z/VM Live Guest Relocation
Planning and Use

Session 12482
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Agenda

- Planning for Live Guest Relocation (LGR)

- Relocation Domains

- Relocating a Guest

- Demo

- Helpful Hints
Planning for Live Guest Relocation
General Guidelines for Relocating a Guest

Make sure all resources used by the virtual machine are available on the destination member

- Facilities (will be handled automatically within a relocation domain)
- Crypto cards
- Capacity for the virtual machine's memory and processor requirements
- Devices
  - Make sure that there really is an equivalent device on the destination
    - OSA should be connected to the same LAN segment
    - FCPs should have access to the same SAN fabric
    - WWPNs and LUNs
    - If possible, use the same device numbers to refer to equivalent devices
  - Equivalency ids (EQID) are defined for devices that need them
    - OSA and FCPs
  - If connected to a VSWITCH, make sure the same VSWITCH is defined on the destination and the OSA have been assigned EQIDs.
  - If the virtual machine has an FCP, make sure the “queue_if_no_path” option is specified in Linux
Guest Configuration for Live Guest Relocation

In order to be eligible to relocate, a guest must be:

- Defined as a single configuration virtual machine
- Running in an ESA or XA virtual machine in ESA/390 or z/Architecture mode
- Logged on and disconnected
- Running only type CP or type IFL virtual processors

**OPTION CHPIDVIRTUALIZATION ONE** should be specified in guest's directory entry

If a guest is using a DCSS or NSS:

- Identical NSS or DCSS must be available on the destination member
- It cannot have the following types of page ranges
  - SW (shared write)
  - SC (shared with CP)
  - SN (shared with no data)
Guest Configuration for Live Guest Relocation (cont.)

- A guest can relocate if it has any of the following:
  - Private virtual disks in storage (created with DEFINE VFB-512 command)
  - An open console file

- A relocating guest can be using any of the following facilities:
  - Virtual machine time bomb (Diag x'288')
  - IUCV connections to *MSG and *MSGALL CP system services
  - Application monitor record (APPLDATA) collection
    • If guest buffer is not in a shared DCSS
  - Single Console Image Facility (SCIF)
  - Collaborative Memory Management Assist (CMMA)

- There are conditions that will prevent a guest from relocating
  - Documented in CP Planning and Administration, Chapter 27 - "Preparing for Live Guest Relocation in a z/VM SSI Cluster"
A relocating guest's current memory size must fit in available space on the destination member.

Virtual memory fully populated, including:
- Private Vdisks
- Estimated size of supporting CP structures

Available space - sum of available memory:
- Paging disk
- Expanded storage
- Central storage
Memory Requirements for Live Guest Relocation…

- Additional checks

  1. Does the guest's current memory size exceed paging capacity on the destination?

Virtual memory fully populated, including
- Private Vdisks
- Estimated size of supporting CP structures

<

Paging disk capacity

*May be overridden if you are certain that this is not applicable to your environment*
Memory Requirements for Live Guest Relocation…

- Additional checks

2. Does the guest's maximum memory size exceed available space on the destination?

Guest's Maximum Memory Size

- Standby and reserved storage
- Current memory size

Available space

- Sum of available memory
- Paging disk
- Expanded storage
- Central storage

*May be overridden if you are certain that this is not applicable to your environment*
Memory Requirements for Live Guest Relocation…

- Additional checks

3. Does the guest's maximum memory size exceed paging capacity on the destination?

*May be overridden if you are certain that this is not applicable to your environment*
Memory Requirements for Live Guest Relocation…

- Include standby and reserved storage settings when calculating maximum memory size for a guest

- Relocations may increase paging demand
  - Available paging space should be at least 2x total virtual memory of all guests
    - Including guests to be relocated to this member
  - Avoid allocating more than 50% of available paging space
    - If size of guests to be relocated increase in-use amount to > 50%, system performance could be affected

```
q alloc page

<table>
<thead>
<tr>
<th>VOLID</th>
<th>RDEV</th>
<th>START</th>
<th>END</th>
<th>PAGES</th>
<th>IN USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>L24B66 4B66</td>
<td>0</td>
<td>3338</td>
<td>601020</td>
<td>252428</td>
<td>252428</td>
</tr>
</tbody>
</table>
```
Relocation Domains
What is a Relocation Domain?

- A relocation domain defines a set of members of an SSI cluster among which virtual machines can relocate freely

- Relocation domains can be defined for business or technical reasons

- Regardless of differences in the facilities of the individual members, a domain has a common architectural level
  - This is the maximal common subset of all the members' facilities

- Several default domains are automatically defined by CP
  - Single member domains for each member in the SSI
  - An SSI domain that will have the features and facilities common to all members

- Defining your own domains is useful in a 3+ member cluster
  - In a 1 or 2 member cluster, all possible domains are defined by default
  - Defined via a SYSTEM CONFIG statement or dynamically by command
Architecture Fencing in Domains

- Guests cannot use facilities or features not included in the domain even if the member they are on has access to those features
  - We call this “fencing”

- Examples of commands/instructions with “fenced” responses:
  - Q CPUID - the model number will always reflect the virtual architecture level, the processor number is set at logon and not affected by relocation or relocation domain changes
  - Diagnose x'00' – will reflect the virtual CPLEVEL
  - STFLE
Relocation Domains

SSI Domain (z10)
GIEF
z/VM 6.2.0

Member1
(z10)
GIEF
z/VM 6.2.0

Member2
(z10)
GIEF
FACILITYX
z/VM 6.2.0+

Member3
(z196)
GIEF
FLOAT-PT
FACILITYX
z/VM 6.2.0

Member4
(z196)
GIEF
FLOAT-PT
z/VM 6.2.0+
Relocation Domains

Member1 (z10) GIEF z/VM 6.2.0

Member2 (z10) GIEF FACILITYX z/VM 6.2.0+

User-defined domain Winnie (z10) GIEF z/VM 6.2.0+

User-defined domain Paddingtn (z10) GIEF, FACILITYX z/VM 6.2.0

Member3 (z196) GIEF FLOAT-PT FACILITYX z/VM 6.2.0

User-defined domain Corduroy (z196) GIEF, FLOAT-PT z/VM 6.2.0

Member4 (z196) GIEF FLOAT-PT z/VM 6.2.0+
Assigning Relocation Domains

- Virtual machines may be assigned to a domain in their directory entry
  - Default for single configuration virtual machines is the SSI domain
  - Default for multiconfiguration virtual machines is their single member domain, which cannot be changed

- Virtual machines are assigned a virtual architecture level when they log on, according to what domain they are in
Assigning Relocation Domains - Directory

```
dirm for lgrrh56 vmrelocate on domain winnie
DVHXTMT1191I Your VMRELOCATE request has been sent for processing to
DVHXTMT1191I DIRMAINT at MEMBER1 via DIRMSAT2.
Ready; T=0.01/0.02 11:32:46
DVHREQ2288I Your VMRELOCATE request for LGRRH56
DVHREQ2288I at * has been accepted.
DVHBIU3450I The source for directory entry LGRRH56 has been updated.
DVHBIU3424I The next ONLINE will take place immediately.
DVHRLA3891I Your DSATCTL request has been relayed.
DVHRLA3891I for processing.
DVHRLA3891I Your DSATCTL request has been relayed.
DVHRLA3891I for processing.
DVHRLA3891I Your DSATCTL request has been relayed.
DVHRLA3891I for processing.
DVHRLA3891I Your DSATCTL request has been relayed.
DVHRLA3891I for processing.
DVHRLA3891I Changes made to directory entry LGRRH56
DVHBIU3428I have been placed online.
DVHREQ2289I Your VMRELOCATE request for LGRRH56
DVHREQ2289I at * has completed; with RC = 0.

USER LGRRH56 E 2G 3G ABCDEFG
   INCLUDE LGRDFLT
   IPL 150
   VMRELOCATE ON DOMAIN WINNIE
   LINK PMAINT 0193 0F93 RR
   MDISK 0150 3390 1 END FL4BC8 MR ALL WRITE MULTI
   MDISK 0151 3390 1 END FL4BC9 MR ALL WRITE MULTI
   MDISK 0152 3390 1 END FL4BCA MR ALL WRITE MULTI
```
Assigning Relocation Domains - Dynamic

- A guest may be dynamically reassigned to a domain with the same or greater facilities—as long as the member it is currently on has access to those facilities.

- Example: before relocating a guest in the SSI domain to a member with more facilities, you may want to reassign it to a domain that includes those facilities.
Live Guest Relocation
Starting and Managing a Live Guest Relocation

- New VMRELOCATE command

  - Several operands to start and monitor relocations, including:
    - **TEST** – determine if guest is eligible for specified relocation
    - **MOVE** – relocates guest
      - **MAXQUIESCE** – maximum quiesce time (relocation is cancelled if exceeded)
      - **MAXTOTAL** – maximum total time (relocation is cancelled if exceeded)
    - **STATUS** – display information about relocations that are in progress
    - **CANCEL** – stop a relocation
What to Know Before Starting Relocations

- Guests are relocated in several stages

- A relocation can be canceled at any time until after the guest's final state is moved
  - `VMRELOCATE CANCEL` command from the source or destination
  - `CPHX` will cancel a `VMRELOCATE SYNC` command

- If there are any eligibility failures at any point until after the guest's final state is moved, the relocation cancels

- The guest continues to run on originating member if a relocation fails or is cancelled
What to Know Before Starting Relocations…

- Use the VMRELOCATE TEST command before you try a VMRELOCATE MOVE

- Choose one class A user to always issue your VMRELOCATE commands
  - Only issue one VMRELOCATE command at a time
    - Default SYNCHRONOUS option to enforce one-at-a-time relocations

- Use the AT command to issue VMRELOCATEs on another member in your SSI cluster

- Know how long your Linux machine can be quiesced, look at applications and when they will timeout (30 seconds? 5 seconds?)
  - Use the MAXQUIESCE option to tell CP how long quiesce time can be
  - If this is exceeded, the relocation will be cancelled and the virtual machine resumed on the source member
Stages of a Live Guest Relocation

1. Eligibility Checks
2. Create Skeleton on Destination
3. Move Guest Memory while guest continues to run

VMRELOCATE MOVE command
LGR, High-Level View of Memory Move

Source

PUSH with resend

Destination

Pass 1

Walk through guest memory moving all non-zero pages

Guest Address Space

Guest Address Space
LGR, High-Level View of Memory Move

Source

Destination

PUSH with resend

Guest Address Space

Guest Address Space

Pass 1

Pass 2

Walk through memory and resend any changed pages.
LGR, High-Level View of Memory Move

Source

Guest Address Space

PUSH with resend

Destination

Guest Address Space

Pass 1

...   ...

Pass 2

...   ...

Pass 3

Repeat
LGR, High-Level View of Memory Move

Source

Destination

Guest Address Space

PUSH with resend

Pass 1

Pass 2

Pass 3

Pass N

Passes

Quiesce guest for final pass.
Stages of a Live Guest Relocation

Step 1: Eligibility Checks

Step 2: Create Skeleton on Destination

Step 3: Move Guest Memory while guest continues to run

Step 4: Quiesce Guest

Step 5a: Guest State Move

Step 5b: I/O Device Move

Step 5c: Penultimate Memory Move

Step 6: Final Memory Move Pass

Step 7: Guest Resumed on Destination
Demo
Helpful Hints
Helpful Hints

Help! My relocation hasn't completed yet!

Try VMRELOCATE STATUS DETAILS
Helpful Hints...

vmrelocate test lgrcp021 gdlrcts1
User LGRCP021 is eligible for relocation to GDLRCTS1
Ready; T=0.01/0.01 15:28:09

vmrelocate move lgrcp021 gdlrcts1 asynchronous maxquiesce 10
Relocation of LGRCP021 from GDLRCTS2 to GDLRCTS1 started
Ready; T=0.01/0.01 15:28:15

vmrelocate status
User From To By Status Elapsed
LGRCP021 GDLRCTS2 GDLRCTS1 CELESKEY Moving Memory 00:00:05
Ready; T=0.01/0.01 15:28:21

vmrelocate status lgrcp021 details
User From To By Status Elapsed
LGRCP021 GDLRCTS2 GDLRCTS1 CELESKEY Moving Memory 00:00:10

Options: ASYNCH IMMED NO
Max Total Time NO LIMIT
Max Quiesce Time 10 sec

Total pages sent 702176 in 1 passes; 524320 pages sent in pass 2
Ready; T=0.01/0.01 15:28:25

User LGRCP021 has been relocated from GDLRCTS2 to GDLRCTS1
Helpful Hints…

*Help! My relocation always exceeds my quiesce time!*

- Are you issuing relocations one at a time?
- Check system constraints, are you trying to relocate to a member that really can't handle another user?
- How many CTCs do you have between your members? How fast are they? How many devices do you have on each CHPID?
Helpful Hints…

I don't trust that you're really leaving the guest running, I want to see what my guest is doing as he relocates!

Use SCIF from another single configuration virtual machine -
SET OBSERVER LINUX01 *

Have the virtual machine spool his console
SPOOL CONS * START

Connect to Linux via SSH or VNC
Helpful Hints…

What are all these messages I see on my Linux console after relocation?

You may see recovery messages for OSA or FCP devices after relocation, this is normal.
Summary

- z/VM Live Guest Relocation is supported for Linux on System z guests
  - Read requirements and restrictions before attempting!

- Guests can be using a variety of devices and services while they relocate

- Set up relocation domains before logging on your guests
  - If you have more than 2 members in your SSI cluster
  - If your cluster spans different hardware or software levels

- Relocation is "safe"
  - A relocation will not be allowed if the relocating guest would overwhelm the destination member's memory
  - "Throttling" is used to mitigate the impact of a relocation on running workloads
  - Relocations can be queried and cancelled manually
  - Relocations might automatically be cancelled to prevent harm to the guest or system
  - If a relocation is cancelled or terminated, the guest continues to run on the source member
More Information

z/VM 6.2 resources
http://www.vm.ibm.com/zvm620/
http://www.vm.ibm.com/events/

z/VM Single System Image Overview
http://www.vm.ibm.com/ssi/

Live Virtual Classes for z/VM and Linux
http://www.vm.ibm.com/education/lvc/

z/VM 6.2 Workshops
http://www.redbooks.ibm.com/cgi-bin/searchsite.cgi?query=Using+z/VM+v6.2+and+Linux

Redbooks
– An Introduction to z/VM SSI and LGR

– Using z/VM v 6.2 Single System Image (SSI) and Live Guest Relocation (LGR)

– DB2 10 for Linux on System z Using z/VM v6.2, Single System Image Clusters and Live Guest Relocation

Whitepaper
– z/VM Migration: Migrating the User Directory and RACF Environment
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40 Years of Virtualization.
Live Guest Relocation – Example

```
q ssi
SSI Name: SSITEST
SSI Mode: Stable
Cross-System Timeouts: Enabled
SSI Persistent Data Record (PDR) device: FL4884 on 4884

<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>GDLLCPX1</td>
<td>Joined</td>
<td>2011-10-13 15:10:18</td>
<td>2011-10-13 15:10:18</td>
</tr>
<tr>
<td>2</td>
<td>GDLLCPX2</td>
<td>Joined</td>
<td>2011-10-13 15:10:12</td>
<td>2011-10-13 15:10:12</td>
</tr>
</tbody>
</table>

Ready; T=0.01/0.01 15:10:41
```
Live Guest Relocation – Example

```
formssi display 141
HCPPDF6619I Persistent Data Record on device 0141 (label FL4B84) is for
HCPPDF6619I PDR
HCPPDF6619I state: Unlocked
HCPPDF6619I time stamp: 10/13/11 15:10:42
HCPPDF6619I cross-system timeouts: Enabled
HCPPDF6619I PDR slot 1
HCPPDF6619I state: Joined
HCPPDF6619I time stamp: 10/13/11 15:10:18
HCPPDF6619I last change: GDDLCPX1
HCPPDF6619I PDR slot 2
HCPPDF6619I state: Joined
HCPPDF6619I time stamp: 10/13/11 15:10:42
HCPPDF6619I last change: GDDLCPX1
HCPPDF6619I PDR slot 3
HCPPDF6619I state: Joined
HCPPDF6619I time stamp: 10/13/11 15:10:42
HCPPDF6619I last change: GDDLCPX2
HCPPDF6619I PDR slot 4
HCPPDF6619I state: Joined
HCPPDF6619I time stamp: 10/13/11 15:10:26
HCPPDF6619I last change: GDDLCPX3
HCPPDF6619I PDR slot 4
HCPPDF6619I state: Joined
HCPPDF6619I time stamp: 10/13/11 15:10:35
HCPPDF6619I last change: GDLMCPX4
Ready: T=0.01/0.01 15:10:48
```
Live Guest Relocation – Example

```bash
xautolog lgmlin21
Command accepted
Ready; T=0.01/0.01 15:11:44
AUTO LOGON *** LGRLIN21 USERS = 21
HCPCLSG056I XAUTOLOG information for LGRLIN21: The IPL command is verifi
set secuser lgmlin21 *
HCPCLSG056I SECUSER of LGRLIN21 initiated.
Ready; T=0.01/0.01 15:11:50
LGRLIN21: Booting default (ipl)...
LGRLIN21: Linux version 2.6.16.60-0.21-default (geeko@buildhost) (gcc ve
UTC 2008
```

```bash
Welcome to SUSE Linux Enterprise Server 10 SP2 (s390x) - Kernel 2.6.16.6
```

```bash
linux-nxpt login:
```

...
Live Guest Relocation – Example

```
q lgmlin21 at all
GDLLCPX2 : LGRLIN21 - DSC
Ready; T=0.01/0.01 15:44:52
```

```
vmrelocate test lgmlin21 to gdllcpx1
User LGRLIN21 is eligible for relocation to GDLLCPX1
Ready; T=0.01/0.01 15:45:21
```

```
VMRELOCATE MOVE LGRLIN21 TO GDLLCPX1 MAXQ 5 SEC
Relocation of LGRLIN21 from GDLLCPX2 to GDLLCPX1 started
User LGRLIN21 has been relocated from GDLLCPX2 to GDLLCPX1
LGRLIN21: User LGRLIN21 has been relocated from GDLLCPX2 to GDLLCPX1
LGRLIN21 has been relocated to GDLLCPX1
LGRLIN21 has been relocated to GDLLCPX1
```

```
```
Live Guest Relocation – Example

LGRLIN21: qeth: check on device 0.0.0700, dstat=x0, cstat=x2 (4) qeth: irb: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
qeth: irb: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
qeth: irb: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
qdio: received check condition on activate queues on device 0.0.0702 (c
qeth: Recovery of device 0.0.0700 started ...
qeth: Device 0.0.0700/0.0.0701/0.0.0702 is a OSD Express card (level: 03
with link type OSD_100 (portname: whatever)
qeth: Hardware IP fragmentation not supported on eth0
qeth: VLAN enabled
qeth: Multicast enabled
qeth: IPV6 enabled
qeth: Broadcast enabled
qeth: Using SW checksumming on eth0.
qeth: Outbound T30 enabled
USER DSC LOGOFF AS LGRLIN21 USERS = 20 FORCED BY SYSTEM
Ready; T=0.01/0.01 15:45:52
LGRLIN21: qeth: Device 0.0.0700 successfully recovered!
Oct 13 15:45:51 linux-nxpt kernel: qeth: check on device 0.0.0700, dstat
00 00 00 00 e0 80"
Oct 13 15:45:51 linux-nxpt kernel: qeth: irb: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Oct 13 15:45:51 linux-nxpt kernel: qeth: irb: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Oct 13 15:45:51 linux-nxpt kernel: qeth: irb: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
LGRLIN21: Oct 13 15:45:51 linux-nxpt kernel: qdio: received check condi
Oct 13 15:45:51 linux-nxpt kernel: qeth: Recovery of device 0.0.0700 sta
Oct 13 15:45:56 linux-nxpt kernel: qeth: Device 0.0.0700/0.0.0701/0.0.07
Oct 13 15:45:56 linux-nxpt kernel: with link type OSD_100 (portname: wha
Oct 13 15:45:56 linux-nxpt kernel: qeth: Using SW checksumming on eth0."
Live Guest Relocation – Example

```bash
q lgrlin21 at all
GDLLCPX1 : LGRLIN21 - DSC
Ready; T=0.01/0.01 15:46:35

AT GDLLCPX1 CMD VMRELOCATE MOVE LGRLIN21 TO GDLLCPX2 MAXQ 5 SEC
Relocation of LGRLIN21 from GDLLCPX1 to GDLLCPX2 started
LGRLIN21: User LGRLIN21 has been relocated from GDLLCPX1 to GDLLCPX2
User LGRLIN21 has been relocated from GDLLCPX1 to GDLLCPX2
LGRLIN21: qeth: check on device 0.0.0700, dstat=x0, cstat=x2 <4>qeth: irqeth: irb: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
qeth: irb: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
qeth: irb: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
qdio : received check condition on activate queues on device 0.0.0702 (c
qeth: Recovery of device 0.0.0700 started ...
qeth: Device 0.0.0700/0.0.0701/0.0.0702 is a OSD Express card (level: 03
with link type OSD_100 (portname: whatever)
qeth: Hardware IP fragmentation not supported on eth0
qeth: VLAN enabled
qeth: Multicast enabled
qeth: IPV6 enabled
qeth: Broadcast enabled
qeth: Using SW checksumming on eth0.
qeth: Outbound TS0 enabled
Ready; T=0.01/0.01 15:47:10
LGRLIN21: qeth: Device 0.0.0700 successfully recovered!
```

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Live Guest Relocation – Example

```
q LGRLIN21 AT ALL
GDLLCPX2 : LGRLIN21 - DSC
Ready; T=0.01/0.01 15:47:41
```