IBM Software Group

PLAN Stability

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The Problem

- Unpredictable, unstable performance of queries due to changes in access paths:
  - Affects Static SQL (REBIND/BIND REPLACE) and Dynamic SQL (PREPARE)
  - Regressions are typically seen when customers migrate to a new release.
  - Also seen during the lifetime of a release when applications are bound/rebound due to maintenance fixes, changes in data and/or schema, or changes in the applications.
- Customers have to do a lot of “prep work” before REBINDing to protect themselves.
- Pinpointing the exact source of such regressions can be hard. When regressions do happen, there are usually no quick fixes.

Why the Access Path Change?

- Estimated cost of multiple plans are closed
  - Easily to be affected by environment and other factors
- Optimizer estimate cost inaccurately
  - Unknown data skew
    - Distribution Stats (V8)
    - Histogram Stats (V9)
  - Lack of correlation statistics
    - Correlation Stats (V8)
  - Predicate estimation with host variables or parameter markers

Possible Solutions

- Ability to backup/restore access path
  - V9 Plan Stability
- Optimization Hints
  - Full Hints
  - CTE Hints
- Avoid conflicting access path choices
  - By design
  - Or, statistically

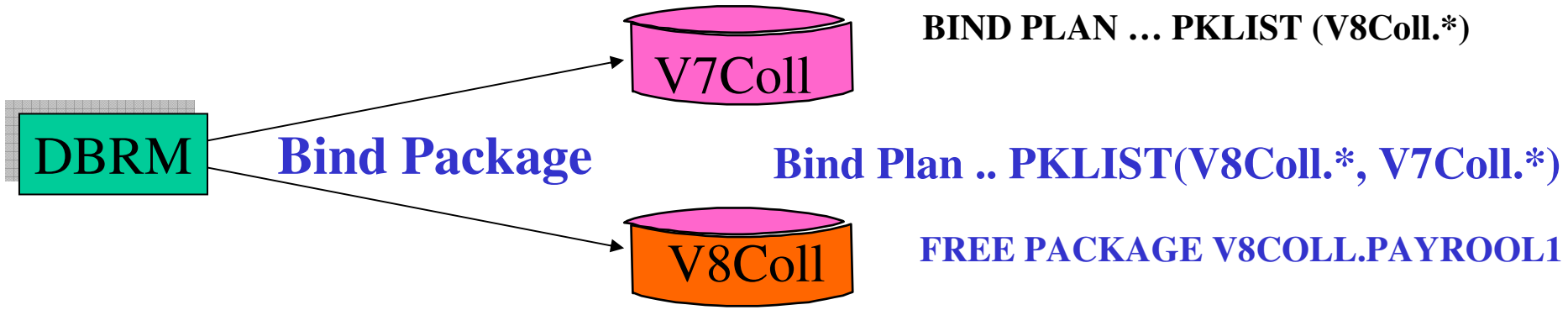
Access Path Backup

Provide an unprecedented level of stability of query performance achieved by stabilizing access paths:

- Dummy Collection (V8)
- Static SQL (V9)
  - Relief from REBIND regressions
  - Remove the fear of REBINDing!
- Dynamic SQL (Vx)
  - Remove the unpredictability of PREPARE
  - Extend Static SQL benefits to Dynamic SQL

V8 Plan Stability – Dummy Collection

- Bind package into a new collection ID



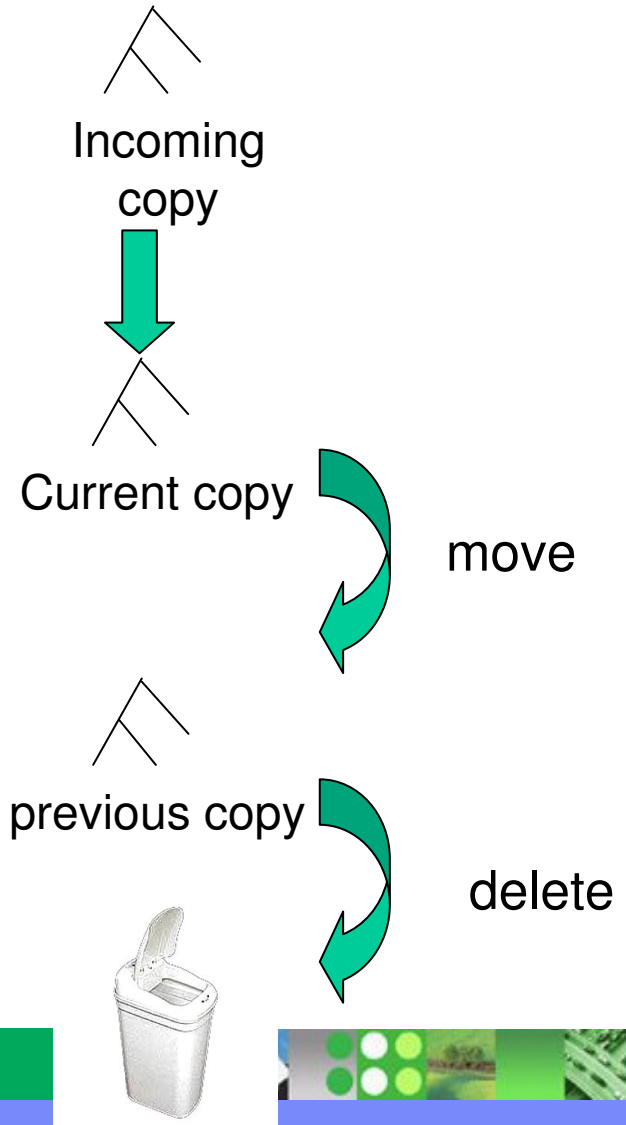
- BIND PLAN with new collection ID Added
- Free regressed packages from the new collection
  - To allow fallback to prior package

V9 Plan Stability

- Ability to backup your static SQL packages
- At REBIND
  - Save old copies of packages in Catalog/Directory
  - Switch back to previous or original version
- Two flavors
  - BASIC
    - 2 copies: Current and Previous
  - EXTENDED
    - 3 copies: Current, Previous, Original
  - Default controlled by a ZPARM (PLANMGMT)
  - Also supported as REBIND options

Plan Stability - BASIC support

REBIND … PLANMGMT(BASIC)



REBIND … SWITCH(PREVIOUS)

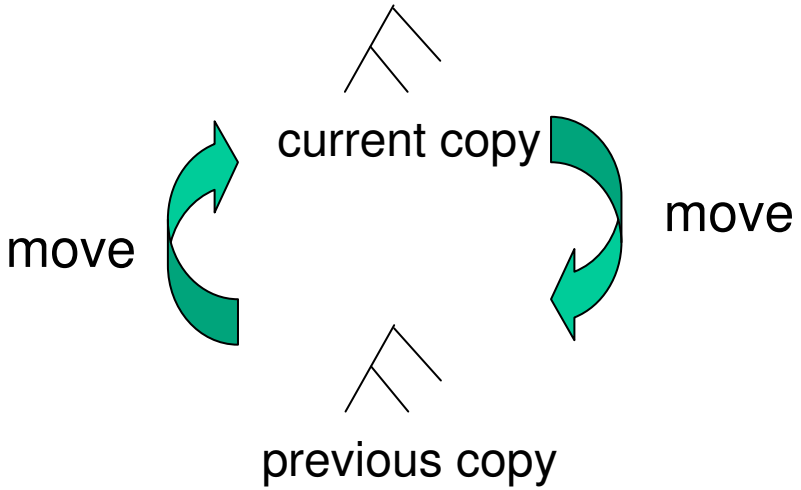
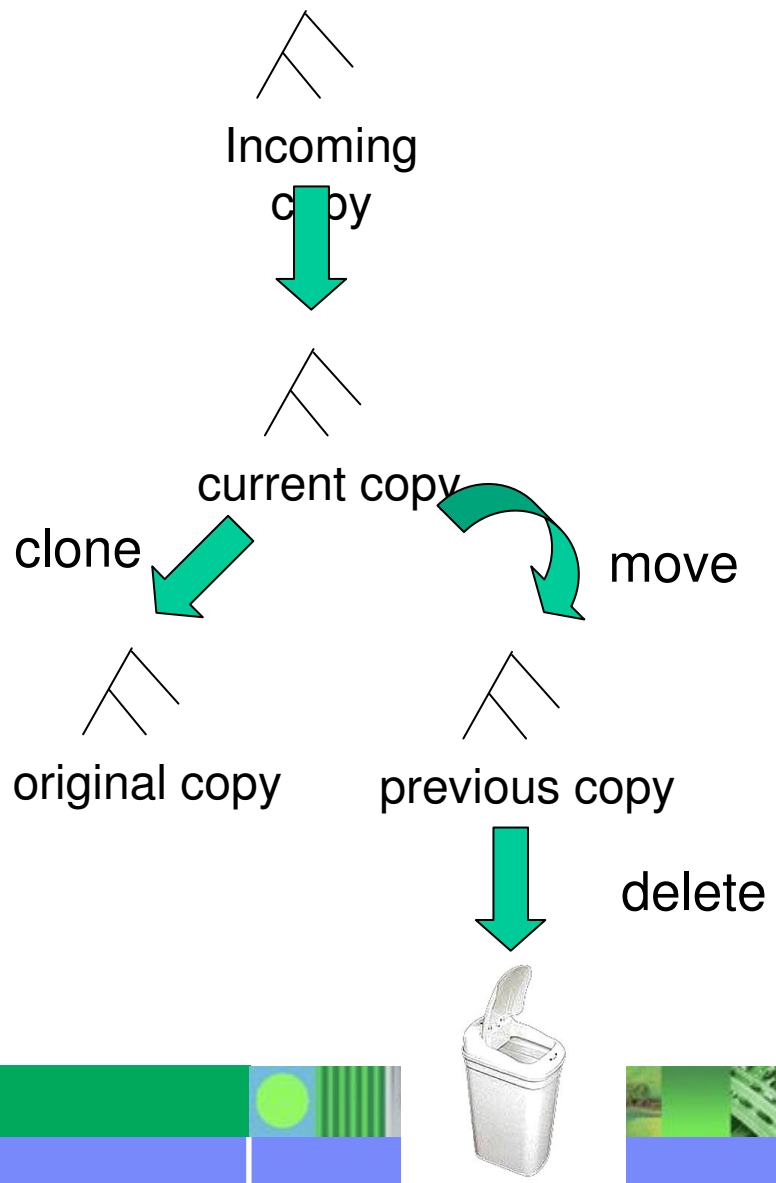


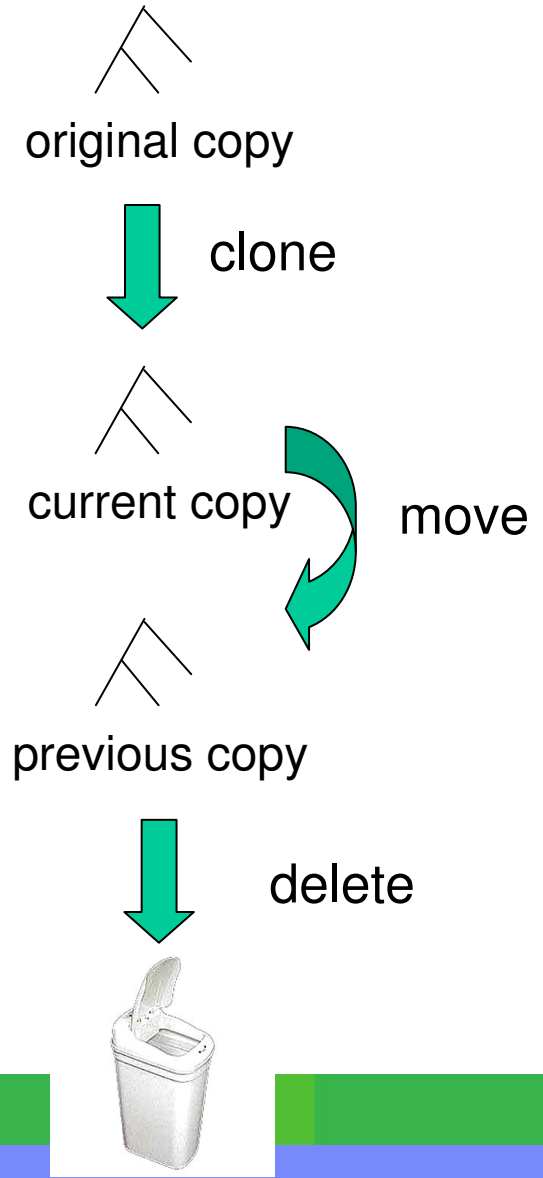
Chart is to be read from bottom to top

Plan Stability - EXTENDED support

REBIND … PLANMGMT(EXTENDED)



REBIND … SWITCH(ORIGINAL)



Plan Stability Notes

- REBIND PACKAGE …
  - PLANMGMT (BASIC)

  2 copies: Current and Previous
  - PLANMGMT (EXTENDED)

  3 copies: Current, Previous, Original

- REBIND PACKAGE …
  - SWITCH(PREVIOUS)

  Switch between current & previous
  - SWITCH(ORIGINAL)

  Switch between current & original

- Most bind options can be changed at REBIND
  - *But a few must be the same …*

- FREE PACKAGE …
  - PLANMGMTSCOPE(ALL) – Free package completely
  - PLANMGMTSCOPE(INACTIVE) – Free old copies

- Catalog support
  - SYSPACKAGE reflects active copy
  - SYSPACKDEP reflects dependencies of all copies
  - Other catalogs (SYSPKSYSTEM, …) reflect metadata for all copies

- Invalidation and Auto Bind
  - Each copy invalidated separately

Why Optimization Hints?

- Temporary fix to resolve immediate crisis
- Access path regresses from previously good path
  - Migrate to new release
  - RUNSTATS + REBIND
  - Environmental change (ridpool, bufferpool, zparm,…)
  - Maintenance upgrade
- Use OPTHINT to address known access path problem when other solutions aren't viable
  - For transactional SQL REOPT too expensive
  - Limitation of optimizer
  - Providing more accurate statistics not viable, or does not solve problem
- Lock in access path

Optimization Hints Overview

- Full Optimization Hints – (V6)
  - Uses PLAN_TABLE as INPUT
  - Allow user to specify desired access path to optimizer
  - Design Point
    - Support “Fallback” to previous access path
    - Experienced users can design their own access path
- Visual Plan Hints
- CTE Hints (V8)

Optimization Hints

- Set ZPARM to enable optimization hints
  - Specify YES in Optimization Hints field
  - Installation panel DSNTIP4
  - ZPARM can be changed on-line
- PLAN_TABLE must be migrated to at lease 49-column format

Static Example

QUERYNO	METHOD	TNAME	BIND_TIME	
100	0	EMP	2007-12-15	
100	1	PROJECT	2007-12-15	old
100	3		2007-12-15	
100	0	EMP	2008-12-16	
100	4	PROJECT	2008-12-16	new
100	0		2008-12-16	

Access Path changed from NLJ to Hybrid Join
performance degraded

Update Plan_Table

QUERYNO	METHOD	TNAME	BIND_TIME	OPTHINT
100	0	EMP	2006-12-15…	**MYHINT**
100	1	PROJECT	2006-12-15…	**MYHINT**
100	3		2006-12-15..	**MYHINT**
100	0	EMP	2007-12-16..	
100	4	PROJECT	2007-12-16	
100	3		2007-12-16..	

- **Update Plan_Table set OPTHINT = 'MYHINT'**
  WHERE QUERYNO = 100 and
  DATE(BIND_TIME) BETWEEN '2007-12-01' and '2002-12-02';

- Further qualify by PROGNAME, APPLNAME, COLLID, VERSION, …

Static Example

- Bind Package or Plan
- If using packages, bind at package level

```
REBIND PACKAGE (myloc.mycoll.mypkg)/PLAN
  EXPLAIN(YES)                          ← validate hint is used
  OPTHINT(MYHINT)
  VALIDATE (BIND)
```

*** BIND should have SQLCODE +394 to indicate Hint is used

Dynamic Example

- SET CURRENT OPTIMIZATION HINT = 'MYHNT';

```
EXPLAIN ALL FOR
  SELECT * FROM EMP, PROJECT
   WHERE ….
   QUERYNO 100;
```

Dynamic SQL uses Special Register

*** BIND should have SQLCODE +394 to indicate Hint is used

Validate Plan_Table

QUERYNO	METHOD	TNAME	BIND_TIME	OPTHINT	HINT_USED
100	0	EMP	2007-12-15	MYHINT	
100	1	PROJECT	2007-12-15	MYHINT	
100	3		2007-12-15	MYHINT	
100	0	EMP	2008-12-16		
100	4	PROJECT	2008-12-16		
100	3		2008-12-16		
100	0	EMP	2008-12-17		MYHINT
100	1	PROJECT	2008-12-17		MYHINT
100	3		2008-12-17		MYHINT

HINT IS USED

CTE Hints

- Available in V8
- Both Dynamic and Static Queries
- Enhance the Hint Usability
  - Attach the Hint with the SQL statement
  - Pass the plan hints into DB2 via a special Common Table Expression embedded within the statement
- Easy to use

CTE Hint

- Turn on OPTHINTS
- The name of CTE must be
  - **DSN_INLINE_OPT_HINT**
- The special CTE has to be the first CTE within the statement

- **WITH DSN_INLINE_OPT_HINT**
  (TABLE_NAME, ACCESS_TYPE, ACCESS_NAME, JOIN_SEQ) AS
  (VALUES (NULL, 'INDEX', NULL, NULL),
  ('T2', NULL, 'INDX1_T2', 1))
  SELECT * FROM T1, T2 WHERE T1.C= T2.C;
- **Host-variable not allowed**
- **SQLCODE +395 issued if hint accepted and DB2 will attempt to use it**

CTE Hint Attributes

Attributes	Comment
TABLE_CREATOR	Name of the table creator
TABLE_NAME	Table name in the query
CORRELATION_NAME	Qualifier to the TABLE_CREATOR and TABLE_NAME
ACCESS_TYPE	**RSCAN, INDEX, INLIST, MULTI_INDEX**
ACCESS_CREATOR	Creator of an INDEX
ACCESS_NAME	Name of an INDEX

CTE Hint Attributes

Attributes	Comment
JOIN_SEQ	Join sequence number
JOIN_METHOD	**NLJ, SMJ, HYBRID**
PARALLELISM_MODE	**CPU, IO, SYSPLEX**
ACCESS_DEGREE	Degree of Parallelism
JOIN_DEGREE	Degree of Parallelism
TABNO	Internal number assigned by DB2 to a table. In most cases, this attribute isn't needed
QBLOCKNO	Internal number assigned by DB2 to query block. In most cases, this attribute isn't needed

CTE Hint Example -1

- First row
  - Enforce to use index access on all tables if no other hint applies to a given table
- Second row
  - Enforce T2 to use index INX1_T2.
  - Force T2 as the leading table

```
WITH DSN_INLINE_OPT_HINT
     (TABLE_NAME, ACCESS_TYPE, ACCESS_NAME, JOIN_SEQ) AS
     (VALUES (NULL, 'INDEX', NULL, NULL),
             ('T2', NULL, 'INDX1_T2', 1))
     SELECT *  FROM T1, T2 WHERE T1.C= T2.C;
```

CTE Hint Example -2

- First row
  - Apply to all instances of T1
  - Enforce to use INX1_T1 for T1
  - Enforce Nested Loop Join
- Second row
  - Apply to all instances of T2
  - Enforce T2 to use index INX1_T2.
  - Force T2 as the leading table

```
WITH DSN_INLINE_OPT_HINT
    (TABLE_NAME,  ACCESS_NAME, JOIN_SEQ, JOIN_METHOD) AS
    (VALUES ('T1', 'INX1_T1', NULL, 'NLJ'),
                ('T2',  'INDX1_T2', 1, NULL))
    SELECT *  FROM T1, T2 WHERE T1.C= T2.C;
```

Hint Limitation

- SQLCODE = 000
  - Hint not found, not used
- SQLCODE +394
  - Hint found, used
  - Optimizer can add necessary sort
  - Optimizer might not be able to support the Hint.
    - Check Reason code
    - Cannot undo query transformation
    - Optimizer determine how index is used

Visual Plan Hints

- Manually altering PLAN_TABLE for hints is difficult
- GUI interface to generate Optimization Hint
  - Graphically alter the explain table
  - Part of Optimization Service Center