

E11

IMS in a Parallel Sysplex

Enhancing Availability, Capacity, and Workload Balancing

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- ▶ VTAM
- ▶ S/390

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Abstract

▲ Abstract

- IMS uses Parallel Sysplex to deliver improved availability, increased capacity, and workload balancing. This presentation shows how IMS data sharing, VTAM generic resources, shared queues, automatic restart management (ARM), and other facilities deliver the promise of Parallel Sysplex.

▲ Agenda

- Availability, Capacity, and Workload Balancing
- IMS Database Manager
- IMS Transaction Manager
- Parallel Sysplex Failure Recovery



Availability

▲ Ability to survive outages

- Outages may be planned or unplanned
- Multiple systems (clones) to do the work
- Routing work to an available system
 - ▶ Online users and batch jobs
- Making data available to all available systems
- Quickly restoring failed systems

Capacity

▲ Ability to do more work

- Multiple systems (clones)
 - ▶ Must be able to do the same work concurrently
 - ▶ Must have access to the same data

- Getting work to the right place
 - ▶ System with capacity
 - ▶ System with functional capability
 - ▶ Online users and batch jobs

- Adding (and deleting) capacity easily

Workload Balancing

▲ Ability to spread work appropriately

- Easily spreading work across multiple systems
 - ▶ Work is both online transactions and batch jobs
- Automatically spreading work to new systems
- Dynamically adjusting work distribution
 - ▶ As workload changes
 - ▶ As systems change



IMS Database Manager



The world depends on it

IMS
Database Manager

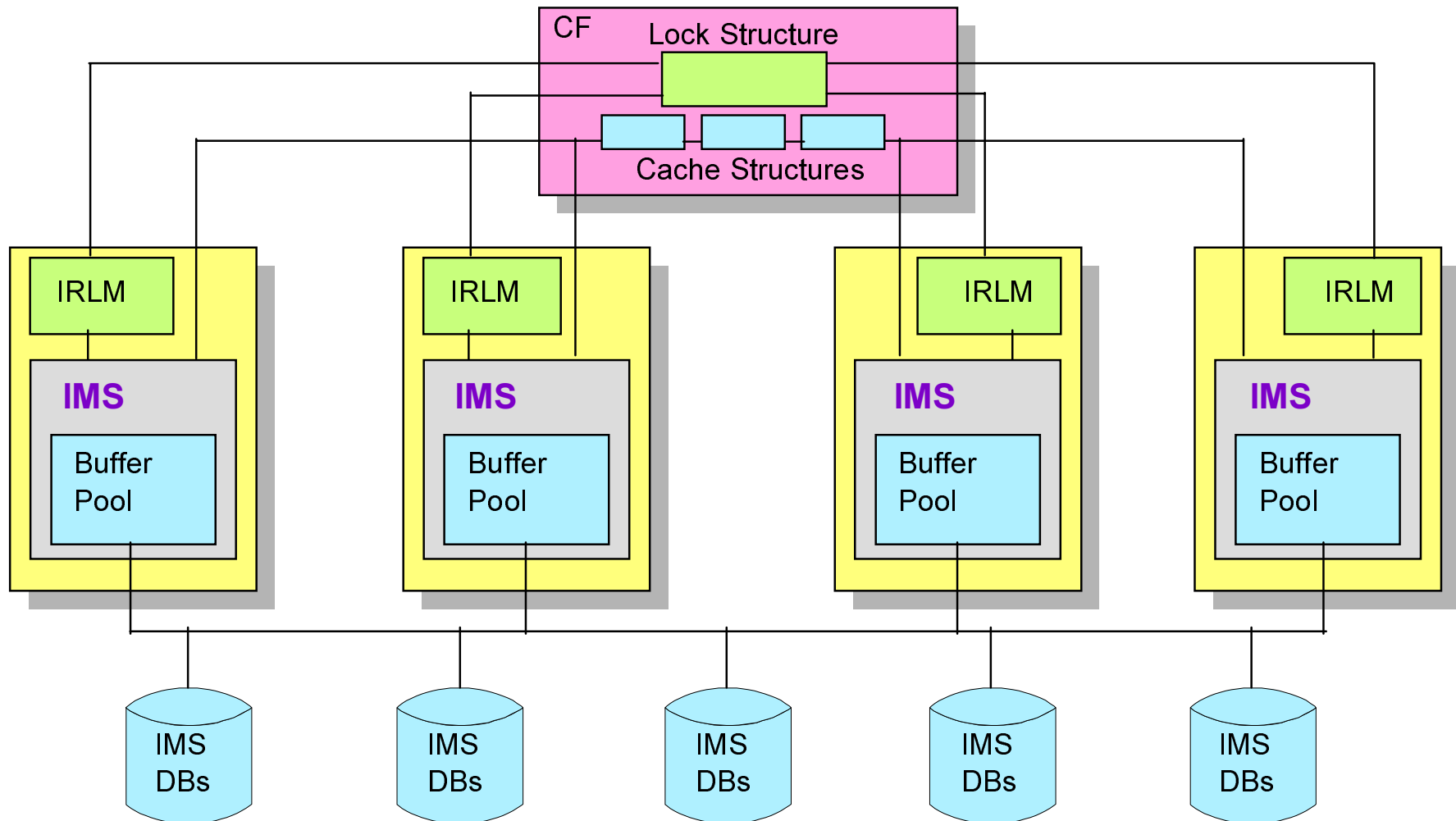


Block Level Data Sharing

▲ Block level data sharing (BLDS)

- N-way data sharing for databases
 - ▶ Up to 255 IMS subsystems on 32 MVSs
- Full capabilities
 - ▶ Multiple updaters
 - ▶ Data integrity

IMSSs, IRLMs, and the CF



IMS systems include TM/DB, DBCTL, and IMS batch jobs.



IMS Data Sharing

▲ No IMS DB restrictions on applications which may use data sharing

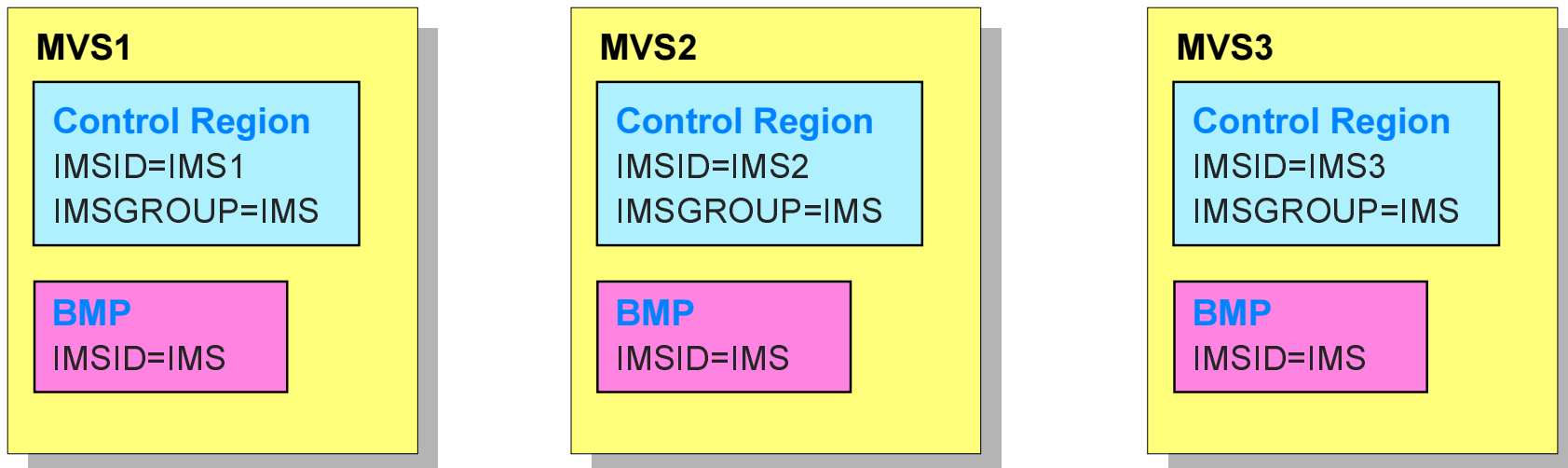
- All full function databases may be shared
- All DEDBs may be shared
 - ▶ All restrictions removed by IMS V6
- MSDBs may be replaced with DEDB VSO

▲ No IMS data affinities

IMSGROUP for Dependent Regions

▲ IMSGROUP for BMPs, MPPs, and IFPs (IMS V6 with PQ21039)

- Generic name for IMS Control Regions
 - ▶ Dependent region may connect to any control region with this generic name
 - ▶ BMP availability, capacity, and workload balancing are made easier





Fast Database Recovery (FDBR)

▲ **FDBR is an availability enhancement in IMS V6**

▲ **The problem:**

- Failed IMS system holds locks for in-flight updates
- Other IMS systems cannot access locked data
- Requests to access data locked by failed system results in application ABENDs



Fast Database Recovery (FDBR)

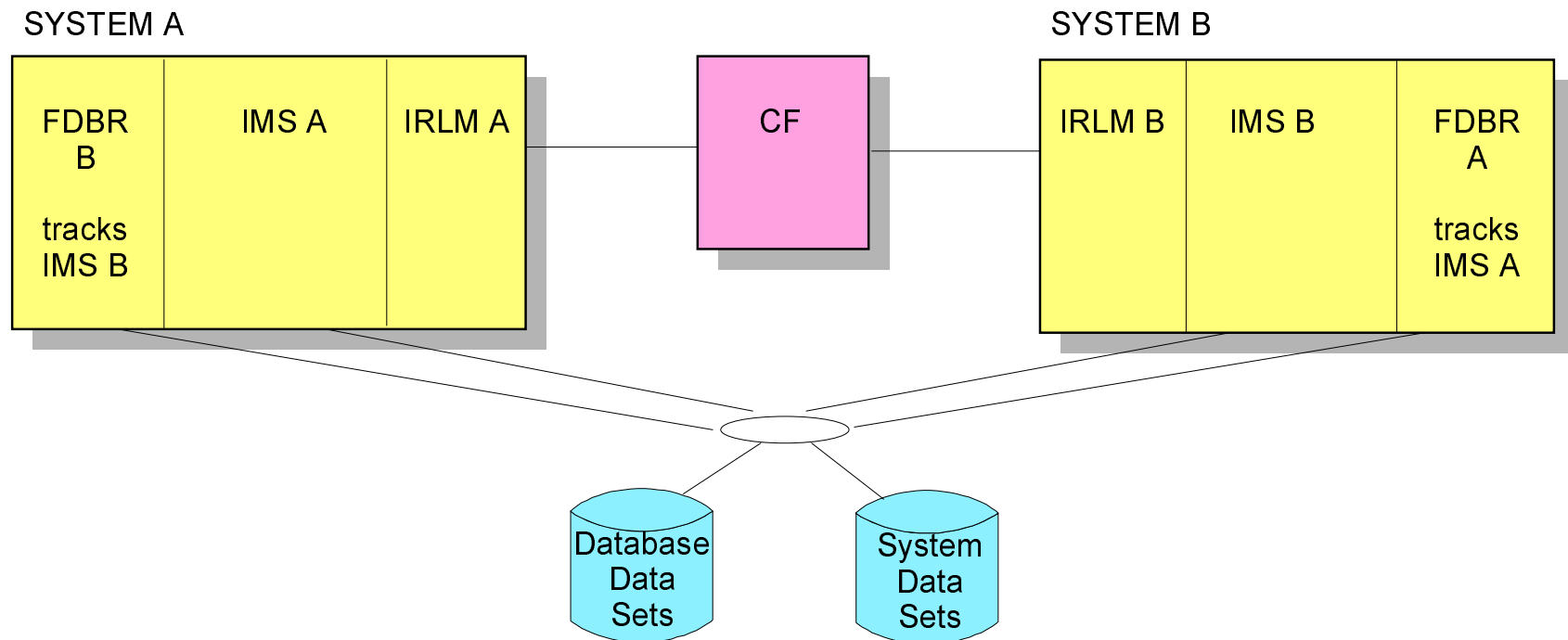
▲ **Fast Database Recovery (FDBR) is the solution:**

- FDBR is an independent region in the Parallel Sysplex
- FDBR recognizes failure of a tracked IMS system
- FDBR backs out in-flight work from failed IMS system

▲ **FDBR provides for fast backouts after failures**

- ▶ Eliminates application ABENDs in other IMS systems

Fast Database Recovery (FDBR)



If SYSTEM A or IMS A fails,
 FDBR A backouts all in-flight work from IMS A
 IMS B has access to all IMS data



IMS Database Summary

▲ IMS data sharing in a Parallel Sysplex

- Higher availability
- Increased capacity
- Usable by IMS TM, CICS, and IMS batch
- All IMS data may be shared (IMS V6)



IMS Transaction Manager



The world depends on it

IMS Transaction Manager



IMS TM in a Parallel Sysplex

▲ Routing terminal connections

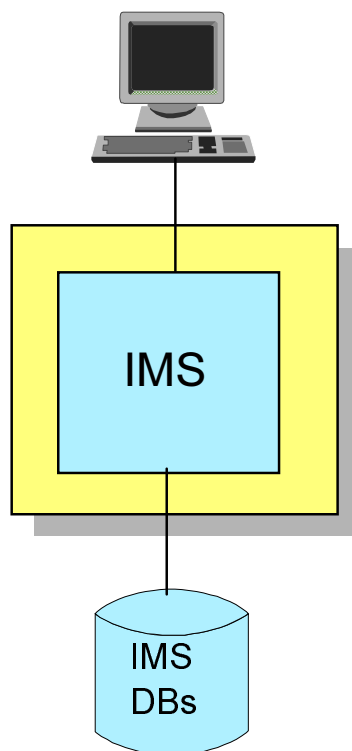
- SNA
 - ▶ USERVAR exit
 - ▶ Generic Resources - requires IMS V6
- TCP/IP
 - ▶ IND
 - ▶ DNS/WLM
 - ▶ Sysplex Distributor

▲ Routing messages between IMS systems

- MSC
- Shared Queues - requires IMS V6

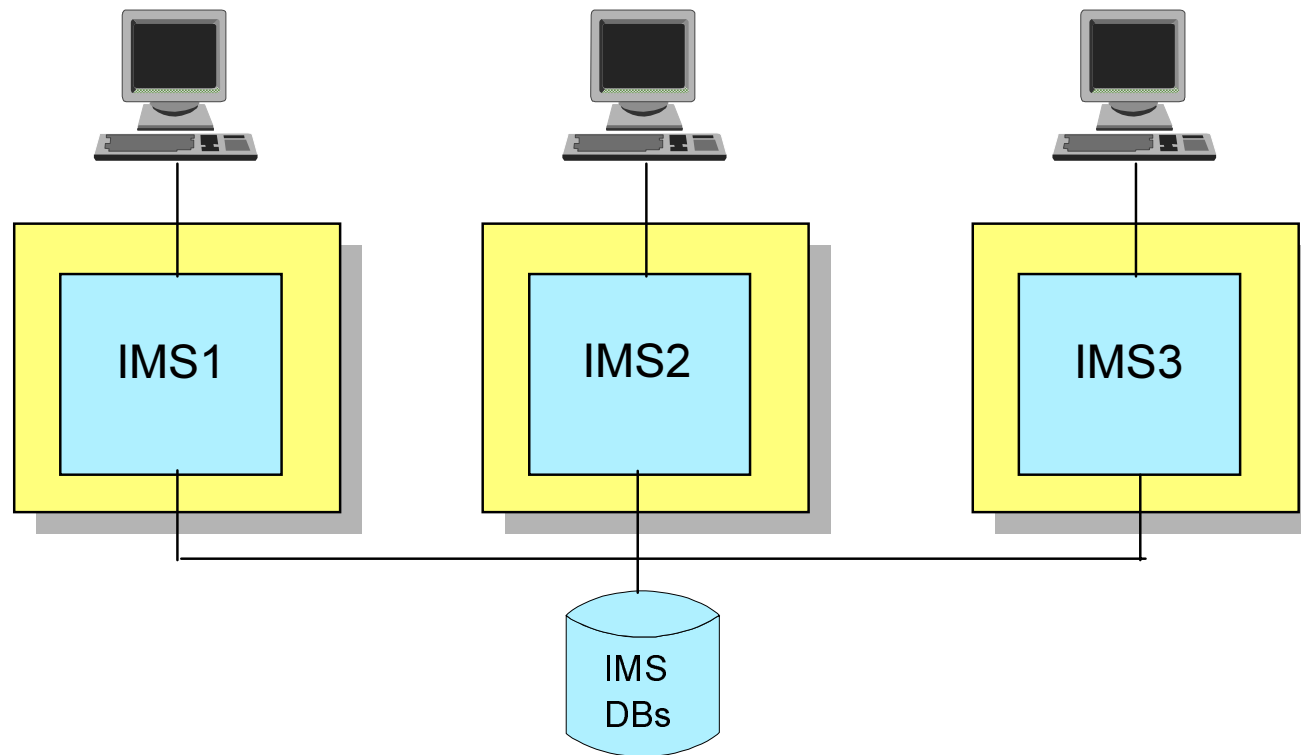
Cloning IMS TM

▲ Before cloning:



Routing SNA logons with USERVAR exit

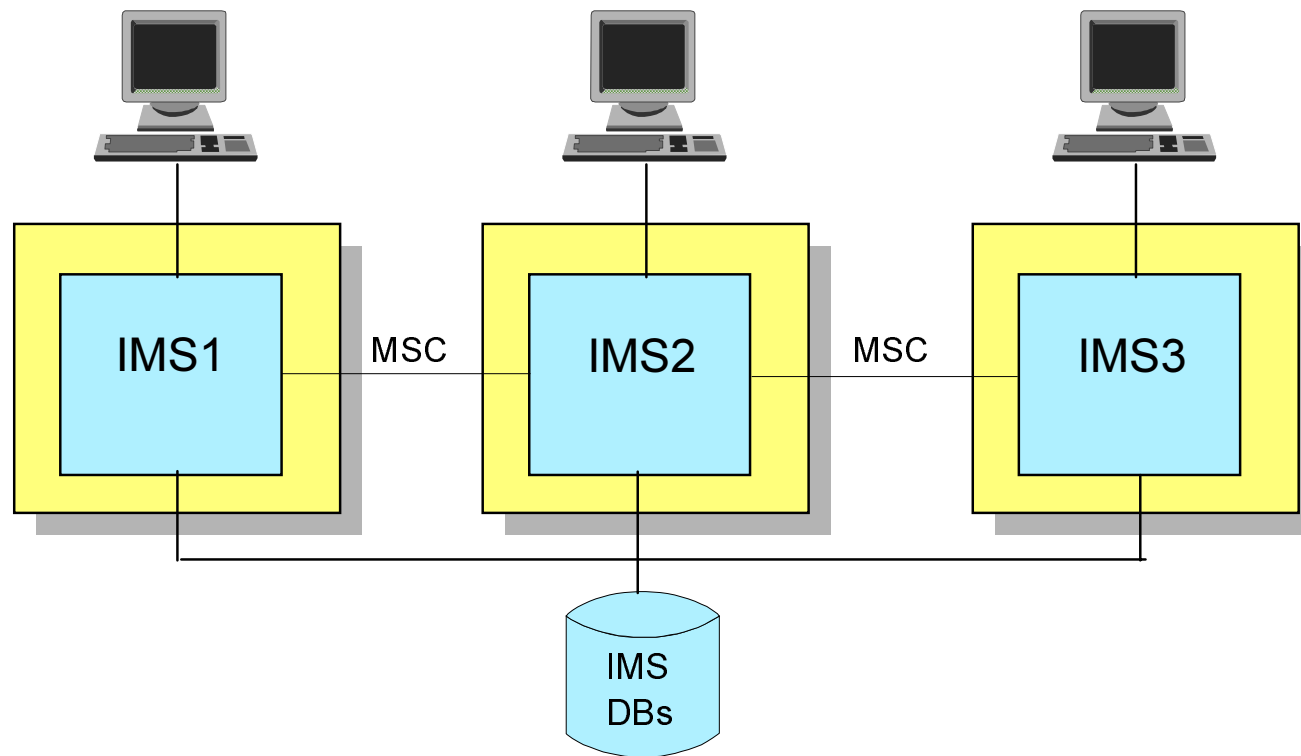
- ▲ **USERVAR exit routine may be used to provide logon to any IMS**
 - Not dynamic
 - ▶ Exit routine is not aware of changes in configuration



Routing messages with MSC

▲ Multiple Systems Coupling (MSC)

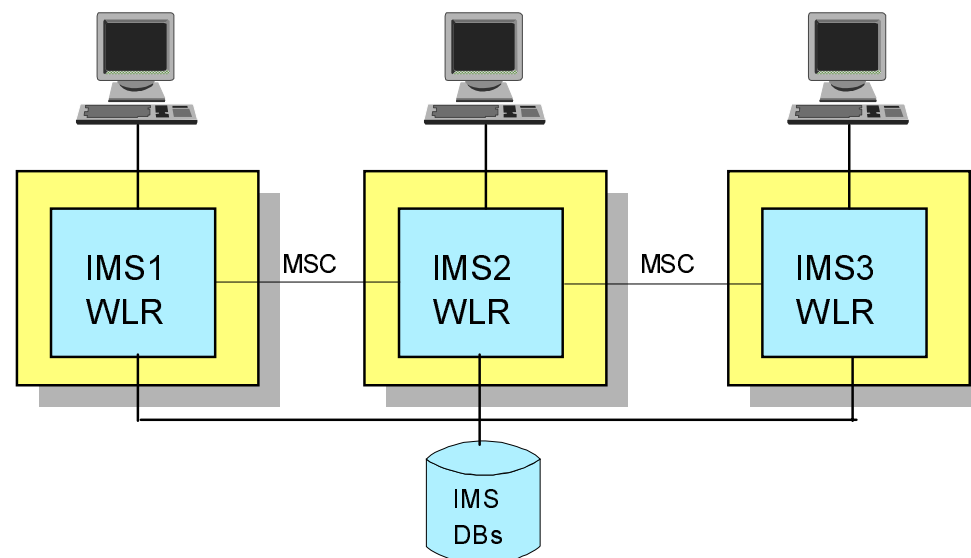
- MSC routes transactions between IMSs



IMS/ESA Workload Router

▲ IMS/ESA Workload Router

- Product which uses MSC to route IMS TM transactions
 - Product is a set of MSC exit routines
- May be used to balance workload
- May be used with IMS V5 or later release





IMS V6 Transaction Manager

▲ **VTAM Generic Resources**

- Balances logons (static balancing)
- Dynamically reacts to configuration changes

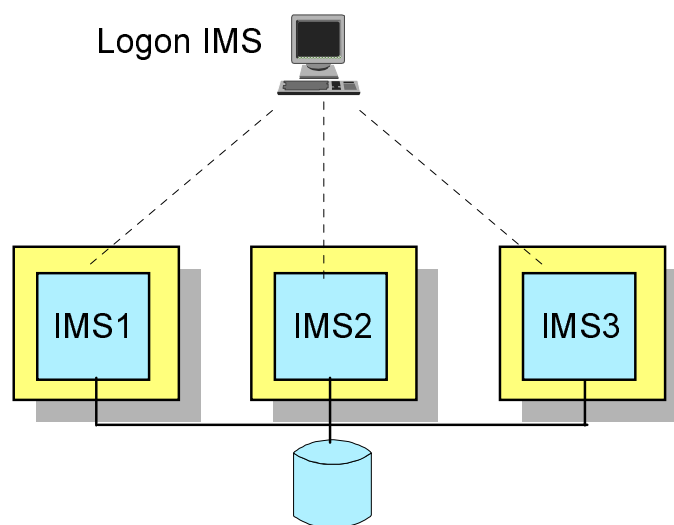
▲ **Shared Message Queues and Shared Expedited Message Handler (EMH)**

- Dynamically balances transaction workload

VTAM Generic Resources

▲ VTAM Generic Resources

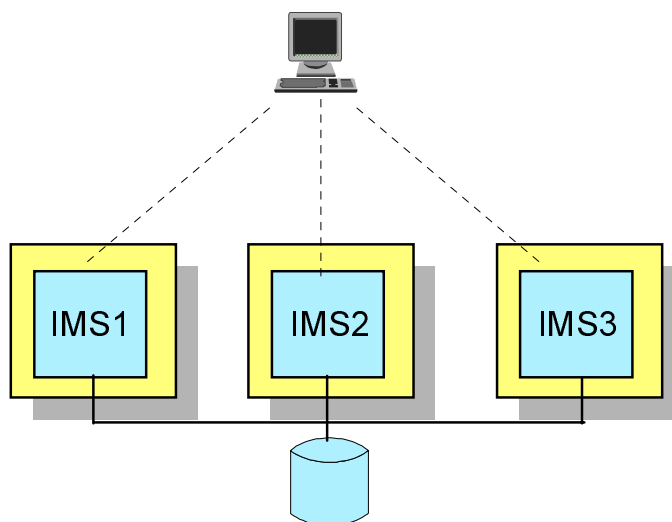
- Single VTAM generic name for cloned IMS systems
- VTAM maps the generic name to a specific IMS



VTAM Generic Resources

▲ VTAM Generic Resources for APPC/IMS

- Uses VTAM Generic Resources support from APPC/MVS
- Does not require IMS V6
 - ▶ Requires MVS 5.1 or later (including OS/390)



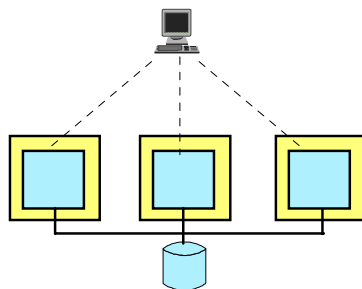
VTAM Generic Resources

▲ VTAM Generic Resources Benefits

- Availability:
 - ▶ Allows users to Logon to any available IMS

- Capacity
 - ▶ New IMS systems may be added without changes to user procedures

- Workload balancing
 - ▶ Spreads users across IMS systems



Web Connections to IMS

▲ Most typical Web server connections to IMS

- TCP/IP Telnet
 - ▶ Uses 3270 (VTAM LU2) interface to IMS
 - May use VTAM Generic Resources

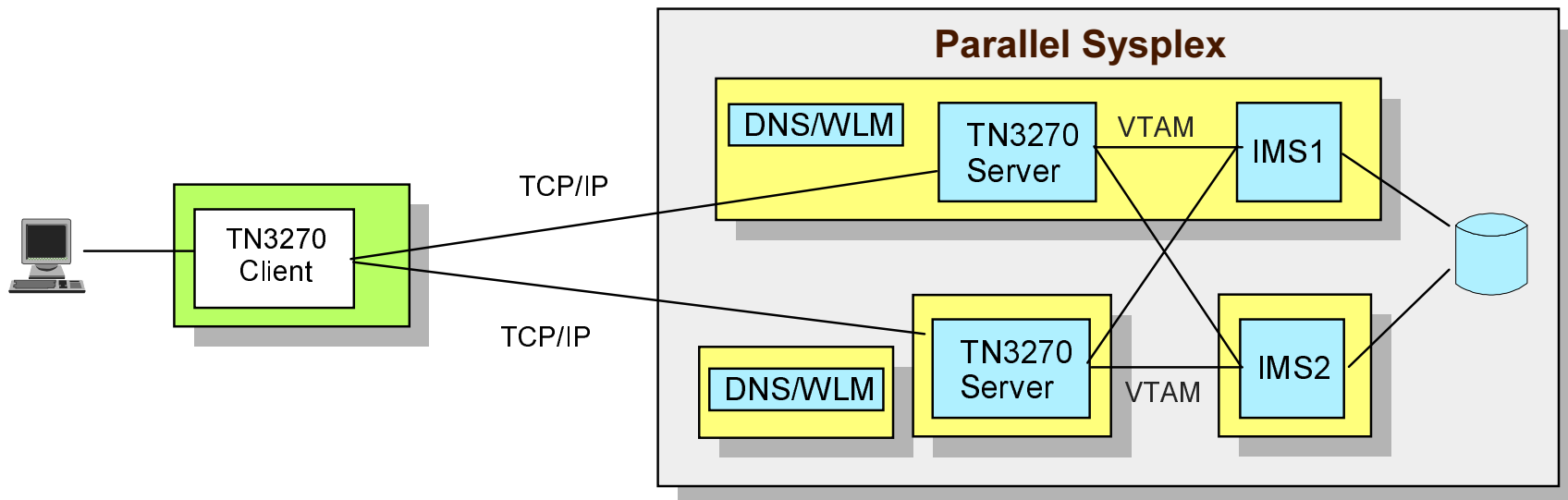
- APPC
 - May use VTAM Generic Resources for APPC/MVS

- TCP/IP sockets to IMS Connect
 - ▶ IMS Connect is follow-on to IMS TOC (ITOC) - IMS TCP/IP OTMA Connector
 - ▶ IMS Connect uses OTMA
 - OTMA is XCF interface to IMS

TCP/IP Connections to IMS

▲ TCP/IP sockets to TN3270 to IMS

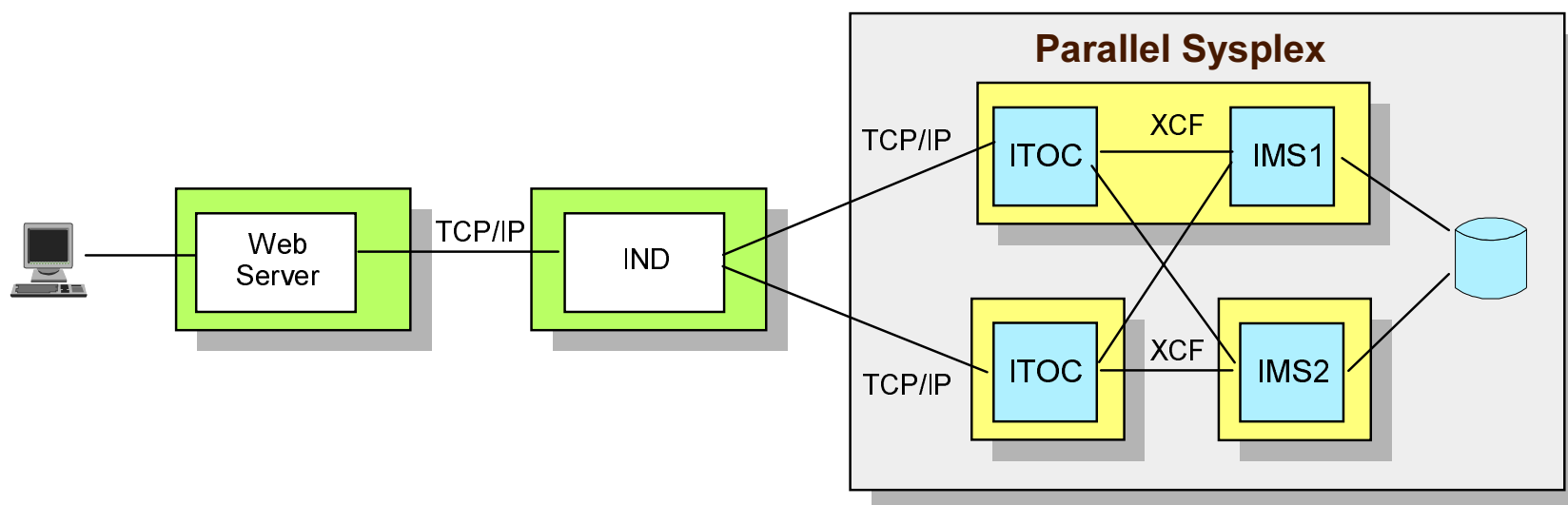
- ▶ Can use [DNS/WLM](#) for TN3270 client to server balancing and availability
 - DNS/WLM runs on OS/390
 - May be on one or more systems in the Sysplex
 - Works well with long-lasting connections
- ▶ Can use VTAM Generic Resources between TN3270 server and IMS
 - TN3270 server and IMS may on different systems in the sysplex



Web TCP/IP Connections to IMS

▲ TCP/IP sockets to IMS Connect (IMS TOC or ITOC)

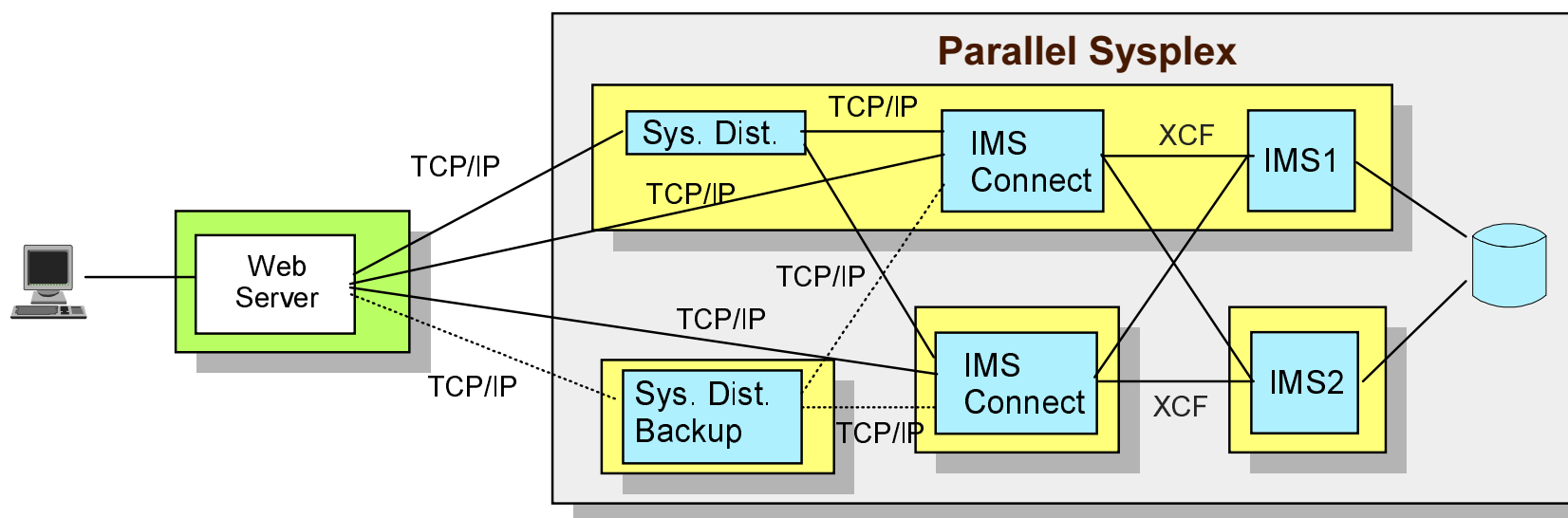
- ▶ IMS Connect is TCP/IP to XCF protocol converter
 - XCF is communication facility within a Parallel Sysplex
- ▶ TCP/IP Sockets can use [Interactive Network Dispatcher \(IND\)](#) for balancing and availability
 - Works well with short-lasting connections
 - IND runs in a separate hardware box (e.g. 2216)



TCP/IP Connections to IMS

▲ OS/390 V2R10 introduces **Sysplex Distributor**

- Replacement for IND
- Does not require extra hardware box
- Sysplex Distributor runs in OS/390
 - ▶ Distributes connection requests across multiple servers (IMS Connects)
 - ▶ Works well with short and long-lasting connections
 - ▶ Backup allows connections to survive an outage of the Sys. Dist. without interruption (if both ends of connection survive)

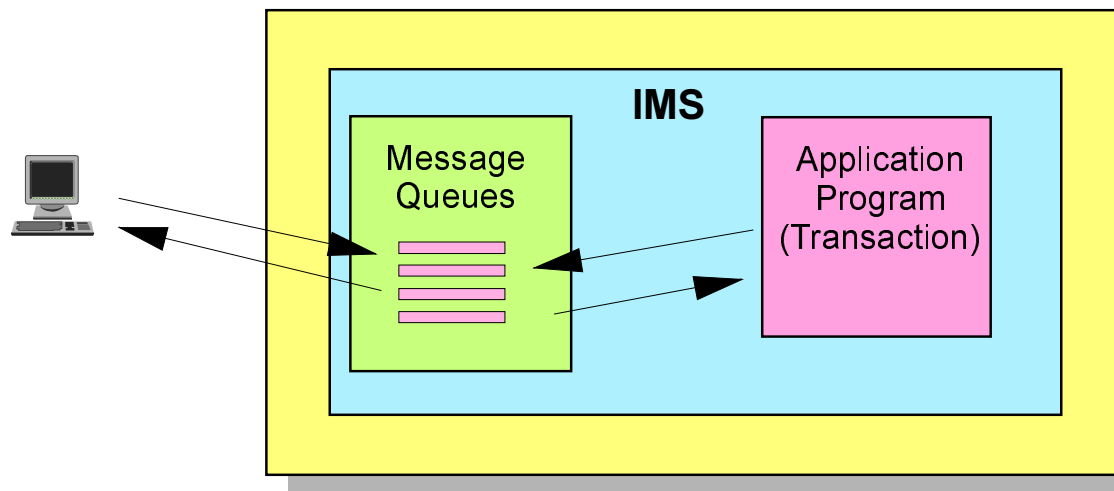


IMS Message Queues

▲ IMS places messages in queues

- Messages may be received from terminals or programs (transactions)
- Messages may be sent to terminals or programs (transactions)

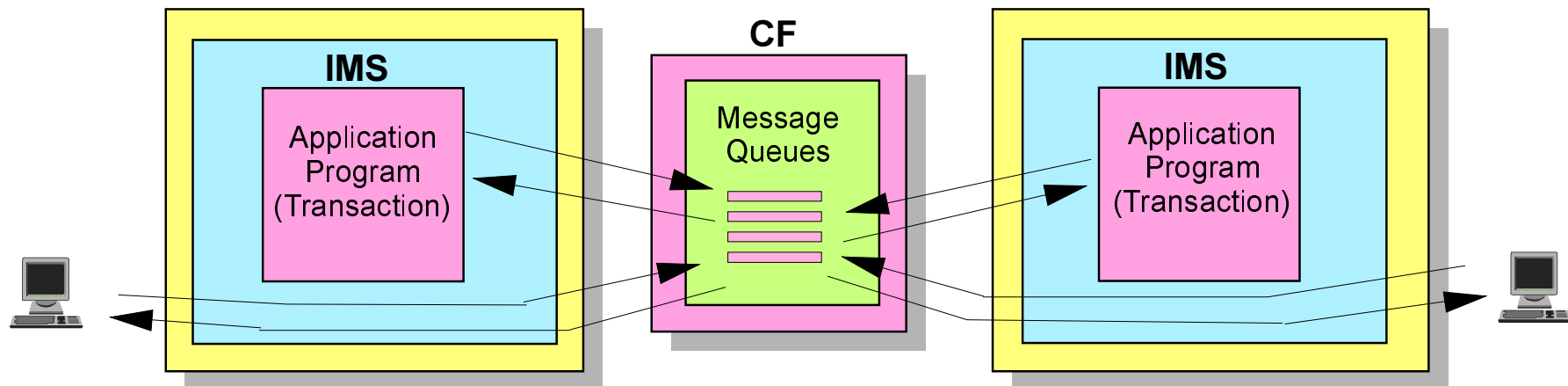
▲ Traditional queues reside in an IMS system



Shared Message Queues

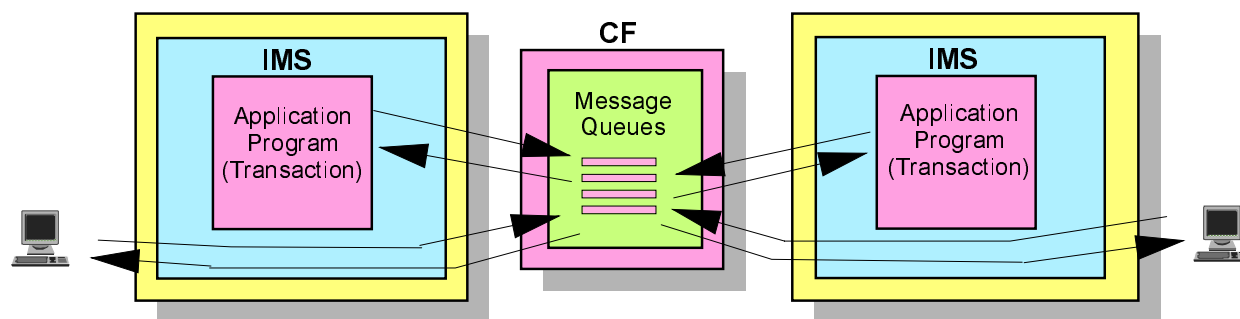
▲ IMS V6 introduced shared message queues

- Multiple IMS systems share one set of queues
- Queues are in CF list structures
- IMS systems place messages in common queues
- IMS systems retrieve messages from common queues



Shared Message Queues

- ▲ **All messages are placed on the shared queues**
- ▲ **IMS subsystem registers interest in some queues**
 - Queues for transactions it can process
 - Queues for terminals which are logged on to that IMS
- ▲ **Each IMS with interest is notified when a queue becomes non-empty**
 - IMS may ask for a message from non-empty queue
- ▲ **Only one IMS receives a message**

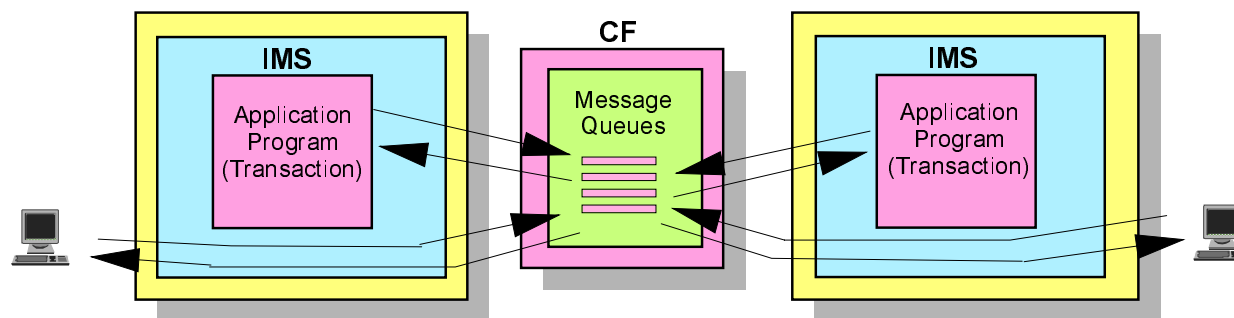


Shared Message Queues

▲ Balancing the workload with shared message queues

- All IMS systems have access to transaction messages
- IMS systems with available resources ask for work
- IMS systems with the most available resources will ask for work more frequently

▲ Shared queues dynamically balance the workload!



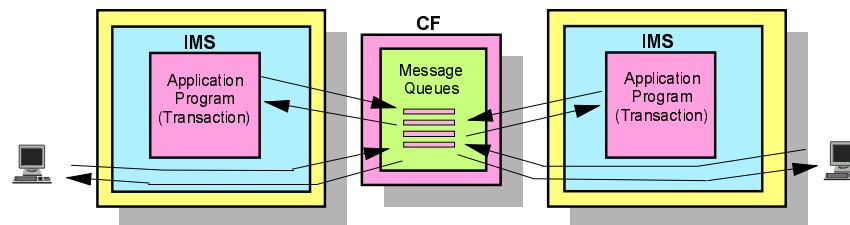
Shared Message Queues

▲ Shared Message Queues Benefits

- Availability
 - ▶ Messages are available from any IMS system

- Capacity
 - ▶ New systems may be added without changes to existing systems
 - ▶ Transaction workload is automatically shared

- Workload balancing
 - ▶ Work is dynamically distributed to systems with available capacity





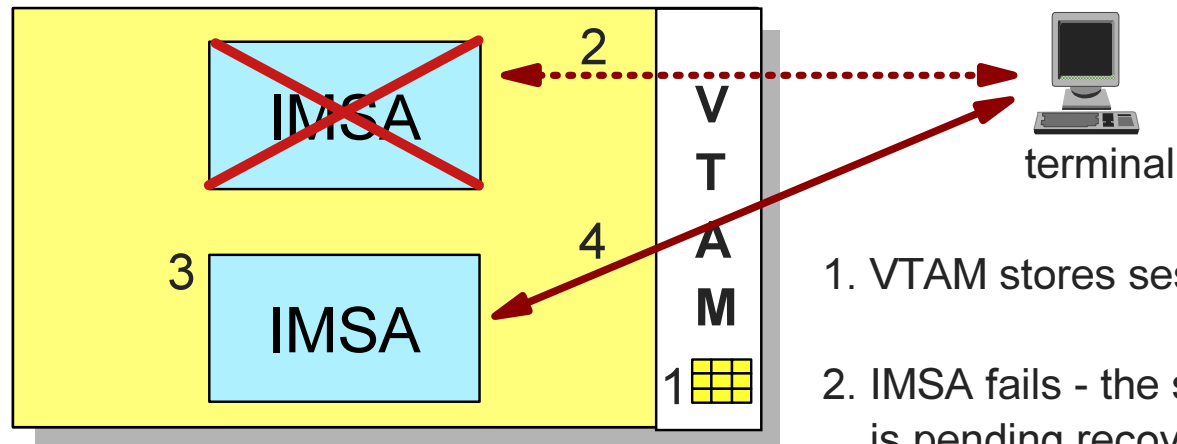
Rapid Network Reconnect (RNR)

▲ **IMS V7 RNR implements support for VTAM Persistent Sessions**

- Eliminates session cleanup/restart following an outage
 - ▶ Multinode persistent sessions support all host outages
 - IMS, VTAM, OS/390, and processor (CEC)
 - ▶ Single node persistent sessions support only IMS outages
 - IMS abends
- Sessions are more quickly reestablished after IMS restarts
 - ▶ Users remain logged on while awaiting IMS restart

Single Node Persistent Sessions

▲ Single Node Persistent Session scenario



1. VTAM stores session data in addr. space

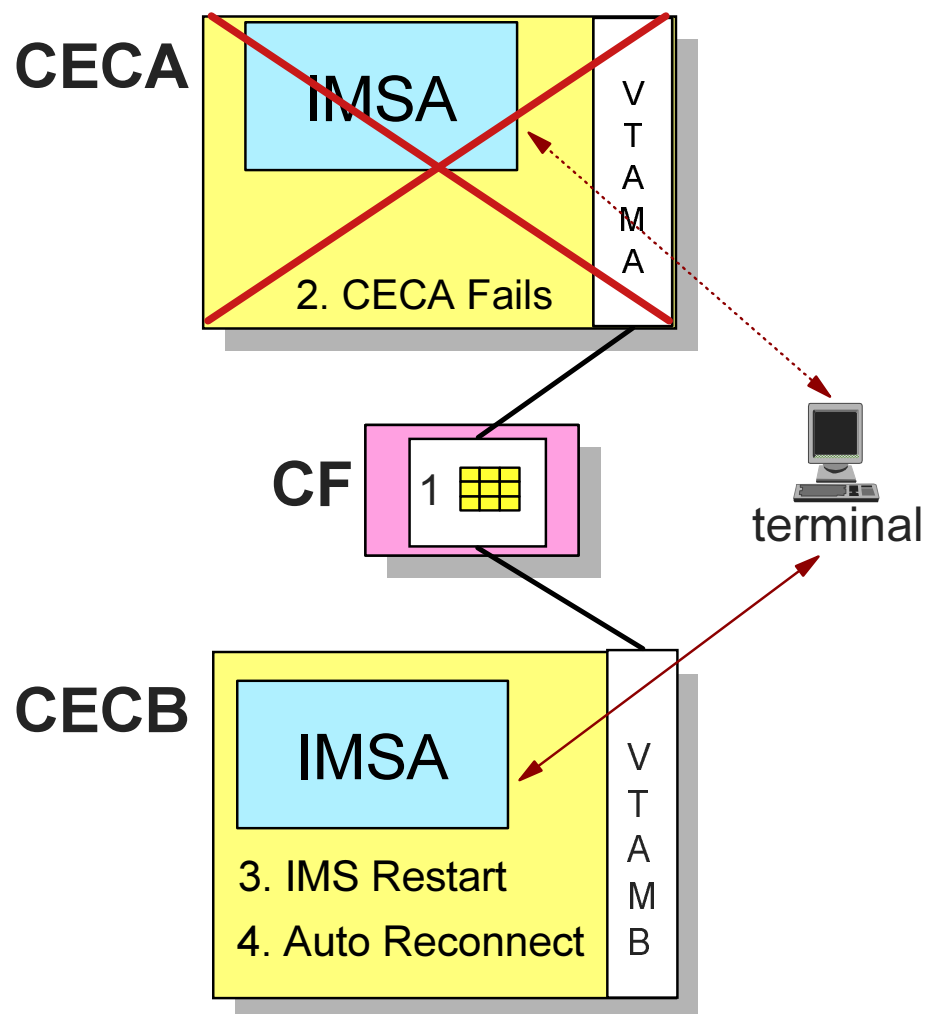
2. IMSA fails - the session to terminal is pending recovery

3. IMSA restarts

4. Auto reconnect of terminal to restarted IMS
- **Terminal is logged on**

Multinode Persistent Sessions

▲ Multinode Persistent Session scenario



1. VTAM stores session data in the CF
2. CECA fails
 - Another VTAM in the Parallel sysplex detects the error
3. IMSA is restarted on CECB
4. The sessions are restarted using information saved in the CF structure
 - **Terminal logged on**



RNR Benefits

- ▲ **Session termination and establishment traffic eliminated**
 - Session information is maintained

- ▲ **Terminal service to same IMS is reestablished more quickly**

- ▲ **Value of RNR depends on how quickly IMS is restarted**

Persistent session support for APPC is provided by APPC/MVS

- Specified on LUADD statement
- Sessions are persistent, conversations are not



IMS TM in a Parallel Sysplex

▲ **IMS/ESA Workload Router**

- Workload balancing

▲ **VTAM Generic Resources**

- Connection workload balancing, availability, capacity

▲ **TCP/IP IND, DNS/WLM, and Sysplex Distributor**

- Connection workload balancing, availability, capacity

▲ **Shared Queues**

- Transaction workload balancing, availability, capacity

▲ **Rapid Network Reconnect**

- Availability



Parallel Sysplex Failure Recovery



The world depends on it

Parallel Sysplex Failure Recovery

Failure Recovery

▲ Parallel Sysplex takes advantage of duplexing

- Multiple subsystems (IMS, DB2, or CICS)
 - ▶ A failure of one may cause its workload to be moved to others
 - VTAM Generic Resources, IMS Shared Queues

- Multiple MVS processors
 - ▶ A failure of one may cause its subsystems to be moved to others
 - Automatic Restart Management (ARM)

- Multiple Coupling Facilities
 - ▶ A failure of one may cause its structures to be moved to others
 - Structure Rebuild
 - ▶ Implementers may create multiple copies of a structure
 - Eliminates need to rebuild on a failure



MVS, Processor, and IMS Failures

▲ When system or IMS fails we need to restart IMS

- Resolve in-flight and in-doubt work
- Release locks and DBRC authorizations

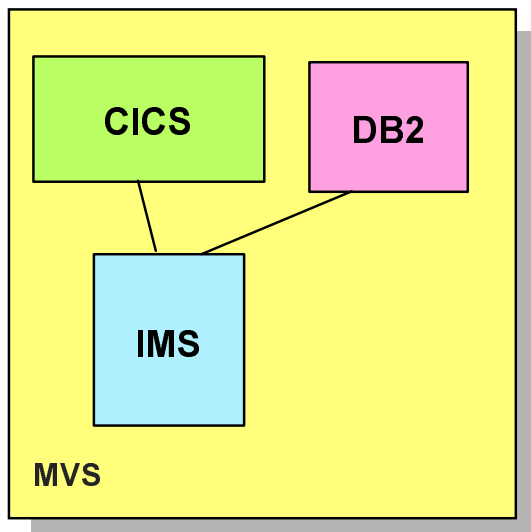
▲ Automatic Restart Management (ARM) may be used

- ARM restarts IMS (DB2, CICS, etc.) on ABENDs and system failures
- Restarts for system failures move work to another system

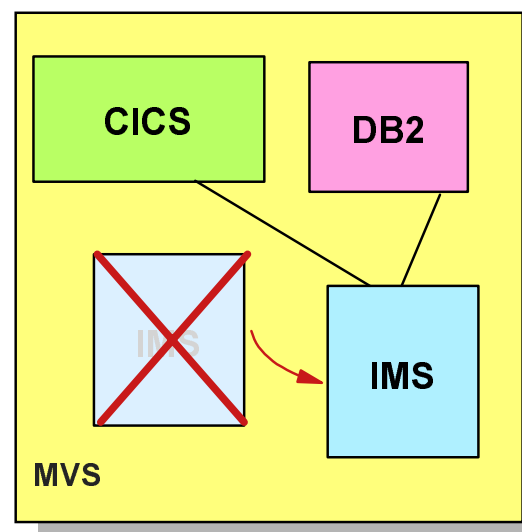
▲ IMS ABEND

- ARM restarts IMS on same MVS

▶ Before ABEND



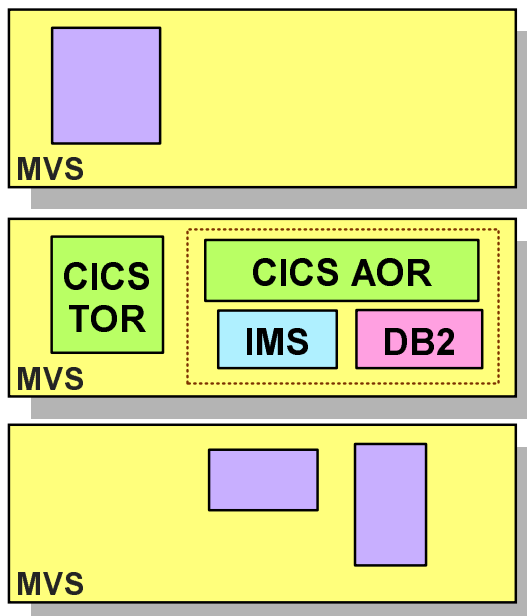
▶ After ABEND



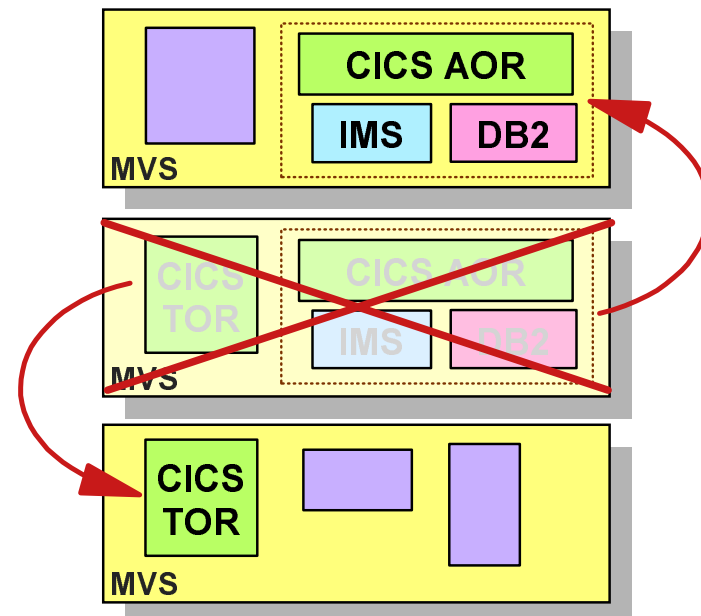
▲ MVS or system failure

- ARM restarts IMS on another MVS in the sysplex
- Subsystems may be grouped for restart on same MVS

► Before failure



► After failure



Using ARM with IMS

▲ ARM must be active in the sysplex

- ARM policy defined and started

▲ IMS must register with ARM

- ARMRST=Y execution parameter

▲ IMS has ARM support for:

- IMS control region
- CQS (shared queues)
- FDBR
- IRLM

Coupling Facility and CF Link Failures

▲ Loss of CF

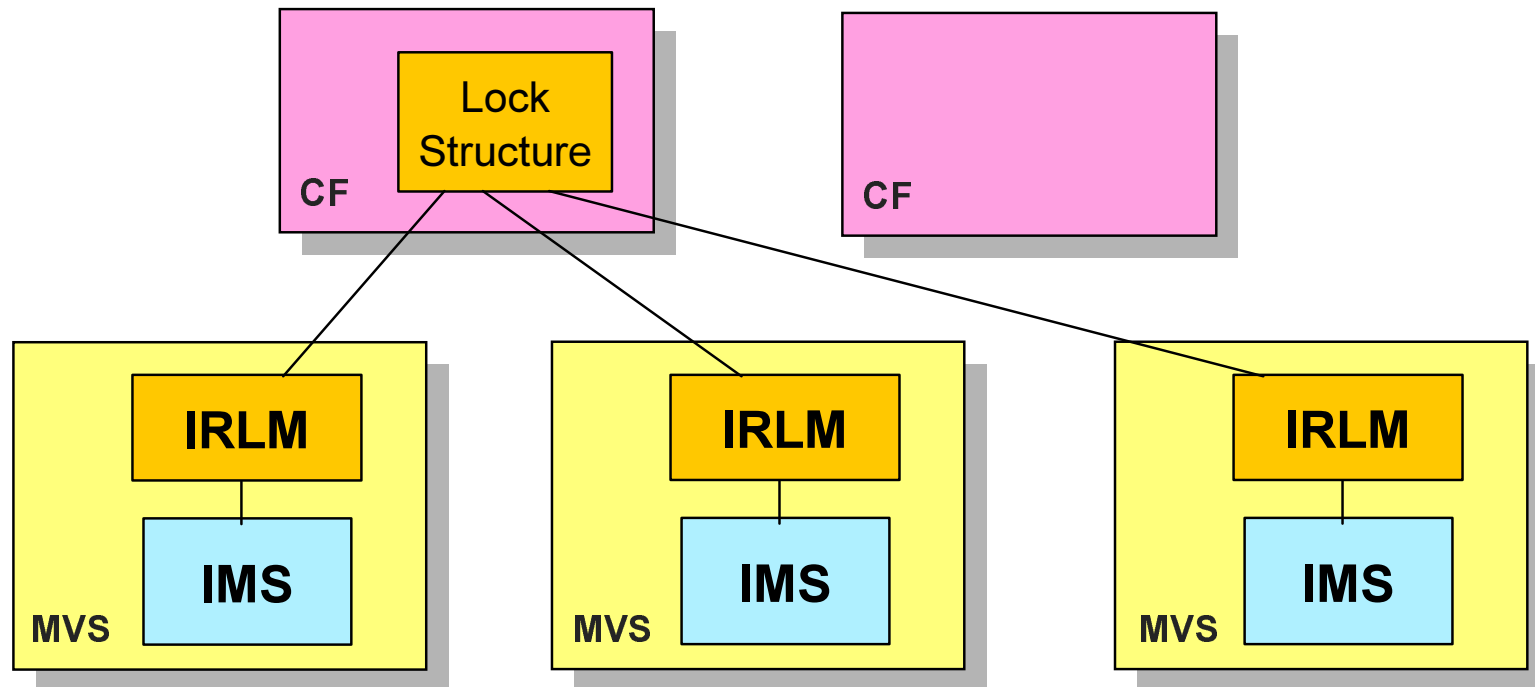
- Structures in failed CF are lost
 - ▶ May be rebuilt on another CF
 - ▶ May have duplicate structure on another CF

▲ Loss of CF link

- Access to structures is lost
 - ▶ May be treated like loss of CF
 - ▶ Structures may be rebuilt or duplicate structure used

Structure Rebuild

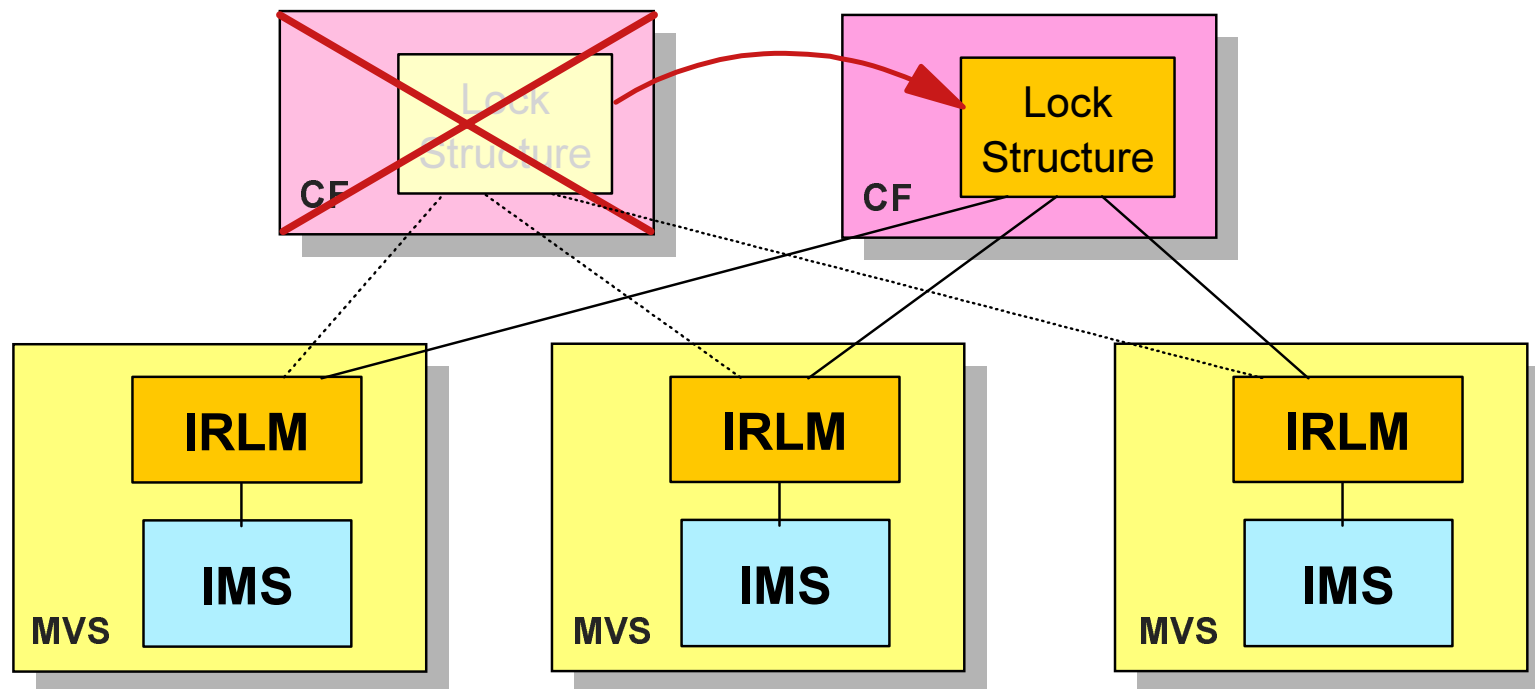
- ▲ **Structure rebuild is used for**
 - IRLM lock, OSAM, VSAM, and Shared Queues structures
 - IRLM lock structure example:



Structure Rebuild

▲ Structure rebuild is used for loss of CF

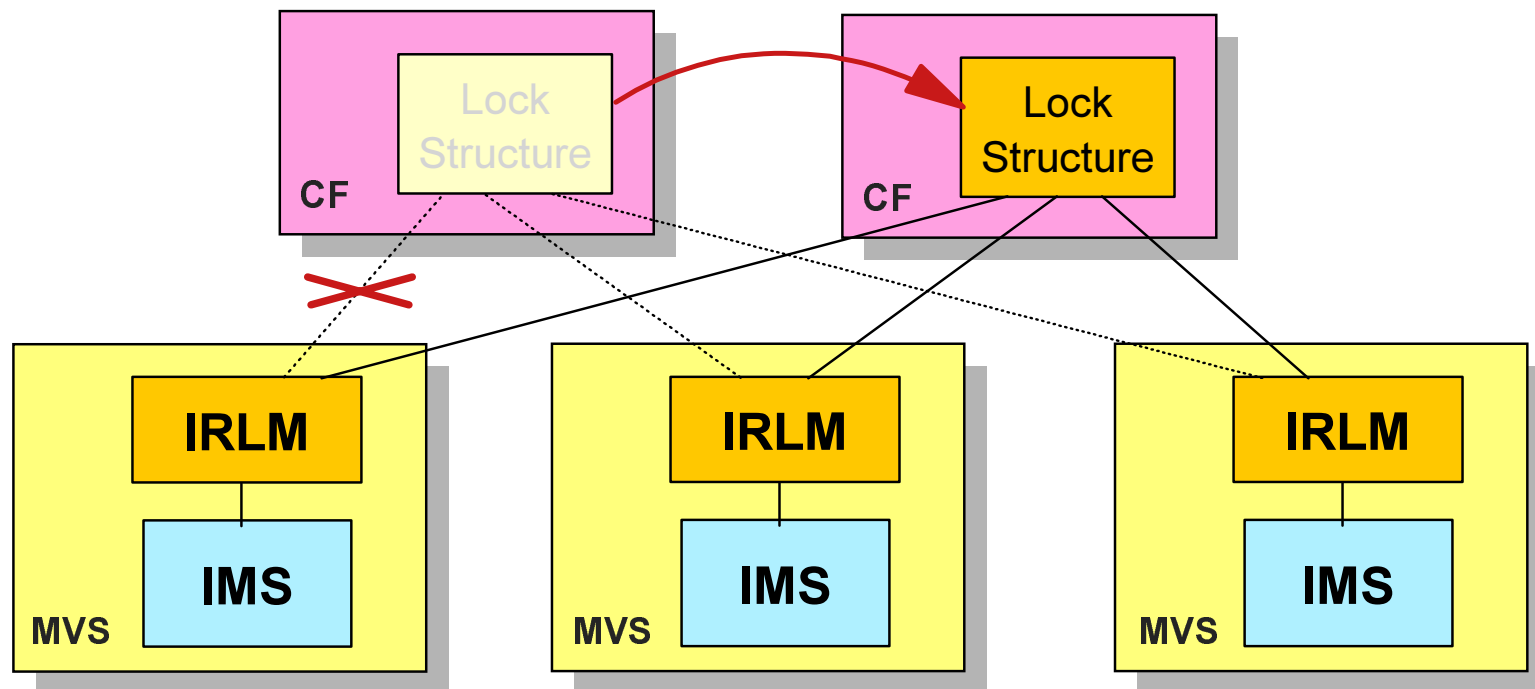
- IRLM lock structure example:



Structure Rebuild

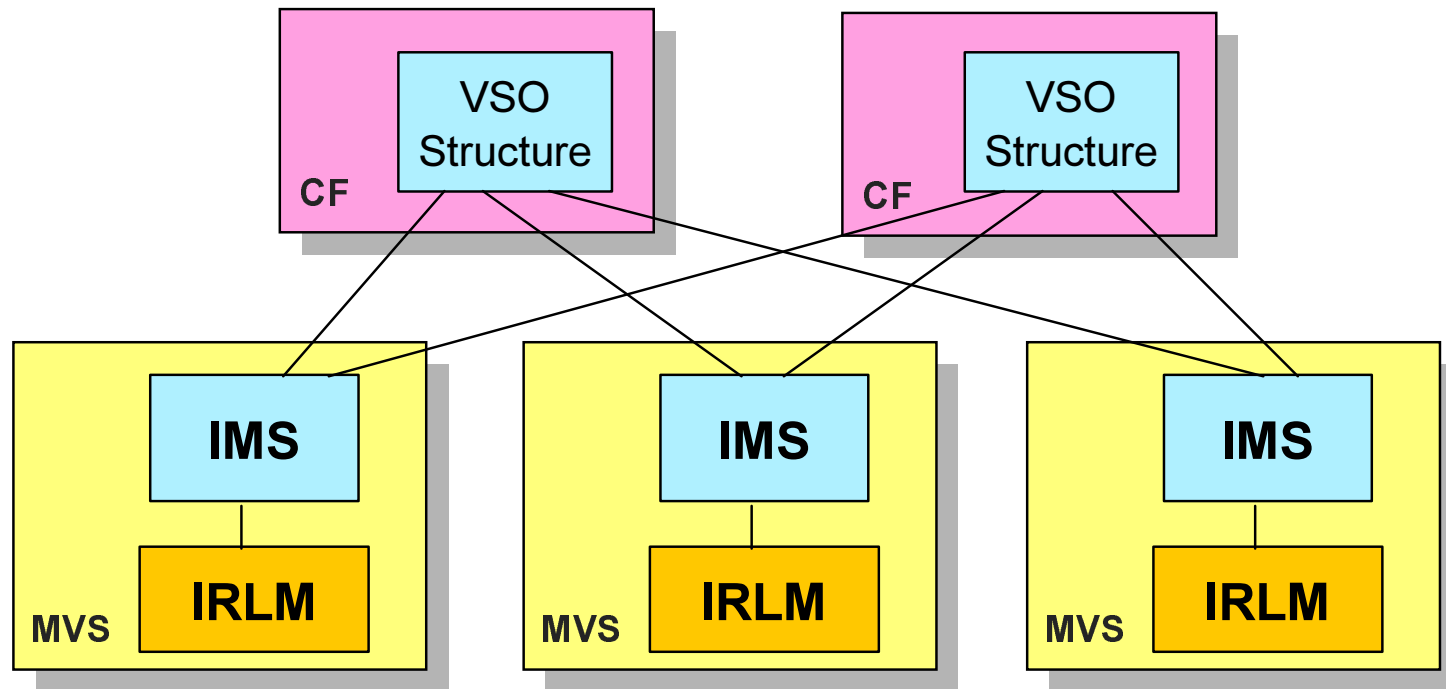
▲ Structure rebuild is used for loss of CF link

- IRLM lock structure example:



Structure Duplication

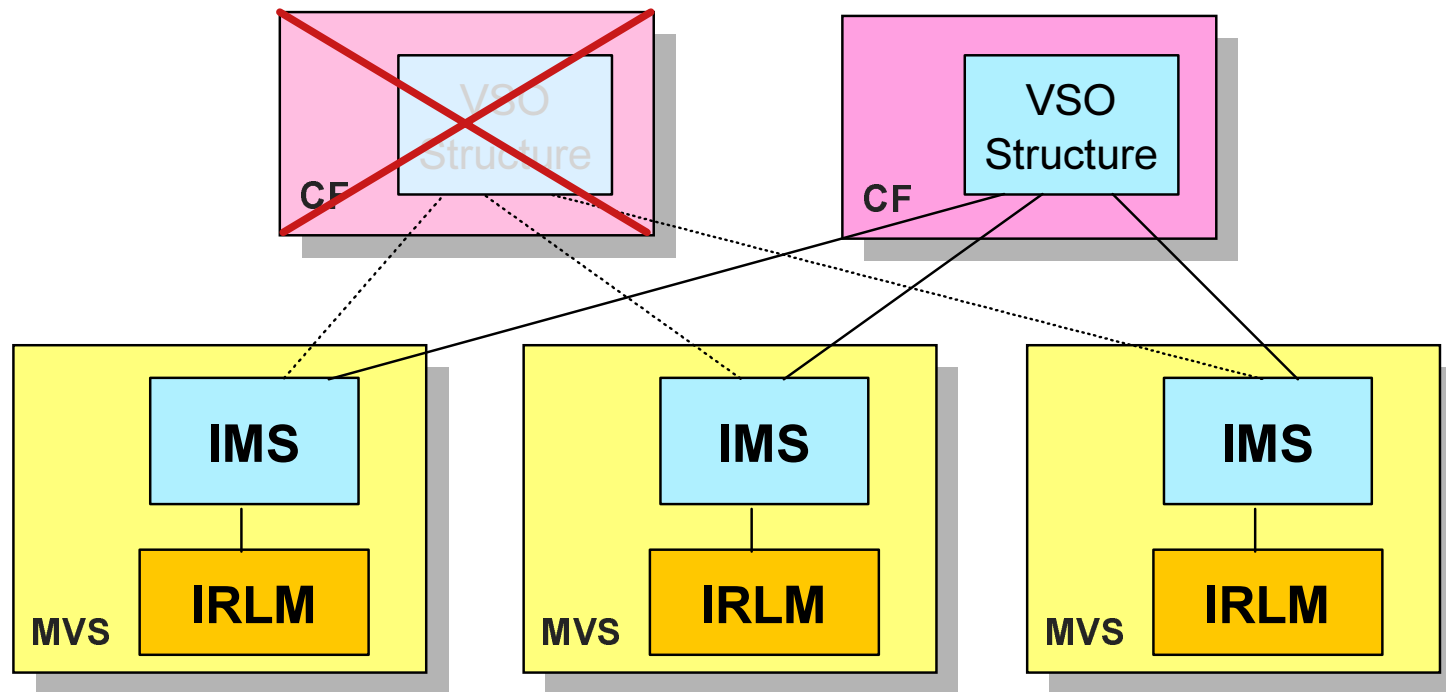
- ▲ **Structure duplication is used for**
 - DEDB VSO structures
 - DEDB VSO structures example:



Structure Duplication

▲ Structure duplication is used for loss of CF

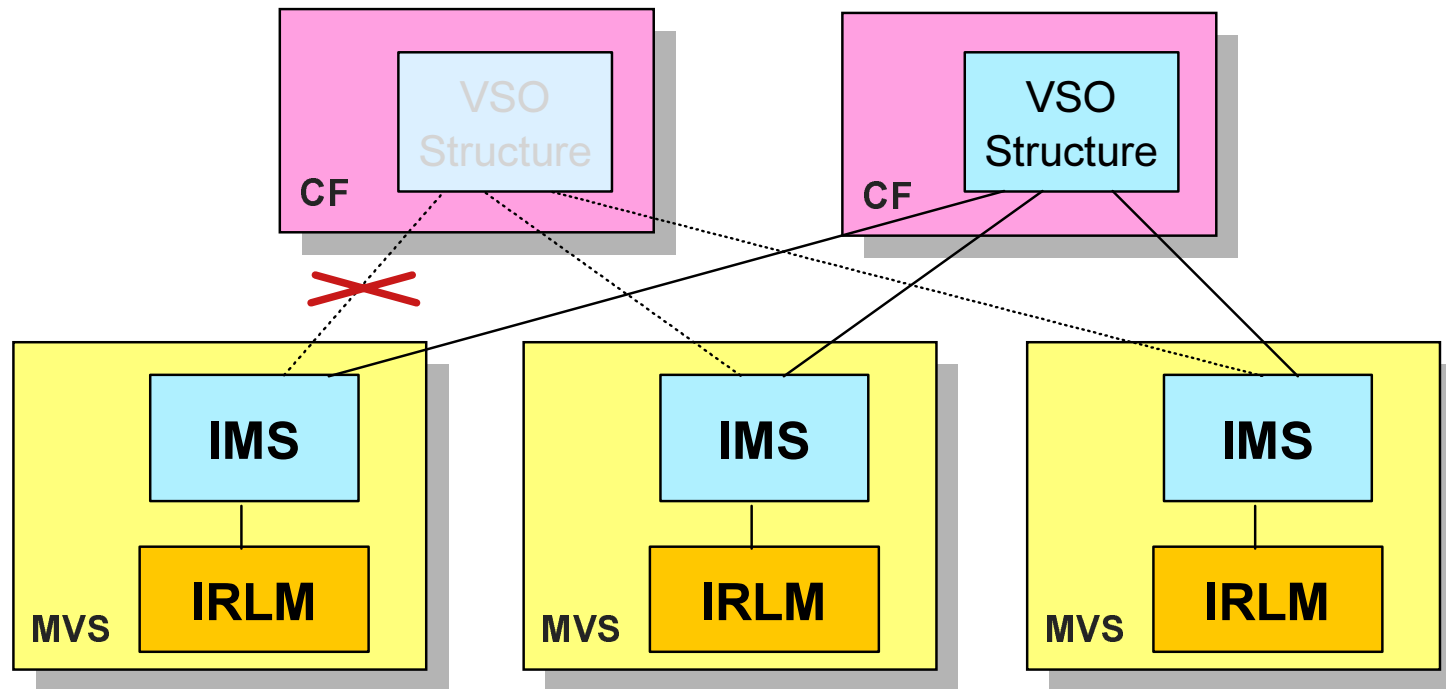
- DEDB VSO structures example:



Structure Duplication

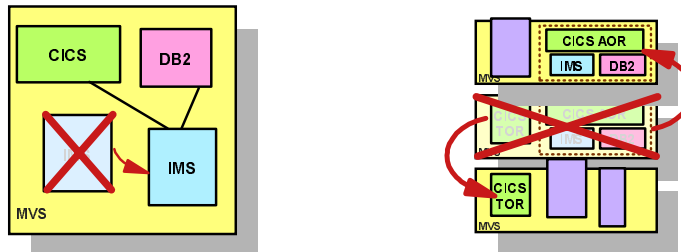
▲ Structure duplication is used for loss of CF link

- DEDB VSO structures example:

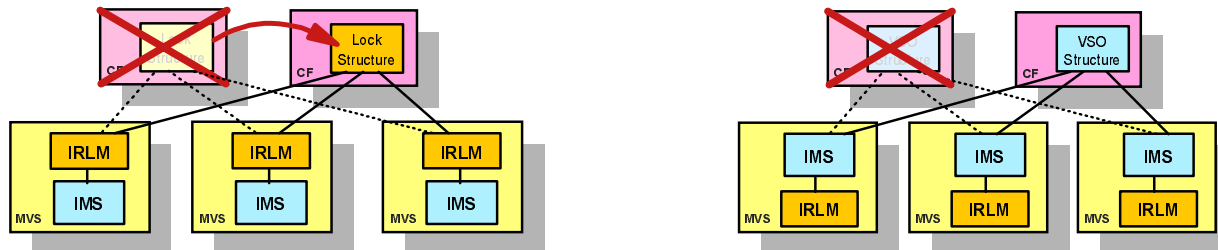


Parallel Sysplex Failure Recovery

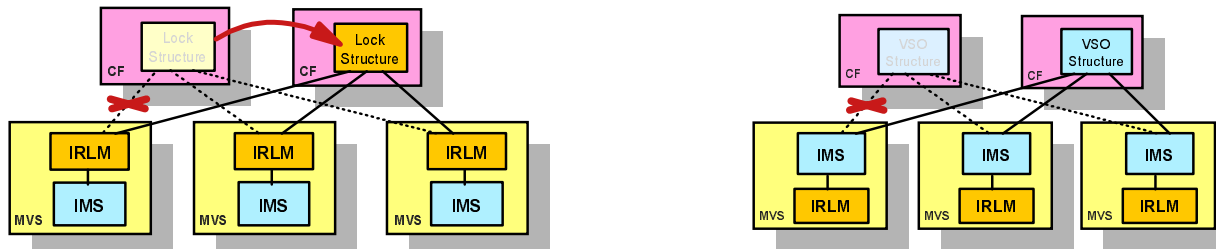
▲ ARM to restart IMS, CICS, DB2, etc.



▲ Structure rebuild and/or duplication to handle CF failures



▲ Structure rebuild and/or duplication to handle CF link failures





IMS in a Parallel Sysplex

▲ High availability

- Data sharing, shared queues, generic resources, IND, DNS/WLM, Sysplex Distributor, RNR (persistent sessions), ARM, structure rebuild, duplicate structures

▲ Increased capacity

- Data sharing, shared queues, generic resources, IND, DNS/WLM, Sysplex Distributor, IMSGROUP

▲ Workload balancing

- Generic resources, IND, DNS/WLM, Sysplex Distributor, Workload Router, shared queues, IMSGROUP



More Information

▲ **Redbooks**

- ***IMS/ESA V6 Parallel Sysplex Migration Planning Guide for IMS TM and DBCTL***, SG24-5461
- ***IMS/ESA Data Sharing in a Parallel Sysplex***, SG24-4831
- ***IMS/ESA Shared Queues: A Planning Guide***, SG24-5257
- ***IMS/ESA Version 6 Shared Queues***, SG24-5088

▲ **The Web**

- **www.ibm.com/ims**
 - ▶ Follow link to IMS V7
 - <http://www-4.ibm.com/software/data/ims/v7/index.html>
 - ▶ Follow link to "Library" then to "IMS Presentations"
 - <http://www-4.ibm.com/software/data/ims/shelf/presentations/>
- **www.ibm.com/support/techdocs**
 - ▶ Search for IMS in "Presentations & Tools"
 - Document PRS160, *IMS V7 Presentation*
 - Document PRS174, *Automatic Restart Management (ARM) with IMS*



Acronyms and Terms

ARM - Automatic Restart Management
AOR - Application Owning Region (CICS)
BLDS - Block Level Data Sharing
BMP - Batch Message Program
CEC - Central Electronic Complex
CF - Coupling Facility
CQS - Common Queue Server (Shared Queues)
DEDB - Data Entry Database (Fast Path)
DNS/WLM - Domain Name Server/Workload Manager
EMH - Expedited Message Handler (Fast Path)
FDBR - Fast Database Recovery
IFP - Interactive Fast Path Region

IND - Interactive Network Dispatcher
ITOC - IMS TCP/IP OTMA Connection
MSDB - Main Storage Database (Fast Path)
MSC - Multiple Systems Coupling
OTMA - Open Transaction Manager Access
SDEP - Sequential Dependent of DEDB
TOR - Terminal Owning Region (CICS)
VSO - Virtual Storage Option for DEDB
WLM - Workload Manager
WLR - Workload Router
XCF - Cross System Coupling Facility