determination of the minimum of all timestamps any assigned ATM profile has been evaluated the last time.
2. Creation of a temporary table containing all user tables of any user database that were either touched since that time (according systabstats), or that are currently opened by ASE and have undergone at least one write operation.
3. Creation of additional temporary tables containing all indexes and data partitions of the tables that have been determined.

This mechanism will greatly restrict the amount of objects that are evaluated in an SAP environment. The only exception here are new ATM profiles and newly configured systems, where ATM needs to initially evaluate all objects.

After the amount of objects has been restricted, ATM reads all ATM profiles of type ATM Profile to Exclude Objects from ATM and type ATM Profile for Special Objects and flags matching objects for either no maintenance or special maintenance.

Selection of objects for ATM profiles of type Standard ATM profile is done by specifying a range of either row count or size. So, for all objects that are neither flagged for no maintenance nor special maintenance, ATM determines the current row count and size.

Up to now, the number of objects that ATM looks at has been reduced to a level where maintenance evaluation is reasonable. In addition, all remaining objects have been flagged according to the assigned ATM profiles for either no maintenance, special maintenance or standard maintenance.

ATM then processes all assigned ATM profiles of type Standard ATM profile or ATM Profile for Special Objects. Each object that is flagged for the respective type of ATM profile and that matches the profile object selection conditions is evaluated according to the ATM profile’s threshold conditions. Depending on the exact definition of the ATM profile, evaluation may happen on individual data partitions and/or indexes instead of on the object as a whole. If defined threshold are violated, maintenance for the object (or one or more of its data partition or indexes) is initiated by generating a corresponding maintenance command and inserting it into the ATM queue.

While ATM creates new entries in the ATM queue, it may happen that the same object or some of its data partitions or indexes are already contained in the ATM queue. Such cases are handled as follows:

1. Identified object is a table:
   - Drop entries from ATM queue that have a lower maintenance priority than the newly identified requirement (including individual data partitions of the table).
   - Drop entries from ATM queue that have an equal maintenance priority, but whose planned maintenance operation is less weighty* than the newly identified requirement (including individual data partitions of the table).
   - Drop individual data partitions from ATM queue that have a completely identical maintenance requirement than just identified for the complete table.
   - Insert table into ATM queue, but only if:
     - Table is not already contained in the ATM queue with higher maintenance priority.
     - Table is not already contained in the ATM queue with equal maintenance priority but higher or equal command weight*.
Note: Data partitions with higher maintenance priority (or identical maintenance priority but higher command weight) will stay queued in parallel.

2. Identified object is an index:
   - Drop entries from ATM queue that have a lower maintenance priority than the newly identified requirement (including individual index partitions).
   - Drop entries from ATM queue that have an equal maintenance priority, but whose planned maintenance operation is less weighty* than the newly identified requirement (including individual index partitions).
   - Drop individual index partitions from ATM queue that have a completely identical maintenance requirement than just indentified for the complete index.
   - Insert table into ATM queue, but only if:
     - Index is not already contained in the ATM queue with higher maintenance priority.
     - Index is not already contained in the ATM queue with equal maintenance priority but higher or equal command weight*.

Note: Index partitions with higher maintenance priority (or identical maintenance priority but higher command weight) will stay queued in parallel.

3. Identified object is a data partition:
   - Drop entries from ATM queue that have a lower maintenance priority than the newly identified requirement (excluding other data partitions or the table itself).
   - Drop entries from ATM queue that have an equal maintenance priority, but whose planned maintenance operation is less weighty* than the newly identified requirement (excluding other data partitions or the table itself).
   - Insert data partition into ATM queue, but only if:
     - Data partition or table is not already contained in the ATM queue with higher maintenance priority.
     - Data partition or table is not already contained in the ATM queue with equal maintenance priority but higher or equal command weight*.

4. Identified object is a data partition:
   - Drop entries from ATM queue that have a lower maintenance priority than the newly identified requirement (excluding other index partitions or the index itself).
   - Drop entries from ATM queue that have an equal maintenance priority, but whose planned maintenance operation is less weighty* than the newly identified requirement (excluding other index partitions or the index itself).
   - Insert data partition into ATM queue, but only if:
     - Index partition or index is not already contained in the ATM queue with higher maintenance priority.
     - Index partition or index is not already contained in the ATM queue with equal maintenance priority but higher or equal command weight*.

* Weighting of maintenance operations is done as follows:
  - Update statistics with sampling of 50% or full update statistics has more weight than update statistics with sampling of 20%.
  - reorg compact has more weight than reorg reclaim_space or reorg forwarded_rows.
• `reorg rebuild` has more weight than `reorg compact` or `reorg rebuild` for an individual index.

**Execution Phase**

Execution of maintenance is now purely based on entries found in the ATM queue. As long as the ATM window has not yet expired and as long as there are still entries remaining in the ATM queue, required maintenance operations are read from the ATM queue according to their maintenance priority and are being executed using the requested ASE execution priority.

After maintenance has been executed on a certain object, it gets moved from the ATM queue into the ATM history. Runtime measurements and the exact maintenance command are recorded in the ATM history for later analysis.

If no objects are remaining in the ATM queue, but the ATM window is configured to repeatedly apply ATM profiles and the ATM window has not yet expired, the ATM window will go into sleep mode until exactly one hour has elapsed since the last evaluation.

**Cleanup Phase**

Before an ATM window completes execution, old data is deleted from the ATM history and ATM log as configured through the SAP DBA Cockpit.
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