How many GCP MSU is my CF $tealing?

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Session LK in Woodcote

TOPICS

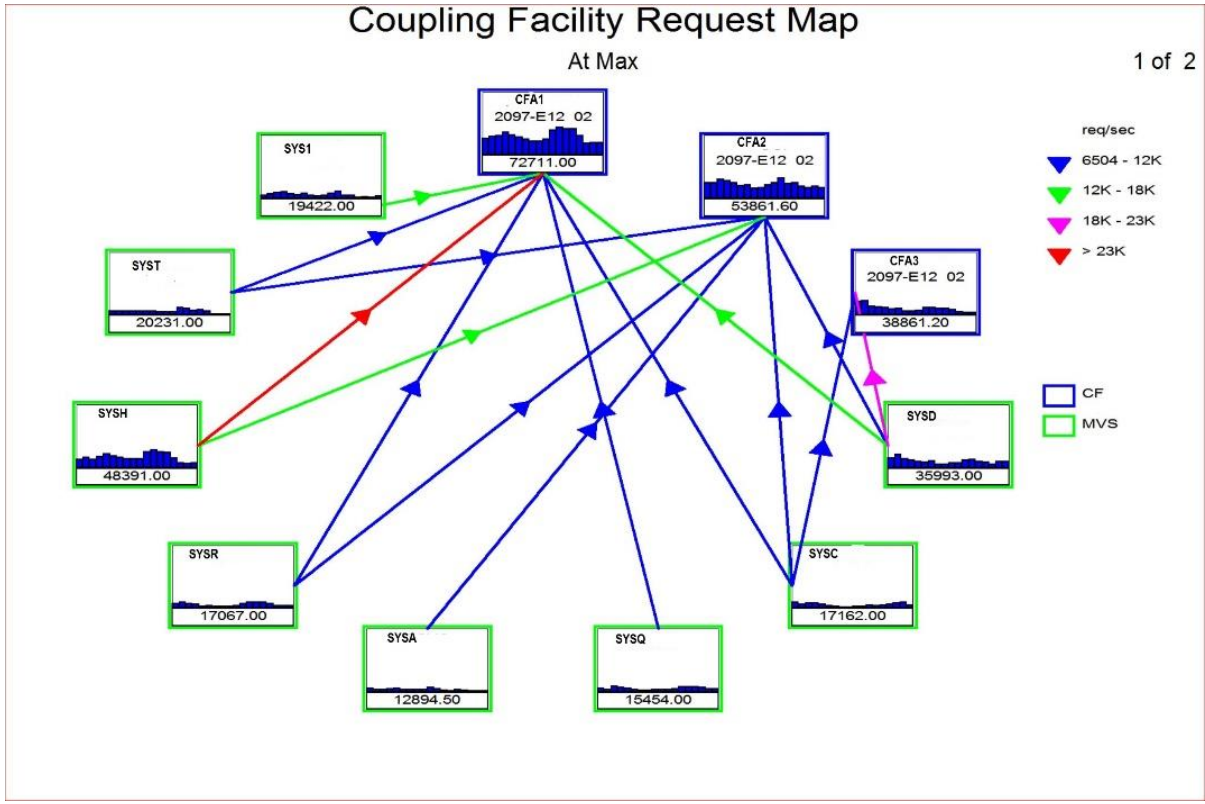
Coupling Facility Induced Spin Loop? (CoFiSL)

- **CoFiSL -** What is it?
- **Determining Impact -** to MLC and CPC Costs
- **Reducing Impact**
  - **Software changes** –
  - **Hardware changes** –
  - **Workload Changes –**

The Coupling Facility

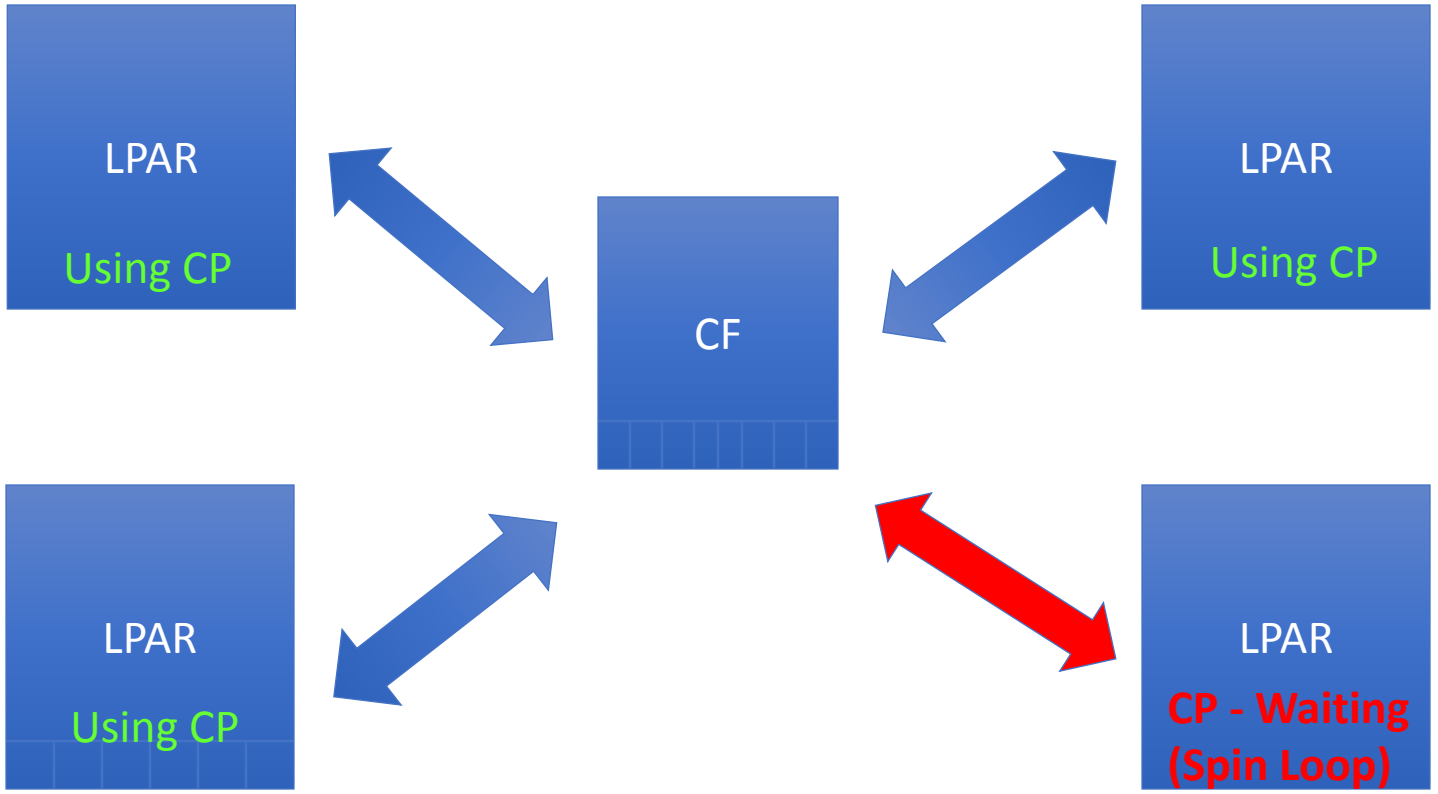
- **SYSPLEX** - highly scalable & available, cluster of LPARs sharing resources.
  - **Coupling Facility (CF)** a critical component for joining resource sharing performance and efficiency.
    - **Efficiency Concern** – response and volume of Synchronous requests

- **Major Synchronous requestors** are:
  - DB2 Data Sharing,
  - IMS data sharing
  - VSAM Record Level Sharing,
  - GRS

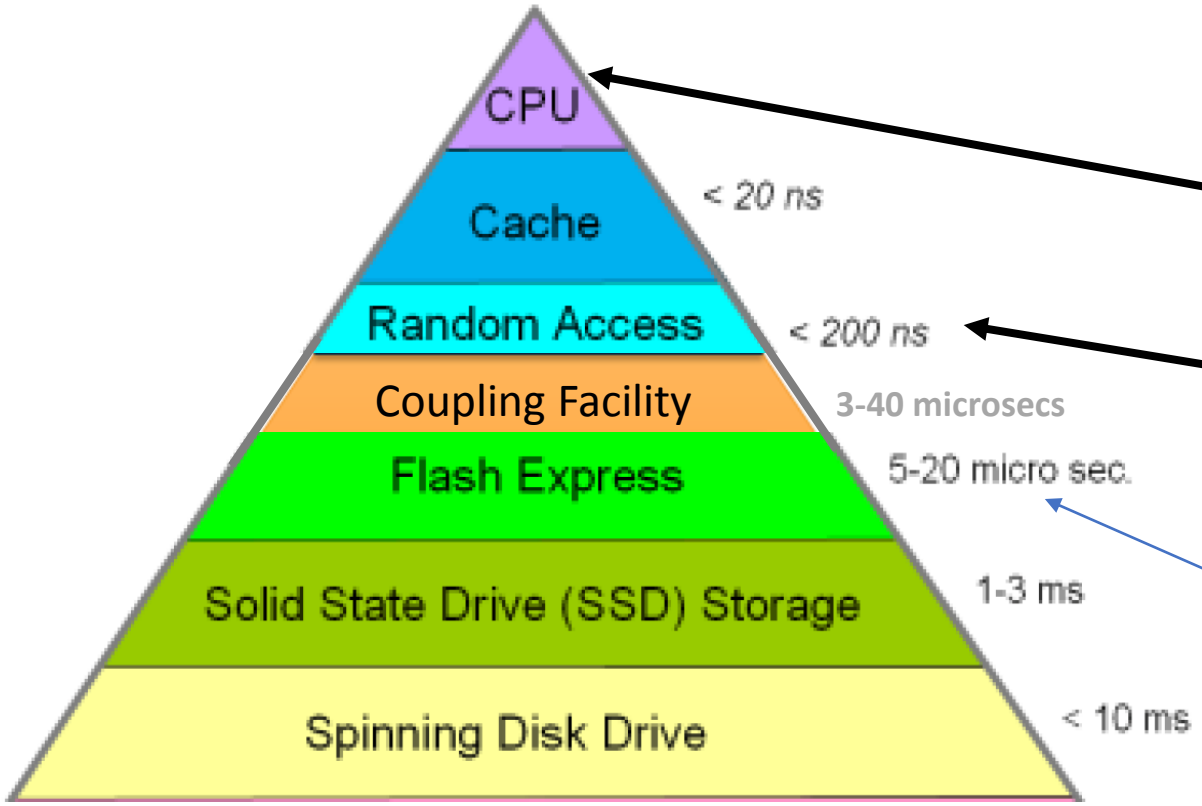


CoFiSL - Overview

Time Critical Requests – are ‘Synchronous’ Requests, the GCP waits for the CF reply.



Why should I care Now?



Relative speed of devices

CPU is faster everything else relatively slower

- RAM is now slow
  - > CHIP Cache on z196+
- Paging devices are slower
  - EC12+ Flash memory (SCM)

Requests Converted (Un / Reported)

RMF / CMF Request Converted #

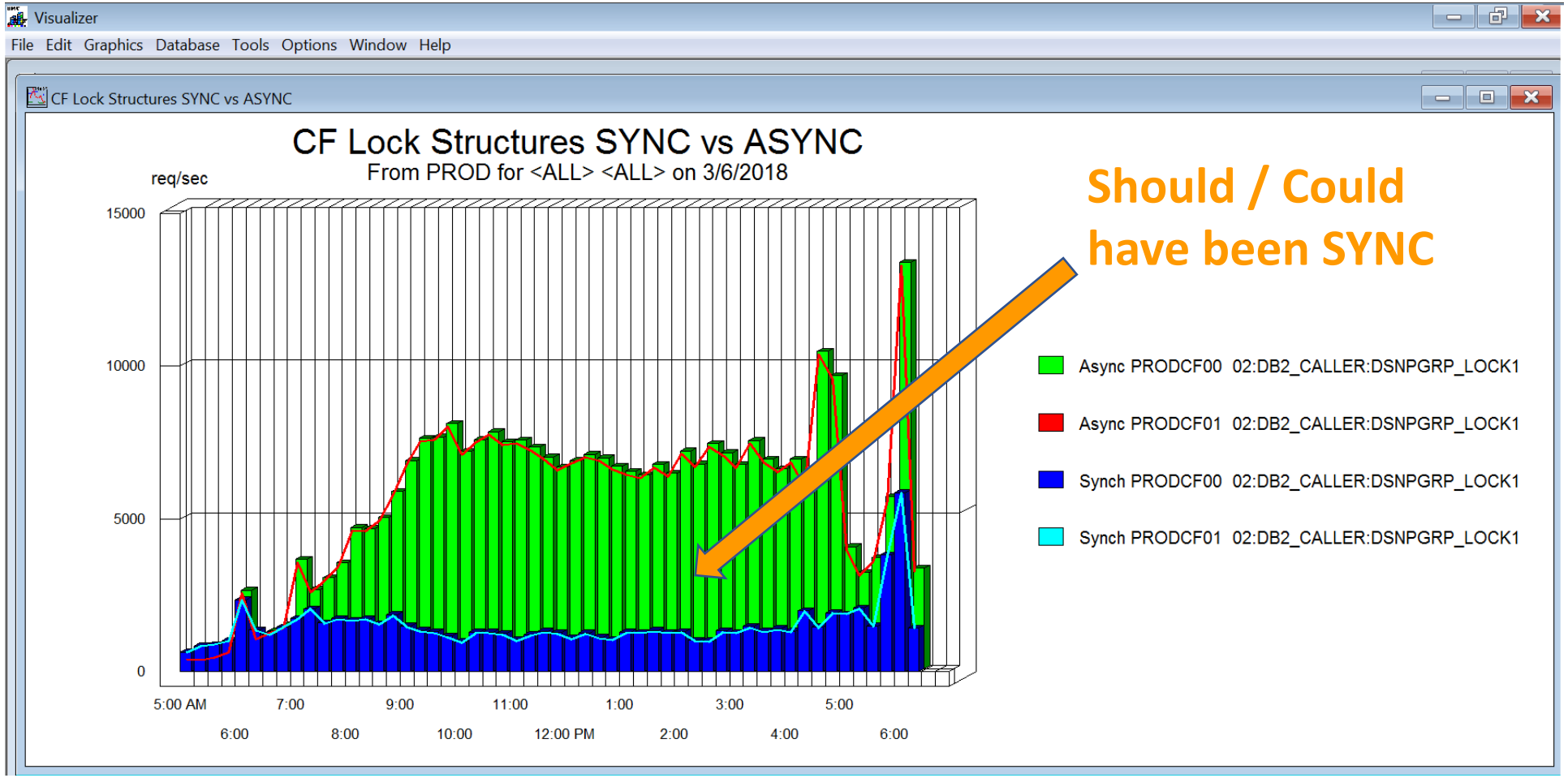
From No CF Subchannels Available

- **Immediate SYNC requests**
  - ***Spin*** waiting for the next available subchannel in most cases
- **Converted to ASYNCH** requests
  - Some locking requests eligible
  - **Unlikely** - with modern CF links with > 32 subchannels per CHPID

XES "Heuristic" Convert - HighSrvTm

- **Req Converted #** - 0
- **Reported as ASYNC** –
  - **Expected SYNC as ASYNC** - Look for w/o request converted count
- **SYNC Queue Subchannel** –
  - **May queue -** Some locking and IXLSYNCH operations
    - Reduces Spin Loop

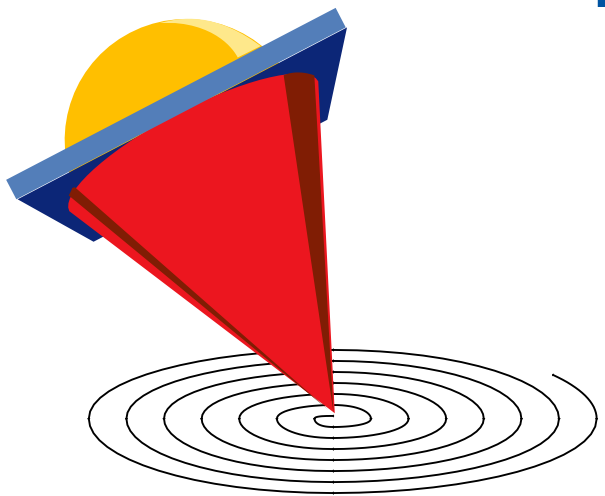
XES Converted – Avoid GCP Spin Duplexed Example



Determining Impact

Expensive GCP MSUs

How much is CF spin loop costing me?

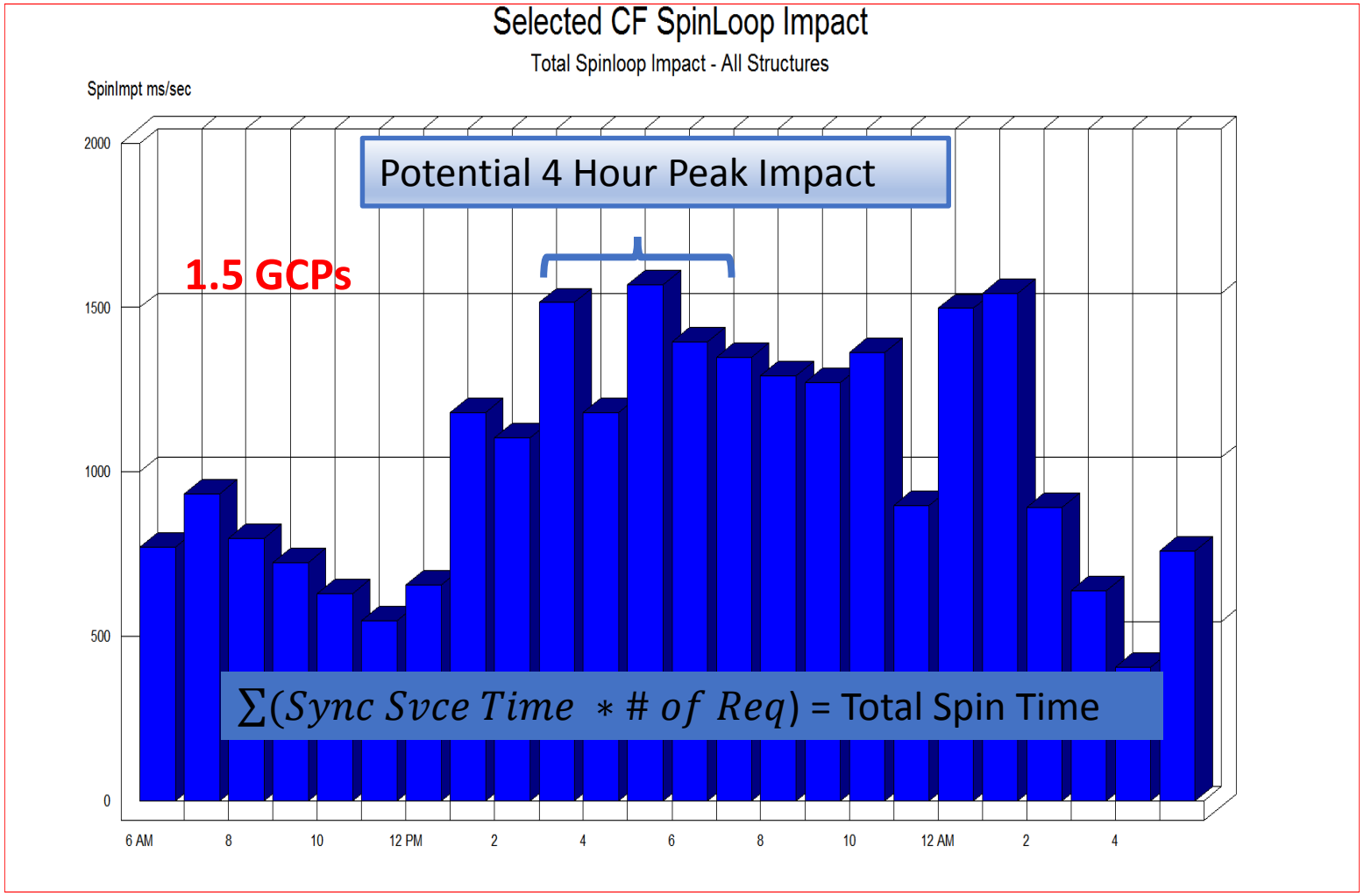


CF spin loop costs

- **GCP MSUs** from Spin loops -
  - **4HRA peak** - CPC / CMP / LPAR?
  - **Demand Peak**?

- **SYNC Service times**
  - **Normal** - What % do they deviate from;
    - Expected
    - Best

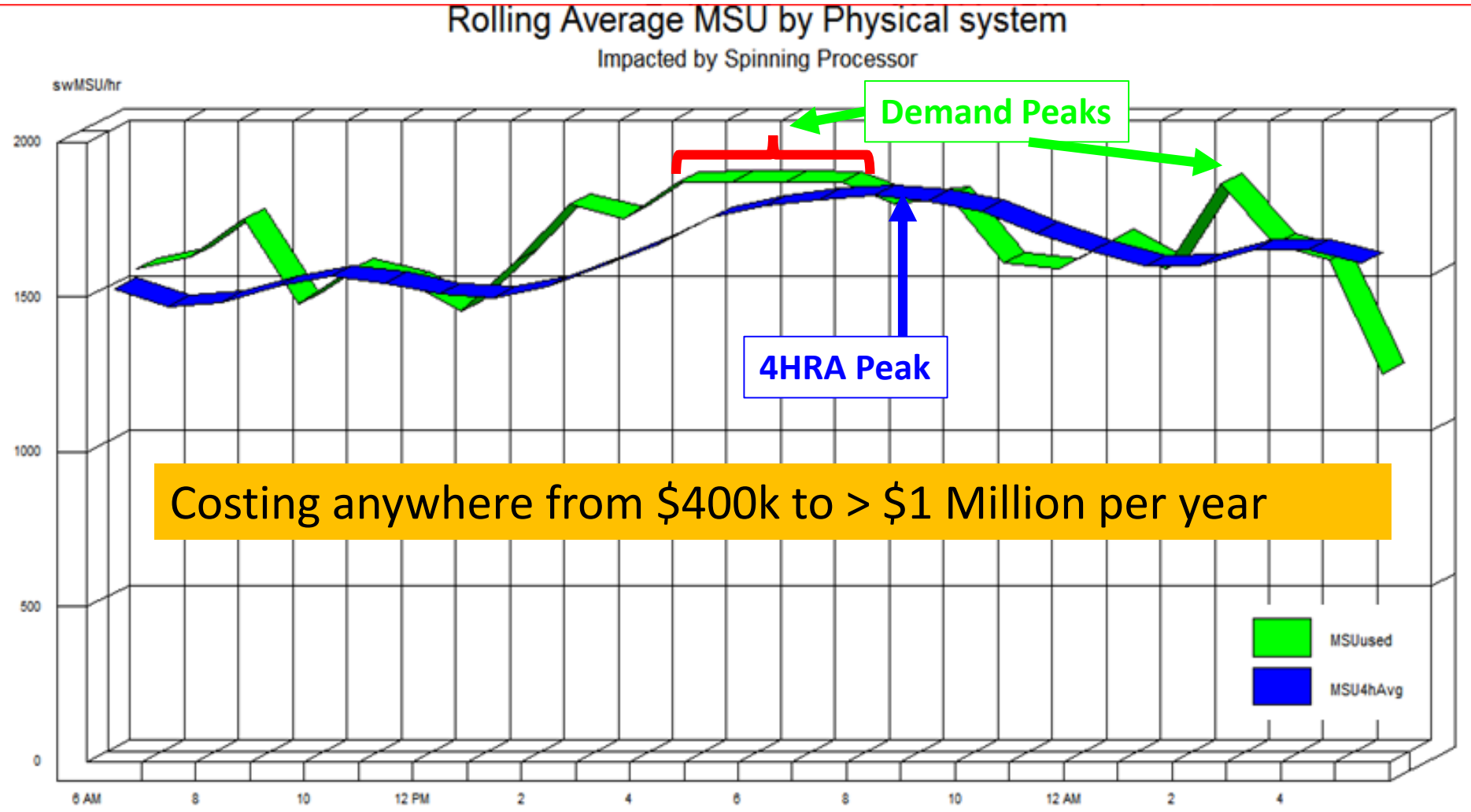
CF Spin Loop GCP MSUs When?



CF Management Critical

- **IBM MLC** - Increased Software bills
- **CPC upgrades** - Accelerated
- **SLAs Impacted** – due to application response issues
  - **Batch Window -** Issues

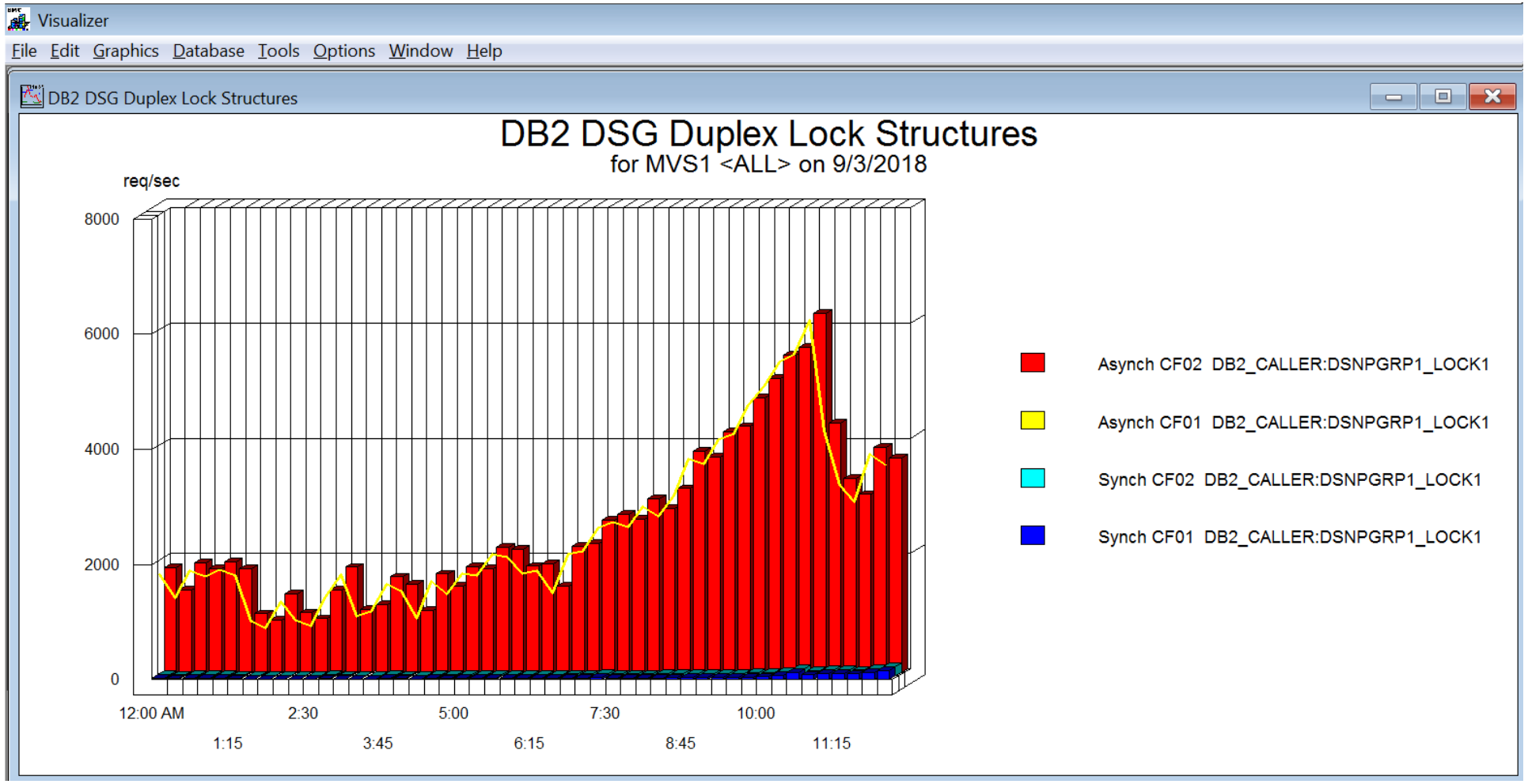
When do I care about Spin Loop MSUs?



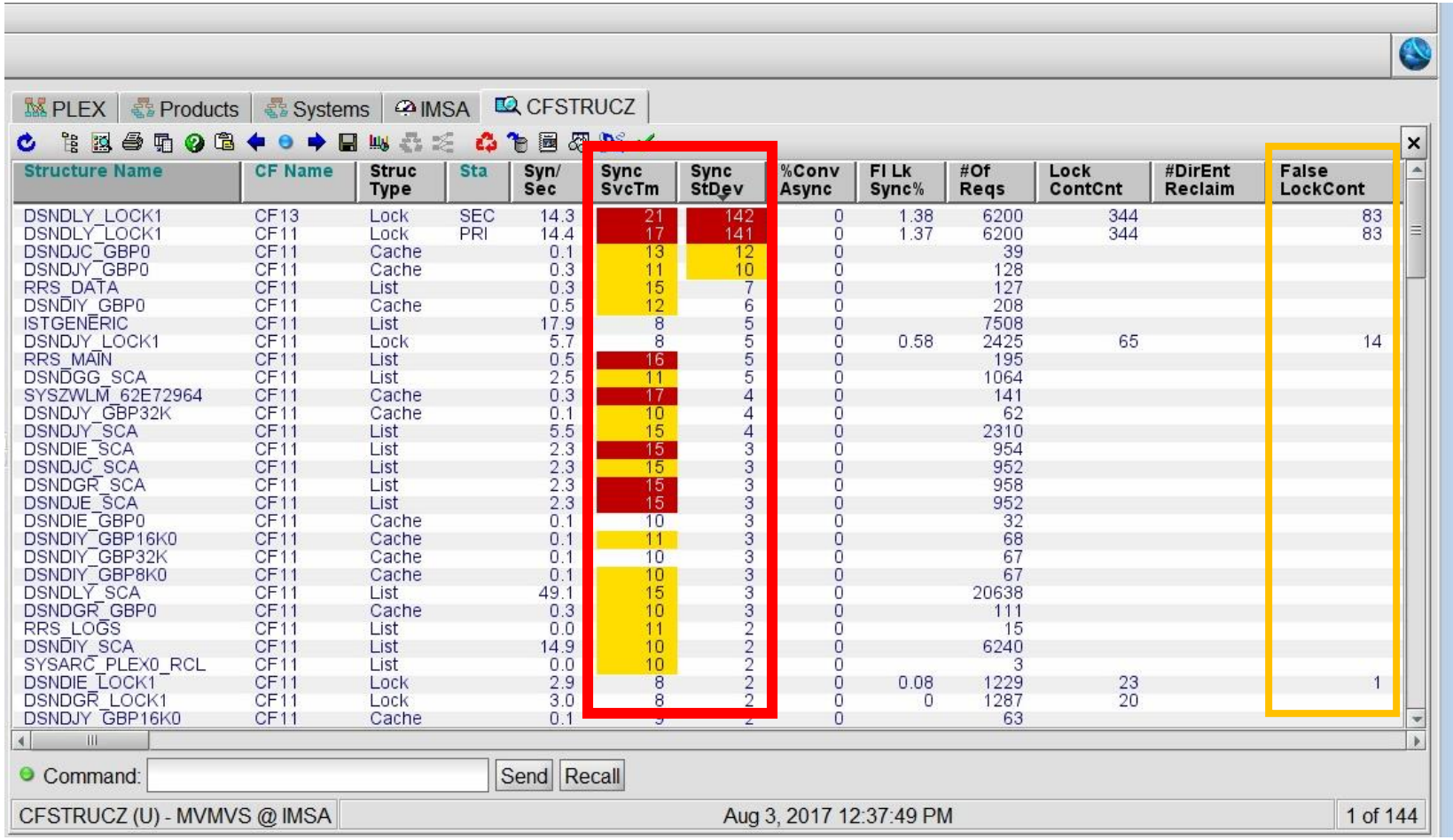
Impact of high SYNC Service times

- **Synchronous** - causes GCP SPIN
  - **GCP MSUs** - charged to requestor
- **XES Issues Asynchronous** – not GCP spin, but;
  - CF % busy &
  - Requestor (not GCP) spin?
  - RNI impact = > MSUs
- **Elongated response** & elapsed time

XES – Converted 99.9% SYNC to ASYNC



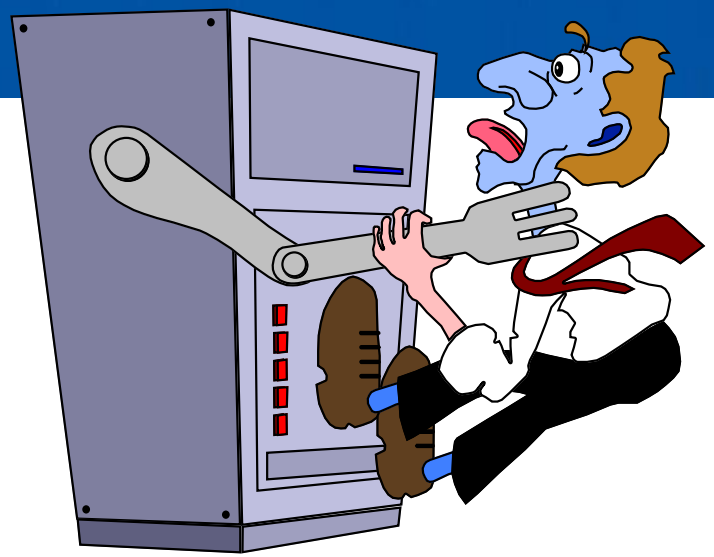
CF KPIs impacting Spin Loop time



Structure Name	CF Name	Struc Type	Sta	Syn/ Sec	Sync SvcTm	Sync StDev	%Conv Async	Fl Lk Sync%	#Of Reqs	Lock ContCnt	#DirEnt Reclaim	False LockCont
DSNDLY_LOCK1	CF13	Lock	SEC	14.3	21	142	0	1.38	6200	344		83
DSNDLY_LOCK1	CF11	Lock	PRI	14.4	17	141	0	1.37	6200	344		83
DSNDJC_GBP0	CF11	Cache		0.1	13	12	0		39			
DSNDJY_GBP0	CF11	Cache		0.3	11	10	0		128			
RRS_DATA	CF11	List		0.3	15	7	0		127			
DSNDIY_GBP0	CF11	Cache		0.5	12	6	0		208			
ISTGENERIC	CF11	List		17.9	8	5	0		7508			
DSNDJY_LOCK1	CF11	Lock		5.7	8	5	0	0.58	2425	65		14
RRS_MAIN	CF11	List		0.5	16	5	0		195			
DSNDGG_SCA	CF11	List		2.5	11	5	0		1064			
SYSZWLM_62E72964	CF11	Cache		0.3	17	4	0		141			
DSNDJY_GBP32K	CF11	Cache		0.1	10	4	0		62			
DSNDJY_SCA	CF11	List		5.5	15	4	0		2310			
DSNDIE_SCA	CF11	List		2.3	15	3	0		954			
DSNDJC_SCA	CF11	List		2.3	15	3	0		952			
DSNDGR_SCA	CF11	List		2.3	15	3	0		958			
DSNDJE_SCA	CF11	List		2.3	15	3	0		952			
DSNDIE_GBP0	CF11	Cache		0.1	10	3	0		32			
DSNDIY_GBP16K0	CF11	Cache		0.1	11	3	0		68			
DSNDIY_GBP32K	CF11	Cache		0.1	10	3	0		67			
DSNDIY_GBP8K0	CF11	Cache		0.1	10	3	0		67			
DSNDLY_SCA	CF11	List		49.1	15	3	0		20638			
DSNDGR_GBP0	CF11	Cache		0.3	10	3	0		111			
RRS_LOGS	CF11	List		0.0	11	2	0		15			
DSNDIY_SCA	CF11	List		14.9	10	2	0		6240			
SYSARC_PLEX0_RCL	CF11	List		0.0	10	2	0		3			
DSNDIE_LOCK1	CF11	Lock		2.9	8	2	0	0.08	1229	23		1
DSNDGR_LOCK1	CF11	Lock		3.0	8	2	0	0	1287	20		
DSNDJY_GBP16K0	CF11	Cache		0.1			0		63			

- Coupling Facility KPIs
  - High Sync Service times or Std Dev
  - False Contention
  - Synchronous to Asynchronous conversion %
    - Reported and
    - More importantly unreported

What hardware changes reduce impact?



Coupling Facility Configuration

- **Response time**
  - **CF Type** - Internal or External
  - **CF Link types** and speeds & % busy

- **CPU Dispatching**
  - **Speed Ratio** - LPAR GCP to CF / ICF CP
  - **CF Dispatching** - # ICFs or CF CPs

CF – PU and Link speeds matter

	Expected Data Transfer Rate (MB/sec)					
	IC	CS5	IFB3	IFB 12x	IFB 1x	ICB-4
		<70m	12x			
z9 EC (2005)	4000			600		1500
z10 EC (2008)	7500			1000	400	1500
z196 (2010)	8900		5000	1000	400	N/A
zEC12 (2012)	9400		5000	1000	400	N/A
z13 (2015)	8500	6000	5000	1000	400	N/A

Always upgrade links w/ CPC

Very cheap compared to wasted MSUs

Then vs Now

- X-CPC > 4x faster
- Same CPC > 2x faster

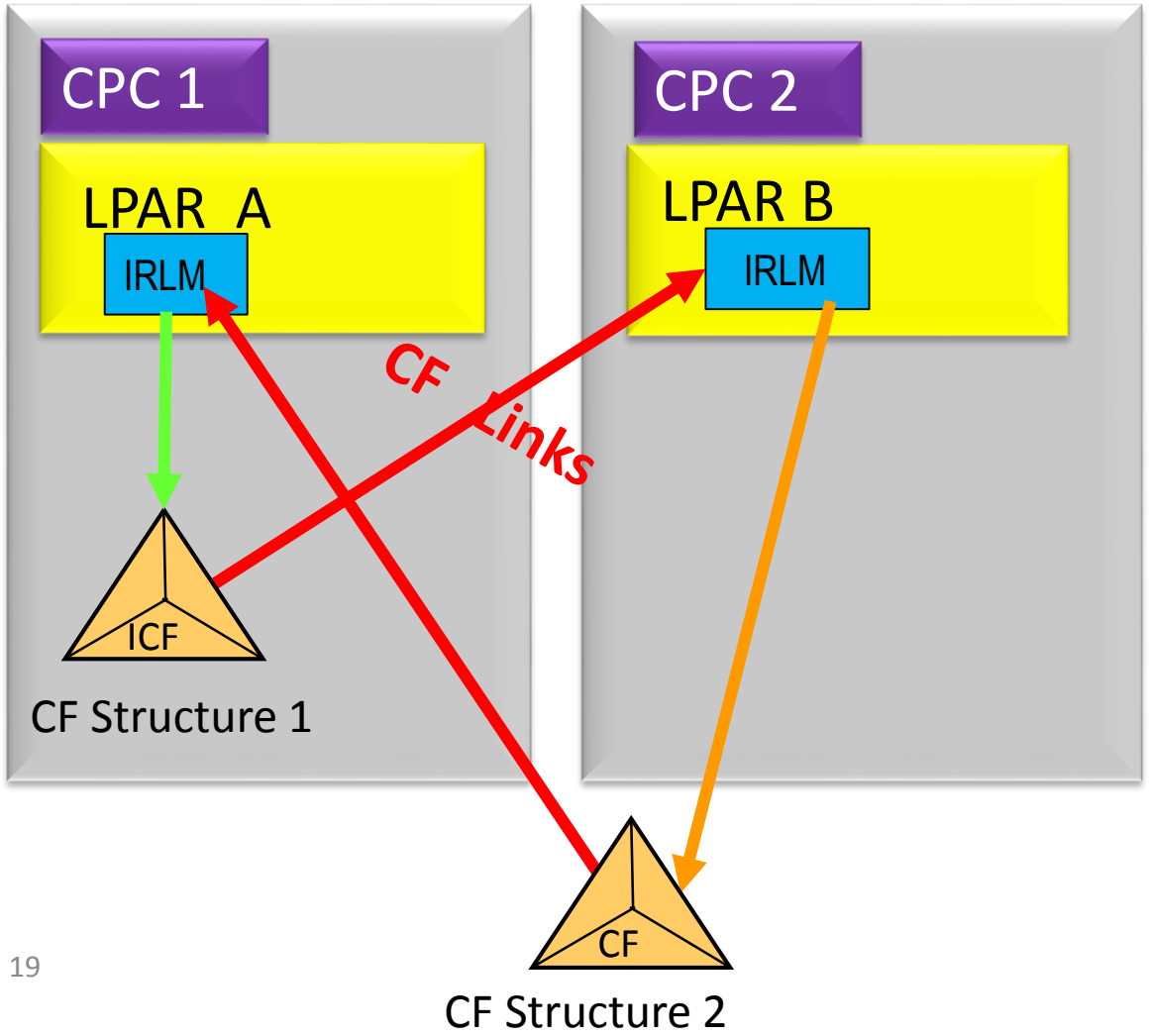
z14 CL5 replaces IFB1x
But same slow speed

CF Links on DB2 Simplex SYNC Locks

ICF01 Structure Name	LPAR Name	CPC Name - Contype	Avg Requests /sec	SYNC Avg Service Time
DB2P_LOCK1	MVS1	CPC01-ICP	24.99	3.6
DB2P_LOCK1	MVS2	CPC02-Link	27.90	23.9

6.5x more Spin loop for remote requests in this good performance example

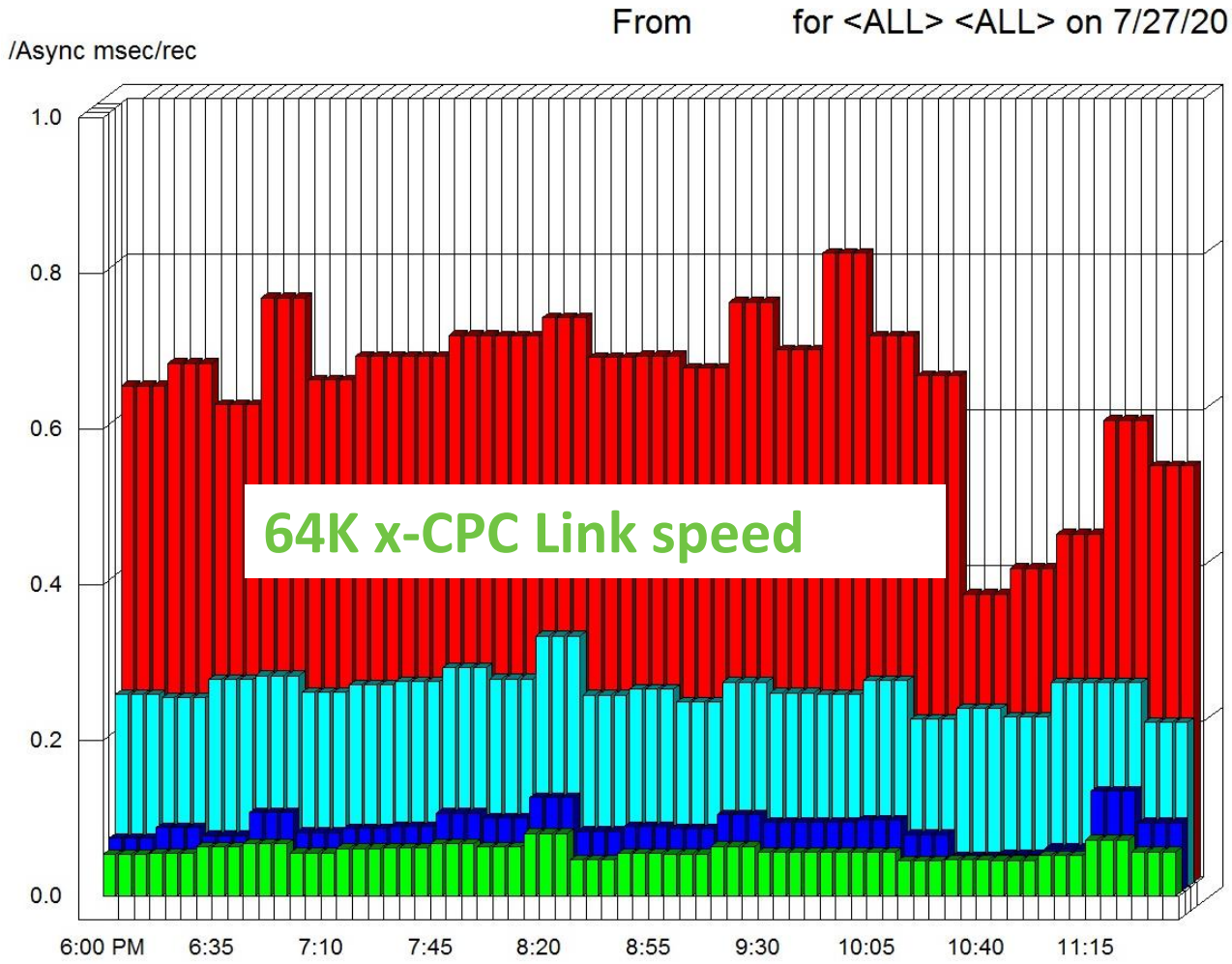
CF Configuration Example



- **CF Types** - ICF and External
- **CF Speed Ratio**
  - Model 500 CPC
  - Model 700 ICF & External
- **Link Types**
  - **Internal** for ICF
  - **External Links** – IFB3-12x

Link Speed & Amount of data matter

Async example – for extreme & known size



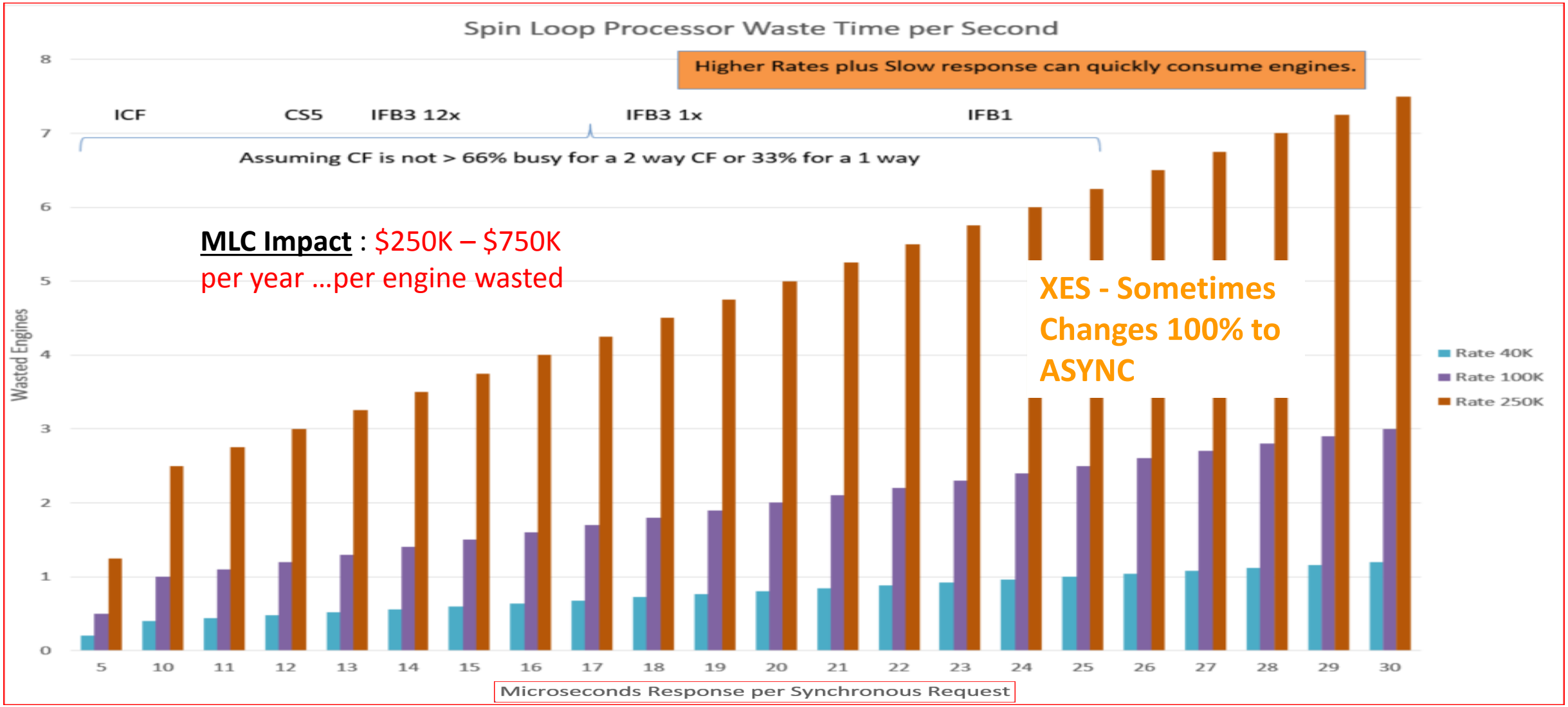
Do I have multiple buffer sizes defined, so I don't transfer excess?

CFRMT1	2097-E40	01:XCF:IXC3	64K
CFRMT1	2097-E40	01:XCF:IXC1	1K
CFLOC1	2097-E40	01:XCF:IXC2	64K
CFLOC1	2097-E40	01:XCF:IXC4	1K

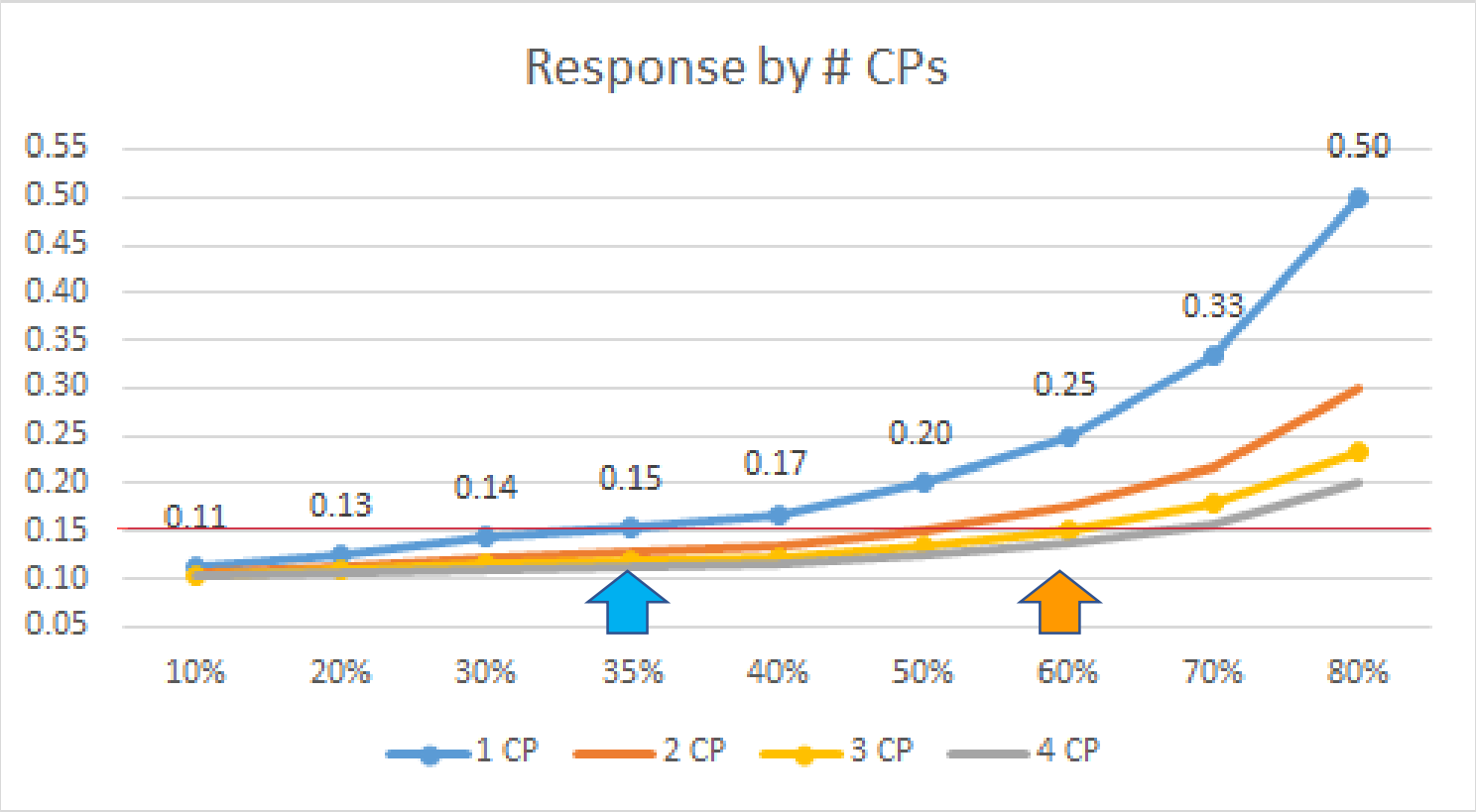
Worse x-CPC w/ slow links

CF transferred bytes = % Busy = Srvtime

Link Types Impact SYNC Srv & Spin

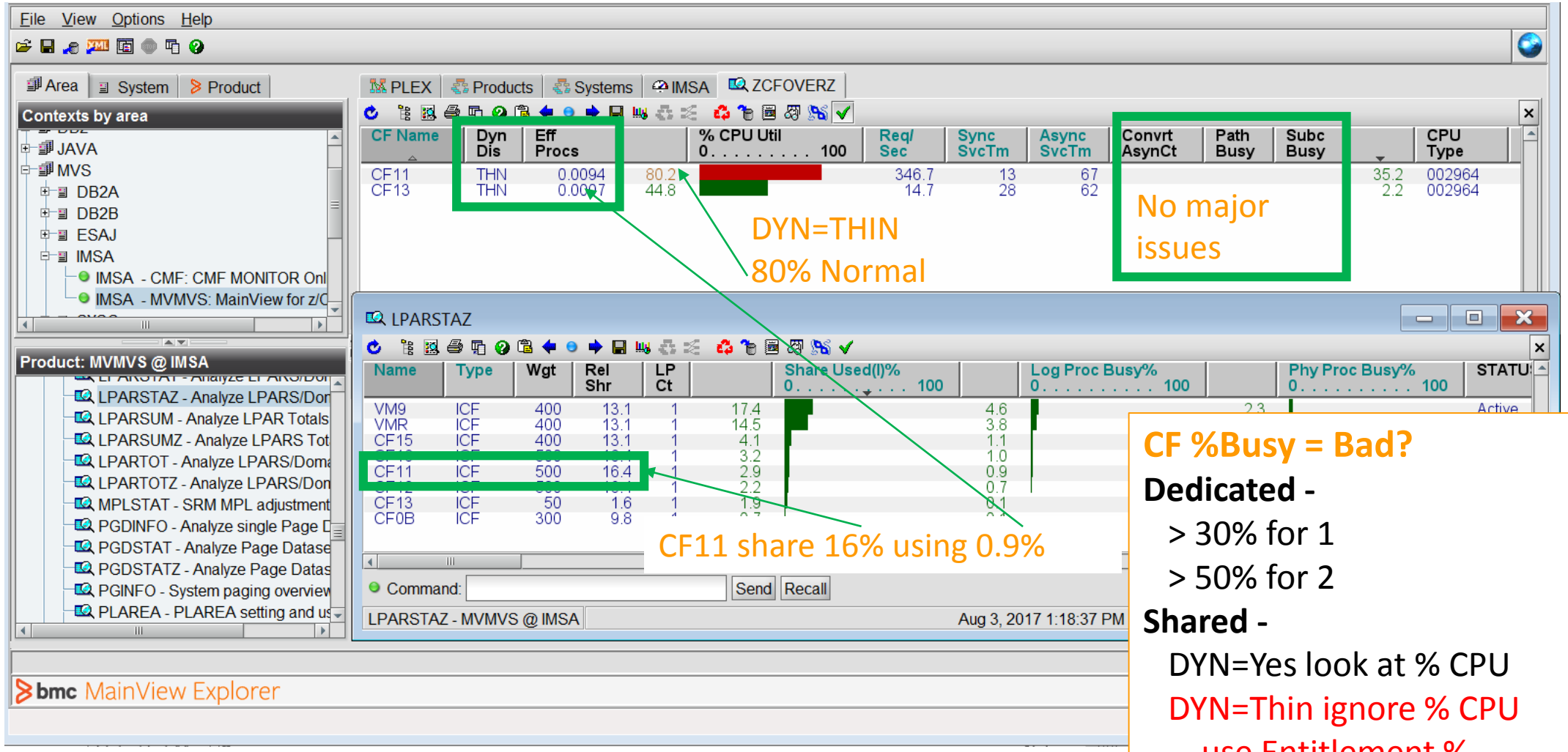


Enough CPs - ensure SYNC w/o convert



- 1 Specialty engine @ 35%
- 2 Specialty CP @ 50-60%

CF High CPU Utilization ?



CF %Busy = Bad?

Dedicated -

> 30% for 1

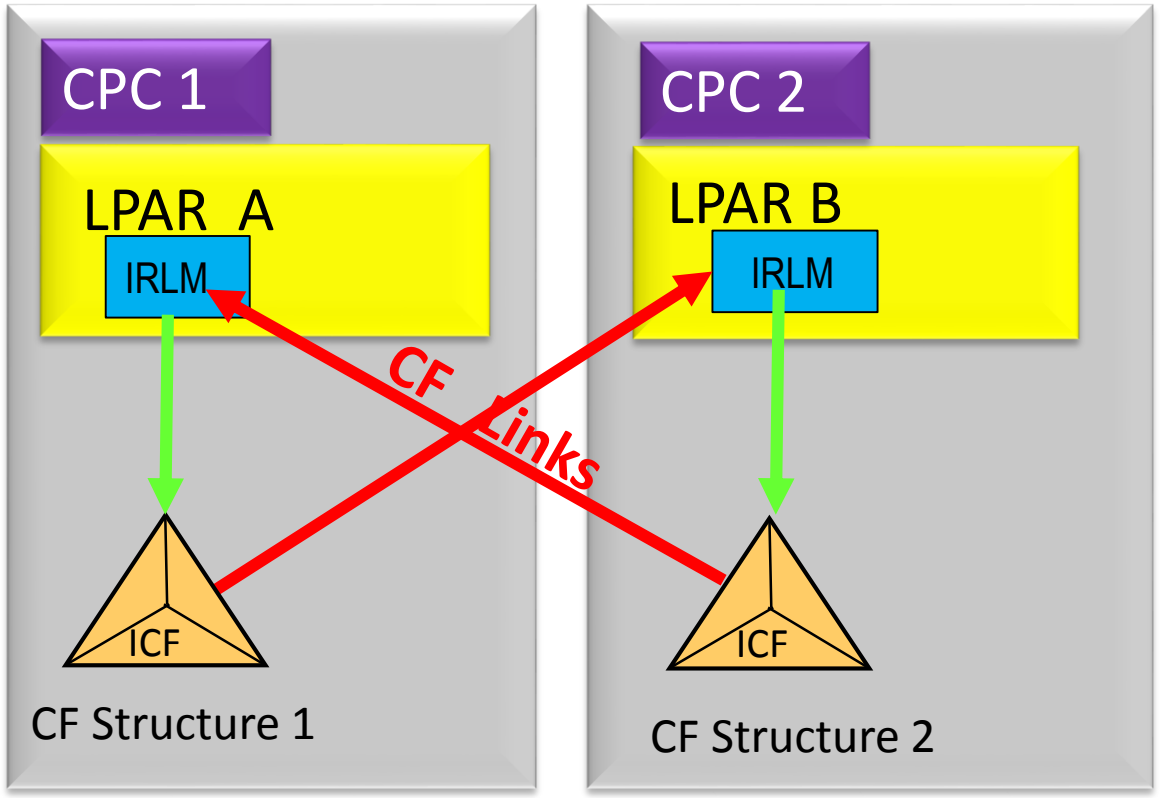
> 50% for 2

Shared -

DYN=Yes look at % CPU

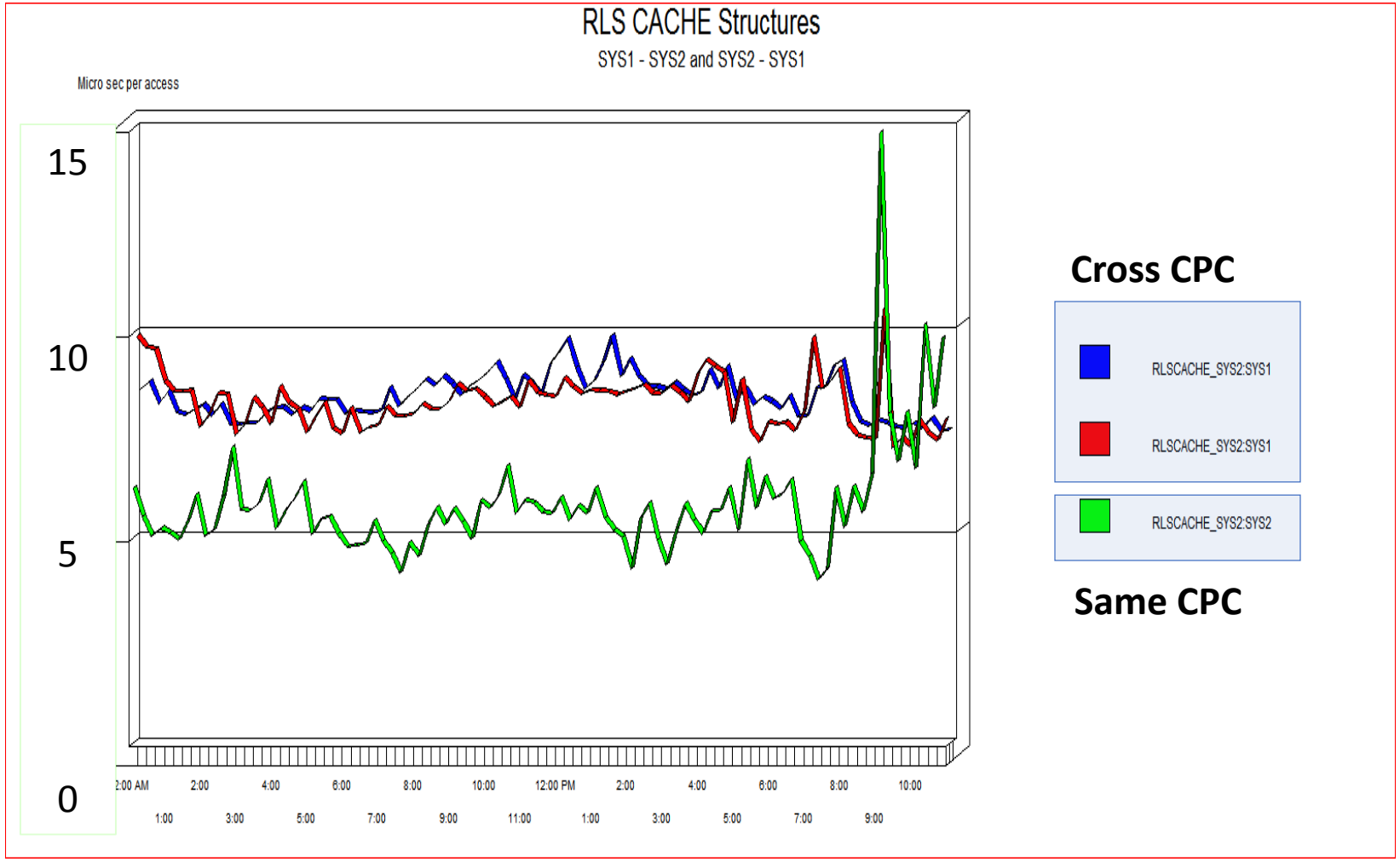
DYN=Thin ignore % CPU use Entitlement %

CF Configuration Example



- **CF Types** – Pair ICFs
- **CF Speed Ratio**
  - Model 500 CPC
  - Model 700 ICF
- **Link Types**
  - **Internal** for ICF
  - **External Links** – CS5

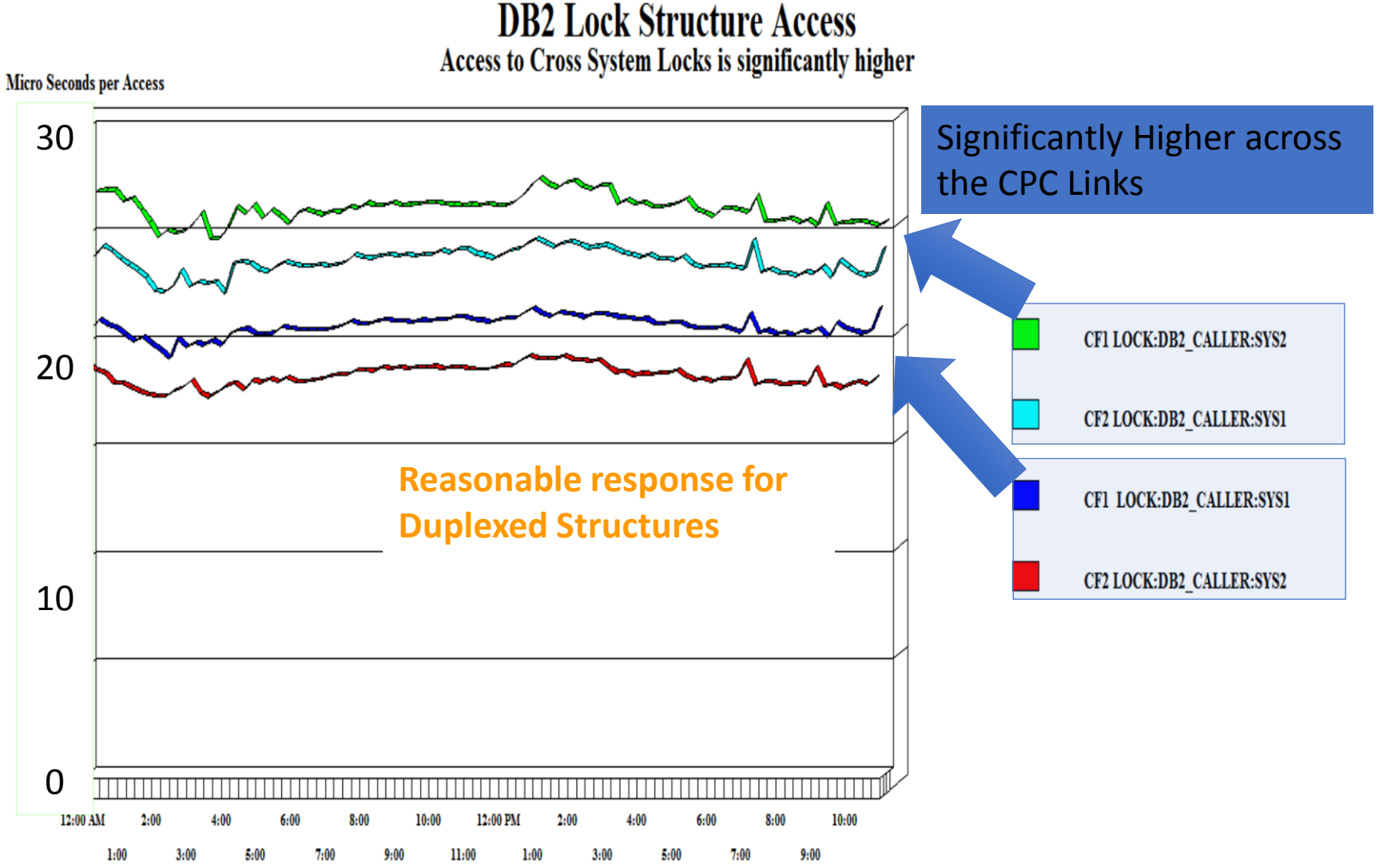
RLS Cache Structures – ICF vs CF Links



Internal - 5 microsec
External 8 microsec
w/ CS5 link

Distance and Link Speeds Matter

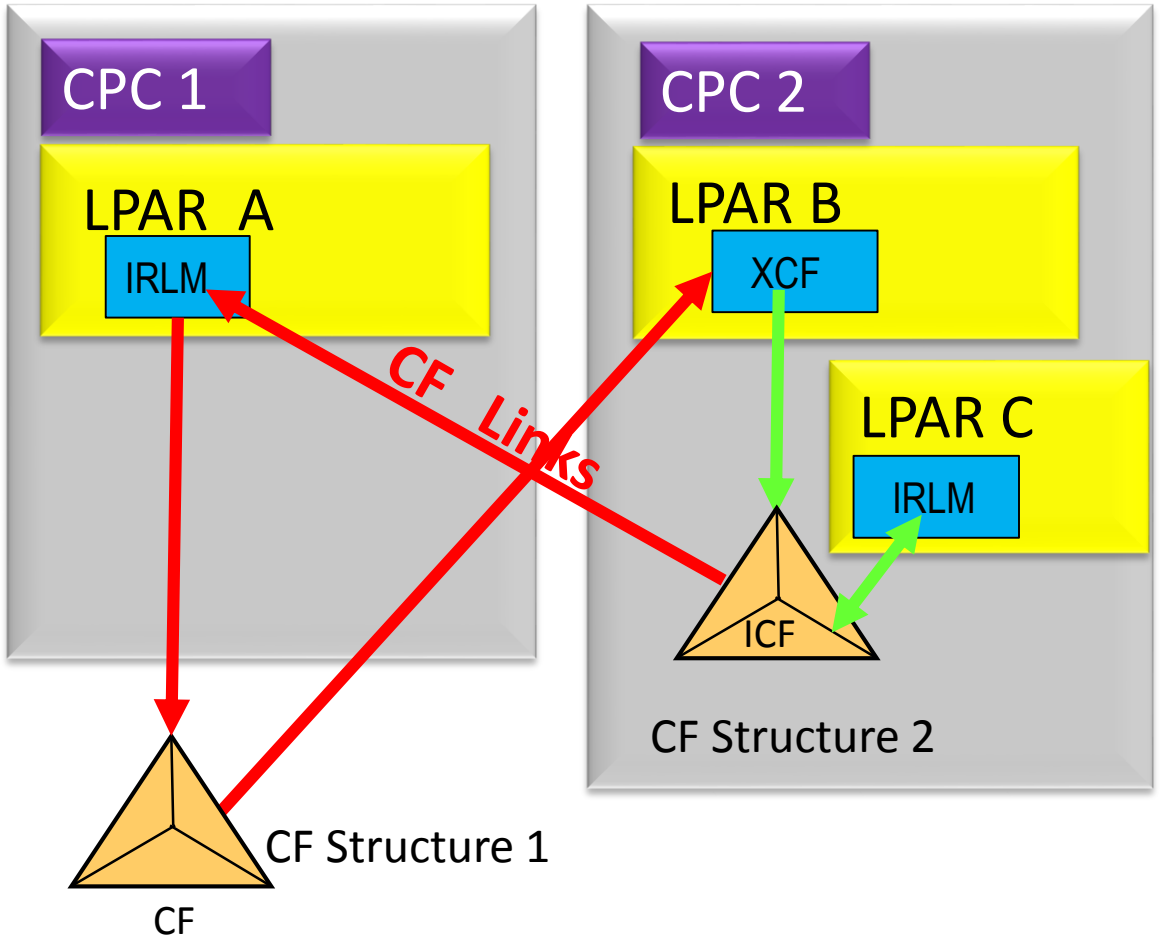
DB2 Lock Duplexing – ICF vs CF w/ Links



Local - 18 - 21 microsec
External 23 -27 microsec
Note: much worse if LR links

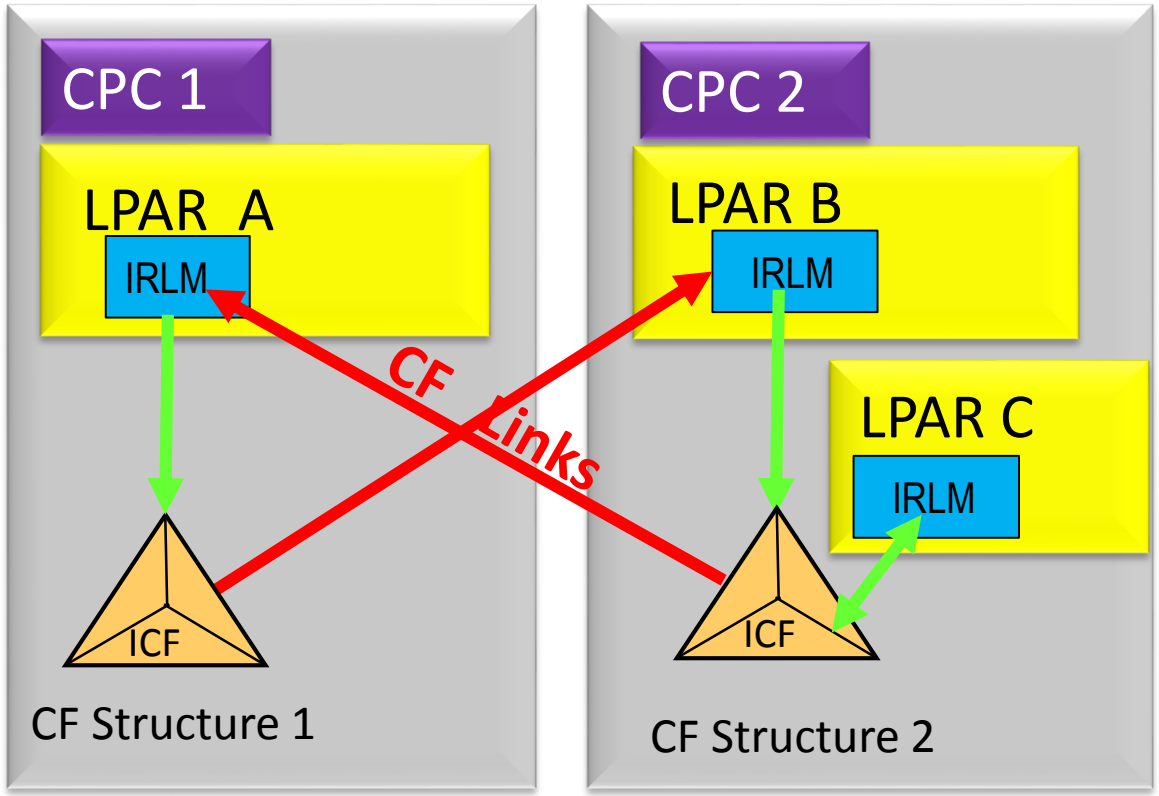
New Async Duplexing
Algorithms may help here.

Typical N-way



- Avoids need for CF structure Duplexing

CF Access Same vs Cross CPC



DUAL ICF vs External

- **Advantage** - Fastest multiple CPC config
- **Disadvantage** - N-way requires Structure Duplexing for recoverability speed
  - **Long Distance** – more penalty
  - **Asynchronous Duplexing** – of CF Lock Structure can eliminate penalty for local to Primary

What software changes reduce impact?

Software / Parameter Changes

Response time

- **ASYNC Lock Duplexing** – DB2 V12
- **CF Overflow DASD** –
  - ie . VSAM RLS -> DASD = path busy
    - Increase CF structure size
- **DB2 GBPs** - high volume SYNC
  - DB2 BP Simulator – improve Local BP hits, avoid GBP
- **False Contention**
  - Increase CF structure size

CPU Dispatching

- **CF Dispatching** – Dynamic Dispatching
- **LPAR Dispatching** - PR/SM Weights, Hiperdispatch
- **Structure Placement** –
  - Local / Short distance to LPAR
  - XCF Paths – one on each
  - DB2 ASYNC Secondary lighter

CF Sync – DB2 Duplexing -

Benefits

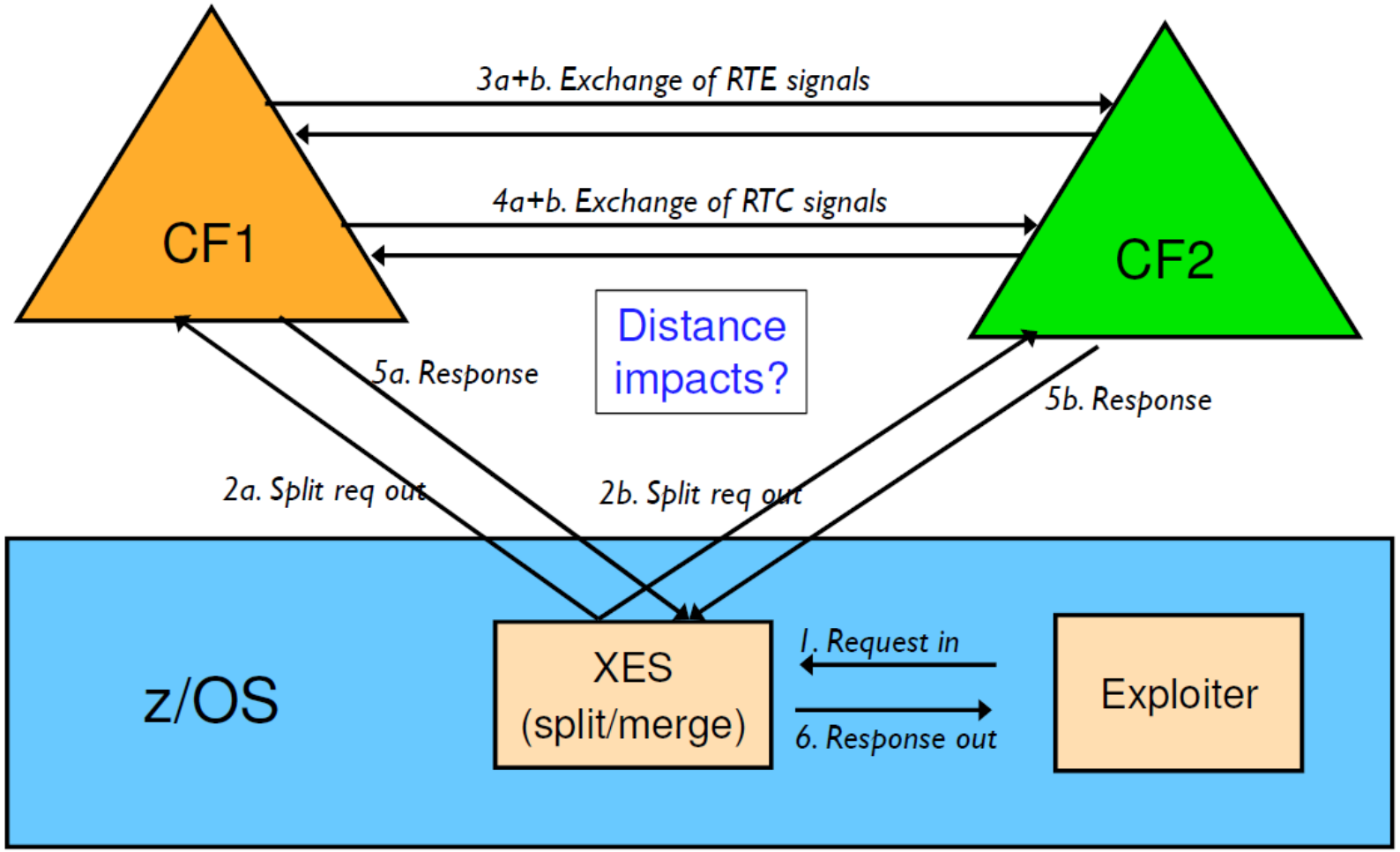
- **SCA and lock structure** "offers marginally faster recovery time"
- **Global Buffer Pools – "**avoid hours of recovery time**",** recovering data from the Db2 logs can be very time consuming

Disadvantages

- **Significant Response Impact**
- **Significant CPU Impact**
  - z/OS CPU = 3x to 4x
    - Direct GCP MSUs
  - CF CPU = 4x to 5x
    - Indirect GCP MSUs
  - CF Link = 6x to 8x

Indirect effects on workload difficult to predict

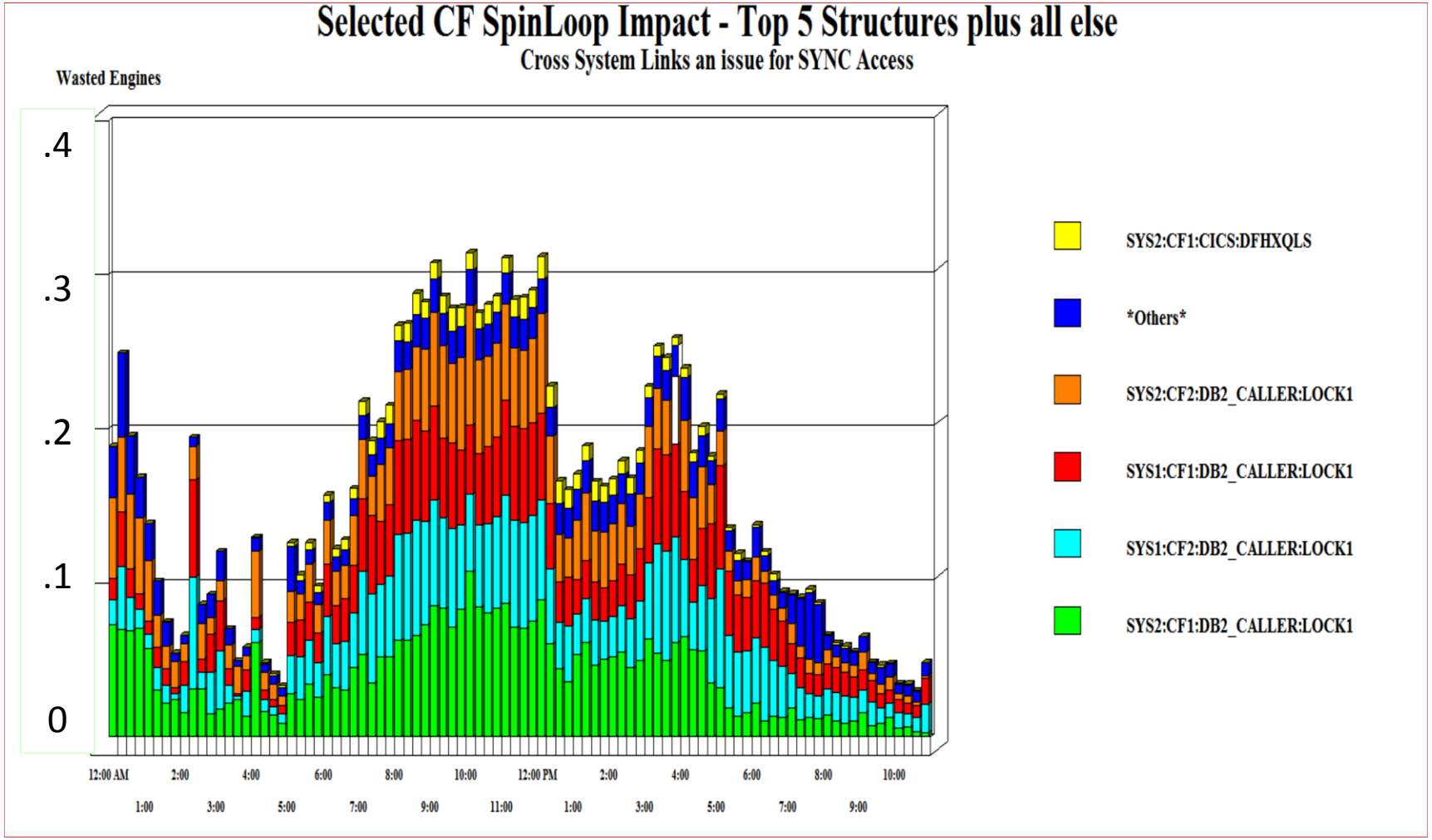
Current CF SYNC Duplexing



- **Structures in-sync**
  - Ensured before response to caller
- **Higher Response**
  - 6 extra Signals
    - 4 CF -> CF
    - 2 to 2nd CF
  - Distance / link type impacts
- **Higher CPU**
  - CF and GCP MSUs

RTE – ready to execute
RTC – ready to complete

Spin Loop Source – Which Structures



Top LS Lock Structures

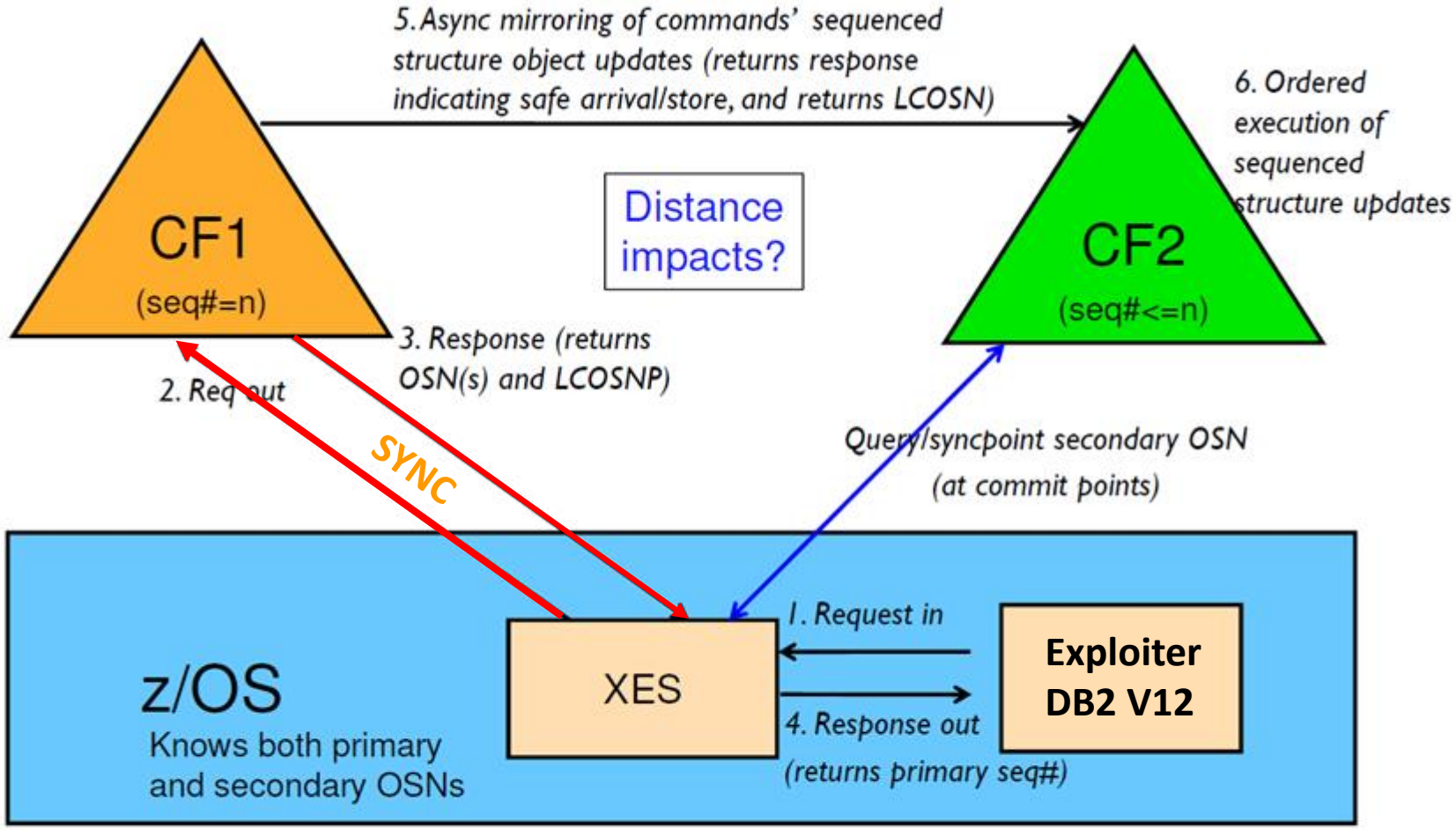
Local - 18 - 21 microsec
External 23 -27 microsec

Duplexing Turned on
New Async Duplexing
should help here.

Wasted Engine Impact:

During the 4 Hour Peak?

CF Async Lock Duplexing – DB2 V12



OSN = Operation Sequence Number
LCOSN = Last OSN completed by secondary
LCOSNP = LCOSN known to primary

Quicker Response

- Before CF2 in sync
- Recovery / commit waits for confirmation

Lower Spin Loop

- SYNC service times similar non-duplexed

ASYNC Duplexing – in RMF Report

```
STRUCTURE NAME = EXAMPLE_LOCK1      TYPE = LOCK    STATUS = ACTIVE PRIMARY ASYNC
          # 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
SYS1       300M        SYNC     294M  52.6    4.6     4.5
          83299        ASYNC   5649K   1.0   64.6    21.8                                                      REQ DEFERRED  2054K
                       CHNGD       0   0.0  INCLUDED IN ASYNC                                                  -CONT         1897K
                                                                                                               -FALSE CONT    267K

SYS2       259M        SYNC     254M  45.5    4.6     4.1    NO SCH     1    0.0   146.0       0.0    0.0    REQ TOTAL      345M
           72049       ASYNC   5134K   0.9   64.8    21.8                                                      REQ DEFERRED  2003K
                       CHNGD       0   0.0  INCLUDED IN ASYNC                                                  -CONT         1922K
                                                                                                               -FALSE CONT    233K

-------------------------------------------------------------------------------------------------------------------------------
TOTAL      559M        SYNC     548M  98.1    4.6     4.3    NO SCH     2    0.0   143.0       4.2    0.0    REQ TOTAL      740M
          155.3K       ASYNC    11M   1.9   64.7    21.8                                                      REQ DEFERRED  4057K
                       CHNGD       0   0.0                                                                    -CONT         3819K
                                                                                                               -FALSE CONT    500K
```

```
STRUCTURE NAME = EXAMPLE_LOCK1      TYPE = LOCK    STATUS = ACTIVE SECONDARY ASYNC
          # 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
SYS1      2797K        SYNC    2797K  50.4   17.0     3.5    NO SCH     0    0.0    0.0        0.0    0.0    REQ TOTAL      395M
           777.1       ASYNC       0   0.0    0.0     0.0                                                      REQ DEFERRED  2054K
                       CHNGD       0   0.0  INCLUDED IN ASYNC                                                  -CONT         1897K
                                                                                                               -FALSE CONT    267K

SYS2      2757K        SYNC    2757K  49.6   15.6     3.6    NO SCH     0    0.0    0.0        0.0    0.0    REQ TOTAL      345M
           766.0       ASYNC       0   0.0    0.0     0.0                                                      REQ DEFERRED  2003K
                       CHNGD       0   0.0  INCLUDED IN ASYNC                                                  -CONT         1922K
                                                                                                               -FALSE CONT    233K

-------------------------------------------------------------------------------------------------------------------------------
TOTAL     5555K        SYNC    5555K  100    16.3     3.6    NO SCH     0    0.0    0.0        0.0    0.0    REQ TOTAL      740M
           1543        ASYNC       0   0.0    0.0     0.0                                                      REQ DEFERRED  4057K
                       CHNGD       0   0.0                                                                    -CONT         3819K
                                                                                                               -FALSE CONT    500K
```

Simplex like SYNC service times

Duplexed / Secondary

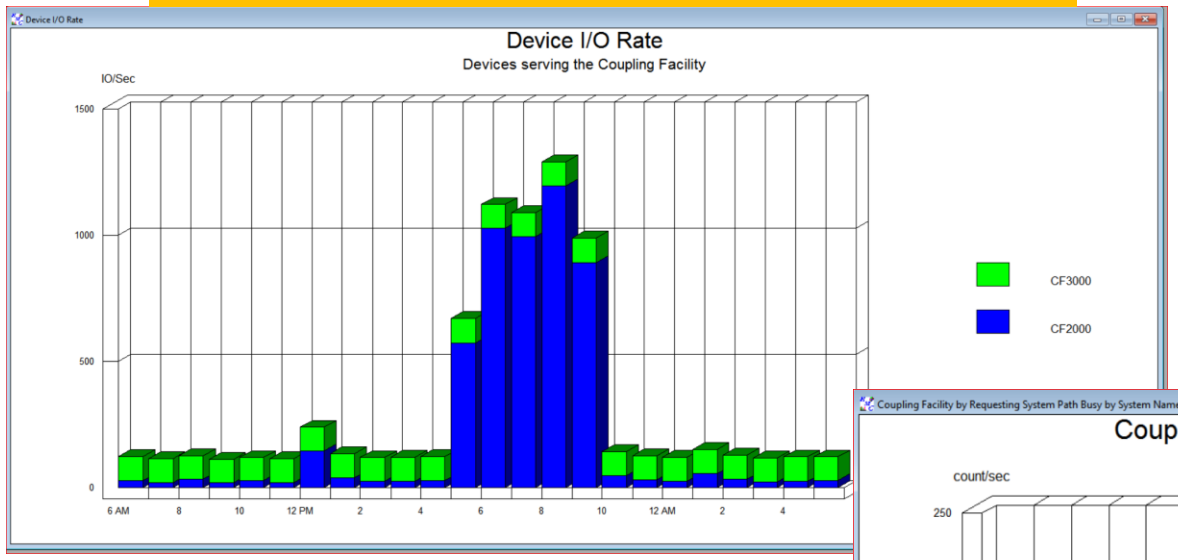
CF structure kept in SYNC

- Via CF to CF
- Vs normal XES / zOS to CF
  - No duplexing SYNC requests made
  - Only Seq # requests on commit

- **Primary** 294.0M
- **Secondary** 2.7M

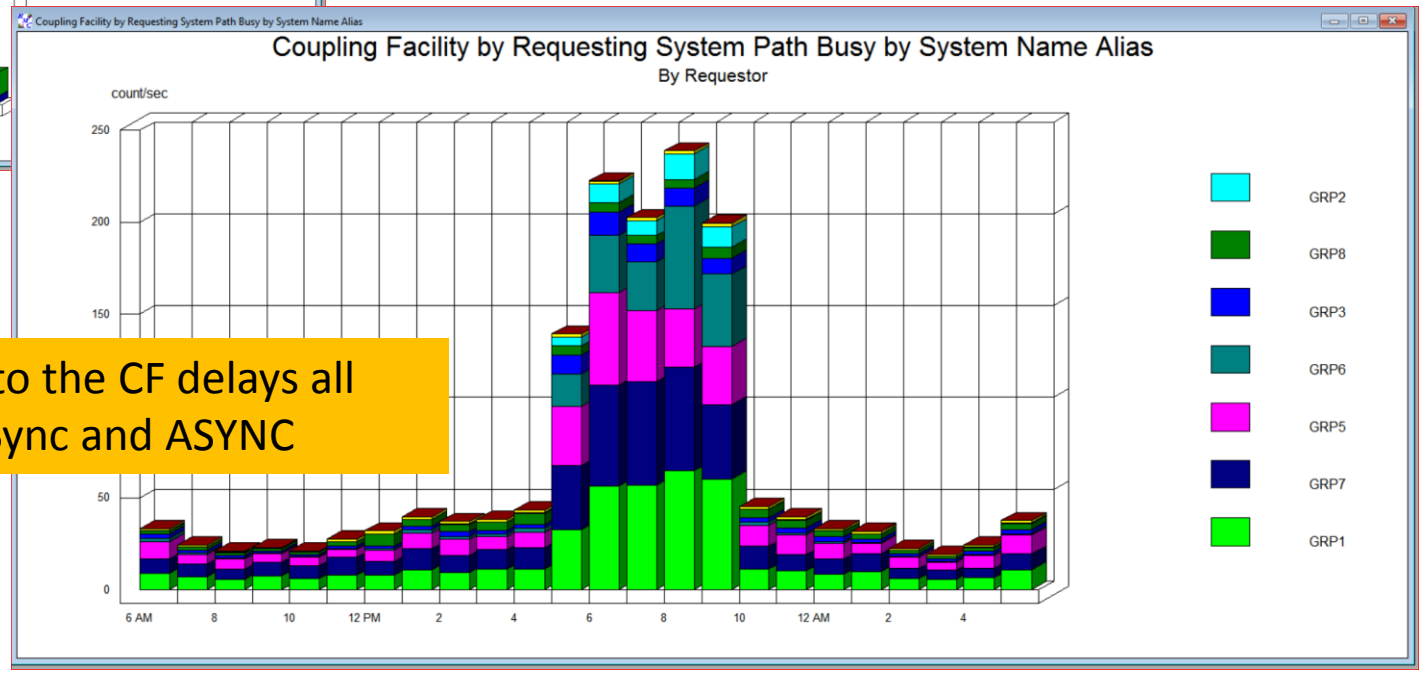
CF Overflow to DASD

Device Usage associated with CF structures



Typical Source of issue

- Requestor CACHE larger than CF structure size
  - Often seen w/ VSAM RLS, cache increased w/o structure increase
  - MQSeries Queues – use SCM



Path busy to the CF delays all requests, Sync and ASYNC

Coupling Facility Structure Usage

- **Balancing Structures across CFs**
  - **Load balance** - structures to ensure both CFs similar CPU Utilization
  - Synchronous Users – Avoid all DB2 SSIDs locks on 1 CF
  - Asynchronous Users – 1 path / CF not all on 1

- **DB2 Global Buffer Pools**
  - Increase Local hit ratio to avoid requests to Global
    - Use DB2 BP Simulator to determine best local BP sizes

CF Data Sharing - Cross Invalidation

```
STRUCTURE NAME = DSNDB6_GBP2       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        141K   SYNC     131K   92.7    19.6     10.2     NO SCH     0     0.0    0.0        0.0     0.0
          156.4    ASYNC     10K    7.3    79.2     74.8     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
                   SUPPR      0     0.0                      DUMP      0     0.0    0.0        0.0     0.0

-------------------------------------------------------------------------------------------------------------------------
TOTAL       141K   SYNC     131K   92.7    19.6     10.2     NO SCH     0     0.0    0.0        0.0     0.0    -- DATA ACCESS ---
          156.4    ASYNC     10K    7.3    79.2     74.8     PR WT      0     0.0    0.0        0.0     0.0    READS      316949
                   CHNGD      0     0.0                      PR CMP     0     0.0    0.0        0.0     0.0    WRITES    1330306
                   SUPPR      0     0.0                      DUMP      0     0.0    0.0        0.0     0.0    CASTOUTS    88294
                                                                                                              XI'S       258700
```

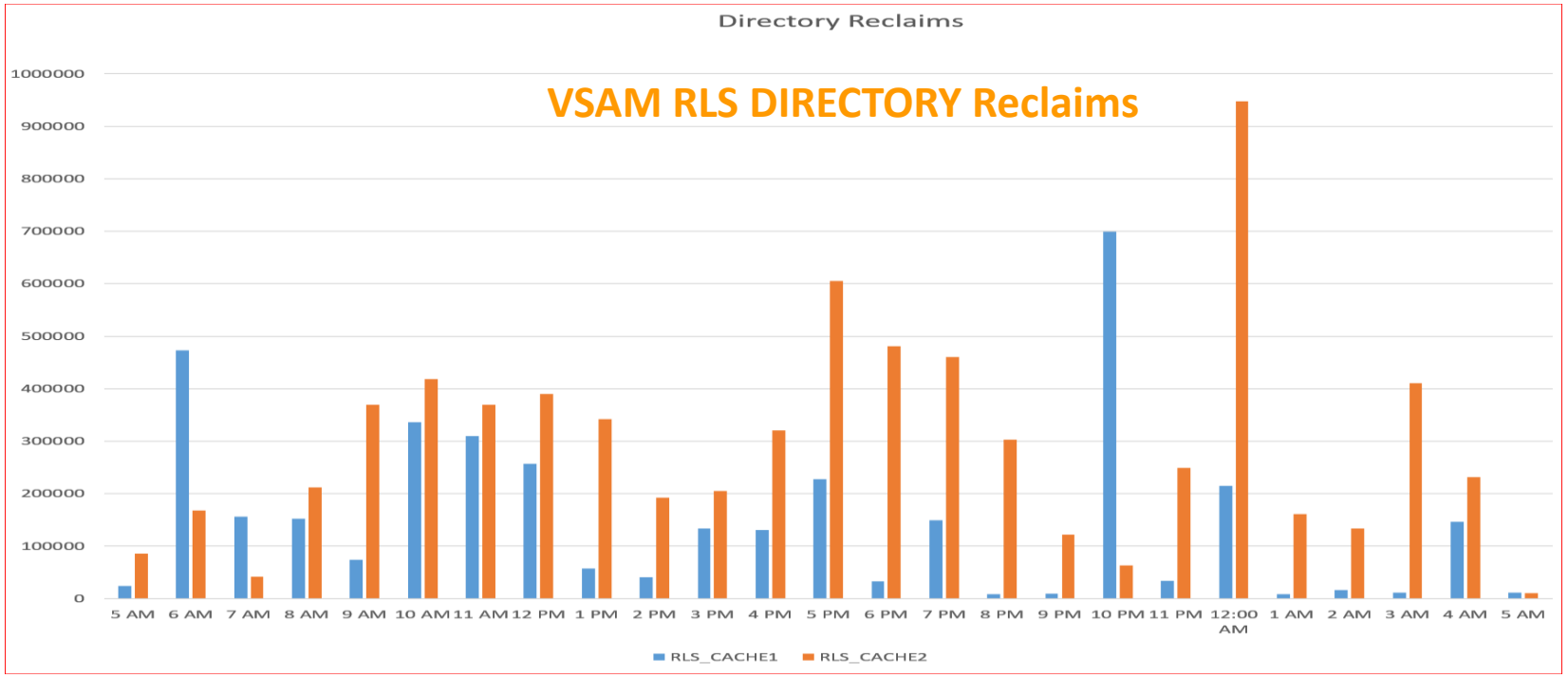
Cross Invalidated (XI's) # - are for directory, store-in and store-thru caches.

High Update Volume - often cause disruptions to the buffers as they have to be 'Invalidated' and re-written.

Avoid x-Sys interest - Run all Batch for a given DB run on same LPAR to avoid CF locks

Directory Reclaims – RLS / DB2 Cause XI

Directory Reclaims – forces CF buffer refresh even if unchanged buffer



Buffer pool size Increase - increases # of directory entries for DB2 or RLS

DB2 DISPLAY GROUPBUFFERPOOL w/ GDETAIL issues

- **DSNB788I message** w/
- #Directory reclaims causing XI

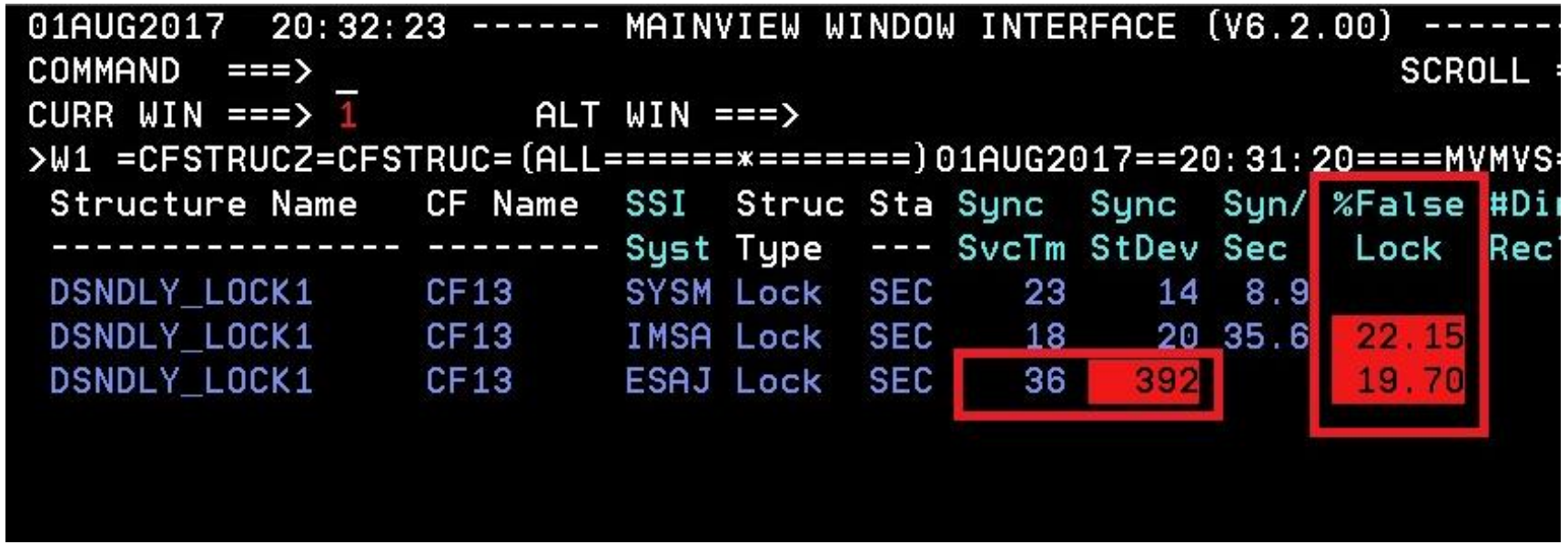
DB2 - ALTER GROUPBUFFERPOOL

Has option to dynamically change ratio of data to directory entries

Lock Contention

- True Contention % = # req delayed / total req
  - ∅ VSAM RLS or DBCTL approx 1%
  - ∅ Online (CICS/IMS) DB2 approx 2%
- **False Contention % = #false / total**
  - ∅ VSAM RLS or DBCTL approx 0.1%
  - ∅ Online (CICS/IMS) DB2 approx 1%
  - ∅ Cause: hashing > lock entries (structure)

False Contention –



Duplexed - Even greater concern as causes even longer delays / extra requests

Shared CFs - Coupling Thin Interrupts

- DYNDISP keyword for the CF, the choices are;
- OFF (Production w/ Dedicated CF CPs)
- ON (Shared CP - Original option fixed time slice)
- **THIN** (CP Sharing - Newer high performance option – interrupt driven)

- IBM Announcement for CFCC Level 19 (September 20, 2013)
- http://www-03.ibm.com/systems/z/advantages/pso/whatsnew.html

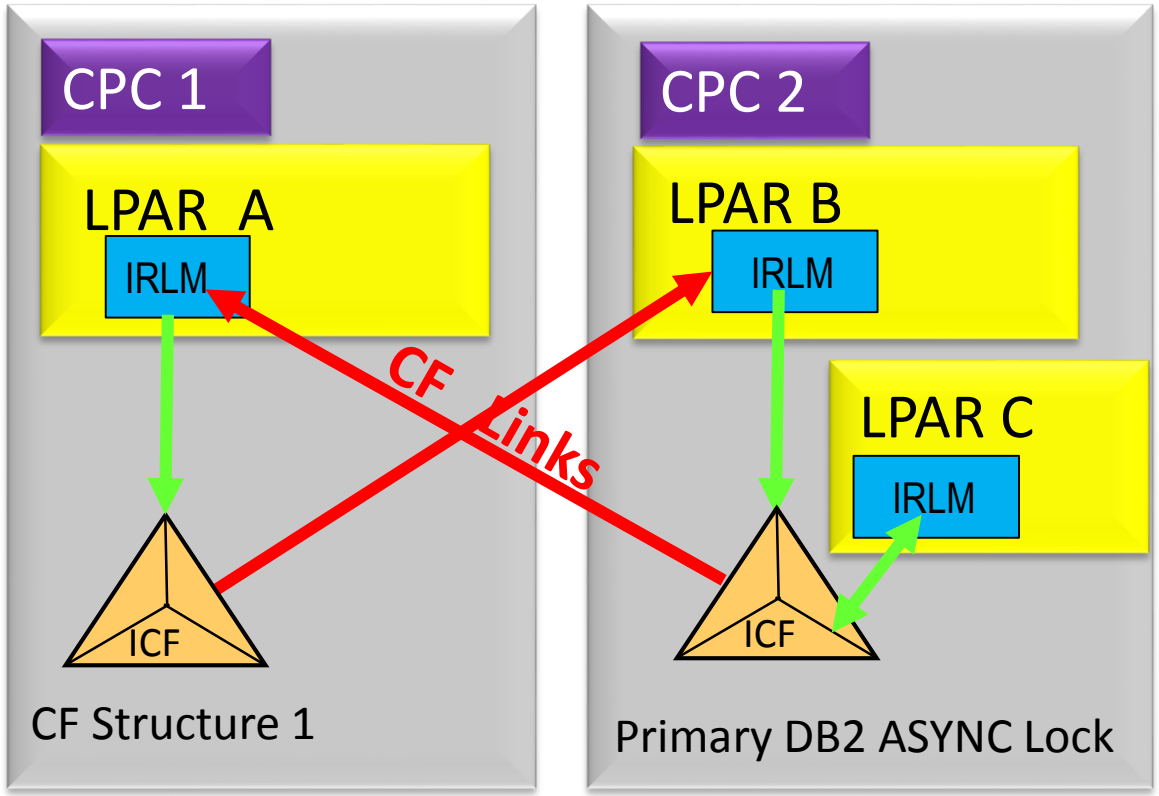
- IBM CF Performance report recommending and documenting performance of new option
- http://www-03.ibm.com/support/techdocs/atsmastr.nsf/5cb5ed706d254a8186256c71006d2e0a/b6f20816aca23acc86257c580053a8cb/$FILE/Coupling%20Thin%20Interrupts%2020131217.pdf

Workload Changes

Who is causing the spin loop?

What can be done about it?

CF Access Same vs Cross CPC



Workload Scheduling

- **Volume –** on CPC2 for local CF speeds
- **Same DB access** – on same LPAR or same CPC LPARs

DB2 - Reduce Number of Locks in CF

- CF Locks only for Inter-DB2 R/W to TBLSPC
  - Batch - Run multiple jobs that access same table / part from
    - 1 Plex member (no locks)
    - Fewer plex member fewer locks
  - Reduce Duration reduces x-system interest
    - ISOLATION Bind
      - RR Locks all pages *touched* until commit (HIGH Overhead)
      - RS Locks all pages *selected* until commit (less)
      - CS Ensures read only committed data (least overhead)
    - ACQUIRE (USE vs alloc)
    - Batch - Release (Commit vs dealloc)

DB2 Group Buffer Pools

- Only if Inter-DB2 R/W Interest
  - Pages written to GBPs
  - Pages Registered in GBPs
- Cross Invalidates - Make sure that GBPs large enough to hold directory entries for every page in local BPs (Directory/Data Ratio)
- Directory Reclaims cause issues

CICS VSAM RLS

- ** All CIs < 4K to CF even w/o interest **
- ** All Locks to CF even w/o interest **
- Look for False Contention on Lock Structure
- CICS Sharing Issues(RLS,DB2,DBCTL)
  - Datatables <4K CI SYNC CF I/O
  - CICS JRN <4K CI SYNC CF I/O

CICS VSAM RLS – Cache Buffers

- **Monitor cache buffers -** % used.
- **Ensure sizes in sync** – for RLS and CF
  - **Used > CF size** – when RLS buffer defined > CF structure overflows to DASD.
- **KPIs to Monitor**:
  - **% requests delayed** by Path Busy
  - **% of Structure storage used** throughout the day.
  - **SMF Records** - Type 74_4, Type 42_15 and 16, VSAM Type64

Summation

Summary

- Total Spin Loop time (Wasted Engines) should be used to drive changes in software and hardware.
- CF Response times are impacted by workloads and configurations.

- Critical components deserve respect and monitoring.
  - It is 12:00 PM, do you know what your ‘CoFiSL’ is?

Tuesday 6th November

Start	End	Stream	Room	Title	Speaker
11:45	12:45	IMS	Wellington B	The No Cost Way to Manage the IMS Catalog	David Schipper
15:00	16:00	IMS	Wellington B	Current Trends in IMS Analytics	David Schipper
16:30	17:30	zCMPA	Woodcote	zIIP stealing GCP MSUs for Capacity Management	Donald Zeunert

Wednesday 7th November

Start	End	Stream	Room	Title	Speaker
09:30	10:30	Db2	Nurburgring	Know your onions when it comes to Db2 indexes	Randy Bright
09:30	10:30	IMS	Wellington B	IMS Checkpoint Pacing	David Schipper
10:45	11:45	zCMPA	Woodcote	How many GCP MSU is my CF stealing?	Don Zeunert

Stop by the BMC booth for more information about sessions or other Q/A with speakers

bmc

Session feedback

- Please submit your feedback at http://conferences.gse.org.uk/2018/feedback/ILI
- Paper feedback forms are also available from the Chair pers
- Session is LK

Contact: Donald_Zeunert@bmc.com

Backup Material

Reference

DB2 ASYNC Lock - Prereqs

- **CPC z13 GA2+** running;
- **z/OS V2.2** with APARs: OA47796, OA49148, OA51945, OA52015
- **IRLM 2.3** with APAR PI68378
- **DB2® V12** with enabling APAR PI66689 for all members of DSG
  - **Available** since - 2016-10-19

- **Coupling facilities** - At least two peer connected
- **CFLEVEL=21** minimum service level 02.16
  - **CFCC** (for current information see the Driver 27 Customer Exception letter at CFCC firmware specified service level)

XCFAS (XES) = GCP MSUs

XES Functions

- CF Structure Sys Mgd Duplexing
- Async completion Mgmt
- Sync to Async conversion
- Global lock manager –
  - IXLLOCK requests
- Asynchronous coupling facility (Simplex and Duplex) lock requests

XES Modules using CPU

- **Global Locking**
  - IXLR1GLU
  - IEAVE* in XCFAS
- **CF Request management**
  - IXLM2XRQ (Duplexing)
  - IXLC3SCN (Async Mgmt)
  - IXLCMFCT (Req Convert)
  - IXLYSCT (Sync Spin loop)

Additional info on Sysplex (CF, XCF) Tuning

- How z/OS (XES) Converts SYNC to ASYNC
- IBM WSC Flash “Parallel Sysplex Performance” FLASH10011
- Redbook - System z Parallel Sysplex Best Practices SG24-7817
- z/OS MVS Setting up a Sysplex (SA23-1399)
  - Chapter 6. Tuning a Sysplex XCF (first and large section)
- Coupling Facility Configuration Options (David Raften)
- VSAM RLS Best Practices (*David LeGendre, Share 2012*)
- *Some key CF Measurements (Peter Enrico)*
- VSAM RLS Performance and Tuning – IBM (Teri Menendez)