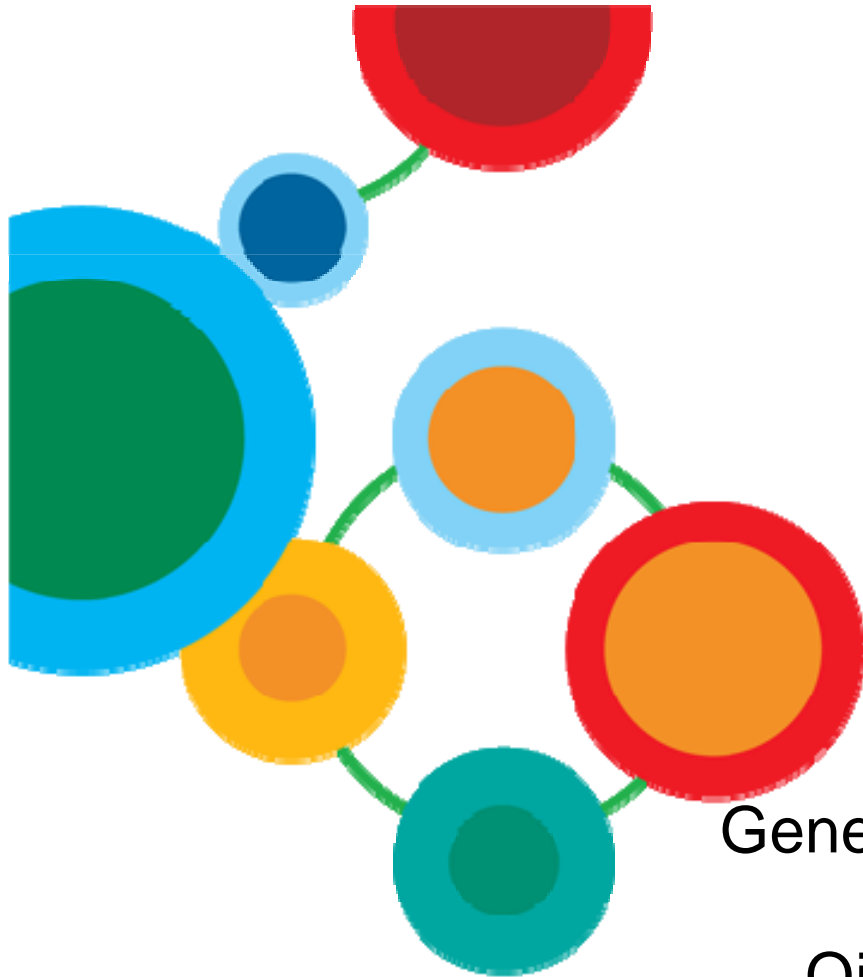




SQL Performance Tuning with Optim Query Tuner In a Top Bank In China

IDZ-1597



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IBM Software

Information On Demand **2011**

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Performance is based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput or performance that any user will experience will vary depending upon many factors, including considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve results similar to those stated here.



Agenda

- Customer Profile and Performance Challenges
- SQL Tuning Practice with Optim Query Tuner
- Managing Access Path Stability – To Be Continued
- Conclusion

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Customer Profile

- One of the top banks and large z installations in China
 - Host core banking application on DB2 9 for z/OS
 - More than 500 million accounts
 - Peak transaction volume: 100 million/Day and 3,000/Sec.
 - More than 6000 packages and 1500 tables in the core banking application
 - Rapid business growth drives application change and MIPS increase

- In-depth z skills available in house

- In transition to host other banking applications on z

Challenges in SQL Tuning

- 'Incremental tuning' for relevant statements
 - Most static SQL statements are simple and well-tuned
 - New tables could be added over the time
 - Existing tables could be changed as well
 - Perform SQL tuning against 'relevant' SQL statements
- SQL tuning for 'problem' packages
 - Baseline performance obtained through OMPE
 - Performance comparison at package level
 - Perform SQL tuning for 'top-N' packages or 'problem' packages
- Tuning for run-away dynamic SQL statements
 - Identification of poorly-performing queries
 - Fast diagnosis and analysis

Streamlined SQL Performance Tuning

Identify Problem Query



Tune Problem Query

Query Tuner Workflow Assistant - Identify Problem Query

Capture SQL from Statement Cache

Create or select a filter for capturing SQL statements from the dym as a new workload.

Database connection: LD92OQT (DB2 for z/OS V9.1 (New-f

Filter

Filter name:

Enable Cache Trace Disable Cache Trace Disable cac

Query Tuner Workflow Assistant - Tune Problem Query

Run All Single-Query Advisors And

Select Query-Tuning Activities

- Query Format and Annotation
- Access Plan Graph
- Statistics Advisor
- Query Advisor
- Access Path Advisor
- Index Advisor
- Summary Report
- Access Path Reports

Implement Recommendations



Validate Improvement

Recommendations - Before Tuning

Advisor	Number	Priority	Description
Recommendations			
Statistics Advisor	1	🚫 HIGH	Repair statistics pro
Query Advisor	2	⚠️ MEDIUM	Provide a predicate
Access Path Advisor	3	⚠️ MEDIUM	Avoid scanning man
Access Path Advisor	4	🟡 LOW	Avoid table space sc
Access Path Advisor	5	🟡 LOW	Avoid sorting (QBLO
Index Advisor	6	🟢 LOW	Index recommendat

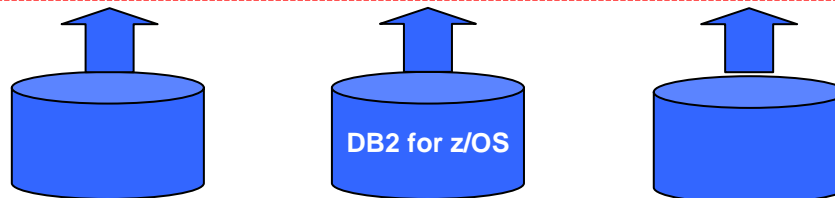
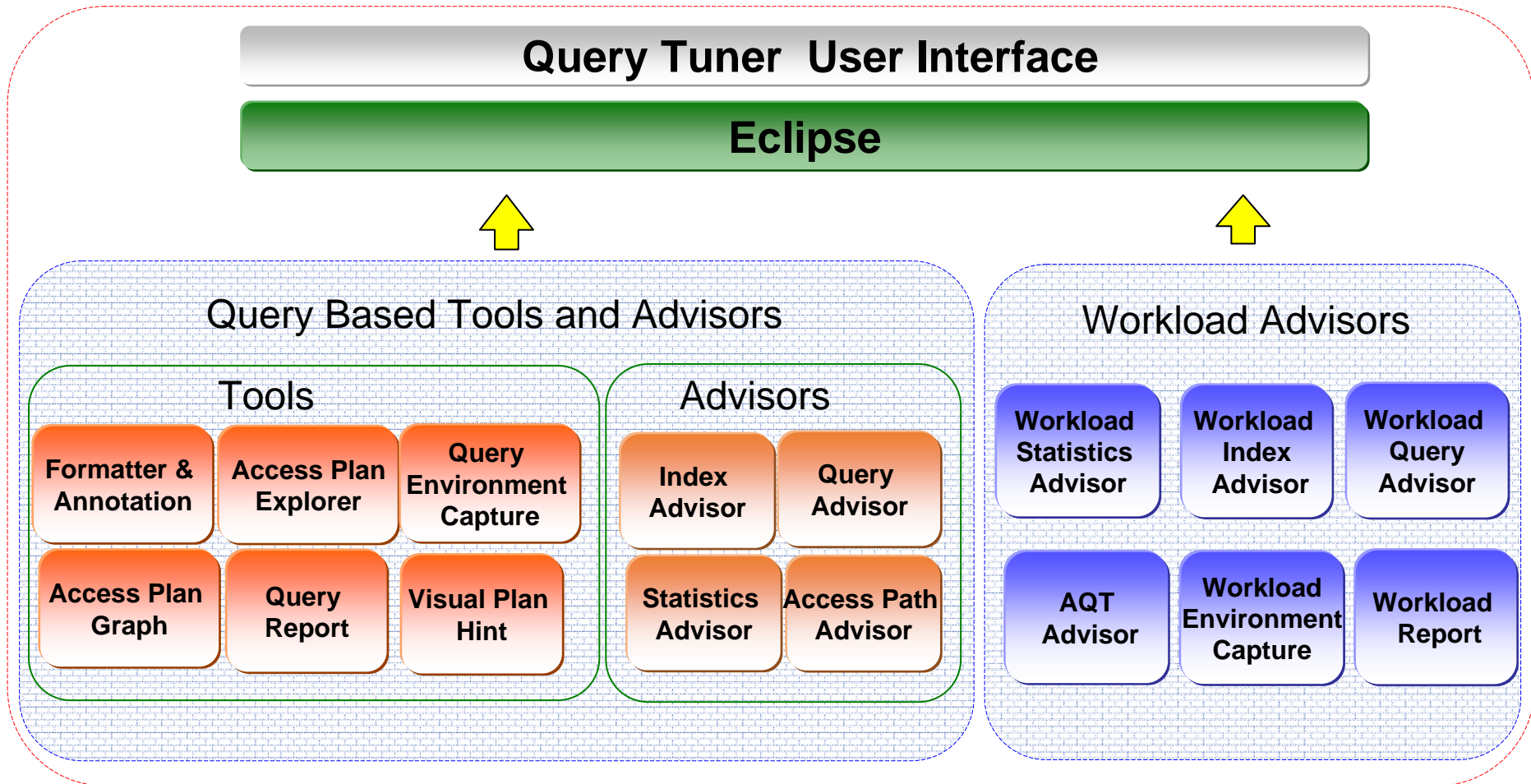
Captured Statements

The number of captured statements is 468. Right-click a statement and select Invoke Advisors and Tools. If w statements.

STMT_ID	STAT_EXEC	STAT_CPU	STAT_ELAP	STAT_GPAG	STMT_TEXT
437	1	51.771259	58.151691	7883624	SELECT CCUS.CUST_FIRST_NAME, CCU
439	1	4.760897	4.833193	13510	SELECT count(COHE.CUST_CODE)
62	3	2.498441	16.607502	181582	SELECT COH.CUST_ORDER_NUMBER, C
44	6	1.144381	2.546111	387945	SELECT CUST_CODE, CUST_FIRST_NAM
66	1	0.807401	3.540449	61670	SELECT COH.CUST_ORDER_NUMBER, C
51	2	0.371849	0.379756	129312	SELECT CUST_CODE, CUST_FIRST_NAM
47	3	0.078672	0.474195	3285	SELECT CUSTCUST_CUSTOMERCUSTOM
50	2	0.051304	0.884514	2154	SELECT CUSTCUST_CUSTOMERCUSTOM
26	1	0.033472	0.824371	1084	SELECT CUSTCUST_CUSTOMERCUSTOM



Optim Query Tuner Key Features



Agenda

- Customer Profile and Performance Challenges
- SQL Tuning Practice with Optim Query Tuner
- Managing Access Path Stability – To Be Continued
- Conclusion

Scenario 1: Incremental Tuning

- Tuning entire application is often unnecessary
 - Large number of packages, tables, and SQL statements
 - Most SQL statements are simple and well tuned
 - Performance problem usually caused by the introduction of new tables and change to existing tables by the application team

- New tables and tables changed are known by test team and production team
 - Small number of new tables added to the application
 - Small percentage of tables changed
 - Impacted statements, however, are not directly known

- It's cumbersome to find the relevant SQL statements for SQL tuning – Optim Query Tuner makes it easier

Step 1: Identify Relevant Queries

Static SQLs are stored in catalog after preparation

Specify filter criteria to identify relevant queries

Name	Operator	Value	Description
PROCMS	=		The estimated processor
PROCSU	=		The estimated processor
TNAME	=	IODT1	The name of a table, mat
CREATOR	=	SYSP	The creator of the new ta
ACCESSNAME	=		For ACESSTYPE I, I1, N,
ACCESSCREATOR	=		For ACESSTYPE I, I1, N,



Step 2: View Captured Queries

Query Tuner Workflow Assistant
Statements ?

1. Status

- Manage and Tune Workloads
- Workload List
- ▼ IODT1
- Statements

The statements in the workload are listed in the table.

Database connection: ✔ LOCV91A (DB2 for z/OS V9.1 (New-Function Mode))

Workload name: IODT1 Number of statements: 29

Workload owner: C01S161 Workload status: EXPLAINED

Description:

You can add statements to the workload. You can to run the single-query advisors and tools.

statement of interest

< Previous 1-29 rows out of 29 are displayed. Next >

STAT_EXEC	PLNAME	COLLID	PKGNAME	VERSION	SECTNOI	STMT_TEXT
1		IODPKG	APK9042		2	DECLARE CUR_IOL CURSOR FOR SELECT IOLJRNNO, IO
1		IODPKG	APK9042		3	UPDATE IODT1 SET IOLAIPNO = 'D' WHERE IOLJRNNO =
1		IODPKG	APK9043		1	DECLARE CUR_AI0R CURSOR FOR SELECT 'DK', COUNT
1		IODPKG	APK9043		2	DECLARE CUR_AI0S CURSOR FOR SELECT IOLJRNNO, I
1		IODPKG	APK9043		3	DECLARE CUR_AI0T CURSOR FOR SELECT IOLBRNO, D
1		IODPKG	APK9043		4	DECLARE CUR_AI0U CURSOR FOR SELECT IOLJRNNO,
1		IODPKG	RPK3906		2	SELECT COUNT (*), IFNULL (SUM (IOLAMT), 0.00) I
1		IODPKG	RPK3906		3	DECLARE iol_cur_z CURSOR FOR SELECT * FROM IODT1
1		IODPKG	RPK3906		4	SELECT COUNT (*), IFNULL (SUM (IOLAMT), 0.00) I
1		IODPKG	RPK3906		5	DECLARE iol_cur_y CURSOR FOR SELECT * FROM IODT:
1		IODPKG	RPK3906		6	SELECT COUNT (*), IFNULL (SUM (IOLAMT), 0.00) I
1		IODPKG	RPK3906		7	DECLARE iol_cur CURSOR FOR SELECT * FROM IODT1 W
1		IODPKG	RPK3911		2	DECLARE iol_cur CURSOR FOR SELECT * FROM IODT1 W
1		IODPKG	RPK3911		3	DECLARE iol_cur CURSOR FOR SELECT * FROM IODT1

Queries from
different packages



Step 3: Analyze Statistics with OQT

Statements | Recommendation Summary | **Workload Statistics Advisor** | Workload Query Advisor | Workload Index Advisor

Existing statistics status - 1 tables need repair out of the 1 tables that were checked

Repair Complete

THIS VERSION OF THE RUNSTATS COMMAND COLLECTS A FULL SET OF STATISTICS FOR THE OBJECTS THAT ARE RELATED TO THE WORKLOAD TO CONSERVE TIME AND CPU RESOURCES. IF YOU WANT ONLY TO REPAIR THE PROBLEMS THAT THE WORKLOAD STATISTICS ADVISOR RECOMMENDS, YOU CAN USE THE REPAIR OPTION.

Run on database server

RUNSTATS Control Statements

```

RUNSTATS TABLESPACE "DABISIO". "TIOIOD"
TABLE("SYSP". "IODT1") SAMPLE 40
COLUMN("IOLEXTCOD", "IOLSEQNO", "IOLAGRCOD", "IOLAMT")
COLGROUP("IOLPROSTS") FREQVAL COUNT 10
COLGROUP("IOLAGRCOD", "IOLPROSTS") FREQVAL COUNT 10
COLGROUP("IOLBRNO") FREQVAL COUNT 10
COLGROUP("IOLAIPNO") FREQVAL COUNT 10
SORTDEVT SYSDA SORTNUM 4
INDEX("SYSP". "XIOIODD1",
"SYSP". "XIOIODD2") KEYCARD,

```

OQT Statistics Advisor generates RUNSTATS command to collect the missing statistics

▼ Statistics Advisor report

Search

Search Report

Keyword

Case-sensitive

Regular expression

Search

Filter

```

Frequency statistics collection time: null
Frequency statistics status: missing
Histogram statistics collection time: null
Histogram statistics status: missing
Possibly point skewed: Yes
Symptom: Columns with low COLCARD (the number of distinct values in a table) are more likely to be skewed.
Possibly range skewed: No

IOLSEQNO
Cardinality: 5968016.0
Uniform statistics collection time: 2010-03-30 16:08:51.381
Uniform statistics status: conflicting
Frequency statistics collection time: null
Frequency statistics status: missing
Histogram statistics collection time: null
Histogram statistics status: missing
Possibly point skewed: No
Possibly range skewed: No

IOLAMT
Cardinality: 364544.0

```

Some statistics are missing



Step 4: Analyze Index Design with OQT

Statements Recommendation Summary Workload Statistics Advisor Workload Que

Estimated performance improvement:	29.42 %
Disk space required (DASD space):	33.46 MB
Total IUD Cost:	0.0 ms

U time: N/A ms
CPU time: 30725 ms

Estimated performance improvement & resource consumption with the new index

Recommendation

Feature Details	Action	Object Name	New Index Columns	Estimated performance improvement (%)	Estimated savings (%)	Estimated cost
<input checked="" type="checkbox"/> Create Indexes						
<input checked="" type="checkbox"/> IODT1						
<input checked="" type="checkbox"/> Index	Create	IODT1_VIRT_IDX_1270705249109	IOLAGRCOD(ASC), IOLAC_DAT(ASC)	99.036662	99.668952	

OQT Index Advisor recommends to create a new index

Workload Index Advisor Related Statements

Save Show Related SQL Statements in the Workload

SQL statement	Estimated performance improvement (%)
DECLARE CUR_IOL CURSOR FOR SELECT IOLJRNNO , IOLAC_DAT , IOLAMT , IOLBRNO , IOLABS FROM IODT1 W...	99
DECLARE CUR_AI0R CURSOR FOR SELECT 'DK' , COUNT (*) , SUM (IOLAMT) , IOLBRNO , IOLTLID FROM IODT1...	98
DECLARE CUR_AI0S CURSOR FOR SELECT IOLJRNNO , 'DK' , IOLAMT , IOLBRNO , IOLTLID , IOLABS FROM IODT1...	98
DECLARE CUR_AI0T CURSOR FOR SELECT IOLBRNO , 'DK' , COUNT (*) , SUM (IOLAMT) FROM IODT1 WHERE I...	98
DECLARE CUR_AI0U CURSOR FOR SELECT IOLJRNNO , 'DK' , IOLAMT , IOLBRNO , IOLTLID , IOLABS FROM IODT1...	98
SELECT COUNT (*) , IFNULL (SUM (IOLAMT) , 0.0) INTO : H , : H FROM IODT1 WHERE IOLAGRCOD = : H AND ...	99

The queries which can benefit from the new index



Summary: Incremental Tuning

- Capture relevant statements from DB2 Catalog
 - Filter by table name and/or table creator
- Analyze captured workload with Workload Advisors
 - Workload Statistics Advisor
Recommendation for critical statistics collection which may impact access path selection
 - Workload Index Advisor
Recommendation for index design which could improve query performance

Scenario 2: Package-driven SQL Tuning

- Baseline performance obtained through OMPE
 - Conduct performance comparison periodically at package level
 - The ‘top-N’ packages are singled out for investigation
 - Based on increase of elapsed time or CPU time (tuning)
 - Based on consumption CPU time (optimization)
- Lack of tools to perform health check for the underlying access path of the SQL statements – Optim Query Tuner offers a viable option

Step 1: Capture Problem Queries from Package

Create Filter

Package and Object Filter

Specify the attributes of packages from which to capture SQL statements. You can also filter by objects that statements in the packages reference.

Steps

1. Filter
2. Package and Object Filter
3. Cost and Object Filter
4. Access Path Filter
5. Sort
6. Columns

Filter by package

Name	Operator	Value	Description
COLLID	=		Name of the package co
NAME	=	IODPKG1	Name of the package.
OWNER	=		Authorization ID of the p
TIMESTAMP	=		Timestamp format: yyyy
BINDTIME	=		Timestamp format: yyyy
QUALIFIER	=		Implicit qualifier for the u
EXPLAIN	=		EXPLAIN option specific
QUERYNO	=		The query number of the

Filter by package name and potentially 'bad' access path operations

<input checked="" type="checkbox"/> Sorts	<input checked="" type="checkbox"/> Non-matching index access	<input type="checkbox"/> Merge scan join
<input checked="" type="checkbox"/> Table space scans	<input type="checkbox"/> Matching index access	<input type="checkbox"/> Nested loop join
<input type="checkbox"/> List prefetch	<input type="checkbox"/> Non-index only access	<input type="checkbox"/> Hybrid join
<input type="checkbox"/> Sequential prefetch	<input type="checkbox"/> Multiple index access	<input type="checkbox"/> Full outer join
<input type="checkbox"/> CP parallelism	<input type="checkbox"/> In-list index access	<input type="checkbox"/> Left outer join
<input type="checkbox"/> I/O parallelism	<input type="checkbox"/> One-fetch access	<input type="checkbox"/> Star join
<input type="checkbox"/> Sysplex query parallelism	<input type="checkbox"/> Index only access	<input type="checkbox"/> Inner join
<input type="checkbox"/> Parallelism determined at run time		

Select All Clear All

Step 2: Perform 'Health Check' with OQT

The screenshot displays the Query Tuner Workflow Assistant interface. On the left, a vertical navigation pane shows five steps: 1. Status, 2. Capture, 3. Manage, 4. Invoke, and 5. Review. Under '2. Capture', the 'Run Advisors and Analysis Tools' step is highlighted. The main window is titled 'Run Single-Query Advisors And Analysis Tools' and contains the following fields and options:

- Specify EXPLAIN options and runtime environment options for the query:
 - Query number: 113
 - SQLID: C01S161
 - Schema: C01S161
 - Current degree: [empty]
 - Current refresh age: [empty]
 - Current maintained table: [empty]
 - Optimization hint: [empty]
- EXPLAIN options and runtime environment options:
 - Use upper case for the SQLID and schema
 - Re-EXPLAIN the query
- Buttons: 'Run Default Advisors and Tools' and 'Select What To Run...' (highlighted with a red box and an arrow pointing to the sub-dialog).
- Query Text - 4022:


```
DECLARE iodcur CURSOR FOR SELECT * FROM
AND IODCONNCOD = : H AND IODCONNFLG = '1
```

The 'Select Query-Tuning Activities' sub-dialog is open, showing a list of activities with checkboxes:

- Query Format and Annotation
- Access Plan Graph
- Statistics Advisor
- Query Advisor
- Access Path Advisor
- Index Advisor
- Summary Report
- Access Path Reports

Buttons at the bottom of the sub-dialog include 'Select All', 'Clear All', and 'OK'.



Step 3: Review Problem SQL with OQT

Original Transformed

The DB2 optimizer suggests the following revision of the query.

Annotations to display: All

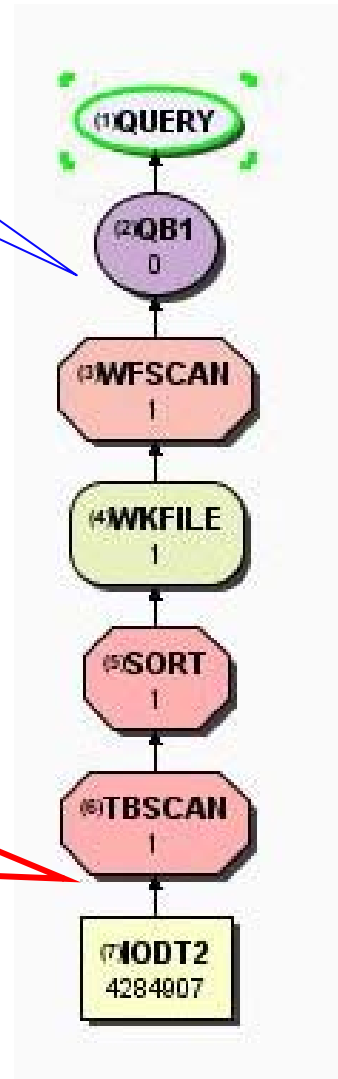
Formatted Query	Annotation
SELECT *	
FROM SYSP.IODT2	CARDF=4,284,907 QUALIFIED_ROWS=1 NPAGESF=306,083
WHERE (SYSP.IODT2.IODCONNCOD = ?	COLCARDF=507,904 MAX_FREQ=(missing) FF=0.000002
AND SYSP.IODT2.IODPROCOD = ?	COLCARDF=34 MAX_FREQ=10.13% FF=0.029
AND SYSP.IODT2.IODCONNFLG = '1'	COLCARDF=3 MAX_FREQ=(missing) FF=0.333
)	
ORDER BY SYSP.IODT2.IODCONTNO ASC	
WITH UR	

Access Plan Graph

Formatted Query

Query Annotation

Table scan over a big table with only one qualified row!



Step 4: Review Health Check Report

Review Single-Query Advisor Recommendations

This page shows the recommendations from the advisors that you ran. To see the details of a recommendation, right-click it and select View Details.

Recommendations - Analysis Result 1
Statistics Advisor Details
Query Advisor Details
Access Plan Advisor Details
Index Advisor Details

Advisor	Number	Priority	Description
[-] Recommendations			
Statistics Advisor	1	🚫 HIGH	Repair statistics problems for this query. Gather missing statistics. Recollect conflicting st...
Statistics Advisor	2	⚠️ MEDIUM	Determine the access path again at runtime. This query contains host variables, paramet...
Query Advisor	3	📉 LOW	Avoid an asterisk (*) or a long column list in the SELECT clause.
Access Path Advisor	4	📉 LOW	Avoid sorting (QBLOCKNO = 1, PLANNO = 2) on a large number of records.
Index Advisor	5	📉 LOW	Index recommendations found.

Recommendations
from OQT advisors

Step 5: Drill Down to Statistics Report

Recommendations - Analysis Result 1 **Statistics Advisor Details**

Recommendation 1: Repair statistics problems for this query. Gather missing statistics. Recollect conflicting statistics and potential obsolete statistics. Collect statistics for potential data skew and d

Repair Complete

This version of the RUNSTATS command collects a full set of statistics for the objects that are related to the query. In the process of collecting it, this command repairs any problems that the Statistics Advisor found. Run this version if you do not need to conserve time and CPU resources. If you want only to repair the problems that the Statistics Advisor found, click the Repair tab.

View and run the RUNSTATS commands that the advisor recommends. You can also compare the recomm server.

Recommended RUNSTATS commands

```
RUNSTATS TABLESPACE "DABISCAS", "TCASIOD"  
TABLE("SYSP", "IODT2") SAMPLE 40  
COLUMN("IODCONNCD")  
COLGROUP("IODCONNFLG") FREQVAL COUNT 15  
SORTNUM 4  
INDEX("SYSP", "XCAIODP" KEYCARD)  
SHRLEVEL CHANGE REPORT YES UPDATE ALL HISTORY NONE
```

OQT Statistics Advisor generates RUNSTATS command to collect the missing statistics

Statistics Advisor report

Search Report

Keyword Case-sensitive
(% = any...: % ? \) Regular expression

Possibly range skewed: No

IODPROCOD

Cardinality:	34.0
Uniform statistics collection time:	2010-03-29 23:37:48.5927
Uniform statistics status:	OK
Frequency statistics collection time:	2010-03-29 23:37:48.5927
Frequency statistics status:	OK
Histogram statistics collection time:	null
Histogram statistics status:	missing
Possibly point skewed:	Yes
Symptom:	Frequency statistics indicates skewing.
Possibly range skewed:	No

Some statistics are missing

Interesting column groups:

Predicate Analysis Report:



Step 6: Drill Down to Index Report

Recommendations - Analysis Result 1 **Index Advisor Details**

Recommendation 5: Index recommendations found.
 Recommended indexes are listed below. You can view and modify the DDL for the recommended indexes or test the recommended indexes as follows.

Estimated performance improvement: 99.96 %
 Disk space required (DASD space): 215.1 MB

Estimated performance improvement & resource consumption with the new index

Custom and recommended indexes

Indexes by Table	Creator	Object Name	Columns	Estimated Disk Space	Custom
<input checked="" type="checkbox"/> IODT2					
<input checked="" type="checkbox"/> Index	DB2OE	IODT2_VIRT_IDX_127060...	IODPROCOD(ASC) ,IODCONNFL...	215.1015625 M	No

OQT Index Advisor recommends to create an new index

Existing indexes

Indexes by Table	Object Name	Columns
<input checked="" type="checkbox"/> IODT2		
Index	XCAIODP	IODPROCOD(ASC) ,IODACTNO(ASC) ,IODCONTNO(ASC)

Summary: Package-driven SQL Tuning

- Use OMEGAMON XE to identify packages for SQL tuning
- Search for queries with ‘catchy’ plan operations
 - Filter by package name
 - Filter by potential “bad” access plan
 - Table scan, Non-matching index scan, etc
 - Sort by PROCMS or PROCSU
- Perform health check with OQT for each problem SQL
- Review reports and implement recommendation

Scenario 3: Tuning Dynamic SQL Statements

- New applications contain dynamic SQL statements
 - Ad hoc dynamic queries with complex structure
 - Not as well-tuned compared to legacy applications
 - New statements introduced as part of application change

- Tuning these SQL statements is more challenging than legacy applications
 - Queries are dynamically generated
 - Queries are more complex

- Optim Query Tuner helps identify problem queries and diagnose the root cause of performance problems

Step 1: Identify Problem Queries

Query Tuner Workflow Assistant

- 1. Status
 - Text Sources
 - Input Text
 - File
 - SQL Category
 - Exported Workload
- 2. Capture
 - DB2 for z/OS Sources
 - Statement Cache
 - Catalog Plan or Package
 - QMF
 - QMF HPO
 - SQL Procedure
 - Plan Table
 - Statement Table
 - Function Table
 - View, Trigger, or SQL UDF
 - DB2 for Linux, UNIX, and Windows Sources
- 3. Manage
- 4. Invoke
- 5. Review
- 6. Compare

Capture SQL from Statement Cache

Create or select a filter for capturing SQL statements from the dynamic statement cache on the subsystem. You can then schedule a time to capture them as a new workload.

Database connection: ✔ ec584 (

Filter

Filter name: ▶ Capture 🕒 Schedule

Disable cache trace after capturing

STMT_ID	STAT_EXEC	STAT_CPU	STAT_ELAP	STAT_GPAG	STMT_TEXT
44854	1	105.792011	321.673401	88323006	INSERT INTO SYS.
43959	348	38.250874	237.240376	2147483647	DELETE FROM SYS.
43960	345	22.440022	1.90163	2147483647	INSERT INTO SYS.
43968	344	14.90068	18.366673	2147483647	DELETE FROM SYS.
44835	2	12.8	93.190525	163721831	INSERT INTO SYS.
43970	344	7	26.149509	2147483647	UPDATE SYSA.RS_
			240414	68437	INSERT INTO SYS.
			8228	384505	DELETE FROM SYS.
			03418	81545402	UPDATE SYSA.RS_
			5215	82818545	UPDATE SYSA.RS_

Identify top-N queries with high CPU time

Elapsed time does not meet the expectation: over 5 minutes per execution



Step 2: Analyze the Problem Query with OQT

The screenshot displays the Query Tuner Workflow Assistant interface. On the left, a vertical navigation pane shows six steps: 1. Status, 2. Capture, 3. Manage, 4. Invoke, 5. Review, and 6. Compare. The '2. Capture' step is active, with 'Run Advisors and Analysis Tools' highlighted. The main window is titled 'Run Single-Query Advisors And Analysis Tools' and contains the following elements:

- Specify EXPLAIN options and runtime environment options for the**: Includes icons for a warning, a document, a checkmark, a speech bubble, and a play button.
- EXPLAIN options and runtime environment options**:
 - Query number: 111
 - SQLID: TCOMM01
 - Schema: TCOMM01
 - Current degree: (empty)
 - Current refresh age: (empty)
 - Current maintained to: (empty)
 - Optimization hint: (empty)
- Use upper case for the SQLID and schema
- Re-EXPLAIN the query
- Buttons: 'Run Default Advisors and Tools' and 'Select What To Run...' (highlighted with a red box and a red arrow pointing to the sub-dialog).
- Query Text - Query 1**:


```
INSERT INTO SYSP.RS_T3 (PROCOD, ORG, C
SELECT DISTINCT A.PROCOD,A.ORG,A.CC
FROM SYSP.RS_T1 A,SYSP.RS_T2 B
WHERE A.PROCOD='44'
AND A.RPTCOD='GF0574'
AND A.DTE='20110131'
AND B.AVBYEA='2011'
AND B.RPTCOD='GF0574'
AND B.RPTCOD=A.RPTCOD
```

The 'Select Query-Tuning Activities' sub-dialog is open, showing a list of activities with checkboxes:

- Query Format and Annotation
- Access Plan Graph
- Statistics Advisor
- Query Advisor
- Access Path Advisor
- Index Advisor
- Summary Report
- Access Path Reports

Buttons at the bottom of the sub-dialog include 'Select All', 'Clear All', and 'OK'.

Step 3: Review the Query with QQT

Formatted Query

Original Transformed

The DB2 optimizer suggests the following revision

Annotations to display: All

DISTINCT causes SORT of the output of the JOIN

Qualified rows before join

```

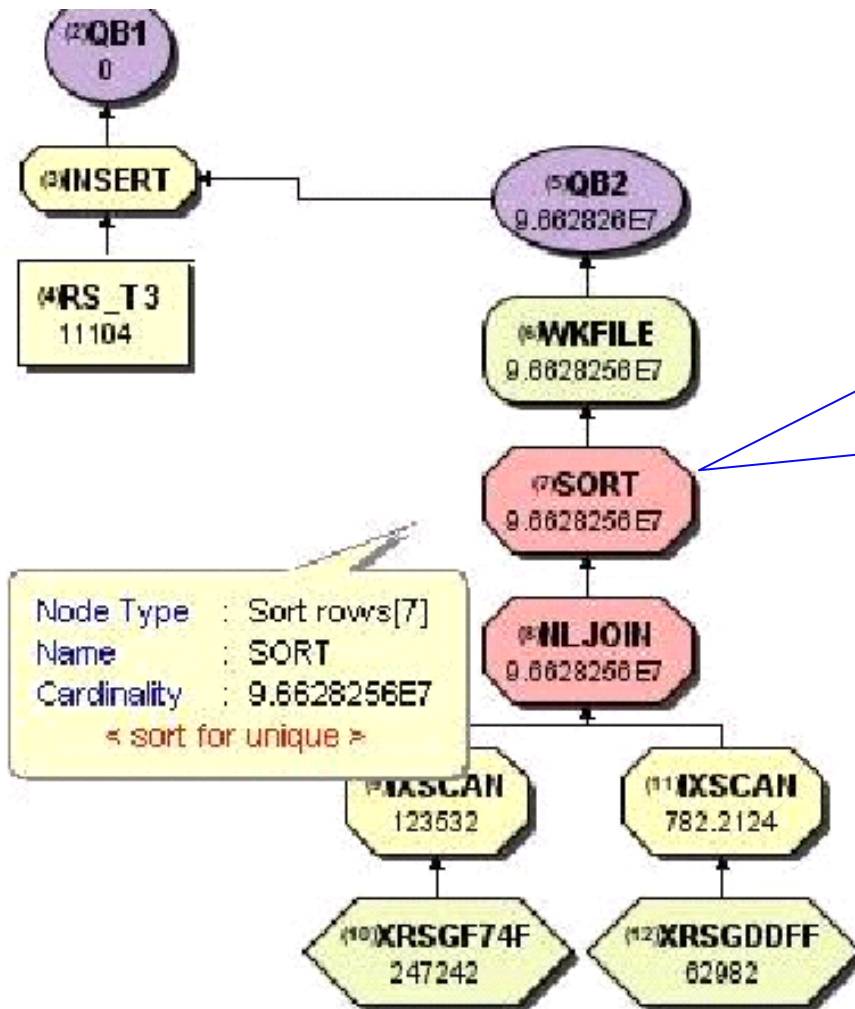
INSERT INTO SYSP.RS_T3
SELECT DISTINCT A.PROCOD
      , A.ORG
      , A.CCY
      , B.COLCOD
FROM SYSP.RS_T2 AS B
      , SYSP.RS_T1 AS A
WHERE ( A.PROCOD = '44'
      AND A.RPTCOD = 'GF0574'
      AND A.DTE = '20110131'
      AND A.RPTCOD = 'GF0574'
      AND B.RPTCOD = 'GF0574'
      AND B.RPTCOD = 'GF0574'
      AND B.AVBYEA = '2011'
      AND B.RPTCOD = A.RPTCOD
)
  
```

Formatted Query	Annotations	Additional Information
INSERT INTO SYSP.RS_T3	QUALIFIED_ROWS=(missing) QUALIFIED_ROWS=0	NPAGESF=...
SELECT DISTINCT A.PROCOD	QUALIFIED_ROWS=782.21875	NPAGESF=2,100
FROM SYSP.RS_T2 AS B	QUALIFIED_ROWS=123,532.0	NPAGESF=11,243
WHERE (A.PROCOD = '44'	COLCARDF=2 MAX_FREQ=50.036% FF=0.5	SYSP.RS_T1.PROCOD
AND A.RPTCOD = 'GF0574'	COLCARDF=1 MAX_FREQ=(missing) FF=1	
AND A.DTE = '20110131'	COLCARDF=1 MAX_FREQ=(missing) FF=1	
AND A.RPTCOD = 'GF0574'	COLCARDF=1 MAX_FREQ=(missing) FF=1	
AND B.RPTCOD = 'GF0574'	COLCARDF=80 MAX_FREQ=(missing) FF=0.012	SYSP.RS_T2.RPTCOD
AND B.RPTCOD = 'GF0574'	COLCARDF=80 MAX_FREQ=(missing) FF=0.012	SYSP.RS_T2.RPTCOD
AND B.AVBYEA = '2011'	COLCARDF=2 MAX_FREQ=99.357% FF=0.994	SYSP.RS_T2.AVBYEA c
AND B.RPTCOD = A.RPTCOD	COLCARDF=80/1 MAX_FREQ=(missing)/(missing) FF=0.012	SYSP.RS_T2.RPTCOD

Formatted Query

Query Annotation

Step 4: Review Access Path with OQT



Sort on join output which contains large number of records

Node Type : Sort rows[7]
 Name : SORT
 Cardinality : 9.8628258E7
 < sort for unique >

Can the SORT be pushed down ?

Step 5: Rewrite the Problem Query

```

INSERT INTO SYSP.RS_T3 (PROCOD, ORG, CCY, DATAINFO)
SELECT T1.PROCOD, T1.ORG, T1.CCY, T2.COLCOD
FROM
(SELECT DISTINCT PROCOD, ORG, CCY
FROM SYSP.RS_T1
WHERE PROCOD = '44' AND RPTCOD = 'GF0574' AND DTE = '20110131') AS T1,
(SELECT DISTINCT COLCOD
FROM SYSP.RS_T2
WHERE AVBYEA = '2011' AND RPTCOD = 'GF0574') AS T2

```

- Push down DISTINCT to avoid large SORT
- Elapsed time reduced to 125 ms from 321.67 seconds

Summary: Tuning Dynamic SQL Statements

- Identify top-N problem queries from statement cache
 - Filter by authorization ID, runtime information, etc
 - Sort by elapsed time, CPU time, get pages, etc
- Analyze problem query with OQT
- Review problem query and the access path with OQT
- Tuning opportunity identified while reviewing the problem query with OQT
- Significant performance improvement obtained

Agenda

- Customer Profile and Performance Challenges
- SQL Tuning Practice with Optim Query Tuner
- Managing Access Path Stability – To Be Continued
- Conclusion

Still an Outstanding Issue with the Customer

- Massive bind/rebind takes place when
 - Migrate to a new DB2 for z/OS release
 - Apply new DB2 for z/OS maintenance level
 - Roll out application change
 - Conduct performance tuning (stats collection, new indexes, etc)
- Exposed to access path changes
 - Where access path gets changed ?
 - Changed for better or worse performance ?
 - It's a nontrivial task
- How to manage access path stability efficiently ?

A Hypothetic Solution – Compare and Report

Query Tuner Workflow Assistant

1. Status

- Single Query
- Compare Access Plan Graphs

2. Capture

- Workload Plan Comparison
- Compare Package Access Plan
- Compare Workload Access Plan
- Workload_0 Comparison Result
- Comparison Result
- 2011-06-24 11:09:07.615278
- Workload Summary

3. Manage

4. Invoke

5. Review

Compare

View Comparison Results by Workload EXPLAIN Snapshots and SQL Statements

Database connection: ✔ STLEC1 (DB2 for z/OS V9.1 (New-Function Mode))

Workload name: Workload_0

EXPLAIN Snapshots

Start Time	Stop Time	Estimated Cost	SQL Statements	SQL Statements Regressed	SQL Statements Improved	SQL Statemen
2011-06-09 14:12:18.516107	2011-06-09 14:15:01.906758	131.748822	31	19	12	0
2011-06-09 13:57:49.878202	2011-06-09 14:00:59.955049	3204.359500	31	19	12	0

Statements

QUERYNO	Cost Increased?	Access Plan Changed?	Cost Increase Percentage	Source Cost	Target Cost	SQL Statem...	Statement Text
22	N	N	-0.841730	2.754421	0.435943	No	DECLARE DB2JCCCURSOR22 CURS
23	N	Y	-0.966203	16.661594	0.563105	No	DECLARE DB2JCCCURSOR23 CURS
24	Y	N	24.226241	12.697139	320.301086	No	DECLARE DB2JCCCURSOR24 CURS
25	N	N	-0.288105	0.262050	0.186552	No	DECLARE DB2JCCCURSOR1 CURS
26	Y	Y	5.624563	3.727429	24.692585	No	DECLARE DB2JCCCURSOR2 CURS
27	Y	Y	4.710336	2.869796	16.387501	No	DECLARE DB2JCCCURSOR3 CURS
28	N	N	-0.027660	2.471699	2.403331	No	DECLARE DB2JCCCURSOR4 CURS
29	Y	Y	43.057705	0.262296	11.556175	No	DECLARE DB2JCCCURSOR5 CURS
30	Y	Y	6.941829	6.047393	48.027363	No	DECLARE DB2JCCCURSOR6 CURS
31	Y	Y	639.455834	1.969033	1261.078979	No	DECLARE DB2JCCCURSOR7 CURS
10	Y	Y	2.016424	13.789546	41.595112	No	DECLARE DB2JCCCURSOR10 CURS
11	N	N	-0.291759	0.260490	0.184490	No	DECLARE DB2JCCCURSOR11 CURS
12	Y	N	0.225622	2.186441	2.679751	No	DECLARE DB2JCCCURSOR12 CURS

A Hypothetic Solution – Assess and Resolve

Query Tuner Workflow Assistant

1. Status
Single Query Comparison
Compare Access Plan Graphs

2. Capture
Workload Plan Comparison
Compare Package Access Plan
Compare Workload Access Plan

3. Manage
STLEC1_Workload_0 Comparison Result
Comparison History
2010-08-23 02:51:12.543404
Workload Summary
Access Path Comparison

4. Invoke

5. Review

6. Compare

Access path comparison result

Workload: Workload_1 STMT_ID: 1011

Old access path

Query Block 1 Query Block 2

New access path

Query Block 1 Query Block 2

Join Change

Comparable Item	Old access path	New access path	Annotate
Join sequence	DEPT->PROJ->EMP	PROJ->EMP->DEPT	
Join method	Table DEPT and PROJ were accessed	Table PROJ and EMP are accessed via SMJ, table DEPT	Require Attention

Table Access Change

Table	Old access path	New access path	Annotate
DEPT	Was the outer table Used table space scan	Is the inner table Using non-matching index scan access using list prefetch	Require Attention
PROJ	Was the inner table	Is the outer table	

Explain Table Record Change

Method	Merge_Join_Cols	Creator	TName	TabNo	AccessType	MatchCols	Access
0		SYSADM	DSNWFQB(02)	4	I	0	
1		DSNR910	FMP	1	I	1	DSNR910

To Be Continued in IOD 2012!



Agenda

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- Managing Access Path Stability – To Be Continued
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OQT Helps Implement Best Practices of SQL Tuning

- Collect statistics properly and diligently
 - Avoid collecting useless stats
 - Detecting conflicting stats
 - Collecting critical distribution stats and column group stats

- Design efficient indexes
 - To support efficient access with local predicates
 - To support efficient access the inner of joins
 - To support sort avoidance and index only access

- Design efficient predicates and queries
 - Predicate application (indexability and stage-1)
 - Predicate transformation and localization
 - Query rewrites which are not supported yet by optimizer

- Expert tuning methodology built in the product

- Learn and implement best practices for SQL tuning with Optim Query Workload Tuner



Resources

- Tuning SQL with Optim Query Tuner
 - <http://www.ibm.com/developerworks/data/library/techarticle/dm-1006optimquerytuner1/>
 - <https://www.ibm.com/developerworks/data/library/techarticle/dm-1105optimquerytuner2/>
- SQL Tuning, Not just for hardcore DBAs anymore
 - <http://www.ibm.dmmagazinedigital.com/dmmagazine/>
- IBM Optim Query Workload Tuner web page
 - <https://www-01.ibm.com/software/data/optim/query-workload-tuner-z/>
- Integrated Data Management
 - <http://www.ibm.com/developerworks/spaces/optim>

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