The Modern Mainframe… At the Heart of Your Business

A Mainframe Primer - Mainframe Clustering

Superior Qualities of Service

- How does the mainframe deliver superior qualities of service?
  - Unmatched scale-up
  - Continuous operation
  - Systematic disaster recovery
- Mainframe clustering technology hardware and software are optimized to provide these qualities of service
  - Unique Parallel Sysplex design is superior

Mainframe Clustering is Superior

- **System z**
  - Specialized hardware for clustering
  - Dedicated high speed fiber interconnect
    - Low latency
  - Integrated exploitation by operating system and all software subsystems
- **Distributed**
  - No special hardware
  - No exploitation of special networking
    - Full software path length
  - Each subsystem (database, application server) is designed to run on commodity servers

1. **Very low overhead in clusters yields ultimate scalability**
2. **Unrivaled high availability**

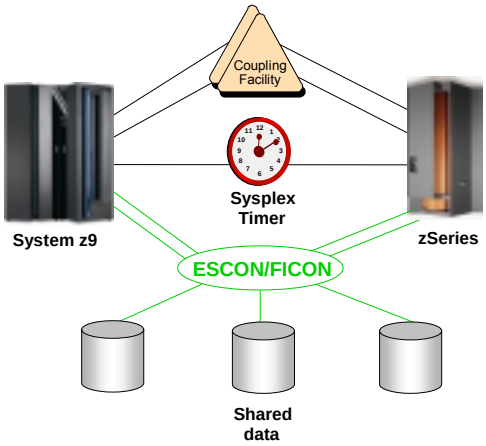
A Primer on Mainframe Clustering

- **Coupling Facility**
  - Dedicated processor with specialized microcode to coordinate shared resources
  - Large amounts of fast memory
  - High speed inter-connect to clustered systems
  - Hardware invalidation of local cache copies
  - Special machine instructions
  - Timing facilities to maintain logical execution-order across coupled systems
  - Fault-Tolerant
- **Parallel Sysplex**
  - Multiple z/OS images clustered using the coupling facility for coordination

This presentation will use the word “image” to refer to a node in a sysplex cluster, “LPAR” may also be used to describe this

Parallel Sysplex – What is it ?

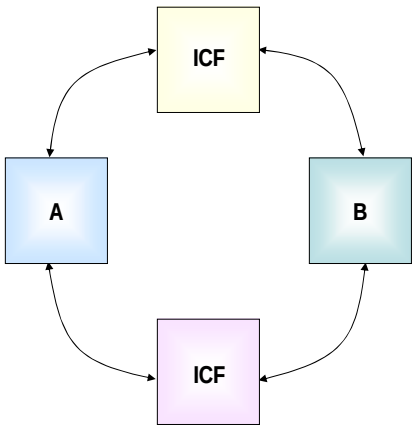
- Hardware
  - Redundant coupling facilities providing processing and shared storage
  - Timing facilities
    - Sysplex timers (Hardware)
    - STP protocol (Software)
  - Dedicated high speed interconnections
  - Fiber switch provides access to data
- Micro-code + Software
  - CFCC (coupling facility control code)
    - High throughput, low latency, micro code control program for the coupling facility
- Clustering service APIs within z/OS
  - XES APIs support program connectivity
  - XCF connectivity configuration
- Workload Management
  - WLM (workload manager within a z/OS instance)
  - IRD (intelligent resource director across LPAR's)
  - Both manage workload across the sysplex



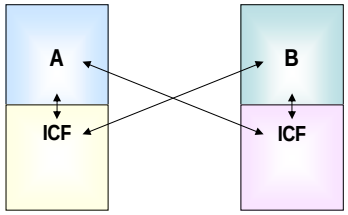
…A Key IBM Unique Differentiator in the IT Industry

Implementation of Coupling Facility

Logical Relationship



Physical Deployment
ICF within System z LPARs

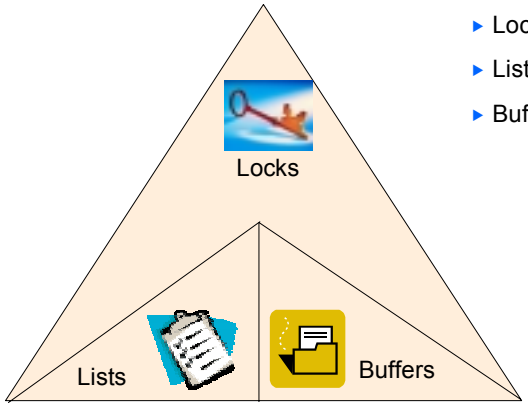


No extra servers needed

Coupling Facility is an Optimized Hardware Technology for Coordinating Clusters

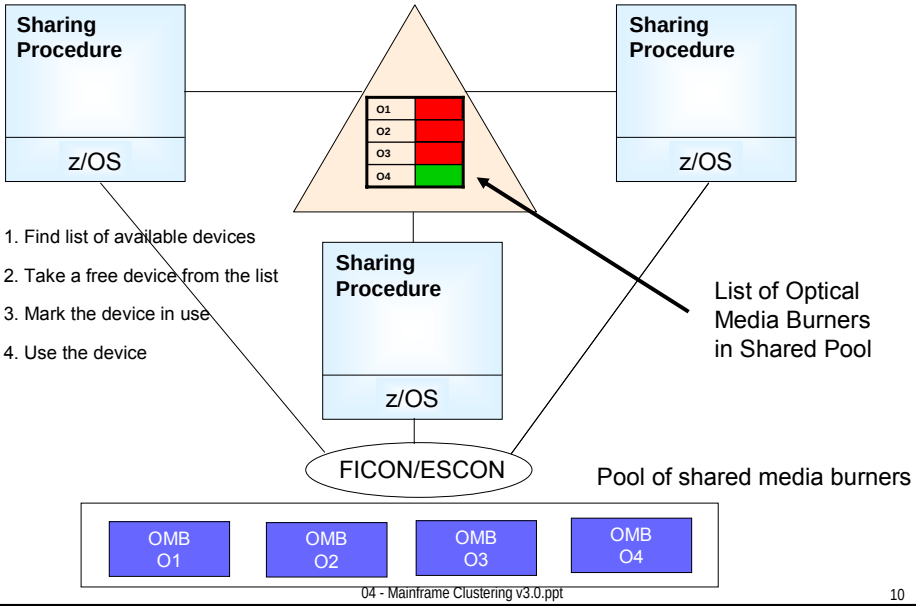
The Coupling Facility implements

- Locks for synchronizing data
- Lists for sharing data
- Buffers for database consistency

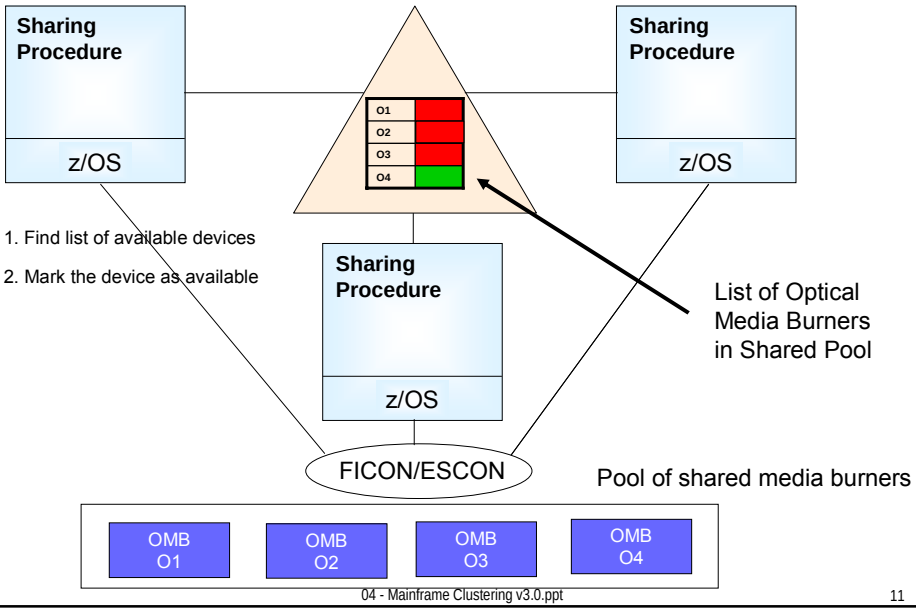


Let's look at examples of how each of these are used in a cluster

Using the List Capability for Sharing Devices Getting a Device for Making a Backup Copy



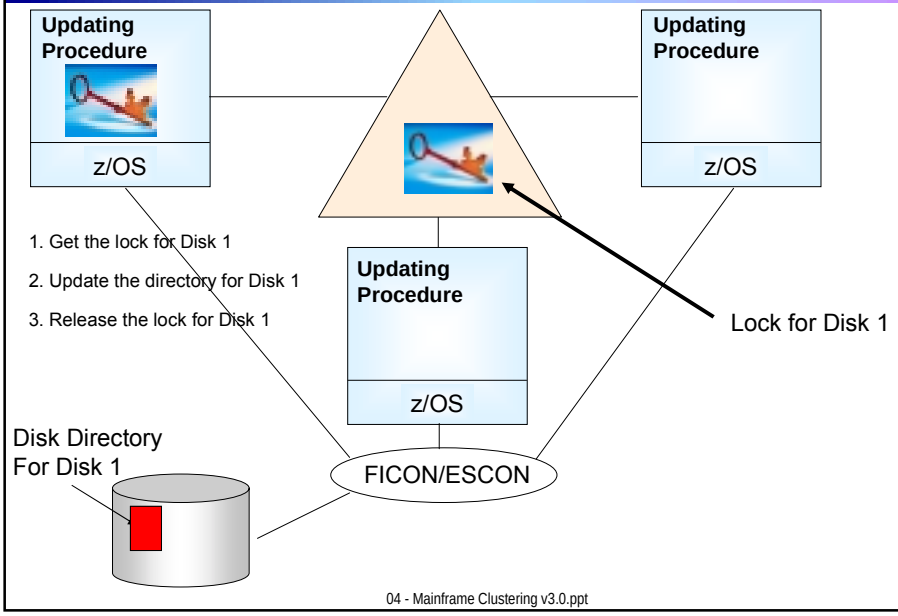
Using the List Capability for Sharing Devices Releasing a Device for Use by Others



Other System Uses of Lists

- Shared Resources
  - Tapes
  - Files
  - Consoles
  - Etc
- Sysplex-wide information
  - Workload-balancing information
  - Status of each system in the sysplex
- Subsystem information
  - Logfiles for recovery
  - Configuration and Restart Data

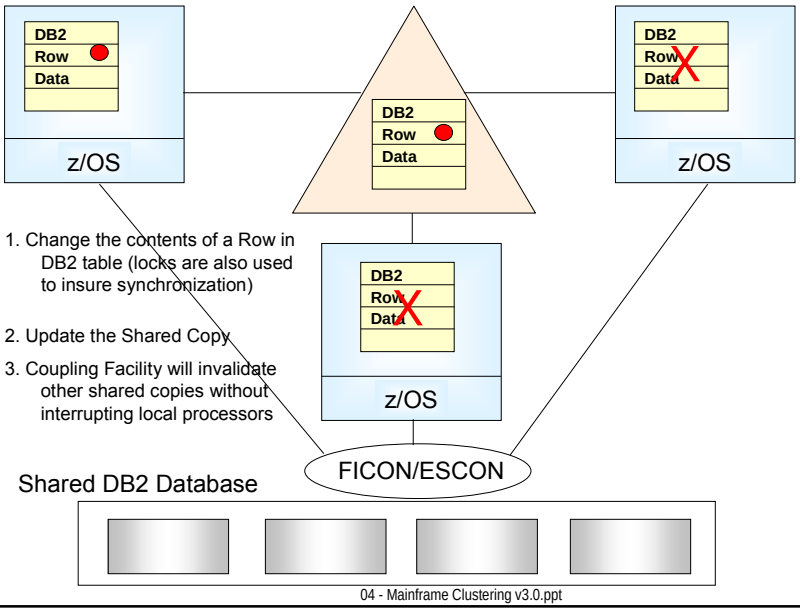
Use of the Lock Capability for Updating Information



Other System Uses of Locks

- Any synchronization of shared information
  - Files
  - Databases
  - System-wide resources

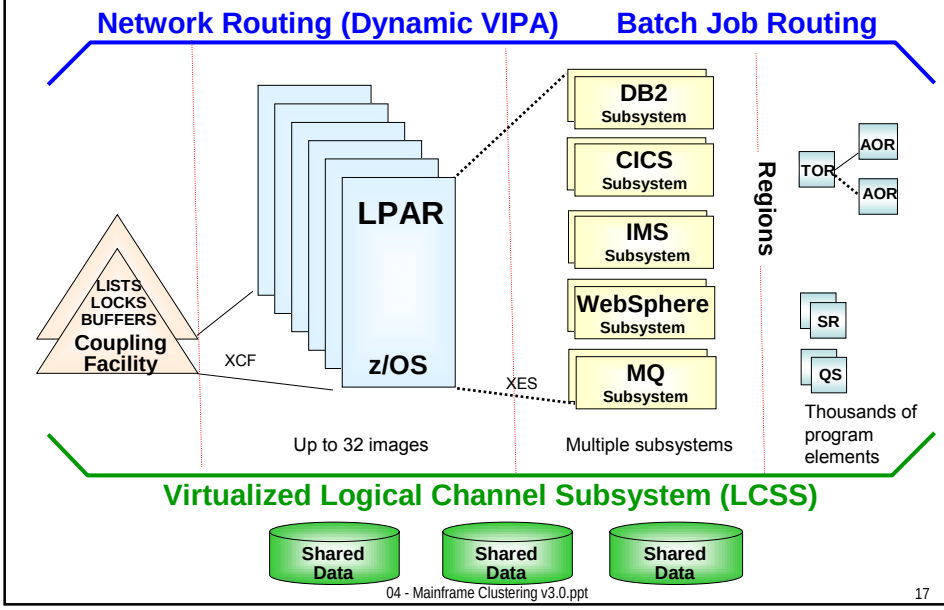
Using the Buffer Capability for DB2 Data Consistency



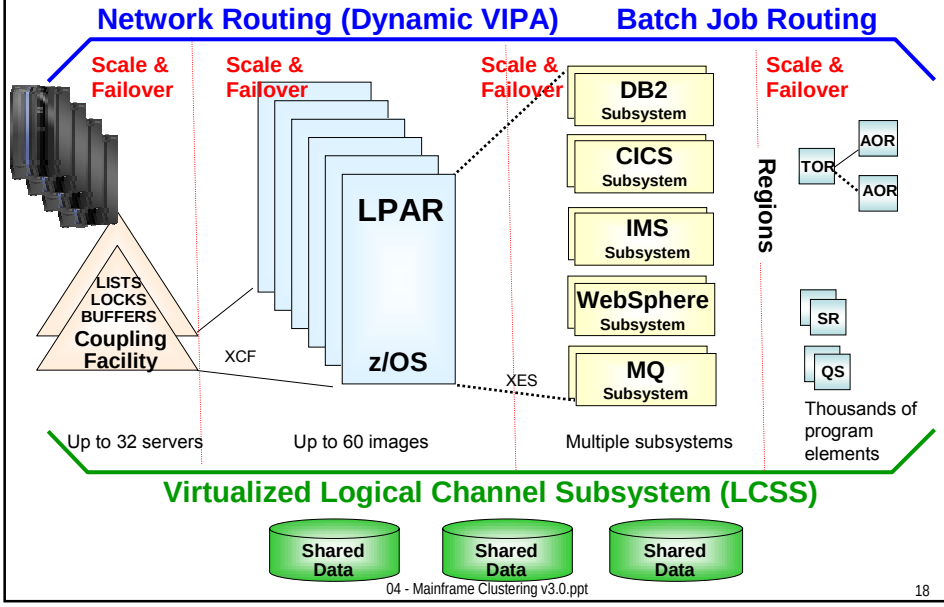
Other Uses of Buffers for Data Consistency

- DB2 for System z
- IMS
- VSAM
- Computer Associates IDMS
- Computer Associates Datacom

Thousands of Program Elements Can Be Coordinated in a Single System Image



Scale and Availability Within Each Layer



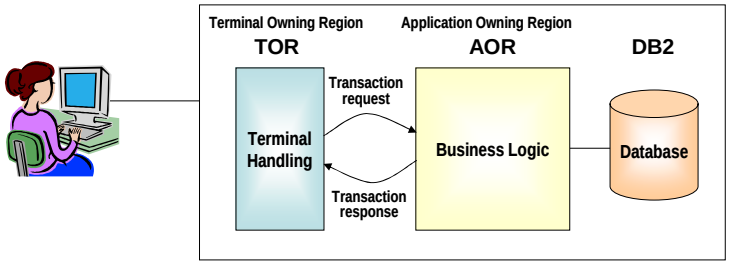
We'll discuss how exploitation of the parallel sysplex helps DB2 beat Oracle RAC later.

Let's take a quick look at how CICS benefits from the parallel sysplex and these multiple layers

IBM

CICS - Regions

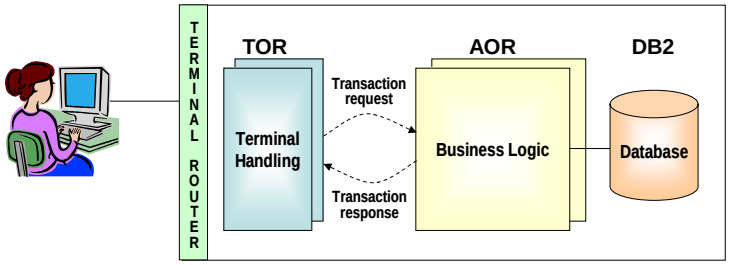
- CICS takes a transaction request from an end user, accesses a database, performs business logic and returns a response (similar to J2EE)



- Each CICS region (TOR and AOR) provides a single thread of execution for a program
- Regions provide transaction isolation

CICS – Multiple Regions in an Image

- Terminal router routes transaction to appropriate TOR



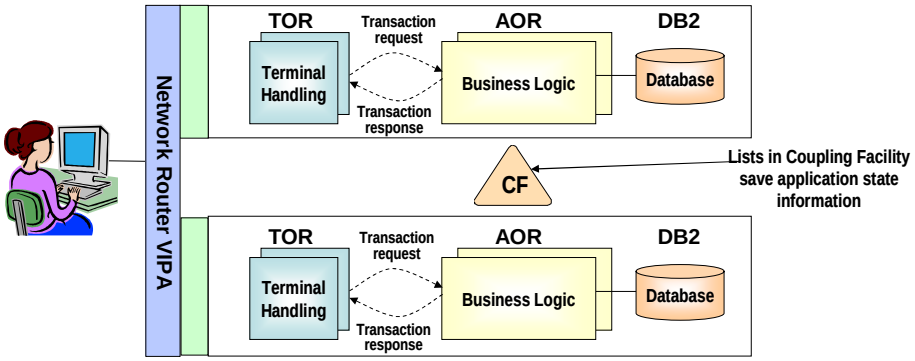
- Multiple TORs and AORs scale by adding system resources (threads, memory, etc)
- Multiple TORs and AORs provide availability
  - A software failure could bring down a region (e.g. programmer error)
  - Current in flight transactions are rolled back
  - New transactions are routed to other regions
  - CICS restarts failed region

Throughput is Maintained in the Event of Software Failure in a Region

- If an AOR or TOR fails the resources it was consuming, processors and memory, etc. are released
- These resources are immediately available for remaining regions
- Throughput can be maintained
- This important capability is lacking in the distributed world

CICS – Multiple Images in a Sysplex

- Multiple regions on multiple machines in a parallel sysplex

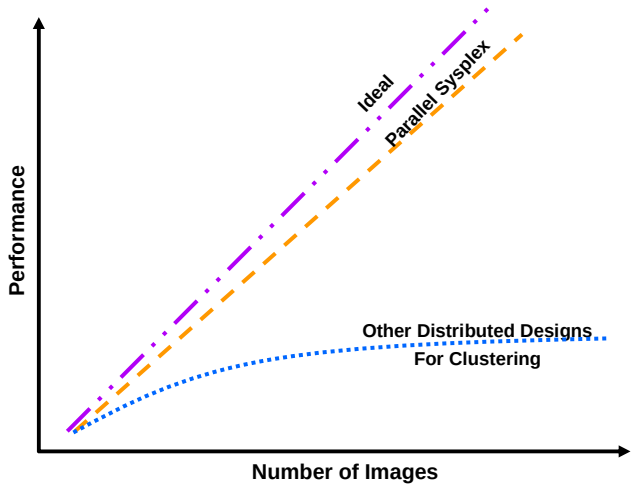


- Scalability is enhanced In that processing resources from up to 32 images in the sysplex can be utilized
- The work of a failed region can be taken over by any other region in the sysplex
- Protects against machine hardware failure or operating system failure

Parallel Sysplex Performance

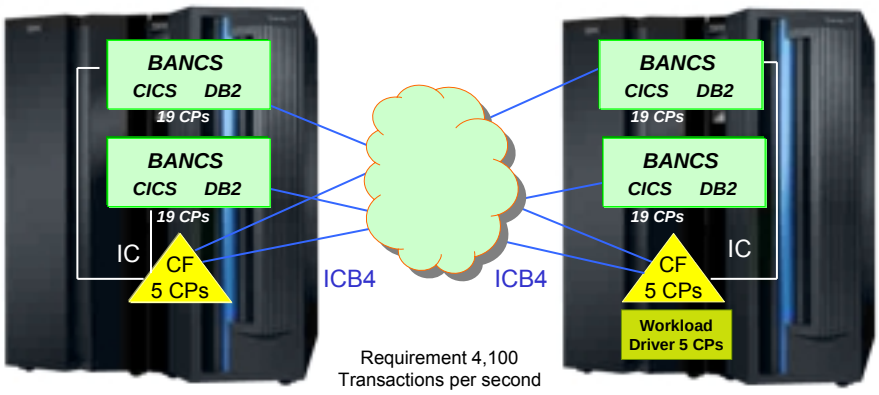
- High performance interconnect and low latency in coupling facility causes minimal overhead
- Typical overhead
  - Multisystem Management – 3%
  - Resource Sharing – 3%
  - Application data sharing – <10%
  - Incremental cost of adding an image – ½%
- Result
  - Near-linear scalability as more systems are added
  - Better efficiency than other clustering schemes

Mainframe Clustering Delivers Near-Linear Scalability



Bank of China Parallel Sysplex Benchmark

Database
- 380 million accounts
- 52 TB Storage
- 4 DS8300

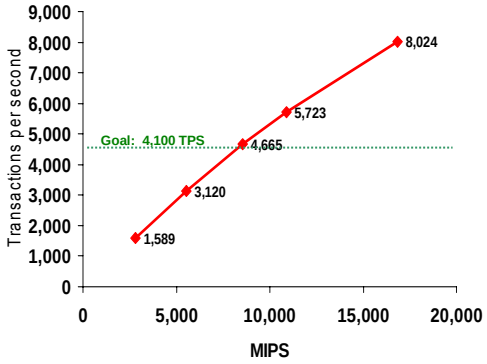


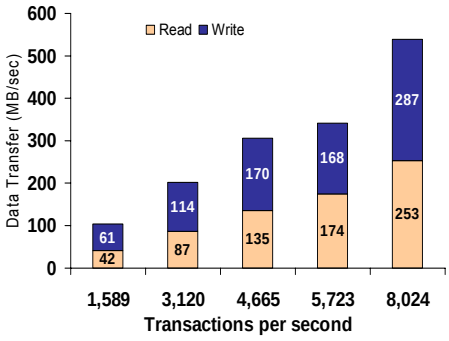
Requirement 4,100
Transactions per second

54-way z9 **54-way z9**

Bank of China Parallel Sysplex Benchmark

Near-Linear Scalability on a Parallel Sysplex running CICS and DB2 in a single system image with No Partitioning Required





Huge scale up, requires huge I/O bandwidth capacity

Mainframe Parallel Sysplex Summary

- Layered approach enables thousands of program elements to cooperate in a single system image with very low overhead
- Ultimate scalability
  - Up to 32 hardware systems each with 54 processors
- Unrivaled high availability
  - Protection against hardware and software failures
- Foundation for a systematic disaster recovery capability