Tuning Your DB2 Buffer Pools

How Much Memory do You Really Need?

Responsive Systems Company
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(732) 972-1261
How much memory do you need?

- The current “bar” on 64-bit machines
  - Maximum available today is 128 Gigabytes
  - It will go up…

- But, how much do you need for your system?
  - We always want more
  - We have always wanted more
  - We have always filled it up

- There are a “few” huge systems that may benefit from massive pool sizes
  - Nobody is going to push this current bar for a while
How much memory do you need?

- How much are you using now?
  - How much more do you think you need?

- Are you sure that more memory will provide better performance?

- We will see today that “more” does not always provide better performance
Who is on a 64-bit Machine now?

- DB2 V8 installed?
- DB2 V8 ordered?
- DB2 V8 Planned?
  - This year?
  - Next year?
  - Someday?
Will more memory help *You*?

- How can you find out?

- Play the guessing game…
  - Just throw it at the system and pools

- But will you get a real benefit?

- Measure before/after performance?
  - When will you measure it?
  - How will you measure it?
  - What is really important as a performance metric?
Buffer Pool Tool® for DB2

- Is the only product that can **Predict** the effect of changes to the most important tuning metric – the **I/O rate/second**
- Provides detailed statistical performance data
- Provides a **proven methodology** for pool tuning
- Shows you how to get it right the first time
- Leverage your system resources while improving performance
Buffer Pool Tool Components

- Collector
- Statistics
- Simulation
- Utilities
- PC Components
  - BPT Graphics
  - Coupling Facility sizing module
Buffer Pool Tool Components

DB2

Data Collector

OR

Proprietary Data Collection Facility

DASD

Does Not Use SMF or GTF

Tape
Buffer Pool Tool Components

- Analysis SubSystem
  - Reports
- DASD
- Tape
- Simulation SubSystem
  - Reports
  - Simulation/Prediction
    - BufferPool Level
    - Object Level

BufferPool Reports
Object Usage Reports
Collector

- Attaches to DB2 using the IFI interface, a standard supported component of DB2
- Starts traces, retrieves data, writes to its own highly blocked dataset
- Collects for a specific period, does not run all the time – yet you need volume for statistical accuracy
  - Small samples are not accurate (what do small and big mean?)
  - Combining many small samples with large time gaps violates approved statistical techniques
Statistics

- Shows you what happened
  - Overall system
  - Each pool
  - Each object within every pool

- Provides a level of information you cannot obtain from any other product
  - Highlights application access path problems
    - Yellow Freight....
    - Other Syspacklist index problem
Simulation - what will happen if...

- Predicts the effect of changes
  - Simple changes
    - Pool sizes
    - Pool thresholds
  - Complex changes (the keys for improving performance)
    - Moving objects into different pools
    - Moving objects into a new (non-existing) pool

- Predicts
  - I/O rate per second
  - Hit ratios, system and application
  - Object working set sizes (will be different at varying pool sizes)
  - Required Pool size/Memory requirements – best performance
You don’t make mistakes with your production system
  - Simple changes can be made by command and monitor the effect
    - Pool sizes
    - Pool thresholds
  - Complex changes require stop/alter/start the object, which requires an outage on that object
    - Moving objects into different pools
    - Moving objects into a new (non-existing) pool
    - The biggest tuning improvements come from re-grouping objects into pools, based on access type & working set size
    - Shows how objects will interact after changes

Simulation has a proven track record with our clients
Utilities Provide Added Benefit

- Application Analysis Facility
  - Plan/Authid

- Object Analysis
  - Object Name

- Connection Type Reporting

- Page Access Distribution Reports
BPTGraph Speeds the Analysis
Harness the power of the workstation

- Quick Analysis by System, Pool and Object
  - A picture is worth a thousand words..

- Top Ten/Worst Ten selections

- Cluster Analysis/Object Grouping

- Include/Exclude Object file generation
BPTGraph - Overall Summary Data
Quick graphic summary of pool performance
BPTGraph - shows pool usage
BPTGraph - shows sequential impactors

Many graphs from drop down menu
BPTGraph - shows object detail

This object lives in the pool
BPTGraph - shows I/O impactors

Not the same as the I/O Rate
BPTGraph - Object Detail Statistics

Click & Sort

Scroll data & Sort Column data
BPTGraph - Expert Tuning Suggestions

Pool Usage

- Sequential
- Random

Rule #10 - VP Sequential Threshold should not be > 25% for Random Pools
Rule #18 - HP should not cache Seq. Pages for a Random Pool. HPSEQT should be 0
Rule #31 - Avg. Synchronous I/O times too high > 22Ms
Rule #38 - Reduce the HPSEQT to favor the random access objects

Buffer Pool Stat Analysis - BP18
BPTGraph - shows I/O reduction/payback

50,000 buffers saves 10 I/O a Sec
BPTGraph - Hit Ratio is not a useful metric
BPTGraph - shows you the problem objects
### Buffer Pool Tool for DB2 - BP0

#### Collection

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Elapsed Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-03-01</td>
<td>10:05:30</td>
<td>00:15:48</td>
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#### System Info

<table>
<thead>
<tr>
<th>System</th>
<th>Sub System</th>
<th>DB2 Version</th>
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</thead>
<tbody>
<tr>
<td>NENT</td>
<td>NBP</td>
<td>7.1</td>
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#### Report Info

<table>
<thead>
<tr>
<th>Pool</th>
<th>I/O</th>
<th>Get Pages</th>
<th>Updates</th>
<th>Hit Ratio</th>
<th>RIO/Sec</th>
<th>WIO/Sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP0</td>
<td>86914</td>
<td>792976</td>
<td>60</td>
<td>77</td>
<td>91.65</td>
<td>0.0</td>
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<tr>
<td>BP2</td>
<td>2989001</td>
<td>20443958</td>
<td>76353</td>
<td>-18.6</td>
<td>3,122.22</td>
<td>30.0</td>
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<tr>
<td>BP3</td>
<td>1304487</td>
<td>16649309</td>
<td>112401</td>
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<tr>
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<td>619697</td>
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<td>7192</td>
<td>-63.1</td>
<td>651.08</td>
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<tr>
<td>BP7</td>
<td>41327</td>
<td>262998</td>
<td>23924</td>
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<td>37.85</td>
<td>5.0</td>
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<td>BP13</td>
<td>39</td>
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<td>88.3</td>
<td>0.03</td>
<td>0.0</td>
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<td>5701</td>
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<tr>
<td>BP32K</td>
<td>10560</td>
<td>82445</td>
<td>19188</td>
<td>84.7</td>
<td>9.29</td>
<td>1.0</td>
</tr>
</tbody>
</table>

#### Statistics

- **Total Read/Write I/O**: 5,058,562
- **Total Get Pages**: 41,120,768
- **Overall Sys Hit Ratio**: 17.50
- **Total Updates**: 462,311
- **Total I/Os per second**: 5,336.04
- **Pages per write**: 2.14

*Huge I/O rate*
BPTGraph

- Pool too small

Buffer Pool Tool for DB2 - BP0

Buffer Pool Info
Name: BP0
Objects: 34
VP Size: 2000
HP Size: 0
Cast Out: Y

Threshold
VPSEQT: 50
HPSEQT: 80
DWQT: 50
VDWQT: 10

Buffer Pool - BP0
Rid (0.3%)
Seq (12.2%)
Rnd (87.5%)

Access Type

Seq. Access: 96707
Rnd. Access: 693589
RID List: 2680
Total: 792,976
BPTGraph -

Pool too small
Pool too small
Pool too small, maybe other problems?
BPTGraph

Buffer Pool Tool for DB2 - BP2

Buffer Pool Info

<table>
<thead>
<tr>
<th>Name</th>
<th>Objects</th>
<th>VP Size</th>
<th>HP Size</th>
<th>Cast Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP2</td>
<td>232</td>
<td>19000</td>
<td>50000</td>
<td>Y</td>
</tr>
</tbody>
</table>

Total Get Pages: 2094085
Get Page Rand: 25199
Get Page Seq: 2068886
Get Page RidList: 0
Avg Synch IO (ms): 2.00

Pages Read Sync: 15199
Pages Read Seqpr: 2089942
Pages Read Listpr: 0
Pages Read Dynpr: 58461
Avg SP IO (Seq Pref): 4.00

App Hit Ratio: 99.3
System Hit Ratio: -3.3
Read IO Rate/sec: 86.93
Pages / Write: 1.61

Close
BPTGraph -

Buffer Pool Tool for DB2 - BP2

Buffer Pool Info
- Name: BP2
  - Objects: 232
  - VP Size: 19000
  - HP Size: 50000
  - Cast Out: Y

Threshold
- VPSEQT: 50
- HPSEQT: 50
- DWQT: 30
- VDWQT: 0

Report Info
- Total Get Pages: 1796540
- Get Page Rand: 30231
- Get Page Seq: 1732519
- Get Page RidList: 33790

Graphic Summary
- Pages Read Sync: 73449
- Pages Read Seqpr: 1606169
- Pages Read Listpr: 32738
- Pages Read Dynpr: 22024

Pool Info
- App Hit Ratio: 95.9
- System Hit Ratio: 3.5

Object Info
- Read IO Rate/sec: 133.57
- Pages / Write: 1.00

Expert Tuning

Close
BPTGraph - object BKPF

Synch I/O is 13x Random Access
BPTGraph - similar pool usage problem
BPTGraph - Another system

512,000 buffers overall, > 2 Gig of memory
BPTGraph - What’s happening here?

Surprise, surprise .... 4 million sequential access? > 10% of the whole system??
BPTGraph - Index on SYSPACKAGE
BPTGraph - Memory resident

- Total Get Pages: 3991395
- Get Page Rand: 0
- Get Page Seq: 3991395
- Get Page RidList: 0
- Pages Read Sync: 0
- Pages Read Seqpr: 0
- Pages Read Listpr: 0
- Pages Read Dynpr: 0
- Avg Synch IO (ms): 0.00
- Avg SP IO (Seq Pref): 0.00
- App Hit Ratio: 100
- System Hit Ratio: 100
- Read IO Rate/sec: 0.00
- Pages / Write: 0.00

Costing 6-8 Mips
BPTGraph - Big pool, dataspace

Buffer Pool Info

Name: BP1
Objects: 617
VP DS Size: 200000
HP DS Size: 0
Cast Out: Y

Threshold
VPSEQT: 10
HPSEQT: 0
DWQT: 1
VDWQT: 0

Buffer Pool - BP1

Seq (0.9%)
Rnd (99.1%)

Access Type

Seq. Access: 215036
Rnd. Access: 23726004
RID List: 0
Total: 23,941,040

All Indexes
BPTGraph - Reasonable payback?

5% reduction

50K buffers, saves 150 I/O sec
### BPTGraph - Another system.

#### Buffer Pool Tool for DB2

**Collection**

<table>
<thead>
<tr>
<th>Pool</th>
<th>I/O</th>
<th>Get Pages</th>
<th>Updates</th>
<th>Hit Ratio</th>
<th>R/O/Sec</th>
<th>W/O/Sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP0</td>
<td>5295</td>
<td>625794</td>
<td>2344</td>
<td>97.3</td>
<td>1.34</td>
<td>0.0</td>
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<tr>
<td>BP1</td>
<td>129690</td>
<td>521373</td>
<td>116586</td>
<td>-76.2</td>
<td>30.69</td>
<td>5.0</td>
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<tr>
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<td>148</td>
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<td>327360</td>
<td>100</td>
<td>0.04</td>
<td>0.0</td>
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<td>549991</td>
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<td>306689</td>
<td>44.4</td>
<td>136.81</td>
<td>16.0</td>
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<td>22.0</td>
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<td>8.70</td>
<td>1.0</td>
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<td>0.0</td>
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<td>55189</td>
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<td>32.72</td>
<td>3.0</td>
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<td>BP32K</td>
<td>4</td>
<td>31</td>
<td>16</td>
<td>103.2</td>
<td>0.00</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**System Info**

- **System**: APB2
- **Sub System**: DPR1
- **DB2 Version**: 7.1

**Summary**

- Total Read/Write IO: 2,042,461
- Total Get Pages: 44,618,834
- Overall Sys Hit Ratio: 58.83
- Total I/Os per second: 568.30
- Total Updates: 4,266,813
- Pages per write: 3.16
BPTGraph -.. Where’s the problem?

<table>
<thead>
<tr>
<th>Buffer Pool Info</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>BP3</td>
</tr>
<tr>
<td>Objects</td>
<td>550</td>
</tr>
<tr>
<td>VP Size</td>
<td>25000</td>
</tr>
<tr>
<td>HP Size</td>
<td>100000</td>
</tr>
<tr>
<td>Cast Out</td>
<td>Y</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Threshold</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>VPSEQT</td>
<td>80</td>
</tr>
<tr>
<td>HPSEQT</td>
<td>50</td>
</tr>
<tr>
<td>DWQT</td>
<td>25</td>
</tr>
<tr>
<td>VDWQPT</td>
<td>5</td>
</tr>
</tbody>
</table>

Buffer Pool - BP3

- RID (0.7%)
- Seq (14.5%)
- Rnd (84.7%)

Access Type

- Seq. Access    | 1485632  |
- Rnd. Access    | 8666704  |
- RID List       | 76100    |
- Total          | 10,228,436 |
BPTGraph - Where’s the problem?

Buffer Pool Info
- Name: BP3
- Objects: 550
- VP Size: 25000
- HP Size: 100000
- Cast Out: Y

Threshold
- VPSEQT: 80
- HPSEQT: 50
- DWQT: 25
- VDWQT: 5

Buffer Pool - BP3
Top Sequential Access * 1K

Top Sequ. A
- DLNSMO01.TAD20LNS
- DLNSED01.TRP10LNS
- DLNSLA01.TAD20LNS
- DLNPA01.TAP10LNO
- DDDLPA01.TSV10DDL
- DLNSMO01.TRP10LNS
- DDLMO01.TSV10DDL
- DLNSED01.TAD20LNS
- DDDLMO01.TLN40DDL
- DCMOMO01.TWQ30CMM
BPTGraph - Some small gain
### BPTGraph - Last system example

#### Collection

<table>
<thead>
<tr>
<th>Date</th>
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<tbody>
<tr>
<td>Time</td>
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<tr>
<td>Elapsed Time</td>
<td>00:58:09</td>
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</table>

#### System Info

<table>
<thead>
<tr>
<th>System</th>
<th>SYS1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub System</td>
<td>DB01</td>
</tr>
<tr>
<td>DB2 Version</td>
<td>7.1</td>
</tr>
</tbody>
</table>

#### Report Info

<table>
<thead>
<tr>
<th>Pool</th>
<th>I/O</th>
<th>Get Pages</th>
<th>Updates</th>
<th>Hit Ratio</th>
<th>RIO/Sec</th>
<th>WIO/Sec</th>
<th>Pages/Write</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP0</td>
<td>627</td>
<td>8085</td>
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<td>-76.9</td>
<td>23.37</td>
<td>0.09</td>
<td>4.47</td>
</tr>
</tbody>
</table>

#### System Info

- Total Read/Write I/O: **1,623,452**
- Total Get Pages: **25,436,064**
- Overall Sys Hit Ratio: **72.64**
- Total I/Os per second: **465.31**
- Total Updates: **1,595,929**
- Pages per write: **2.47**
BPTGraph - Last system example

Buffer Pool Info
- Name: BP2
- Objects: 185
- VP Size: 17000
- HP Size: 45000
- Cast Out: Y

Threshold
- VPSEQT: 80
- HPSEQT: 80
- DWQT: 10
- VDWQT: 0

Buffer Pool - BP2
- Seq (61.4%)
- Rnd (34.1%)
- RID (4.5%)

Access Type

Seq. Access
3869581
Rnd. Access
2149963
RID List
206201
Total
6,305,745
### Buffer Pool Info

<table>
<thead>
<tr>
<th>Name</th>
<th>Objects</th>
<th>VP Size</th>
<th>HP Size</th>
<th>Cast Out</th>
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</thead>
<tbody>
<tr>
<td>BP2</td>
<td>185</td>
<td>17000</td>
<td>45000</td>
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</table>

### Threshold

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPSEQT</td>
<td>80</td>
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<tr>
<td>HPSEQT</td>
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<tr>
<td>DWQT</td>
<td>10</td>
</tr>
<tr>
<td>VDQWT</td>
<td>0</td>
</tr>
</tbody>
</table>

**Buffer Pool - BP2**

**Top Sequential Access * 1K**

- BSIS.BSIS
- LFA1.LFA1
- VBRK.VBRK
- BTAB16.SBTAB16
- BSIP.BSIP
- AUFK.AUFK
- COSP.COSP
- T800S.T800S
- ZDT#FMS.ZDT#FMS
- BTAB04.SBTAB04
BPTGraph - Just add some memory?

Memory will help....
BPTGraph - Better Performance

Same or less memory.....

Moving the objects provides a much larger gain
BPTGraph - Better Performance

By moving the 2 large SPs
The proper grouping of objects into pools is the proven approach for optimizing the memory/performance trade-off.

Prediction/Simulation shows the benefits of proper grouping, both for I/O reduction, and for Hit Ratio.

Cluster Analysis shows you which objects belong together, and which should be moved out of a pool.
Buffer Pool Tuning Steps

- Select your busy periods
  - Monitor performance, keep performance history
    - Both system and application
- Collect performance data
- Evaluate statistics, use BPTGraph to highlight the pools with highest I/O rates
- Identify the objects causing the most I/Os
  - Simulate pool size changes, use BPTGraph to evaluate both size changes, and moving objects to different pools
  - Implement changes that provide the greatest benefit
    - Monitor performance, compare to original system & application performance
Benefits

- Reduced transaction response times
  - Average of 15% across the client base
- Reduced batch elapsed times
  - In some cases, more than an hour
- Improved client and user productivity
- Saves CPU $$ through I/O elimination
- Better usage of memory resources
- Highlights application problems not shown by other products
Buffer Pool Tool  Benefits

- Provides the only proven methodology for pool tuning
- Removes the guesswork
- Helps educates your staff
- Helps leverage your people resources
  - Time is money
Buffer Pool Tool will Help You...

- Leverage your costly Hardware investments
- Optimize your performance from available resources
- Improve service to your internal and external clients
- Reduced online response times provide
  - Improved productivity – cost savings
  - Clients get a better impression of the corporation
    - A better impression provides more long term growth and profitability
CPU Saving from I/O Elimination

The chart shows the cost savings in CPU from I/O elimination across different CPU minutes and I/O seconds. The y-axis represents the cost in $1,000,000, while the x-axis represents the CPU minutes and I/O seconds. The bars indicate the cost savings for $15, $20, and $25 CPU minutes, with different colors for 10, 25, 40, and 60 I/O seconds.
Buffer Pool Tool

- Does not try to be everything to everybody
- Helps you learn about your system & applications
- Helps you learn about DB2 performance
- Expert tuning is based upon accepted thresholds, and the performance of your system
- Shows you the underlying reasons for things, and helps you make the best performance choices
Coupling Facility Sizing Module

- Imports Statistics from multiple systems
- Provides the Initial Sizings for all CF Structures
- New sizings when planning to add another member

Included component of Buffer Pool Tool
Buffer Pool Optimizer

- Automates the simulation/prediction process
- Optimize performance for pools or objects
- Generates the statements to move objects, set thresholds, and number of buffers
- Optimizes for three performance periods
- Provides sets of control statements to change pool sizes and thresholds for different performance periods
  - Online vs batch
Summary

- Proven Solution, the industry standard for years
- Real client base, with client references *you can actually speak with…*
- Clients with measured performance improvements
- Clients that will talk about their cost savings
- Running on DB2 V8 right now, we have worked on every version prior to GA.
Caution for the future….

- Don’t be fooled and think that the need for tuning will go away with 64-bit processors and large memory

- Throwing memory at DB2 and pools does not get rid of performance problems
Questions?

What additional information can I provide?

Is there anything else you would like to see?