DB2 Performance Tuning
Using Omegamon DB2 Performance Expert
- Use Case Examples and Practical Applications

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2013 Feb. 5
Session Number 12693
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Session Objectives and Agenda

• Objectives:
  • Provides the first step of understanding the most important DB2 traces - accounting and statistics
  • Using batch report from **IBM Tivoli OMEGAMON XE for DB2 Performance Expert on z/OS** (OMPE), examine real case studies

• Agenda
  • Part I : DB2 trace basics
    • Statistics and Accounting traces
    • From workload to thread level
  • Part II : Case studies
    • Examples : How to use DB2 traces to tune the DB2 applications
Which DB2 applications that you want to focus?
- RMF Workload activity report
- DB2 accounting trace (connection type)

Within the workload, which packages spend most CPU or elapsed time?
• **PART I**
  • Most Important DB2 Traces - Accounting and Statistics
  • OMPE support on Aggregated Accounting in Statistics
  • Creating Effective Accounting Reports
  • Case Study (1) – DB2 CPU Increase at Migration

• **PART II**
  • Case Study (2) – Sync I/O Wait
  • Case Study (3) – DB2 CPU Increase
  • Case Study (4) – Page Latch Contention
  • Case Study (5) – Page Latch Contention
  • Case Study (6) – Monitoring accelerated queries using IDAA

Complete your sessions evaluation online at SHARE.org/SFEval
Case Study (1)  Top Down Analysis -1

One Hour DB2 CPU Usage

CPU time in second

- CICS
- DB2 call
- RRS
- TSO
- Utility
- DB2 addr(non zIIP)
- DB2 addr(zIIP)
- DRDA

After

Before
Case Study (1)  Top Down Analysis -2

- OMPE:
  ACCOUNTING REPORT  REPORT LAYOUT(SHORT) ORDER(PROGRAM)

<table>
<thead>
<tr>
<th>Package</th>
<th>Occurrence</th>
<th>CPU</th>
<th>Total CPU</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB2PROD.aaaa.package1</td>
<td>59</td>
<td>163.000</td>
<td>9617.000</td>
</tr>
<tr>
<td>DB2PROD.aaaa.package2</td>
<td>15464</td>
<td>0.020808</td>
<td>321.775</td>
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<tr>
<td>DB2PROD.aaaa.package3</td>
<td>37263</td>
<td>0.004912</td>
<td>183.036</td>
</tr>
<tr>
<td>DB2PROD.aaaa.package4</td>
<td>96409</td>
<td>0.00189</td>
<td>182.213</td>
</tr>
<tr>
<td>DB2PROD.aaaa.package5</td>
<td>164</td>
<td>0.996136</td>
<td>163.366</td>
</tr>
<tr>
<td>DB2PROD.aaaa.package6</td>
<td>96</td>
<td>1.660326</td>
<td>159.391</td>
</tr>
<tr>
<td>DB2PROD.aaaa.package7</td>
<td>334</td>
<td>0.426137</td>
<td>142.330</td>
</tr>
<tr>
<td>DB2PROD.aaaa.package8</td>
<td>61</td>
<td>2.231446</td>
<td>136.118</td>
</tr>
<tr>
<td>DB2PROD.aaaa.package9</td>
<td>51</td>
<td>1.738584</td>
<td>88.668</td>
</tr>
<tr>
<td>DB2PROD.aaaa.package10</td>
<td>11</td>
<td>7.44109</td>
<td>81.859</td>
</tr>
<tr>
<td>DB2PROD.aaaa.package11</td>
<td>208</td>
<td>0.359636</td>
<td>74.804</td>
</tr>
<tr>
<td>DB2PROD.aaaa.package12</td>
<td>204</td>
<td>0.348851</td>
<td>71.165</td>
</tr>
</tbody>
</table>
Case Study (1) Top Down Analysis -3

One Hour DB2 CPU usage

- After
- Before

CPU time (second)

CICS
DB2 call
DRDA
DRDA-AP issue
RRS
TSO
Utility
DB2 addr(non zIIP)
DB2 addr(zIIP)
DB2 Accounting and Statistics

- **Statistics (SMF 100, 102)**
  - DB2 Subsystem level
    - How many DML, getpage, lock, etc per second in the DB2 member
    - Interval base
    - CLASS 1,2,3,4,5,6,8,9
    - Recommend CLASS(*)

- **Accounting (SMF 101)**
  - DB2 Thread level
    - How much CPU the thread consumed
  - CLASS 1,2,3,4,5,6,7,8,10
    - Recommend Class(1,2,3,7,8)
Statistics Trace & Report

- Statistics trace is a prime indicator of system status and performance

- Address space CPU time
  - TCB and SRB time for
    - MSTR, DBM1, IRLM, DDF
  - zIIP time under address space

- Workload at system level
  - DML/DDL activities
  - Locking activities
  - DB2 latches
  - Log activities
  - Plan/Package
  - DRDA activities
  - Open/Close

- Pools/Storage usage
  - EDM pools
  - RID pool
  - Statement cache
  - Local Buffer pools
  - Group buffer pools
  - Workfile usage
  - Authorization cache
  - Virtual and real storage usage
  - zOS metrics
Statistics Monitoring - Best Practices

- Statistics Interval – STATIME
  - DB2 9 default 5 min
  - DB2 10 1 minute for basic statistics
- Statistics overhead
  - Negligible cpu cost
- Best practices and Rules of thumbs based on DB2 statistics can be found…
  - https://www.ibm.com/developerworks/data/bestpractices/db2zos/
What is recorded in DB2 Accounting Trace?

Almost everything you want to know about the DB2 thread

- Elapsed time
  - Nested and non nested
- CPU time
  - GP and zIIP/zAAP
- Wait time
- DML activities
- DDL activities
- Local and Global Lock activities

- Local buffer pools
- Group buffer pools
- DRDA information
- LOG activities
- Data Capture
- Dynamic Statements
- Query Parallelism
- Sproc, Triggers, UDF
- LOB and XML

- Note: zIIP CPU times reported in DB2 traces are normalized to the speed of the general purpose processors
DB2 Accounting Trace

- To Start
  - STA TRA(ACCTG) .... Or at DB2 startup SMFACCT in ZPARM

- IFCIDs
  - IFCID 3 – plan level info
  - IFCID 239 – package level info

- Accounting Trace classes
  - Class 1 – total time (elapsed and CPU) – IFCID 3
  - Class 2 – time in DB2 (elapsed and CPU) – adds info to IFCID3
  - Class 3 – suspension time in DB2 – adds info to IFCID 3
  - Class 7 – package info (similar to class 2)
  - Class 8 – package info (similar to class 3)
  - Class 10 – package detail SQL/locking/BP info at package level
Notes: DB2 Accounting data is written at

- Thread deallocation (including abends)
- (re)signon in case of thread reuse by IMS/CICS
  - ACCOUNTREC (UOW / TASK) in DB2ENTRY for CICS
- At commit for RRS threads using accounting-interval COMMIT on signon/ auth signon / context signon
- At commit when CMTSTAT=INACTIVE and provided connection can go inactive
  - JCC applications: same packages (i.e SYSLN200)
    - to identify a specific JDBC transaction/application, accounting strings need to be set.
    - setDB2ClientAccountingInformation
    - db2.jcc.accountingInterval=COMMIT in DB2JccConfiguration.properties
  - Things that prevent a connection from going inactive:
    - Touched a package that uses Keepdynamic(yes)
      - If only reason for not going inactive is the use of keepdynamic(yes), still cut acctg (and reset enclave)
    - Active DGTT (not explicitly or implicitly dropped)
    - Open cursor with hold
    - Held LOB locator
Notes: How To Set Client Information

- Ease of analysis
  - PLANNAME: db2jcc_a if you do not set client info set

- Java methods for existing Set Client Information API
  - setClientUser(zheng)
  - setClientWorkStation(CL01)
  - setClientApplicationInformation(payment)
  - setClientAccountingInformation(String)

- WebSphere Application Server before V6.0
  - Only settable as DB2 DataSource property
  - limited because information can not be changed dynamically

- WebSphere Application Server Version 6.0 supports explicit and implicit setting of client information
  - Example how to call explicitly
    - WSConnection conn = (WSConnection) ds.getConnection();
    - props.setProperty(WSConnection.CLIENT_ID, "user123");
    - conn.setClientInformation(props);
  - Example how to call implicitly by turning on WebSphere Trace Group
    - WAS.clientinfo=all=enabled or
    - WAS.clientinfopluslogging=all=enabled
DB2 Traces and Overhead

- DB2 Statistics: Negligible
- DB2 Accounting: CPU Typically less than 5%
  - Class 1: less than 5% CPU overhead
  - Class 2: 1 to 10% CPU overhead, typically less than 5%
    - Class 2 accounting (SQL statement level)
      - Can be higher for fetch-intensive applications, up to 20%
      - V8 multi-row Fetch can make this overhead negligible
  - Class 3: less than 1% CPU overhead
    - Much higher than 1% cpu overhead for class 3 acctg has been observed in a rare situation of very high internal DB2 latch contention rate, eg over 10000/sec.
  - Class 7 and 8 (Package): less than 1-3% cpu overhead,
  - Class 10 (Package Detail): 2-5% overhead
CPU time and Trace / Monitor Products

• One of the most common reason of CPU degradation in many DB2 performance PMRs
• Suspect trace / Monitoring overhead if you see 2-3x CPU increase without access path change
• Be aware what traces are on in your system by display trace command

• Minimize orphaned trace records
  • Orphaned traces because monitoring (eg vendor tool) stopped but not DB2 trace. The same CPU overhead as monitoring is on.
  • DB2 tries to eliminate orphaned trace records
• How can you tell CPU usage without your online monitoring?
  • Batch reporting
  • RMF Workload activity report

Statistics - from a customer

<table>
<thead>
<tr>
<th>IFC DEST</th>
<th>Written</th>
<th>Not written, Not accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMF</td>
<td>6306K</td>
<td>0</td>
</tr>
<tr>
<td>OP1</td>
<td>7851K</td>
<td>11199</td>
</tr>
<tr>
<td>OP6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>OP7</td>
<td>0</td>
<td>6304K</td>
</tr>
<tr>
<td>OP8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
How to connect RMF and DB2 accounting-1?

RMF Workload Activity Report for 6 mins

<table>
<thead>
<tr>
<th>-TRANSACTIONS-</th>
<th>TRANS-TIME</th>
<th>HH.MM.SS.TTT</th>
<th>--DASD I/O--</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AVG</td>
<td>413.87</td>
<td>ACTUAL</td>
<td>69</td>
<td>SSCHRT</td>
<td>54643</td>
</tr>
<tr>
<td>MPL</td>
<td>413.87</td>
<td>EXECUTION</td>
<td>69</td>
<td>RESP</td>
<td>7.0</td>
</tr>
<tr>
<td>ENDED</td>
<td>2222178</td>
<td>QUEUED</td>
<td>0</td>
<td>CONN</td>
<td>0.1</td>
</tr>
<tr>
<td>END/S</td>
<td>5995.48</td>
<td>R/S AFFIN</td>
<td>0</td>
<td>DISC</td>
<td>6.7</td>
</tr>
<tr>
<td>#SWAPS</td>
<td>0</td>
<td>INELIGIBLE</td>
<td>0</td>
<td>Q+PEND</td>
<td>0.1</td>
</tr>
<tr>
<td>EXCTD</td>
<td>0</td>
<td>CONVERSION</td>
<td>0</td>
<td>IOSQ</td>
<td>0.0</td>
</tr>
<tr>
<td>AVG ENC</td>
<td>413.87</td>
<td>STD DEV</td>
<td>226</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Accounting Report for 6 mins

Transaction Rate 5995 trx/sec

Transaction response time 69 ms

<table>
<thead>
<tr>
<th>HIGHLIGHTS</th>
<th>AVERAGE</th>
<th>APPL (CL.1)</th>
<th>DB2 (CL.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>#OCCURRENCES</td>
<td>2107173</td>
<td>0.068947</td>
<td>0.067564</td>
</tr>
<tr>
<td>#NORMAL TERMINAT</td>
<td>2107173</td>
<td>0.001749</td>
<td>0.000700</td>
</tr>
<tr>
<td>#COMMENTS</td>
<td>2105049</td>
<td>0.066852</td>
<td>0.066852</td>
</tr>
<tr>
<td>#ROLLBACKS</td>
<td>2158</td>
<td>0.000346</td>
<td>0.000012</td>
</tr>
<tr>
<td>SYNCH I/O AVG.</td>
<td>0.008253</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Complete your sessions evaluation online at SHARE.org/SFEval
How to connect RMF and DB2 accounting -2?

RMF Workload Activity Report for 6 mins

- SERVICE TIME ---APPL %---
  - CPU 3630.475  CP 979.51
  - SRB 0.000  AAPCP 0.00
  - RCT 0.000  IIPCP 578.75
  - IIT 0.000
  - HST 0.000  AAP N/A
  - AAP N/A  IIP N/A
  - IIP N/A

- TRANSACTIONS -
  - AVG 413.87
  - MPL 413.87
  - ENDED 2222178
  - END/S 5995.48

- NUMBER OF ACTIVE DBATS    414.26

Transaction CPU time 1.6 ms

Accounting and Statistics Report for 6 mins

- AVERAGE APPL(CL.1)
  - -------------- --------------
  - CP CPU TIME 0.001598
  - AGENT 0.0001598
  - NONNESTED 0.000240
  - STORED PRC 0.001342
  - UDF 0.000016
  - TRIGGER 0.000000
  - PAR. TASKS 0.000000
  - SECP CPU 0.000956

- Eligible zIIP offload rate  59%

Statistics – DBM1

- NUMBER OF ACTIVE DBATS 414.26

- SECP / CP CPU 0.000956 / 0.001598 =59%

# of Concurrent Threads 414
Reducing Volumes of Accounting Traces

• Accounting roll-up for RRS and DDF
  • Aggregating accounting data for the same values of the client-side identifiers (end user ID, end user transaction/application name, end user workstation name)
    • zparm ACCUMUID controls which combination of IDs is used
    • zparm ACCUMACC controls when the aggregated accounting records are externalized – default 10
  • DB2 10 add roll up support for package Accounting
• DB2 10 Compression of SMF records
  • zparm SMFCOMP ON (default OFF)
  • Requires decompression support from monitoring products
  • DB2 supplies DSNTSMFD to decompress DB2 traces
  • Small overhead (1%) with great compression ratio (60-80%)
New Accounting in Statistics Support

• DB2 APAR PM62797
  • Supports aggregation of accounting data into statistics report
  • Collect IFCID3 and IFCID369 (or statistics class 9)
• OMPE V511 APAR PM72949
  • Statistics formatter can publish aggregated accounting data
  • Statistics aggregate CPU/Elapsed time info into statistics trace
### Aggregated Accounting in Statistics (OMPE example)

<table>
<thead>
<tr>
<th>CONNTYPE</th>
<th>CL1 ELAPSED</th>
<th>CL1 CPU</th>
<th>CL1 SE CPU</th>
<th>CL2 ELAPSED</th>
<th>CL2 CPU</th>
<th>CL2 SE CPU</th>
<th>CL3 SUSP</th>
<th>THREADS</th>
</tr>
</thead>
<tbody>
<tr>
<td>BATCH</td>
<td>1:14.326062</td>
<td>8.882753</td>
<td>0.000000</td>
<td>1:14.234073</td>
<td>8.879979</td>
<td>0.000000</td>
<td>1:05.997069</td>
<td>3.00</td>
</tr>
<tr>
<td>CICS</td>
<td>N/P</td>
<td>N/P</td>
<td>N/P</td>
<td>N/P</td>
<td>N/P</td>
<td>N/P</td>
<td>N/P</td>
<td>0.00</td>
</tr>
<tr>
<td>DDF</td>
<td>1:23:47.54247</td>
<td>4:02.519462</td>
<td>0.000000</td>
<td>1:11:52.05797</td>
<td>2:33.206501</td>
<td>0.000000</td>
<td>1:07:58.67980</td>
<td>221.0K</td>
</tr>
<tr>
<td>IMS</td>
<td>N/P</td>
<td>N/P</td>
<td>N/P</td>
<td>N/P</td>
<td>N/P</td>
<td>N/P</td>
<td>N/P</td>
<td>0.00</td>
</tr>
<tr>
<td>RRSAF</td>
<td>1:40:13.74934</td>
<td>1:46.557250</td>
<td>0.000000</td>
<td>1:11:53.96995</td>
<td>1:09.962190</td>
<td>0.000000</td>
<td>1:10:43.87768</td>
<td>110.1K</td>
</tr>
<tr>
<td>UTILITY</td>
<td>27:27.200715</td>
<td>9:09.367476</td>
<td>0.000000</td>
<td>9:54.465831</td>
<td>6:40.422900</td>
<td>0.000000</td>
<td>1:30.511908</td>
<td>16.00</td>
</tr>
</tbody>
</table>

### CPU Times

<table>
<thead>
<tr>
<th>SERVICE DESCRIPTION</th>
<th>CPU TIMES</th>
<th>TCB TIME</th>
<th>PREEMPT SRB</th>
<th>NONPREEMPT SRB</th>
<th>TOTAL TIME</th>
<th>PREEMPT IIP SRB</th>
<th>/COMMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYSTEM SERVICES ADDRESS SPACE</td>
<td>0.311114</td>
<td>5.912448</td>
<td>0.020002</td>
<td>6.243564</td>
<td>N/A</td>
<td>0.000019</td>
<td></td>
</tr>
<tr>
<td>DATABASE SERVICES ADDRESS SPACE</td>
<td>6.097576</td>
<td>48.396869</td>
<td>0.697035</td>
<td>55.191480</td>
<td>0.000000</td>
<td>0.000166</td>
<td></td>
</tr>
<tr>
<td>IRLM</td>
<td>0.000108</td>
<td>0.000000</td>
<td>0.296435</td>
<td>0.296543</td>
<td>N/A</td>
<td>0.000001</td>
<td></td>
</tr>
<tr>
<td>DDF ADDRESS SPACE</td>
<td>0.056293</td>
<td>4:15.98835</td>
<td>11.350365</td>
<td>4:27.395008</td>
<td>0.000000</td>
<td>0.000803</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>6.465091</td>
<td>5:10.297667</td>
<td>12.363837</td>
<td>5:29.126594</td>
<td>0.000000</td>
<td>0.000988</td>
<td></td>
</tr>
</tbody>
</table>
Find Focus Area – Top Consumers

- This gives you a big picture of your DB2 activities
- To produce this information:
  - Aggregated accounting in statistics by CONNTYPE, or
  - OMPE batch report
    ACCOUNTING REPORT ORDER(CONNTYPE)
How To Narrow Down Plan/Package Level?

- OMPE ACCOUNTING FILE or SAVE-FILE to create input data for,
  - Performance Warehouse
    - ACCOUNTING FILE or Save-File
    - LOAD into DB2 Performance table
    - Query from the tables
  - Spreadsheet input generator: PM73732 (Dec. 2012)
    - ACCOUNTING FILE or Save-File
    - Spreadsheet Input Data Generator Utility to create CSV format
    - Imported into spreadsheets
- OMPE batch ACCOUNTING report generation
Creating Effective Accounting Report

- Filter input data using INCLUDE, EXCLUDE
  - By connection INCLUDE(CONNTYPE(DRDA))
  - By authid INCLUDE(AUTHID(DB2USR1))
- Reduce to cover the specific time using REDUCE
  - Example: Reports for every hour from 8:30 to 12:00
    REDUCE FROM (,08:30) TO (,12:00)
    INTERVAL (60) BOUNDARY (60)
    REPORT FROM (,08:30) TO (,12:00)
- TOP processing
  - Example: Top 10 occurrences of highest DB2 CPU usage
    ACCOUNTING TRACE TOP (10 ONLY INDB2PT)
Notes : TOP Processing

• Useful TOP keywords
  • INAPPLET(cl1 elapsed)
  • INDB2ET (cl2 elapsed)
  • INAPPLPT(cl1 CPU)
  • INDB2PT(cl2 CPU)
  • INDB2WT(wait in DB2)
  • TOTSUSTM(class3)
  • DMLSTATS(DML)
  • UPDPERCM (Update/Insert/Del)
  • TOTSUSP(class3 events)
  • NOTACCT(not account)
  • GETPATES(getpages)
  • BUFUPDTS(buffer updates)
  • SYNCREAD(sync read events)
Case Study (1) Top Down Analysis -3

One Hour DB2 CPU usage

- After
- Before

CPU time (second)

- CICS
- DB2 call
- DRDA
- DRDA-AP issue
- RRS
- TSO
- Utility
- DB2 addr(non zIIP)
- DB2 addr(zIIP)
How Do You Determine Access Path Issue or Not from Accounting Trace?

- Primary indicators in accounting traces
  - Number of SQL statements and rows fetched
  - Number of get pages
- Verify access path information
- Example..

<table>
<thead>
<tr>
<th></th>
<th>Package A – Bad</th>
<th>Package A – Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL7 Elapsed</td>
<td>247 sec</td>
<td>20 sec</td>
</tr>
<tr>
<td>CL7 CPU</td>
<td>163 sec</td>
<td>6 sec</td>
</tr>
<tr>
<td>SQL STMT</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>DB2 Entry/Exit</td>
<td>360</td>
<td>360</td>
</tr>
<tr>
<td>GETPAGES</td>
<td>1636K</td>
<td>1453</td>
</tr>
</tbody>
</table>
Notes:  Once Access Path Issue Confirmed

• Make sure optimizer does have enough information – RUNSTATS should be up to date to find the right filter factors

• Collect information
  • Service SQL information (DDL, Catalog statistics information, explain tables)

• Use plan management (PLANMGMNT) for static applications, hint (static/dynamic) to correct access path.

• Consider DB2 10 APPREUSE(ERROR)
Methods for capturing documentation for all releases is documented here

- OSC and DB2PLI8 do not support DB2 10

**YSPROC.ADMIN_INFO_SQL** supports V8 -> V10 *(Required)*

- Excellent developerWorks article here:
- It is installed in V10 base and is subject to the installation verification process
  - DB2HLQ.SDSNSAMP(DSNTESR) will create and bind it
  - calling program is DSNADMSB, and sample JCL in DSNTEJ6I
  - Ensure DB2 9 and DB2 10 have APAR PM39871 applied

**Data Studio V3.1** incorporates this procedure into a GUI *(Best Practice)*

- No charge product, replacement for OSC and Visual Explain
- Several versions:
  - *DBA’s should download the Administration Client*
  - Incorporates Statistics Advisor
  - FTP doc directly to DB2 Level 2
  - Can be used to duplicate stats in TEST environment
• PART I
  • Most Important DB2 Traces - Accounting and Statistics
  • OMPE support on Aggregated Accounting in Statistics
  • Creating Effective Accounting Reports
  • Case Study (1) – DB2 CPU Increase at Migration

• PART II
  • Case Study (2) – Sync I/O Wait
  • Case Study (3) – DB2 CPU Increase
  • Case Study (4) – Page Latch Contention
  • Case Study (5) – Page Latch Contention
  • Case Study (6) – Monitoring accelerated queries using IDAA
Accounting Class 1,2,3 and 7,8

- thread allocation
- 1st SQL
- 2nd SQL
- thread deallocation

Class 1 elapsed and CPU
Class 2 elapsed and CPU
Class 3 Suspensions

Out of DB2
In DB2

Class 7 and 8 is used for package scope reporting. It is equivalent to Class 2 and 3.
What If Activity Time Is Split as …

Class1 : Class2

In DB2
Out of DB2

Class1 : Class2

In DB2
Out of DB2

Class2 CPU : Class3

CPU
Wait time

Class2 CPU : Class3

CPU
Wait time
### Case Study (2) Sync I/O Wait -1

<table>
<thead>
<tr>
<th>MARKET#0</th>
<th>AVERAGE TIME</th>
<th>AVG.EV</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCK/LATCH</td>
<td>0.001157</td>
<td>2.05</td>
</tr>
<tr>
<td>SYNCHRONOUS I/O</td>
<td>0.117791</td>
<td>81.96</td>
</tr>
<tr>
<td>OTHER READ I/O</td>
<td>0.002557</td>
<td>1.26</td>
</tr>
<tr>
<td>OTHER WRITE I/O</td>
<td>0.000000</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL CL8 SUSPENS.</td>
<td>0.121505</td>
<td>85.26</td>
</tr>
</tbody>
</table>

Avg 1.4 ms per I/O req

<table>
<thead>
<tr>
<th>MARKET#0</th>
<th>AVERAGE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPOOL HIT RATIO (%)</td>
<td>13.55</td>
<td>N/A</td>
</tr>
<tr>
<td>GETPAGES</td>
<td>605.21</td>
<td>2126103</td>
</tr>
<tr>
<td>BUFFER UPDATES</td>
<td>0.01</td>
<td>51</td>
</tr>
<tr>
<td>SYNCHRONOUS WRITE</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>SYNCHRONOUS READ</td>
<td>81.96</td>
<td>287925</td>
</tr>
</tbody>
</table>
Synchronous Database I/O Suspensions

- A common timer for:
  - Synchronous database reads
  - Synchronous database writes
  - Delay due CPU constraint

- A separate timer for synchronous log writes

- Use BP statistics to find out how many of the suspensions should be attributed to synchronous reads vs. writes

- Avg I/O wait time in Acctg rpt = 0.028539 ms/12.41 events = 0.002 msec / sync DB IO
When You See High I/O Wait ..

- Verify if access path is optimal
  - Excessive Getpage
  - Identify which objects from BPOOL section
- Verify average I/O resp time
  - If significantly larger than RMF
    • CPU delay instead of I/O delay
- Buffer Pool Tuning
- REORG : Data/Index
- I/O configuration tuning using RMF data
  • DISK CACHE hit
  • DASD Activity report
- Make sure of sufficient I/O resources
  • Hiper PAV (Parallel Access Volume) for concurrent I/O
  • SSD hot data which cannot be fit in DB2 buffer pools
Notes: Buffer Pool Guideline

• Buffer pool hit ratio = GETPAGE req/ Sync Read
• Buffer pool separation
  • For example,
    • Index, Data, Workfile
    • Write intensive data and read intensive data
  • In memory buffer pool
    • Page steal - FIFO
    • Disable prefetch - avoid unnecessary prefetch
    • High VDWQT threshold - keep pages in buffer pools
• Compressed data page stays compressed in buffer pool, expands when rows are evaluated
• Compressed index (V9 NFM) is expanded in buffer pool
• Control unit caching
  • Control unit cache is typically larger than buffer pools (= real storage)
  • Compression can raise control unit cache if not buffer pool hit

• Workfile bpool
  • Set Sequential Prefetch threshold = 99 % as all workfile read are sequential
  • Assign enough 32K workfile buffers for DB2 9.
    • Before DB2 9 record size > 4K uses 32K workfile
    • DB2 9 record size > 100 bytes uses 32K workfile
Notes: Buffer Pool Guideline – Index buffer pools

- Generally, assign more buffers than data
  - Better chance to be utilized than Table
- For large indexes, at least assign enough buffers for non-leaf pages
  - 1 billion rows table with 200 index entries per 4K pages
  - $1,000,000 / 200 = 5,000,000$ Leaf Pages
  - $5,000,000 / 200 = 25,000$ Level 2 (Non Leaf)
  - $25,000 / 200 = 125$ Level 3 (Non Leaf)
  - $125 / 200 = 1$ Level 4 (Non leaf)
  - Total Non Leaf page = 25126
- Consider to use Large Index pages (V9 NFM) if the index is accessed key order
  - Getpage and split reduction
  - Compressed Index page is expanded at I/O time, stays uncompressed in buffer pool.
Case Study (2) Sync I/O Wait -2

<table>
<thead>
<tr>
<th>MARKET#0</th>
<th>AVERAGE TIME</th>
<th>AVG.EV</th>
</tr>
</thead>
<tbody>
<tr>
<td>__________________________</td>
<td>--------------</td>
<td>--------</td>
</tr>
<tr>
<td>LOCK/LATCH</td>
<td>0.001157</td>
<td>2.05</td>
</tr>
<tr>
<td>SYNCHRONOUS I/O</td>
<td>0.117791</td>
<td>81.96</td>
</tr>
<tr>
<td>OTHER READ I/O</td>
<td>0.002557</td>
<td>1.26</td>
</tr>
<tr>
<td>OTHER WRITE I/O</td>
<td>0.000000</td>
<td>0.00</td>
</tr>
<tr>
<td>TOTAL CL8 SUSPENS.</td>
<td>0.121505</td>
<td>85.26</td>
</tr>
</tbody>
</table>

Sync I/O reduction by
1. Separate BPOOL for better hit ratio
2. Increase BPOOL size
3. Compress the data page
### Case Study (3) DB2 CPU Increase -1

**Before**

<table>
<thead>
<tr>
<th>TIMES/EVENTS</th>
<th>APPL(CL.1)</th>
<th>DB2 (CL.2)</th>
<th>CLASS 3 SUSPENSIONS</th>
<th>ELAPSED TIME</th>
<th>EVENTS</th>
<th>HIGHLIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELAPSED TIME</td>
<td>5:42.43304</td>
<td>5:41:25:154</td>
<td>LOCK/LATCH(DB2+IRLM)</td>
<td>0.011943</td>
<td>899</td>
<td>THREAD TYPE: ALLIED</td>
</tr>
<tr>
<td>NONNESTED</td>
<td>5:42.43304</td>
<td>5:41:25:154</td>
<td>IRLM LOCK+LATCH</td>
<td>N/A</td>
<td>N/A</td>
<td>TERM. CONDITION: NORMAL</td>
</tr>
<tr>
<td>STORED PROC</td>
<td>0.000000</td>
<td>0.000000</td>
<td>DB2 LATCH</td>
<td>N/A</td>
<td>N/A</td>
<td>INVOKE REASON: DEALLOC</td>
</tr>
<tr>
<td>UDF</td>
<td>0.000000</td>
<td>0.000000</td>
<td>SYNCHRON. I/O</td>
<td>1:29.529632</td>
<td>140511</td>
<td>PARALLELISM: NO</td>
</tr>
<tr>
<td>TRIGGER</td>
<td>0.000000</td>
<td>0.000000</td>
<td>DATABASE I/O</td>
<td>1:29.529632</td>
<td>140511</td>
<td></td>
</tr>
<tr>
<td>CP CPU TIME</td>
<td>2:49.02071</td>
<td>2:48.90302</td>
<td>OTHER READ I/O</td>
<td>1:17.309528</td>
<td>19145</td>
<td>AUTONOMOUS TX: N/A</td>
</tr>
<tr>
<td>AGENT</td>
<td>2:49.02071</td>
<td>2:48.90302</td>
<td>OTHER WRITE I/O</td>
<td>0.528574</td>
<td>964</td>
<td>QUANTITY: 0</td>
</tr>
<tr>
<td>NONNESTED</td>
<td>2:49.02071</td>
<td>2:48.90302</td>
<td>SER. TASK SWTCH</td>
<td>0.005164</td>
<td>2</td>
<td>COMMITS: 1</td>
</tr>
<tr>
<td>STORED PRC</td>
<td>0.000000</td>
<td>0.000000</td>
<td>UPDATE COMMIT</td>
<td>0.000760</td>
<td>1</td>
<td>ROLLBACK: 0</td>
</tr>
</tbody>
</table>

**After**

<table>
<thead>
<tr>
<th>TIMES/EVENTS</th>
<th>APPL(CL.1)</th>
<th>DB2 (CL.2)</th>
<th>CLASS 3 SUSPENSIONS</th>
<th>ELAPSED TIME</th>
<th>EVENTS</th>
<th>HIGHLIGHTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELAPSED TIME</td>
<td>1:30:35.31</td>
<td>1:30:33.65</td>
<td>LOCK/LATCH(DB2+IRLM)</td>
<td>0.005413</td>
<td>865</td>
<td>THREAD TYPE: ALLIED</td>
</tr>
<tr>
<td>NONNESTED</td>
<td>1:30:35.31</td>
<td>1:30:33.65</td>
<td>IRLM LOCK+LATCH</td>
<td>0.002994</td>
<td>8</td>
<td>TERM. CONDITION: NORMAL</td>
</tr>
<tr>
<td>STORED PROC</td>
<td>0.000000</td>
<td>0.000000</td>
<td>DB2 LATCH</td>
<td>0.002419</td>
<td>857</td>
<td>INVOKE REASON: DEALLOC</td>
</tr>
<tr>
<td>UDF</td>
<td>0.000000</td>
<td>0.000000</td>
<td>SYNCHRON. I/O</td>
<td>1:21.613858</td>
<td>149888</td>
<td>PARALLELISM: NO</td>
</tr>
<tr>
<td>TRIGGER</td>
<td>0.000000</td>
<td>0.000000</td>
<td>DATABASE I/O</td>
<td>1:21.613858</td>
<td>149888</td>
<td></td>
</tr>
<tr>
<td>CP CPU TIME</td>
<td>1:26:14.02</td>
<td>1:26:13.91</td>
<td>OTHER READ I/O</td>
<td>1:07.245210</td>
<td>14135</td>
<td>AUTONOMOUS TX: N/A</td>
</tr>
<tr>
<td>AGENT</td>
<td>1:26:14.02</td>
<td>1:26:13.91</td>
<td>OTHER WRITE I/O</td>
<td>0.421171</td>
<td>621</td>
<td>QUANTITY: 0</td>
</tr>
<tr>
<td>NONNESTED</td>
<td>1:26:14.02</td>
<td>1:26:13.91</td>
<td>SER. TASK SWTCH</td>
<td>2.682449</td>
<td>163</td>
<td>COMMITS: 1</td>
</tr>
<tr>
<td>STORED PRC</td>
<td>0.000000</td>
<td>0.000000</td>
<td>UPDATE COMMIT</td>
<td>0.000833</td>
<td>1</td>
<td>ROLLBACK: 0</td>
</tr>
</tbody>
</table>

**DB2 CPU time**

Before: 2:48.90
After: 1:26:13.91
# Case Study(2) – DB2 CPU Increase -2

## Key Counters In Accounting

<table>
<thead>
<tr>
<th></th>
<th>Good case (V9)</th>
<th>Bad case (V10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL2 Elapsed Time</td>
<td>5:41.251</td>
<td>1:30:33.650</td>
</tr>
<tr>
<td>CL2 CPU Time</td>
<td>2:48.903</td>
<td>1:26:13.912</td>
</tr>
<tr>
<td>CL3 Suspension Time</td>
<td>2:37.384</td>
<td>2:31.968</td>
</tr>
<tr>
<td>Commit</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SELECT</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>UPDATE / ROWs</td>
<td>1 / 1</td>
<td>1 / 1</td>
</tr>
<tr>
<td>OPEN / CLOSE</td>
<td>3 / 3</td>
<td>3 / 3</td>
</tr>
<tr>
<td>FETCH / ROWS</td>
<td>74 / 71</td>
<td>74 / 71</td>
</tr>
<tr>
<td>GETPAGES</td>
<td>6143825</td>
<td>6135464</td>
</tr>
<tr>
<td>Sync Read</td>
<td>140518</td>
<td>149888</td>
</tr>
<tr>
<td>Dyn. Prefetch</td>
<td>104050</td>
<td>440213</td>
</tr>
<tr>
<td>Pages Read Async</td>
<td>1607301</td>
<td>1610632</td>
</tr>
</tbody>
</table>
Case Study(2) CPU Increase -3

• Same DML activities, approx. same getpage
  • Indication of NO Access Path change
  • Plan table confirmed they are taking same access path
  • Dynamic prefetch change does not impact Class 2 CPU time
• Significant CPU increase without access path change
  • First, suspect monitoring issue
    • Try without monitoring product
    • This particular example was confirmed there was no CPU increase without monitoring product
• If not, get a help from IBM
Case Study(4) High Page Latch Wait in Read Only Concurrent Batch Programs

<table>
<thead>
<tr>
<th>Accounting Trace</th>
<th>Time in second</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1 Elapsed</td>
<td>3954</td>
</tr>
<tr>
<td>Class 2 Elapsed</td>
<td>3595</td>
</tr>
<tr>
<td>Class 2 CPU</td>
<td>1140</td>
</tr>
<tr>
<td>Class 3 Suspension</td>
<td>2283</td>
</tr>
<tr>
<td>DB2 Latch</td>
<td>94</td>
</tr>
<tr>
<td>Page Latch</td>
<td>2188</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accounting Trace</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELECT</td>
<td>16327K</td>
</tr>
<tr>
<td>FETCH</td>
<td>25318K</td>
</tr>
<tr>
<td>COMMIT</td>
<td>10981</td>
</tr>
<tr>
<td>Getpages</td>
<td>125847K</td>
</tr>
<tr>
<td>Buffer Update</td>
<td>46633K</td>
</tr>
</tbody>
</table>

- What is page latch wait?
- Why are there Buffer Update with Read only transaction?
Page Latch Suspensions

- application address space
- DB2 address space

INSERT

getpage hit, but page latched by someone else

.wait for other agents' writes

page latch suspend

wait

page latch resume

What if ...

Wait for page latch suspensions

Most often during high insert activity

- Space map page
  - Partitioning
  - MEMBER CLUSTER
- Data page
  - Randomize inserts
- Use IFCID 226, 227 for detail analysis

Complete your sessions evaluation online at SHARE.org/SFEval

SHARE in San Francisco 2013
Case Study(4) High Page Latch with Read Only Concurrent Batches -2

• Why are there buffer update in read-only plan?
  • Workfile activities due to sort operation

• Concurrent insert into sort workfiles
  • Space map contention if there are not enough workfile datasets

• Many 32K workfiles but not enough 4K workfiles
  • Additional workfile table spaces to distribute workfile activities
  • Significant improvement once additional 4K workfiles are added
Case Study(5) Concurrent Insert Transaction -1

- Problem: 600 concurrent sequential inserts running slow
- Accounting shows,

<table>
<thead>
<tr>
<th>Per transaction</th>
<th>Time in second</th>
</tr>
</thead>
<tbody>
<tr>
<td>#of transaction</td>
<td>65651</td>
</tr>
<tr>
<td>Class 1 Elapsed</td>
<td>1.748</td>
</tr>
<tr>
<td>Class 2 Elapsed</td>
<td>1.700</td>
</tr>
<tr>
<td>Class 2 CPU</td>
<td>0.007</td>
</tr>
<tr>
<td>Class 3 Suspension</td>
<td>1.666</td>
</tr>
<tr>
<td>Page Latch</td>
<td>1.646</td>
</tr>
<tr>
<td>INSERT</td>
<td>1</td>
</tr>
<tr>
<td>Getpage</td>
<td>45</td>
</tr>
</tbody>
</table>
Case Study(5) Concurrent Insert Transaction -2

• High page latch contention using concurrent sequential insert
  • Detail page latch trace (IFCID 226/227) points out the table space’s space map pages are suffering contention
    
    DB2PM LOCKING REPORT LEVEL(SUSPENSION) ORDER (DATABASE-PAGESET)
    
• Large record size -> only 1-2 rows fit in the page
• Contention for searching space vs. marking space map full

--- SUSPEND REASONS ---

<table>
<thead>
<tr>
<th>LOCK RESOURCE</th>
<th>TOTAL</th>
<th>LOCAL</th>
<th>GLOB.</th>
<th>S.NFY</th>
<th>--- NORMAL ---</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE</td>
<td>NAME</td>
<td>SUSPENDS LATCH</td>
<td>IRLMQ</td>
<td>OTHER NMBR</td>
<td>AET NMBR</td>
</tr>
<tr>
<td>PAGE</td>
<td>PAGE=X'000C4D05'</td>
<td>92055 0 0 0 92K 0.044785</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BPID=BP10</td>
<td>0 0 92055</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAGE</td>
<td>PAGE=X'000C4223'</td>
<td>58299 0 0 0 58K 0.058537</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BPID=BP10</td>
<td>0 0 58299</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

• Larger page size (32K) should reduce frequency of space map update
Case Study(5) Concurrent Insert Transaction -3

- Changed the page size from 4K to 32K
- Accounting shows, significant performance improvement

<table>
<thead>
<tr>
<th>Per transaction</th>
<th>4K page</th>
<th>32K page</th>
</tr>
</thead>
<tbody>
<tr>
<td>#of transaction</td>
<td>65651</td>
<td>51833</td>
</tr>
<tr>
<td>Class 1 Elapsed</td>
<td>1.748</td>
<td>0.582</td>
</tr>
<tr>
<td>Class 2 Elapsed</td>
<td>1.700</td>
<td>0.026</td>
</tr>
<tr>
<td>Class 2 CPU</td>
<td>0.007</td>
<td>0.0009</td>
</tr>
<tr>
<td>Class 3 Suspension</td>
<td>1.666</td>
<td>0.024</td>
</tr>
<tr>
<td>Page Latch</td>
<td>1.646</td>
<td>0.020</td>
</tr>
<tr>
<td>INSERT</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Getpage</td>
<td>45</td>
<td>5</td>
</tr>
</tbody>
</table>
## Case Study(6) IDAA Queries Executed in Netezza

<table>
<thead>
<tr>
<th>Accounting Trace</th>
<th>Time in second</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1 Elapsed</td>
<td>1399</td>
</tr>
<tr>
<td>Class 2 Elapsed</td>
<td>1396</td>
</tr>
<tr>
<td>Class 2 CPU</td>
<td>6.776</td>
</tr>
<tr>
<td>Class 3 Suspension</td>
<td>1389</td>
</tr>
<tr>
<td>Other Service Task Switch</td>
<td>1389</td>
</tr>
<tr>
<td># Rows Fetched</td>
<td>1708862</td>
</tr>
</tbody>
</table>

Time spent in Accelerator
OMPE Support For Accelerator - Accounting

New ACCELERATOR section in Accounting

<table>
<thead>
<tr>
<th>ACCELERATOR</th>
<th>TOTAL</th>
<th>ACCELERATOR</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCCURRENCES</td>
<td>1</td>
<td>ELAPSED TIME</td>
<td></td>
</tr>
<tr>
<td>CONNECTS</td>
<td>1</td>
<td>SVCS TCP/IP</td>
<td>23:09.097443</td>
</tr>
<tr>
<td>REQUESTS</td>
<td>2</td>
<td>ACCUM ACCEL</td>
<td>23:09.004780</td>
</tr>
<tr>
<td>TIMED OUT</td>
<td>0</td>
<td>CPU TIME</td>
<td></td>
</tr>
<tr>
<td>FAILED</td>
<td>0</td>
<td>SVCS TCP/IP</td>
<td>0.035621</td>
</tr>
<tr>
<td>SENT</td>
<td></td>
<td>ACCUM ACCEL</td>
<td>3:47.718000</td>
</tr>
<tr>
<td>BYTES</td>
<td>4003</td>
<td>WAIT TIME</td>
<td></td>
</tr>
<tr>
<td>MESSAGES</td>
<td>11</td>
<td>ACCUM ACCEL</td>
<td>0.040455</td>
</tr>
<tr>
<td>BLOCKS</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROWS</td>
<td>0</td>
<td>DB2 THREAD</td>
<td></td>
</tr>
<tr>
<td>RECEIVED</td>
<td></td>
<td>CLASS 1</td>
<td></td>
</tr>
<tr>
<td>BYTES</td>
<td>54684708</td>
<td>ELAPSED</td>
<td>23:19.330365</td>
</tr>
<tr>
<td>MESSAGES</td>
<td>24</td>
<td>CP CPU</td>
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OMPE Support For Accelerator – Statistics

New ACCELERATOR section in Statistics

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<th>Test1</th>
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<th>Test1</th>
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<td>Coordinator Avg CPU Utilization (%)</td>
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Summary

• Sources of key performance indicators
  • DB2 Statistics and Accounting
  • RMF Reports

• Use DB2 traces to make an informed tuning
  • Top down analysis
  • Where does problem transaction spend time?
    • CPU vs. suspension time

• Case Studies using OMPE batch reporting
  • Problem diagnosis
  • Performance tuning
  • Performance monitoring
Thank you!

- Questions?
- email: Akiko Hoshikawa, akiko@us.ibm.com
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