z/VM Single System Image and Guest Mobility Preview

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IBM Statement of Direction – July 22, 2010

- **z/VM Single System Image with Live Guest Relocation**

IBM intends to provide capabilities that permit multiple z/VM systems to collaborate in a manner that presents a single system image to virtual servers. An integrated set of functions will enable multiple z/VM systems to share system resources across the single system image cluster. Among those functions will be Live Guest Relocation, the ability to move a running Linux virtual machine from one member of the cluster to another. This virtual server mobility technology is intended to enhance workload balancing across a set of z/VM systems and to help clients avoid planned outages for virtual servers when performing z/VM or hardware maintenance.

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Topics

- Introduction - z/VM Single System Image (SSI) Clusters
- Major Attributes of a z/VM SSI Cluster
- z/VM SSI Cluster Operation
- Planning and Creating a z/VM SSI Cluster
Introduction
z/VM Single System Image (SSI) Cluster

- Up to 4 z/VM systems (members) in an ISFC collection
  - Provides a set of shared resources for the z/VM systems and their virtual machines
    - Managed as a single resource pool
  - Recommend 2 CECs, 2 LPARs on each

- CP validates and manages all resource and data sharing
  - Uses ISFC messages that flow across channel-to-channel connections between members
  - No virtual servers required

- Each member can access common resources
  - Shared DASD volumes
  - Same Ethernet LAN segments
  - Same storage area networks (SANs)

- **NOT** compatible with CSE (Cross System Extensions)
  - Cannot have SSI and CSE in same cluster
  - Disk sharing between an SSI cluster and a CSE cluster requires manual management of links
    - No automatic link protection or cache management
Benefits of a z/VM SSI Cluster

- Facilitates horizontal growth of z/VM workloads

- Reduce effect of z/VM planned outages
  - z/VM and hardware maintenance are less disruptive to workloads

- Eases deployment and maintenance of multiple z/VM images

- **Live Guest Relocation** provides virtual server mobility
  - Dynamically move virtual servers (guests) from one member to another
  - Less disruptive workload balancing
z/VM SSI Cluster

- **Member 1**
  - Non-shared volumes
  - Shared volumes
  - Multiple CTCs for ISFC-based SSI communications

- **Member 2**
  - Shared volumes
  - Common LAN for guest IP communications (optionally, with shared SAN for guest FCP connections)

- **Member 3**
  - Shared volumes

- **Member 4**
  - Shared volumes
Major Attributes of a z/VM SSI Cluster
Multisystem Installation

- SSI cluster can be created with a single z/VM install
  - Customer provides information about the cluster on installation panels
    - DASD volumes
    - Channel-to-channel connections for ISFC
  - z/VM images are installed and configured as an SSI cluster
    - Shared system configuration file
    - Shared source directory

- Non-SSI single system installation also available
  - System resources defined in same way as for SSI
    - Facilitates later conversion to an SSI cluster
DASD Volumes and Minidisks

System disks - One set per member

Member 1

- IPL
- M01RES
  - MAINT CF1 CPLOAD
  - Warm start Checkpoint
  - Object Directory
  - MAINT 190 / 193
  - MAINT 19D / 19E
- M01P01 Paging
- M01S01 Spool

Cluster-wide disks
One set per cluster

- VMCOM1
  - PDR
  - CF0 CONFIG
  - 41D
  - Source Directory
- vrmRL1
- vrmRL2
- MAINTvrm 490 / 493
- MAINTvrm 51D
- MAINTvrm CF2

Release disks
One set per release per cluster

Member 2

- IPL
- M02RES
  - MAINT CF1 CPLOAD
  - Warm start Checkpoint
  - Object Directory
  - MAINT 190 / 193
  - MAINT 19D / 19E
- M02P01 Paging
- M02S01 Spool
### Single Maintenance Stream per release

1. Logon to MAINTvrm on *either* member and run **SERVICE**

### Service applied privately to each member

2. Logon to MAINTvrm on Member 1 and **PUT2PROD**

3. Logon to MAINTvrm on Member 2 and **PUT2PROD**
Common System Configuration File

- Resides on new shared parm disk

- Define cluster name and each of its member systems
  - SYSTEM_IDENTIFIER enhanced
    - LPAR name can be matched to define system name
    - System name can be set to the LPAR name

- Identify direct ISFC links between members

- Define CP Owned volumes
  - Private
    - Paging
    - Tdisk
    - Sysres
  - Shared
    - Spool
    - SSI common volume

- Can include member-specific configuration
Common System Configuration File...

- **CP Owned volumes**

```plaintext
/***********************************************************/ /*                                     SYSRES VOLUME      */ /***********************************************************/
VMSYS01: CP_Owned Slot 1 M01RES
VMSYS02: CP_Owned Slot 1 M02RES
VMSYS03: CP_Owned Slot 1 M03RES
VMSYS04: CP_Owned Slot 1 M04RES

/***********************************************************/ /*                                     COMMON VOLUME       */ /***********************************************************/
CP_Owned Slot 5 VMCOM1

/***********************************************************/ /*                                    DUMP & SPOOL VOLUMES */ /***********************************************************/
/* Dump and spool volumes begin with slot 10 and are */
/* assigned in ascending order, without regard to the */
/* system that owns them. */
CP_Owned Slot 10 M01S01
CP_Owned Slot 11 M02S01
CP_Owned Slot 12 M03S01
CP_Owned Slot 13 M04S01
```
Common System Configuration File...

- **CP_Owned volumes** ...

```plaintext
/**********************************************************
PAGE & TDISK VOLUMES */
/* To avoid interference with spool volumes and to */
/* automatically have all unused slots defined as */
/* "Reserved", begin with slot 255 and assign them in */
/* descending order. */
/**********************************************************/

VMSYS01: BEGIN
   CP_Owned Slot 254 M01T01
   CP_Owned Slot 255 M01P01
VMSYS01: END

VMSYS02: BEGIN
   CP_Owned Slot 254 M02T01
   CP_Owned Slot 255 M02P01
VMSYS02: END

VMSYS03: BEGIN
   CP_Owned Slot 254 M03T01
   CP_Owned Slot 255 M03P01
VMSYS03: END

VMSYS04: BEGIN
   CP_Owned Slot 254 M04T01
   CP_Owned Slot 255 M04P01
VMSYS04: END
```
Persistent Data Record (PDR)

- Cross-system serialization point on disk
  - Must be a shared 3390 volume
  - Created and viewed with a new utility

- Contains information about member status
  - Used for health-checking

- Heartbeat data
  - Ensures that a stalled or stopped member can be detected
Ownership Checking – CP-Owned Volumes

- Each CP-owned volume in an SSI cluster will be marked with ownership information
  - Cluster name
  - System name of the owning member
  - The marking is created using CPFMTXA

- Ensures that one member does not allocate CP data on a volume owned by another member
  - Warm start, checkpoint, spool, paging, temporary disk, directory

- No need to worry about OWN and SHARED on CP_OWNED definitions
  - Ignored on SSI members

- QUERY CPOWNED will be enhanced to display ownership information
Defining Virtual Machines – Shared Source Directory

- All user definitions in a single shared source directory

- Run DIRECTXA on each member

- No system affinity (SYSAFFIN)

- Identical object directories on each member

- Single security context
  - Each user has same access rights and privileges on each member

Using a directory manager is strongly recommended!
Defining Virtual Machines – Shared Source Directory…

Traditional Definition

- May log on to any member
  - Only one member at a time
- General Workload
  - Guest Operating Systems
  - Service virtual machines requiring only one logon in the cluster

New Definition

- May log on to multiple members at the same time (known by IDENTITY name)
- System support virtual machines
- Service virtual machines

USER

Single Configuration Virtual Machine

IDENTITY

SUBCONFIG 1
- Multiple Configuration Virtual Machine

SUBCONFIG 2
- Multiple Configuration Virtual Machine
Cross-System Spool

- Spool files are managed cooperatively and shared among all members of an SSI cluster.

- Single-configuration virtual machines (most users) have a single logical view of all of their spool files:
  - Access, manipulate, and transfer all files from any member where they are logged on.
  - Regardless of which member they were created on.

- Multiconfiguration virtual machines do not participate in cross-system spool:
  - Each instance only has access to files created on the member where it is logged on.

- All spool volumes in the SSI cluster are shared (R/W) by all members:
  - Each member creates files on only the volumes that it owns.
  - Each member can access and update files on all volumes.

<table>
<thead>
<tr>
<th>SLOT</th>
<th>VOL-ID</th>
<th>RDEV</th>
<th>TYPE</th>
<th>STATUS</th>
<th>SSIOWNER</th>
<th>SYSOWNER</th>
</tr>
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<tbody>
<tr>
<td>10</td>
<td>M01S01</td>
<td>C4A8</td>
<td>OWN</td>
<td>ONLINE AND ATTACHED</td>
<td>CLUSTERA</td>
<td>VMSYS01</td>
</tr>
<tr>
<td>11</td>
<td>M02S01</td>
<td>C4B8</td>
<td>SHARE</td>
<td>ONLINE AND ATTACHED</td>
<td>CLUSTERA</td>
<td>VMSYS02</td>
</tr>
<tr>
<td>12</td>
<td>M01S02</td>
<td>C4A9</td>
<td>OWN</td>
<td>ONLINE AND ATTACHED</td>
<td>CLUSTERA</td>
<td>VMSYS01</td>
</tr>
<tr>
<td>13</td>
<td>M02S02</td>
<td>C4B9</td>
<td>SHARE</td>
<td>ONLINE AND ATTACHED</td>
<td>CLUSTERA</td>
<td>VMSYS02</td>
</tr>
<tr>
<td>14</td>
<td>M01S03</td>
<td>C4AA</td>
<td>DUMP</td>
<td>ONLINE AND ATTACHED</td>
<td>CLUSTERA</td>
<td>VMSYS01</td>
</tr>
<tr>
<td>15</td>
<td>M02S03</td>
<td>C4BA</td>
<td>DUMP</td>
<td>ONLINE AND ATTACHED</td>
<td>CLUSTERA</td>
<td>VMSYS02</td>
</tr>
<tr>
<td>16</td>
<td>------</td>
<td>----</td>
<td>-----</td>
<td>RESERVED</td>
<td>--------</td>
<td>----------</td>
</tr>
</tbody>
</table>

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Cross-System SCIF

- Cross-System SCIF (Single Console Image Facility)
  - Allows one virtual machine (secondary user) to monitor and control one or more disconnected virtual machines (primary users)
    - CONSOLE statement in directory
    - SET SECUSER command
    - SET OBSERVER command
  - Secondary and primary users can be logged on different members of an SSI cluster

- Some restrictions for multiconfiguration virtual machines
Cross-System CP Commands

- Virtual machines on other members can be the target of some CP commands
  - Single configuration virtual machines are usually found wherever they are logged on
  - Multiconfiguration virtual machines require explicit targeting

- **AT** `sysname` operand for the following commands
  - MESSAGE (MSG)
  - MSGNOH
  - SEND
  - SMSG
  - WARNING

  ```
  MSG userid AT sysname
  ```

- CMS TELL and SENDFILE commands require RSCS in order to communicate with multiconfiguration virtual machines on other members

- **AT** command can be used to issue most privileged commands on another active member

  ```
  AT sysname CMD cmdname
  ```
Cross-System Minidisk Management

- Minidisks can either be shared across all members or restricted to a single member
  - CP checks for conflicts throughout the cluster when a link is requested

- Virtual reserve/release for fullpack minidisks is supported across members
  - Only supported on one member at a time for non-fullpack minidisks

- Volumes can be shared with systems outside the SSI cluster
  - **SHARED YES** on RDEVICE statement or SET RDEVICE command
  - Link conflicts must be managed manually
  - Not eligible for minidisk cache
  - **Use with care**
Cross-System Minidisk Management...

- Automatic minidisk cache management
Real Device Management

- Unique identification of real devices within an SSI cluster
  - Ensures that all members are using the same physical devices where required

- CP generates an equivalency identifier (EQID) for each disk volume and tape drive
  - Physical device has same EQID on all members

- EQID for network adapters (CTC, FCP, OSA, Hipersockets) must be defined by system administrator
  - Connected to same network/fabric
  - Conveying same access rights

- EQIDs used to select equivalent device for live guest relocation and to assure data integrity
Virtual Networking Management

- Assignment of MAC addresses by CP is coordinated across an SSI cluster
  - Ensure that new MAC addresses aren't being used by any member
  - Guest relocation moves a MAC address to another member

- Each member of a cluster should have identical network connectivity
  - Virtual switches with same name defined on each member
  - Same (named) virtual switches on different members should have physical OSA ports connected to the same physical LAN segment
    - Assured by EQID assignments
Live Guest Relocation

- Relocate a running Linux virtual server (guest) from one member of an SSI cluster to another
  - Load balancing
  - Moving workload off a member requiring maintenance

- Relocating guests continue to run on source member until destination is ready
  - Briefly quiesced
  - Resumed on destination member

- New CP command will initiate and manage guest relocations
  - Relocation capacity determined by various factors (e.g. system load, ISFC bandwidth, etc.)

- A guest to be relocated must meet eligibility requirements, including:
  - It must be logged on but disconnected
  - Architecture and functional environment on destination must be comparable
  - Destination member must have capacity to accommodate the guest
  - Devices and resources needed by guest must be shared and available on destination
Live Guest Relocation – Relocation Domains

- Identifies a set of members among which guests can relocate freely (without regard to hardware models, firmware, or features)
  - Domains are defined in system configuration file or by command
  - Default domains:
    - Entire cluster (includes all members)
    - Single-member domains for each member

- Used to define a subset of members to which a particular guest can be relocated

- Single configuration virtual machines
  - Relocation domain can be defined in directory; changed with CP command
  - Default domain is entire cluster

- Multiple configuration virtual machines
  - Permanently assigned to single member domain for each member it can log on to
z/VM SSI Cluster Operation
SSI Cluster Management

- A system that is configured as a member of an SSI cluster joins the cluster during IPL
  - Verifies that its configuration is compatible with the cluster
  - Establishes communication with other members

- Members leave the SSI cluster when they shut down

- Status can be viewed with new commands
SSI Cluster Management - Features for Greater Reliability

- Cross-checking of configuration details as members join cluster and as resources are used
  - SSI membership definition and identity
  - Consistent definition of shared spool volumes
  - Compatible virtual network configurations (MAC address ranges, VSwitch definitions)

- Cluster-wide policing of resource access
  - Volume ownership marking to prevent dual use
  - Coordinated minidisk link checking
  - Autonomic minidisk cache management
  - Single logon enforcement

- Communications failure “locks down” future resource allocations until resolved

- Comprehensive checking for resource and machine feature compatibility during relocation
  - Adjustment of “virtual architecture level” to support customer relocation policy
### SSI Cluster Status – Example 1

**SSI Name:** CLUSTERA  
**SSI Mode:** Influx  
**Cross-System Timeouts:** Enabled  
**SSI Persistent Data Record (PDR) device:** VMCOM1 on EFE0

<table>
<thead>
<tr>
<th>SLOT</th>
<th>SYSTEMID</th>
<th>STATE</th>
<th>PDR HEARTBEAT</th>
<th>RECEIVED HEARTBEAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VMSYS01</td>
<td>Joined</td>
<td>2010-07-11 21:22:00</td>
<td>2010-07-11 21:22:00</td>
</tr>
<tr>
<td>3</td>
<td>VMSYS03</td>
<td>Joining</td>
<td>2010-07-11 21:21:57</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>VMSYS04</td>
<td>Down (not IPLed)</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>
SSI Cluster Status – Example 2

HCPPDF6618I Persistent Data Record on device EFE0 (label VMCOM1) is for CLUSTER A
HCPPDF6619I PDR state: Unlocked
time stamp: 07/11/10 21:22:03
cross-system timeouts: Enabled
HCPPDF6619I PDR slot 1 system: VMSYS01
state: Joined
time stamp: 07/11/10 21:22:00
last change: VMSYS01
HCPPDF6619I PDR slot 2 system: VMSYS02
state: Joined
time stamp: 07/11/10 21:21:40
last change: VMSYS02
HCPPDF6619I PDR slot 3 system: VMSYS03
state: Joining
time stamp: 07/11/10 21:21:57
last change: VMSYS03
HCPPDF6619I PDR slot 4 system: VMSYS04
state: Down
time stamp: 07/02/10 17:02:25
last change: VMSYS02
Planning and Creating a z/VM SSI Cluster
SSI Cluster Requirements

- Servers must be IBM System z10 or later

- Shared and non-shared DASD
  - 3390 volume required for the PDR

- LPARs
  - 1-16 FICON CTC devices between LPARs
    - Provide direct ISFC links from each member to all other members
  - FICON channels to shared DASD
  - OSA access to the same LAN segments
  - FCP access to same storage area networks (SANs) with same storage access rights

- Shared system configuration file for all members

- Shared source directory containing user definitions for all members

- Capacity planning for each member of the SSI cluster
  - Ensure sufficient resources are available to contain shifting workload
    - Guests that will relocate
    - Guests that logon to different members
SSI Cluster Restrictions

- Physical systems must be close enough to allow
  - FICON CTC connections
  - Shared DASD
  - Common network and disk fabric connections

- Installation to SCSI devices is not supported
  - Guests may use SCSI devices

- If using RACF, the database must reside on a fullpack 3390 volume

- Live Guest Relocation will be supported for only Linux on System z guests
SSI Cluster Setup – Suggested Practices

- Use the same real device numbers across LPARs to simplify cloning of z/VM systems
  - DASD volumes
  - Ranges for OSA and hipersockets subchannels connected to same network
  - Ranges for FCP subchannels connected to the same fabric

- Install no more than 2 members of an SSI cluster on the same server

- Maintain parallel volume layouts for each member (again, simplifies cloning)

- Allocate object directory (DRCT) extents only on the system residence volume for each member

- Do not place user data on the installation volumes
  - Simplifies release-to-release migration

- Keep member-specific data and SSI cluster data on separate volumes
  - Simplifies cloning and release-to-release migration

- Use a directory manager
Summary

- Allow sufficient time to plan for an SSI cluster
  - Migration from current environment
  - Configuration
  - Sharing resources and data

- Plan for extra
  - CPU capacity
  - Memory
  - CTC connections

- An SSI cluster gives you
  - Workload balancing (take the workload to the hardware)
  - Maintenance on your schedule (not the application owner)
  - Easier multi-system operation
Thanks!

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