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IBM DB2® for z/OS: Data Sharing Technical Deep Dive

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Assumptions

- This is a technical discussion of DB2 for z/OS Data Sharing topics
- The audience should be familiar with DB2 for z/OS Data Sharing concepts, behavior and benefits, based on
  - Experience with a data sharing environment
  - Recent data sharing education
  - DB2 for z/OS publications or Redbooks®
  - Flexible capacity
  - Scalability
  - High availability
  - Dynamic workload balancing

Acronyms

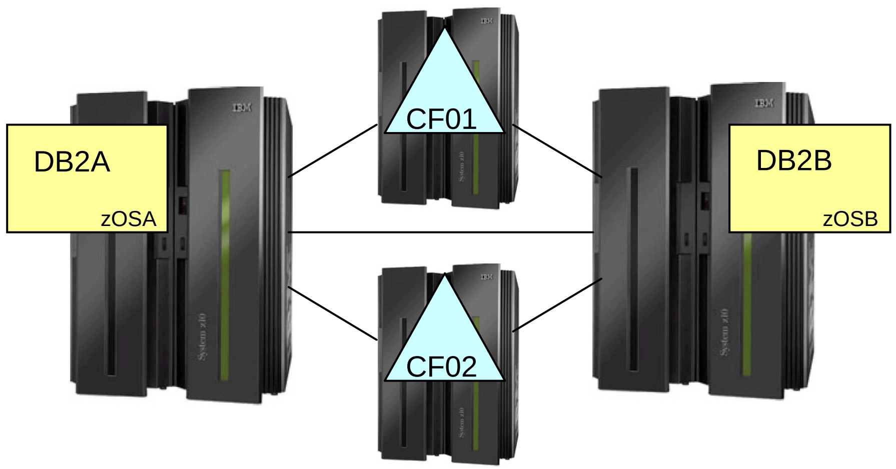
- CF – Coupling Facility LPAR
  - ICF – Integrated CF, aka Internal CF
- CFRM – CF Resource Management, definitions in CFRM policy
- CFCC – CF Control Code
- CF Links – connectivity between CF LPAR and ‘host’ CECs
  - ISC – fiber links, medium to long distance
  - ICB – copper links, very short distance
  - PSIFB - InfiniBand® links, short (12X IB) to long (1X IB) distance
  - IC – internal, microcode links for ICFs
- XCF – Cross-System Coupling Facility – communication between CECs
- XES – Cross-System Extended Services, z/OS component that manages CFs

Agenda

- DB2 Data Sharing
  - Configurations
  - Standard CF interaction
  - Performance monitoring
  - Auto Alter
- Workload growth
  - Lock structure
  - GBPs
  - Changes in configuration
    - CF considerations
- What’s New in DB2 10 and DB2 11

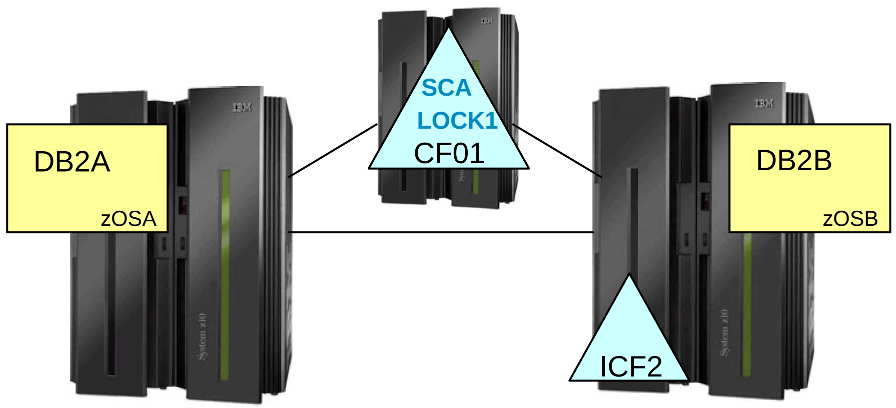
DB2 Data Sharing Starting Configuration

- Starting with DB2 V4



DB2 Data Sharing: Usual Configuration

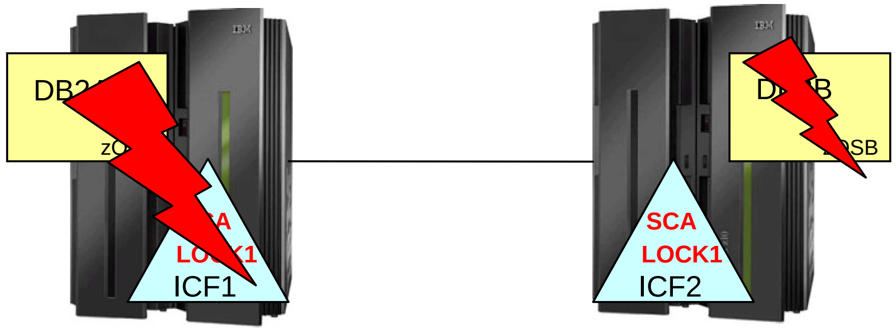
- Introduction of ICF



  - SCA and LOCK1 on external CF; isolated from DB2 and IRLM members
  - Duplexed GBPs spread across CF01 and ICF2

DB2 Data Sharing: 2-ICF Configuration

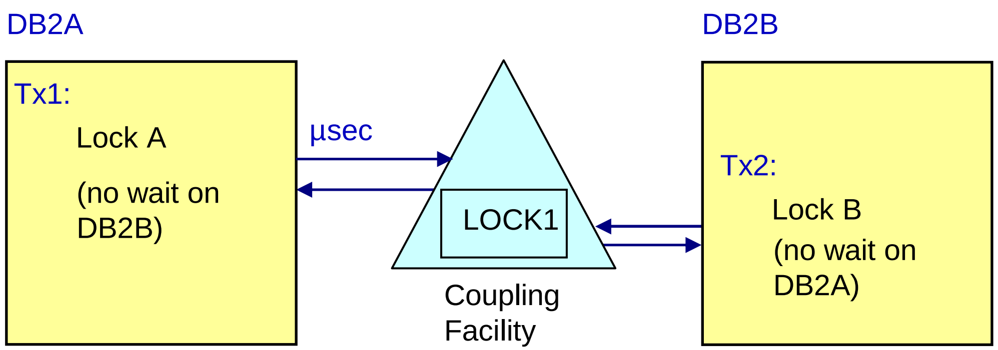
- Reduced number of CEC footprints
- Risk of 'double failure': DB2 and SCA, IRLM and LOCK1
  - If structure and exploiter fail, other members fail, too.



- Duplexed SCA and LOCK1 strongly recommended in this configuration
  - DB2B remains active, even if CEC on left is lost
  - Additional cost: host CPU, CF CPU, and CF link busy

Data Sharing: Locking

- Global locking using Parallel Sysplex® coupling technology
  - Inter-system concurrency control



  - Cost of obtaining lock does not increase when adding 3rd through nth members
  - This example assumes no contention

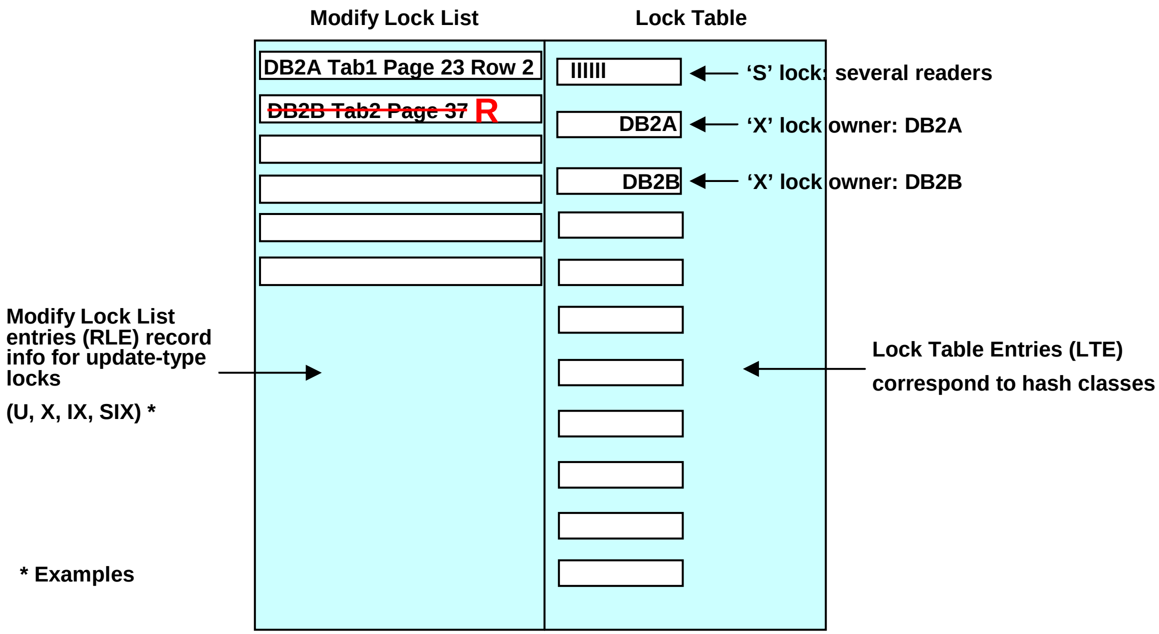
Notes: Lock Structure (LOCK1)

- Used by IRLM to manage global locking

- Holds L-locks and P-locks
  - L-locks to track concurrency
    - Parent L-locks: e.g. table space intent locks
    - Child L-locks: page or row locks
    - Others…
  - P-locks to track coherency. Examples:
    - Page set P-locks: table space, partition, index, index partition
    - Page P-locks: data page (RLL), index leaf page, space map page
    - Others…
- Consists of a lock table (hash table) and a modify lock list
  - Lock table controls access to resources
    - One entry can record multiple readers and one updater (owner)
  - Modify lock list contains detailed information for update-type locks
    - Entries become retained locks in case of an IRLM or DB2 failure

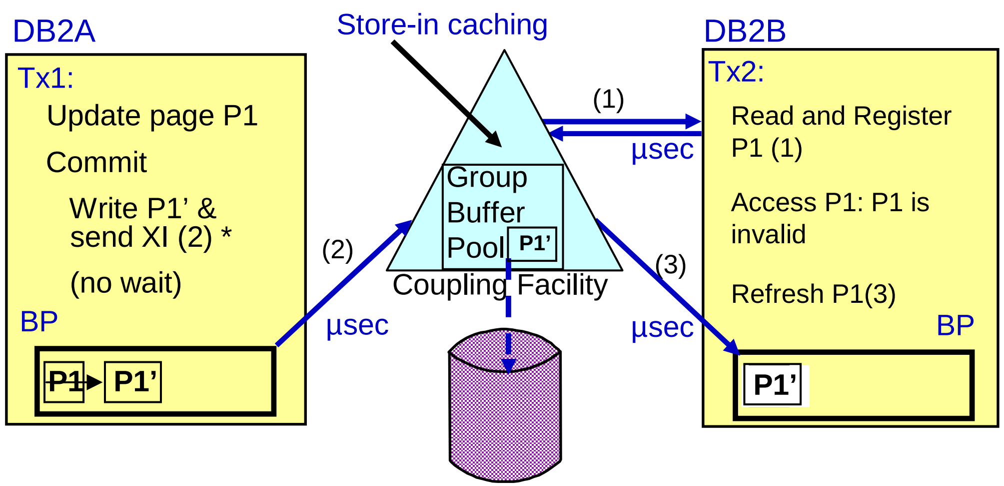
Lock Structure (LOCK1)

- Simplified view



Data Sharing: Managing changed data

- Inter-system buffer coherency control
  - Example: DB2A has write interest in the table space, and page P1 is in DB2A's buffer pool



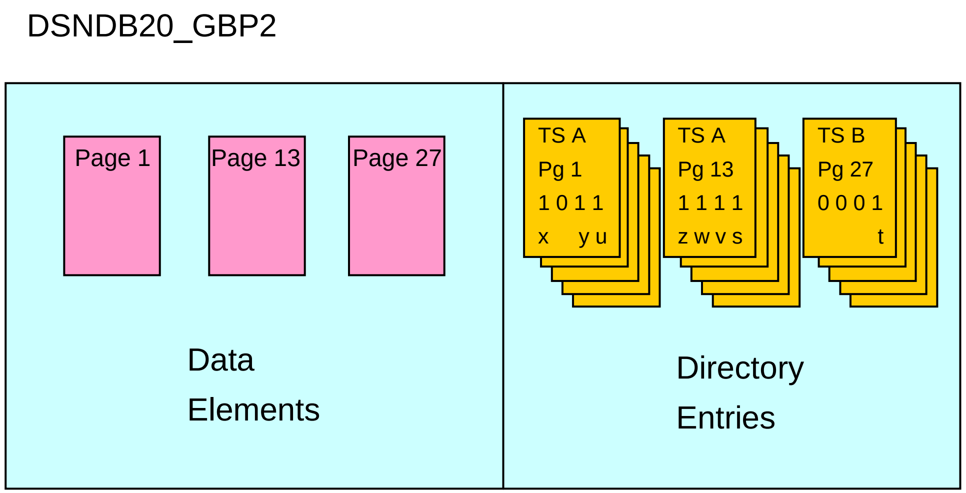
- * Cross-invalidate (XI) to other member without interrupt

Notes: Group Buffer Pools (GBPs)

- DB2 uses GBPs to
  - Manage buffer coherency
  - Cache changed pages
    - Optionally cache read-only pages
- GBP consists of directory entries and data elements
  - Directory entries manage coherency by tracking interest in a data or index page by any DB2 member in the data sharing group
    - There is one directory entry for each page in the aggregate pool, no matter how many DB2 members have a copy of that page
  - Data elements are the cached pages that a DB2 member changed
  - In GBP duplexing, data elements exist in both the primary and secondary GBP
    - Directory entries in secondary GBP only exist for the changed pages

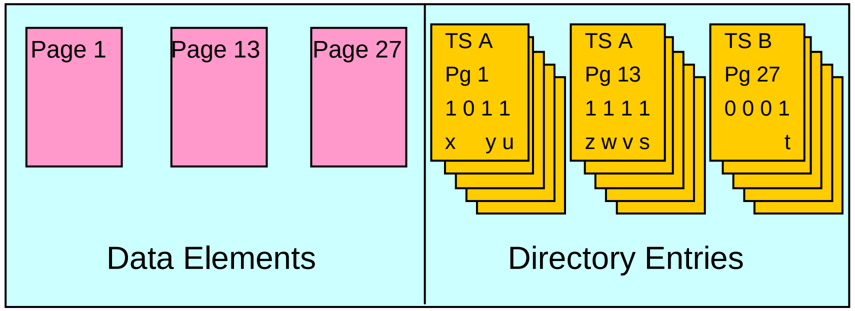
Group Buffer Pool (GBP)

- Simplified view



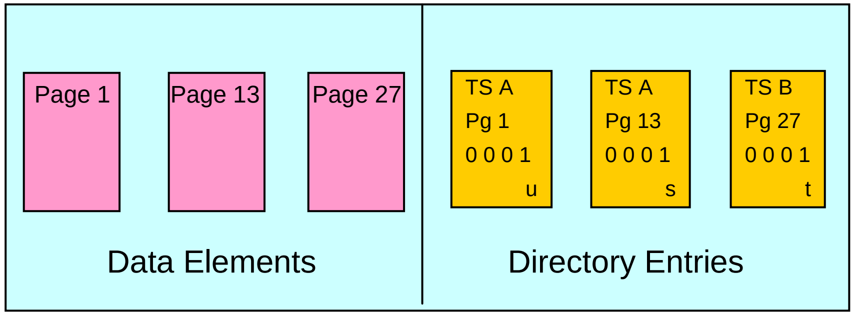
GBP Duplexing

- DSNDB20_GBP2 – Primary; “Old” on CF01



-Cache changed pages
-Register interest
-Search if local buffer miss
-Castout

- DSNDB20_GBP2 – Secondary; “New” on ICF2



-Cache changed pages

Monitoring LOCK1

- RMF CF Activity Report
  - Structure Summary

```
1                                C O U P L I N G   F A C I L I T Y   A C T I V I T Y
                                                                                                    PAGE   1
        z/OS V1R6              SYSPLEX ****                DATE 09/16/2008            INTERVAL 015.00.489
                       CONVERTED TO z/OS V1R9 RMF          TIME 08.59.00              CYCLE 10.000 SECONDS

--------------------------------------------------------------------------------------------------------------------------------
   -
 COUPLING FACILITY NAME = CFP01
 TOTAL SAMPLES(AVG) =    90  (MAX) =    90  (MIN) =    89
--------------------------------------------------------------------------------------------------------------------------------
   -
                                        COUPLING  FACILITY  USAGE  SUMMARY
--------------------------------------------------------------------------------------------------------------------------------
   -
 STRUCTURE SUMMARY
--------------------------------------------------------------------------------------------------------------------------------
   -
                                          % OF             % OF    % OF     AVG    LST/DIR   DATA      LOCK     DIR REC/
        STRUCTURE                  ALLOC  CF         #     ALL     CF       REQ/   ENTRIES   ELEMENTS  ENTRIES  DIR REC
 TYPE   NAME          STATUS CHG   SIZE   STOR     REQ     REQ     UTIL     SEC    TOT/CUR   TOT/CUR   TOT/CUR  XI'S

 LOCK   DSNDB2B_LOCK1 ACTIVE        16M    0.1       0     0.0     0.0     0.00     24K        0       4194K      N/A
                                                                                      32        0        7381      N/A
        DSNDB2P_LOCK1 ACTIVE        64M    0.5   1483K    10.5     0.0   1646.5    100K        0         17M      N/A
                                                                                    2121        0        207K      N/A
        DSNDB2Q_LOCK1 ACTIVE        16M    0.1       0     0.0     0.0     0.00     24K        0       4194K      N/A
                                                                                     272        0         48K      N/A
        DSNDB2R_LOCK1 ACTIVE        16M    0.1       0     0.0     0.0     0.00     24K        0       4194K      N/A
                                                                                      13        0        5717      N/A
```

Notes: Key Points – LOCK1 Structure Summary

- Size can be an issue
  - Determines the number of Lock Table entries (LTE) and space for Modify Lock List entries (RLE)
- Requests per second is important
  - “Busy” is relative; < 5K/sec is not very busy
  - Observed: 166K/sec – very busy
- LIST/DIR ENTRIES = Modify Lock List entries (RLE)
- LOCK ENTRIES = 2-byte Lock Table entries (LTE)
  - May be 4- or 8-byte entries if > 7 members in the data sharing group
  - IRLM automatically rebuilds the lock structure when the 8th member (4-byte entries) or 23rd member (8-byte entries) joins the data sharing group

Monitoring LOCK1, cont.

- RMF CF Activity Report
  - Structure Activity

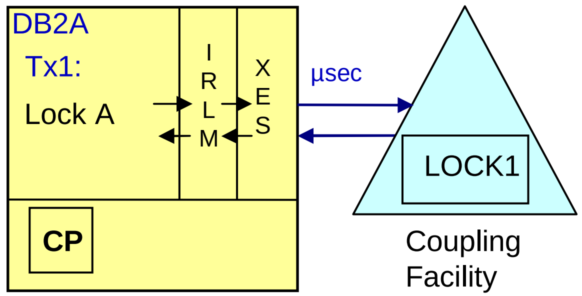
```
STRUCTURE NAME = DSNDB2P_LOCK1     TYPE = LOCK   STATUS = ACTIVE
              # REQ    -------------- REQUESTS -------------   -------------- DELAYED REQUESTS ------------
              TOTAL            #     % OF  -SERV TIME(MIC)-     REASON     #    % OF   ---- AVG                  EXTERNAL REQUEST
              AVG/SEC         REQ    ALL     AVG    STD_DEV               REQ   REQ    /DEL                      CONTENTIONS

    SYSA        567K  SYNC    523K   35.3    44.6     64.3     NO SCH  316    0.1   16.8         94.5     0.0   REQ TOTAL      784K
              630.1   ASYNC    44K    3.0   150.0    325.8     PR WT     0    0.0    0.0          0.0     0.0   REQ DEFERRED  4634
                      CHNGD     0     0.0   INCLUDED IN ASYNC  PR CMP 3016    0.5  643.6         1418     3.4   -CONT         4198
                                                                                                               -FALSE CONT    742

    SYSB        916K  SYNC    853K   57.6    43.5     85.3     NO SCH   49    0.0   80.7        184.8     0.0   REQ TOTAL     1256K
               1017   ASYNC    62K    4.2   147.7    259.6     PR WT     0    0.0    0.0          0.0     0.0   REQ DEFERRED  5437
                      CHNGD     0     0.0   INCLUDED IN ASYNC  PR CMP    0    0.0    0.0          0.0     0.0   -CONT         4703
                                                                                                               -FALSE CONT    705

   -----------------------------------------------------------------------------------------------------------------------------
               1483K  SYNC   1376K   92.8    43.9     78.0     NO SCH  365    0.0   25.3                       REQ TOTAL     2040K
               1647   ASYNC   106K    7.2   148.6    288.9     PR WT     0    0.0    0.0                       REQ DEFERRED   10K
                      CHNGD     0     0.0                      PR CMP 3016    0.2  933.9         1597     1.9   -CONT         8901
                                                                                                               -FALSE CONT   1447
```

Notes: Key Points – LOCK1 Structure Activity

- # REQ TOTAL
  - These are requests on the subchannel
    - Compare with EXTERNAL REQUEST CONTENTIONS: REQ TOTAL, which reflects API requests to XES and should be the higher number
- SERV TIME(MIC) – service time in microseconds
  - SYNC is key metric – ‘good’ number is relative to CF configuration
    - If ASYNC is non-zero it could be ‘block unlock’, or some requests were converted, either due to subchannel busy or heuristic algorithm
- CONT and FALSE CONT
  - Contention - recommend: CONT/REQ TOTAL < 2%
  - False Contention - recommend: FALSE CONT/REQ TOTAL < 1%
    - If higher, adjust size of LOCK1 to double size of Hash Table

Heuristic Algorithm and LOCK1

- Most LOCK1 requests are synchronous CF requests
  - Synchronous CF request means host CP is busy for duration of request
  - Long synchronous service times = high host CPU overhead



- XES can convert synchronous request to asynchronous
  - Heuristic algorithm based on measured lock service times
  - Host CP can now do other work during CF request
  - There is some host CP cost to setting up asynchronous request
  - Also elapsed time impact on lock requests

Monitoring GBPs

- RMF CF Activity Report
  - Structure Summary

```
1                                  C O U P L I N G   F A C I L I T Y   A C T I V I T Y
                                                                                                    PAGE    1
         z/OS V1R6            SYSPLEX ****                DATE 09/16/2008              INTERVAL 015.00.489
                         CONVERTED TO z/OS V1R9 RMF       TIME 08.59.00                CYCLE 10.000 SECONDS

------------------------------------------------------------------------------------------------------------------------------
    -
  COUPLING FACILITY NAME = CFP01
  TOTAL SAMPLES(AVG) =     90  (MAX) =     90  (MIN) =     89
------------------------------------------------------------------------------------------------------------------------------
    -
                                               COUPLING  FACILITY  USAGE  SUMMARY
------------------------------------------------------------------------------------------------------------------------------
    -
  STRUCTURE SUMMARY
------------------------------------------------------------------------------------------------------------------------------
    -
```

TYPE	STRUCTURE NAME	STATUS CHG	ALLOC SIZE	% OF CF STOR	# REQ	% OF ALL REQ	% OF CF UTIL	AVG REQ/ SEC	LST/DIR ENTRIES TOT/CUR	DATA ELEMENTS TOT/CUR	LOCK ENTRIES TOT/CUR	DIR REC/ DIR REC XI'S
CACHE	DSNDB2P_GBP0	ACTIVE	34M	0.3	529	0.0	0.0	0.59	29K	5732	N/A	0
									19	19	N/A	0
	DSNDB2P_GBP1	ACTIVE	501M	4.1	18380	0.1	0.0	20.41	494K	82K	N/A	0
									5406	5406	N/A	0
	DSNDB2P_GBP16K0	ACTIVE	8M	0.1	120	0.0	0.0	0.13	1590	1270	N/A	0
									0	0	N/A	0
	DSNDB2P_GBP16K1	ACTIVE	32M	0.3	42641	0.3	0.0	47.35	50K	2876	N/A	0
									18K	1980	N/A	0
	DSNDB2P_GBP2	ACTIVE	2G	16.8	8681	0.1	0.0	9.64	1236K	412K	N/A	0
									844	844	N/A	0
	DSNDB2P_GBP3	ACTIVE	8M	0.1	94	0.0	0.0	0.10	6008	1201	N/A	0
									0	0	N/A	0
	DSNDB2P_GBP32K	ACTIVE	10M	0.1	132	0.0	0.0	0.15	840	1344	N/A	0
									2	16	N/A	0
	DSNDB2P_GBP32K1	ACTIVE	16M	0.1	120	0.0	0.0	0.13	1438	2862	N/A	0
									1	0	N/A	0
	DSNDB2P_GBP5	ACTIVE	256M	2.1	358	0.0	0.0	0.40	521K	13K	N/A	0
									7	7	N/A	0

Notes: Key Points – GBPs Structure Summary

- Size and requests per second important
- LIST/DIR ENTRIES = directory entries
- DATA ELEMENTS = data pages
  - If current directory entries = current data pages, probably secondary GBP (GBP duplexing)
    - Could also be the effect of Auto Alter
- DIR REC/DIR REC XI'S = directory reclaims / cross-invalidations (XI's) due to directory reclaims
  - Should be zero! Investigate if non-zero, especially XI's
    - If DIR REC XI'S non-zero, potential performance impact
  - CF report does not have directory reclaim details
    - Use –DIS GBPOOL GDETAIL

Monitoring GBPs, cont.

- RMF CF Activity Report
  - Structure Activity

```
STRUCTURE NAME = DSNDB2P_GBP1      TYPE = CACHE   STATUS = ACTIVE
             # REQ    -------------- REQUESTS -------------    -------------- DELAYED REQUESTS -------------
    SYSTEM   TOTAL               #     % OF  -SERV TIME(MIC)-    REASON     #    % OF  ---- AVG TIME(MIC) -----
    NAME     AVG/SEC             REQ    ALL     AVG    STD_DEV              REQ    REQ    /DEL      STD_DEV    /ALL

    SYSA     124       SYNC      19     0.1    12.0      6.8     NO SCH    34     0.3  853.4       837.8     2.3
                       ASYNC     12K   67.6    73.2    297.3     PR WT      0     0.0    0.0         0.0     0.0
                       CHNGD      0     0.0  INCLUDED IN ASYNC   PR CMP     0     0.0    0.0         0.0     0.0
                                                                 DUMP       0     0.0    0.0         0.0     0.0

    SYSB      59       SYNC      44     0.2    54.9    246.0     NO SCH     0     0.0    0.0         0.0     0.0
                       ASYNC   5887    32.0    54.7    110.9     PR WT      0     0.0    0.0         0.0     0.0
                       CHNGD      0     0.0  INCLUDED IN ASYNC   PR CMP     0     0.0    0.0         0.0     0.0
                                                                 DUMP       0     0.0    0.0         0.0     0.0

   ------------------------------------------------------------------------------------------------------------------
     -
    TOTAL    18380     SYNC      63     0.3    41.9    205.9     NO SCH    34     0.2  853.4       837.8   [illegible].6   -- DATA ACCESS --
     -
             20.42     ASYNC     18K    100    67.3    253.0     PR WT      0     0.0                             READS            0
                       CHNGD      0     0.0                      PR CMP     0     0.0                       0     WRITES       29183
                                                                 DUMP       0     0.0                             CASTOUTS         0
                                                                                                                  XI'S         11542
```

Secondary GBP

Monitoring GBPs, cont.

- RMF CF Activity Report
  - Structure Activity

```
STRUCTURE NAME = DSNDB2P_GBP1      TYPE = CACHE   STATUS = ACTIVE
              # REQ    -------------- REQUESTS -------------    -------------- DELAYED REQUESTS -------------
    SYSTEM    TOTAL            #     % OF  -SERV TIME(MIC)-    REASON    #   % OF  ---- AVG TIME(MIC) -----
    NAME      AVG/SEC         REQ    ALL     AVG    STD_DEV           REQ   REQ   /DEL      STD_DEV   /ALL

                       SYNC    183K   30.5    18.0     47.5     NO SCH  819    0.4  1341        2830    5.6
                       ASYNC    14K    2.3   152.7    369.3     PR WT     0    0.0   0.0         0.0    0.0
                       CHNGD   818     0.1  INCLUDED IN ASYNC   PR CMP    0    0.0   0.0         0.0    0.0
                                                                DUMP      0    0.0   0.0         0.0    0.0

                       SYNC    363K   60.5    15.9     74.5     NO SCH  124    0.0  770.1      912.6    0.2
                       ASYNC    40K    6.6   143.7    354.7     PR WT     0    0.0   0.0         0.0    0.0
                       CHNGD   124     0.0  INCLUDED IN ASYNC   PR CMP    0    0.0   0.0         0.0    0.0
                                                                DUMP      0    0.0   0.0         0.0    0.0

    --------------------------------------------------------------------------------------------------------------------------------
       -
    TOTAL         599K SYNC    545K   90.9    16.6     66.7     NO SCH  943    0.2  1266        2665    2.0   -- DATA ACCESS --
       -
              665.9    ASYNC    53K    8.9   146.0    358.5     PR WT     0    0.0                             READS       16712
                       CHNGD   942     0.2                      PR CMP    0    0.0                      0      WRITES      29186
                                                                DUMP      0    0.0                             CASTOUTS    12172
                                                                                                               XI'S        20401
```

Primary GBP

Notes: Key Points – GBPs Structure Activity

- SERV TIME(MIC)
  - SYNC is key metric – ‘good’ number is relative to CF configuration
    - If REQ/SEC < 100, variations in service time probably not significant
  - ASYNC requests are expected, especially in secondary GBPs
- XI’s in lower right are not necessarily reclaims
  - Most likely business as usual

Monitoring GBPs: -DIS GBPOOL

- –DIS GBPOOL(*) TYPE(GCONN) GDETAIL(*)
  - Contains status and definition information as well as statistics
  - Reports statistics since GBP allocation
- –DIS GBPOOL(*) TYPE(GCONN) GDETAIL(INTERVAL)
  - To monitor an interval, execute this command before and after the desired interval.
  - Output messages from second command will show GBP statistics for the interval
- Typical problems due to incorrectly defined GBP
  - Directory entry reclaims
  - XIs due to directory entry reclaims
  - Writes failed due to lack of storage

–DIS GBPOOL(*) TYPE(GCONN) GDETAIL(*)

```
07.57.32 STC34822  DSNB784I  -DB2A GROUP DETAIL STATISTICS  362
   362                           READS
   362                             DATA RETURNED                          = 1842830
07.57.32 STC34822  DSNB785I  -DB2A     DATA NOT RETURNED  363
   363                               DIRECTORY ENTRY EXISTED              = 1490516
   363                               DIRECTORY ENTRY CREATED              = 9995482
   363                               DIRECTORY ENTRY NOT CREATED          = 26712646, 0
07.57.32 STC34822  DSNB786I  -DB2A   WRITES  364
   364                             CHANGED PAGES                          = 50473770
   364                             CLEAN PAGES                            = 3408467
   364                             FAILED DUE TO LACK OF STO              = 48
   364                           CHANGED PAGES SNAPSHOT VALUE             = 5568
07.57.32 STC34822  DSNB787I  -DB2A   RECLAIMS  365
   365                             FOR DIRECTORY ENTRIES                  = 80726
   365                             FOR DATA ENTRIES                       = 28878053
   365                           CASTOUTS                                 = 28679918
07.57.32 STC34822  DSNB788I  -DB2A   CROSS INVALIDATIONS  366
   366                             DUE TO DIRECTORY RECLAIMS              = 56680
   366                             DUE TO WRITES                          = 2666240
   366                             EXPLICIT                               = 0
07.57.32 STC34822  DSNB762I  -DB2A DUPLEXING STATISTICS FOR GBP11-SEC  367
   367                           WRITES
   367                             CHANGED PAGES                          = 50072797
   367                             FAILED DUE TO LACK OF STORAGE          = 48
   367                           CHANGED PAGES SNAPSHOT VALUE             = 5568
```

Notes: Sizing CF Structures

- http://www.ibm.com/systems/support/z/cfsizer
  - CF Structure Sizer Tool
- *DB2 Version 9.1 for z/OS Installation Guide*, GC18-9846
- *DB2 10 for z/OS Installation and Migration Guide*, GC19-2974
- *DB2 11 for z/OS Installation and Migration Guide,* GC19-4056
  - Knowledge Center: cf sizing for DB2 10 or 11
- Rule of thumb for GBPs
  - Start with CFSizer INITSIZE
  - Round up
  - Make that result INITSIZE; make SIZE up to twice that value
  - Use Auto Alter

Auto Alter – What is it?

IBM

- Autonomic effort by XES to avoid filling up any kind of structure. For GBPs:
  - If all data elements (pages) are changed, writes cannot occur
  - If all directory entries are marked changed, new pages cannot be registered
- Auto Alter has algorithms that
  - can increase or decrease number of entries and/or elements to avoid structure full conditions
  - can increase or decrease the size of the structure
- Can alter, dynamically, the precise directory to data ratio for GBPs
- Design point is for gradual growth, not spikes

Auto Alter and DB2

- DB2 Structures support Auto Alter
- LOCK1 – effective on Modify Lock List entries (RLEs)
  - Lock Table entries (LTE) cannot be changed without a rebuild
- SCA – can be increased
- Main value is for Group Buffer Pools (GBPs). Why?
  - People tend not to tune GBPs
    - Organizational division of labor
      - DB2 DBAs responsible for local BPs – may forget about GBPs
      - z/OS responsible for GBPs – and they own the CFRM Policy
  - DB2 needs ?? more directory entries than data page elements
  - Each –ALTER to change directory entries means manual GBP rebuild
- Works for duplexed GBPs

Auto Alter – When not to use it

- CF available storage is <10%
  - Auto Alter reduces the size of “alterable” structures below INITSIZE (to MINSIZE), attempting to get 10% available storage in the CF
- Not enough storage for size of structure, especially in Test environments
  - XES reaches SIZE quickly
  - Reclaim avoidance results in constant XES attempts to increase directory entries and reduce data pages
    - Reclaim avoidance alone does not allow structure size increase
  - Attempts usually fruitless - produce alarming console messages
  - Hint: test one structure, correctly sized, instead of all

Workload Growth

- Increased transaction, batch and/or query volumes
- New applications
- Mergers
- New business opportunities
- Regulatory compliance
- Technology advances

Workload Changes and LOCK1

- Increased lock requests may lead to
  - Higher CF CPU busy
  - Higher synchronous service time, and host CPU cost
  - Higher transaction or query elapsed time, higher job run time
- New applications may not follow standards
  - Less lock avoidance by new applications may mean more locking for existing applications
  - Long commit scopes hold Modify Lock List entries (RLEs) longer
  - Row level locking increases demand for RLEs
- False contention could increase, requiring more Lock Table Entries (LTEs)

Workload Changes and LOCK1

- Possible solutions
  - Increase CF CPU capacity
    - More CPs and/or faster CPs
  - Increase the number of RLEs
    - SETXCF START,ALTER,strnm=&,SIZE=&
      to increase the size of LOCK1
      - Assumes allocation < SIZE in CFRM policy
      - Else change CFRM policy definition, rebuild structure
  - Increase the number of LTEs
    - Requires a structure rebuild with larger allocation
      - CFRM policy change required if allocation already = SIZE
  - CF storage increase may be necessary

LOCK1 Example

- RMF CF Activity Report
  - Structure Activity

```
STRUCTURE NAME = DSN****_LOCK1     TYPE = LOCK   STATUS = ACTIVE
              # REQ    -------------- REQUESTS -------------    -------------- DELAYED REQUESTS -------------
    SYSTEM    TOTAL              #     % OF  -SERV TIME(MIC)-    REASON     #    % OF  ---- AVG TIME(MIC) -----   EXTERNAL REQUEST
    NAME      AVG/SEC           REQ     ALL      AVG   STD_DEV             REQ    REQ   /DEL     STD_DEV   /ALL   CONTENTIONS

    S***        232M   SYNC    232M    38.8     11.0       5.8   NO SCH   88K    0.0   30.8       236.2    0.0   REQ TOTAL      133M
              64403    ASYNC   750      0.0               413.5   PR WT     0     0.0    0.0         0.0    0.0   REQ DEFERRED   239K
                       CHNGD     0      0.0  I      ED IN ASYNC   PR CMP    0     0.0    0.0         0.0    0.0   -CONT          239K
                                                                                                                -FALSE CONT    162K

    S***        187M   SYNC    187M    31.2                5.5   NO SCH   14K    0.0   15.0        67.2    0.0   REQ TOTAL       99M
              51870    ASYNC     0      0.0                0.0   PR WT            0.0    0.0         0.0    0.0   REQ DEFERRED   218K
                       CHNGD     0      0.0  I      ED IN ASYNC   PR CMP           0.0    0.0         0.0    0.0   -CONT          218K
                                                                                                                -FALSE CONT    111K

    S***        179M   SYNC    179M    30.0                5.9   NO SCH 50        0.0   19.7        37.5    0.0   REQ TOTAL      106M
              49841    ASYNC  1500      0.0               87.7   PR WT            0.0    0.0         0.0    0.0   REQ DEFERRED   333K
                       CHNGD     0      0.0          IN ASYNC   PR CMP           0.0    0.0         0.0    0.0   -CONT          333K
                                                                                                                -FALSE CONT    242K
--------------------------------------------------------------------------------------------------------------------------------
                598M   SYNC    598M    100      10.7       5.7   NO SCH  108K    0.0   28.2       215.6                        337M
              166.1K   ASYNC  2250      0.0     80.2     249.4   PR WT     0     0.0    0.0         0.0    0.0                 790K
                       CHNGD     0      0.0                      PR CMP    0     0.0    0.0         0.0    0.0   -CONT          790K
                                                                                                                -FALSE CONT    515K
```

Workload Changes and GBPs

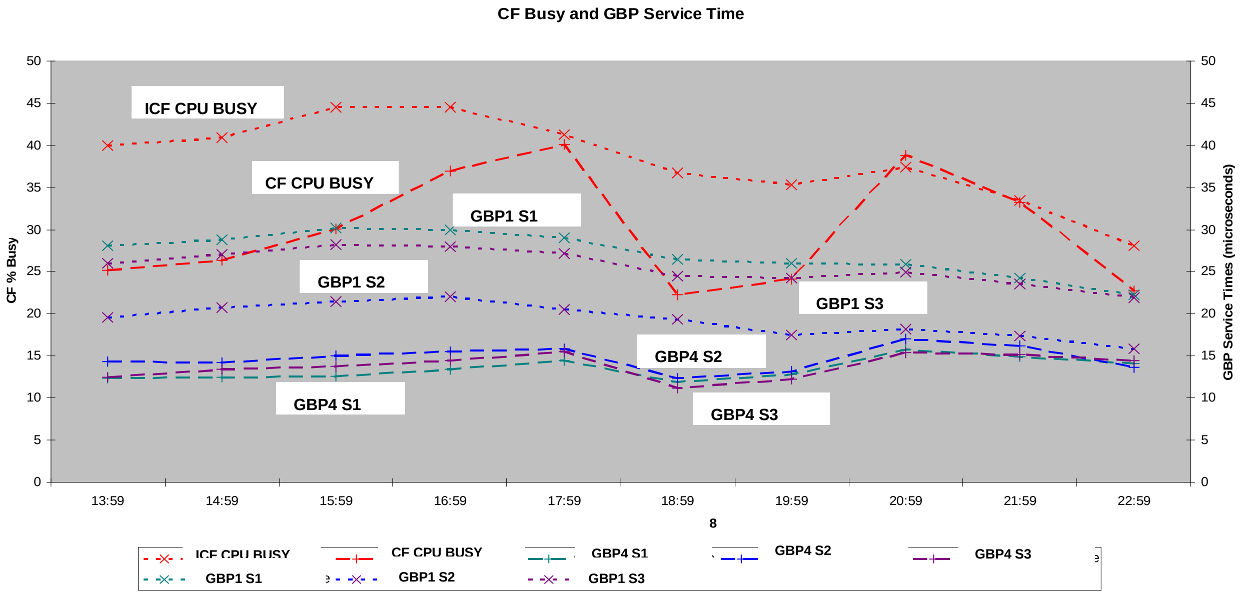
- Increased GBP requests may lead to
  - Higher CF CPU busy
  - Higher synchronous service time, and host CPU cost
  - Higher transaction or query elapsed time, higher job run time
- New applications may
  - Change access patterns of existing tables or indexes
  - Add tables and indexes to existing buffer pools
- Local buffer pool allocations may increase
  - GBPs might be forgotten

Workload Changes and GBPs

- Possible solutions
  - Increase CF CPU capacity
    - More CPs and/or faster CPs
  - Increase the size of the GBPs
  - Tune local buffer pool thresholds and GBP thresholds
  - CF storage increase may be necessary

GBPs and Impact of CF Busy

- ICF has two CPs
- CF (external) has three CPs



GBPs and Impact of CF Busy, cont.

- GBP1 on ICF was very busy over a 10 hour interval
  - S1: 178 M synchronous requests
  - S3: 144.5 M synchronous requests
  - If 10 µsec saved from each request, over 300 CPU seconds per hour of ‘host effect’ could be saved from GBP1 alone
- How could 10 µsec be saved?
  - Increase number of CPs on ICF to reduce CF busy and improve service time
  - Upgrade CEC with ICF to reduce CF service times

Workload Changes and SCA

- New applications or new workloads may add tables and indexes
- New clients may require additional databases
- Auto Alter may be able to handle most of the increase
- Use CF Structure Sizer Tool to validate CFRM policy definition

When New Members Join the Data Sharing Group

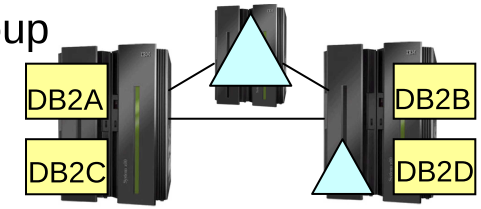
- GBP – review sizes
  - Increased demand for directory entries and data elements
  - Auto Alter may not be sufficient to handle multiple new members
- LOCK1
  - 4-byte LTEs required when 8^{th} member joins the group
    - Automatic rebuild will normally result in half as many LTEs, so false contention will increase
    - Prepare for larger LTEs before adding 8^{th} member
  - 8-byte LTEs required when 23^{rd} member joins the group
    - Automatic rebuild has same considerations

Configuration Changes

- CF Considerations
  - Balanced performance: CF technology = CEC technology
  - Unbalanced configuration examples:
    - zEC12 CF and z196 CEC – good for the CEC
    - z196 CF and zEC12 CEC – more Host Effect cost to CEC
    - z10 CF and zEC12 CEC – 'heuristic algorithm' likely to convert many synchronous requests to asynchronous
      - Algorithm represents tradeoff of host effect versus cost of conversion
      - Elapsed times, contention, and time outs likely to increase
  - Increase in distance between CF and CEC can have similar effect
    - Asynchronous conversion frequently observed as distance between CEC and CF increases

Creative Use of CF Storage

- As more DB2 members join the group
  - Consider GBPCACHE ALL
    - Each page is read into GBP on first access
    - Only one member incurs I/O cost for each page
    - Local buffers can be smaller – GBP acts as very fast cache



- If large objects with very random access and minimal page re-reference
  - Consider GBPCACHE NONE
    - Saves GBP access on local page miss
    - Enforces ‘store through cache’: synchronous writes to disk at commit
      - Modern cache controllers minimize negative impact

DB2 10 for z/OS

Data Sharing Highlights

DB2 10 for z/OS and Data Sharing

- Deleting member of data sharing group
  - Offline utility
- Deleting structures during group restart
  - DEL_CFSTRUCTS_ON_RESTART - DSNZPARM for DR
- Sub-group attach
- DDF Restart Light – handle indoubts
- MEMBER CLUSTER for UTS
- -MODIFY DDF – online changes for LOCATION ALIAS

- LRSN spin avoidance
- IFCID 359 – index split
- GBP DELETE_NAME processing
- BP scan avoidance

DB2 11 for z/OS

Data Sharing Highlights

DB2 11 for z/OS Data Sharing Enhancements

- Castout enhancements: New CLASST setting – similar to VDWQT
- RESTART LIGHT Enhancements
- Buffer pool enhancements

- GBP Write-around
  - If GBP / CF busy, write new pages to directly to disk
  - Reduce impact of flood of new pages on rest of GBP
- Automatic LPL or GRECP recovery
- CF DELETE_NAME
- Locking enhancements
- Index split performance
- LRSN spin avoidance – extended LRSN

Additional Resources

- ***Data Sharing: Planning and Administration***
  - DB2 9 for z/OS: SC18-9845
  - DB2 10 for z/OS: SC19-2973
  - DB2 11 for z/OS: SC19-4055
  - KC db2 data sharing planning

Questions?

Thank you!