# Coupling Technology
# Overview and Planning

## What's the right stuff for me?

SHARE Seattle 16813

EWCP

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March 3, 2015

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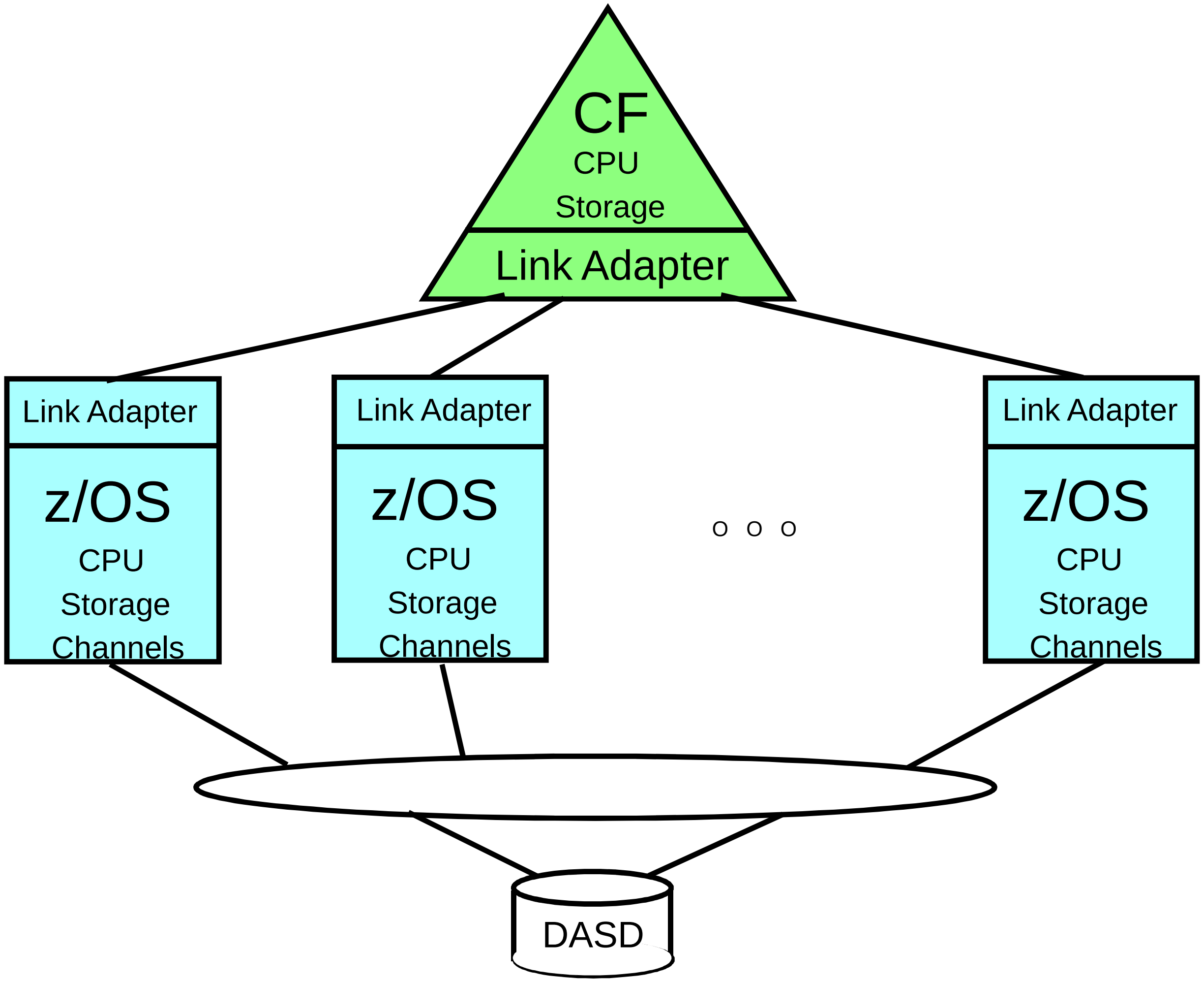
# Parallel Sysplex
# Overview and hottest players

- ►Resource Sharing
  - –XCF
  - –GRS Star
  - –logs
- ►Data sharing
  - –locking
  - –global buffer pool
- ►Workload management
  - –VTAM
  - –CICS TS
  - –IMS SMQ
  - –MQ shared queues



# What coupling technology is right for me?

- CF Functionality
- CF Capacity
- CF Service Time

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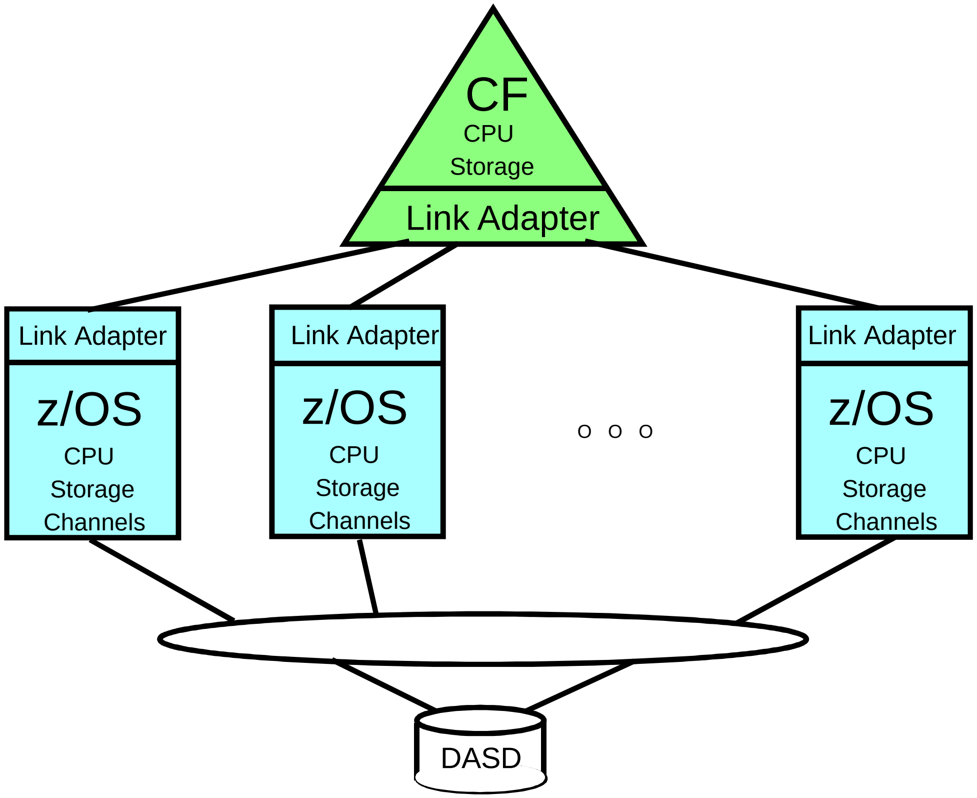
- CF Functionality
  - ►CFCC levels
- CF Capacity
- CF Service Time



# CFCC Level Functional Highlights

- z990/z900/z890/z800
  - CF level 1-10 functions plus ...
  - CF level 12: 64 bit exploitation, 48 tasks, SM structure duplexing
  - CF level 13: DB2 castout improvements

- z9EC/z9BC/z990/z890
  - CF level 14: CFCC dispatcher enhancements

- z9EC/z9BC/z10EC/z10BC
  - CF level 15: 112 tasks, CPU % by structure

- z10EC/z10BC
  - CF level 16: improved SM duplexing, improved LN for IMS and MQ

- z196/z114
  - CF level 17: 2047 structures, enhanced serviceability

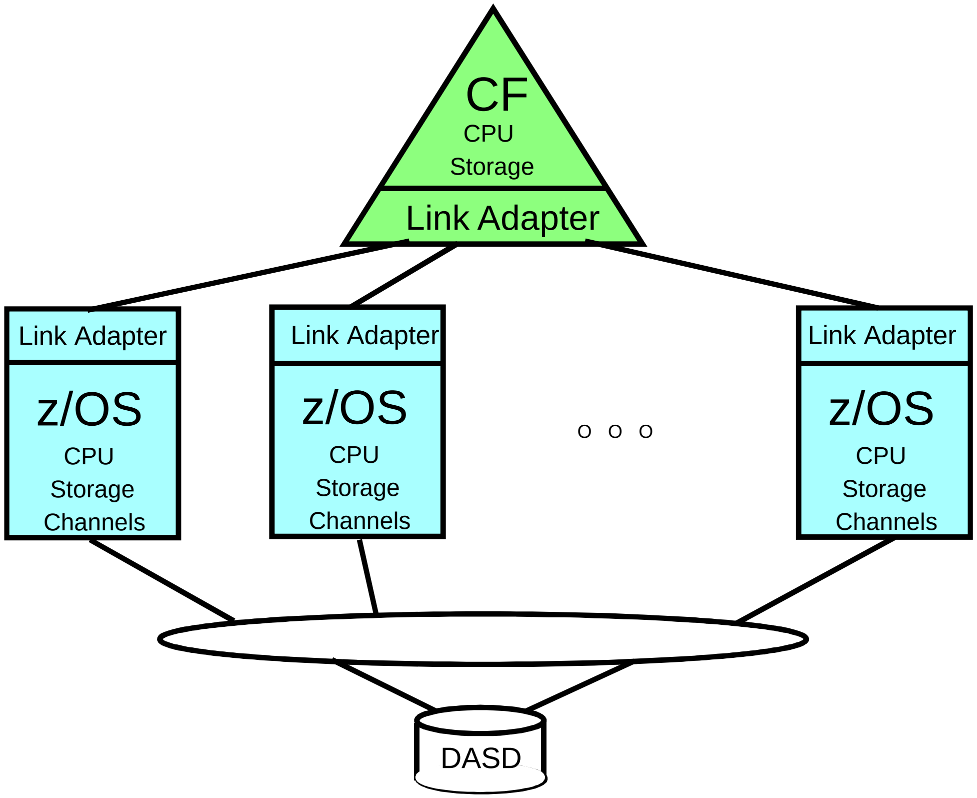
- zEC12
  - CF level 18: enhanced serviceability, improved structure size alters

- zEC12 GA2, zBC12
  - CF level 19: coupling thin interrupts

- z13
  - CF level 20: ICA SR link support, large cache structure performance improvements,
    256 coupling CHPIDS per CEC (128 per CF image)

# What coupling technology is right for me?

- CF Functionality
  - ►CFCC levels
  - ►CF Partitions
    - –dedicated versus shared processors
    - –standalone versus internal
      - •CF Duplexing



- CF Capacity

- CF Service Time

# CF Partition Options:  dedicated or shared processors?

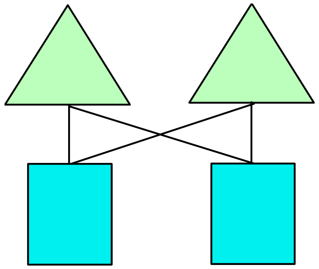
- Dedicated processor(s)
  - ►best for production

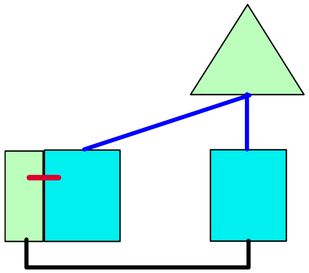
- Shared processor(s) prior to CF level 19 (zEC12 GA2, zBC12)
  - ►At best, could have 1 shared CF image with good service time, while the rest have poor to bad service time (but still often acceptable for test sysplexes)
  - ►Potential use for test or non-data-sharing production

- Shared processor(s) with CF level 19 and above
  - ►CF image dynamic dispatch setting: DYNDISP=OFF|ON|THIN
    - OFF = logical processor (LP) constantly polls for work when dispatched
    - ON = LP dynamically adjusted pattern of sleep (up to 10k mics) and polling
    - THIN = LP is awoken when work arrives, polls for work, then sleeps
  - ►Subject to PR/SM time slice management based on LP usage pattern
    - OFF will cause LP to run to end of time slice and may be undispatched
    - ON or THIN will generally have LP voluntarily sleep prior to end of time slice
  - ►THIN provides near dedicated service times to shared CF images
    - Hugely increases opportunity to share CF processors among multiple production and test/development partitions

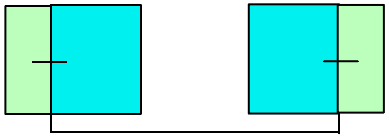
# CF Partition Options:  standalone or internal CF?

- Standalone or “logical” standalone CF in the configuration
  - Inherently provides failure isolation
  - Easier maintenance
  - More connectivity
  - Most commonly used for …
    - Large sysplexes
    - Intensive data sharing workloads



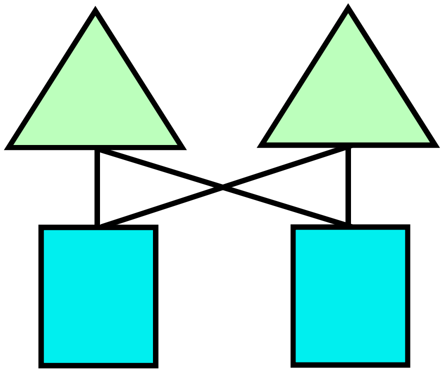


- All internal CFs in the configuration
  - Less costly than separate footprints
  - Technology upgrades simultaneously with host
  - Take advantage of internal coupling links
  - Needs SM duplexing to provide failure isolation
    - MIPS cost can be prohibitive to intensive data sharing workloads
  - Most commonly used for …
    - Smaller sysplexes
    - Resource sharing or low-intensity data sharing workloads

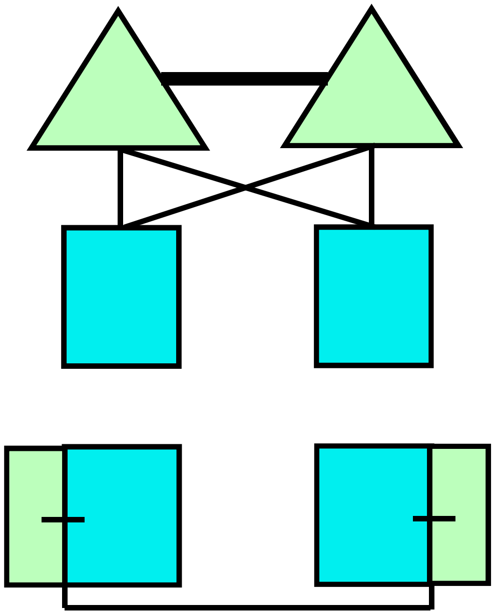


# What is CF duplexing?

- User Managed CF structure duplexing
  - ►Available only for DB2 GBPs and VSO
  - ►User (DB2 or IMS shared VSO)
    - –asks for primary/secondary structures
    - –writes updates to both
    - –synchronizes via already held locks



- System Managed CF structure duplexing
  - ►Installation selects duplexing option
    - –for specific exploiters/structures
  - ►System
    - –creates primary/secondary structures
    - –writes updates to both
    - –synchronizes via 2 CF-to-CF ops



# CF duplexing:  value vs. cost

- Value
  - ►Faster recovery from CF failures
    - –much, much faster compared to log recovery (40x)
    - –faster compared to rebuild (4x)
  - ►Provides failure isolation
    - –fully exploit ICFs

- Cost
  - ►Increased resource requirements:  host CPU, CF CPU, CF links
  - ►User Managed (DB2 GBP and VSO structures)
    - –2x times 1% to 100% (typically 20%) of simplex cost
  - ►System Managed (list and lock structures)
    - –3x to 5x times near 100% of simplex cost

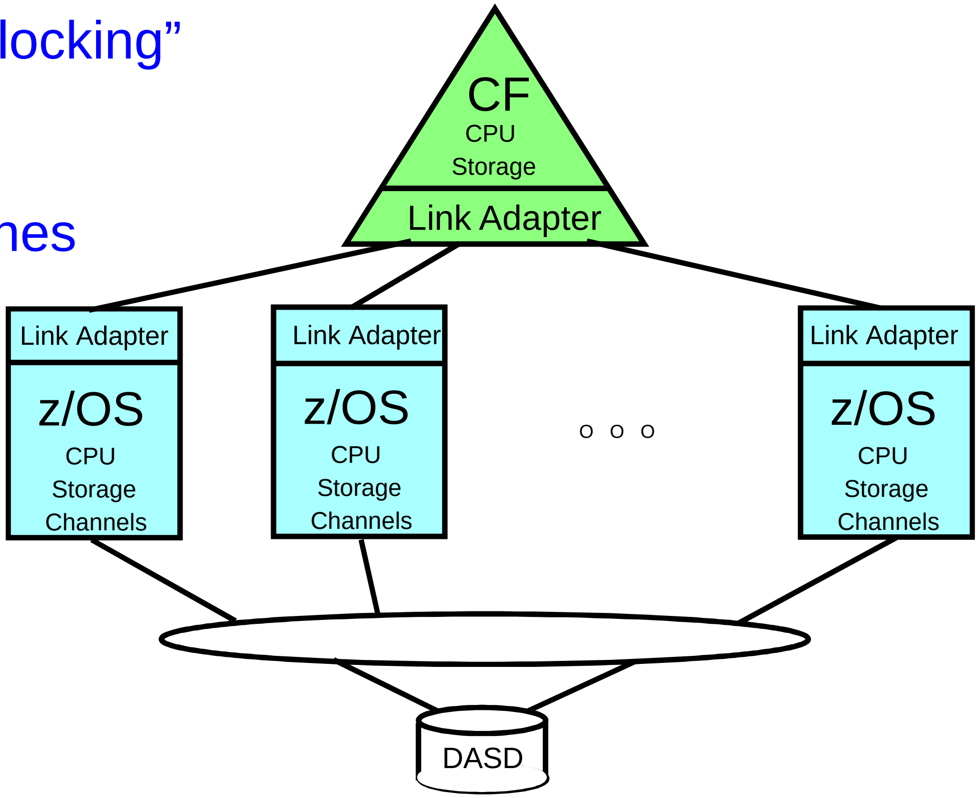
- Selectively enable when value > cost

# What coupling technology is right for me?

- CF Functionality

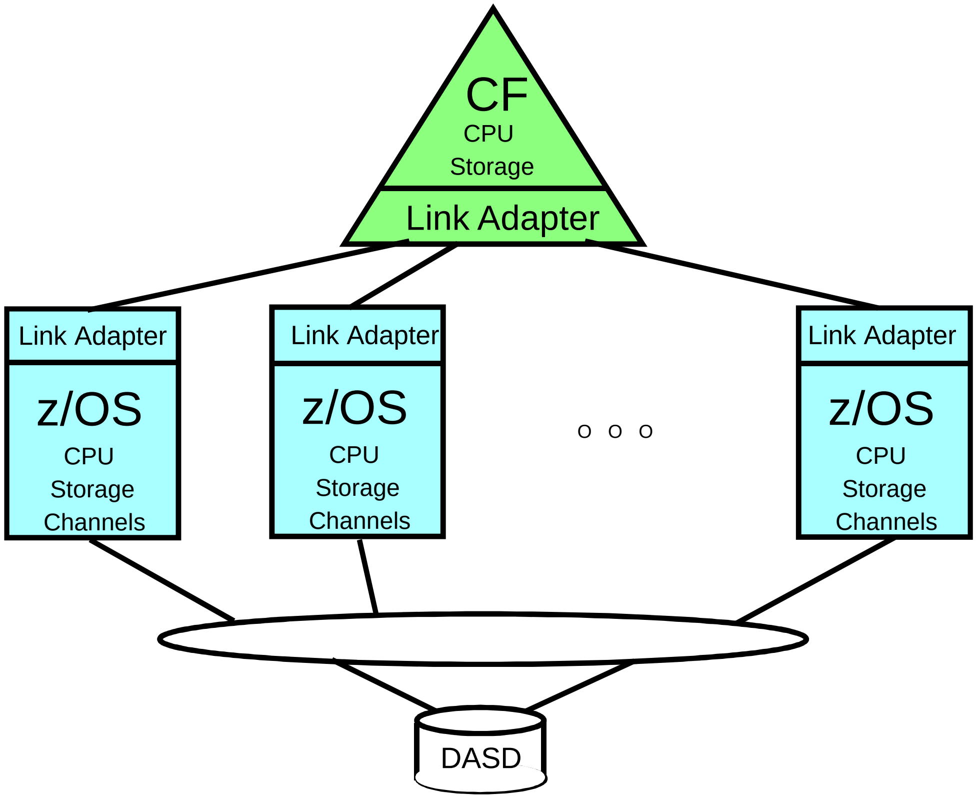
- CF Capacity
  - ►Need enough to handle the request rate (keep utilization < 50%)
    - ►Note 1way CFs <30% due to
      - •Single server queuing
      - •Long running commands “blocking” short commands
  - ►Add engines or move to faster engines

- CF Service Time



# What coupling technology is right for me?

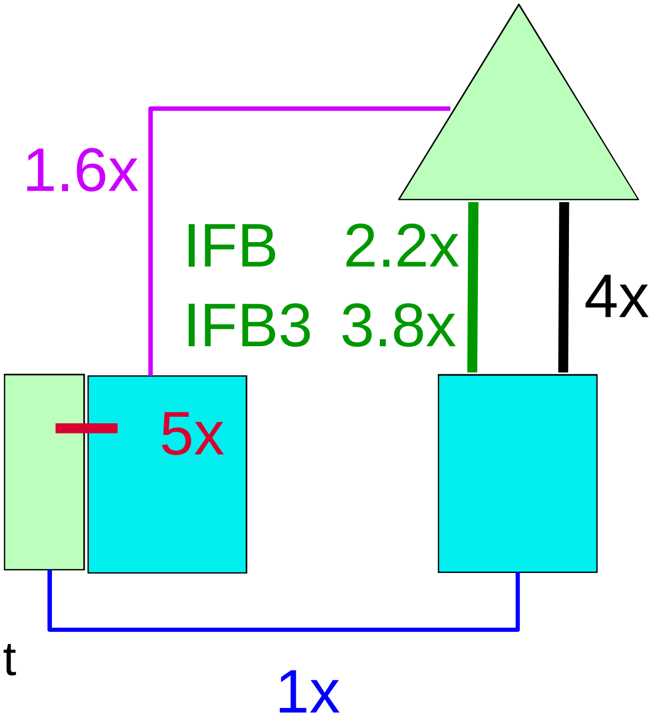
- CF Functionality
- CF Capacity
- CF Service Time
  - Affected by
    - –speed of CF engine
    - –link technology



# Coupling Link Choices - Overview

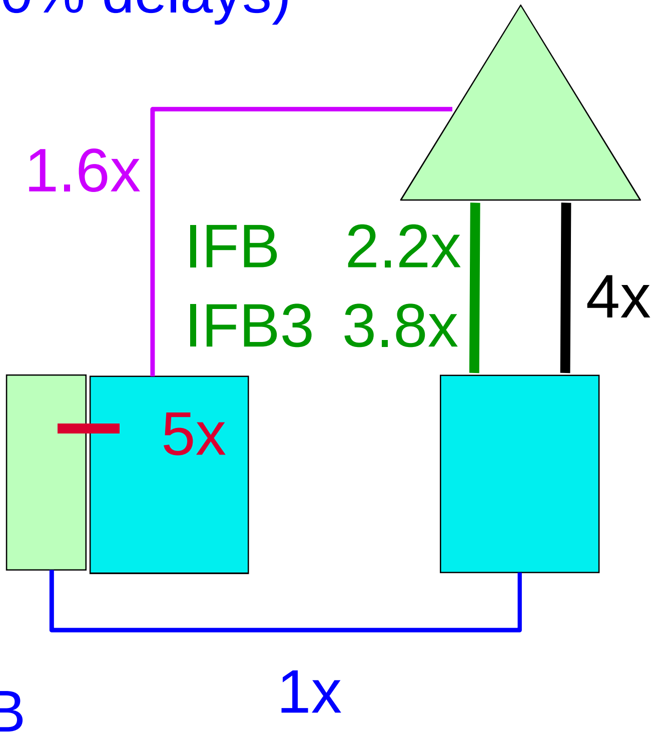
- ISC (Inter-System Channel) – NA after zEC12/zBC12
  - Fiber optics, I/O Adapter card, >10km with qualified WDM solutions
- ICB (Integrated Cluster Bus) – NA after z10EC/z10BC
  - Copper cable plugs close to memory bus, 10m max length
- IC (Internal Coupling Channel)
  - Microcode - no external connection
  - Only between partitions on same processor
- 12x IFB and 12X IFB3 (InfiniBand)
  - 150 meter max distance optical cabling
  - Supports multiple CHPIDs per physical link
  - Multiple CF partitions can share physical link
- 1x IFB
  - 10km and longer distances with qualified WDM solutions
  - Same multiple CHPIDs and sharing flexibility as 12x
  - 32 subchannels (up from 7) per CHPID (intro z196 GA2)
- ICA SR (CS5 is the CHPID name) – intro z13
  - ICA (Integrated Coupling Adapter) connects to PCIe fanout
  - 150 meter max distance
  - Supports up to 4 CHPIDs per physical link

Relative Performance
Based on avg data xfer size



# IFB and ICA SR Link Configuration Advantages

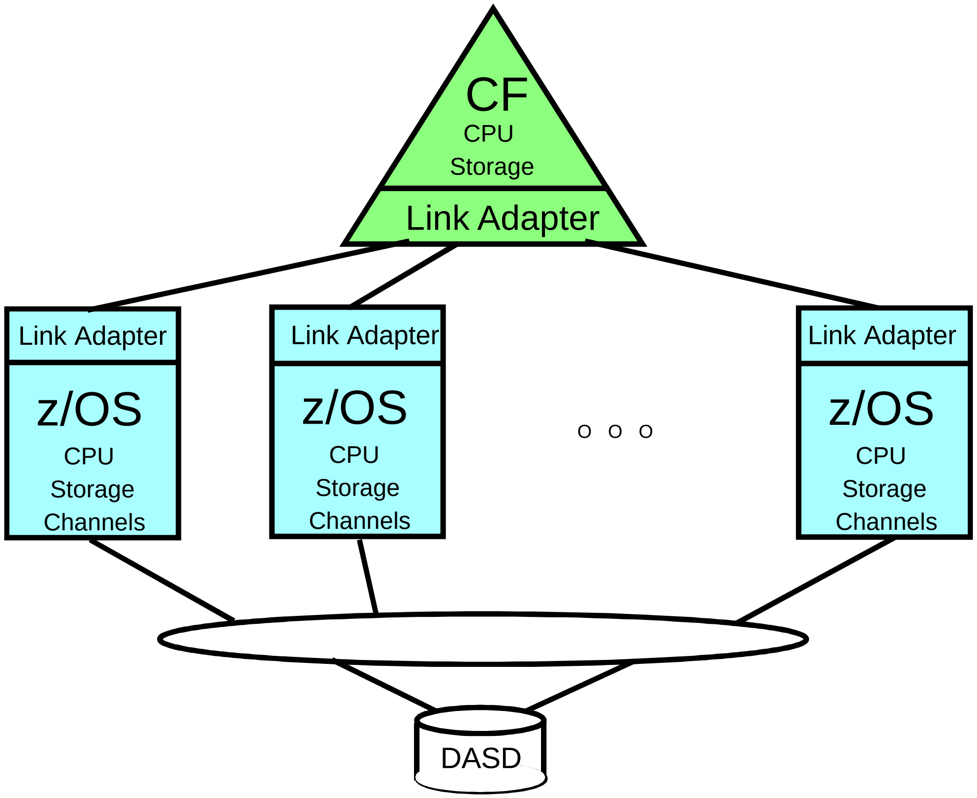
- Pure Capacity
  - 1 1x IFB = 1 ISC3
  - 1 ICA SR = 1 12x IFB(3) = 1 ICB4 = 4 ISC3s
- Eliminating subchannel and path delays (ROT <10% delays)
  - Often >2 ICB4s or >2 ISC3s are configured not for capacity but for extra subchannels/paths to eliminate delays
  - Multiple CHPID support with ICA and IFB links and 32 subchannel support with 1x IFB can often be used in lieu of adding more links beyond 2 for redundancy
- Multiple sysplexes sharing hardware
  - Production, development, test sysplexes may share hardware – each needs own ICB4 or ISC3 links
  - Multiple CHPID support with ICA and IFB links can often be used in lieu of configuring separate links for each sysplex



- Multiple CHPID recommendations for ICA and IFB
  - Most sysplexes will find 2 links defined with 2 CHPIDs each to be sufficient
    - ►Provides 28 subchannels which generally is sufficient to stay under ROT of <10% delays
  - May define up to a max of 4 CHPIDS per link for connectivity or to reduce delays for heavy loads
    - ►4 is either the practical limit (IFB) or the actual limit (ICA)

# What coupling technology is right for me?

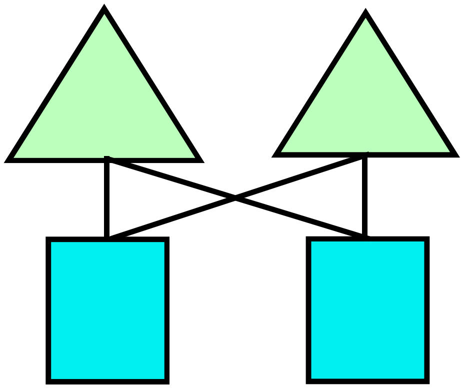
- CF Functionality
- CF Capacity
- CF Service Time
  - ►Affected by
    - –speed of CF engine
    - –link technology
  - ►Affects cost of data sharing
    - –host processor dwells
      for synchronous requests



# CF Operations:  synchronous or asynchronous

- Describes state of host processor engine issuing CF operation

- Synchronous operation
  - ►SW cost: exploiter+XES
  - ►HW cost ("dwelling time")

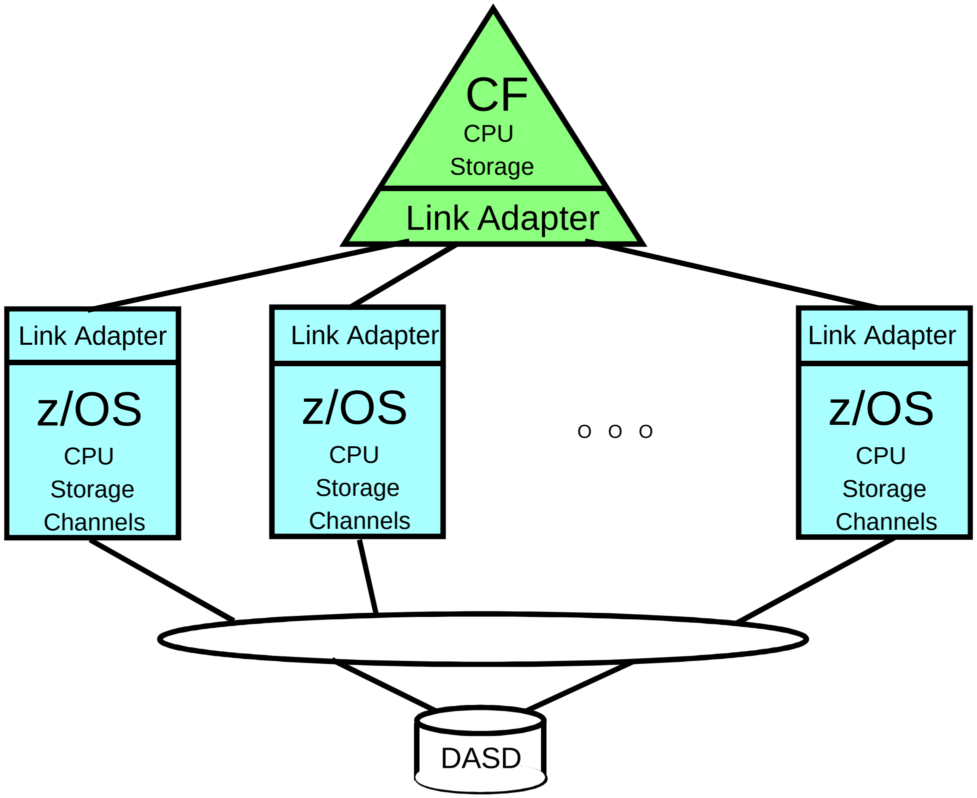


- Asynchronous operation
  - ►SW cost
    - –exploiter+XES+SRBs
    - –task switching impact on HW
  - ►HW cost - virtually none (no dwelling)
  - ►CF service time elongation
    - –added latency for XES to recognize completion of operation
    - –vastly reduced by coupling thin interrupts on zEC12 GA2 / zBC12 / z13 processors
      - • need z/OS V2R1 or proper maintenance on V1R12 and V1R13

- Which when?
  - ►Exploiter can specify synch or asynch
  - ►If synch, XES heuristic can override and issue it asynch
    - –based on measured synch service time versus "breakeven" cost of asynch
  - ►If issued synch and encounter subchannel busy, will change to asynch

# What coupling technology is right for me?

- CF Functionality
- CF Capacity
- CF Service Time
  - Affected by
    - –speed of CF engine
    - –link technology
  - Affects cost of data sharing
    - –host processor dwells for synchronous requests
  - Impact relative to ...
    - –Rate of requests to the CF
    - –Speed of the host processor



# Host Capacity Effect

- Directly related to activity to CF
  - CF request rate x SW+HW cost

- Varies based on
  - Portion of workload involved in data sharing
  - Access rate to shared data
  - Type of hardware for Host, CF and CF links

- Typical system-level effects
  - Resource Sharing:  2-3% versus single image
  - Data sharing primary production application:  5-10%

- Individual Transaction/Job effects - can have wide variation

# Production Examples

Host Effect with primary application involved in data sharing

| Industry | Trx Mgr / DB Mgr | z/OS Images | CF access per Mi | % of used capacity |
|---|---|---|---|---|
| Banking | CICS/IMS | 4 | 9 | 11% |
| Banking | CICS/IMS | 8 | 8 | 9% |
| Banking | IMS/IMS | 2 | 5 | 7% |
| Pharmacy | CICS/DB2 | 3 | 8 | 10% |
| Insurance | CICS/IMS+DB2 | 9 | 9 | 10% |
| Banking | IMS/IMS+DB2 | 4 | 8 | 11% |
| Transportation | CICS/DB2 | 3 | 6 | 8% |
| Banking | IMS/IMS+DB2 | 2 | 7 | 9% |
| Retail | CICS/DB2+IMS | 3 | 4 | 5% |
| Shipping | CICS/DB2+IMS | 2 | 8 | 9% |

# Coupling Technology versus Host Processor Speed

Host effect with primary application involved in data sharing
Chart is based on 9 CF ops/Mi – may be scaled linearly for other rates

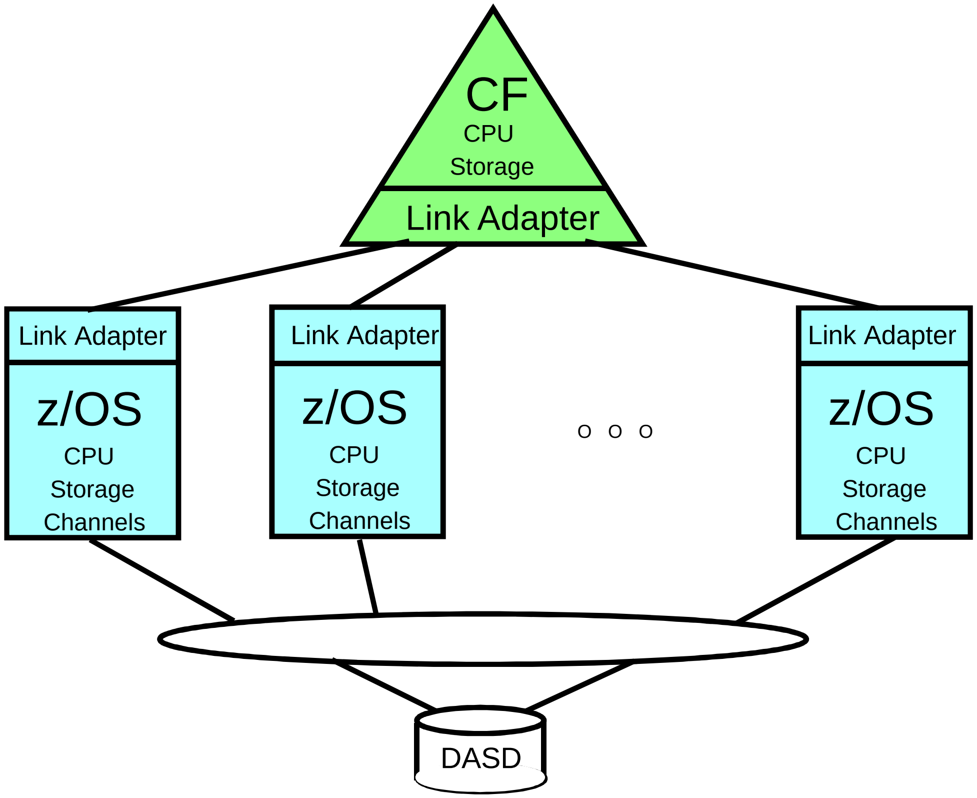
| CF\Host | z114 | z196 | zBC12 | zEC12 | z13 |
|---|---|---|---|---|---|
| z114 ISC3 | 17% | 21% | 19% | 24% | NA |
| z114 1x IFB | 14% | 17% | 17% | 21% | 22% |
| z114 12x IFB | 12% | 15% | 15% | 17% | 19% |
| z114 12x IFB3 | 10% | 12% | 12% | 13% | 14% |
| z196 ISC3 | 17% | 21% | 19% | 24% | NA |
| z196 1x IFB | 13% | 16% | 16% | 18% | 21% |
| z196 12x IFB | 11% | 14% | 14% | 15% | 17% |
| z196 12x IFB3 | 9% | 11% | 10% | 12% | 13% |
| zBC12 ISC3 | 17% | 21% | 19% | 24% | NA |
| zBC12 1x IFB | 14% | 18% | 17% | 20% | 22% |
| zBC12 12x IFB | 12% | 15% | 14% | 17% | 18% |
| zBC12 12x IFB3 | 10% | 11% | 11% | 12% | 14% |
| zEC12 ISC3 | 17% | 21% | 19% | 24% | NA |
| zEC12 1x IFB | 13% | 16% | 16% | 18% | 20% |
| zEC12 12x IFB | 11% | 13% | 13% | 15% | 17% |
| zEC12 12x IFB3 | 9% | 10% | 10% | 11% | 12% |
| z13 1x IFB | 14% | 17% | 16% | 19% | 20% |
| z13 12x IFB | 12% | 14% | 14% | 16% | 17% |
| z13 12x IFB3 | 9% | 11% | 10% | 12% | 12% |
| z13 CS5 | NA | NA | NA | NA | 11% |

With z/OS 1.2 and above, synch-> asynch conversion caps values in the table at about 18%
IC links scale with the speed of the host technology and would provide an 8% effect in each case

# What coupling technology is right for me?

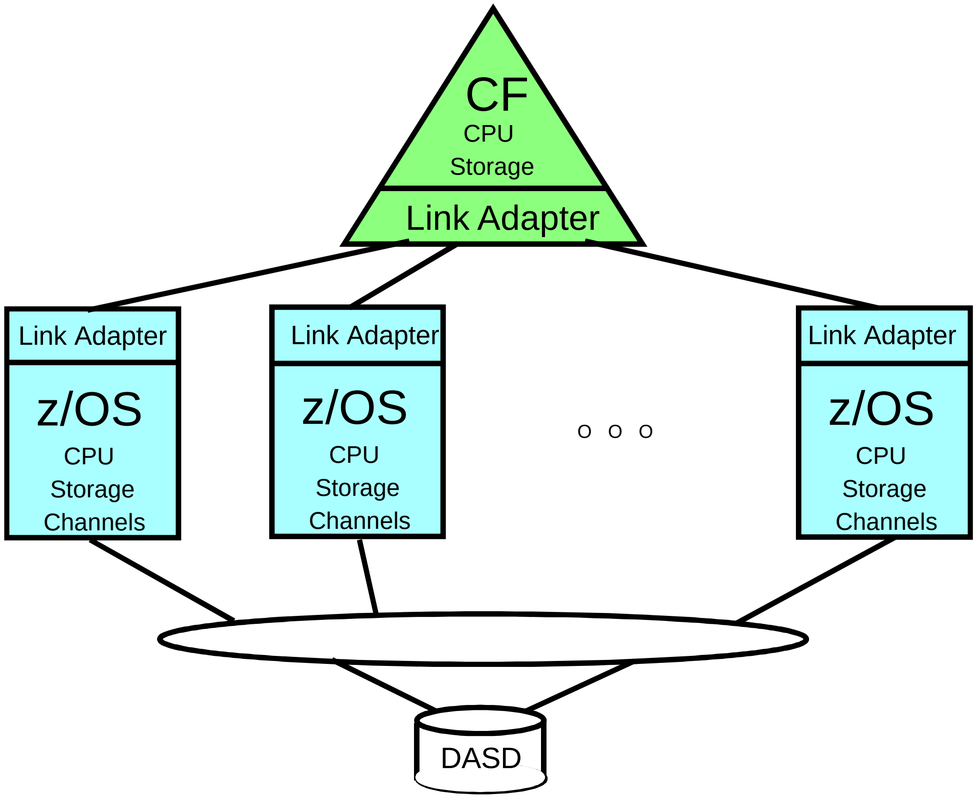
## Your Handy Dandy Checklist

- CF Functionality
  - ►CFCC level, dedicated vs shared, standalone vs internal
- CF Capacity
  - ►Need enough to handle the request rate (keep utilization < 50%)
  - ►Add engines or move to faster engines
- CF Service Time
  - ►Affected by
    - –speed of CF engine
    - –link technology
  - ►Affects cost of data sharing
    - –host processor dwells for synchronous requests
  - ►Impact relative to ...
    - –Rate of requests to the CF
    - –Speed of the host processor



# For those considering data sharing over distance ...

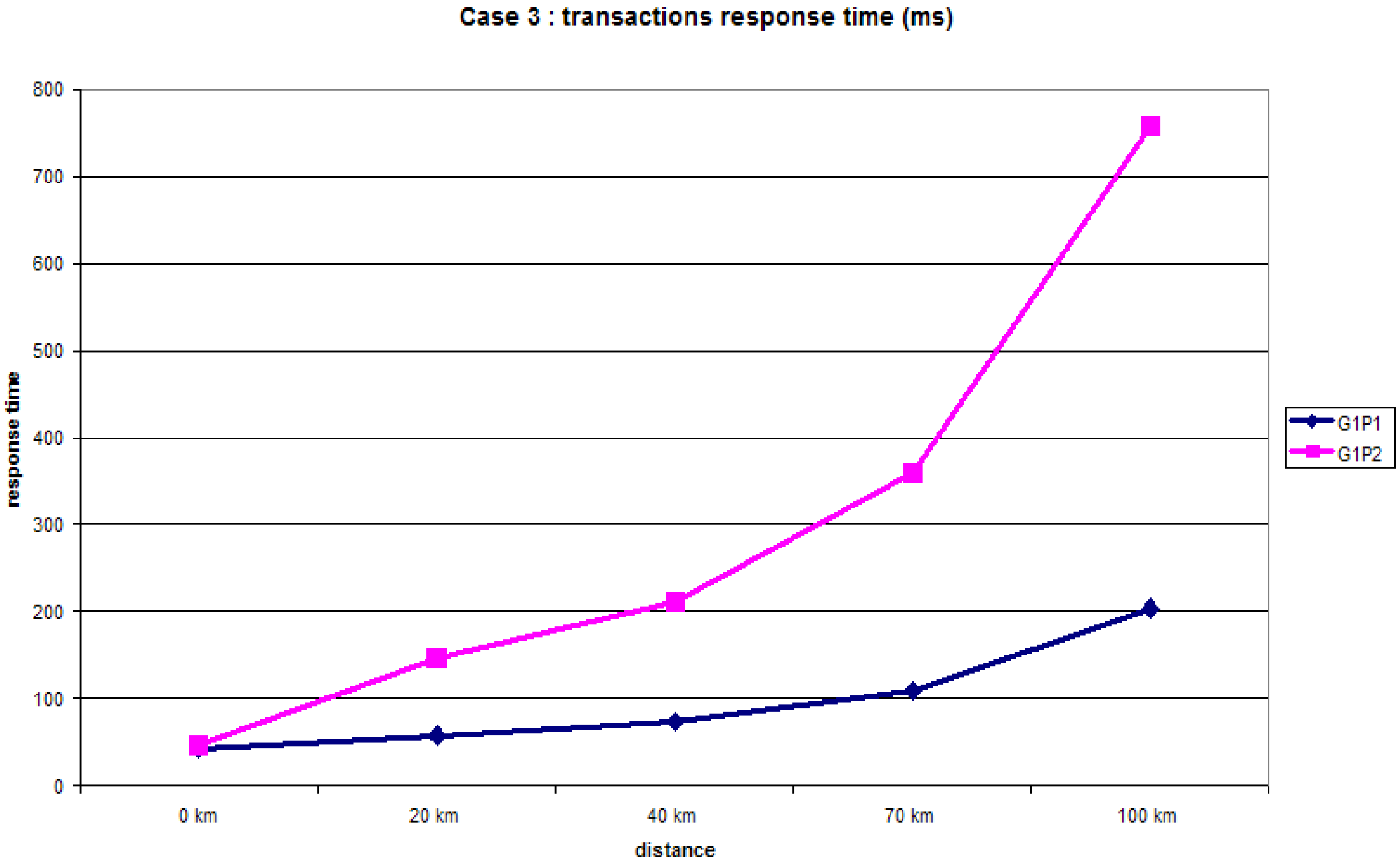
- CF Functionality
- CF Capacity
- CF Service Time
  - ►Affected by
    - –speed of CF engine
    - –link technology
    - –distance between host and CF
      - - elongates by 10 mics per km due to speed of light thru fiber
  - ►Can affect application performance
    - –transaction waits for synch and asynch requests
      - - potential impact on subsystem queues and lock contention



# Example Distance Impact

Benchmark CICS/DB2 data sharing application

- G1P1 LPAR local to CF with lock structure and primary GBPs
- G1P2 LPAR remote to CF with lock structure and primary GBPs



# Data sharing over distance summary

- CF service time elongation (versus synch request)
  - +50 mics due to change to asynch (this goes away with coupling thin interrupts)
  - +10 mics per km due to speed of light through fiber (round trip to CF)
- Host impact is capped by synch to asynch conversion
- Will likely need more link buffers (subchannels) between host and remote CF
  - link buffer (subchannel) busy grows linearly with elongated service time
  - 1x IFB multiple CHPIDs and 32 subchannels per CHPID support helps here
- Potential application performance impact
  - increased transaction response time
    - increased internal subsystem queues
    - increased lock contention
- Each application will react differently
- Difficult to predict impact
- Suggest application stress testing with simultated distance (e.g., fiber suitcases)

# References

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  - System Managed CF Structure Duplexing White Paper

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