SAP® MaxDB™
Introduction to Query Optimization
Version 7.7

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THE BEST-RUN BUSINESSES RUN SAP™

Optimization Overview

Optimization

Explain

Strategy Examples

Query Rewrite

Update Statistics

Goals of Optimization

Goal: Minimizing resource-consumption like

- CPU-time
- I/O-load
- Memory
- Disk space

SQL Commands affected by optimization

- SELECT (mass select, single select)
- Update
- Delete
- Insert

Types of Optimizers

Rule based optimizer

- Access strategy is defined through rules at parsing time.
- Does not depend on values in the WHERE clause
- ***The rule determines which access type is selected.***

Cost based optimizer

- Searching strategy is detemined via
  - current column content (values)
  - indexes available
  - estimated count of (page) accesses
- ‚***Lowest cost‘ strategy will be used.***

There are two types of optimizers for relational database systems: rule-based and cost-based optimizers.

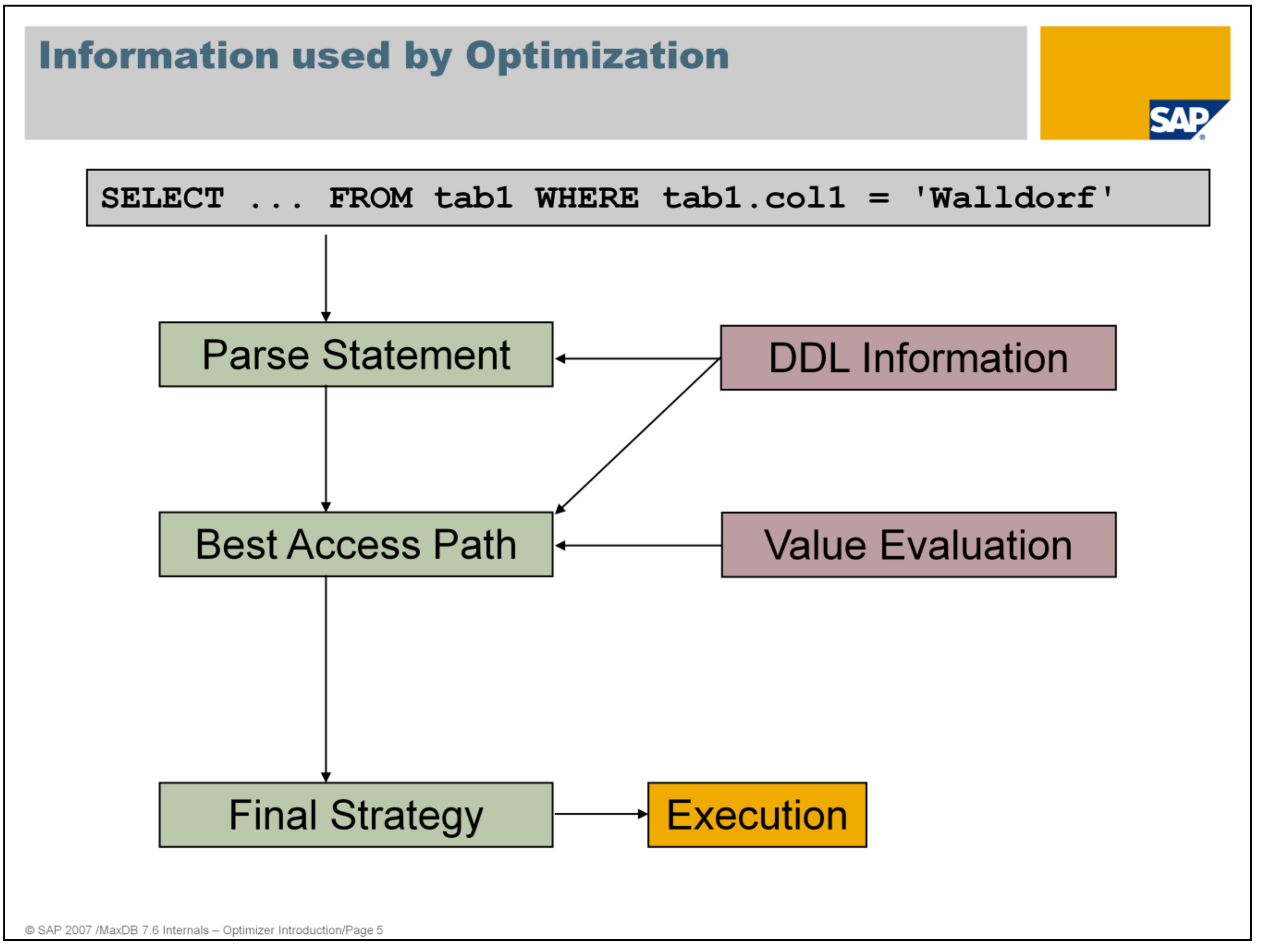
The rule-based optimizer works according to certain rules. For example, if an index is available, this index will be used for access - independent of the values in the WHERE condition. With the rule-based optimizer, the strategy for processing SQL statements is decided at the time of parsing.

Cost-based optimizers determine the best search strategy with the help of statistical information about the size of the table and values within the table columns.

A cost-benefit plan is created for the various access options. The best strategy is chosen to execute the command depending on the values defined in the WHERE condition. Therefore, the eventual search strategy can only be determined at the time of execution.

MaxDB supports cost-based optimizers.

Before the optimization Query Rewrite checks if the statement can be reformulated in a reasonable way. This check and conversion is done rule-based.



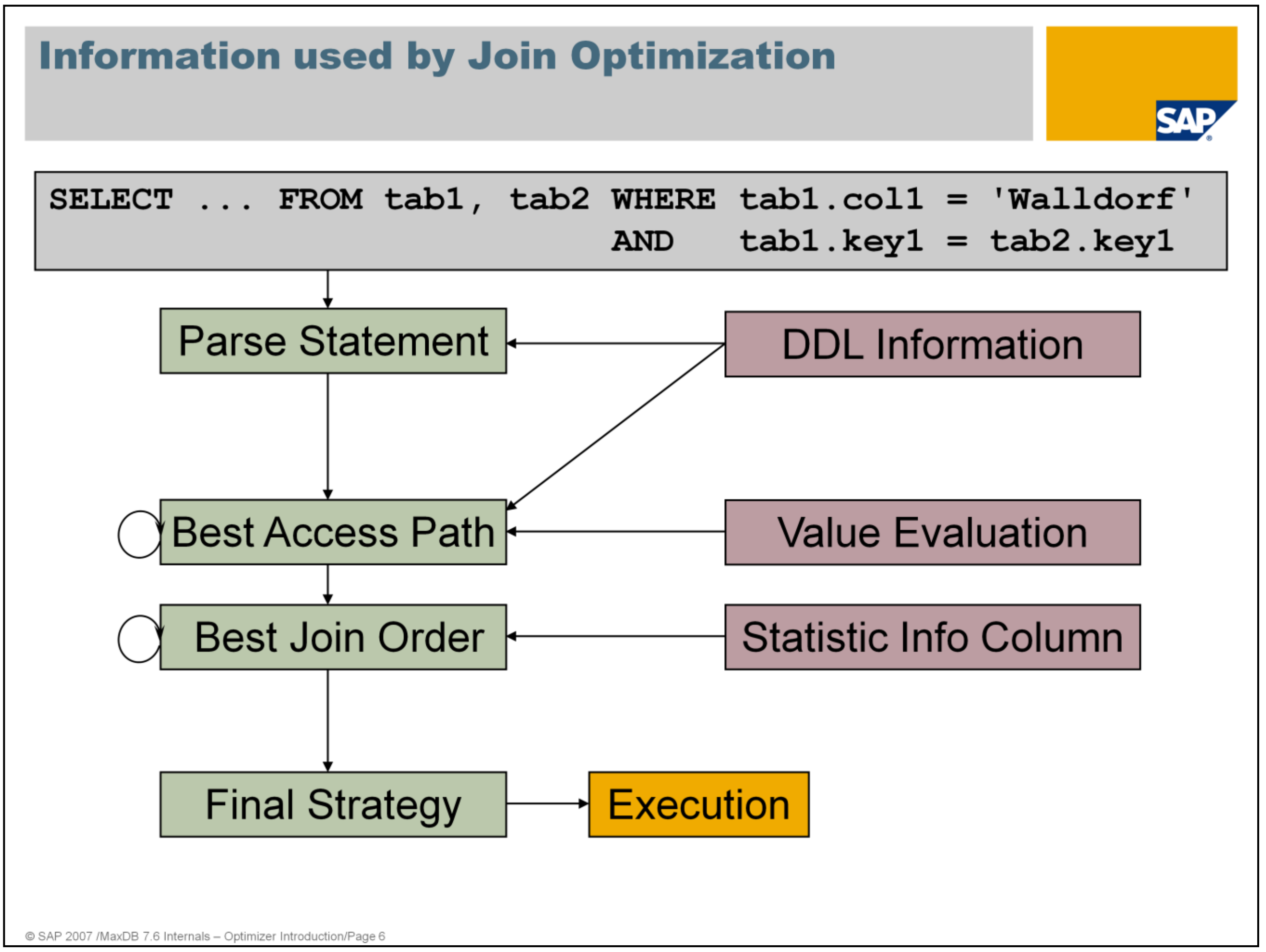
First, an SQL statement is processed by the parser. This performs a syntactic and semantic analysis. In the semantic analysis, tables and their column data are checked.

The optimizer determines which primary and secondary keys are available for the table and checks whether a corresponding key can be used to search for values.

For secondary keys, the number of differing values plays an important role. Example: it does not make sense to search using an index if there is only one secondary key value, it is precisely this value that will be searched for, and additional table fields will be queried.

The number of pages that have to be read in the secondary index is determined by generating a start and a stop key. Depending on the number of pages of the table, it is decided whether it is worthwhile to search using the index. The number of pages of the entire table is located in the statistics.

At the end, the strategy with which the SQL statement will be executed is determined.



For a JOIN, the optimizer seeks out the most suitable access path for each table.

Then it has to be decided in which order the tables will be processed and connected with each other. The resulting result sets should be as small as possible. For the join columns, the values are unknown before the execution. Therefore, the join optimizer can only work with the statistical values for columns.

Which condition will be evaluated ?

Single table select

- Column = value
- Column <, <=, >=, > value
- Column BETWEEN value AND value
- Column IN (value, value, ...)
- Column LIKE string value (including %,?,...)
- Column = (ANY) <subquery>
- Column IN <subquery>

Join select

- Table1_column = table2_column
- Table1_column <, <=, >=, > table2_column
- (Condition has to be on the ‚Top-AND-Level‘ of the <search condition>)

The search conditions that the optimizer can use to determine the optimal search strategy are the following:

- Equality conditions
- Range conditions
- IN conditions
- IN conditions

Here, the search conditions are displayed in the order of their valency. In other words, with the same preconditions an equality condition is evaluated as being better than an IN condition.

The SQL Optimizer also converts conditions under certain circumstances. If a single value is specified in an IN condition multiple times, the condition is converted into an equality condition.

Table Examples: ZZTELE, ZZSTADTTEIL

```
Create Table ZZTELE
( NAME        CHAR(40),
  VORNAME     CHAR(20),
  STR         CHAR(40),
  NR          INT,
  PLZ         CHAR(5),
  ORT         CHAR(25),
  CODE        CHAR(31),
  ADDINFO     CHAR(31),
  PRIMARY KEY
  (NAME,VORNAME,STR) )
```

# of records: around 115,000

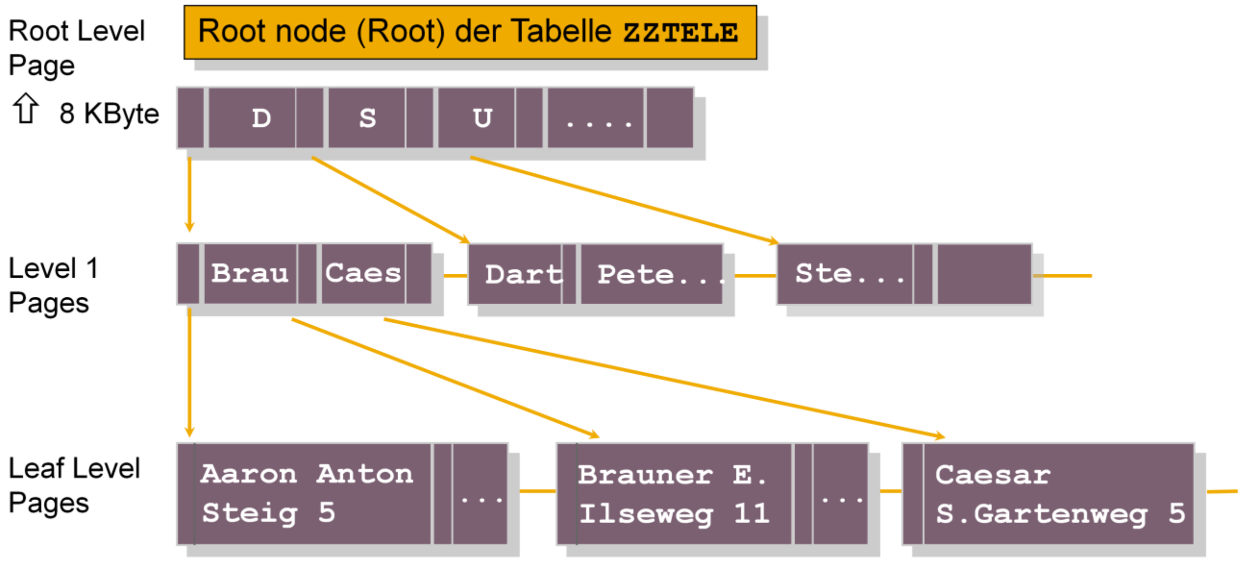
```
Create Table ZZSTADTTEIL
( PLZ         CHAR(5),
  ORT         CHAR(25),
  STADTTEIL CHAR(40),
  PRIMARY KEY
  (PLZ) )
```

# of records : around 20,000

In the following examples, we use the table ZZTELE with approx. 115,000 records.

For joins and subqueries, the examples also refer to the table ZZSTADTTEIL with approx. 20000 records.

Storing data in a B*tree



Base data as well as index data (secondary key) is stored in B*tree structures.

The data of the base tables and the indexes are stored in B*Tree format.

When creating a table, the root page is created. A root page can contain a maximum of 8 KB.

If data records are entered in the tables, the root page is filled with what are known as separators. A separator is made up of the primary key of the data record. However, due to space limitations, the entire key is not saved as a separator in the root page, but rather only the part of the key up to the first significant digit in the key. The more significant a key is, the smaller the separators are and the more separators can be managed in the root page.

For very small tables, all data records are already stored in the root page. If the root page is filled, entering additional records in the table will automatically generate an additional tree level, or what is known as the Level 1 pages level. The root page will then consist only of separators and pointers to the corresponding lower level containing the information with a distinguishing separator.

Primary and Secondary keys (indexes)

Primary key

- The primary key is kept on the data tree (clustered)
- No separate tree for primary key !
- The primary key is used as separator in B*trees
- The records are stored in primary key order

Secondary key (index)

- Create a separate B*tree for the secondary key
- A secondary key does not contain physical addresses pointing to the base data but logical addresses in terms of primary keys

Explain (1)

Input : EXPLAIN <Select-Command>

Output : Description of search strategy

- EXPLAIN is used with Select commands that access base tables
- EXPLAIN does not execute the specified Select command.
- The explain command cannot be used with UPDATE , DELETE or INSERT commands

In the ABAP-based SAP application server, EXPLAIN is available in transactions ST05 and DB50 (in the command monitor).

In the SQL editor of the Database Studio you can send an EXPLAIN via context menu (right mouse click) to the database. The output is shown in a separate window.

You can display the search strategy for INSERT, DELETE and UPDATE commands by transforming the command into a SELECT. The additional option FOR REUSE ensures that the result table is stored. Example:

Example:

```
UPDATE ZZTELE
SET ADDINFO = 'ledig'
WHERE NAME = 'Mueller'
AND     VORNAME = ' Egon'
AND     STR = ' Wexstraße'

SELECT * FROM ZZTELE
WHERE NAME = 'Mueller'
AND     VORNAME = ' Egon'
AND     STR = ' Wexstraße'
FOR REUSE
```

Explain (2)

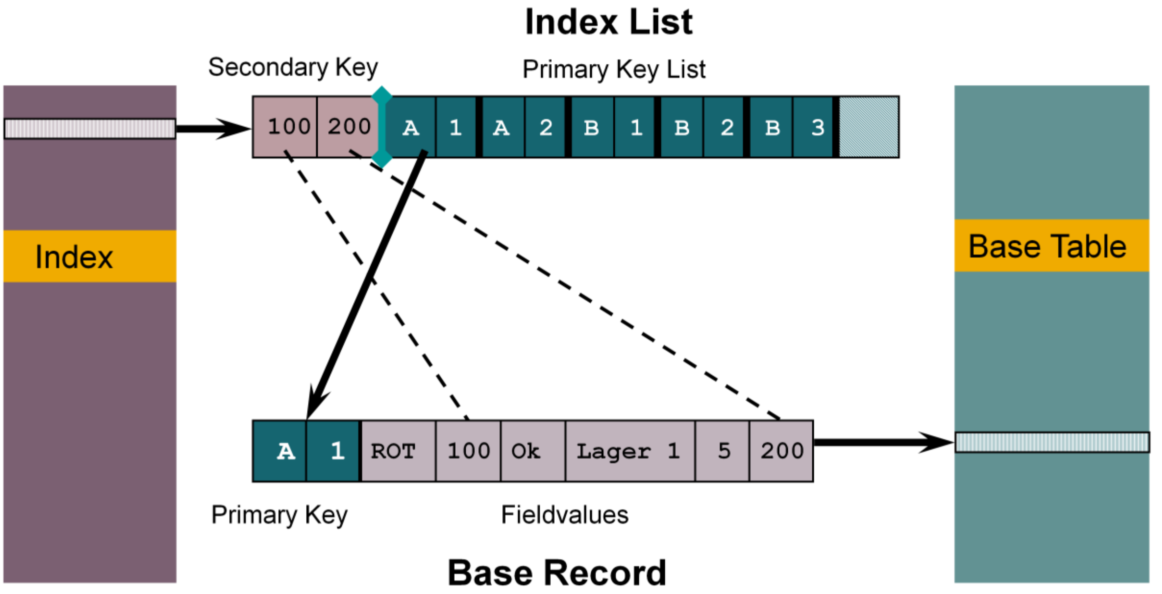
SCHEMANAME	TABLENAME	COLUMN_OR_INDEX	STRATEGY	PAGECOUNT
Schema	Table 1	Names of key or index columns	Name of chosen strategy for this table	Number of affected data pages
Schema	Table 2	Names of key or index columns	Name of chosen strategy for this table	Number of affected data pages
			RESULT IS (NOT) COPIED, COSTVALUE IS	Estimated costs
	Result name		Applied Query Rewrite rules	Number of ues

EXPLAIN shows:

- one block for each table from the SELECT-FROM list
- the order of the strategies reflects the order of execution
- the order of the strategies reflects the order of execution
- COPIED / NOT COPIED --> Results set is generated/not generated
- "Estimated costs" provides an estimate about the number of disk accesses (logical I/Os).
- Applied Query Rewrite rules and the frequency of their use

Search Strategies

Index and base table



An index contains the data of the secondary key as well as the respective primary key Using the primary key, the data can be found in the base table. For each index, a B* tree is created, which is sorted according to the values of the secondary key.

There is no record ID or anything similar. The unique ID of a record is the primary key (or for multiple keys, the combination of primary key fields).

If no primary key was specified when the table was generated, the database generates the internal field `SYSKEY` of the type `CHAR(8) BYTE`. This field is filled with unique values.

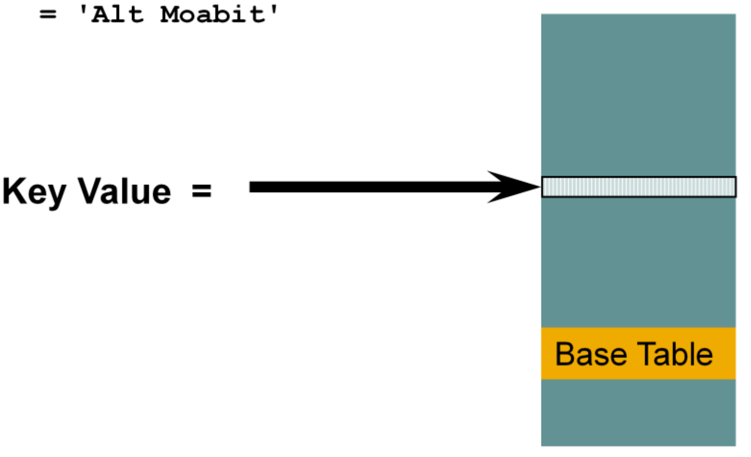
Searching via an index is relatively costly. The access is only worthwhile if less than approx. 30% of the records can be determined from the index and no result set is generated.

On the following page you will find examples of search strategies. The list of strategies is not complete. A complete list of search strategies can be found in the documentation.

Basic Information -> Background Knowledge -> SQL Optimizer -> Search Strategy -> List of all search strategies

EQUAL CONDITION FOR KEY

```
SELECT * FROM zztele
  WHERE Name    = 'Aaron'
  AND   Vorname = 'Anton'
  AND   Str     = 'Alt Moabit'
```

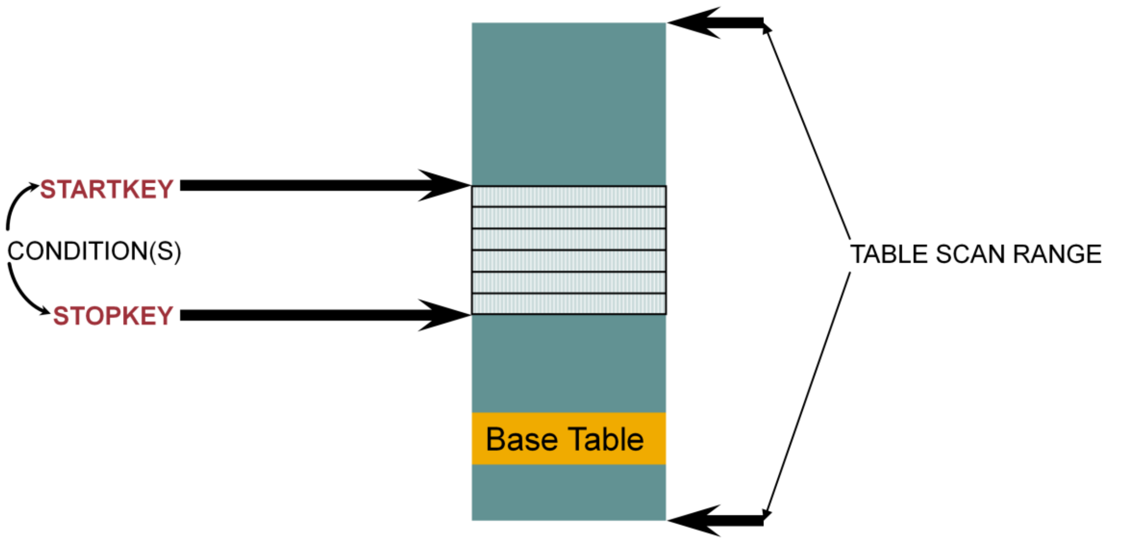


EQUAL CONDITION FOR KEY provides an efficient access path through "direct access" to the base table.

The decision in favor of this strategy will already have been made at the time of parsing because, independent of the data in the search conditions, no better search strategy is possible.

RANGE CONDITION FOR KEY

```
SELECT * FROM zztele WHERE Name = 'Schmidt'
                     AND   Vorname like 'A%'
SELECT * FROM zztele
```



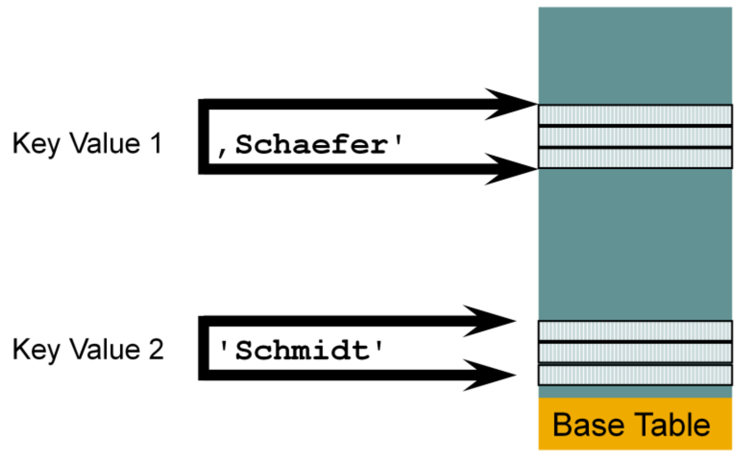
If a portion of the start of the primary key is specified in the WHERE condition, the strategy RANGE CONDITION FOR KEY will be executed.

If the index and primary key cannot be used, the base table will be searched completely (TABLE SCAN).

An intermediate result set is not generated.

IN CONDITION FOR KEY

```
SELECT * FROM zztele
WHERE Name IN (‘Schaefer', 'Schmidt')
```



The IN condition can be placed on each field of a primary key.

Only one IN condition is taken into account.

The primary key fields that precede the field with the IN condition may only be specified in an EQUAL condition.

An intermediate result set is generated. The result set is sorted according to the primary key.

As of version 7.4, the optimizer checks whether the RANGE CONDITION FOR KEY is advantageous. This happens if the values in the IN condition are close to each other. Example:

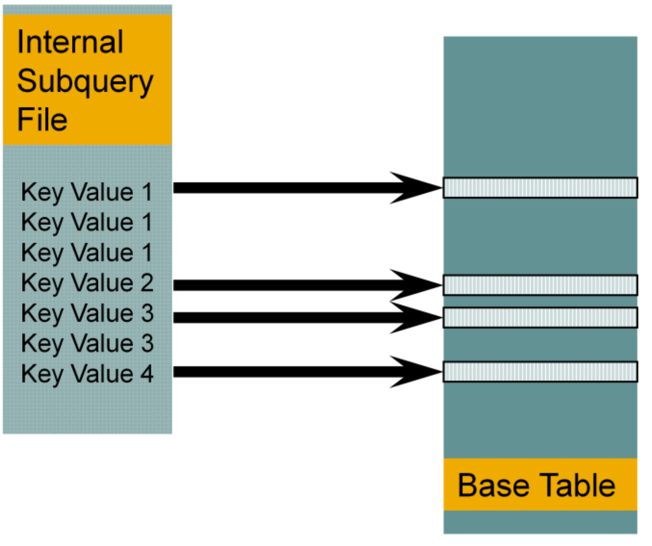
```
SELECT *
 FROM zztele
 WHERE name IN  ( 'Schaefer' , 'Schmidt')
```

There are additional names in the table that are located between the values 'Schaefer' and 'Schmidt'. There are additional names in the table that are located between the values 'Schaefer' and 'Schmidt'. Thus, using this search condition, records are also included that do not belong to the results set. However, the strategy is more favorable since only one start and stop key have to be determined.

RANGE CONDITION FOR KEY (SUBQUERY)

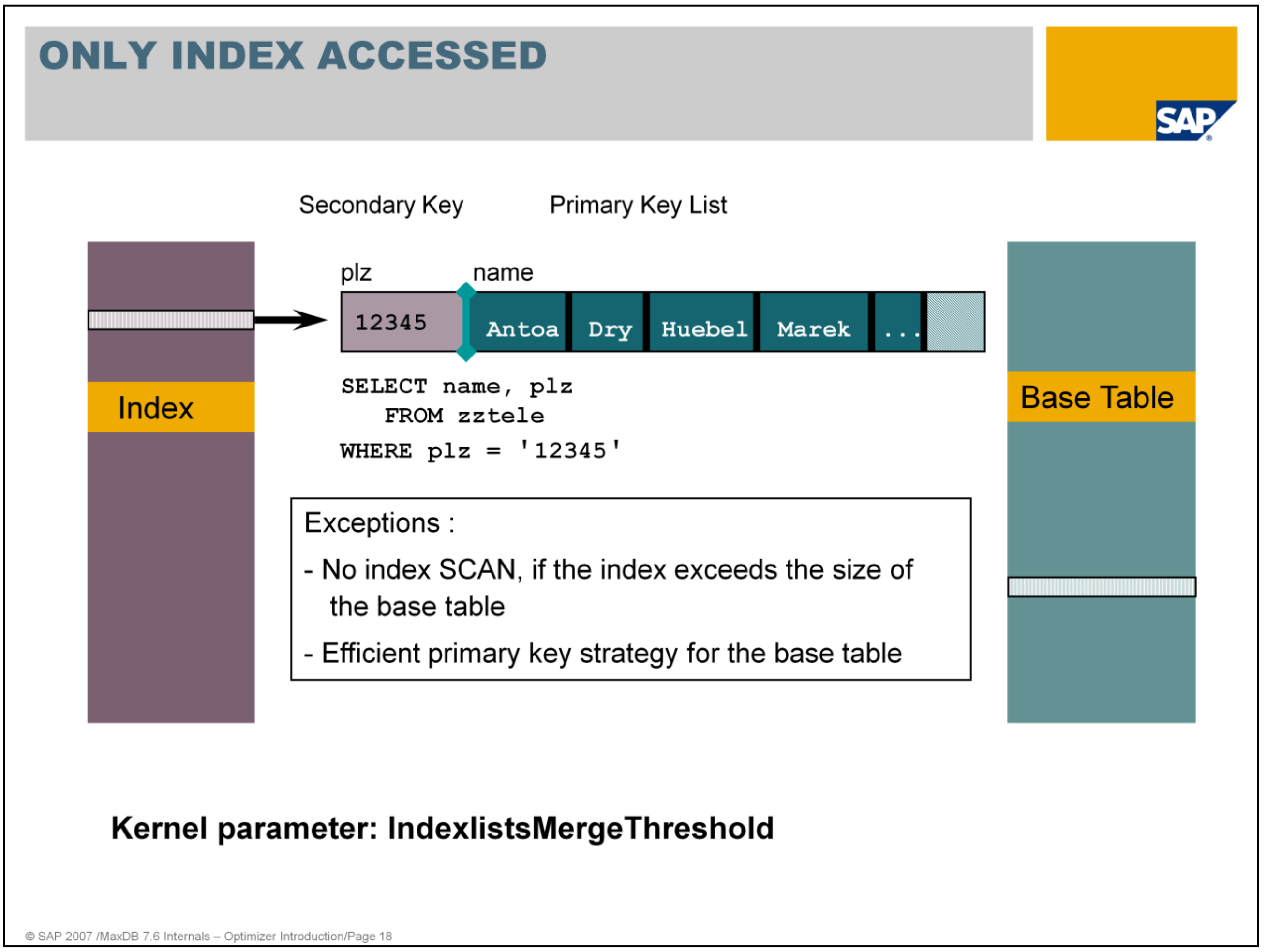
```
CREATE INDEX "ZZSTADTTEIL~1" ON ZZSTADTTEIL(STADTTEIL)

SELECT * FROM zztele WHERE name IN
(SELECT stadtteil FROM zzstadtteil
                WHERE stadtteil = 'Ahlheim' )
```



If a subquery returns primary key values, EQUAL CONDITION FOR KEY or RANGE CONDITION FOR KEY is used on the base table. The result set is sorted according to primary key values.

An intermediate result set is generated.



If a SELECT statement only addresses columns that are also contained in an index (SELECT list, WHERE clause), then only this index will be accessed for the execution of the command.

Advantage:

- In some cases, significantly fewer pages that have to be searched
- Optimal usage of sorting of secondary and primary keys in the index
- No additional access to the base table
- No determination of access costs (only for the join)

Exceptions:

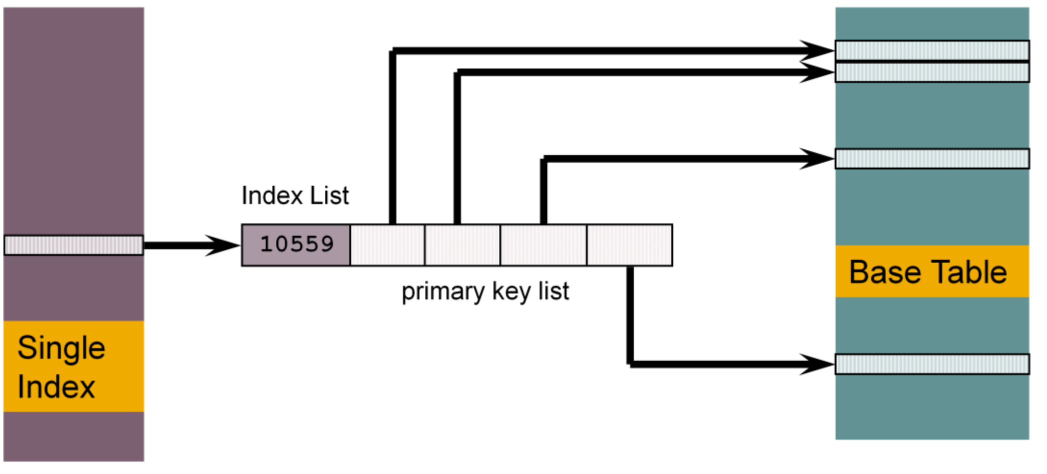
- No index SCAN if the index is larger than the base table
- Efficient primary key strategy via the base table

The old name for parameter IndexlistsMergeThreshold was OPTIM_INV_ONLY.

EQUAL CONDITION FOR INDEX

```
CREATE INDEX "ZZTELE~3" ON ZZTELE(PLZ)

SELECT * FROM zztele
  WHERE plz = '10559'
```



Efficient access path for fields with greater selectivity

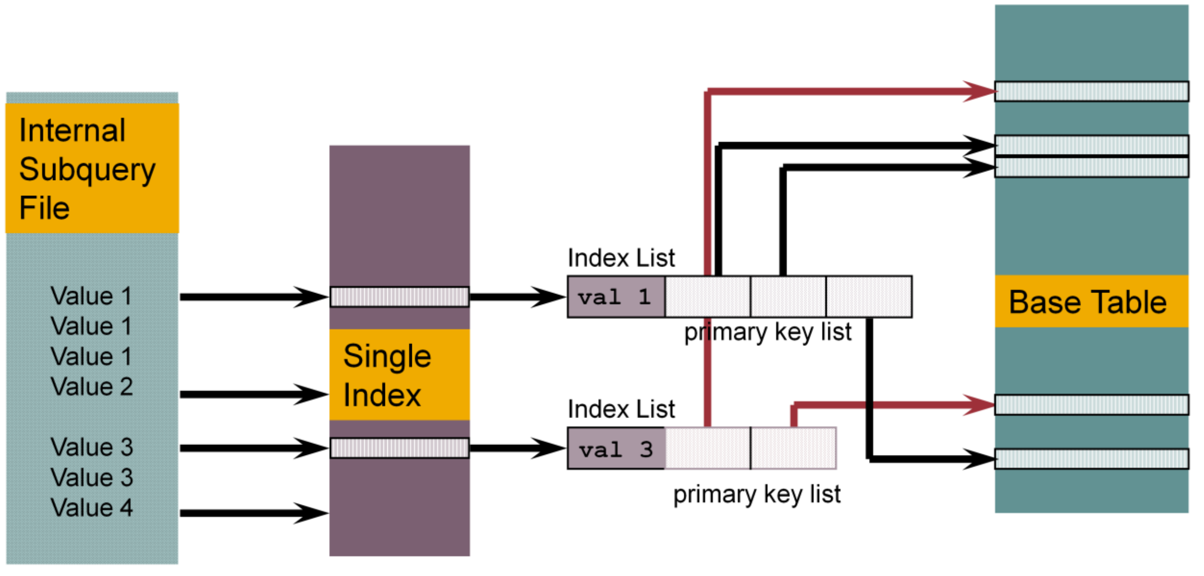
When determining the strategy, additional costs (index_overhead) for accessing the base data via the index are taken into account.

The optimizer also opts for the strategy EQUAL CONDITION FOR INDEX, if all fields of a multiple index in the WHERE condition are specified with an equality condition.

An intermediate result set is not generated.

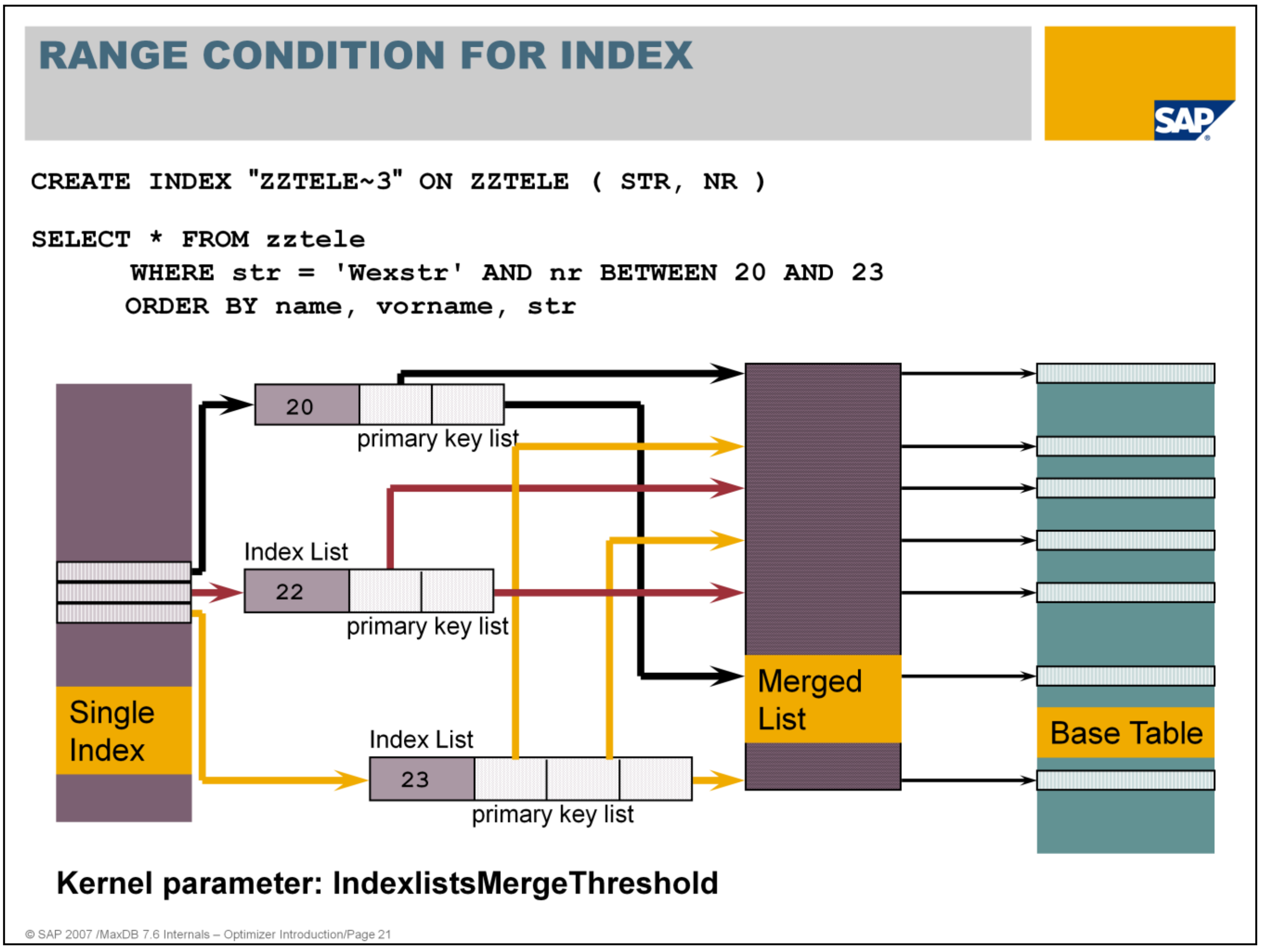
EQUAL CONDITION FOR INDEX (SUBQUERY)

```
CREATE INDEX "ZZTELE~3" ON ZZTELE(PLZ)
SELECT * FROM zztele WHERE plz IN
  ( SELECT plz FROM zzstadtteil WHERE plz = '12047' )
```



The result set is sorted according to the secondary key sequence. If only values from the index are queried, the Only Index strategy is used.

An intermediate result set is generated.



The result set is sorted according to the primary key.

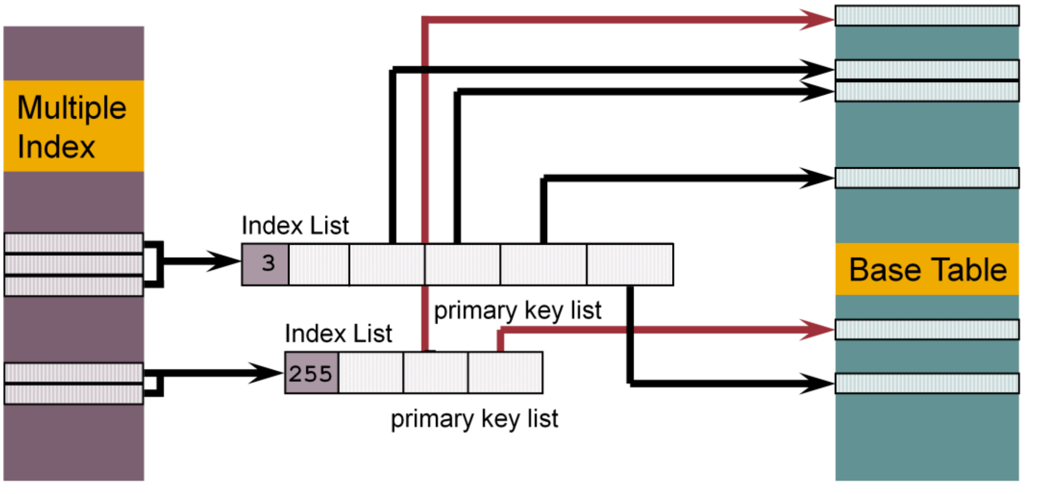
Using the additional strategy TEMPORARY INDEX CREATED, the primary keys are sorted in a merge list. The optimum cache usage is guaranteed using access to the base data in the order of the primary keys.

The maximum size of the merge lists that are generated can be configured using the parameter IndexlistsMergeThreshold (OPTIM_MAX_MERGE).

An intermediate result set is not generated.

IN CONDITION FOR INDEX

```
CREATE INDEX "ZZTELE~3" ON ZZTELE ( STR, NR )
SELECT * FROM zztele
  WHERE str = 'Wexstr' AND nr IN (3, 255)
```



A secondary key can be taken into account for an IN condition. Only one IN condition is taken into account.

The secondary key fields that precede the field with the IN condition may only be specified in an EQUAL condition.

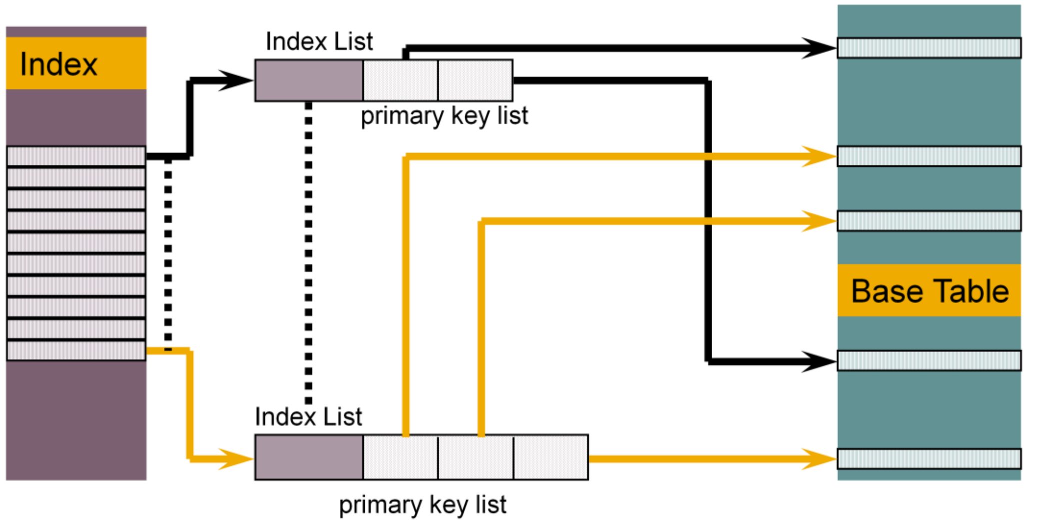
The result set is sorted according to the secondary key.

The Only Index strategy can be used.

An intermediate result set is generated.

INDEX SCAN

```
CREATE INDEX "ZZTELE~2" ON zztele ( str, nr )
SELECT * FROM zztele WHERE name BETWEEN 'A' and 'D'
   ORDER BY str, nr
```



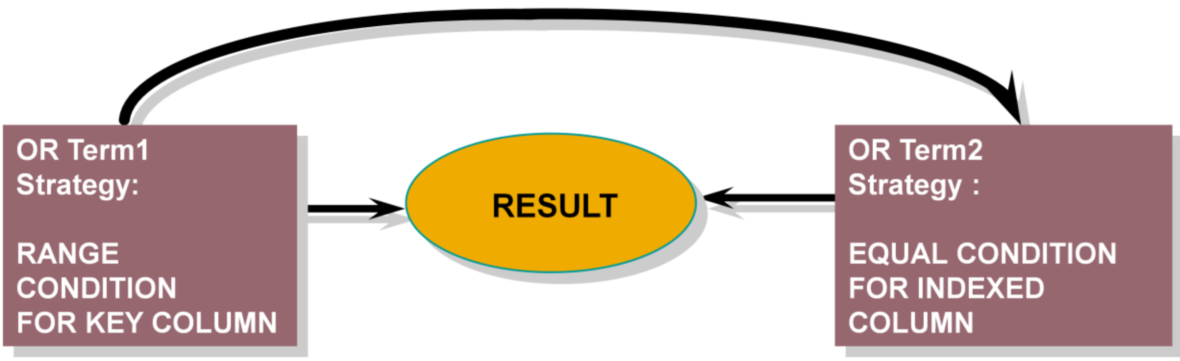
During an INDEX SCAN, all entries are read via the index in the order of the secondary key. An intermediate results set is not generated.

As of version 7.4, NULL values are also included in single indexes. Thus, this strategy can be used on all indexes.

If a Table Scan is to be carried out for an ORDER BY because no index can be used, an intermediate result set is generated.

DIFFERENT STRATEGIES FOR OR-TERMS

```
CREATE INDEX "ZZTELE~3" ON ZZTELE(PLZ)
SELECT * FROM zztele
 WHERE name= 'Aaron'
  OR    plz    = '12345'
```



Nested OR terms are analyzed down to the third level.

The strategy search is only carried out if there is no adequate strategy on the highest level.

If the costs of the strategy search exceed the costs determined for the highest level, the strategy search is discontinued.

An intermediate result set is generated.

Within the SAP environment, similar statements are also generated by SELECTS with RANGES.

NO STRATEGY NOW (ONLY AT EXECUTION TIME)

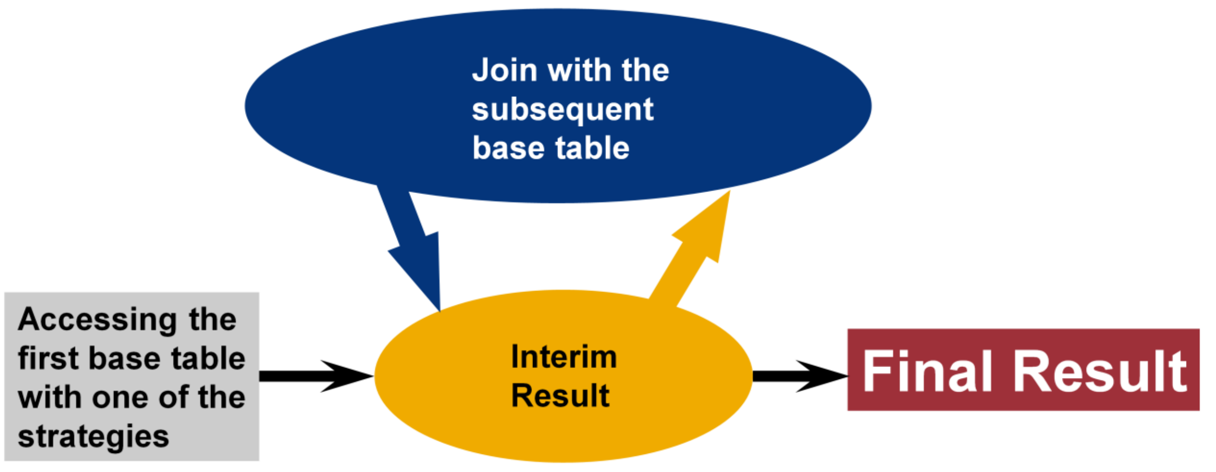
Strategy will be determined first during execution of the command

Is displayed for queries if the access path will be determined first when they are executed

Is displayed for queries containing sub-queries or correlated sub-queries: strategy will first be determined when interim results become available.

Join Strategies (1)

```
SELECT * FROM zztele, zzstadtteil
  WHERE zztele.Plz = zzstadtteil.Plz
  AND   zztele.Ort = zzstadtteil.Ort
  AND   zztele.name = 'Mueller'
```



The costs for a join are based on information about the value distribution.

In general, the costs of a join decrease as the number of joined columns increases.

For joins, an intermediate result set is always generated.

Join Strategies (2)

```
SELECT * FROM scantab, jointab
  WHERE scantab.A = jointab.Col1
  AND   scantab.B = jointab.Col2
```

Join Strategy	Meaning
JOIN VIA KEY COLUMN	col1 is the sole primary key column col2 is a standard column
JOIN VIA KEY RANGE	col1 is the first primary key column col2 is a standard column
JOIN VIA MULTIPLE KEY COLUMNS	col1 is the first primary key column col2 is the last primary key column
JOIN VIA RANGE OF MULTIPLE KEY COLUMNS	col1 is the first primary key column col2 is the second primary key column

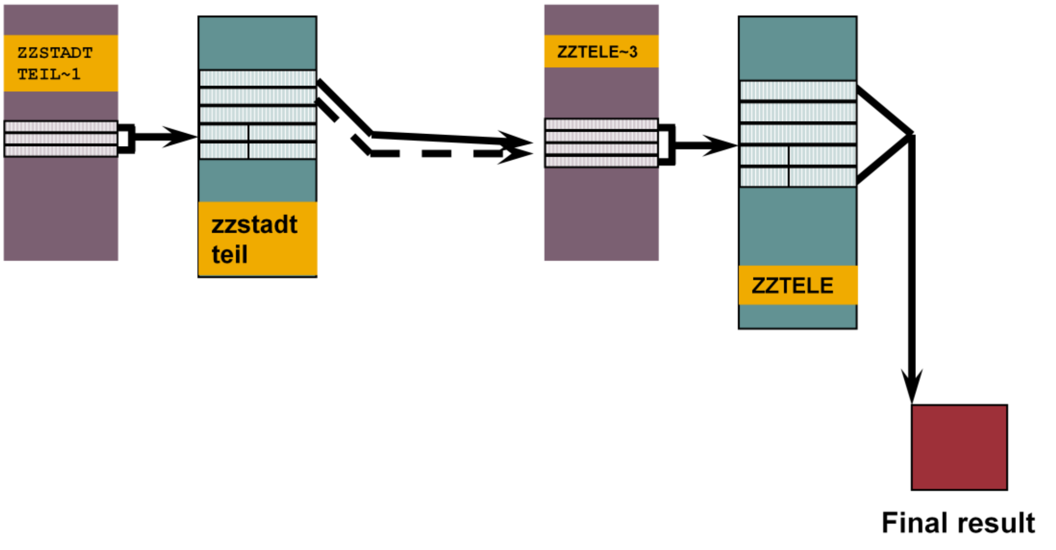
Join Strategies (3)

```
SELECT * FROM scantab, jointab
  WHERE scantab.A = jointab.Col1
  AND   scantab.B = jointab.Col2
```

Join Strategy	Meaning
JOIN VIA INDEXED COLUMN	col1 is a single index column col2 is a standard column
JOIN VIA MULTIPLE INDEXED COLUMNS	col1 is the first column of a multiple index col2 is the last column of a multiple index
JOIN VIA RANGE OF MULTIPLE INDEXED COLUMNS	col1 is the first column of a multiple index col2 is the second column of a multiple index

Join Across two Tables (Nested Loop)

```
CREATE INDEX "ZZTELE~3" ON ZZTELE(PLZ)
CREATE INDEX "ZZSTADTTEIL~1" ON ZZSTADTTEIL(STADTTEIL)
SELECT * FROM zztele, zzstadtteil
 WHERE zztele.plz = zzstadtteil.plz
   AND zzstadtteil.stadtteil = 'Moabit'
```

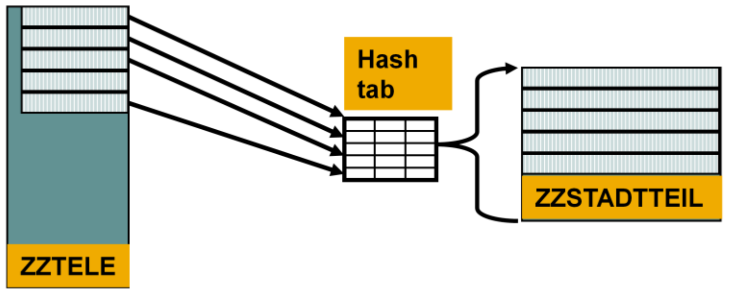


Joins are mostly executed with the Nested Loop method. In doing so for the single join transitions no result sets are built. Only the final result is fully created before the first row is delivered.

As of version 7.7 there is no more possibility to choose between Sorted Merge or Nested Loop by a parameter setting (JOIN_OPERATOR_IMPLEMENTATION).There are only marginal disadvantages concerning CPU usage for Nested Loop with the current algorithms. Therewith the Nested Loop can deliver the result faster and with the use of less resources.

Hash Join

```
CREATE INDEX "ZZTELE~3" ON ZZTELE(PLZ)
SELECT zztele.plz FROM zztele, zzstadtteil
 WHERE zztele.plz = zzstadtteil.plz
```



Kernel parameter: EnableJoinHashTableOptimization

The hash join strategy is employed when a join transition to a small table is done and it is probable that a large number of records needs to be read from the small table.

In this case it would be faster to import the small table once and generate a temporary has table. Searching for the keys in a hash table is faster than searching via the B* tree of the table.

The strategy "TABLE HASHED" identifies the join via a hash table.

The old parameters influencing this behaviour were MAX_HASHTABLE_MEMORY and MAX_SINGLE_HASHTABLE_SIZE.

Hints

Hints provide the Optimizer with rules that it can use if necessary.

Example:

```
SELECT /*+ORDERED*/ zztele.plz, zzstadtteil.stadtteil
FROM zzstadtteil, zztele
  WHERE zztele.plz = zzstadtteil.plz
       AND zzstadtteil.stadtteil = 'Moabit‘
```

Hints are supported as of:

- MaxDB Version 7.5
- WebAS ABAP Version 6.20

MaxDB supports the following hints, the meaning of which can be extracted from SAP note 832544:
KEYACCESS, KEYRANGE, INDEXACCESS[(<INDEXNAME>)] , KEYSCAN, INDEXSCAN, INDEXRANGE, BUILDRESULT, FETCHRESULT, DISABLE_INVONLY, IN_STRATEGY, SUBQ_STRATEGY, TRACE, ORDERED, COORDINATOR_JOIN, OPERATOR_JOIN, PARALLEL_SERVER(<unsigned integer>), NOACCESSPATH, ACCESS=<access hint list>, BUFFERSIZE, QUERYREWRITE_OP , QUERYREWRITE_STMT, QUERYREWRITE_NO

Query Rewrite

Query Rewrite rebuilds SQL statements by the use of rules to enable the optimizer to find the best strategy.

Example: DistinctPullUp

```
SELECT DISTINCT * FROM zztele
➔ SELECT "NAME", "VORNAME", "STR", "NR",
         "PLZ", "ORT", "CODE", "ADDINFO"
    FROM "SAPR3"."ZZTELE" AS "_T1„
```

In this example the term DISTINCT is removed as the result set may only contain unique rows. There is no need for the application to create an internal result set to guarantee the uniqueness of the rows.

Query Rewrite investigates the statement after the syntactical analysis.

Query Rewrite does a semantical analysis and rebuilds the statement if rules can be applied. Several rules can be applied.

Some rules (f.e. DistinctPushDownTo) do not change the statement itself but the internal Query Graph. This allows tp apply other rules.

The execution of some rules does not rearrange the statement but provides some additional information. The rule DistinctPullUp deposits the information that all rows are unique. It is not necessary for the execution of the statement to create an internal result set to guarantee the uniqueness of the result rows then.

The rearranged statement with the possible execution plans is stored in internal format within Shared SQL or the catalog cache, respectively.During the execution the optimizer determines the best execution plan for the rearranged statement.

Query Rewrite works rule-based. Statistical data is not taken into account. There is no evaluation of data.

Query Rewrite Rules

Changing the column ACTIVE in the view QUERYREWRITERULES effects if a rule is switched on or off.

```
select * from queryrewriterules
```

	RULENAME	ACTIVE	COMMENT
1	AddLocalPredicates	YES	Add Local Predicates for Joins with OR-Predicates
2	ConvertExistentialSubquery	NO	Convert a correlated existential subquery to an IN clause
3	ConvertOrToIn	YES	Convert OR to IN
4	ConvertToExistentialSubquery	NO	Convert INTERSECT or EXCEPT to an existential subquery
5	DistinctForSubqueries	YES	Set Distinct for existential and all subqueries
6	DistinctPullUp	YES	Remove distinct elimination in a select if all fromselects are distinct
7	DistinctPushDownFrom	YES	Distinct push down from
8	DistinctPushDownTo	YES	Distinct push down to
9	EliminateGroupByOrDistinct	YES	Remove unnecessary GROUP BY or DISTINCT
10	EliminateOrderBy	YES	Remove unnecessary ORDER BY
11	EliminateSubqueries	YES	EliminateSubqueries
12	MergeExistentialSubquery	YES	Merge a select with an existential subquery
13	MergeFromSelectOrView	YES	Merge a select with a fromselect or view
14	NormalizePredicates	NO	Normalize Predicates
15	OptimizeSubqueries	YES	OptimizeSubqueries
16	PushDownPredicates	YES	Push down predicates
17	PushDownProjection	YES	Push down projection
18	PushDownQuantifier	NO	Push down quantifier
19	RemoveConstFromGroupOrOrderBy	YES	Remove unnecessary constants from GROUP BY or ORDER BY
20	SimplifyPredicates	YES	Simplify Predicates

You can influence the use of Query Rewrite by setting the parameter ENABLEQUERYREWRITE.

Furthermore you have the possibility to switch single rules on or off. Use an UPDATE statement on table QUERYREWRITERULES to set the attribute ACTIVE for the corresponding rule to YES or NO.

Monitoring Query Rewrite

EXPLAIN QUERYREWRITE shows the result of Query Rewrite as SQL statement.

```
explain queryrewrite
select distinct *
from zztele
```

	STATEMENT
1	SELECT "NAME", "VORNAME", "STR", "NR", "PLZ", "ORT", "CODE", "ADDINFO" FROM "SAPA1S"."ZZTELE" AS "_T1"

The view MONITOR indicates how often different rules were applied.

```
select * from monitor
where type = 'REWRITE'
```

	TYPE	DESCRIPTION	VALUE
1	REWRITE	EliminateSubqueries	5
2	REWRITE	OptimizeSubqueries	13
3	REWRITE	SimplifyPredicates	6
4	REWRITE	EliminateOrderBy	19
5	REWRITE	EliminateGroupByOrDistinct	0
6	REWRITE	RemoveConstFromGroupOrOrderBy	0
7	REWRITE	MergeFromSelectOrView	40
8	REWRITE	MergeExistentialSubquery	15
9	REWRITE	ConvertExistentialSubquery	0
10	REWRITE	ConvertToExistentialSubquery	0
11	REWRITE	DistinctPullUp	273

Mit Hilfe von EXPLAIN QUERYREWRITE können Sie das Statement ermitteln, wie es nach der Rewrite-Bearbeitung zur Ausführung kommt.

Die View SYSDBA.MONITOR zeigt an, welche Regel seit dem Start der Datenbank wie oft aufgerufen wurde.

Update Statistics (1)

```
UPDATE STAT[ISTICS]  [<owner>.]<table_name>
([ESTIMATE SAMPLE <unsigned_integer> <PERCENT,ROWS>])
```

To determine the best possible access path, in particular for joins, the Optimizer requires statistical information. If such information is not kept current, the system may make erroneous strategic decisions.

`UPDATE STATISTICS` determines values about the size of a table as well as the size and value distribution of indexes.

`UPDATE STATISTICS` should be executed following large-scale change transactions `(INSERT/LOAD, UPDATE, DELETE).`

Start using the DBM command sql_updatestat and sql_updatestat_per_systemtable or via the CCMS (transactions DB13, DB21).

As of version 7.5, MaxDB requires statistics data only for joins and selects with a restriction of the records in the result, such as „WHERE ROWNUM <= n“.

For the table itself, Update Statistics only determines data if the current size information is not already in the file directory. This does not apply to table created with databases of versions < 7.6 and for which no size information could yet be determined in the file directory.

Update Statistics determines statistics data for all columns that are primary key or index columns. It also determines the statistics data for all columns outside of the primary key and the index, if statistics are available.

When the Optimizer discovers tables with outdated statistics data, it enters them in the table SYSUPDSTATWANTED. The DBM command sql_updatestat_per_systemtable executes Update Statistics for all tables listed in SYSUPDSTATWANTED.

The DBM command executes Update Statistics for all tables in the database.

Update Statistics imports the data for a table from all data volumes in parallel. This makes it very speedy.

As of version 7.6, the sampling procedure in the standard uses a new algorithm for calculating the statistics data. You can determine the algorithm to be used with the parameter UPDATESTAT_SAMPLE_ALGO. The new algorithm generates more accurate statistics with fewer records read.

The programs "xpu" and "updcol" are no longer available as of version 7.6.

Update Statistics (2)

```
ALTER TABLE <table_name>
  SAMPLE <unsigned_integer> <PERCENT,ROWS>
```

The default value for the number of rows to be included when determining the statistics is stored in the database catalog.

This value can be changed either directly with ALTER TABLE or using transaction DB50 -> Problem Analysis -> Tables/Views

For tables that grow and shrink very quickly, such as spool tables, for example, it is a good idea to set the sampling rate to 0. This prevents Update Statistics from being requested and executed for these tables.

For tables that were created with versions < 7.6, the counters for size data in the file directory after upgrade to version 7.5 are not yet available. You can determine the counters with a CHECK DATA in the ADMIN state or with CHECK TABLE WITH SHARE LOCK. CHECK TABLE sets a share lock for the duration of the check.

After the upgrade from versions < 7.6 to versions >= 7.6, all table names are transferred to the table SYSUPDATECOUNTERWANTED. With every restart, the database attempts to determine the counters for all remaining tables in SYSUPDATECOUNTERWANTED for the file directory. A share lock is set on a table during processing. Determination of the counters is immediately terminated for a table if the share lock causes a lock collision.

With the following command dbmcli starts an Update Statistics with sampling for all tables of one schema:

sql_updatestat SAP<SID>.* estimate

Update Statistics (3)

```
SELECT * FROM OPTIMIZERSTATISTICS
WHERE tablename = '...'
```

- Shows the current statistic values that will be used by the optimizer to determine the strategy.

TABLENAME	INDEXNAME	COLUMNNAME	DISTINCTVALUES	PAGECOUNT
ZZTELE	?	ADDINFO	1969	?
ZZTELE	?	CODE	2	?
ZZTELE	?	NAME	13363	?
ZZTELE	?	NR	255	?
ZZTELE	?	ORT	2	?
ZZTELE	?	PLZ	20001	?
ZZTELE	?	STR	8	?
ZZTELE	?	VORNAME	5156	?
ZZTELE	CODE	?	?	1155
ZZTELE	ZZTELE~1	?	?	1165
ZZTELE	ZZTELE~3	?	?	1112
ZZTELE	ZZTELE~4	?	?	1334
ZZTELE	ZZTELE~2	?	?	1548
ZZTELE	?	TABLE STATISTICS	114199	1800

The Optimizer only uses the statistics data for tables only if the counters for size data are not in the file directory.

Counters in the File Directory

```
SELECT  f.type, r.tablename, r.indexname, f.entrycount,
        f.treeindexsize, f.treeleavessize, f.lobsize
  FROM    files f, roots r
  WHERE   f.fileid = r.tableid
  AND     r.tablename IN ('ZZTELE' )
```

- Displays the current counter values in the file directory.

TYPE	TABLENAME	INDEXNAME	ENTRYCOUNT	TREEINDEXSIZE	TREELEAVESSIZE	LOBSIZE
TABLE	ZZTELE	?	114199	144	14400	0
INDEX	ZZTELE	CODE	2	9240	9240	?
INDEX	ZZTELE	ZZTELE~1	10	9320	9320	?
INDEX	ZZTELE	ZZTELE~3	20001	8896	8896	?
INDEX	ZZTELE	ZZTELE~4	5156	10672	10672	?
INDEX	ZZTELE	ZZTELE~2	513	12384	12384	?

The values for TREENINDEXSIZE, TREELEAVESIZE and LOBSIZE are entered in KB.

For tables, ENTRYCOUNT shows the number of records per table. For indexes, ENTRYCOUNT shows the number of different values for the secondary key.

Optimizer restrictions

Maximum number of JOIN tables in SELECT Commands	256
Maximum number of JOIN connections	32767
Maximum number of ORDER columns	128
Maximum number of primary key columns within a strategy	20

An overview of general restrictions can be found in the reference handbook in the *Restrictions* chapter.

Thank you!