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Key Metrics for DB2 for z/OS Subsystem and Application Performance Monitoring (Part 2)

New England DB2 Users Group
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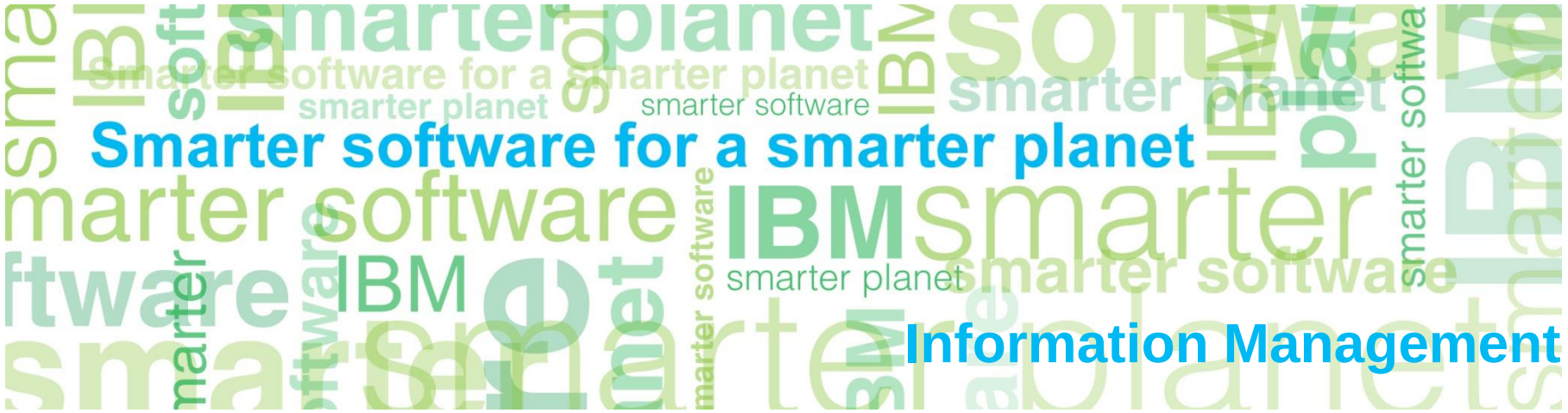


Agenda

- Part 1
  - DB2 monitor-generated reports versus online displays
  - Application performance: DB2 monitor accounting reports (and displays)
- Part 2
  - Subsystem performance: DB2 monitor statistics reports (and displays)
  - The best bits in DB2 and CICS DISPLAY command output
  - Important DB2-related stuff in z/OS monitor reports and displays

Subsystem performance: DB2 monitor statistics reports (and displays)

How are your buffer pools doing?

- Key metric: total read I/Os per second
  - Referring to sample report output below, total read I/O rate for buffer pool BP2 is 3059.56 per second (sum of synchronous reads plus all prefetch reads)
    - If > 1000 I/Os per second, enlarge the pool, if possible (more on this to come)
    - If between 100 and 1000 I/Os per second, consider enlarging the pool if LPAR memory resource is adequate
    - Note that if pool is used to “pin” objects in memory, desired read I/O rate is 0

```
BP2 READ OPERATIONS              /SECOND
-------------------------        -------
SYNCHRONOUS READS                2417.42
SEQUENTIAL PREFETCH READS         199.12
LIST PREFETCH READS                83.58
DYNAMIC PREFETCH READS            359.44
```

Add these up

Can a buffer pool be made larger?

- If buffer pool configuration is too large relative to real storage, performance of non-DB2 work can be negatively impacted
- Check z/OS LPAR's demand paging rate (z/OS monitor)
  - If demand paging rate is in low single digits per second (or less) during busy processing periods, z/OS LPAR's memory resource is not stressed – should be OK to enlarge buffer pool
    - That said, I generally don't like to see the size of a DB2 subsystem's buffer pool configuration exceed half of the size of LPAR memory
  - If demand paging rate is in the mid single digits per second (or more), I'd be reluctant to increase the size of the buffer pool configuration
    - But you could increase size of BPx by decreasing size of BPy by same amount
- In DB2 data sharing group, increase in size of local buffer pool could require enlargement of corresponding group buffer pool

Buffer pool monitoring: data manager threshold

- Data manager threshold (DMTH) is reached when 95% of the buffers in a pool are unavailable (meaning, either in-use or holding changed pages that have not yet been externalized)
  - When DMTH is hit, DB2 does a GETPAGE for every row retrieved from a page in the pool – result can be big CPU utilization spike
- Usually, DMTH hit because buffer pool is too small
  - Another cause I've seen: horizontal, vertical deferred write thresholds are set too high for a pool dedicated to work file table spaces
    - Setting these thresholds higher for work file buffer pools than for other buffer pools is OK (work file pending writes don't affect DB2 restart time), and that can save some cycles, but don't overdo it

BP2 WRITE OPERATIONS	QUANTITY
DM THRESHOLD	0.00

More on buffer pools dedicated to work files

- Referring to sample report output below, you want zeros in all of these fields – if some are > 0, buffer pool probably too small
- Check statistics for the pool used for the 4K work file table spaces and the one used for the 32K work file table spaces

BP7 SORT/MERGE	QUANTITY
MERGE PASS DEGRADED-LOW BUF	0.00
WORKFILE REQ.REJCTD-LOW BUF	0.00
WORKFILE NOT CREATED-NO BUF	0.00
WORKFILE PRF NOT SCHEDULED	0.00

DB2 10 changed virtual storage for packages

- Starting with DB2 10:
  - Almost all thread-related package virtual storage above 2 GB "bar" *for packages bound or rebound in DB2 10 system*
  - Also, this virtual storage comes out of agent local pool, not the EDM pool
- Performance implications:
  - Eliminated latching related to use of EDM pool storage for copies of packages used by threads
  - Lots more virtual storage "head room" for using RELEASE(DEALLOCATE) to improve CPU efficiency
- Monitoring: no longer limited by EDM pool size, but as you use more virtual storage for packages (e.g., more use of RELEASE(DEALLOCATE)), watch system's demand paging rate
  - You want that to be in the low single digits (or less) per second

How many DB2 checkpoints?

- I generally like to see a DB2 checkpoint frequency of one every 5-10 minutes – some folks who want shorter DB2 restart times aim for a checkpoint every 2-5 minutes
  - You're balancing restart time versus overhead of checkpointing
  - The snippet below is from a Statistics Long report that spanned a 2-hour period, so 8 checkpoints works out to one every 15 minutes – that's a little less frequent than I'd like to see
  - Via ZPARMs, you can set checkpoint frequency in terms of minutes between checkpoints or log records written between checkpoints (or, starting with DB2 10, both – whichever limit is reached first)

```
SUBSYSTEM SERVICES                    QUANTITY
---------------------------           --------
SYSTEM EVENT CHECKPOINT                   8.00
```

What about pseudo-close activity?

- When a data set open for read/write goes for a pseudo-close interval without being updated, it's switched to read-only state (back to read/write at next data-changing SQL statement)
  - Pseudo-close interval determined via two ZPARMS: PCLOSEN (specifies a number of checkpoints) and PCLOSET (specifies a number of minutes) – interval is based on which limit is reached first
  - As with checkpointing, a balancing act: faster data recovery (with more pseudo-close activity) versus overhead of pseudo-close
  - My opinion: pseudo-close frequency of 20-40 per minute is reasonable
    - Value in report snippet below equates to 81 per minute – on high side
    - Higher pseudo-close rate could be OK if number of open data sets is multiple 10s of thousands

```
OPEN/CLOSE ACTIVITY                    /SECOND
---------------------------            -------
DSETS CONVERTED R/W -> R/O               1.35
```

RID list processing

- Prior to Version 10, if DB2 ran short on storage in processing a RID list, it reverted to table space scan for query being executed
  - Not good – if it was going to be a TS scan, you'd probably prefer for DB2 to do that from the get-go, vs. starting first down the RID list path
- DB2 10: much larger RID pool default size (400 MB) – if that's not enough, DB2 will process RID list using work file space
  - If you see RID processing overflow activity, may want to increase RID pool size (real storage resource permitting)

RID blocks are 32 KB apiece →

RID LIST PROCESSING	QUANTITY
MAX RID BLOCKS OVERFLOWED	0.00
CURRENT RID BLOCKS OVERFL.	0.00
OVERFLOWED-NO STORAGE	0.00
OVERFLOWED-MAX LIMIT	0.00

DBATs

- Snippet shows that during report period (two hours), there were almost 3 million times when a DBAT was needed to service a DRDA transaction, and DB2 had to create new DBAT 256 times
  - That's a very good use of pooled threads – helps CPU efficiency
  - If you saw more create DBAT activity and less pool DBAT reuse, might want to increase value of POOLINAC in ZPARM (number of seconds that a DBAT can be idle in the pool before being terminated)

```
GLOBAL DDF ACTIVITY                QUANTITY
---------------------------        --------
DBATS CREATED                        256.00
POOL DBATS REUSED                   2919.8K
```

More on DBATs

GLOBAL DDF ACTIVITY	QUANTITY
DBAT/CONN QUEUED-MAX ACTIVE	0.00
CONN REJECTED-MAX CONNECTED	0.00

If value in this field is non-zero, make MAXDBAT larger

If value in this field is non-zero, make CONDBAT larger

DB2 10 introduced high performance DBATs

- The report fields shown below indicate the use of high performance DBATs in the DB2 system
- "Regular" DBAT becomes a high performance DBAT when used to execute package bound with RELEASE(DEALLOCATE)
  - Conceptually similar to CICS-DB2 protected entry threads
- Note: high performance DBATs deplete supply of pooled DBATs
  - If you're going to use RELEASE(DEALLOCATE) for some DRDA-invoked packages, you might want to up the value of MAXDBAT in ZPARM

```
GLOBAL DDF ACTIVITY                    QUANTITY
-----------------------------          --------
CUR ACTIVE DBATS-BND DEALLC                0.00
HWM ACTIVE DBATS-BND DEALLC                0.00
```

If this number gets anywhere near your MAXDBAT value, increase MAXDBAT

DB2 address space CPU utilization

- Excerpt from report covering a 2-hour period in DB2 9 system
  - IRLM, DB2 system services address spaces use very little CPU time
  - Database services address space CPU time mostly related to database writes, prefetch reads (starting with DB2 10: these I/Os are zIIP-eligible)
  - DDF address space uses very little CPU time with respect to "system" tasks (TCB and non-preemptable SRB time)
  - CPU time associated with DDF preemptable SRBs is basically the cost of SQL execution for statements coming through DDF – just as SQL statement CPU time is charged to (for example) CICS regions

CPU TIMES	TCB TIME	PREEMPT SRB	NONPREEMPT SRB	PREEMPT IIP SRB
SYSTEM SVCS	12.646	0.000	2:03.883	N/A
DB SVCS	5:33.773	0.004	50:05.190	0.394
IRLM	0.003	0.000	21.245	N/A
DDF	1:02.659	3:13:21.699	2:10.283	2:55:43.179

Preemptable SRB time consumed on general-purpose engines, consumed on zIIPs

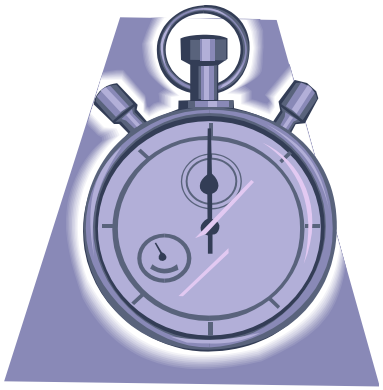
The best bits in DB2 and CICS DISPLAY command output

My favorite: -DISPLAY BUFFERPOOL

- My preferred form of the command:

  -DISPLAY BUFFERPOOL(ACTIVE) DETAIL

- My preferred way of using the command:
  - Issue the command during a busy time on the system
  - Wait an hour, and issue the command again
  - Take the output of the second issuance of the command, and divide activity numbers by 3600 to get per-second figures



-DISPLAY BUFFERPOOL output (abridged)

```
DSNB401I  -DB1P BUFFERPOOL NAME BP3, BUFFERPOOL ID 3, USE COUNT 121
DSNB402I  -DB1P BUFFER POOL SIZE = 40000 BUFFERS
             IN-USE/UPDATED  =       26   BUFFERS ACTIVE  =    40000
DSNB406I  -DB1P PGFIX ATTRIBUTE -
             CURRENT = NO (YES good for high-I/O pools - CPU savings)
             PENDING = NO
           PAGE STEALING METHOD = LRU (DB2 9: use FIFO for "pinned-object" pools;
DSNB404I  -DB1P THRESHOLDS -                DB2 10/11: NONE for pinned-object pools)
            VP SEQUENTIAL    = 80
            DEFERRED WRITE   = 50   VERTICAL DEFERRED WRT  = 10,  0
DSNB409I  -DB1P INCREMENTAL STATISTICS SINCE 10:00:08 JUN 28, 2010
DSNB411I  -DB1P RANDOM GETPAGE    = 26054523 SYNC READ I/O (R) =
623335 (A)
           SEQ.   GETPAGE    =  1253010 SYNC READ I/O (S) =    37095 (B)
(0 is good!) → DMTH HIT      =        0 PAGE-INS REQUIRED =        0
DSNB412I  -DB1P SEQUENTIAL PREFETCH -  (memory probably not under pressure)
             REQUESTS        =    28880   PREFETCH I/O    =     9229 (C)
DSNB413I  -DB1P LIST PREFETCH -
             REQUESTS        =        0   PREFETCH I/O    =        0 (D)
DSNB414I  -DB1P DYNAMIC PREFETCH -
             REQUESTS        =   158785   PREFETCH I/O    =    21123 (E)
```

Read I/Os per second = (A + B + C + D + E) / seconds in interval

-DISPLAY BUFFERPOOL output (continued)

If > 0, pool may be undersized

```
DSNB415I  -DB1P PREFETCH DISABLED -
             NO BUFFER       =         0   NO READ ENGINE  =         0
DSNB420I  -DB1P SYS PAGE UPDATES  =  2770777 SYS PAGES WRITTEN =
436472
            ASYNC WRITE I/O   =     17836 SYNC WRITE I/O    =        15
            PAGE-INS REQUIRED =         0
DSNB421I  -DB1P DWT HIT           =         0 VERTICAL DWT HIT  =
3373
```

Want most I/Os to be async (if most are sync, consider lowering DWQT, VDWQT)

(memory probably not under pressure)

If these thresholds not hit, or hit only a few times in an hour, consider lowering DWQT and/or VDWQT. If hit one or more times per second, consider increasing DWQT and/or VDWQT. Very low values here are OK if rate of buffer updates is very low. Very low values here also possible and OK if DB2 running in data sharing mode (changed paged are written to group buffer pools in coupling facilities at commit time).

An interesting form of -DISPLAY BUFFERPOOL

- -DISPLAY BUFFERPOOL(BPn) SERVICE(4)
  - Valid in a DB2 10 environment
  - You'd issue this form of the command for a buffer pool defined with PGFIX(YES), and output would include the following:

This option is not documented in the official DB2 manuals (it's mentioned in a couple of IBM redbooks)

```
DSNB999I  -DBP1 DSNB1DBP  SERVICE( 4 )OUTPUT
DSNB999I  -DBP1 4K PAGES 2344
DSNB999I  -DBP1 1M PAGES 6656
```

You won't find this message in the DB2 10 *Messages* manual

Unless fix for PI12512 is applied, buffers are backed by 1 MB frames in chunks of 6566

If 1 MB page frames are available in the LPAR, DB2 10 will request that they be used to back a PGFIX(YES) buffer pool – good for CPU efficiency

DB2 11, -DISPLAY BUFFERPOOL, 1 MB frames

- No need for funky-looking syntax with DB2 11
  - Just -DISPLAY BUFFERPOOL(BPn)
  - Output will include the following:

This message is documented in the DB2 11 *Messages* manual

This is the value specified for FRAMESIZE in -ALTER BUFFERPOOL command (new DB2 11 option), or the default (4K for PGFIX(NO) pool, 1M for PGFIX(YES) if 1M frames available)

```
DSNB546I  - PREFERRED FRAME SIZE 4K
          4000 BUFFERS USING 4K FRAME SIZE ALLOCATED
```

Actual allocation of pool's buffers with respect to size of page frames used (one DSNB546I message for each different frame size used)

-DISPLAY DDF DETAIL output (abridged)

```
DSNL080I  @ DSNLTDDF DISPLAY DDF REPORT FOLLOWS:
DSNL081I STATUS=STARTD
DSNL082I LOCATION           LUNAME            GENERICLU
DSNL083I ABCDE123           USATLGA.ABCDE123  -NONE
DSNL084I TCPPORT=446   SECPORT=0     RESPORT=5001  IPNAME=-NONE
DSNL085I IPADDR=::1.22.33.444
DSNL086I SQL    DOMAIN=prodmvs.demo.las.com
DSNL090I DT=A  CONDBAT=    200 MDBAT=  100
DSNL092I ADBAT=   1 QUEDBAT=       0 INADBAT=       0 CONQUED=       0
DSNL093I DSCDBAT=      0 INACONN=    0
DSNL099I DSNLTDDF DISPLAY DDF REPORT COMPLETE
```

With inactive DDF threads, number of client connections to DB2 can exceed number of active DBATs

Cumulative number of times (since last DB2 restart) that work had to wait for a DBAT to become available - if > 0, consider increasing MAXDBAT in ZPARM

Current number of queued connection requests

DSNC DISPLAY STATISTICS (CICS command)

```
DFHDB2014 07/09/98 14:35:45 IYK4Z2G1 Statistics report follows for RCTJT
accessing DB2 DB3A

                                                          -----COMMITS----
DB2ENTRY  PLAN      CALLS    AUTHS    W/P  HIGH    ABORTS  1-PHASE  2-PHASE
*COMMAND              1        1      1     1         0        0        0
*POOL     ********    4        1      0     1         0        2        0
XC05      TESTP05    22        1     11     2         0        7        5
XP05      ********    5        2      0     1         0        1        1
DFHDB2020 01/17/98 15:45:27 IYKA4Z2G1 The display command is complete.
```

Asterisks mean that dynamic plan allocation is used (I'm not big on that)

Indicates, for DB2ENTRY resources, the number of times transactions overflowed to the pool (assuming THREADWAIT(POOL) specified); for pool threads, indicates the number of times that transactions were queued up waiting for a thread

- *If > 0, may need to increase number of pool threads – and make sure that TCBLIMIT is sufficiently large in DB2CONN resource definition*

Important DB2-related stuff in z/OS monitor reports and displays

RMF CPU activity (abridged)

```
1                          C P U  A C T I V I T Y

z/OS V1R10          SYSTEM ID P01          START 05/24/2010-09.00.00
                 RPT VERSION V1R10 RMF     END   05/24/2010-11.00.00
-CPU  xxxx    MODEL  yyy   H/W MODEL  zzz
0---CPU---     ---------------- TIME % -------
 NUM   TYPE     LPAR BUSY     MVS BUSY
  0     CP      89.96          98.65
  1     CP      89.94          98.59
  2     CP      89.93          98.50
  3     CP      89.89          98.41
  4     CP      89.85          98.29
  5     CP      89.80          98.19
  6     CP      89.66          97.98
 TOTAL/AVG      89.86          98.37
0 7     IIP     45.39          45.45
  8     IIP     47.19          47.25
 TOTAL/AVG      46.29          46.35
```

- Higher zIIP utilization is good, because zIIP MIPS cost less than general-purpose MIPS, but don't let zIIP utilization get too high, or you could have significant amount of zIIP-eligible work running on general-purpose engines (may want to keep zIIP engine utilization under 60%)
- Some organizations looking to boost nighttime zIIP utilization are selectively binding batch packages with DEGREE(ANY) or using SYSQUERYOPTS catalog table for statement-level control of parallelization

RMF Summary Report (abridged)

```
1                    R M F   S U M M A R Y   R E P O R T

   z/OS  V1R10              SYSTEM ID P01              START 02/15/2010-08.30.00
                            RPT VERSION V1R10 RMF      END   02/15/2010-11.00.00
0
 NUMBER OF INTERVALS 5                 TOTAL LENGTH OF INTERVALS 02.29.57
-DATE    TIME      INT    CPU    DASD  DASD    SWAP  DEMAND
 MM/DD HH.MM.SS MM.SS   BUSY   RESP  RATE    RATE  PAGING
002/15 08.30.00 29.59   78.3    1.2 13191    0.00    2.65
 02/15 09.00.00 30.00   90.5    1.2 14783    0.00    3.89
 02/15 09.30.00 29.59   87.0    1.2 13327    0.00    1.42
 02/15 10.00.00 30.00   86.0    1.2 12542    0.00    1.46
002/15 10.30.00 29.59   88.3    1.2 13029    0.00    4.03
-TOTAL/AVERAGE          86.0    1.2 13375    0.00    2.69
```

- As noted previously, demand paging rate should be in the low single digits per second (or less)
- 4-6 per second is "yellow light" territory
- High single digits per second (or more): LPAR memory resource is under more pressure than you'd like – add memory or reduce memory consumption

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