Parallel Sysplex Measurement and Tuning - Hints and Tips

z/OS Performance
Education, Software, and
Managed Service Providers

Creators of Pivotor®

Instructor: Peter Enrico

Email: Peter.Enrico@EPStrategies.com

Enterprise Performance Strategies, Inc.
3457-53rd Avenue North, #145
Bradenton, FL 34210
http://www.epstrategies.com
http://www.pivotor.com

Voice: 813-435-2297
Mobile: 941-685-6789

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Questions?

Send email to Peter at Peter.Enrico@EPStrategies.com, or visit our websites at http://www.epstrategies.com and http://www.pivotor.com.

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Abstract

- **Abstract**

  - z/OS performance measurement and tuning can sometimes be a big and intimidating area to explore. In the z/OS environment there is so many measurements available, and there are so many areas to be tuned. Where should one start to become quickly productive.

    During this presentation, Peter Enrico will discuss a variety of Coupling Facility and Parallel Sysplex performance measurements and performance tuning recommendations. Attending this session is sure to get any z/OS performance analyst productive and started on their journey to z/OS Sysplex optimization.

Performance Workshops Available

During these workshops you will be analyzing your own data!

- WLM Performance and Re-evaluating of Goals
  - Instructor: Peter Enrico
  - Scheduled: June 24 - 28, 2013 Raleigh, North Carolina, USA
  - Scheduled: September 09 – 13, 2013 Munich, Germany
  - Schedule September 23 – 27, 2013 Indianapolis, Indiana

- Parallel Sysplex and z/OS Performance Tuning (Web / Internet Based!)
  - Instructor: Peter Enrico
  - Scheduled: July 09 – 11, 2013 Web based
  - Scheduled: August 26 – 29, 2013 Web based

- Essential z/OS Performance Tuning
  - Instructor: Peter Enrico and Tom Beretvas

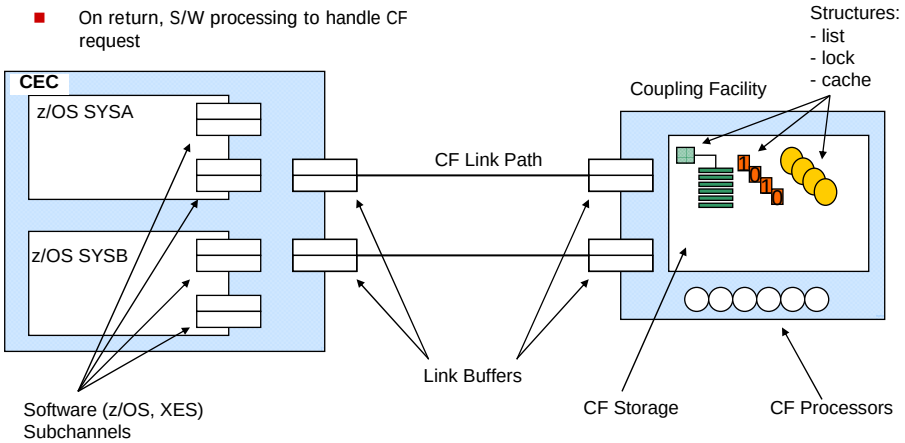
- z/OS Capacity Planning and Performance Analysis
  - Instructor: Ray Wicks

CF Reports Processing/Discussion Offer !!!

- Special Reports Offer!
  - See your Coupling Facility records in chart and table format
  - Please contact me, Peter Enrico for instructions for sending raw SMF data
    - Send an email to peter.enrico@epstrategies.com
  - Deliverable: Dozens of coupling facility based reports (charts and tables)
    - Configuration / Setup questions
    - Link and general load performance
    - Host effect
    - Processor
    - Storage usage
    - List structure
    - Lock structure
    - Cache structure
    - Duplexing
    - Much more...
    - One-on-one phone call to explain your coupling facility measurements

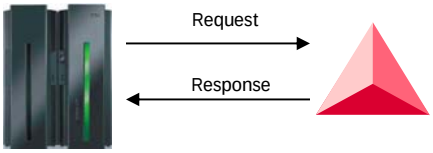
Performance Analyst View of CF Resource

- z/OS Processing
  - S/W processing to make CF request
  - Request a sub-channel
  - Request a path
  - Data transfer over link
  - On return, S/W processing to handle CF request
- Coupling Facility Processing
  - Link time (i.e. time on path)
  - CF busy processing request



Examples of factors that influence performance

- Performance is heavily dependant on a number of variables:
  - Speed of requesting CPU
    - Faster processor will 'wait faster' for a response from a slower processor
  - Type of request – Synchronous versus Asynchronous
  - Busy conditions (Subchannel, path)
  - Time it takes to transmit data to the CF
    - CF link performance
    - Speed of data over link
    - Distances
  - Configuration and speed of CF processor
    - Shared or dedicated CF engines?
  - Structures size deficiencies that may result in additional processing
  - CF structure duplexing

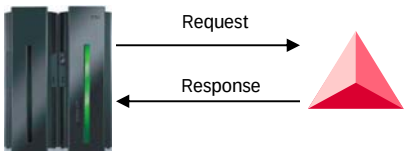


Many Questions Need to be Asked of CF Measurements

- Configuration / Setup questions
- Link and general load performance questions
- Host effect questions
- Processor related questions
- Storage usage related questions
- List structure related questions
- Lock structure related questions
- Cache structure related questions
- Duplexing related questions

Coupling Facility Measurement Questions
Subjects of this Presentation

- What is the structure configuration?
- How many requests to the CF is each structure responsible for, and what sorts of response times are the requests incurring?
- What is the spin component of the host effect?
- Are there cross invalidates due to directory reclaims?
- What percentage of Lock requests are due to false contention?

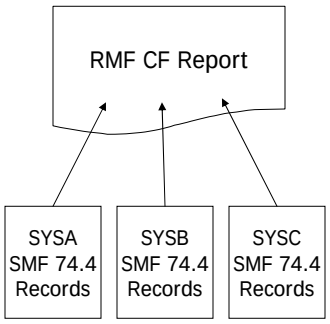


Sources of CF Measurements

- CMF / RMF Monitor I Coupling Facility Activity report
  - Actually collected by the RMF Monitor III data gatherer
  - Based off of the SMF 74.4 records
  - One record per CF per system in the Sysplex
- CMF / RMF Post Processor Reports divided up into four main sections
  - Coupling Facility Usage Summary
    - Structure Summary
    - Storage Summary
    - Processor Summary
  - Coupling Facility Structure Activity
    - Request Rates
    - Service & Delay Times
    - Other structure activity such as Caching and Locking statistics
  - Coupling Facility Subchannel Activity
    - Request Rates
    - Service & Delay Times
  - Coupling Facility to Coupling Facility communication

CF Sysplex Report

- Make sure data from all systems in Sysplex is included
- Coupling Facility measurements are best analyzed when data from all participating systems is analyzed together
  - One SMF record per CF per system in the Sysplex
  - All SMF records for each CF from every system need to be combined
  - If not, some of the measurements are misleading
- Also, make sure if you have multiple CFs that you examine the measurements from each one.



How many requests to the CF is each structure responsible for? What sorts of response times are the requests incurring?

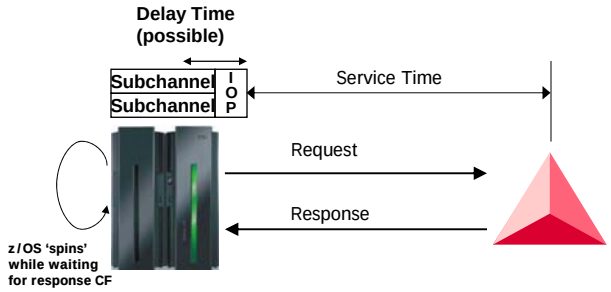
Synchronous Response Times

Asynchronous Response Times

CF Synchronous Request Processing

- Requesting processor spins waiting for CF request to complete
- Two types of sync requests
  - Those that must continuously run as synchronous
    - Lock requests - XES spins
  - Those that start out as sync
    - But converted to async if doing so helps performance
    - Sync cache/list requests - XES changes to async

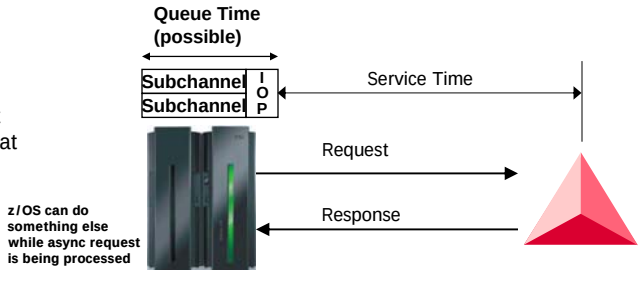
Impacts response time of sender, and performance of sending system



CF Asynchronous Request Processing

- Requesting processor can do other processing while the CF request is queued
  - Immediate reply is not required
    - Async cache/list requests - XES queues
  - Serialized access is not required
  - Some async requests start out as sync requests and then converted to async
    - XES changes to async based on busy conditions, and response time conditions

Performance impact much less severe that sync requests



Best Sync and Async Service Times Expected

- Speed of sending processor and CF factor in greatly into service times
- Response time guidelines:
  - Sync requests should be in the range of 7 to 20 microseconds (or lower)
  - Async requests should be in the range of 80 to 300 microseconds (or lower)
- The ranges are service times take into account the transfer of data
  - Low end of ranges – when there is no transfer of data (such as a GRSLOCK request)
  - High end of ranges – when there is the largest transfer of data allowed
    - Sync request – 4K is largest transfer of data allowed
    - Async request – 64K is largest transfer of data allowed

CF Subchannel Activity Report

- Usage of the Report
  - For measurement and monitoring of subchannel and path utilizations
  - Data reported for all paths for each connected system
  - Insight into synchronous and asynchronous request processing
- Report divided up into the following sections on system basis
  - Subchannel and path configuration and usage
  - Request load and response time information for all paths from each system
  - Delay information
- Measuring and monitoring coupling facility links
  - It is important to ensure that there are enough coupling facility links
    - Helps to decrease service times & queuing times
  - Every CF link is associated with two CF subchannels
  - Data sent to the CF are first loaded into these subchannels
- Possible performance conditions
  - Not enough subchannels
  - Subchannel busy
  - Path busy

Quick Check of Response Times: Use CF Subchannel Activity Report

COUPLING FACILITY NAME = P1CF001

SUBCHANNEL ACTIVITY

SYSTEM NAME	# REQ TOTAL AVG/SEC	-- CF TYPE	LINKS -- GEN	USE	PTH BUSY	---------- REQUESTS ----------	# REQ	-SERVICE TIME(MIC)- AVG	STD_DEV	---------- DELAYED	# REQ	% OF REQ	/DE
SYS0	49994	CFP	2	2	0	SYNC	31901	20.6	6.7	LIST/CACHE	39	0.3	484.
	55.5	SUBCH	14	14		ASYNC	9875	541.3	579.4	LOCK	0	0.0	0.
						CHANGED	39	INCLUDED IN ASYNC		TOTAL	39	0.1	
						UNSUCC	0	0.0	0.0				
SYS1	927793	CFP	2	2	0	SYNC	595881	22.0	13.7	LIST/CACHE	466	0.1	235.
	1030.9	SUBCH	14	14		ASYNC	323352	94.1	115.6	LOCK	36	0.0	117.
						CHANGED	502	INCLUDED IN ASYNC		TOTAL	502	0.1	
						UNSUCC	0	0.0	0.0				
SYS2	316464	CFP	2	2	1	SYNC	284943	21.1	7.9	LIST/CACHE	0	0.0	0.
	351.6	SUBCH	14	14		ASYNC	22643	191.7	375.2	LOCK	0	0.0	0.
						CHANGED	0	INCLUDED IN ASYNC		TOTAL	0	0.0	
						UNSUCC	0	0.0	0.0				
SYS3	326032	CFP	2	2	0	SYNC	269931	20.5	16.4	LIST/CACHE	0	0.0	0.
	362.3	SUBCH	14	14		ASYNC	49018	165.9	217.5	LOCK	0	0.0	0.
						CHANGED	0	INCLUDED IN ASYNC		TOTAL	0	0.0	
						UNSUCC	0	0.0	0.0				
SYS4	907973	CFP	2	2	6	SYNC	801643	20.9	10.2	LIST/CACHE	246	0.2	368.
	1008.9	SUBCH	14	14		ASYNC	110086	129.8	212.7	LOCK	0	0.0	0.
						CHANGED	246	INCLUDED IN ASYNC		TOTAL	246	0.0	
						UNSUCC	0	0.0	0.0				

Quick Check of Response Times: RMF CF Structure Activity Summary

- Usage of the Report
  - For measurement and monitoring of structure activity
  - Data reported for each individual structure
  - Structure activity reported on per system basis and for total CF
- Report divided up into the following sections on a per structure per system basis
  - Structure information
  - Request load and response time information
  - Delay information
- Much of report reads very similar to CF Subchannel Activity
  - Only data for each individual structure
  - Total # REQ incremented by 1 rather than 2 for
    - Sync non-immediate path busy
    - Async path busy

Quick Check of Response Times: Use CF Structure Activity Report

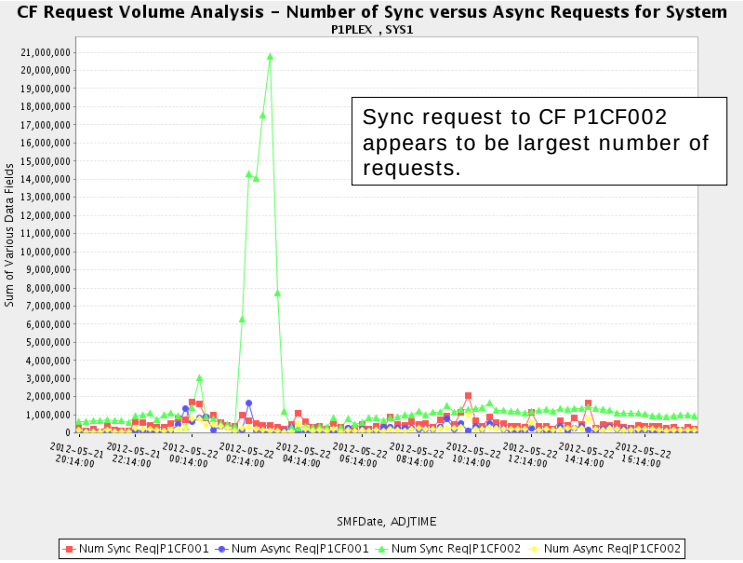
COUPLING FACILITY NAME = P1CF001

COUPLING FACILITY STRUCTURE ACTIVITY

STRUCTURE NAME = DSNDB10_LOCK1 TYPE = LOCK STATUS = ACTIVE

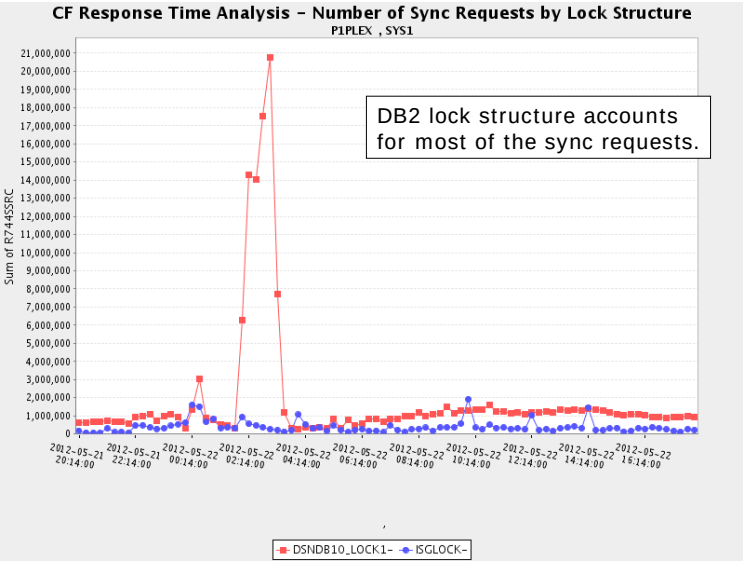
SYSTEM NAME	# REQ TOTAL AVG/SEC		REQUESTS # REQ	% OF ALL	-SERV TIME(MIC)- AVG	STD_DEV	REASON	DELAYED REQUESTS # REQ	% OF REQ	---- AVG TIME(MIC) -- /DEL	STD_DEV	/A
SYS0	82847	SYNC	79K	1.7	20.0	3.9	NO SCH	0	0.0	0.0	0.0	0
	92.05	ASYNC	3788	0.1	123.5	136.9	PR WT	0	0.0	0.0	0.0	0
		CHNGD	0	0.0	INCLUDED	IN ASYNC	PR CMP	0	0.0	0.0	0.0	0
SYS1	1588K	SYNC	1508K	31.8	20.5	4.2	NO SCH	0	0.0	0.0	0.0	0
	1764	ASYNC	80K	1.7	72.1	16.8	PR WT	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
SYS2	1163K	SYNC	1120K	23.7	20.8	4.2	NO SCH	0	0.0	0.0	0.0	0
	1293	ASYNC	43K	0.9	95.6	100.0	PR WT	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
SYS3	723K	SYNC	706K	14.9	20.3	5.5	NO SCH	0	0.0	0.0	0.0	0
	803.2	ASYNC	17K	0.4	175.1	276.0	PR WT	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
SYS4	1179K	SYNC	1134K	24.0	20.8	4.6	NO SCH	0	0.0	0.0	0.0	0
	1310	ASYNC	45K	0.9	90.3	171.8	PR WT	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
TOTAL	4736K	SYNC	4548K	96.0	20.6	4.5	NO SCH	0	0.0	0.0	0.0	0
	5262	ASYNC	188K	4.0	92.2	132.4	PR WT	0	0.0	0.0	0.0	0

Looking at Volume of Requests SYS1 is Sending to CF

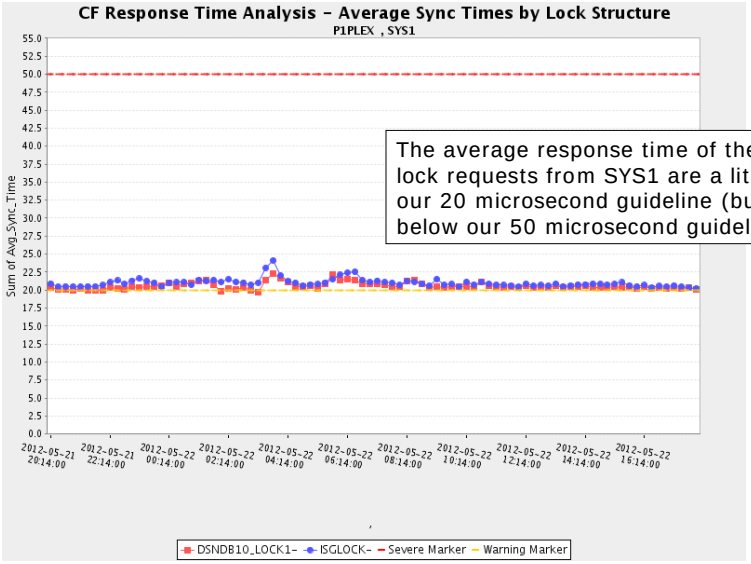


Sync request to CF P1CF002 appears to be largest number of requests.

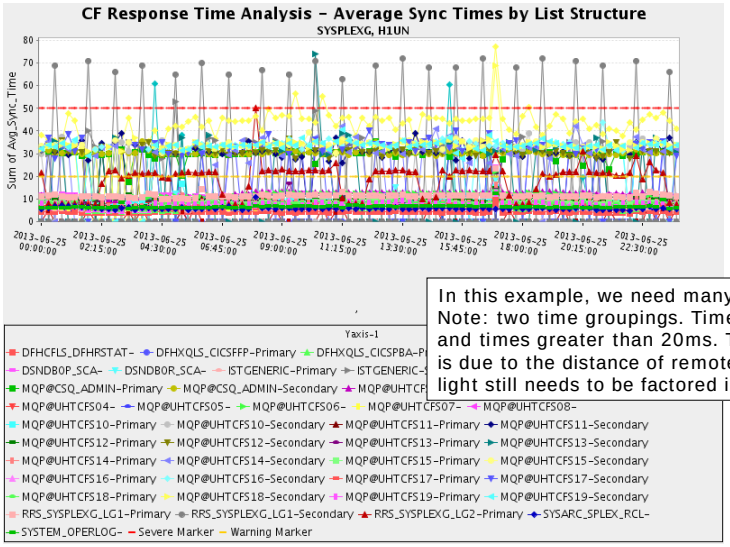
Number of Sync CF Requests – Lock Structures requests to SYS1



Average Sync Request Response Times – Lock Structures

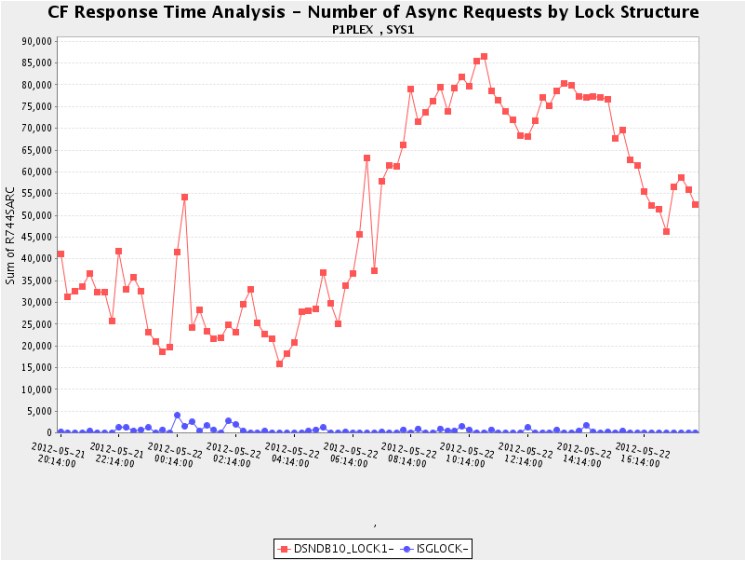


Average Sync Request Response Times – Lock Structures - Alternative Example showing RTs to Remote CF

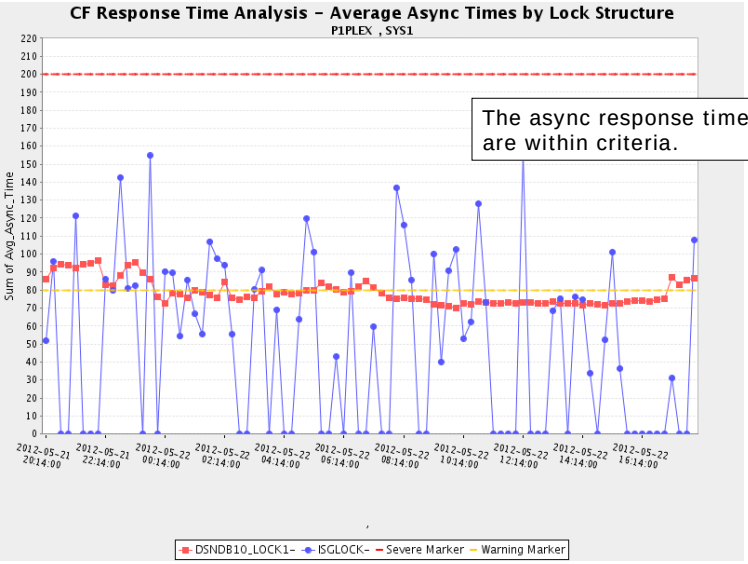


In this example, we need many lock structures. Note: two time groupings. Times less than 20ms, and times greater than 20ms. This difference is due to the distance of remote CF. Speed of light still needs to be factored in.

Number of Async CF Requests – Lock Structures



Average Async Request Response Times – Lock Structures



What is the spin component of the host effect?

In other words… how many CPU seconds are consumed by the requesting z/OS system while it is 'spinning' waiting for the CF to respond to sync requests?

Performance Cost of Parallel Sysplex

- Host CPU effect
  - Cost to host (z/OS) system and its workloads by having it participate in a parallel Sysplex
- Host CPU effect varies based on
  - What portion of the workload is involved in data sharing
  - Access rate to the shared data
  - Hardware configuration for host, CF, and CF links
  - Number of systems in the Sysplex
- According to IBM, the typical observed performance cost for Parallel Sysplex is:
  - 3%
    - Cost of multisystem management
    - Cost of resource sharing
  - <10% - Cost of data sharing
  - 0.5% - Incremental cost of adding a new system image to the Sysplex
- Effects on individual transactions / jobs can vary widely

Coupling Technology versus Host Processor Speeds

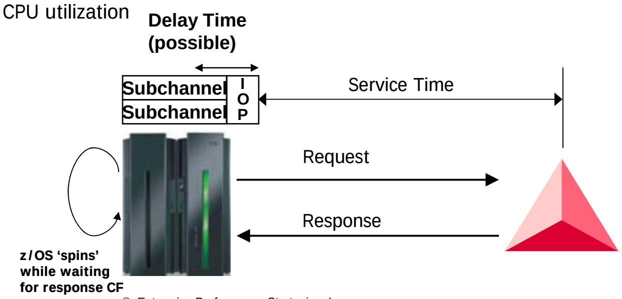
Source: The Top 10 Questions, Gary King, IBM

Host	z890	z990	z9 BC	z9 EC	z10 BC	z10 EC	z196
z890 ISC	13%	15%	16%	17%	19%	21%	NA
z890 ICB	9%	10%	10%	11%	12%	13%	NA
z990 ISC	13%	14%	14%	15%	17%	19%	NA
z990 ICB	9%	9%	9%	10%	12%	13%	NA
z9 BC ISC	12%	13%	14%	15%	17%	19%	23%
z9 BC PSIFB 12X	NA	NA	NA	NA	13%	14%	16%
z9 BC ICB	8%	9%	9%	10%	11%	12%	NA
z9 EC ISC	12%	13%	13%	14%	16%	18%	22%
z9 EC PSIFB 12X	NA	NA	NA	NA	13%	14%	16%
z9 EC ICB	8%	8%	8%	9%	10%	11%	NA
z10 BC ISC	12%	13%	13%	14%	16%	18%	22%
z10 BC PSIFB 12X	NA	NA	11%	12%	13%	14%	15%
z10 BC ICB	8%	8%	8%	9%	10%	11%	NA
z10 EC ISC	11%	12%	12%	13%	15%	17%	22%
z10 EC PSIFB 12X	NA	NA	10%	11%	12%	13%	15%
z10 EC ICB	7%	7%	7%	8%	9%	10%	NA
z196 ISC	NA	NA	11%	12%	14%	16%	21%
z196 PSIFB 12X	NA	NA	9%	10%	11%	12%	14%

Sync Spin Seconds as a component of Host Effect (One of four primary components)

- One component of the estimated host effect is CPU seconds consumed due to sync immediate Spin
  - Sync Immediate requests cause processor issuing the request to 'spin'
  - How many CPU seconds did the sending z/OS LPAR spend spinning?
    - Logical processor unavailable to other work running in the same LPAR
    - Physical processor that logical processor is dispatched to is unavailable to other LPARs
  - It is helpful to understand capacity consumed to these spinning conditions
    - It part of CPU utilization

Impacts response time of sender, and performance of sending system



Using CF Subchannel Activity Report to Calculate CPU Spin Seconds for System

- CPU seconds consumed due to sync immediate Spin can be calculated by the Coupling Facility Subchannel Activity Report
  - ***Remember to do this exercise for both coupling facilities!***

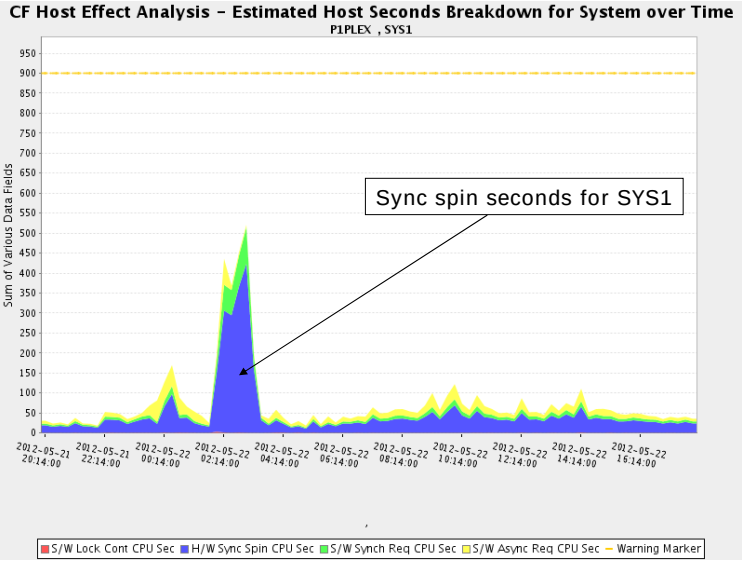
$$\text{CPU Seconds Spinning} = \frac{(\#\text{REQ Sync})*(\text{Sync Service Time})}{1{,}000{,}000}$$

$$\text{CPU Seconds Spinning} = \frac{(595{,}881)*(22)}{1{,}000{,}000} = 13.1 \text{ seconds CPU Spin}$$

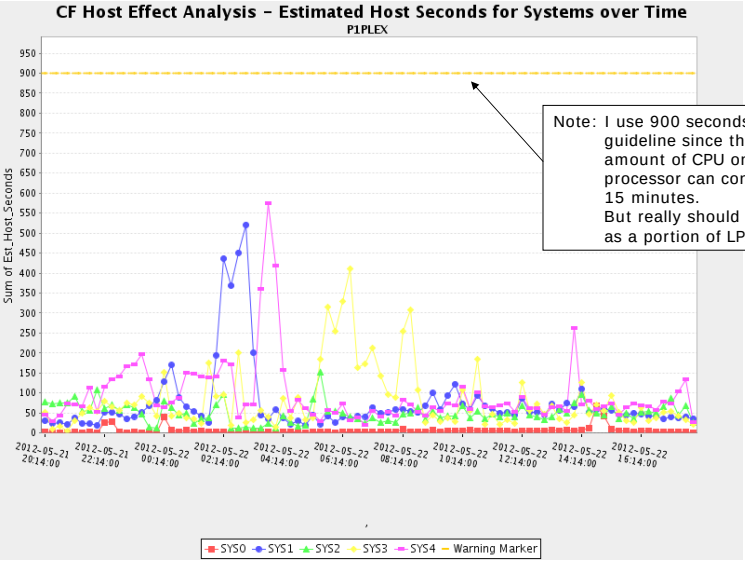
- If you wanted, you can now represent this as a subcomponent of LPAR Busy %

```
         # REQ                                ----------- REQUESTS -----------   ------------------ DELAYED R
SYSTEM   TOTAL    -- CF LINKS --  PTH                  #   -SERVICE TIME(MIC)-                 #    % OF  -----
NAME     AVG/SEC TYPE  GEN  USE   BUSY                REQ     AVG    STD_DEV                 REQ    REQ   /DEL

SYS1     927793  CFP     2    2      0   SYNC      595881    22.0       13.7   LIST/CACHE  466    0.1  235.5
         1030.9  SUBCH  14   14          ASYNC     323352    94.1      115.6   LOCK         36    0.0  117.3
                                         CHANGED      502  INCLUDED IN ASYNC   TOTAL       502    0.1
                                         UNSUCC         0     0.0        0.0
```

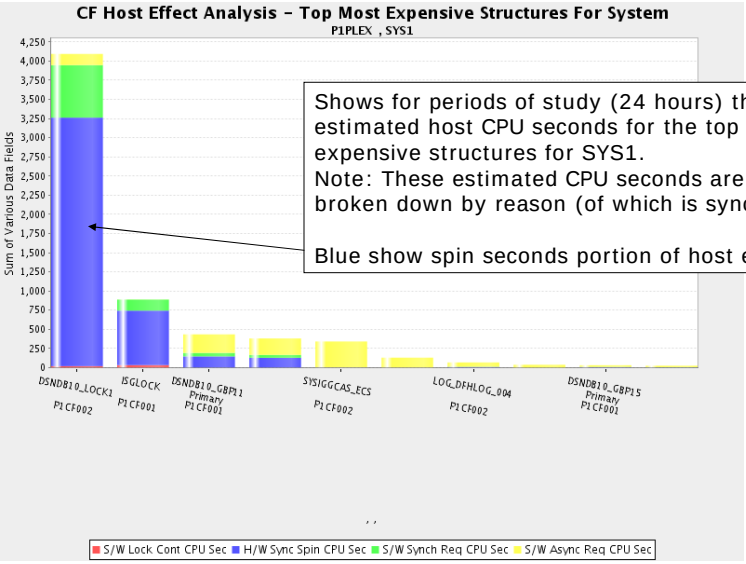
Example: Estimated Host Effect Seconds for SYS1



Looking at Estimated Host Effect CPU Second by System



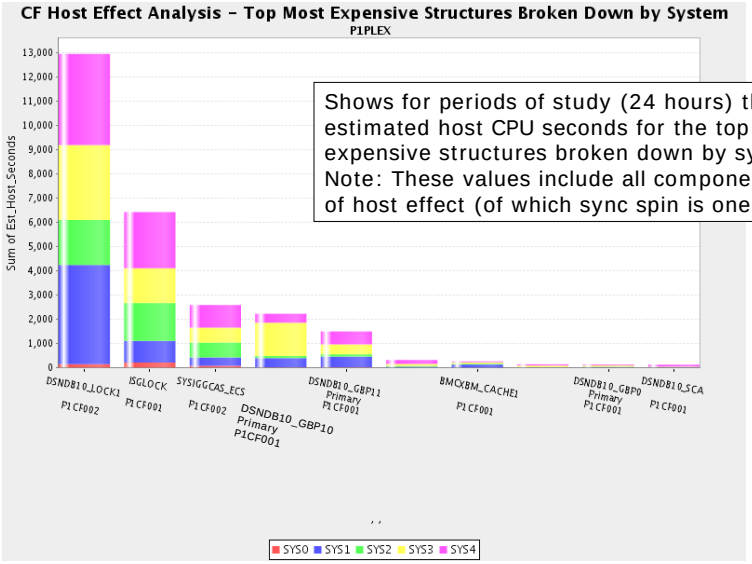
Example: SYS1 Most Expensive Structures



Shows for periods of study (24 hours) the estimated host CPU seconds for the top most expensive structures for SYS1.
Note: These estimated CPU seconds are broken down by reason (of which is sync spin).

Blue show spin seconds portion of host effect.

When Calculated by Structure…

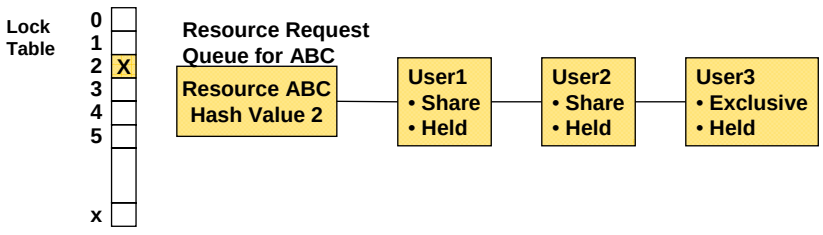


Shows for periods of study (24 hours) the estimated host CPU seconds for the top most expensive structures broken down by system
Note: These values include all components of host effect (of which sync spin is one)

What percentage of Lock requests are due to false contention?

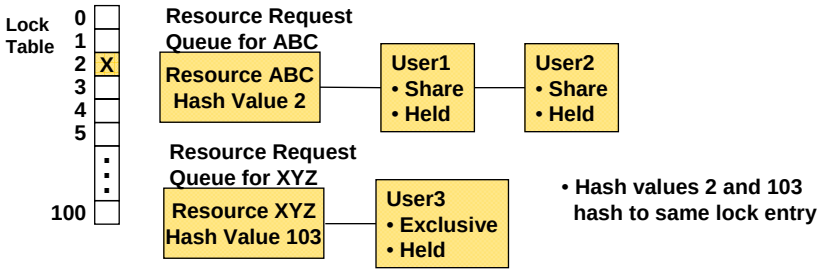
Types of Lock Contention

- Real Lock Contention
  - Contention caused by multiple units of work attempting to serialize on the same resource
  - Factors that influence real lock contention
    - How the locks are being used
    - Amount of time locks are held
    - Degree of data sharing
  - Alleviate real lock contention by tuning the workload (not by tuning the Sysplex or CF structures)



Types of Lock Contention

- False Lock Contention
  - When multiple lock names are hashed to the same lock entry
    - Results in significant excessive processing overhead to resolve
  - Factors that influence false lock contention
    - Size of lock structure
    - Granularity of locking (record, file, block)
    - Concurrent users connected to lock structure
  - Alleviate false lock contention by increasing lock structure size



Tuning Lock Structures

- Lock structures can incur two types of contention
  - True lock contention
    - Multiple units of work attempting to serialize on the same resource
    - Factors that influence real lock contention
      - how the locks are being used and amount of time locks are held
      - degree of data sharing
    - Alleviate real lock contention by tuning the workload (not by tuning the sysplex or CF structures)
  - False lock contention
    - When multiple lock names are hashed to the same lock entry
      - Results in significant excessive processing overhead to resolve
    - Factors that influence false lock contention
      - size of lock structure and granularity of locking (record, file, block)
      - concurrent users connected to lock structure
    - Alleviate false lock contention by increasing lock structure size
      - Be careful of very large structures. Impact to rebuild during recovery may outweigh the performance impact of false contention

Tuning Lock Structures

- Use Coupling Facility Structure Summary
  - Look at LOCK ENTRIES (TOT/CUR)
    - Is current approaching total as workload is growing
      - False contention may happen soon in the future as workload continues to grow
      - May need to increase the allocated size
  - All lock requests are synchronous
    - Make sure service time are within guidelines

STRUCTURE SUMMARY

TYPE	STRUCTURE NAME	STATUS	CHG	ALLOC SIZE	% OF CF STORAGE	# REQ	% OF ALL REQ	AVG REQ/ SEC	LST/DIR ENTRIES TOT/CUR	DATA ELEMENTS TOT/CUR	LOCK ENTRIES TOT/CUR	DIR REC/ DIR REC XI'S
LOCK	DSNDGP2_LOCK1	ACTIVE		32M	1.3%	112196	4.7%	124.66	102K	0	8389K	N/A
									358	0	19K	N/A
	DSNDGP3_LOCK1	ACTIVE		32M	1.3%	207627	8.7%	230.70	102K	0	8389K	N/A
									2365	0	72K	N/A
	DSNDGP5_LOCK1	ACTIVE		32M	1.3%	5953	0.2%	6.61	102K	0	8389K	N/A
									54	0	5717	N/A
	(edited…)											
	DSNDGT1_LOCK1	ACTIVE		8M	0.3%	119395	5.0%	132.66	25K	0	2097K	N/A
									419	0	0	N/A
	DSNDGT3_LOCK1	ACTIVE		8M	0.3%	3632	0.2%	4.04	25K	0	2097K	N/A
									1	0	0	N/A

Tuning Lock Structures

- Monitor true lock contention
  - Less than 5% CONT events of REQ TOTAL
  - Lock contention = percent of CONT of Request Total
    - ROT: < .1% for CICS/DBCTL, CICS/VSAM RLS, GRSSTAR
    - ROT: < 1% for IMS-TM/DB2 (less than 5% is probably OK)
    - If missing ROT, look at other areas (like batch) that may be using the locks

COUPLING FACILITY STRUCTURE ACTIVITY

STRUCTURE NAME = DSNDB3G_LOCK1 TYPE = LOCK STATUS = ACTIVE

SYSTEM NAME	# REQ TOTAL AVG/SEC	REQUESTS # REQ	% OF ALL	AVG -SERV TIME(MIC)-	STD_DEV	REASON	DELAYED REQUESTS # REQ	% OF REQ	AVG TIME(MIC) /DEL	STD_DEV	/ALL	EXTERNAL REQUEST CONTENTIONS	
SYSA	1946K	SYNC 1946K	6.7	15.6	8.4	NO SCH	0	0.0	0.0	0.0	0.0	REQ TOTAL	2226K
	1081	ASYNC 0	0.0	0.0	0.0	PR WT	0	0.0	0.0	0.0	0.0	REQ DEFERRED	67K
		CHNGD 0	0.0	INCLUDED IN ASYNC		PR CMP	0	0.0	0.0	0.0	0.0	-CONT	67K
												-FALSE CONT	16K
SYSB	3471K	SYNC 3471K	11.9	12.8	7.5	NO SCH	38	0.0	11.4	4.5	0.0	REQ TOTAL	3617K
	1928	ASYNC 0	0.0	0.0	0.0	PR WT	0	0.0	0.0	0.0	0.0	REQ DEFERRED	77K
		CHNGD 0	0.0	INCLUDED IN ASYNC		PR CMP	0	0.0	0.0	0.0	0.0	-CONT	77K
												-FALSE CONT	14K
(edited…)													
TOTAL	29048K	SYNC 29M	100	12.9	7.6	NO SCH	785	0.0	9.7	16.6	0.0	REQ TOTAL	28M
	16138	ASYNC 4497	0.0	81.5	87.9	PR WT	0	0.0	0.0	0.0	0.0	REQ DEFERRED	376K
		CHNGD 0	0.0			PR CMP	0	0.0	0.0	0.0	0.0	-CONT	375K
												-FALSE CONT	81K

Tuning Lock Structures cont…

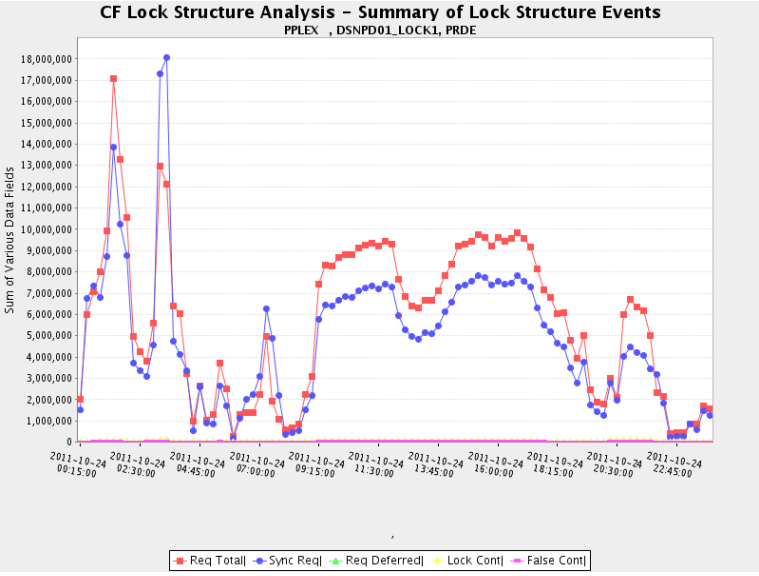
- Monitor false lock contention
  - Recommend less than 0.5% FALSE CONT of REQ TOTAL
  - False contention = FALSE CONT / REQ TOTAL
  - Make sure it is zero, but take into consideration the increase in rebuild time
  - If greater, then increase structure size (increases number of lock entries)

COUPLING FACILITY STRUCTURE ACTIVITY

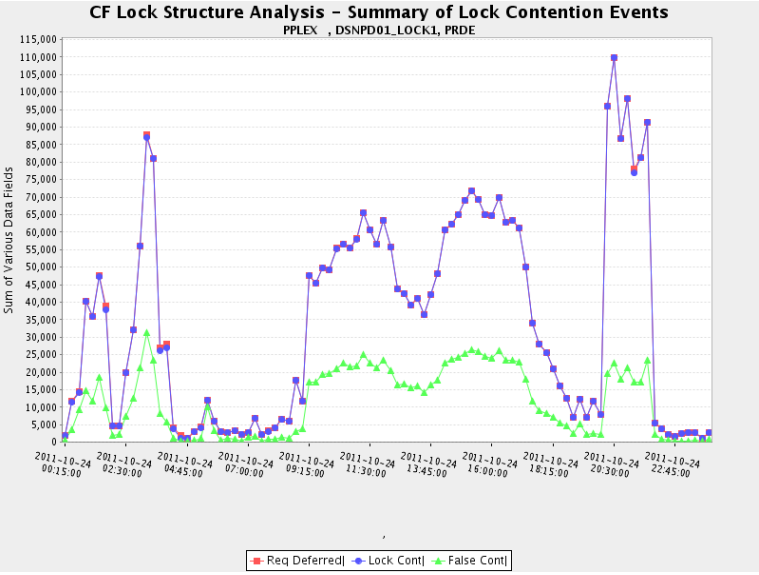
STRUCTURE NAME = DSNDB3G_LOCK1 TYPE = LOCK STATUS = ACTIVE

SYSTEM NAME	# REQ TOTAL AVG/SEC		REQUESTS # REQ	% OF ALL	-SERV TIME(MIC)- AVG	STD_DEV	REASON	DELAYED REQUESTS # REQ	% OF REQ	---- AVG TIME(MIC) ----- /DEL	STD_DEV	/ALL	EXTERNAL REQUEST CONTENTIONS	
SYSA	1946K	SYNC	1946K	6.7	15.6	8.4	NO SCH	0	0.0	0.0	0.0	0.0	REQ TOTAL	2226K
	1081	ASYNC	0	0.0	0.0	0.0	PR WT	0	0.0	0.0	0.0	0.0	REQ DEFERRED	67K
		CHNGD	0	0.0	INCLUDED IN ASYNC		PR CMP	0	0.0	0.0	0.0	0.0	-CONT	67K
													-FALSE CONT	16K
SYSB	3471K	SYNC	3471K	11.9	12.8	7.5	NO SCH	38	0.0	11.4	4.5	0.0	REQ TOTAL	3617K
	1928	ASYNC	0	0.0	0.0	0.0	PR WT	0	0.0	0.0	0.0	0.0	REQ DEFERRED	77K
		CHNGD	0	0.0	INCLUDED IN ASYNC		PR CMP	0	0.0	0.0	0.0	0.0	-CONT	77K
													-FALSE CONT	14K
(edited…)														
TOTAL	29048K	SYNC	29M	100	12.9	7.6	NO SCH	785	0.0	9.7	16.6	0.0	REQ TOTAL	28M
	16138	ASYNC	4497	0.0	81.5	87.9	PR WT	0	0.0	0.0	0.0	0.0	REQ DEFERRED	376K
		CHNGD	0	0.0			PR CMP	0	0.0	0.0	0.0	0.0	-CONT	375K
													-FALSE CONT	81K

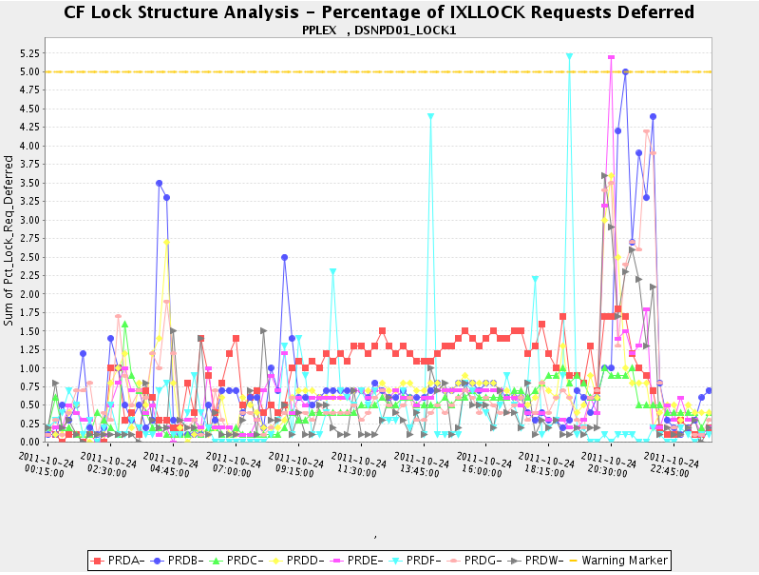
Lock Structure Events



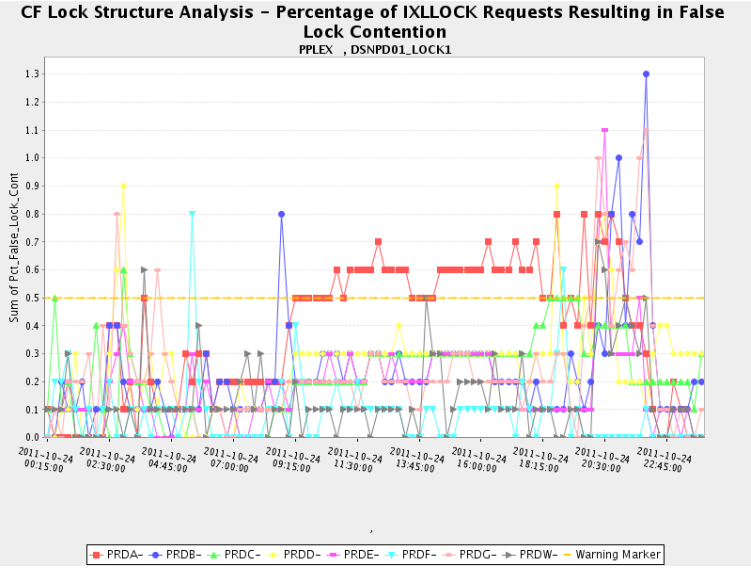
Lock Structure Events



Lock Structure Events



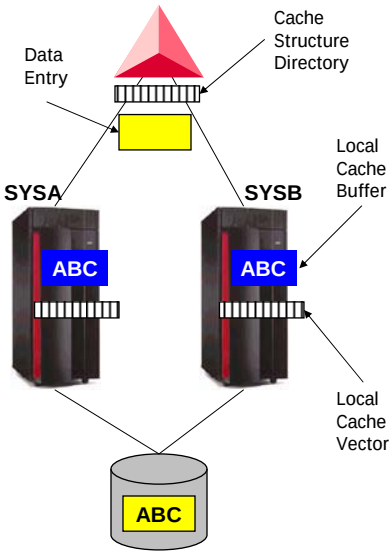
Lock Structure Events



Are there cross invalidates due to directory reclaims?

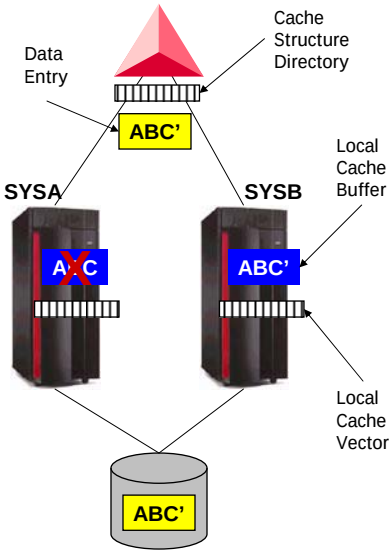
General Case of Shared Data Read (Generic example)

- Initial Read (if the data has never been read before)
  - Read data and register interest in data into the coupling facility
  - Data may or may not have also been written to the CF upon read
  - Coupling facility always knows which systems have interest in which data
  - Local cache vectors indicate if a system's data is the most recent copy or is invalidated
- Subsequent read / reference of the data
  - Local cache vectors used to determine if local buffers contain the most recent copy (and if not the data is re-read).
    - May have been cross invalidated due to an update.
  - Updated page is then gotten from either CF or DASD



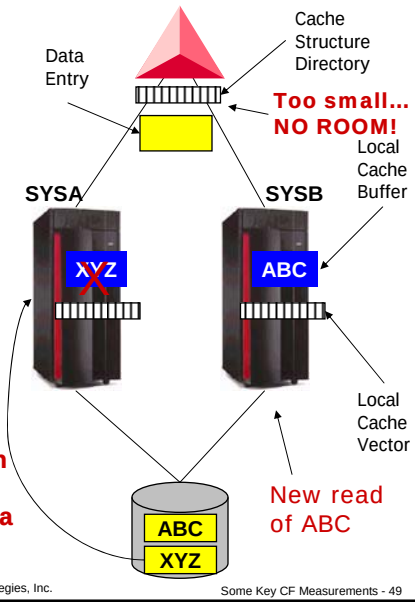
General Case of Cross Invalidates Due To Writes (Generic example)

- To update the data
  - Updating system must obtain a lock to serialize data update
  - Data is updated in local buffers
  - CF notified of update
  - CF cross invalidates (XI) all the local buffers of the other systems that have registered an interest in this data by marking the data as invalid in the local cache vector tables of each system.
  - Based on installation setup, the updated data may or may not be written immediately to the CF and/or DASD



General Case Cross Invalidate Due to Directory Reclaim (Generic example)

- XI for Directory Reclaim count
  - The number of times that a directory entry was stolen and XI signals had to be sent to a system because the page for the directory entry was cached in one or more systems
- Directory Entry Reclaim count
  - The number of times that a page name assignment required a coupling facility directory entry to be reclaimed (stolen).



Cross Invalidates Due To Directory Reclaims

- Cross Invalidates (XIs)
  - When a data item residing in a local buffer was marked invalid by the coupling facility
    - To the cache structure user, this means the data item must be re-acquired from DASD or perhaps the coupling facility structure, and interest in the item must be re-registered in the coupling facility structure.
  - There are 5 reasons for Cross Invalids
    - One reason is XI due to Directory Reclaim
- XI for Directory Reclaim
  - The number of times that a directory entry was stolen and XI signals had to be sent to a system because the page for the directory entry was cached in one or more systems
- Directory Entry Reclaims
  - The number of times that a page name assignment required a coupling facility directory entry to be reclaimed (stolen).

Coupling Facility Usage Summary for CF

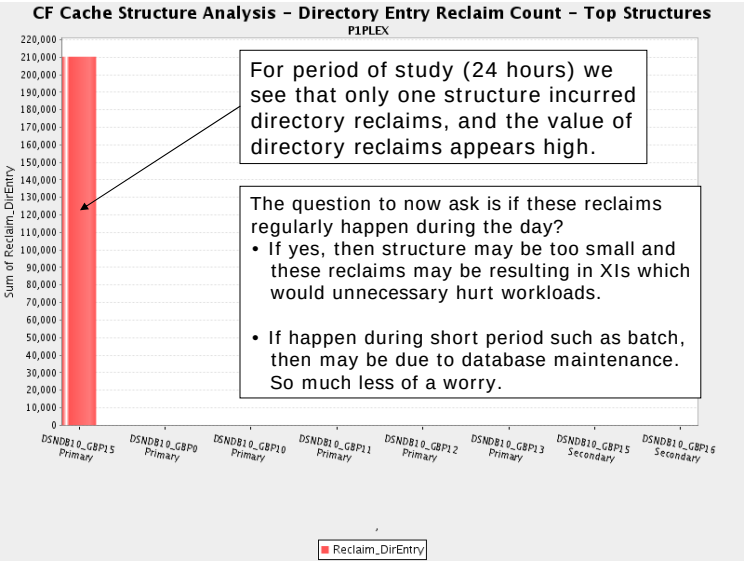
- Provides measurements for total activity to a structure, and usage summary

```
                                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 V1R11              SYSPLEX P1PLEX              DATE 05/22/2012          INTERVAL 015.00.000
                             RPT VERSION V1R11 RMF       TIME 08.59.00            CYCLE 01.000 SECONDS
-------------------------------------------------------------------------------------------------------------------------
COUPLING FACILITY NAME = P1CFALT
TOTAL SAMPLES(AVG) =   900  (MAX) =   900  (MIN) =   900
-------------------------------------------------------------------------------------------------------------------------
                                          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
LIST  LOG_DFHLOG_001    ACTIVE            12M       0.2   18341   0.3    1.2   20.38    2408     9736       N/A      N/A
                                                                                          1675     5921       N/A      N/A
      LOG_DFHLOG_002    ACTIVE            12M       0.2    3272   0.1    0.2    3.64    2408     9736       N/A      N/A
                                                                                           950     3907       N/A      N/A
      LOG_DFHLOG_003    ACTIVE            12M       0.2   10355   0.2    0.6   11.51    2408     9736       N/A      N/A
                                                                                          1623     5655       N/A      N/A
      LOG_DFHLOG_004    ACTIVE            12M       0.2   38674   0.7    2.0   42.97    2408     9736       N/A      N/A
                                                                                          1336     4830       N/A      N/A

LOCK  DSNDB10_LOCK1     ACTIVE           256M       4.4    4736K  84.7   70.0  5262.0     368K        0       67M      N/A
                                                                                          3794        0      645K      N/A

CACHE DSNDB10_GBP0      ACTIVE            65M       1.1   14612   0.3    0.7   16.24      85K     8472       N/A        0
                        SEC                                                                44       44       N/A        0
      DSNDB10_GBP10     ACTIVE             1G      17.8   20628   0.4    2.1   22.92    1397K     140K       N/A        0
                        SEC                                                               173      173       N/A        0
      DSNDB10_GBP11     ACTIVE             1G      17.8   79094   1.4    4.8   87.88    1397K     140K       N/A        0
                        SEC                                                                62       62       N/A        0
      DSNDB10_GBP12     ACTIVE            17M       0.3     147   0.0    0.1    0.16      18K     1845       N/A        0
                        SEC                                                                 1        1       N/A        0
      etc…
```


Analyzing Cache Structure Activity Example

```
STRUCTURE NAME = DSNDB10_GBP15     TYPE = CACHE   STATUS = ACTIVE PRIMARY
             # 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

   SYS0         0    SYNC      0     0.0     0.0     0.0     NO SCH     0    0.0    0.0        0.0    0.0
              0.00   ASYNC     0     0.0     0.0     0.0     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

   SYS1     16323    SYNC   2680    16.0    24.4     4.4     NO SCH     1    0.0  974.0        0.0    0.1
             18.14   ASYNC    14K   81.2    49.1    25.2     PR WT      0    0.0    0.0        0.0    0.0
                     CHNGD     1     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

   SYS2         0    SYNC      0     0.0     0.0     0.0     NO SCH     0    0.0    0.0        0.0    0.0
              0.00   ASYNC     0     0.0     0.0     0.0     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

   SYS3         0    SYNC      0     0.0     0.0     0.0     NO SCH     0    0.0    0.0        0.0    0.0
              0.00   ASYNC     0     0.0     0.0     0.0     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

   SYS4       475    SYNC      3     0.0    51.3     0.6     NO SCH     0    0.0    0.0        0.0    0.0
              0.53   ASYNC   472     2.8    91.4    89.1     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    16798    SYNC   2683    16.0    24.4     4.5     NO SCH     1    0.0  974.0        0.0    0.1
             18.66   ASYNC    14K   84.0    50.5    30.6     PR WT      0    0.0    0.0        0.0    0.0
                     CHNGD     1     0.0                     PR CMP     0    0.0    0.0        0.0    0.0
                                                             DUMP       0    0.0    0.0        0.0    0.0

                                                                  -- DATA ACCESS ---
                                                                  READS          19
                                                                  WRITES        186
                                                                  CASTOUTS      181
                                                                  XI'S          262
```

Are any Cache Structures doing Directory Reclaims?

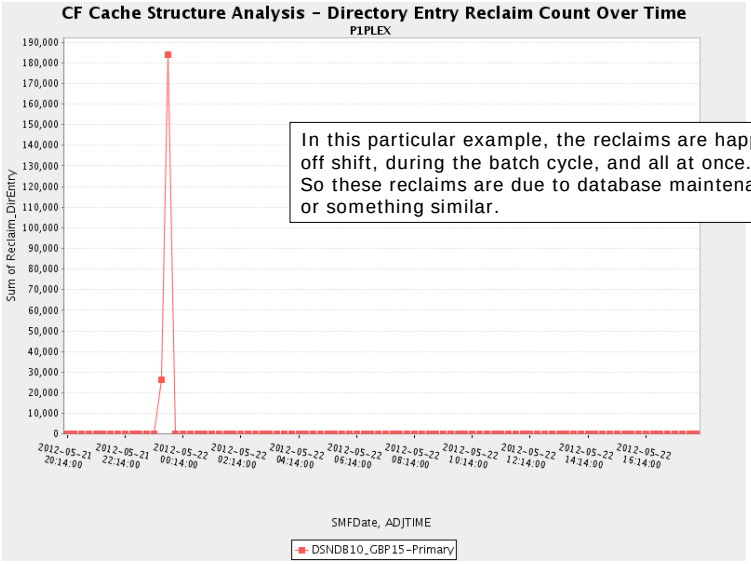


For period of study (24 hours) we see that only one structure incurred directory reclaims, and the value of directory reclaims appears high.

The question to now ask is if these reclaims regularly happen during the day?

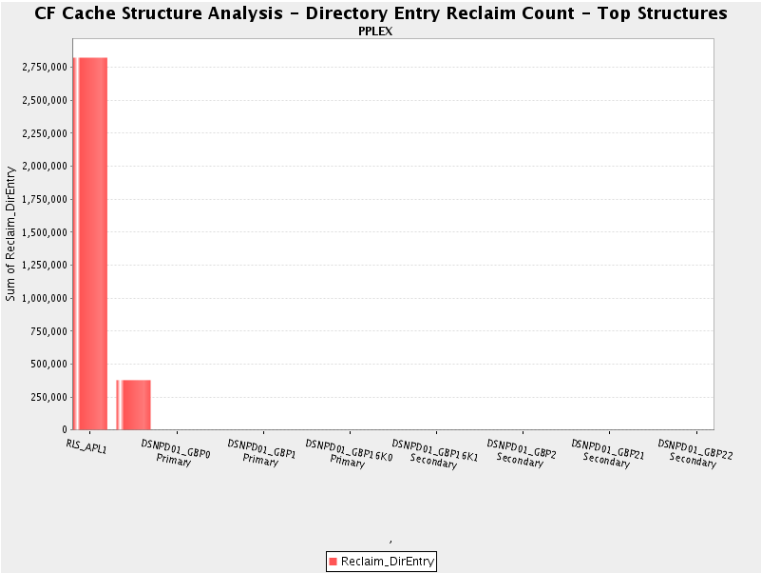
- If yes, then structure may be too small and these reclaims may be resulting in XIs which would unnecessary hurt workloads.
- If happen during short period such as batch, then may be due to database maintenance. So much less of a worry.

Example of Directory Reclaims During Batch

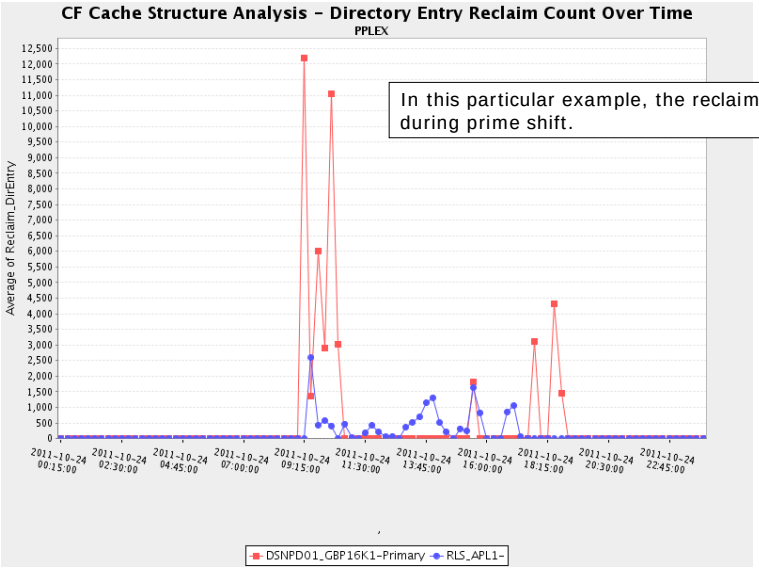


In this particular example, the reclaims are happening off shift, during the batch cycle, and all at once.
So these reclaims are due to database maintenance, or something similar.

Directory Reclaims in 24 hours (different Sysplex example)

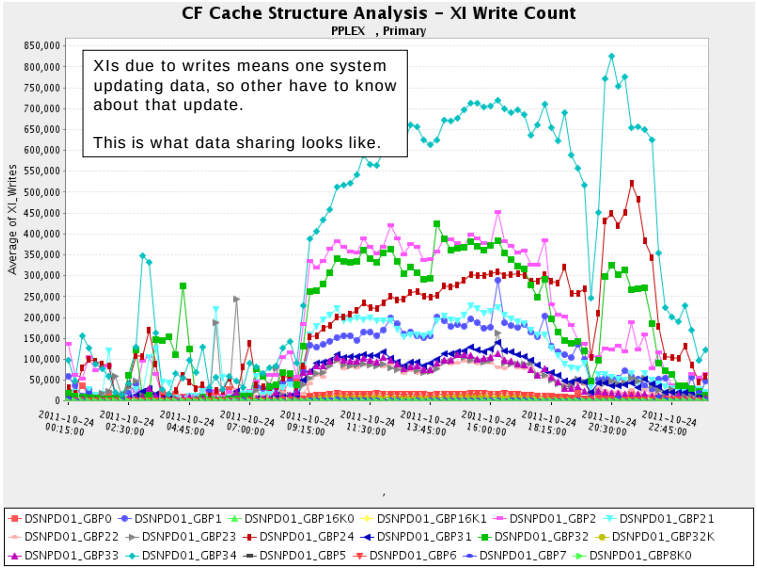


Directory Reclaims Over Time (different Sysplex example)

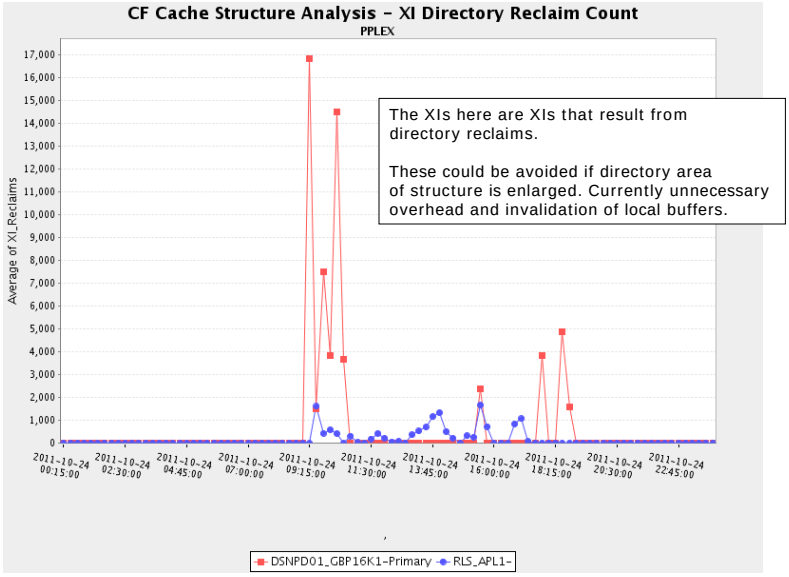


In this particular example, the reclaims are happening during prime shift.

Cross Invalidates Due to Writes (different Sysplex example)



Cross Invalidates Due to Directory Reclaims (different Sysplex example)



What is the structure configuration?

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Coupling Facility Usage Summary

- Provides an overview of how well the resources in CF are being utilized
  - Report divided up into three primary sections
    - Structure Summary - 1st Section of the report
    - Storage Summary - Middle Section of the report
    - Processor Summary - Final section of the report

```
                              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 V1R11            SYSPLEX P1PLEX          DATE 05/22/2012          INTERVAL 015.00.000
                           RPT VERSION V1R11 RMF   TIME 08.59.00            CYCLE 01.000 SECONDS
--------------------------------------------------------------------------------------------------------------
 COUPLING FACILITY NAME = P1CF002
 TOTAL SAMPLES(AVG) =   900  (MAX) =   900  (MIN) =   900
--------------------------------------------------------------------------------------------------------------
                                     COUPLING  FACILITY  USAGE  SUMMARY
--------------------------------------------------------------------------------------------------------------
 STRUCTURE SUMMARY
--------------------------------------------------------------------------------------------------------------
         (edited…)
                      Normally reports summary of all structures

--------------------------------------------------------------------------------------------------------------
 STORAGE SUMMARY
--------------------------------------------------------------------------------------------------------------
         (edited…)
                      Normally reports storage usage

 PROCESSOR SUMMARY
--------------------------------------------------------------------------------------------------------------
         (edited…)
                      Normally reports processor usage
```

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Coupling Facility Usage Summary for CF

- Provides measurements for total activity to a structure, and usage summary

```
                    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 V1R11          SYSPLEX P1PLEX        DATE 05/22/2012        INTERVAL 015.00.000
                       RPT VERSION V1R11 RMF TIME 08.59.00          CYCLE 01.000 SECONDS
------------------------------------------------------------------------------------------
 COUPLING FACILITY NAME = P1CF001
 TOTAL SAMPLES(AVG) =   900  (MAX) =   900  (MIN) =   900
------------------------------------------------------------------------------------------
                          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
LIST	LOG_DFHLOG_001	ACTIVE	12M	0.2	18341	0.3	1.2	20.38	2408	9736	N/A	N/A
									1675	5921	N/A	N/A
	LOG_DFHLOG_002	ACTIVE	12M	0.2	3272	0.1	0.2	3.64	2408	9736	N/A	N/A
									950	3907	N/A	N/A
	LOG_DFHLOG_003	ACTIVE	12M	0.2	10355	0.2	0.6	11.51	2408	9736	N/A	N/A
									1623	5655	N/A	N/A
	LOG_DFHLOG_004	ACTIVE	12M	0.2	38674	0.7	2.0	42.97	2408	9736	N/A	N/A
									1336	4830	N/A	N/A
LOCK	DSNDB10_LOCK1	ACTIVE	256M	4.4	4736K	84.7	70.0	5262.0	368K	0	67M	N/A
									3794	0	645K	N/A
CACHE	DSNDB10_GBP0	ACTIVE	65M	1.1	14612	0.3	0.7	16.24	85K	8472	N/A	0
		SEC							44	44	N/A	0
	DSNDB10_GBP10	ACTIVE	1G	17.8	20628	0.4	2.1	22.92	1397K	140K	N/A	0
		SEC							173	173	N/A	0
	DSNDB10_GBP11	ACTIVE	1G	17.8	79094	1.4	4.8	87.88	1397K	140K	N/A	0
		SEC							62	62	N/A	0
	DSNDB10_GBP12	ACTIVE	17M	0.3	147	0.0	0.1	0.16	18K	1845	N/A	0
		SEC							1	1	N/A	0

etc…

Example of Summarizing Structure Layout

Sysplex	CF_Name	Structure_Type	Structure_Name	Str_Duplexed	Str_Placement	Structure_Alloc_MB
P1PLEX	P1CF001	Cache	DSNDB10_GBP0	Y	Secondary	65
			DSNDB10_GBP10	Y	Secondary	1033
			DSNDB10_GBP11	Y	Secondary	1033
			DSNDB10_GBP12	Y	Secondary	17
			DSNDB10_GBP13	Y	Primary	17
			DSNDB10_GBP15	Y	Secondary	17
			DSNDB10_GBP16	Y	Primary	17
			DSNDB10_GBP16K0	Y	Secondary	25
			DSNDB10_GBP16K2	Y	Secondary	25
			DSNDB10_GBP32K	Y	Secondary	26
			DSNDB10_GBP4	Y	Secondary	49
			DSNDB10_GBP8K0	Y	Primary	25
			SYSIGGCAS_ECS	N		3
		ListU	LOG_DFHLOG_001	N		12
			LOG_DFHLOG_002	N		12
			LOG_DFHLOG_003	N		12
			LOG_DFHLOG_004	N		12
		Lock	DSNDB10_LOCK1	N		256

As a reminder…
Many Questions Need to be Asked of CF Measurements

- Configuration / Setup questions
- Link and general load performance questions
- Host effect questions
- Processor related questions
- Storage usage related questions
- List structure related questions
- Lock structure related questions
- Cache structure related questions
- Duplexing related questions

Thank you!

Please contact me directly if you need more information, or if you want to show me your measurements to get my thoughts.

Email: Peter.Enrico@EPStrategies.com