



## Top Ten DB2 for Linux, UNIX and Windows Explain Tips

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## Objectives

- Understand where access plans can exist and how to explain them
- Learn how to get explain information about query execution
- Learn how to ensure that the explain contains all the important information
- Discuss some techniques for monitoring access plan changes over time
- Learn how to interpret and understand explain information

## The explain facility – what is it?

- Internal phase of the optimizer that captures critical information used in selecting the query access plan
- Access plan information is written to a set of tables
- External tools to format explain table contents:
  - **Visual Explain**
    - GUI to render and navigate query access plans
      - Supports DB2 10.5, DB2 10.1, DB2 9.7, DB2 9.5 FP1 and DB2 9.1 FP5
    - Common GUI for IBM data servers (DB2/z and IDS)
    - Available in a variety of IBM tools
  - **db2exfmt**
    - Text-based output from the explain tables
    - Command-line interface

The explain facility is used to display the query access plan chosen by the query optimizer to run an SQL statement. It contains extensive details about the relational operations used to run the SQL statement such as the plan operators, their arguments, order of execution, and costs. Since the query access plan is one of the most critical factors in query performance, it is important to be able to understand the explain facility output in order to diagnose query performance problems.

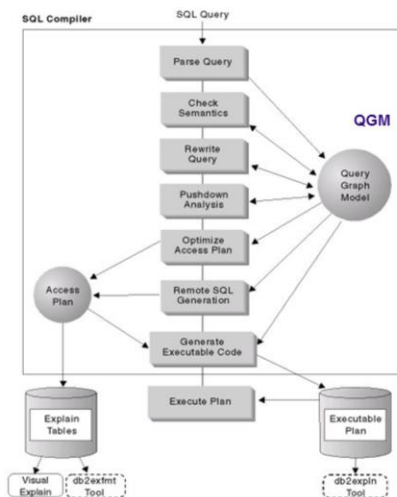
Explain information is typically used to:

- understand why application performance has changed
- evaluate performance tuning efforts

## The explain facility – why should I care?

- Helps understand optimizer decisions
- Maintain a history of access plans for important SQL, during key transition periods
  - New index additions
  - Large data updates/additions
  - Catalog statistics changes
  - Major version upgrades
  - Significant DB or DB manager configuration changes
- Problem determination is easier, and often faster with a reference access plan to compare against

## Phases of SQL Compilation



- Sometimes references to 'optimization' really mean SQL compilation
- There is a lot more involved to SQL compilation

### Parsing

- Catch syntax errors
- Generate internal representation of query

### Semantic checking

- Determine if query makes sense
- Incorporate view definitions
- Add logic for constraint checking and triggers

### Query optimization

- Modify query to improve performance (Query Rewrite)
- Choose the most efficient "access plan"

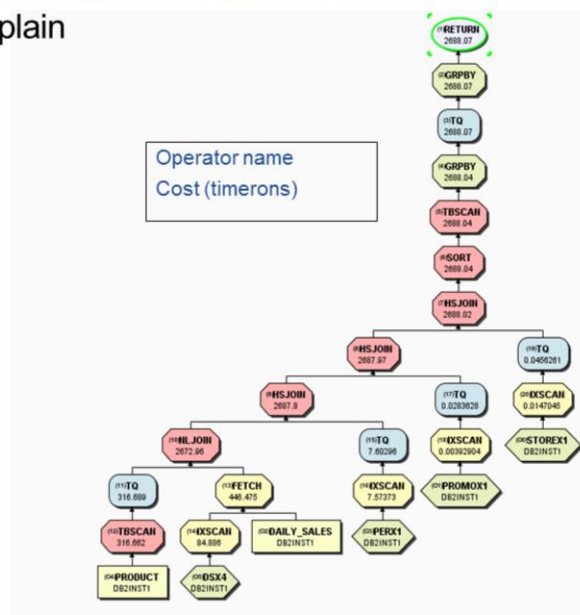
### Pushdown Analysis

- Federation "optimization"

### Threaded code generation

- Generate efficient "executable" code
- "Access section"

# Visual Explain



## db2exfmt

[illegible]

Cardinality
Operator name
(Operator ID)
Cost (timerons)
I/O (pages)

## Tip # 1: How to create the explain tables

- Visual Explain tools create the explain tables automatically
- Use SYSINSTALLOBJECTS stored procedure:

```
CALL SYSPROC.SYSINSTALLOBJECTS  
('EXPLAIN', 'C', CAST (NULL AS VARCHAR(128)), 'DB2USER' )
```

OR

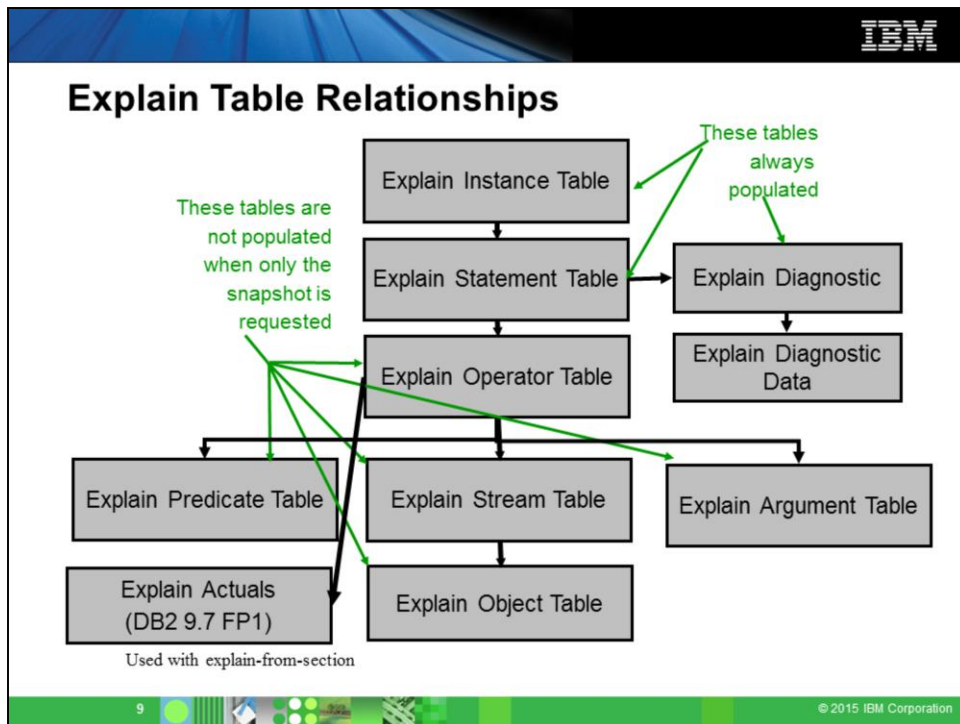
- Create the explain tables manually using EXPLAIN.DDL, found in the sqllib/misc directory

```
db2 -tvf ~/sqllib/misc/EXPLAIN.DDL
```

- There are 10 explain tables
  - 1 added in DB29.7 FP1
- DB2 inserts details of selected plan into the explain tables
- Various details about the explain tables and tools can be found in the DB2 Information Center:

[http://www-01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/c0005134.html](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/c0005134.html)





There are 10 explain tables, and 6 index advisor tables. This talk will not touch upon the index advisor tables.

The **Explain Instance** table contains information about a grouping of explain statements. This grouping is usually for static SQL statements that are part of the same source file.

The **Explain Statement** table contains information about a specific statement. There are 2 entries in this table for each SQL statement explain: the original statement, and the planned statement. Associated with the planned statement, is the rest of the Query Access Plan.

The **Explain Operator** table contains information about each of the operations in the Query Access Plan.

The **Explain Stream** table describes how each of the operators are linked together, and link to **Explain Objects**.

The **Explain Objects** tables describes all of the objects (indexes, tables, table functions) used by the Query Access Plan

The **Explain Predicate** tables describes all of the predicates applied by a particular **Explain Operator**.

The **Explain Argument** table describes additional arguments for the operator.

The **Explain Diagnostic** table contains diagnostic information about the statement such as tables or indexes that are missing statistics or why an MQT or statistical view wasn't used.

The **Explain Diagnostic Data** table contains multiple rows for each diagnostic

message. These rows contain message tokens associated with the message.

The **Explain Actuals** table contains runtime actuals information. Currently, it contains the actual number of rows processed by each operator in the EXPLAIN\_OPERATOR table.

## How is explain information collected?

- There are many different ways to collect explain information!
- This presentation will cover most of them
- There are many ways because SQL can be issued in different contexts:
  - Static, dynamic
  - Stored procedures, triggers and functions
- The most common methods:
  - Use the EXPLAIN statement:

```
EXPLAIN PLAN FOR SELECT ... FROM T1, T2 WHERE...
```
  - Use the CURRENT EXPLAIN MODE special register

```
SET CURRENT EXPLAIN MODE EXPLAIN
SELECT ... FROM T1, T2 WHERE...
SET CURRENT EXPLAIN MODE NO
```

## Tip #2: EXPLAIN statement or EXPLAIN MODE special register?

- The EXPLAIN statement is useful if you want to uniquely identify each instance of an explained statement:

```
EXPLAIN PLAN SET QUERYNO = 13 SET QUERYTAG = 'TEST13'  
FOR SELECT ... FROM T1, T2 WHERE...
```

- Values are stored in EXPLAIN\_STATEMENT QUERYNO and QUERYTAG columns
- The EXPLAIN MODE special register is useful when:
- You want to explain a set of SQL statements without changing each one:

```
SET CURRENT EXPLAIN MODE EXPLAIN  
<stmt 1>  
<stmt 2>  
SET CURRENT EXPLAIN MODE NO
```

- Want to explain AND execute the statements

```
SET CURRENT EXPLAIN MODE YES
```

### Tip # 3: Avoid db2expln or dynexpln

- These are tools that interpret the compiled version of the statement (access section)
- Contains less optimizer information about the query access plan
- Insufficient details about why operations were chosen
  - No selectivity estimates or estimated cardinality or costs per operator
- dynexpln is discontinued in DB2 10.1

## Tip #4: How to explain a dynamic SQL statement after it is prepared

- Why would you want to do this?
  - Because explaining an SQL statement in the present, may not produce the same access plan that was produced in the past.
  - The optimizer considers many environmental factors such as catalog statistics, the DB and DBM configuration and the compilation environment.
  - These factors might've changed since the statement was prepared and they might be hard to re-specify.
- Where might the prepared SQL statement exist?
  - Dynamic statement cache
  - System catalogs
  - Activity event monitor table
- The prepared SQL statement is called an *access section*
- So the access section must be explained

## Explain from Access Section

- Explain from access section? But didn't you just say not to use db2expln because it is based on the access section?
- Explain from access section looks at some additional information that is included with the real access section.
- It is also invoked as a stored procedure so it can be called via SQL

## Explain from Access Section

- 3 step process:
  1. Obtain information identifying the location of the access section
  2. Use this information to call a stored procedure to write explain information to the explain tables
    - 4 stored procedures, for different purposes
  3. Use an explain table formatting tool to view the explain
    - db2exfmt
    - Visual Explain
- Requires DB2 9.7 FP1



Explain from Access Section Example

- Explaining a statement from the dynamic statement cache

1. Locate the access section. Need the **executable ID**.

```
SELECT SECTION_TYPE, EXECUTABLE_ID, VARCHAR(STMT_TEXT, 200) AS TEXT
FROM TABLE( MON_GET_PKG_CACHE_STMT ( 'D', NULL, NULL, -2)) as T
WHERE T.NUM_EXEC_WITH_METRICS <> 0 AND STMT_TYPE_ID LIKE 'DML%'
GROUP BY SECTION_TYPE, EXECUTABLE ID, VARCHAR(STMT TEXT, 200)
```

- An executable ID is an opaque binary token that uniquely identifies the SQL statement section that was executed.

- *VARCHAR(32) FOR BIT DATA*

2. Call a stored procedure to write the explain information to the explain tables

```
CALL EXPLAIN_FROM_SECTION (  
x'01000000000000005F0000000000000000000000000020020101108135629359000', -- Executable  
ID  
  
'M',          -- Section is obtained from the package cache  
NULL,         -- Optional: package cache event monitor name  
0,            -- Member  
NULL,         -- Optional: explain table schema  
?, ?, ?, ? ) -- Output arguments used to locate entry in explain  
tables
```

## Explain from Access Section Example (continued)

- Output of EXPLAIN\_FROM\_SECTION call:

Value of output parameters

```
-----  
Parameter Name : EXPLAIN_SCHEMA  
Parameter Value : DB2DOCS  
  
Parameter Name : EXPLAIN_REQUESTER  
Parameter Value : DB2DOCS  
  
Parameter Name : EXPLAIN_TIME  
Parameter Value : 2014-11-08-13.57.52.984001  
  
Parameter Name : SOURCE_NAME  
Parameter Value : SQLC2H21  
  
Parameter Name : SOURCE_SCHEMA  
Parameter Value : NULLID  
  
Parameter Name : SOURCE_VERSION  
Parameter Value :
```

- Format the explain information:

```
db2exfmt -d gsdb -e db2docs -w 2014-11-08-13.57.52.984001 -n SQLC2H21  
-s NULLID -t -#0
```

## Explain from Access Section – Alternative Method

- Faster method when many statements need to be explained
- Collect section separately – explain later
  - Writing to the explain tables can be expensive
  - Can collect sections from one DB and explain on another!
- Available in DB2 10.5 FP4

Method 1	Method 2
1) Locate the executable ID for the access section	1) Locate the executable ID for the access section
2) Call EXPLAIN_FROM_SECTION to write explain information to explain tables	2a) Call MON_GET_SECTION table function to store access section in a user table (new in 10.5 FP4)
	2b) Call EXPLAIN_FROM_DATA to write explain information to explain tables
3) Format explain table contents (db2exfmt or visual explain)	3) Format explain table contents (db2exfmt or visual explain)

[http://www-01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.sql.rtn.doc/doc/r0061346.html?cp=SSEPGG\\_10.5.0%2F3-6-1-3-10-48&lang=en](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.sql.rtn.doc/doc/r0061346.html?cp=SSEPGG_10.5.0%2F3-6-1-3-10-48&lang=en)

```
INSERT INTO REPOSITORY_SECTIONS(STMT_TEXT, STMTID,
PLANID, SEMANTIC_ENV_ID, SECTION_DATA) SELECT STMT_TEXT,
STMTID, PLANID, SEMANTIC_ENV_ID, ( SELECT B.SECTION_ENV
FROM TABLE(MON_GET_SECTION(A.EXECUTABLE_ID)) AS B)
SECTION_DATA FROM
TABLE(MON_GET_PKG_CACHE_STMT(NULL,NULL,NULL,-2)) AS A
```

You can use this information to build a history of statements that ran. You can use the EXPLAIN\_FROM\_DATA stored procedure to examine the access plan for each saved statement by passing the saved section to the stored procedure.

## Populating an access section repository

```

INSERT INTO REPOSITORY_SECTIONS
(STMT_TEXT, STMTID, PLANID, SEMANTIC_ENV_ID, SECTION_DATA)
SELECT STMT_TEXT, STMTID, PLANID, SEMANTIC_ENV_ID,
(SELECT B.SECTION_ENV FROM TABLE ( MON_GET_SECTION( A.EXECUTABLE_ID )) AS B)
SECTION_DATA
FROM
TABLE ( MON_GET_PKG_CACHE_STMT
(NULL, -- section_type (optional): 'S':static, 'D':dynamic
NULL, -- executable_id (optional)
<modified_within>5</modified_within> -- search_args (optional)
-2)) -- member
AS A

```

- Compare STMTID, PLANID and SEMANTIC\_ENV\_ID to determine if the access plan is new
  - More about this later!!
- Use EXPLAIN\_FROM\_DATA to get the explain based in the access section contained in SECTION\_DATA

## Tip #5: The best way to explain static SQL statements

- There are 2 main ways to explain static SQL:
  1. **Explain when the package is prepared or bound**
    - Must specify the EXPLAIN option on PREP or BIND command
      - YES = populate explain tables for static SQL at prepare/bind
      - ALL = same as YES, except dynamic SQL is explained at runtime
      - ONLY = explain only, but don't create a package
    - But what if EXPLAIN wasn't specified?
    - What if you didn't know there was actually a package, like there is for triggers and functions?
  2. **Explain based on the access section stored in the catalogs**
    - Use EXPLAIN\_FROM\_CATALOG stored procedure
    - Can get an explain after packages are bound, or triggers and functions are created
    - But there are a couple of gotchas:
      - Need to determine the package name for functions and triggers
        - (See example in speaker notes and next page)
      - Can only explain 1 section at a time
      - A wrapper procedure can solve these problems

Example query to retrieve parameters for EXPLAIN\_FROM\_CATALOG call:

```
select r.routineschema, r.routinename, d.bschem as pkgschema, d.bname as
pkgname, s.version as pkgversion, s.sectno
from SYSCAT.STATEMENTS AS S,
SYSCAT.ROUTINEDEP AS D,
SYSCAT.ROUTINES AS R
WHERE D.BTYPE = 'K' AND
R.SPECIFICNAME = D.ROUTINENAME AND
R.ROUTINESCHEMA = D.ROUTINESCHEMA AND
S.PKGSHEMA = D.BSCHEMA AND
S.PKGNAME = D.BNAME AND
R.ROUTINENAME = ;
```

```
>>-EXPLAIN_FROM_CATALOG----->
>--(--pkgschema--,--pkgname--,--pkgversion--,--sectno--,--explain_schema-->
>--,,--explain_requester--,--explain_time--,--source_name--,--source_schema--
```

,--source\_version--)-><

## Example query to retrieve parameters for EXPLAIN\_FROM\_CATALOG call:

```
select r.routineschema, r.routinename, d.bschem as pkgschema, d.bname as pkgname, s.version as
pkgversion, s.sectno
from SYSCAT.STATEMENTS AS S,
SYSCAT.ROUTINEDEP AS D,
SYSCAT.ROUTINES AS R
WHERE D.BTYPE = 'K' AND
R.SPECIFICNAME = D.ROUTINENAME AND
R.ROUTINESCHEMA = D.ROUTINESCHEMA AND
S.PKGSHEMA = D.BSCHEMA AND
S.PKGNAME = D.BNAME AND
R.ROUTINENAME = <YOUR ROUTINE NAME> ;
```

```
>>-EXPLAIN_FROM_CATALOG----->
>--(--pkgschema--,--pkgname--,--pkgversion--,--sectno--,--explain_schema-->
>--(--explain_requester--,--explain_time--,--source_name--,--source_schema--,--source_version--)-
><
```

## Explain from Access Section Routines

- **EXPLAIN\_FROM\_SECTION**
  - Access section resides in:
    - In-memory package cache
    - Package cache event monitor
  - Identify by executable ID and location
- **EXPLAIN\_FROM\_ACTIVITY**
  - Access section resides in an activity event monitor table
    - Must specify COLLECTACTIVITY DATAWITH SECTION when defining workload management objects (workload, service class, threshold, work action)
  - Identify by application ID, activity ID, UOW ID, and activity event monitor name
- **EXPLAIN\_FROM\_CATALOG**
  - Access sections for static SQL
  - Identify by package name, package schema, unique ID, and section number
- **EXPLAIN\_FROM\_DATA**
  - Pass access section directly to procedure
  - Point at access section in any arbitrary location
- All procedures:
  - Accept explain schema as input
  - Return explain table key as output



## Explain from Access Section

- Activity event monitors
  - Can be created for:
    - workloads
    - service classes
    - thresholds
    - work action
  - The Workload Management (WLM) feature is required to create these DB objects
  - Activity event monitors can be created for the default workloads and service classes shipped with DB2
    - SYSDEFAULTUSERWORKLOAD
      - SYSDEFAULTUSERCLASS
    - SYSDEFAULTADMWORKLOAD
    - But beware that ALL system activity will be monitored

## Explain from Access Section

- Explain information is a subset of full explain
  - Does not include all explain information in the section, to avoid increasing package cache memory
- The **most important** information is included
  - All operators, predicate text, estimated cardinality, most operator arguments
- What is missing:
  - Only TOTAL\_COST and FIRST\_ROW\_COST are included
  - Stream column names
  - DB partition class columns
  - Many statistics
  - Implicitly (compiler) referenced objects
- But still WAY more information than db2expln

## Tip #6: How to verify the optimizer's estimates?

- Why would you want to do this?
- Consider what the optimizer does:
  - Models the execution of the access plan
  - **Estimates the number of rows** produced by each plan operator
  - Models the:
    - CPU, I/O, and memory costs for each plan operator
    - Communications costs (in partitioned and federated environments)
  - Selects the access plan with the cheapest cost
  - The estimate of the number of rows (AKA: cardinality) is **the most important factor** in the estimated cost
  - So it is the first thing to verify when examining a suspect access plan

## Explain with Actual Cardinality

- Capture cardinality (number of rows) processed by each access plan operator at runtime
- Compare with the optimizer's estimates to identify possible access plan problems
  - Estimated cardinality is most important input to cost model
- Use explain from access section mechanism
- Must use activity event monitor
  - Use WLM, specify COLLECT ACTIVITY DATA WITH DETAILS,SECTION
    - For workload, service class, threshold, work action
    - ALTER WORKLOAD WL1 COLLECT ACTIVITY DATA WITH DETAILS,SECTION
  - Alternatively, use WLM\_SET\_CONN\_ENV stored procedure to enable collection for the current connection (**DB2 9.7 FP2**)
    - `wlm_set_conn_env(null, '<collectactdata>with details, section</collectactdata><collectsectionactuals>base</collectsectionactuals>');`
- Use EXPLAIN\_FROM\_ACTIVITY stored procedure to populate explain tables

[http://www-](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/c0056362.html)

[01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/c0056362.html](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/c0056362.html)

[http://www-](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.sql.rtn.doc/doc/r0056929.html?cp=SSEPGG_10.5.0%2F3-6-1-3-18-16)

[01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.sql.rtn.doc/doc/r0056929.html?cp=SSEPGG\\_10.5.0%2F3-6-1-3-18-16](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.sql.rtn.doc/doc/r0056929.html?cp=SSEPGG_10.5.0%2F3-6-1-3-18-16)

## Explain with Actual Cardinality

- How to make it work:
  1. Enable a DB configuration parameter:  
**section\_actuals [base | none]**
  2. Create activity event monitor
  3. Create workload or use default workload (to collect activity data)
    - Alternative: WLM\_SET\_CONN\_ENV for the current connection
  4. Activate activity event monitor
  5. Execute SQL statement
  6. Locate SQL statement information in event monitor table to pass to EXPLAIN\_FROM\_ACTIVITY stored procedure
  7. Call EXPLAIN\_FROM\_ACTIVITY
  8. db2exfmt
- A simpler option:
  - db2caem -d <dbname> -st "SQL stmt"**
  - DB2 Capture Activity Event Monitor data tool
- Can also be requested using Optim Query Workload Tuner

[http://www-01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/c0056362.html?lang=en](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/c0056362.html?lang=en)

### Setup:

Enable DB configuration parameter if section actuals collection is to be enabled for the entire database.

Alternatively, they can be enabled at the session level using WLM\_SET\_CONN\_ENV(). See steps further below.

DB2 UPDATE DATABASE CONFIGURATION USING SECTION\_ACTUALS BASE;

### Collection:

The easiest method is to use the db2caem tool:

```
db2caem -d <dbname> -st "SQL stmt"
```

Otherwise, these are the manual steps:

Create event monitor

```
CREATE EVENT MONITOR ACTEVMON FOR ACTIVITIES WRITE TO TABLE;
```

There are 2 methods to perform collection:

1) WLM setup:

Create workload or use default workload (to collect activity data)

2) Use WLM\_SET\_CONN\_ENV stored procedure for the current connection

```
call wlm_set_conn_env(null, '<collectactdata>with details, section </collectactdata><collectsectionactuals>base</collectsectionactuals>');
```

Activate activity event monitor

```
SET EVENT MONITOR ACTEVMON STATE 1;
```

Execute SQL statement

Locate SQL statement information in event monitor table to pass to EXPLAIN\_FROM\_ACTIVITY stored procedure:

```
SELECT APPL_ID,    UOW_ID,    ACTIVITY_ID,    STMT_TEXT FROM ACTIVITYSTMT_ACTEVMON;
-- APPL_ID        UOW_ID    ACTIVITY_ID    STMT_TEXT
```

```
-----
-- *N2.DB2INST1.0B5A1222841      1          1 SELECT * FROM ...
```

Populate the explain tables:

```
CALL EXPLAIN_FROM_ACTIVITY( '*N2.DB2INST1.0B5A12222841', 1, 1, 'ACTEVMON', 'MYSCHEMA', '?', '?', '?', '?' );
```

Format the explain tables as usual e.g. db2exfmt

## Explain with Actual Cardinality

db2exfmt example

```

Rows
Rows Actual
RETURN
( 1)
Cost
I/O
|
54
396
>^HSJOIN
( 2)
153.056
NA
/-----\
54      20
396      0
>^HSJOIN  TBSCAN
( 3)      ( 12)
140.872   11.0302
NA        NA
|
54      6      20
396      0      NA
>^HSJOIN  IXSCAN  TABLE: SYSIBM
( 4)      ( 11)  SYSAUDITPOLICIES
138.033   2.01136
NA        NA
|
54      6      -1
396      0      NA
>^HSJOIN  IXSCAN  INDEX: SYSIBM
( 5)      ( 10)  INDCOLLATIONS04

```

[http://www-01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/t0056414.html](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/t0056414.html)

## Tip #7: How to see the relevant statistics for a particular query

- Request the ***explain snapshot*** when collecting the explain
  - A binary object containing statistics information
  - Stored in EXPLAIN\_STATEMENT.SNAPSHOT column (BLOB)
- Automatically formatted by db2exfmt or Visual Explain
- Contains ALL relevant statistics

- Not all statistics are included in EXPLAIN\_OBJECT table

```
SET CURRENT EXPLAIN MODE EXPLAIN
```

```
SET CURRENT EXPLAIN SNAPSHOT EXPLAIN
```

```
<SQL stmt>
```

```
OR
```

```
EXPLAIN PLAN WITH SNAPSHOT FOR <SQL stmt>
```

- You can also format the statistics yourself with EXPLAIN\_FORMAT\_STATS scalar function

[http://www-01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.sql.rtn.doc/doc/r0052902.html?cp=SSEPGG\\_10.5.0%2F3-6-1-3-8-1&lang=en](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.sql.rtn.doc/doc/r0052902.html?cp=SSEPGG_10.5.0%2F3-6-1-3-8-1&lang=en)



## Collecting Relevant Statistics with Explain

- Why is this useful?
  - Obvious reason:
    - Helpful for understanding optimizer decisions
  - Non-obvious reason:
    - Statistics can change frequently due to [automatic statistics collection](#)
    - The statistics in the statistics cache could be more current than those in the system catalogs!
- I recommend always collecting the explain snapshot
- Not available with explain from access section

[http://www-01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/c0011762.html?cp=SSEPGG\\_10.5.0%2F2-6-2-10-11-1&lang=en](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/c0011762.html?cp=SSEPGG_10.5.0%2F2-6-2-10-11-1&lang=en)

Synchronous statistics collection does not store the statistics in the system catalog. Instead, the statistics are stored in a statistics cache and are later stored in the system catalog by an asynchronous operation. This storage sequence avoids the memory usage and possible lock contention that are involved in updating the system catalog. Statistics in the statistics cache are available for subsequent SQL compilation requests.

## Tip #8: How to determine if an access plan has changed

- Straightforward approach is to compare the old and new explain table information
  - This is expensive, complex and some plan details don't have a significant impact on performance
- Solution: Access plans are uniquely identified by a **plan id**
  - **New feature in 10.5 FP4**
- The plan id is a 64-bit hash key based on important aspects of the access plan
  - Operator type, order, arguments, referenced objects
- Reported in explain output as a RETURN operator argument

```
PLANID : (Access plan identifier)
        ad9edacfcc17d2e4
```

[http://www-01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.admin.mon.doc/doc/r0061351.html?cp=SSEPGG\\_10.5.0&lang=en](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.admin.mon.doc/doc/r0061351.html?cp=SSEPGG_10.5.0&lang=en)

The hash key value which identifies a query plan for a section.

The planid monitor element tracks important performance sensitive aspects of the access plan. Such aspects include the list and layout of access plan operators, identifiers of the objects that are being accessed, the number of each type of predicate for each operator, and performance sensitive operator arguments.

## Access Plan IDs

- PLANID is returned by some monitoring functions
- PLANID is included in activity event monitor tables
  - ACTIVITYSTMT\_<evmon\_name>
- Allows tracking access plan changes for **current and historical** execution

Table Function Name	Description
MON_GET_ACTIVITY	Return a list of current activities (still executing).
MON_GET_ACTIVITY_DETAILS	Return information about a current activity as an XML document.
MON_GET_PKG_CACHE_STMT	Returns a point-in-time view of both static and dynamic SQL statements in the database package cache.
MON_GET_PKG_CACHE_STMT_DETAILS	Get package cache statement metrics as an XML document. Represents the accumulation of all metrics for statements in the package cache.
WLM_GET_WORKLOAD_OCCURENCE_ACTIVITIES	Same as MON_GET_ACTIVITY, but different authorizations.

[http://www-01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.admin.mon.doc/doc/r0061351.html?cp=SSEPGG\\_10.5.0&lang=en](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.admin.mon.doc/doc/r0061351.html?cp=SSEPGG_10.5.0&lang=en)

## Comparing Access Plans using PLANID

- PLANIDs are only comparable for a *particular SQL statement* executed in a *particular semantic environment*
- Semantic environment id (SEMANTIC\_ENV\_ID)
  - Hash value computed over the **default schema** and **function path** elements in the compilation environment
  - Needed to distinguish statements with identical text but executed with different schemas or function paths
- Statement id (STMTID)
  - Hash value computed over the **normalized** SQL statement text
  - Following statements have the same STMTID
 

```
SELECT NAME FROM CUSTOMER WHERE ID = 111
SELECT NAME FROM CUSTOMER WHERE ID = 222
```
  - Normalization uses the same approach as optimization guidelines inexact statement text matching
  - This means that there could be multiple PLANIDs for a given STMTID

[http://www-01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.admin.mon.doc/doc/r0061359.html?lang=en](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.admin.mon.doc/doc/r0061359.html?lang=en)

Use the semantic environment ID with the query statement ID monitor element (stmtid) to identify an SQL statement. The semantic compilation environment ID is used to distinguish queries that have the same statement text, but are semantically different because they reference different objects. For example, the table that is referenced in the statement `SELECT * FROM T1` depends on the value of the default schema in the compilation environment. If two users with different default schemas issued this statement, there would be two entries for the statement in the package cache. The two entries would have the same stmtid value, but would have different values for semantic\_env\_id.

Inexact statement matching rules:

[http://www-01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/c0059000.html?cp=SSEPGG\\_10.5.0&lang=en](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.admin.perf.doc/doc/c0059000.html?cp=SSEPGG_10.5.0&lang=en)

## Comparing Access Plans using PLANID

- SEMANTIC\_ENV\_ID and STMTID are available wherever PLANID is available
- Included in explain tables:
 

```
SEMEVID : (Semantic environment identifier)
0000000000000001
STMTID   : (Normalized statement identifier)
fdc3021bec913ac9
```
- PLANID, STMTID and SEMANTIC\_ENV\_ID are stable across future fixpaks and releases
- PLANID does not change if DB objects (tables, indexes, etc.) are recreated with the same definition
  - PLANID is based on the object name excluding schema
  - Allows comparing PLANIDs across different DBs where tables with the same name exist in different schemas
  - **Useful for comparing access plans from a test and production system**

PLANIDs should be compared for the 'same' SQL statement, executed within the 'same' semantic or compilation environment. The semantic environment includes the schema and function path. For example, the same SQL statement could have different access plans if it were issued with different schemas, because it references tables with the same names, but different definitions. Monitoring and explain report a semantic environment id (SEMANTIC\_ENV\_ID) for this purpose. So the 'key' for a unique instance of an SQL statement is STMTID and SEMANTIC\_ENV\_ID.

The STMTID is a hash computed based on a normalized form of the original SQL statement text that strips out literals e.g. "select name from customer where id = 111" and "'select name from customer where id = 222" would have the same STMTID. This means that a given STMTID could have multiple PLANIDs associated with it, if the literals affected costing and plan selection. One can further differentiate the statements for a given STMTID by comparing the original SQL statement text. This approach allows the flexibility to track statements based only on STMTID (and SEMANTIC\_ENV\_ID) and PLANID, to reduce the amount of data collected, for applications that don't use input variables or statement concentration.

PLANID is based on DB object names excluding their schema. So the PLANID for “SELECT C1 FROM T1” could be the same for different T1s in different schemas. This is useful for comparing access plans when the T1s have the same definition but are in different schemas. This approach also prevents PLANIDs from changing if DB objects are recreated.

## Comparing Access Plans using PLANID

- So tip #8 is really about how to avoid using explain
- Explaining isn't necessary if the PLANID is the same
  - For the same STMTID and SEMANTIC\_ENV\_ID
- Even when access plans are captured using explain, only the PLANIDs need to be compared
  - Requires some SQL 'pivoting' to retrieve these IDs
  - See speaker notes for an example



```

select es.explain_time, varchar(statement_text,100),
(select varchar(ea.argument_value,20) as planid
from explain_argument ea
where ea.argument_type = 'PLANID' and
eo.operator_id = ea.operator_id and
es.explain_requester = ea.explain_requester and
es.explain_time = ea.explain_time),
(select varchar(ea.argument_value,20) as stmtid
from explain_argument ea
where ea.argument_type = 'STMTID' and
eo.operator_id = ea.operator_id and
es.explain_requester = ea.explain_requester and
es.explain_time = ea.explain_time),
(select varchar(ea.argument_value,20) as semantic_env_id
from explain_argument ea
where ea.argument_type = 'SEMEVID' and
eo.operator_id = ea.operator_id and
es.explain_requester = ea.explain_requester and
es.explain_time = ea.explain_time)
from explain_statement es, explain_operator eo
where
eo.operator_type = 'RETURN' and
es.explain_level = 'O' and
es.explain_requester = eo.explain_requester and
es.explain_time = eo.explain_time;

```

## Tip #9: Explain Diagnostic Messages

- Explain can provide helpful information such as:
  - Notification about missing statistics
  - Information about whether or not materialized query tables (MQTs) or statistical views could be matched
  - Syntax errors when using optimization profiles
  - Index recommendations in limited contexts (for zig-zag join)
  - [More will be added in future releases](#)



## Explain Diagnostic Messages

- 2 additional explain tables:
  - EXPLAIN\_DIAGNOSTICS and EXPLAIN\_DIAGNOSTICS\_DATA
- Formatted message text appears in the db2exfmt output or visual explain:

EXP0020W Table has no statistics. The table "DB2DBA"."SALES" has not had runstats run on it. This may result in a sub-optimal access plan and poor performance.

EXP0060W The following materialized query table (MQT) or statistical view was not eligible for query optimization: "DB2DBA"."SV\_STORE". The MQT cannot be used for query optimization because one or more tables, views or subqueries specified in the MQT could not be found in the query that is being explained.

EXP0147W The following statistical views may have been used by the optimizer to estimate cardinalities: "DB2DBA"."SV\_STORE".

EXP0256I Analysis of the query shows that the query might execute faster if an additional index was created to enable zigzag join. Schema name: "DB2DBA". Table name: "SALES". Column list: "PERIODKEY, REGIONKEY, PRODUCTKEY".

## Tip #10: Upgrading Explain Tables

- Sometimes new DB2 releases add new explain tables and/or explain table columns
- Previous explain tables are always upward compatible
  - But some new functionality is skipped if tables or columns are missing
- Solution – upgrade explain tables using:
  - db2exmig
  - OR
  - SYSINSTALLOBJECTS stored procedure

```
CALL SYSPROC.SYSINSTALLOBJECTS('EXPLAIN', 'M',  
CAST (NULL AS VARCHAR(128)), -- Table space name. Table space of  
existing  
-- explain tables is always used.  
CAST (NULL AS VARCHAR(128))) -- Optional schema. Default is SYSTOOLS.
```

[http://www-01.ibm.com/support/knowledgecenter/SSEPGG\\_10.5.0/com.ibm.db2.luw.qb.upgrade.doc/doc/t0007195.html?lang=en](http://www-01.ibm.com/support/knowledgecenter/SSEPGG_10.5.0/com.ibm.db2.luw.qb.upgrade.doc/doc/t0007195.html?lang=en)

## Bonus tip: Why are my explain tables are getting big?

- DB2 only inserts into the explain tables
- Allows more flexibility
- But deleting everything is easy to do:  

```
DELETE FROM EXPLAIN_INSTANCE
```
- Referential integrity is defined by default and EXPLAIN\_INSTANCE is at the top of the hierarchy