Everything You Wanted to Know about DB2 Logs, but Were Afraid to Ask

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Session: 17408
Agenda

• DB2 Logs Introduction
• DB2 Logging Components
• Log Performance
• How to Leverage the DB2 Log
• DIY Log Analysis
• DB2 Log Analysis Tool
DB2 Log Introduction

• Central to every updating transaction
• Key resource for DB2
  – Integrity
  – Recovery
• Bottleneck for transactional activity
What’s in a Log?

- Unit of recovery
- Checkpoint data
- Database page set control records
- Other miscellaneous stuff!
Unit of Recovery Data

- Type of activity (Insert, Update, Delete)
- Before and after images of rows/columns
  - Redo and undo records
- Compensatory log records
- Authid and plan name
- DBID, PSID, OBID
- DBNAME and TSNAME (inferred)
- RBA/LRSN/URID
RBA and LRSN

- Changed from 6 bytes to 10 bytes with version 11
- RBA (non-data-sharing)
  - Ever increasing hexadecimal number
- LRSN (data sharing)
  - Based on timestamps from the Sysplex Timer
  - Starts with 0 when a new (non-data sharing) DB2 subsystem is started.
- Each log record is assigned a unique RBA/LRSN (URID)
- Increases with change activity
- Tracked in the BSDS
Checkpoint Triggers

• Elapsed time
• Number of log records
• CHECKPOINT FREQ
• Log switch
• End of successful restart
• Normal termination
• SET LOG LOGLOAD(0)
Other Quirky Log Content

- Dataset creation and deletion
- Database Exception (DBET)
  - -DIS DATABASE(name) RESTRICT
- Compression dictionaries (v11)
- Image copies registered in the log
  - DSNDB01.SYSUTILX
  - DSNDB01.DB01
  - DSNDB06.SYSCOPY
  - DSNDB01.SYSDBDXA
DB2 LOGGING COMPONENTS
DB2 Log Components

Active Logs:
- LOG 1
- LOG 2
- LOG 3

Archive Logs:
- Arch N
- Arch N+1
- Arch N+2

Complete your session evaluations online at www.SHARE.org/Orlando-Eval
BSDS and the Logs

• Manages logs (active and archive)
• Tracks
  – Active logs and RBA range
  – Archive logs
  – Recent log point
  – Checkpoint data
DSNJU003 (Change Log Inventory)

• Add or delete active or archive log data sets
• Add or delete checkpoint records
• Modify the value for the highest-written log RBA value or the highest-offloaded RBA value
• Other non-log stuff
DSNJU004 (Print Log Map)

- Log data set name, log RBA association, and log LRSN for both copy 1 and copy 2 of all active and archive log data sets
- Active log data sets that are available for new log data
- Contents of the checkpoint queue
- Archive log command history
- Other stuff …
DSNZPARMs for Logs

- DSN6LOGP DEALLCT=(0000),
  - MAXARCH=10000,
  - MAXRTU=2,
  - OUTBUFF=4000,
  - TWOACTV=YES,
  - TWOARCH=YES,
  - ARC2FRST=NO

- ARCHIVE LOG FREQ
- ARCHIVE LOG RACF
- MAXARCH
LOG PERFORMANCE

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Improving Log Performance

• Separate Archive logs and Active logs
  – Separate volumes (physical disks if you can)
• Separate log copies (as above)
• Make log output buffers as large as feasible (OUTBUFF)
• VSAM stripe DB2 logs (or not!)
  – … “generally unnecessary with the latest devices”
• Remote replication considerations
  – Latency introduction by synchronous array replication
DB2 Commit Process

1. **App** reads from DB2
2. Updates data in DB2
3. **Commit** transaction in DB2
4. **Wait** for transaction to complete
5. **LOG** is updated
6. **TS** is updated

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Synchronous Array Replication

- DB2
- Local Array
- Remote Array
- Latency

PPRC / SRDF / Truecopy

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zHyperWrite (Dec 2014)

• Reduces latency of synchronous replication
• New function provided by OA45662
  – (OA45125, OA44973, PI25747)
• IECIOSxx
  – HYPERWRITE=yes/no
• SETIOS HYPERWRITE={YES|NO}
• Pre-requisites
  – z/OS 2.1, Hyperswap/TPC-R Hyperswap/PPRC
  – DS8870 (w/specific MCL)
Data Capture Changes

• Logs more data into the log
  – Whole rows vs. first changed byte to last changed byte
• Provides an in-record context for an UPDATE
• Does not affect INSERTs or DELETEs
HOW TO LEVERAGE THE DB2 LOG
Log Data Use Cases

• Reporting of DB2 log activity
• Auditing of DB2 update, insert, delete activity
• Recovery of DB2 data
• Replication of DB2 objects
Reporting on DB2 Activity

- Change activity level and tracking
- Application RI reporting
  - “Grouper function”
- DDL tracking and reporting
- Report on non-Z change activity
Auditing Catalog Changes

• Report activity affecting DB2 catalog objects
• Display INSERT, UPDATE, and DELETE activity
• Translate the activity to
  – GRANT, REVOKE
  – CREATE, ALTER, DROP
• Display the timestamp when the action occurred
Change Activity Auditing

- Who changed what and when
  - Plan name
  - Package name
  - Table name
  - Activity (insert, update, delete)
  - Values (before and after)
- Show the sequence of the changes
- Valuable data for security-sensitive information
- Text alerts for unexpected changes
DB2 Log Auditing

- Monitor/Audit table activity
  - UPDATE/INSERT/DELETE
  - Who is changing data?
  - What is the sequence of the changes?
- Load reports into audit tables for review
Recovery Possibilities

• Generate SQL to UNDO or REDO changes recorded in the log
  – Surgical transaction removal
• Support for dropped object recovery
  – Report on and recover data for dropped objects
  – After DDL is recreated, restore the data in the regenerated table back to its state prior to the table being dropped
Replication Possibilities

- Replay changes on another system / object
  - LOAD or REDO SQL
- Use for data warehousing / internal processes
- Use for setting up test systems
  - Use production data for authentic application testing
DIY LOG ANALYSIS

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Log Record Structures

Physical Records

- VSAM CI
- Logical
- PT1
- PT2
- PT3
## Log Record Types

<table>
<thead>
<tr>
<th>Record Type</th>
<th>Event Type</th>
<th>#Sub Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>0002</td>
<td>Page set control</td>
<td>9</td>
</tr>
<tr>
<td>0004</td>
<td>SYSCOPY utility</td>
<td></td>
</tr>
<tr>
<td>0010</td>
<td>System event</td>
<td></td>
</tr>
<tr>
<td>0020</td>
<td>Unit of recovery control</td>
<td>11</td>
</tr>
<tr>
<td>0100</td>
<td>Checkpoint</td>
<td>2</td>
</tr>
<tr>
<td>0200</td>
<td>Unit of recovery undo</td>
<td></td>
</tr>
<tr>
<td>0400</td>
<td>Unit of recovery redo</td>
<td></td>
</tr>
<tr>
<td>0800</td>
<td>Archive log command</td>
<td></td>
</tr>
<tr>
<td>2200</td>
<td>Savepoint</td>
<td>2</td>
</tr>
<tr>
<td>4200</td>
<td>End of rollback to savepoint</td>
<td>2</td>
</tr>
<tr>
<td>4400</td>
<td>Alter or modify recovery log record</td>
<td>1</td>
</tr>
</tbody>
</table>

**sdsnmacs(dsndqj00)**

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Accessing Log Records Using the Exit

• Log Capture Exit routine
  – Performance critical exit
  – DSNJL004
Accessing the Log Data Using IFI

- Using IFI
  - START TRACE(P) CLASS(30) IFCID(126) DEST(OPX)
  - Real time access to log buffers in the online performance buffer
  - Synchronous
  - Asynchronous

- Read specific log records ranges with IFCID 129 parameter (READS)
- Read complete log data with IFCID 306 (READS)
  - DB2 can decompress records if requested!!
  - Can merge from multiple members
  - Archive data sets can be accessed
Image Copy Requirements

- Context for update!!!!
- Interrogate SYSCOPY
- Allocate the IMAGE COPY
- Reverse engineer the IMAGE COPY data pages
- Baseline the row content

Data Capture Changes
Managing “Odd” Log events

- REORGs
- Not logged activities
- Adding Columns
  - Table Versioning
- LOADs
- Compression dictionary rebuilds
Managing Compression

• Compressed rows require a compression dictionary to decompress
• Which compression dictionary?
• REORG kept/redefined CD?
• Understanding the CD layout
• How to reverse engineer the CD?
• How volatile is the structure?
Can DSN1LOGP help?

- Prints log records from active or archive logs
- Breaks up the physical records into logical records
  - Still unformatted
- Useful for debugging your DYI code
DB2 LOG ANALYSIS TOOL

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IBM DB2 Log Analysis Tool (LAT)

• Provides robust:
  – Reporting/Auditing
  – Recovery
  – Replication

• Always day one support for new DB2 versions
  – Even DB2 11 with the RBA size change

• Extensive use of zIIP processors
LAT Reporting

- General report and detail report
- Custom reports by filter:
  - Authid
  - Plan
  - Table owner/name
  - Database, table space
  - ID (OBID, PSID, DBID)
  - Time range
  - URID
  - Activity (I/U/D)
Other Interesting reports

• Quiet time
• Commit frequency
• Log Expiration time
• Catalog audit
• Distributed transaction (DDF)
• Load back into DB2 for analysis
V3.5.0 ----------- Generate database activity report (general) ---- SC01/SS1A
COMMAND ==> 

*DB2 subsystem name..... SS1A (SSID)
*Action................ E (E - Edit, S - Submit)
   Job Identifier........
*Generate details....... Y (Y/N)
*Data Sharing Mode..... Y (Y/N)
*Specify logs.......... N (Y/N)
*LOAD options.......... N (Y/N)
Misc flags............. (X - Bypass SYSLGRNX,
       P - Include partial recovery points,
       H - High speed mode)
*Output flags.......... GS (B - Bypass reports, G - General, S - Summary,
       X - Extended, T - Transaction,
       Q - Quiet time, I - Impact,
       J - Impact by row, F - Commit Frequency,
       C - Continuous mode file)

Log range:
   Start/End Date-Time.... 2014/01/11 - 00:00:00 / 2014/09/01 - 00:00:00
   Start/End RBA (URID)... / 
   Start/End LRSNs........ / 
   Continuous mode file..
V3.5.0 -------- Generate database activity report (general) ---- SC01/SS1A
COMMAND --->

More: -

Start/End Date-Time... 2014/01/11 - 00:00:00 / 2014/09/01 - 00:00:00
Start/End RBA (URID)... / 
Start/End LRSNs....... / 
Continuous mode file...
*Resolve started UDWs... N (Y/N)
*Override GMT offset... N (Y/N)
  with this GMT offset.. +00:00

Filters for log data:
*Show UPDATEs......... Y (Y/N)
*Show DELETEs......... Y (Y - Yes, N - No,
  X - Yes, but exclude mass deletes)
*Show INSERTs......... Y (Y - Yes, N - No, X - Yes, but exclude loads)
*Show rollbacks....... N (Y - Yes, N - No, O - Only)
*Compensation recs.... N (Y/N)
*Include LOB/XML data.. N (Y/N)
*Show uncommitted.... N (Y/N)
*Include catalog data.. N (Y/N)
*Misc filters......... Y (Y/N)
*Object filters........ A (N - None, M - By Name,
  I - By IDs, A - Advanced)
*Filter file usage..... N (N - None, S - Save, E - Edit, U - Use)
Filter file name.....
LAT Recovery

- Dropped object
  - Support this effort though DML
- Surgical transaction removal
  - Through SQL engine
- Recovery to earlier state using SQL engine
  - Backwards or forwards
Replication

- Create load files for other DB2 systems
- Create CSV, EBCDIC files
- Create fixed column EBCDIC files
Summary

- The DB2 LOG contains a wealth of data that can be used for:
  - Auditing
  - Reporting
  - Replication
  - Recovery
- It can be processed by home-grown programs
- IBM DB2 Log Analysis Tool is a good alternative
References

- DB2 Admin Guide (Chapter 14)
  - Details on Log layouts etc
- DB2 Managing Performance (Chapter 48)
  - Programming the IFI interface
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