Performance Improvement using Indexes and ABAP Hints

Applies to:

Release SAP 4.6B and greater. For more information, visit the Performance homepage.

Summary

This article describes the techniques that can be used when faced with problem of long background job runs or when the overall system performance is low. It explains how one can conclude the need for Secondary Index or ABAP hints. It then explains in detail how a Secondary Index and ABAP hint can be created.

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Overview

Optimized performance of background jobs are a prerequisite in live production environments. No matter how optimized the ABAP code is, over a period of time due to accumulation of large amounts of data in tables, programs can go into a long run.

In such instances, index definitions needs to be checked. If the query is such that it cannot use the primary key, creation of a secondary index can be considered.

There are instances when the SAP Cost Based Optimizer (CBO) over-rides the secondary index and continues to do a sequential read on the table. At such times, coding an ABAP hint that would force the CBO to use the secondary index can be used.

Secondary Index

Need of Secondary Indexes

By default the Primary key forms the primary index of database tables. Whenever a SELECT query is executed, the system checks if the fields in selection or the filter are part of the primary key. If yes, then the cost of executing such a query is less. Therefore, it is always advisable for users to consider the primary key while coding SELECT queries.

It might not always be possible to use the Primary key fields in the queries. Programs having SELECT queries with non-key fields are vulnerable to go into a long run. This can happen if the table contents increase over a period of time.

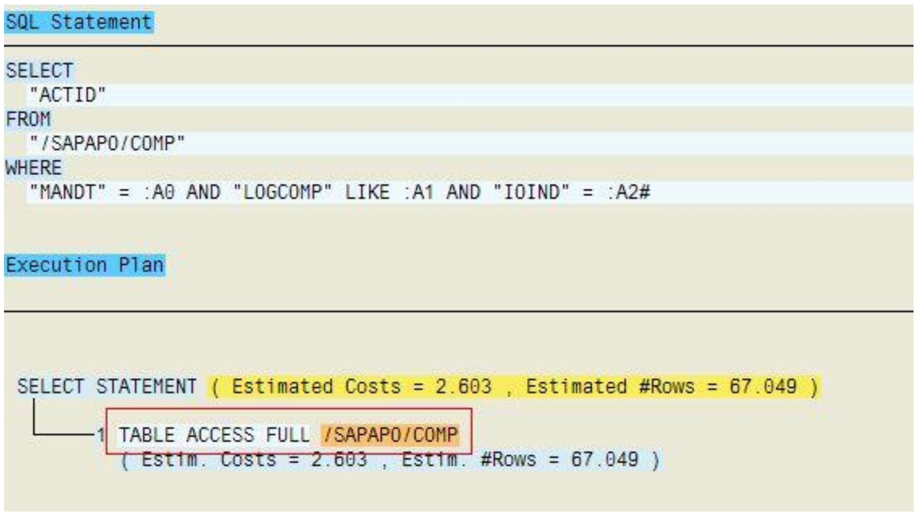
At such times, one can create a secondary index, which would include the fields that are part of the selection/ filter of your SELECT query. At execution time, when the system uses the Secondary Index while fetching data from table, the cost of such a hit would be less.

Given below is an example on how one can go about deciding the need for a Secondary Index. The issue explained here occurred on an APO production system:

1. The background jobs gradually took long to complete. Therefore, a trace of the execution was done
2. It pointed to the query that gave the performance issue. In the example explained here, the program used to run for 600000+ seconds that eventually terminated due to lack of memory space.

Further investigation of the job and a trace reveled that almost 27 hours of execution is spent reading from table /SAPAPO/COMP.

Execution plan of the query is as shown below:



```
SQL Statement

SELECT
  "ACTID"
FROM
  "/SAPAPO/COMP"
WHERE
  "MANDT" = :A0 AND "LOGCOMP" LIKE :A1 AND "IOIND" = :A2#


Execution Plan


 SELECT STATEMENT ( Estimated Costs = 2.603 , Estimated #Rows = 67.049 )
  |
  └─────1 TABLE ACCESS FULL /SAPAPO/COMP
           ( Estim. Costs = 2.603 , Estim. #Rows = 67.049 )
```

Following is the SQL Statement at system level:

SELECT
  "ACTID"
FROM
  "/SAPAPO/COMP"
WHERE
  "MANDT" = :A0 AND "LOGCOMP" LIKE :A1 AND "IOIND" = :A2#

The sequential reads on this table was slow. Upon reviewing the execution plan of this SQL statement, it was noted that a full table scan was being done of this table, which performance wise is pretty intensive.

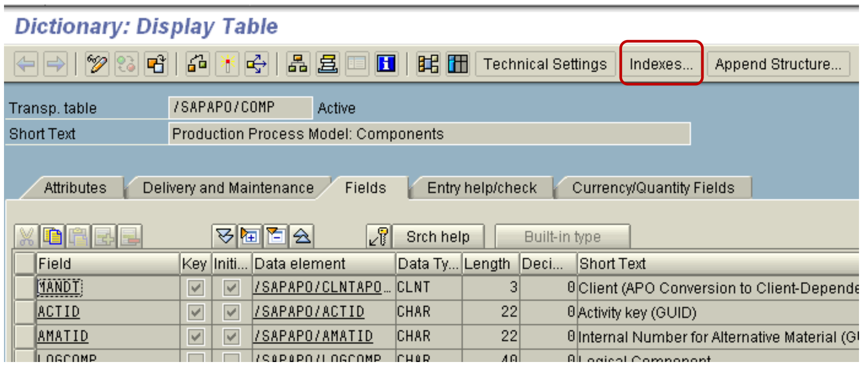
Normally such a SQL statement should use an index, which would optimize the reads. The indices defined against this table were checked and none of them were adequate for this SQL statement. This was because the order of the fields in the indices did not match the order of the predicates in the SQL statement. Hence it did the full table scans. In such cases it is advisable to create a secondary index.

For this example, the order of the fields would be: MANDT, LOGCOMP and IOIND

How to create Secondary Index

Given below are the steps to create a Secondary Index. Standard SAP APO table /SAPAPO/COMP is considered for explanation.

1. Click on the *Indexes* button on the Application tool bar of SE11 T-Code.

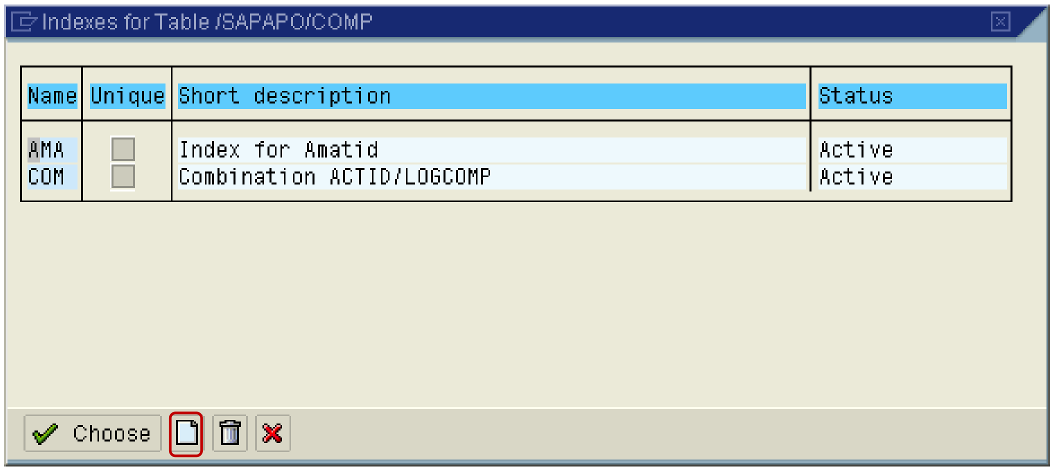


Dictionary: Display Table

Transp. table: /SAPAPO/COMP Active
Short Text: Production Process Model: Components

Field	Key	Initi...	Data element	Data Ty...	Length	Deci...	Short Text
MANDT	✓	✓	/SAPAPO/CLNTAPO	CLNT	3	0	Client (APO Conversion to Client-Depende
ACTID	✓	✓	/SAPAPO/ACTID	CHAR	22	0	Activity key (GUID)
AMATID	✓	✓	/SAPAPO/AMATID	CHAR	22	0	Internal Number for Alternative Material (G
LOGCOMP			/SAPAPO/LOGCOMP	CHAR	40	0	Logical Component

On the pop-up that appears, click on the Create (F5) 🗋 button


Indexes for Table /SAPAPO/COMP

Name	Unique	Short description	Status
AMA	☐	Index for Amatid	Active
COM	☐	Combination ACTID/LOGCOMP	Active

2. Enter an appropriate Index Name e.g. ZLC (Z* for Custom Secondary Indexes) and click OK

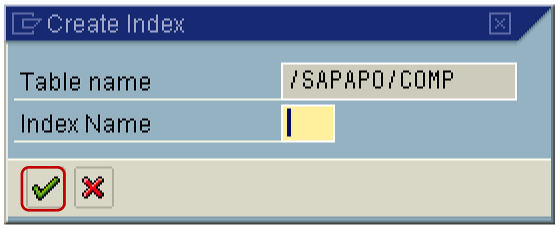
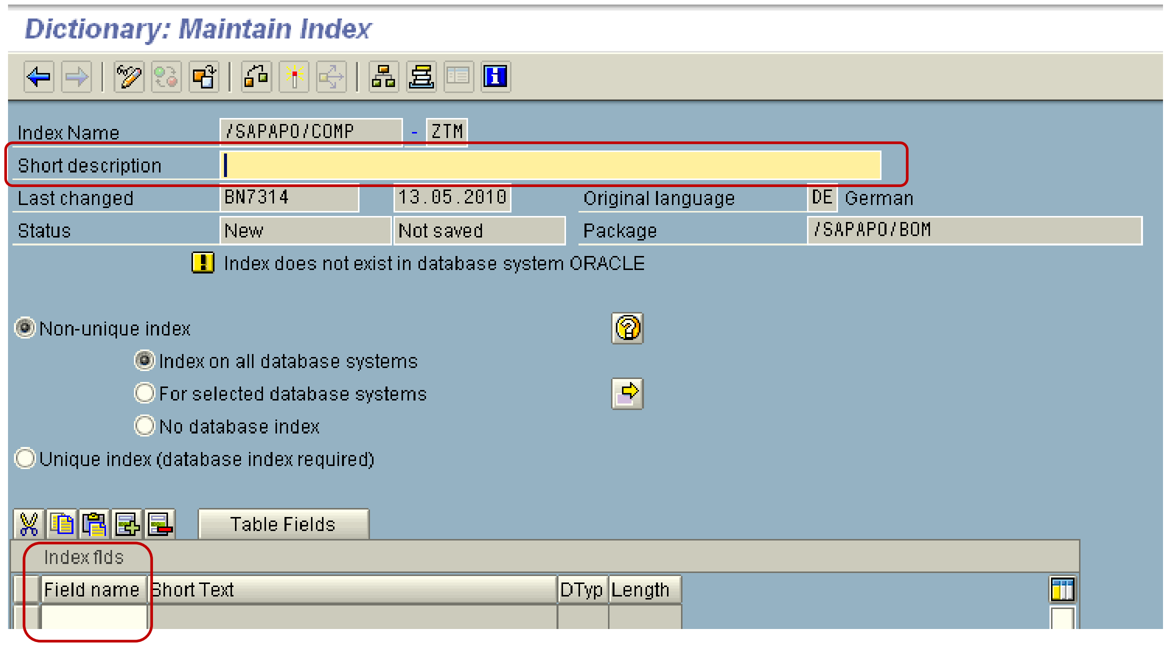


Table name	/SAPAPO/COMP
Index Name	

3. Make note of the Information messages (if any) and click on OK button.
4. Enter the Short Description and fields that you need to be included in the Secondary Index


Dictionary: Maintain Index

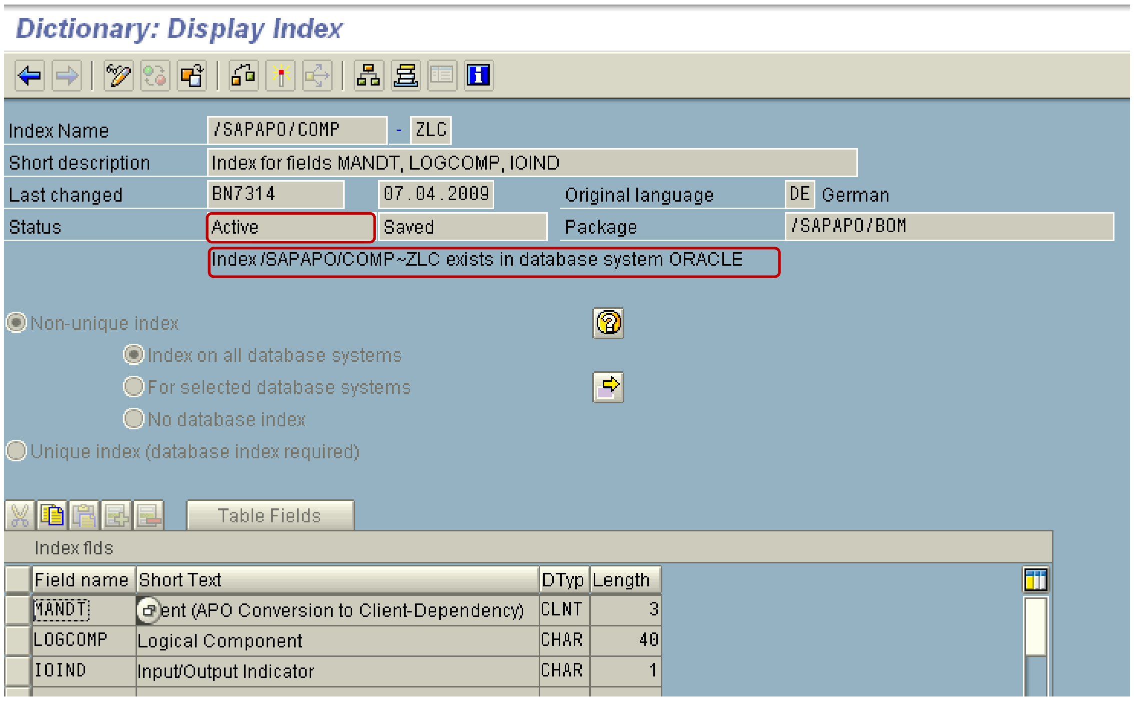
Index Name	/SAPAPO/COMP	- ZTM		
Short description				
Last changed	BN7314	13.05.2010	Original language	DE German
Status	New	Not saved	Package	/SAPAPO/BOM

Index does not exist in database system ORACLE

[✓ Non-unique index]
[✓ Index on all database systems]
For selected database systems
No database index
Unique index (database index required)

Field name	Short Text	DTyp	Length

5. Save and Activate the Index. This will change the status to Active.


Dictionary: Display Index

Index Name	/SAPAPO/COMP - ZLC				
Short description	Index for fields MANDT, LOGCOMP, IOIND				
Last changed	BN7314	07.04.2009	Original language	DE	German
Status	Active	Saved	Package	/SAPAPO/BOM	
	Index /SAPAPO/COMP~ZLC exists in database system ORACLE				

[● Non-unique index]
[● Index on all database systems]
For selected database systems
No database index
Unique index (database index required)

Index flds

Field name	Short Text	DTyp	Length
MANDT	ent (APO Conversion to Client-Dependency)	CLNT	3
LOGCOMP	Logical Component	CHAR	40
IOIND	Input/Output Indicator	CHAR	1

6. After the Index is created, stats update needs to be done. This is usually done by the Basis team.
7. Also, a point to be noted is that the index can be imported to production environment and the index can be activated in oracle at low activity period as this might have a performance impact. This activity should be done with consultation with the DBA/ Basis team
8. When the job is then executed, it gave better performance than before the introduction of Secondary Index.

Database Hints

Need of Database Hints

In another instance, though the secondary index existed for the custom table, the Oracle Cost Based Optimizer (CBO) chose to ignore it and did a full table scan instead. This could be because the CBO found the cost of full table scan lower than the cost of using the secondary index. This was most likely caused by oracle profile settings which make full table scan more favorable. In such cases, in order to optimize performance we need to force the system to use the existing Secondary Index. This can be done by using Database Hints. Hints force the CBO to use the index defined in the query.

In case of the example used below, the Secondary Index alone did not improve performance. Further analysis on these runtimes revealed that oracle did not make use of the Secondary index and preferred doing full table scans. The job run times was 35000+ seconds.

An SQL trace of the job while it ran revealed that the query took an average of 3.4 seconds to execute and this multiplied by the number of iterations explained the long runtimes of the job.

How to create Database Hints

In order to have the report to consider the secondary index created, a hint would need to be added in the SQL query of the ABAP.

SQL should be modified to the following in the ABAP:

```
SELECT <fields> INTO <work area> FROM <database table>
        WHERE <logical expression>
          AND <logical expression>
 %_HINTS <database name> 'INDEX("<database table>" "Index name")'.
```

The Hint will be specific to one database system. Appropriate value needs to be put for <database name> viz. ORACLE, DB2 etc. Once the index is created, import the modified report which includes the hint for the index usage. Once this index is activated in oracle, Basis team will update the stats on the table.

Points to remember while using Indexes and Hints

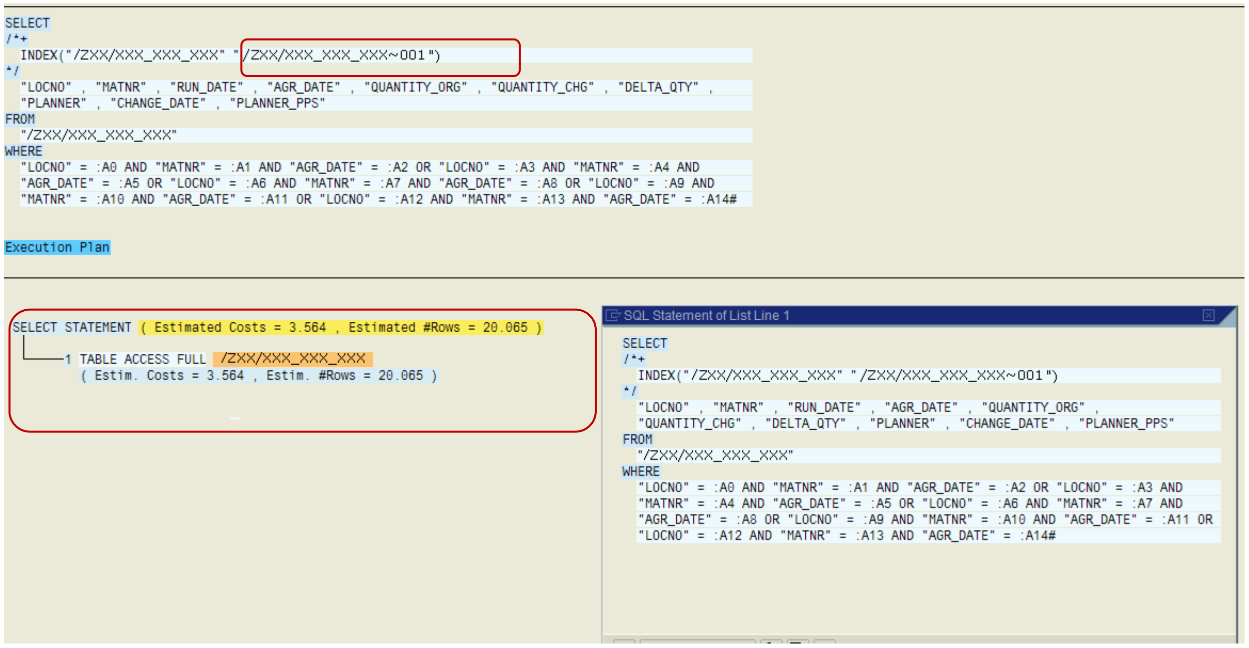
Following points are to be noted while working with Indexes and Hints:

1. The ABAP syntax check does not indicate an error if the Index name mentioned in the hint is incorrect.
2. If the hint is not valid (e.g. wrong index, syntax error), the query is handled by the CBO like there would be no hint specified, and oracle can take the wrong "access path" based on wrong stats.

In other words, always make sure that the Index name in the data dictionary (SE11) and the Index created in the Oracle database matches. In case the Oracle index name differs from that of SE11, either change the index name for the hint in ABAP to the one created on oracle or add the index name created in oracle as a second index for the hint. With two indexes specified, the hint should be able to use index which got created on oracle.

Refer the following screen shots for better understanding:

1. Query execution plan showing it's doing full table scans. For this custom table a secondary index was created with the relevant fields:

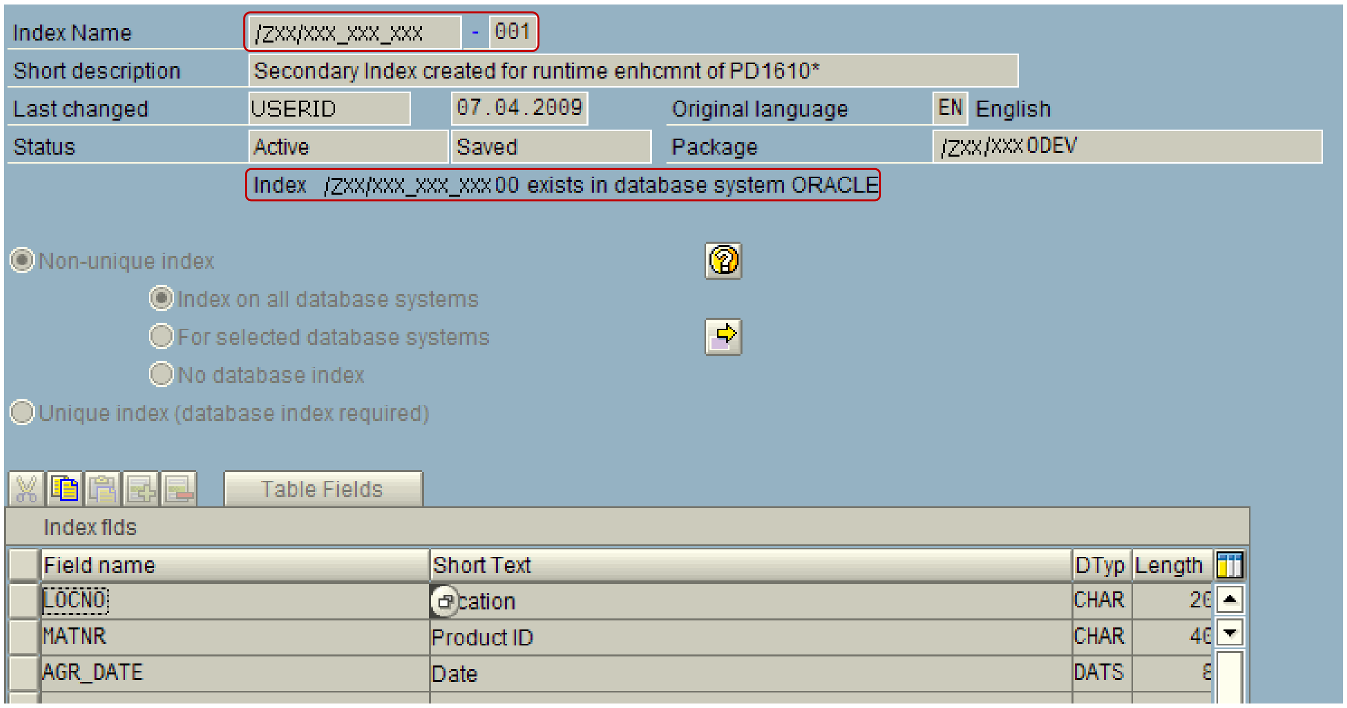


```
SELECT
/*+
  INDEX("/ZXX/XXX_XXX_XXX" "/ZXX/XXX_XXX_XXX~001")
*/
  "LOCNO" , "MATNR" , "RUN_DATE" , "AGR_DATE" , "QUANTITY_ORG" , "QUANTITY_CHG" , "DELTA_QTY" ,
  "PLANNER" , "CHANGE_DATE" , "PLANNER_PPS"
FROM
  "/ZXX/XXX_XXX_XXX"
WHERE
  "LOCNO" = :A0 AND "MATNR" = :A1 AND "AGR_DATE" = :A2 OR "LOCNO" = :A3 AND "MATNR" = :A4 AND
  "AGR_DATE" = :A5 OR "LOCNO" = :A6 AND "MATNR" = :A7 AND "AGR_DATE" = :A8 OR "LOCNO" = :A9 AND
  "MATNR" = :A10 AND "AGR_DATE" = :A11 OR "LOCNO" = :A12 AND "MATNR" = :A13 AND "AGR_DATE" = :A14#


Execution Plan
```

```
SELECT STATEMENT ( Estimated Costs = 3.564 , Estimated #Rows = 20.065 )
 └──1 TABLE ACCESS FULL /ZXX/XXX_XXX_XXX
        ( Estim. Costs = 3.564 , Estim. #Rows = 20.065 )
```

```
SELECT
/*+
  INDEX("/ZXX/XXX_XXX_XXX" "/ZXX/XXX_XXX_XXX~001")
*/
  "LOCNO" , "MATNR" , "RUN_DATE" , "AGR_DATE" , "QUANTITY_ORG" ,
  "QUANTITY_CHG" , "DELTA_QTY" , "PLANNER" , "CHANGE_DATE" , "PLANNER_PPS"
FROM
  "/ZXX/XXX_XXX_XXX"
WHERE
  "LOCNO" = :A0 AND "MATNR" = :A1 AND "AGR_DATE" = :A2 OR "LOCNO" = :A3 AND
  "MATNR" = :A4 AND "AGR_DATE" = :A5 OR "LOCNO" = :A6 AND "MATNR" = :A7 AND
  "AGR_DATE" = :A8 OR "LOCNO" = :A9 AND "MATNR" = :A10 AND "AGR_DATE" = :A11 OR
  "LOCNO" = :A12 AND "MATNR" = :A13 AND "AGR_DATE" = :A14#
```

2. Index definition in SE11, shows different name for the index than that in oracle. ABAP code is pointing to the Data Dictionary name of the index, but this one doesn't exist on Oracle. So the hint is not used and job is doing full table scans.



Index Name	/ZXX/XXX_XXX_XXX - 001			
Short description	Secondary Index created for runtime enhcmnt of PD1610*			
Last changed	USERID	07.04.2009	Original language	EN English
Status	Active	Saved	Package	/ZXX/XXX0DEV

Index /ZXX/XXX_XXX_XXX00 exists in database system ORACLE

[✓ Non-unique index]

[✓ Index on all database systems]

For selected database systems

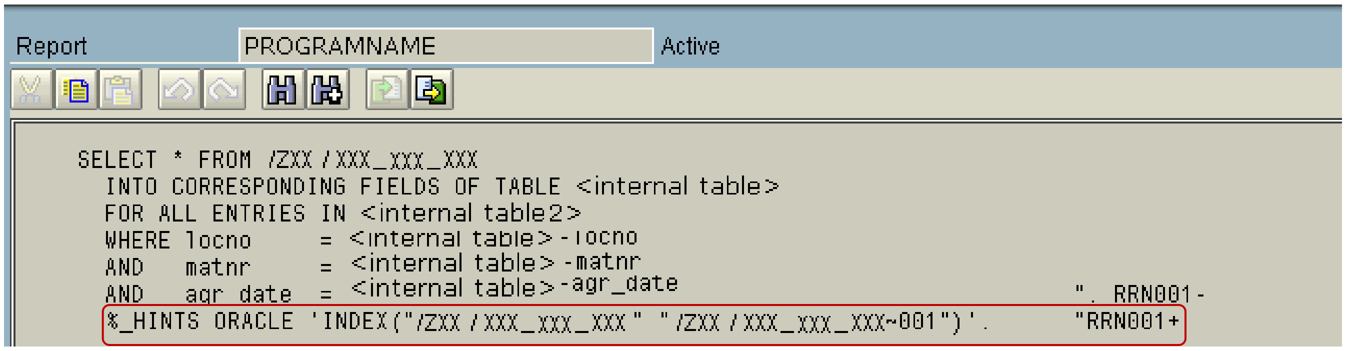
No database index

Unique index (database index required)

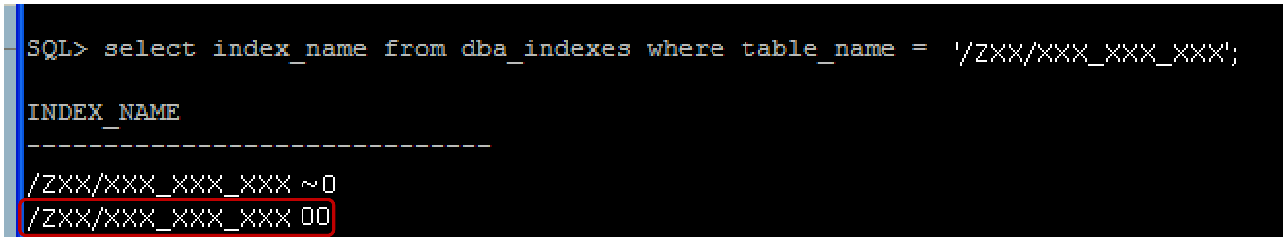
Index flds

Field name	Short Text	DTyp	Length
LOCNO	cation	CHAR	20
MATNR	Product ID	CHAR	40
AGR_DATE	Date	DATS	8

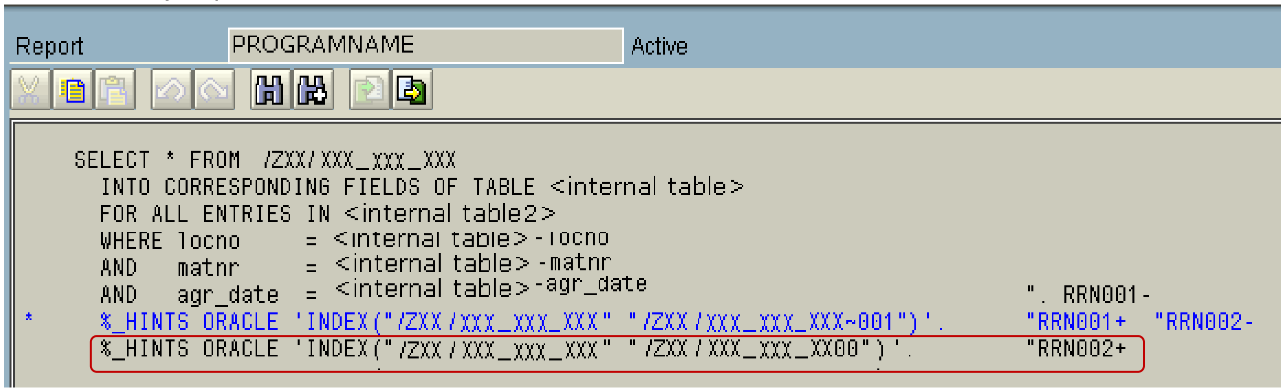
3. Hint in ABAP is pointing to the Database Dictionary name for the index:


```
Report    PROGRAMNAME    Active

    SELECT * FROM /ZXX/XXX_XXX_XXX
      INTO CORRESPONDING FIELDS OF TABLE <internal table>
      FOR ALL ENTRIES IN <internal table2>
      WHERE locno     = <internal table>-locno
      AND   matnr     = <internal table>-matnr
      AND   agr_date  = <internal table>-agr_date                        ". RRN001-
      %_HINTS ORACLE 'INDEX("/ZXX/XXX_XXX_XXX" "/ZXX/XXX_XXX_XXX~001")'.     "RRN001+
```

4. Index name on oracle level


```
SQL> select index_name from dba_indexes where table_name = '/ZXX/XXX_XXX_XXX';

INDEX_NAME
------------------------------
/ZXX/XXX_XXX_XXX~0
/ZXX/XXX_XXX_XXX 00
```

5. The ABAP was modified to use the Oracle Index name and the program's performance was considerably improved.


```
Report    PROGRAMNAME    Active

    SELECT * FROM /ZXX/XXX_XXX_XXX
      INTO CORRESPONDING FIELDS OF TABLE <internal table>
      FOR ALL ENTRIES IN <internal table2>
      WHERE locno     = <internal table>-locno
      AND   matnr     = <internal table>-matnr
      AND   agr_date  = <internal table>-agr_date                        ". RRN001-
*     %_HINTS ORACLE 'INDEX("/ZXX/XXX_XXX_XXX" "/ZXX/XXX_XXX_XXX~001")'.     "RRN001+  "RRN002-
      %_HINTS ORACLE 'INDEX("/ZXX/XXX_XXX_XXX" "/ZXX/XXX_XXX_XX00")'.        "RRN002+
```

For the above given example, the runtime of the changed program came down to approximately 3700 seconds from 35000+ seconds.

Please note that creation of Secondary Indexes and ABAP Hints should be done with clear communication with the Database Administrator and Basis team.

Related Content

http://help.sap.com/saphelp_nw04/helpdata/en/cf/21eb47446011d189700000e8322d00/frameset.htm

https://websmp130.sap-ag.de/sap(bD1lbiZjPTAwMQ==)/bc/bsp/spn/sapnotes/index2.htm?numm=129385

For more information, visit the Performance homepage.

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