Recovery Techniques for the New DBA

Terry Schwartz
NTT DATA

Abstract

- This session focuses on the procedures and utilities that a CA IDMS Database Administrator can use to identify and correct a database integrity problem. Attendees learn the recovery methods available and when they are appropriate to use. Also covered are techniques for preventing integrity problems. Attend this sessions if you are responsible for the integrity of your shop's database.

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Biography

- Terry Schwartz
  NTT DATA
- Over 30 years experience with CA IDMS
- IUA Treasurer
- Infrequent presenter at IUA Conferences and CA World

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Agenda

- Disaster Recovery and Business Continuity
- Types of Integrity Problems
- Causes of Integrity Problems
- How to detect Integrity Problems
- How to fix Integrity Problems
- How to avoid Integrity Problems
- Backup and Recovery Techniques
- Summary

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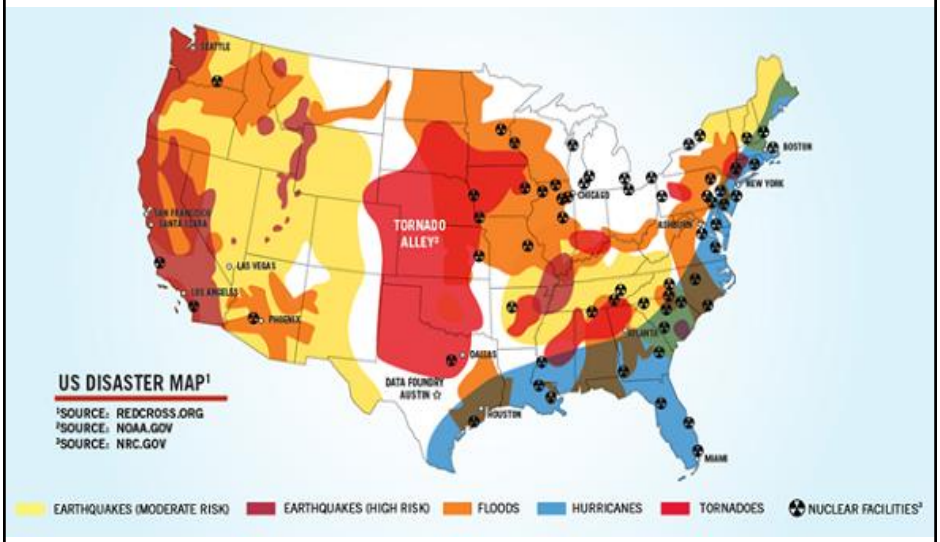
Disasters



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Business Continuity and Disaster Recovery

Why is BC/DR Important ?

According to the National Archives & Records Administration in Washington, more than 93% of companies that suffered a serious data loss after a disaster and who were unable to access their data center for 10 days or more, filed for bankruptcy within just 12 months of the incident.

Corporate directors can be held libel under “Prudent Man Laws” for failing to protect the business from a disaster event.
(varies from state to state and country)

Within two years after Hurricane Andrew in Florida (1992), 80% of affected companies that lacked a business continuity plan went out of business (FEMA)

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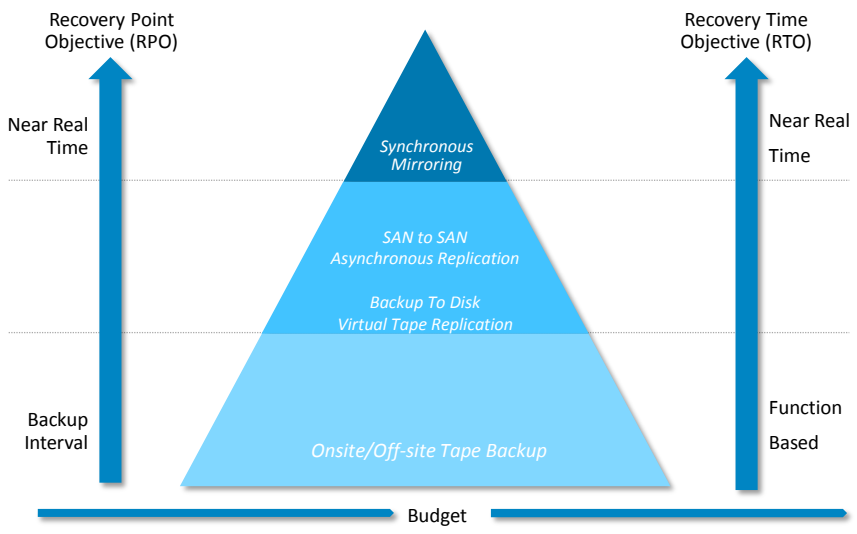
Business Continuity and Disaster Recovery



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Business Continuity and Disaster Recovery

- Certifications
  - Certified Business Continuity Planner (CBCP)
    - www.drii .org
    - Qualifications - 5 years of experience
    - Certification Exam
    - Annual certification fee

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Types of Integrity Problems

- Physical Database Integrity Problems
  - Record errors
    - Compressed record errors
    - Record in wrong area
    - Wrong record length
  - Broken chains
    - Pointer errors
    - Set errors
    - Integrated Index errors
    - Fragmented record errors
  - Page errors

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Types of Integrity Problems

- Logical Database Integrity Problems
  - Business rules not respected
    - Orphaned records with no owner
    - 1-n relationship not respected
  - Application program ran correctly with wrong input

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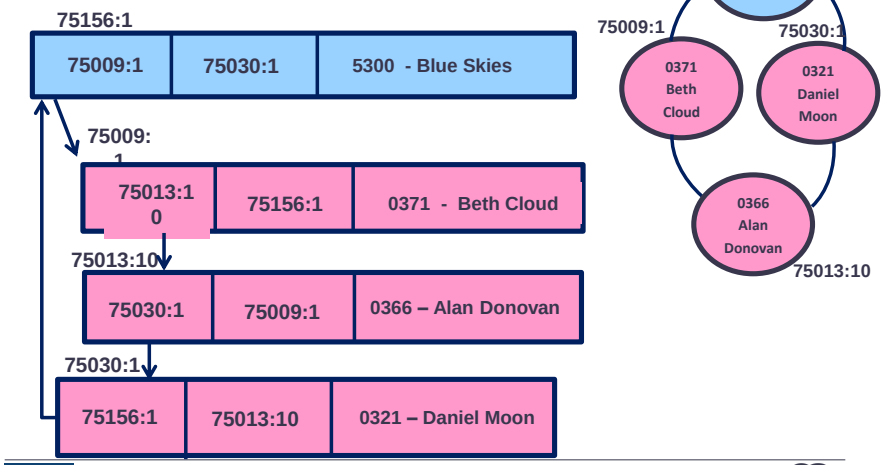
Physical Database Integrity Problems

- Pointer errors



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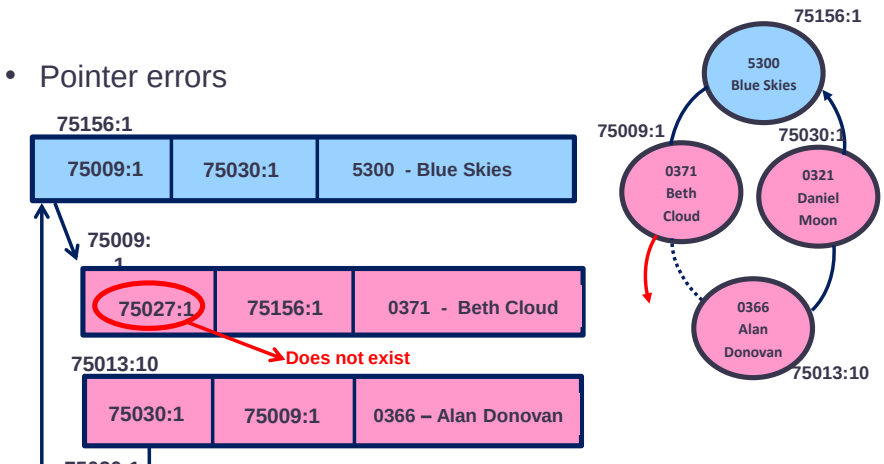
Physical Database Integrity Problems

- Pointer errors



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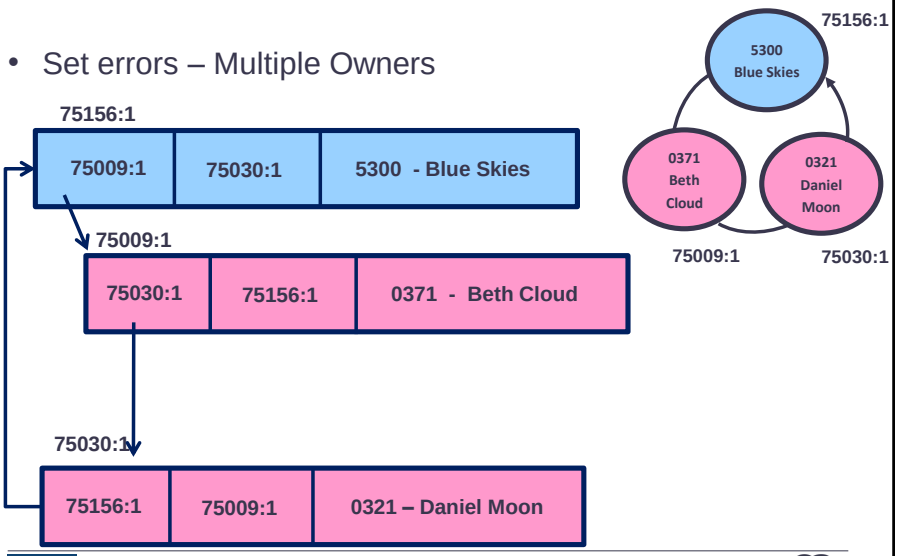
Physical Database Integrity Problems

- Set errors – Multiple Owners



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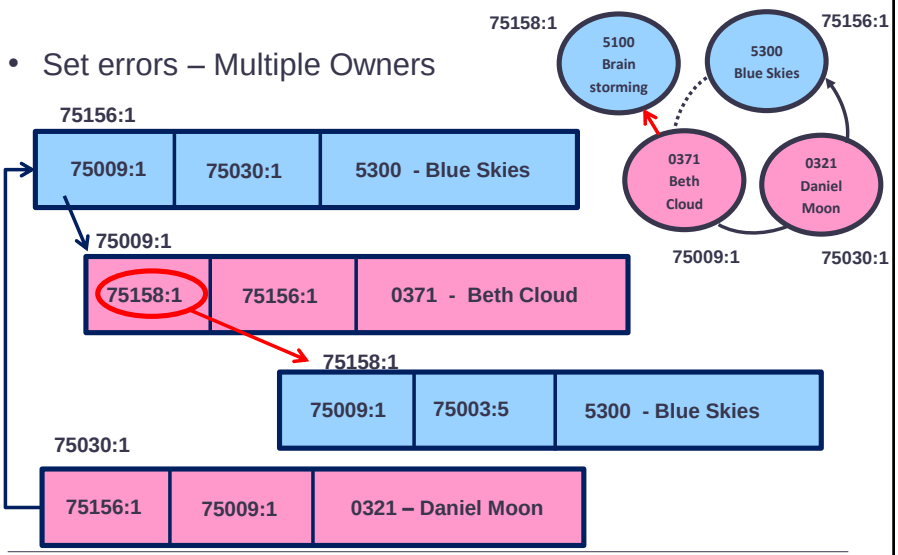
Physical Database Integrity Problems

- Set errors – Multiple Owners



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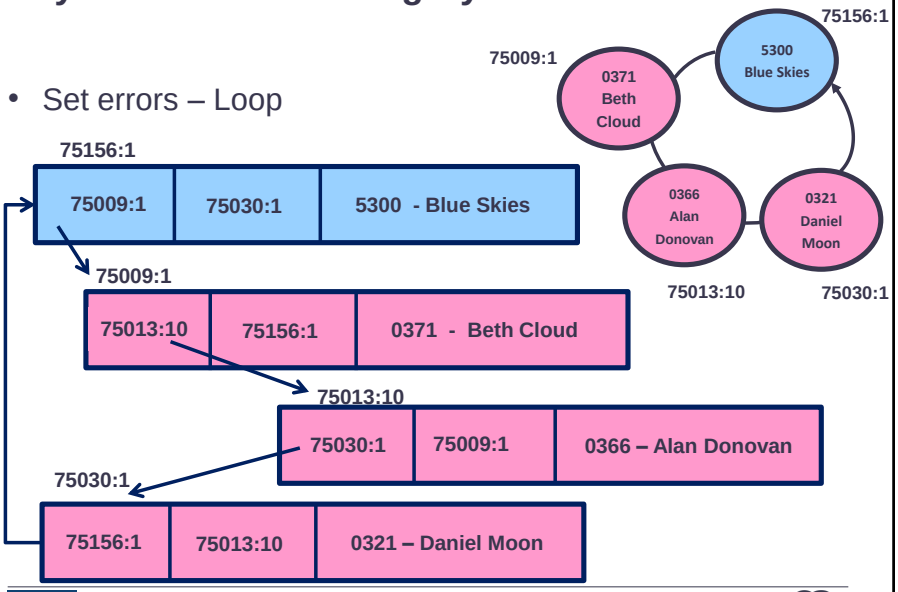
Physical Database Integrity Problems

- Set errors – Loop



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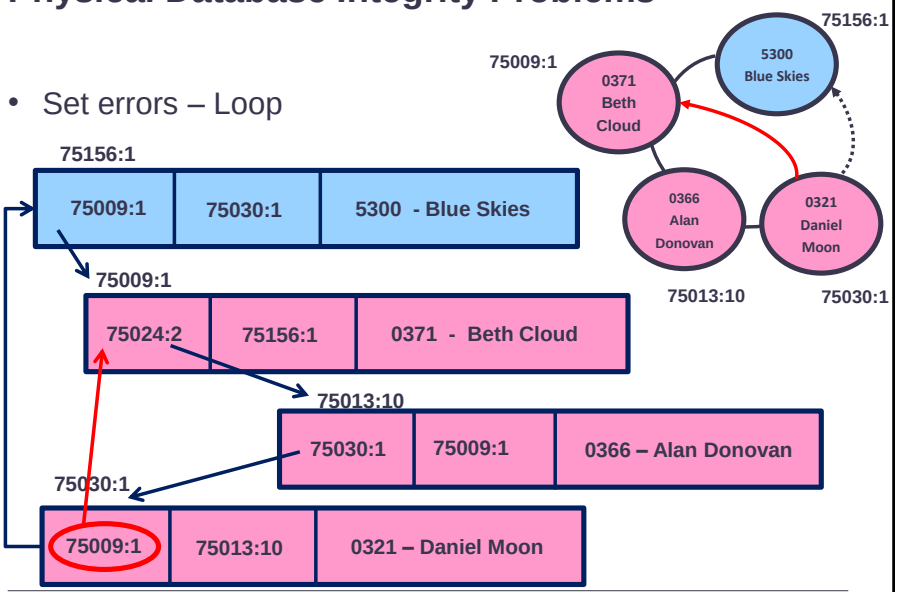
Physical Database Integrity Problems

- Set errors – Loop



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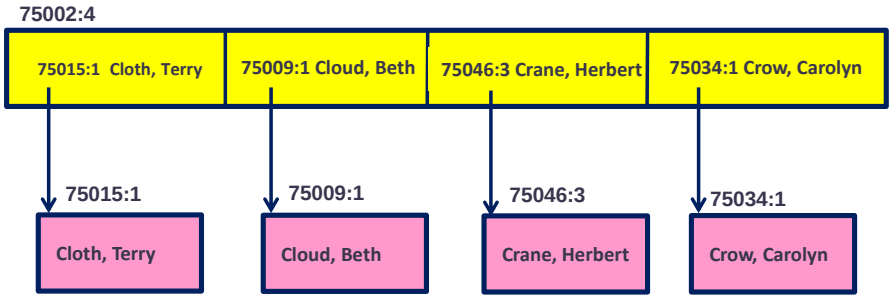
Physical Database Integrity Problems

- Integrated Index Errors



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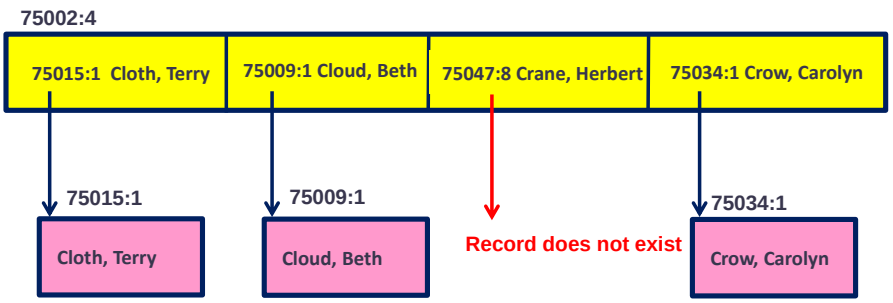
Physical Database Integrity Problems

- Integrated Index Errors



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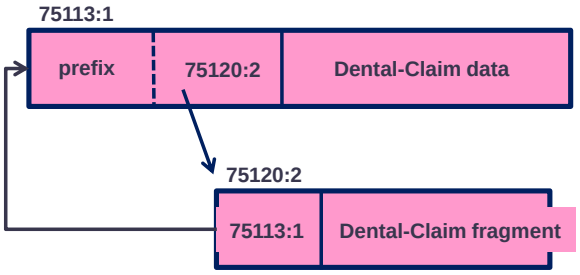
Physical Database Integrity Problems

- Fragmented record errors



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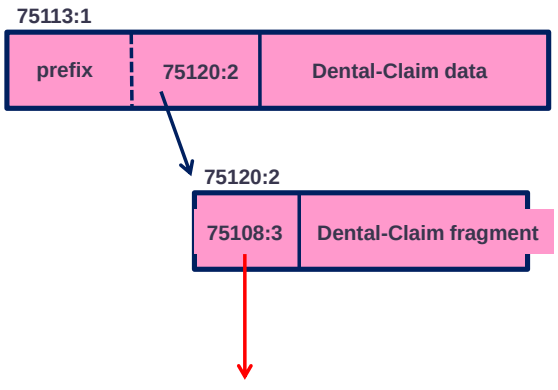
Physical Database Integrity Problems

- Fragmented record errors



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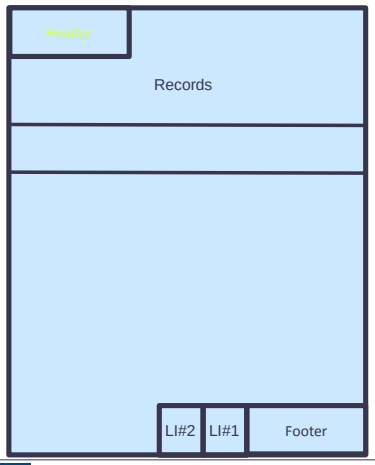
Physical Database Integrity Problems

- Page Errors



Header: Page Number (4 bytes)
SR1 record (12 bytes):
- Next, Prior of CALC chain (8 bytes)
- Space Available on page (2 bytes)
- 00 (2 bytes)

Footer: Line Index 0 (8 bytes):
Record ID (2 bytes)
Offset (2 bytes)
Length of record (2 bytes)
Length of prefix (2 bytes)
Line Space Count (2 bytes)
00 (2 bytes)
Page Number (4 bytes)

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Causes of Integrity Problems

- Physical Integrity Problem:
  - Improper Recovery from
    - Program failure
    - System failure
    - Hardware failure
  - Hardware malfunction
  - Improper use of FIX PAGE, UNLOCK
  - Rare software problem
    - Fix RO88664(R18), RO88341 (R18.5), RO88672(R19), RO88798 (R18.5 DOS)

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Causes of Integrity Problems

- Logical Integrity Problem:
  - Application Program bug
  - Execution of program at wrong time

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How to Detect Integrity Problems – at runtime

- Loop
- Error-Status
  - 0226 ERASE
  - XX60 Inconsistent record in set
  - XX61 Invalid dbkey
- Abend Codes
  - 1117 Cannot adjust space available on page
  - 1123 Broken Fragment chain
  - 1164 Error trying to backout previous error while linking record in set
  - 1197 Error trying to delink a record from a set
  - 1198 Error trying to link a record into a set

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How to Detect Integrity Problems – at runtime

- Messages
  - DB002304 Invalid record in set
  - DB002305 Dbkey in set not found
  - DB002423 Dbkey not found
  - DB002424 SR8 record not found
  - DC598203 SR2 pointer no good
  - UT003012 Possible broken chain/invalid SSC
  - UT016018 SR8 orphan count

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How to Detect Integrity Problems - reporting

- IDMSDBAN
  - Report 2 – Area Report
    - Checks Page Integrity

```
IDMSDBAN - DATA BASE ANALYSIS                          REPORT 1:  MESSAGES

598601 - AREA PROCESSING BEGINNING: EMPDEMO.EMP-DEMO-REGION
598505 - PAGE        0/75002      PAGE CORNERS INCORRECT
```

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How to Detect Integrity Problems - reporting

- IDMSDBAN
  - Report 4 – Record report

```
IDMSDBAN - DATA BASE ANALYSIS                                REPORT 1:  MESSAGES

598601 - AREA PROCESSING BEGINNING: EMPDEMO.EMP-DEMO-REGION
598516 - DBKEY       0/75009:1    LI RECORD LENGTH NE SS RECORD LENGTH (FLR)
```

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How to Detect Integrity Problems - reporting

- IDMSDBAN
  - Report 5 – Set report

Invalid pointer:

```
IDMSDBAN PHASE II - SET ANALYSIS                          REPORT 1A:  MESSAGES                          DATE        TIME       PAGE
                                                                                                       04/25/16    12464168        1
599001 - PHASE II PROCESSING BEGUN
599803 - END PASS                                          0
599801 - FROM-RECORDS WRITTEN TO SORT                     65
599802 - TO-RECORDS WRITTEN TO SORT                       65
599806 - INDEX SR8  DESCRIPTORS WRITTEN                    0
599807 - INDEX DOWN DESCRIPTORS WRITTEN                    0
599808 - INDEX UP   DESCRIPTORS WRITTEN                    0
599809 - INDEX NO-UP MEM. DESCRIPTORS WRITTEN              0
599810 - INDEX NO-UP DOWN DESCRIPTORS WRITTEN              0
599702 - NEXT LINK NOT FOUND       SET=DEPT-EMPLOYEE      CHAIN     START OF LINK        0/75030:1   OWNER IS AT         0/75156:1
                                   CHAIN LENGTH      1              LINK POINTS TO        0/75027:1   PRIOR IN PFX        0/75013:10

599703 - PRIOR LINK NOT FOUND      SET=DEPT-EMPLOYEE      CHAIN     START OF LINK        0/75156:1   OWNER IS AT         0/75156:1
                                   CHAIN LENGTH      1              LINK POINTS TO        0/75009:1   PRIOR IN PFX        0/75030:1
```

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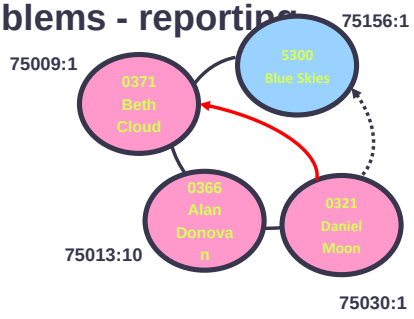
How to Detect Integrity Problems - reporting

- IDMSDBAN
  - Report 5 – Set report

Loop in pointers:




```
599701 - DUPLICATE TO-DBKEY        SET=DEPT-EMPLOYEE      CHAIN     START OF LINK    0/75030:1   OWNER IS AT     0/75156:1
                                   CHAIN LENGTH      1            LINK POINTS TO   0/75009:1   PRIOR IN PFX    0/75013:10

599701 - DUPLICATE TO-DBKEY        SET=DEPT-EMPLOYEE      CHAIN     START OF LINK    0/75156:1   OWNER IS AT     0/75156:1
                                   CHAIN LENGTH      1            LINK POINTS TO   0/75009:1   PRIOR IN PFX    0/75030:1

599703 - PRIOR LINK NOT FOUND      SET=DEPT-EMPLOYEE      CHAIN     START OF LINK    0/75009:1   OWNER IS AT     0/75156:1
                                   CHAIN LENGTH      1            LINK POINTS TO   0/75013:10  PRIOR IN PFX    0/75156:1

599703 - PRIOR LINK NOT FOUND      SET=DEPT-EMPLOYEE      CHAIN     START OF LINK    0/75156:1   OWNER IS AT     0/75156:1
                                   CHAIN LENGTH      1            LINK POINTS TO   0/75009:1   PRIOR IN PFX    0/75030:1

599706 - NO OWNER IN THIS CHAIN    SET=DEPT-EMPLOYEE      CHAIN     START OF LINK    0/75013:10  OWNER IS AT     0/75156:1
                                   CHAIN LENGTH      2            LINK POINTS TO   0/75009:1   PRIOR IN PFX    0/75009:1
```

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How to Detect Integrity Problems - reporting

- DB Audit Option
  - AUDIT : checks set integrity

```
REPT034I INTEGRITY ERRORS DETECTED IN SET...DEPT-EMPLOYEE
      --OWNER RECORD-- -ID- -------DBKEY-------  -----NEXT DBKEY----  ----PRIOR DBKEY----  ---------------RECORD DATA----------------
      DEPARTMENT       0410      75,156-0001          75,009-0001          75,030-0001    5300BLUE SKIES
                                                                                         FFFFCDEC4EDCCE4444444444444444444444444444
                                 01259401             01250101             01251601    530023450229520000000000000000000000000000
REPT036I RECORDS DETECTED WALKING NEXT FROM OWNER . . .
      | ---RECORD NAME-- -ID- -------DBKEY-------  -----NEXT DBKEY----  ----PRIOR DBKEY----  ----OWNER DBKEY----   -----RECORD DATA-----
      EMPLOYEE         0415      75,009-0001          75,013-0010          75,156-0001          75,156-0001      0371BETH       CLOUD
                                                                                                                FFFFCCEC444444CDDEC44
                                 01250101             0125050A             01259401             01259401         037125380000003364400
      EMPLOYEE         0415      75,013-0010          75,030-0001          75,009-0001          75,156-0001      0366ALAN       DONOVAN
                                                                                                                FFFFCDCD444444CDDDECD
                                 0125050A             01251601             01250101             01259401         036613150000004656515
      EMPLOYEE         0415      75,030-0001          75,009-0001          75,013-0010          75,156-0001      0321DANIEL     MOON
                                                                                                                FFFFCDCCD4444DDDD444
                                 01251601             01250101             0125050A             01259401         032141595300004665000
REPT071E SET LOOP DETECTED
REPT039I NEXT  DBKEY POINTS TO PREVIOUSLY AUDITED RECORD IN SET
REPT037I RECORDS DETECTED WALKING PRIOR FROM OWNER . . .
      EMPLOYEE         0415      75,030-0001          75,009-0001          75,013-0010          75,156-0001      0321DANIEL     MOON
                                                                                                                FFFFCCDCCD4444DDDD444
                                 01251601             01250101             0125050A             01259401         032141595300004665000
REPT069E NEXT DBKEY DOES NOT POINT BACK TO NEXT RECORD IN SET
      EMPLOYEE         0415      75,013-0010          75,030-0001          75,009-0001          75,156-0001      0366ALAN       DONOVAN
                                                                                                                FFFFCDCD444444CDDDECD
                                 0125050A             01251601             01250101             01259401         036613150000004656515
      EMPLOYEE         0415      75,009-0001          75,013-0010          75,156-0001          75,156-0001      0371BETH       CLOUD
                                                                                                                FFFFCCEC444444CDDEC44
                                 01250101             0125050A             01259401             01259401         037125380000003364400
REPT038I RECORDS DETECTED WALKING NEXT  FROM      75,030-0001. .
REPT039I NEXT  DBKEY POINTS TO PREVIOUSLY AUDITED RECORD IN SET
```

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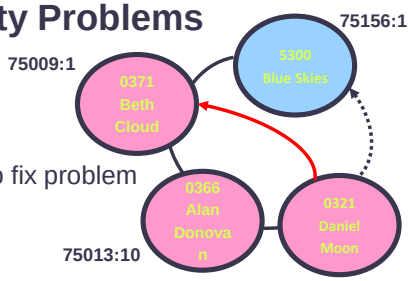
How to Fix Physical Integrity Problems



- DB Audit Option
  - FIX=SIMULATE : proposes how to fix problem

75030:1

```
*****************************************************************************************************************
******************************************* S I M U L A T E D   A F T E R   I M A G E ******************************************
*****************************************************************************************************************
REPT035I FIXING PERFORMED ON SET...DEPT-EMPLOYEE
      --OWNER RECORD-- -ID- -------DBKEY-------  -----NEXT DBKEY---- ----PRIOR DBKEY----  ---------------RECORD DATA---------------
      DEPARTMENT       0410      75,156-0001         75,009-0001         75,030-0001     5300BLUE SKIES
                                                                                           FFFFCDEC4EDCCE444444444444444444444444444
                                   01259401            01250101            01251601     53002345022952000000000000000000000000000
      ---RECORD NAME-- -ID- -------DBKEY-------  -----NEXT DBKEY---- ----PRIOR DBKEY---- ----OWNER DBKEY----  -----RECORD DATA-----
      EMPLOYEE         0415      75,009-0001         75,013-0010         75,156-0001         75,156-0001     0371BETH      CLOUD
                                                                                                               FFFFCCEC444444CDDEC44
                                   01250101            0125050A            01259401            01259401     037125380000003364400
      EMPLOYEE         0415      75,013-0010         75,030-0001         75,009-0001         75,156-0001     0366ALAN      DONOVAN
                                                                                                               FFFFCDCD444444CDDDECD
                                   0125050A            01251601            01250101            01259401     036613150000004656515
      EMPLOYEE         0415      75,030-0001         75,156-0001         75,013-0010         75,156-0001     0321DANIEL    MOON
                                                                                                               FFFFCCDCCD4444DDDD444
                                   01251601            01259401            0125050A            01259401     032141595300004665000
```

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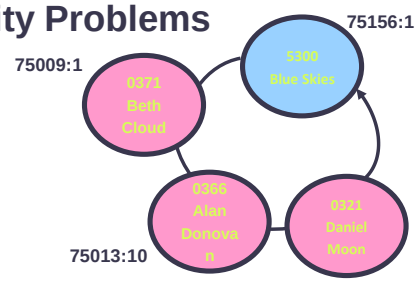
How to Fix Physical Integrity Problems



- DB Audit Option
  - FIX=UPDATE : fixes problem

75030:1

```
*****************************************************************************************************************
******************************************************* A F T E R   I M A G E ******************************************
*****************************************************************************************************************
REPT035I FIXING PERFORMED ON SET...DEPT-EMPLOYEE
      --OWNER RECORD-- -ID- -------DBKEY-------  -----NEXT DBKEY---- ----PRIOR DBKEY----  ---------------RECORD DATA---------------
      DEPARTMENT       0410      75,156-0001         75,009-0001         75,030-0001     5300BLUE SKIES
                                                                                           FFFFCDEC4EDCCE444444444444444444444444444
                                   01259401            01250101            01251601     53002345022952000000000000000000000000000
      ---RECORD NAME-- -ID- -------DBKEY-------  -----NEXT DBKEY---- ----PRIOR DBKEY---- ----OWNER DBKEY----  -----RECORD DATA-----
      EMPLOYEE         0415      75,009-0001         75,013-0010         75,156-0001         75,156-0001     0371BETH      CLOUD
                                                                                                               FFFFCCEC444444CDDEC44
                                   01250101            0125050A            01259401            01259401     037125380000003364400
      EMPLOYEE         0415      75,013-0010         75,030-0001         75,009-0001         75,156-0001     0366ALAN      DONOVAN
                                                                                                               FFFFCDCD444444CDDDECD
                                   0125050A            01251601            01250101            01259401     036613150000004656515
      EMPLOYEE         0415      75,030-0001         75,156-0001         75,013-0010         75,156-0001     0321DANIEL    MOON
                                                                                                               FFFFCCDCCD4444DDDD444
                                   01251601            01259401            0125050A            01259401     032141595300004665000
```

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How to Fix Physical Integrity Problems

- IDMSRPTS
  - Get record's set definition to correct broken chain

```
RECORD NAME........ EMPLOYEE
RECORD VERSION..... 0100
RECORD ID.......... 0415
RECORD LENGTH...... FIXED
LOCATION MODE...... CALC USING   EMP-ID-0415                        DUPLICATES NOT ALLOWED
WITHIN............. EMP-DEMO-REGION     OFFSET          5 PGS FOR          95 PGS
DBKEY POSITIONS.... SET............. TYPE........ NEXT  PRIOR OWNER
                    CALC             MEMBER          1     2
                    DEPT-EMPLOYEE    MEMBER          3     4     5
                    EMP-NAME-NDX     INDEX MEMBER    6
                    OFFICE-EMPLOYEE  INDEX MEMBER    7           8
                    EMP-COVERAGE     OWNER           9    10
                    EMP-EMPOSITION   OWNER          11    12
                    EMP-EXPERTISE    OWNER          13    14
                    MANAGES          OWNER          15    16
                    REPORTS-TO       OWNER          17    18
```

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How to Fix Physical Integrity Problems

- PRINT PAGE
  - Preparation to manually fix broken chain

```
PAGE 75,030              PAGE GROUP 0        AVAILABLE SPACE 4,536
000000   00012516 01251601 01251601 11B80000  01251600 01251600 01250101 0125050A   *................ ................*
000020   01259401 0124FA02 01259908 01259902  01256B05 01256B05 01251603 01251602   *..m.......r...r. ..,...,.........*
000040   01251604 01251605 01251607 01251606  0125120E 01251D0F F0F3F2F1 C4C1D5C9   *................ .......0321DANI*
000060   C5D34040 4040D4D6 D6D54040 40404040  40404040 40F1F640 E2D2E8C8 C9C7C840   *EL    MOON           16 SKYHIGH *
000080   C4D94040 40404040 40E6C5E2 E3D6D540  40404040 40404040 D4C1F0F4 F3F7F140   *DR       WESTON         MA04371 *
0000A0   404040F6 F1F7F4F9 F2F1F4F1 F4F0F1F0  F2F3F4F8 F1F1F0F1 F1F9F7F8 F0F1F0F3   *   6174921414010 2348110119780103*
0000C0   F0F0F0F0 F0F0F0F0 F1F9F4F4 F0F3F2F4  01251601 01251603 01251601 01259D08   *0000000019440324 ................*
0000E0   0125050B 01259D08 F1F9F7F8 F0F1F0F3  F1F9F8F1 F1F0F0F9 F5F30055 00000C07   *........19780103 1981100953......*
000100   0C000C00 0C000000 01251602 01251601  01251601 01259A06 01259A06 01259A06   *................ ................*
000120   F1F9F8F1 F1F0F1F0 F0F0F0F0 F0F0F0F0  F7F10072 00000C01 0C000C00 0C000000   *1981101000000000 71...........*
000140   01251605 01251601 01251601 0125A008  0125A004 F0F4F1F9 F6F5F0F5 F0F50000   *................ ....0419650505..*
000160   01251601 01251604 01251601 01259D09  01259D01 F0F3F1F9 F7F5F1F2 F1F50000   *................ ....0319751215..*
000180   01251601 01251607 01251601 0125050A  0125050A 0125050A C140F1F9 F8F1F1F1   *................ ........A 198111*
0001A0   F1F00000 01251606 01251601 01251601  01250101 01250A0D 01250101 C140F1F9   *10............. ............A 19*
0001C0   F8F1F1F1 F1F00000 00000000 00000000  00000000 00000000 00000000 00000000   *811110......... ................*
0001E0   00000000 00000000 00000000 00000000  00000000 00000000 00000000 00000000   *................ ................*
000200   --SAME--
001380   01CC01A4 00240018 01CC0180 00240018  01A90160 00200014 01A90140 00200014   *...u........... .z.-.....z. ....*
0013A0   01A40108 00380018 01A400D0 00380018  019F0010 00C00048 00010004 000C0008   *.u.......u.}.... .¤...{..........*
0013C0   00480007 00012516                                                          *........*

    1      4     0  0004     75,030-001     75,030-001
  415    120     1  0010     75,030-000     75,030-000     75,009-001     75,013-010     75,156-001     75,002-002
                             75,161-008     75,161-002     75,115-005     75,115-005     75,030-003     75,030-002
                             75,030-004     75,030-005     75,030-007     75,030-006     75,026-014     75,037-015
                          *0321DANIEL    MOON           16 SKYHIGH DR       WESTON         MA04371    617492141401023*
                          *481101197801030000000019440324*
```

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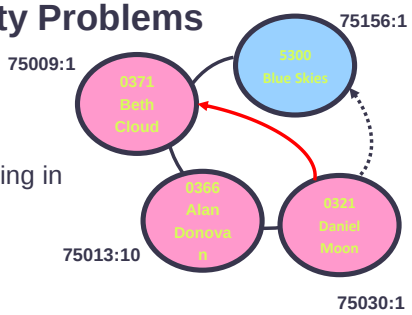
How to Fix Physical Integrity Problems

- FIX PAGE
  - Manually fix broken chain by plugging in proper value



In our example, NEXT pointer of 75030:1 should be equal to 75156:1

```
IDMSBCF  18.5                                    CA IDMS Batch Command Facility

FIX PAGE 75030
VER 0018 0125,0101
REP 0018 0125,9401
```

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How to Fix Logical Integrity Problems

- Application program bug
  - Fix the bug
  - Might need one-time program to fix data
- Execution of program at wrong time or with wrong input
  - What do you do ?
  - Depends on when problem is discovered
    - If right after => Rollback
    - If not => one-time program to fix data

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How to Avoid Integrity Problems

- Proper backup and recovery procedures
- Never run UNLOCK on locked databases unless you are 150% certain there are no broken chains

Database maintenance is done under the covers by DBMS if area opened in update mode

- Apply HYPER apars regarding data integrity

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Backup and Recovery Techniques

- Frequently scheduled backups
  - Quiesced backups
    - CV down
    - CV up – Areas quiesced
      - DCMT VARY AREA RETRIEVAL or OFFLINE
      - DCMT VARY SEGMENT RETRIEVAL or OFFLINE
      - DCMT QUIESCE AREA
      - DCMT QUIESCE SEGMENT
      - DCMT QUIESCE DBNAME

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Backup and Recovery Techniques

- Frequently scheduled backups (cont'd)
  - Hot backups
    - Quiesce update activity on areas
    - Note date/time of quiesce point
    - Restart update activity on areas
    - Backup the areas
    - Optionally, get another quiesce point on areas

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Backup and Recovery Techniques

- Frequently scheduled backups
  - Local mode update jobs
    - Backup before job
    - Backup after job

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Backup and Recovery Techniques

- Recovery after warmstart failure
  - Offload all journal files
  - ROLLBACK ACTIVE
  - UNLOCK areas not affected by ROLLBACK
  - FORMAT journals

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Backup and Recovery Techniques

- Recovery from database I/O error
  - If transactions' recovery successfully
    - DCMT VARY AREA xxx OFFLINE
    - Fix problem
    - DCMT VARY AREA xxx ONLINE

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Backup and Recovery Techniques

- Recovery from database I/O error (cont'd)
  - If transactions' recovery unsuccessfully
    - DCMT VARY AREA xxx TRANSIENT RETRIEVAL/OFFLINE
    - DCMT VARY JOURNAL
    - DCMT VARY FILE DEALLOCATE
    - Restore backup
    - ROLLFORWARD FILE
    - Rename files
    - DCMT VARY FILE ALLOCATE
    - DCMT VARY FILE ACTIVE
    - DCMT VARY AREA ONLINE

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Backup and Recovery Techniques

- Recovery from journal I/O error (cont'd)
  - Quiesce update activity
  - If all update transactions finish normally
    - Backup areas
    - Format affected journal file
    - DCMT VARY AREA ONLINE

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Backup and Recovery Techniques

- Recovery from journal I/O error
  - If you get SUSPENDED TRANSACTIONS
    - Cancel the system
    - Restore backups of all areas in update mode
    - ROLLFORWARD COMPLETE for all those areas
    - FORMAT JOURNAL ALL
    - Backup areas
    - Restart system

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Backup and Recovery Techniques

- Recovery from local mode operations
  - Not journaling
    - Restore backup taken before job
  - Journaling to tape
    - ROLLBACK with local tape journal
  - Journaling to disk
    - Copy disk journal to tape
    - ROLLBACK with tape journal
  - If using incomplete journal file
    - FIX JOURNAL

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Backup and Recovery Techniques

- Mixed mode recovery
  - When database is updated by both CV and local mode job (at different times)
    - Will need CV and local journals
    - Can use MERGE ARCHIVE or
    - Can run separate ROLLFORWARD jobs

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Summary

- Important to have backup and recovery procedures (and to test them out!!!)
- Be VERY cautious when using UNLOCK and FIX PAGE

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Questions & Answers

Please Complete a Session Evaluation Form

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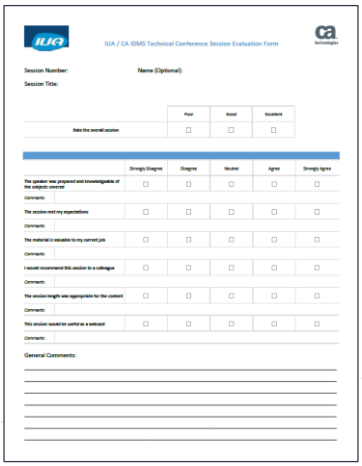
- After completing your session evaluation form, place it in the envelope at the front of the room



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Session Number: Name (Optional):

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	Poor	Good	Excellent
Rate the overall session	☐	☐	☐

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The speaker was prepared and knowledgeable of the subjects covered	☐	☐	☐	☐	☐
Comments:					
The session met my expectations	☐	☐	☐	☐	☐
Comments:					
The material is valuable to my current job	☐	☐	☐	☐	☐
Comments:					
I would recommend this session to a colleague	☐	☐	☐	☐	☐
Comments:					
The session length was appropriate for the content	☐	☐	☐	☐	☐
Comments:					
This session would be useful as a webcast	☐	☐	☐	☐	☐
Comments:					

General Comments:

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