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

Paul Pendle, Rocket Software
Session: 16906
Agenda

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

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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
- Authid and plan name
- DBNAME and TSNAME
- DBID, PSID, OBID
- Compensatory log records
- 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

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Checkpoint Log Record Triggers

- Elapsed time
- Number of log records
- CHECKPOINT FREQ
- Log switch
- End of successful restart
- Normal termination
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.DBDO1
- DSNDB06.SYSCOPY
- DSNDB01.SYSDBDXA
DB2 LOGGING COMPONENTS

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DB2 Log Components

Active Logs
- LOG 1
- LOG 2
- LOG 3

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

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BDS and the Logs

- Manages logs (active and archive)
- Tracks
  - Active Logs and RBA range
  - Archive Logs
  - Recent log point
  - Checkpoints
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

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Synchronous Array Replication

DB2

Local Array

Remote Array

commit
CE/DE
PPRC / SRDF / Truecopy
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 rather than single columns
• Provides an in-record context for an update

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HOW TO LEVERAGE THE DB2 LOG

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Log Data Use Cases

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

- Change activity level and tracking
- Application RI reporting
- 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

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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

• 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
- Used for data warehousing / internal processes
- Used for setting up test systems
  - Use production data for authentic application testing
Log Record Structures

Physical Records

VSAM CI

Logical

PT1 PT2

 Logical

PT1 PT2 PT3

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# 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 the Log Data

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

• Log Capture Exit routine
  – Performance critical exit
  – DSNJL004
Image Copy Requirements

- Interrogate SYSCOPY
- Allocate the IMAGE COPY
- Reverse engineer the IMAGE COPY data pages
- Baseline the row content

Data Capture Changes

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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?
SYSIBM.SYSLGRNX

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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 (U/I/D)
General Report (1)

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...

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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 UOWs... 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.......

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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 output files (v3.5)
Summary

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

• http://www-03.ibm.com/software/products/en/db2lat
• DB2 Admin Guide (Chapter 14)
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