Sharing and Maintaining SLES 11 Linux under z/VM using DCSSs and an NSS

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Section 1: Introduction

This paper shows how to use Dis-contiguous Saved Segments (DCSSs) and a Named Saved System (NSS) with the concept of a read-only root file system. The use of DCSSs offers the possibility of performance gains.

The Web site associated with this paper is:

http://www.vm.ibm.com/linux/dcss/

Also, see the z/VM® performance report entitled *DCSS Above 2 GB*, on the Web at:

http://www.vm.ibm.com/perf/reports/zvm/html/540dcss.html

The sections in this paper after this introduction are as follow:

1.1 Prospective readers

This white paper is written for system administrators who want to implement the environment and techniques described within, on the mainframe platform using z/VM Version 5 Release 4 (V5.4) and Novell® SUSE® Linux Enterprise Server 11 (SLES 11).

1.2 History

This paper follows from three previous papers:

1) The IBM Redpaper *Sharing and maintaining Linux® under z/VM*, largely based on input from architects and system administrators from Nationwide Insurance. This paper introduced the concept of a read-only root file system. It was published in February of 2008 on the Web at:

http://www.redbooks.ibm.com/abstracts/redp4322.html

2) *Sharing and maintaining SLES 10 SP2 Linux under z/VM*. Most of the input came from system administrators at Penn State University. This paper upgraded the Linux distribution to SLES 10 SP2, and it elaborated on the maintenance system. It was published in July of 2009 on the Web at:

http://linuxvm.org/present/ro-root-S10.pdf

3) *Sharing and maintaining RHEL 5.3 Linux under z/VM*. This paper took the work on Novell's SLES and adapted it for Red Hat's RHEL 5.3. It was published in September of 2009 on the Web at:

http://linuxvm.org/present/ro-root-RH5.pdf

The differences from the previous papers are as follows:

- The Linux distribution described is SLES 11.
- A single DCSS swap space is used rather than VDISK and minidisk swap spaces.
- The read-write directory is **/usr/local/**, per the File system Hierarchy Specification (FHS), not **/local/**.
- It uses 100 as the IPL address, not 1B0
- It uses four read-only file systems: **/**, **/boot/**, **/usr/share/** and **/var/lib/rpm/** and one read-write: **/usr/local/**. Other read-write directories and files are stored in **/usr/local/** and later bind-mounted in place.
- It uses all Linux scripts, no longer any REXX EXECs
- The **/etc/** file system is also read-only with only those files that need to be modified being bind-mounted read-write.
- Code from RHEL was adapted to use the **readonlyroot** boot parameter, the **/etc/sysconfig/readonly-root** and **/etc/rwtab** configuration files. This enables commonality between SLES and RHEL.

1.3 Credits and feedback

This paper was written by Michael MacIsaac, Carlos Ordonez and Vic Cross of IBM.

Thanks go out to many people including Bill Bitner, Pam Christina, Bill Holder, David Jeffers, George Madl, Peter Oberparleiter, Christian Paro, Denny Refsnider, Gonzalo Muelas Serrano, Steve Shultz, Jim Switzer, Nick Wang, Romney White, Steve Wilkins, Eva Yan, Hongjie Yang and Wesley Yee, of IBM and also Andreas Gruenbacher and Mark Post of Novell/SuSE.

If you have feedback or questions on this paper, you can e-mail it to mikemac at us.ibm.com.

Section 2: Background on DCSSs and NSSs

In z/VM, a *segment* is a portion of storage (system memory) 1MB in size. A *saved segment* refers to a segment (or collection of segments) that has been stored in z/VM spool space. Sometimes, as with segments of type EN or SN, only a description of the segment is saved in spool, with no data from memory saved. Once saved to the spool, a saved segment can be accessed by either any virtual machine or by a restricted set of virtual machines on the z/VM system, either by loading the segment into its virtual storage or by the segment being mapped into the addressable range of the virtual machine.

Segments can be marked "shared", which means they can be accessed by a number of virtual machines, or "exclusive" and thereby accessible only by a single virtual machine. Segments can also be marked as "read-only" or "writable" (read-write). These markings can be made in almost any combination: it is possible to have a shared writable segment (although there are no common uses of this in Linux).

The most common combinations of segment markings are "shared read-only" and "exclusive writable". When a number of virtual machines are mapped to a shared-read-only segment, every virtual machine sees exactly the same segment in z/VM's real storage and none of them can modify it. With exclusive-writable, every virtual machine has its own copy of the segment--but before making the copied segment accessible to the virtual machine, CP initializes it from the contents of the segment that was originally saved.

In the context of Linux on System z, there are two types of saved segment provided by z/VM: the *Discontiguous Saved Segment* and the *Named Saved System*[1].

2.1 What is DCSS?

Discontiguous Saved Segment (DCSS) is a z/VM technology that allows a portion of the storage of a guest to be saved. This saved storage can then be shared between a number of guests, which all see the same storage. DCSS is a powerful tool that

1The third type of segment, the *segment space*, is not directly supported by Linux at this time and will not be discussed in this paper.

gives z/VM administrators a way to provide high levels of resource sharing between guests, combined with excellent performance.

A DCSS can be created covering a continuous range of addresses, or a number of different sections of the guest's address range (the ``DC", for dis-contiguous, in the name). It can even have parts that are read-write, allowing each guest to have its own copy of a portion of the shared segment that it can modify.

Linux can utilize DCSS technology to build file systems that reside in memory, allowing drastic reduction in file system I/O for system files. Combined with *eXecute-In-Place* (XIP) capability, the amount of central storage required to host a group of Linux systems running similar workloads is greatly reduced, and this leads to the ability to run larger numbers of virtual Linux systems in a given system footprint.

DCSSs can either be *shared* or *exclusive* segments. A shared segment means the same memory is accessed by multiple virtual machines. Any change to that memory made by one virtual machine is instantaneously seen by all virtual machines accessing the segment. An exclusive segment means each virtual machine that accesses the segment has its own exclusive copy of that segment. In this case, changes made by one virtual machine are not seen by other virtual machines accessing the segment. Whether or not a particular portion of a DCSS is read-write does not determine whether it is exclusive or shared.

More detail on DCSS can be found in the z/VM *Saved Segments Planning and Administration* manual, on the Web at:

`http://publibz.boulder.ibm.com/epubs/pdf/hcsg4b10.pdf`

2.1.1 Linux support of DCSS

Linux makes use of a DCSS by presenting it as a block device, in the same way that DASDs are presented for use. The **dcssblk** device driver is part of the Linux kernel and does the work of making a DCSS appear as a block device.

Even though a DCSS looks just like other block devices, the **dcssblk** driver does this in such a way that file systems that support XIP recognize that the file system is memory-addressable. Current versions of the Linux second-extended (ext2) file system support XIP using a mount option and a DCSS-backed ext2 file system can provide this capability.

2.1.2 Factors that limit DCSS use

Linux has had DCSS support for a long time, but little adoption of DCSS has taken place. There are a couple of reasons for that.

2.1.2.1 DCSS size and location restrictions in z/VM

Prior to z/VM 5.4, no DCSS could reside above the 2GB bar. In addition, for 31-bit guests, the ceiling was actually lower than 2GB due to system requirements, and by the time you allocated the central storage for Linux, there was usually little space left for any DCSSs. Even in a 64-bit guest, where the guest's central storage could be relocated above the 2GB bar to make more room for DCSSs, the maximum size restriction imposed by the 2GB bar posed a significant barrier to DCSS use.

2.1.2.2 Software maintenance and updates

Most procedures for building Linux file systems in a DCSS involved manually copying files from a standard Linux file system to the DCSS (this was particularly apparent in some DCSS methods that worked around the size restrictions described earlier). This was seen prone to error, requiring careful attention to package changes and providing little opportunity to be automated. This paper shows a way to automate the process with the **rw2ro.sh** script.

2.1.3 z/VM 5.4 and DCSS

In the announcement letter for z/VM 5.4, IBM announced changes to the DCSS function. In particular, the 2GB bar has been

removed, meaning that a DCSS can reside almost anywhere in addressable storage[1].

While a single DCSS cannot be larger than 2GB, the Linux **dcssblk** driver now allows DCSSs to be concatenated so that multiple DCSSs can be made to appear to Linux as a single device. This will allow very large DCSS-backed file systems to be built, eliminating the maintenance complexity of some of the previous DCSS configuration approaches.

2.1.4 Working with DCSSs

The z/VM **DEFSEG** and **SAVESEG** commands allow you to map pages of memory contents and store them in disk-backed SPOOL space that can be made accessible to multiple virtual machines. The Linux DCSS block device driver, **dcssblk**, is used to provide disk-like access to these saved segments. The Linux XIP technology allows you to treat code in a memory-backed file system as if it were a part of the virtual memory space. Normally executables on disk have to first be loaded into memory, however, executables that start in memory can be “executed in place”.

Together these tools allow multiple Linux guests to share one copy of commonly executed code, and reduce overall memory use by Linux guests.

The IBM Linux on System z kernel developers have produced a manual explaining how DCSS is used in Linux. This document contains a lot of background on **dcssblk** and its use.

- *How to use Execute-in-Place Technology with Linux on z/VM* on the Web at:

  http://download.boulder.ibm.com/ibmdl/pub/software/dw/linux390/docu/l26dhe00.pdf

The following document is also recommended reading:

- Chapters 19 and 20 of *Device Drivers, Features, and Commands* on the Web at:

  http://download.boulder.ibm.com/ibmdl/pub/software/dw/linux390/docu/l26ddd01.pdf

2.2 Named Saved Systems

Named Saved System (NSS) is a z/VM technology that allows a bootable operating system ``snapshot'' to be saved to the z/VM spool. This system snapshot can be shared and started by many z/VM guests, all of which can boot it like an operating system disk and run the system therein.

Usually, a NSS is created at a very early stage in the initialization of the operating system. This allows the OS in the NSS to detect hardware and other features at the time it is started in each guest.

A NSS must be defined specifically for the operating system image it will contain. This is because different operating systems have different memory locations which must be kept exclusive-writable or that can be shared. z/VM keeps track of these mappings, ensuring that guests get their own copy of pages that are writable while giving shared access to read-only pages. In addition, each operating system that creates an NSS must do so with an awareness of what areas to be saved must be read-only and sharable or read-write and exclusive.

2.2.1 Previous Limitations

Initially, Linux had no explicit support for NSS. Since an NSS is effectively an IPLable snapshot of memory though, the fact that Linux did not have its own support did not stop enthusiastic fans of Linux on z/VM from experimenting with booting Linux from an NSS. The process was troublesome, however, as it required manual inspection of a built kernel to determine which parts of the kernel address space could be shared and which had to be writable.

Another important limitation involves device configuration, particularly DASDs. Early Linux kernels were built with the DASD driver in a monolithic fashion stored in the kernel (i.e. not built as a module). This meant that the only way that DASD could be configured was on the Linux kernel command line. Because of this, when the kernel was saved to a NSS the DASD configuration was too -- all guests that shared the NSS had to have identical DASD setup. This issue was partially mitigated when Linux vendors started building the DASD drivers as modules, but more sophisticated boot processes have been required to make a NSS truly sharable among guests with differing hardware configurations.

1In practical terms, a DCSS must reside within the first 512GB of guest storage.

2.2.2 Linux use of NSS

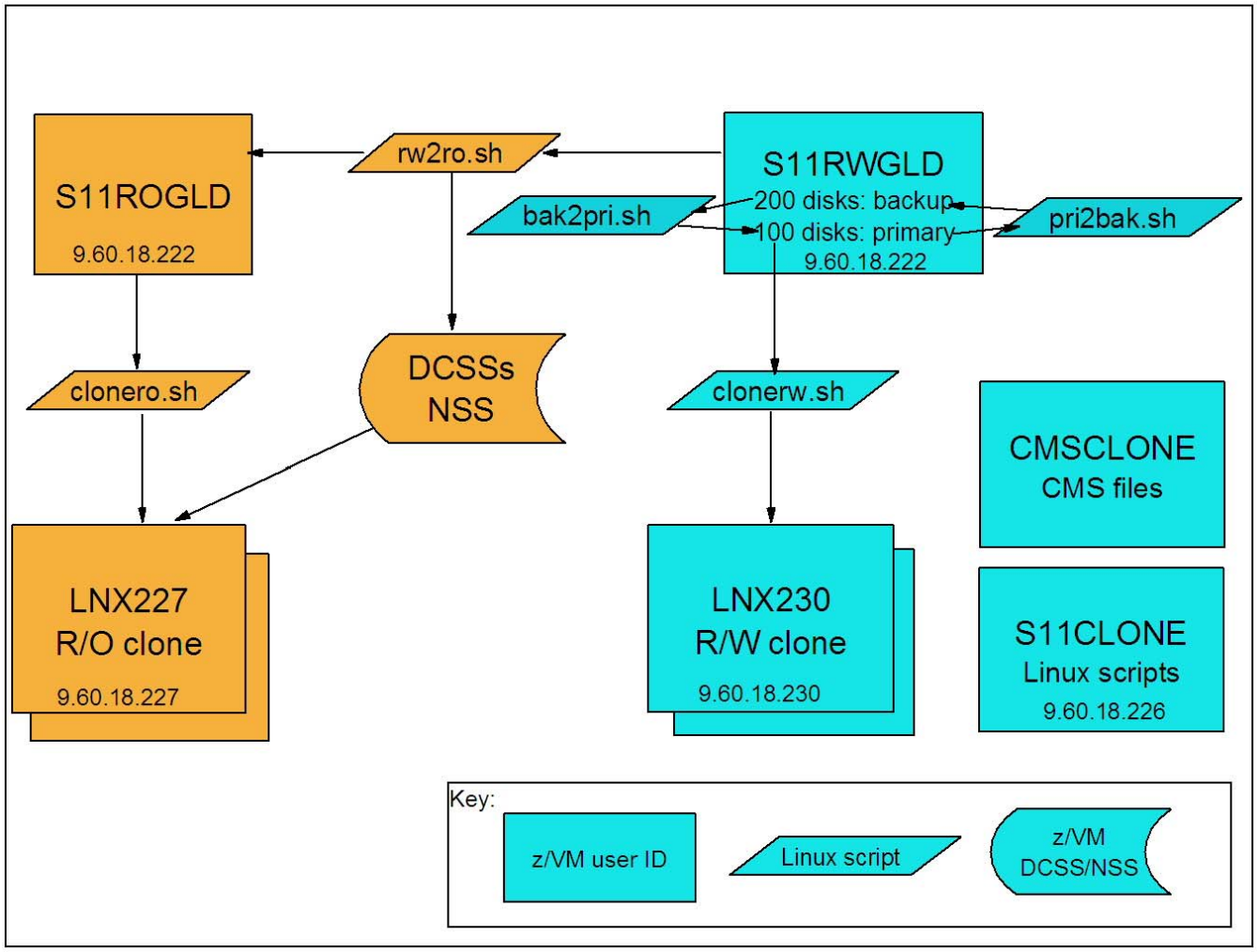
Linux now has built-in capability to define its own NSS mappings, simplifying the creation of a Linux-bootable NSS. Not only that, when NSS support is included in the Linux kernel it is built in a way that structures read-only and writable sections to maximize the amount of address space that can be marked read-only (in the same way that other operating systems that can be stored in NSS, like CMS, do).

The Linux NSS support provides easy creation and saving of the NSS through a new kernel parameter which triggers the saving of a NSS from the kernel being booted. This means that building a NSS is as simple as adding a single parameter to the kernel command line and IPLing.

Section 3: Summary of virtual machines

Before building a read-only root system is described, a methodology for maintaining and cloning a conventional read-write Linux system is addressed. The read-write system is created with a maintenance plan in mind.

Following is a block diagram of the system described in this paper. The conventional read-write setup is shown on the right side of the diagram (in turquoise if you can see color in the figure) and the read-only components are shown on the left size (in gold):



Following is a summary of the function of the virtual machines in the system.

3.0.0.1 CMSCLONE

This virtual machine runs CMS. It contains a 192 disk that will become each Linux user ID's read-only 191 disk. It is no longer needed to run REXX EXECs as all the “heavy lifting” is now done with Linux scripts.

3.0.0.2 S11CLONE

This virtual machine is “the cloner”. It runs a Linux system that contains the tools used for cloning and to modify the golden read-write Linux image on S11RWGLD into a read-only root Linux image that shares file systems using DCSSs and an NSS onto S11ROGLD.

Following are the important files in **/usr/local/sbin/** on this system:

clonero.sh A script to clone read-only Linux systems

clonerw.sh A script to clone read-write Linux systems

rw2ro.sh A script that copies read-write disks from S11RWGLD to S11ROGLD and modifies certain files

pri2bak.sh A backup script that copies the primary 100 disks to the backup 200 disks

bak2pri.sh A rollback script that copies the backup 200 disks to the primary 100 disks

This virtual machine will use a DCSS for a swap space, but it will not use DCSSs for file systems.

3.0.0.3 S11RWGLD

This is read-write “golden image” virtual machine. It contains four primary disks at 100-103 and four backup disks at 200-203. Maintenance of the golden image is done on this virtual machine. It is normally shut down so it can be cloned from.

Following are the important files this system:

boot.findself A new script in **/etc/init.d/**, run at first boot to set the host name and IP of the new Linux guest

boot.rootfsck A modified boot script in **/etc/init.d/** for read-only Linux guests.

cloneprep.sh A new script that removes extraneous files before cloning

setup-block.sh A modified script in **/lib/mkinitrd/scripts/** to load the **dcssblk** driver in the initial RAMdisk

3.0.0.4 S11ROGLD

The read-only gold virtual machine. The golden image from S11RWGLD is copied to here and modified to become a read-only root system. It contains a read-write 102 minidisk and a read-write 100 minidisk that will later be used to create an NSS. The 101 and 103 disks are not necessary as the file systems will be stored in DCSSs. It is also normally shut down.

3.1 Minidisk and DCSS layout

Following are the minidisks, DCSSs and corresponding file systems used in this paper:

File system	Cylinders/size	vdev	Type	Notes
/boot/	60/41 MB	100	ext2/xip	Contains the files used to boot the system and create the NSS named **S11LNX1**. Installed as ext2, but later made to be of type xip
/	3338/2.2 GB	101	ext2/xip	Saved as the DCSS named **S11ROOT1**. Mounted read-only. Installed as ext2, but later made to be of type xip
/usr/local/	1669/1.2 GB	102	ext3	Mounted read-write – contains copies of **/root/**, **/srv/**, **/var/** and certain files in **/etc/** which get bind-mounted read-write.
/usr/share/	1609/1.1 GB	103	ext2/xip	Saved as the DCSS named **S11SHAR1**. Mounted read-only.

				Installed as ext2, but later made to be of type xip
/var/lib/rpm/	N/A	N/A	ext2/xip	Saved as the DCSS named **S11RPM1**.

A read-write system requires approximately two 3390-3s, or about 4.5GB. A read-only system requires 1669 cylinders, or about 1.1GB.

Section 4: Planning the Linux memory footprint

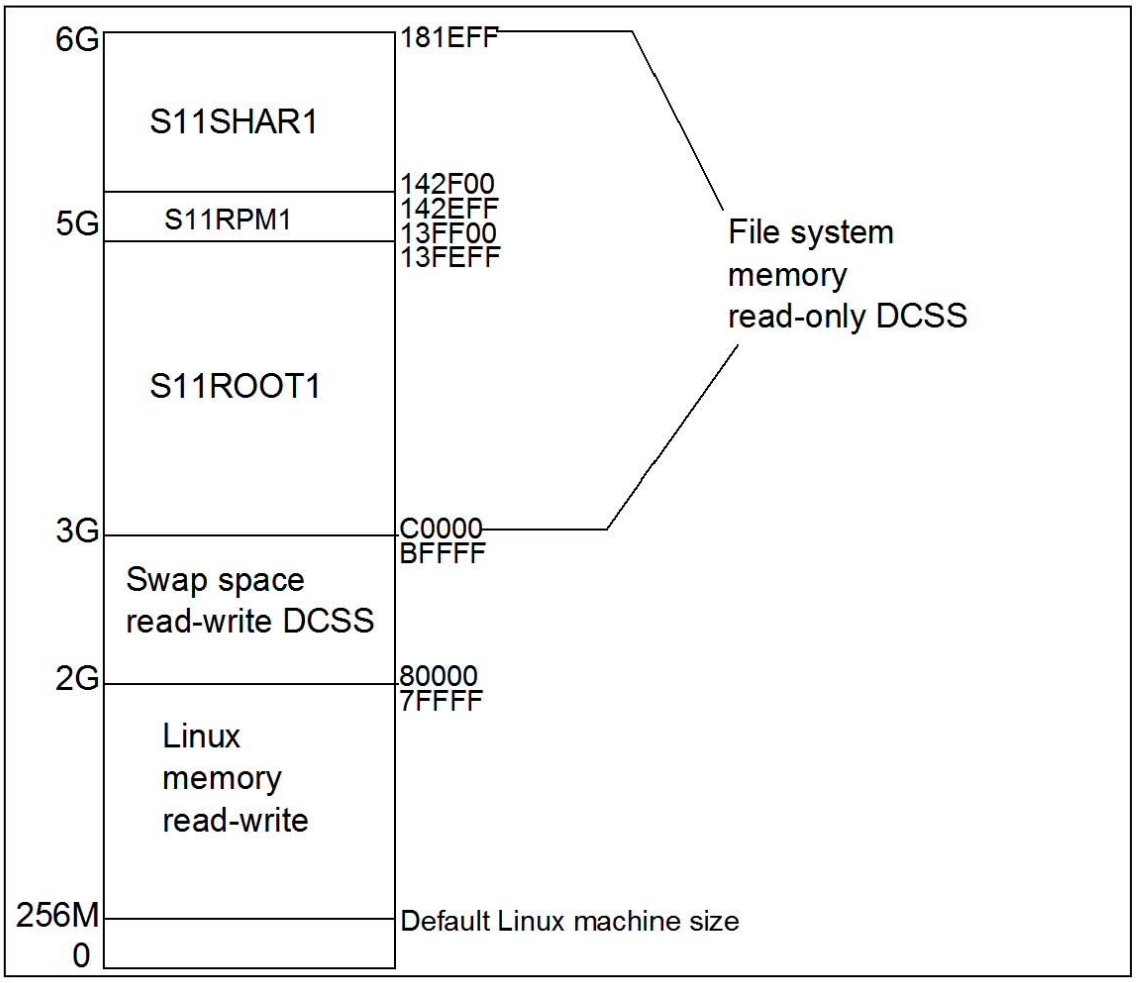
The size the DCSS swap space and file systems must be chosen. DCSS ranges are expressed as the hexadecimal (base 16) number of 4KB (2**12) pages. To do hexadecimal math, sometimes a *cheat sheet* is helpful:

Number of 4KB pages	**Size in powers of two**	**Size in KB, MB, GB**
1	2**12	4K
10	2**16	64K
100	2**20	1M
1000	2**24	16M
10000	2**28	256M
100000	2**32	4G

The following sizes for the DCSSs are chosen for this paper:

DCSS name	**Size**	**Range in 4KB pages**	**Description**
SWAPPING	1G	`80000-BFFFF`	DCSS for swapping
S11ROOT1	2047M	`C0000-13FEFF`	Largest possible single DCSS for the root file system
S11RPM1	64M	`13FF00-142EFF`	Small DCSS for the RPM database in **/var/lib/rpm/**.
S11SHAR1	1G	`142F00-181EFF`	DCSS for the **/usr/share/** file system

The following figure shows the memory footprint for Linux main memory and DCSSs used in this paper. A default virtual machine size of 256M is chosen for most Linux systems. “Headroom” is left to move the machine size up to 2GB. A 1GB swap space is used for between 2 and 3 GB. Between 3 and just about 5 GB, the largest size DCSS is used for the root file system. A small 64 MB DCSS is used for the **/var/lib/rpm/** file system. Finally, a 1GB DCSS is used for **/usr/share/**.



Linux memory footprint

Section 5: Creating a read-write cloning system

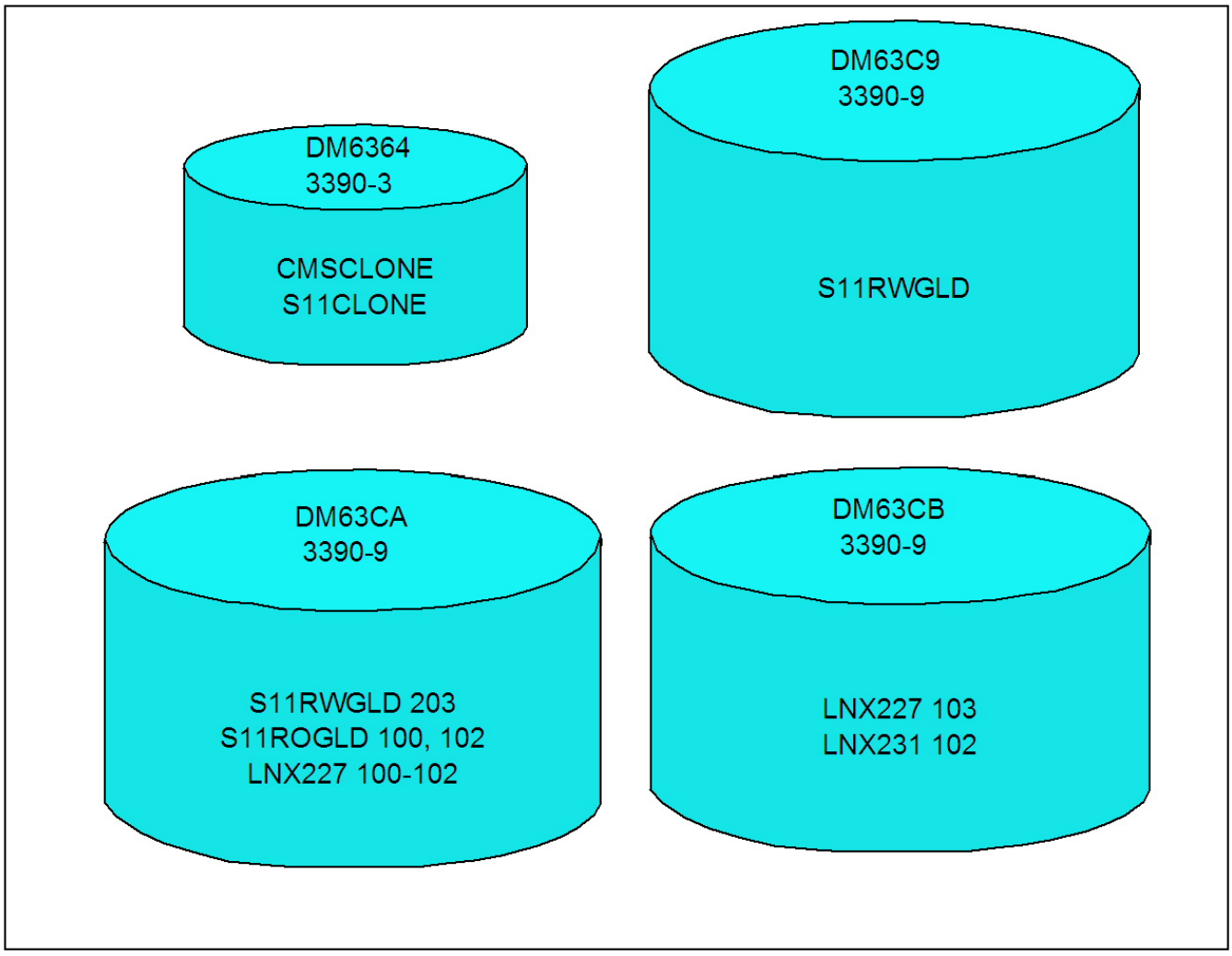
The steps to create a read-write system that can be cloned are as follow:

1) Plan Linux disks
2) Plan page and spool space for z/VM
3) Create the first z/VM user IDs
4) Download the associated tar file
5) Populate the disks on CMSCLONE
6) Install SLES 11 onto S11RWGLD – the golden image
7) Install and customize SLES 11 onto S11CLONE – the "cloner"
8) Create a DCSS for a swap space
9) Customize Linux on the golden image
10) Backup the golden image

11) Clone Linux

5.1 Disk planning

One 3390-3 and three 3390-9s are initially used. Following is a diagram that shows the user IDs, mindisks and volsers:



Initial disk layout

5.2 Page and spool space planning

Because DCSSs are often backed by spool space, additional spool space will be needed. Also, adequate page space will be needed, as usual. When z/VM is installed onto 3390-3s, one of the five volumes is for spool space and one is for page space. This will not be enough space.

On the z/VM system used to write this paper, two spool volumes were added – a 3390-3 and a 3390-9. This provided a total size of about 11GB of spool space. After setting up the system, 67% of it was being used:


```
==> q alloc spool
                EXTENT     EXTENT  TOTAL  PAGES   HIGH    %
VOLID  RDEV      START        END  PAGES IN USE   PAGE USED
------ ---- ---------- ---------- ------ ------ ------ ----
DV6153 6153          1       3338 600840 504831 562320  84%
DS61A0 61A0          0      10016  1761K   996K  1694K  56%
DS632F 632F          0       3338 601020 504068 530640  83%
                                  ------ ------        ----
SUMMARY                            2934K  1981K         67%
USABLE                             2934K  1981K         67%
```

A second 3390-3 volume was added for more page space. A total of 54% was being used when measured. In general, the amount of page space should not go much over 50%, or adding more spool space should be considered.

```
==> q alloc page
                EXTENT     EXTENT  TOTAL  PAGES   HIGH    %
VOLID  RDEV      START        END  PAGES IN USE   PAGE USED
------ ---- ---------- ---------- ------ ------ ------ ----
DV6154 6154          1       3338 600840 319460 565362  53%
DP632E 632E          0       3338 601020 330539 601019  54%
                                  ------ ------        ----
SUMMARY                            1174K 649999         54%
USABLE                             1174K 649999         54%
```

5.3 Defining z/VM virtual machines

Note to implementors: If you're implementing this environment, you will probably have the urge to change minidisk sizes, file system layouts, or other configurations. Please resist this urge :)) Some of the associated files rely on this specific setup and changing settings is likely to prevent the read-only golden image from running. Get the system working once, then you can throw it out, change settings and tailor it to your liking.

One user directory PROFILE, named **LNXDFLT**, is created to be used by all Linux systems. Each Linux system will get a virtual NIC starting at virtual address 0600 that will attach to the virtual switch named **VSW1**:

```
PROFILE LNXDFLT
   CPU 00 BASE
   CPU 01
   IPL CMS
   MACHINE ESA 4
   CONSOLE 0009 3215 T
   NICDEF 0600 TYPE QDIO LAN SYSTEM VSW1
   SPOOL 000C 2540 READER *
   SPOOL 000D 2540 PUNCH A
   SPOOL 000E 1403 A
   LINK MAINT 0190 0190 RR
   LINK MAINT 019D 019D RR
   LINK MAINT 019E 019E RR
   LINK CMSCLONE 0192 0191 RR
   LINK TCPMAINT 0592 0592 RR
```

For reference, following is VSWITCH definition statement in the SYSTEM CONFIG file. It defines the VSWITCH named VSW1 using OSA real devices starting at address 1004 (primary) and 1100 (for failover):

```
/* define a VSWITCH */
define vswitch vsw1 rdev 1004 1100
```

Four user IDs are defined.

1. The CMSCLONE 192 disk will become the Linux user ID's read-only 191 disk. Also the 192 disk will contain the install files for SLES 11 (kernel, parameter file initial RAMdisk).
2. The S11CLONE user ID is given a single minidisk onto which Linux will be installed. Its main purpose is to run shell scripts, so only a minimal installation is required. It needs B privilege class to invoke FLASHCOPY and E privilege class to save DCSSs
3. The S11RWGLD user ID is the *golden image*. It is given four minidisks 100-103 for the primary golden image, and three more, 200-203 for a backup copy.
4. The S11ROGLD user id is given a 100 minidisk for the **/boot/** file system, and a 102 for **/usr/local/**, but it does not require a 101 nor a 103 minidisk because the file systems will be stored in DCSSs. It needs E privilege class to create an NSS.

Following are the directory entries:

```
USER CMSCLONE PASSWD 64M 128M G
   INCLUDE IBMDFLT
   IPL CMS
   MACHINE ESA 4
   OPTION APPLMON
   MDISK 0191 3390 0001 0030 DM6364 MR PASSWD PASSWD PASSWD
   MDISK 0192 3390 0031 0100 DM6364 MR ALL PASSWD PASSWD
*
USER S11CLONE PASSWD 256M 8G BEG
   INCLUDE LNXDFLT
   OPTION APPLMON LNKNOPAS
   MDISK 0100 3390 0131 3208 DM6364 MR PASSWD PASSWD PASSWD
*
USER S11RWGLD PASSWD 1G 2G G
   INCLUDE LNXDFLT
   OPTION APPLMON
   MDISK 0100 3390 0001 0060 DM63C9 MR PASSWD PASSWD PASSWD
   MDISK 0101 3390 0061 1609 DM63C9 MR PASSWD PASSWD PASSWD
   MDISK 0102 3390 1670 1669 DM63C9 MR PASSWD PASSWD PASSWD
   MDISK 0103 3390 3339 3338 DM63C9 MR PASSWD PASSWD PASSWD
   MDISK 0200 3390 6677 0060 DM63C9 MR PASSWD PASSWD PASSWD
   MDISK 0201 3390 6737 1609 DM63C9 MR PASSWD PASSWD PASSWD
   MDISK 0202 3390 8346 1669 DM63C9 MR PASSWD PASSWD PASSWD
   MDISK 0203 3390 0001 3338 DM63CA MR PASSWD PASSWD PASSWD
*
USER S11ROGLD PASSWD 256M 2G EG
   INCLUDE LNXDFLT
   OPTION APPLMON
   MDISK 0100 3390 3339 0060 DM63CA MR PASSWD PASSWD PASSWD
   MDISK 0102 3390 3399 1669 DM63CA MR PASSWD PASSWD PASSWD
```

For the new virtual machines to be able to access the VSWITCH, the following commands are added to the PROFILE EXEC on AUTOLOG1:

```
'cp set vswitch vsw1 grant s11clone'
'cp set vswitch vsw1 grant s11rwgld'
'cp set vswitch vsw1 grant s11rogld'
```

These three commands are also run interactively to take effect for the current z/VM session.

5.4 Downloading the associated tar file

The tar file associated with this paper is available at:

http://ibm.com/vm/linux/dcss/ror-s11.tgz

It is downloaded to a Linux or UNIX machine and untarred. The z/VM files are needed before the first Linux system is installed. Later, the tar file is copied to the Linux worker system running on S11CLONE.

Download the tar file to the **/tmp/** directory of any Linux or UNIX system. Untar and uncompress the tar file with the **tar** command:

```
# cd /tmp
# tar xzvf ror-s11-S11.tgz
README.txt
sbin/
sbin/boot.rootfsck.S11
sbin/rwtab.S11
sbin/cloneprep.sh
sbin/clonerw.sh
sbin/rw2ro.sh
sbin/boot.findself
sbin/bak2pri.sh
sbin/pri2bak.sh
sbin/fstab.S11
sbin/rorfuncs.sh
sbin/readonly-root.S11
sbin/clonero.sh
vm/
vm/sles11.exec
vm/sample.parm-s11
vm/profile.exec
vm/profile.xedit
```

You should now have access to the files associated with this paper.

5.5 Populating the disks on CMSCLONE

Log on to the new CMSCLONE user ID. Format the 191 and 192 disks for CMS using the **FORMAT** command.

Copy the following files to the CMSCLONE 192 disk. These files will be available to each Linux virtual machine as its 191 or A disk. The first four files are in the tar file associated with this paper. The last two files are on the SLES 11 install media:

PROFILE EXEC	An initialization file for each Linux to boot it from minidisk 100 or an NSS
PROFILE XEDIT	An XEDIT initialization file similar to that on the MAINT 191 disk
SAMPLE PARM-S11	A sample SLES 11 parameter file
SLES11 EXEC	An EXEC to invoke the SLES 11 installation program
SLES11 KERNEL	The SLES 11 kernel - in the SLES 11 install media at **/boot/s390x/vmrdr.ikr**.
SLES11 INITRD	The SLES 11 initial RAMdisk – in the SLES 11 install media at **/boot/s390x/initrd**.

Following is a sample FTP session shown moving the files from the associated tar file. In this example the IP address of the z/VM system is 9.60.18.141:

```
# cd /tmp/vm
# ftp 9.60.18.141
...
```

```
Name (9.60.18.141:root): cmsclone
331 Send password please.
Password:
230 CMSCLONE logged in; working directory = CMSCLONE 191
Remote system type is z/VM.
ftp> cd cmsclone.192
...
ftp> mput *
mput profile.exec [anpqy?]? a
...
125 Storing file 'profile.exec'
...
125 Storing file 'profile.xedit'
...
125 Storing file 'sample.parm-s11'
...
125 Storing file 'sles11.exec'
...
ftp> quit
```

5.6 Installing SLES 11 onto S11RWGLD

Install a Linux system into the S11RWGLD virtual machine. This will become the Linux *golden image*.

Before starting the install process, set up an NFS install server. Mount the ISO image of DVD1 loopback over a directory and export that directory. In this paper, the NFS server is running with the IP address of 9.60.18.133, the ISO image of SLES 11 is stored in **/nfs/sles11/** and the exported directory is **/nfs/sles11/dvd1**

The SLES 11 kernel and initial RAMdisk are in the **boot/** directory on the DVD. Use FTP to copy them to the CMSCLONE 192 disk as the files **SLES11 KERNEL** and **SLES11 INITRD**. Don't forget to transfer them in binary mode, with fixed-record 80 byte blocks. This can usually be accomplished by the FTP sub-commands **bin** and **site fix 80** (or **quote site fix 80**).

- Following is a sample FTP session of SLES 11 kernel and RAMdisk from the installation media to the CMSCLONE 192 disk. In this example the IP address of the z/VM system is ***9.60.18.141***:

  ```
  # cd /nfs/sles11/dvd1/boot/s390x
  # ftp 9.60.18.141
  Name (9.60.18.141:root): cmsclone
  Password:
  ftp> cd cmsclone.192
  ftp> bin
  200 Representation type is IMAGE.
  ftp> site fix 80
  200 Site command was accepted.
  ftp> put vmrdr.ikr sles11.kernel
  ...
  ftp> put initrd sles11.initrd
  ...
  ftp> quit
  ```

- Start a 3270 session and log on as CMSCLONE. Copy the SAMPLE PARM-S11 file to S11RWGLD PARM-S11.

  ```
  ==> copy sample parm-s11 d s11rwgld = =
  ```

- Configure the new file with the correct IP and DNS information on the CMSCLONE 192 disk. Following is the example used in this paper:

  ```
  ==> xedit s11rwgld parm-s11 d
  ```



```
ramdisk_size=65536 root=/dev/ram1 ro init=/linuxrc TERM=dumb
HostIP=9.60.18.222 Hostname=gpok222.endicott.ibm.com
Gateway=9.60.18.129 Netmask=255.255.255.128
Broadcast=9.60.18.255 Layer2=0
ReadChannel=0.0.0600  WriteChannel=0.0.0601  DataChannel=0.0.0602
Nameserver=9.0.2.11
portname=whatever
portno=0
Install=nfs://9.60.18.133/nfs/sles11/dvd1
UseVNC=1  VNCPassword=12345678
InstNetDev=osa OsaInterface=qdio OsaMedium=eth Manual=0
```

- Log on to the S11RWGLD virtual machine. Watch for error messages about minidisks or the VSWITCH. You should see the PROFILE EXEC run that you copied to the CMSCLONE 192 disk:

```
00: NIC 0600 is created; devices 0600-0602 defined
00: z/VM Version 5 Release 4.0, Service Level 0801 (64-bit),
00: built on IBM Virtualization Technology
00: There is no logmsg data
00: FILES: 0003 RDR,   NO PRT,   NO PUN
00: LOGON AT 12:15:50 EST THURSDAY 11/05/09
z/VM V5.4.0    2008-10-22 15:36

DMSACP723I A (191) R/O
DMSACP723I C (592) R/O
00: DASD 0100 3390 DM63C9 R/W         60 CYL ON DASD  63C9 SUBCHANNEL = 0000
Do you want to IPL Linux from 100? y/n
n
```

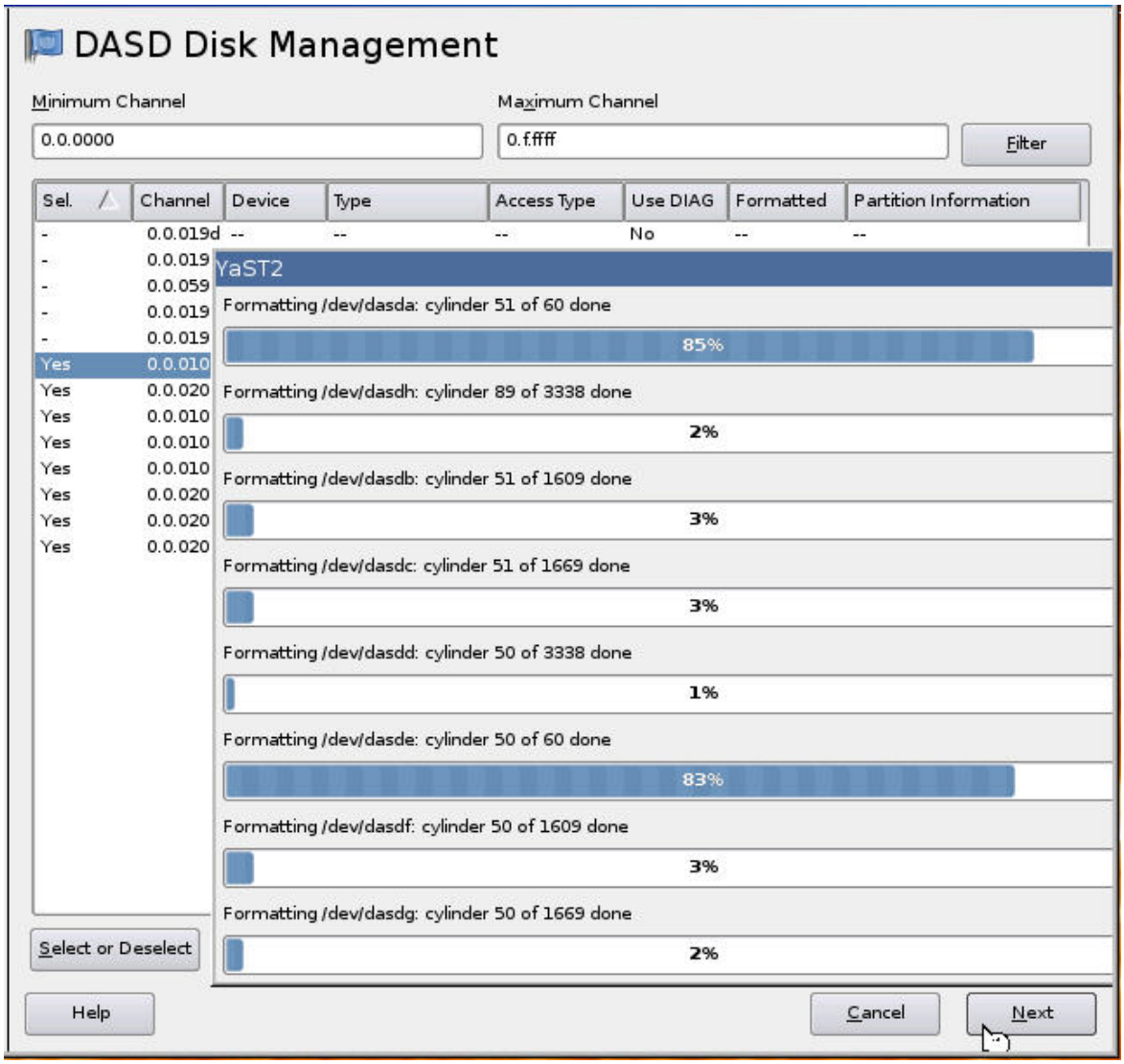
- Verify the machine size is 1GB. If it is not, set it to 1GB with the CP command **DEF STOR 1G**.

```
==> q stor
00: STORAGE = 1G
```

- Install a minimal SLES 11 system by starting the installation with the **SLES11 EXEC**.

```
==> sles11
00: 0000003 FILES PURGED
00: RDR FILE 0004 SENT FROM S11RWGLD PUN WAS 0004 RECS 085K CPY  001 A NOHOLD NO
KEEP
00: RDR FILE 0005 SENT FROM S11RWGLD PUN WAS 0005 RECS 0011 CPY  001 A NOHOLD NO
KEEP
00: RDR FILE 0006 SENT FROM S11RWGLD PUN WAS 0006 RECS 161K CPY  001 A NOHOLD NO
KEEP
00: 0000003 FILES CHANGED
00: 0000003 FILES CHANGED
Initializing cgroup subsys cpuset
Initializing cgroup subsys cpu
Linux version 2.6.27.19-5-default (geeko@buildhost) (gcc version 4.3.2 Ýgcc-4_3-
branch revision 141291¨ (SUSE Linux) ) #1 SMP 2009-02-28 04:40:21 +0100
setup.1a06a7: Linux is running as a z/VM guest operating system in 64-bit mode
...
```

- Start a VNC client to the install program.
- Accept the license agreement.
- Activate and format eight disks, 100-103 and 200-203. The following figure shows the disks being formatted:

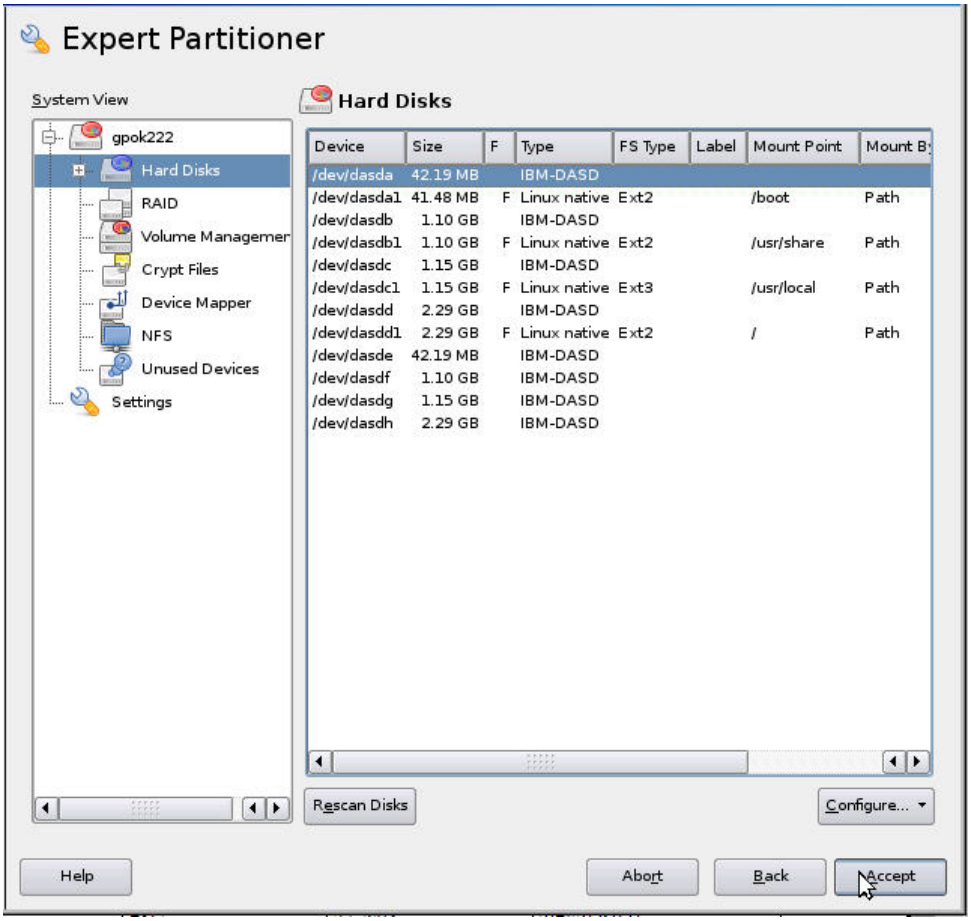


Activating and formatting eight minidisks

In the *Installation Settings* window, select **Partitioning**. Create the following partitions:

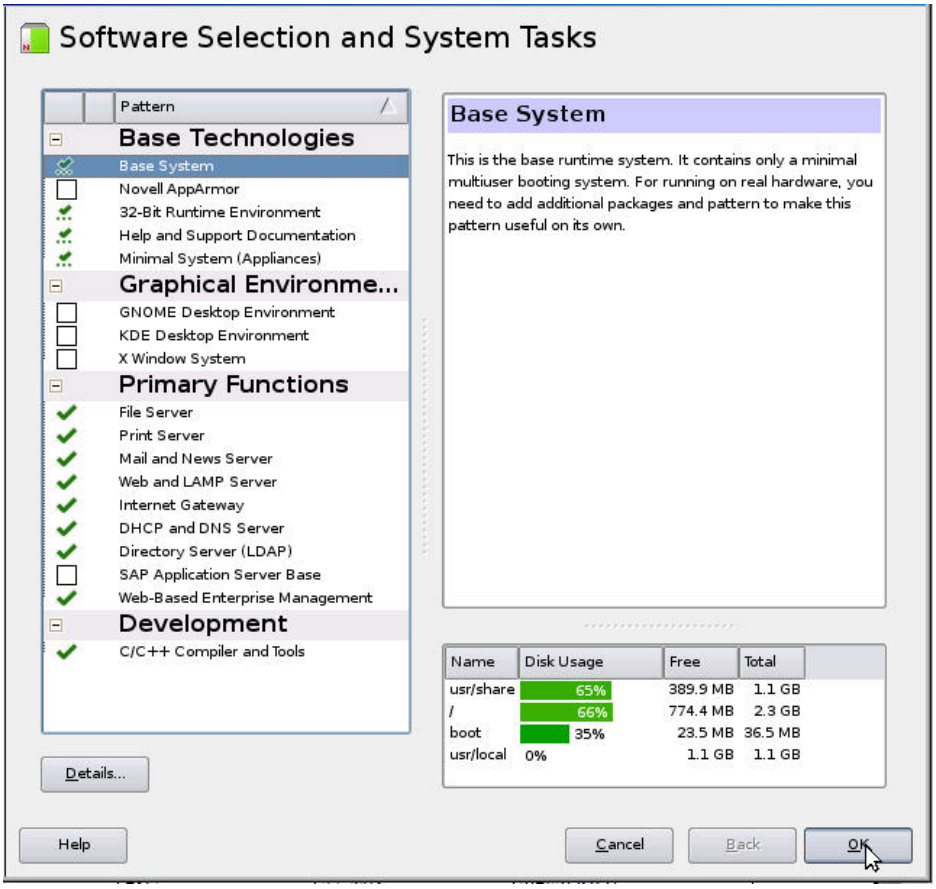
Minidisk	File System	File System type	Disk
100	**/boot/**	ext2	/dev/dasda
101	**/usr/share/**	ext2	/dev/dasdb
102	**/usr/local/**	ext3	/dev/dasdc
103	/	ext2	/dev/dasdd

Following is a summary of the Expert Partitioner screen:



Partitioning disks

Following is a summary of the software. All selections on the *Graphical Environment* package group are deselected. Most of the *Primary Functions* and *Development* package groups are selected. This is so each of the clones will have a good array of tools standard. The following figure shows the *Software Selection* choices:



Software selection

After the first half of the install completes, the new system is now automatically IPLed from 100 (with SLES 10 and earlier distributions, this step was manual). Complete the second half of the install using the following notes:

- On the *Host and Domain Name* panel, deselect the box **Change Hostname via DHCP**.
- On the *Network Configuration* panel, set the Firewall to be **disabled**.
- On the *Test Internet Connection* panel, the box **No, Skip This Test** was selected due to firewalls.
- On the *Installation Overview* panel, turn off the OpenLDAP Server (**Don't use LDAP**).
- On the *Installation Completed* panel, deselect the check box **Clone This System for Autoyast**.

When the installation process completes, the “golden” Linux image should now be installed.

5.6.0.1 Analyzing the new system

Start an SSH session as root to the golden image. Query the file systems with the **df -h** command:

```
# df -h
Filesystem            Size  Used Avail Use% Mounted on
/dev/dasda1           2.3G  1.7G  521M  77% /
udev                  499M  132K  499M   1% /dev
/dev/dasdb1            40M   14M   24M  37% /boot
/dev/dasdd1           1.2G   34M  1.1G   4% /usr/local
/dev/dasdc1           1.1G  764M  289M  73% /usr/share
```


The read-write file systems **/root/**, **/srv/** and **/var/** will later be copied to **/usr/local/** on the read-only root clones. Right now, those file systems occupy only about 70MB of disk space:

```
# du -sm /root /srv /var
1       /root
1       /srv
69      /var
```

This system will be the *golden image* and the basis for both the read-write and the read-only clones.

5.7 Installing and customizing SLES 11 onto S11CLONE

On the S11CLONE virtual machine, install a SLES 11 system onto a single minidisk at virtual device 100. To do this, perform the following steps. The high level steps are listed here, but cookbook-style details are not:

- Create a parameter file, S11CLONE PARM-S11 on the CMSCLONE 192 disk.
- Set the IP address and host name.
- Give the virtual machine access to the VSWITCH.
- Set the virtual storage of the S11CLONE virtual machine to 1G (**Important**: Don't forget the **DEF STOR 1G** command or the SLES 11 installation will most likely fail!)
- Start the install process with the **SLES11 EXEC**.
- Format just the 100 minidisk.
- Install a minimal system (**Base System** and **Minimal System (Appliances)**) with a single root file system.

Then make the following customizations (additional details follow):

- Upgrade the Linux kernel (Don't forget to run **zipl** afterwards)
- Copy and unwind the tar file associated with this paper.
- Set the **cmm**, **vmcp** and **dcssblk** modules to load at boot time.
- Pass parameters to the **dcssblk** module.

5.7.1 Upgrading the Linux kernel

The default SLES 11 kernel must be upgraded. There appears to be a bug in the default 2.6.27.19 kernel. One of the manifestations of this bug is that the kernel can freeze the entire system when a disk is being deactivated with the **chccwdev -d** command.

Check the default level of the kernel in SLES 11 with the **rpm** command:

```
# rpm -qa | grep kernel
kernel-default-base-2.6.27.19-5.1
kernel-default-2.6.27.19-5.1
```

This shows the kernel is at the 2.6.27.19 level.

If you have access to the upgrade RPMs, the following five RPMs can be updated with the **rpm -Uvh** command:

```
kernel-default-2.6.27.29-0.1.1.s390x.rpm
kernel-default-base-2.6.27.29-0.1.1.s390x.rpm
kernel-default-man-2.6.27.29-0.1.1.s390x.rpm
module-init-tools-3.4-70.5_70.6.1.s390x.delta.rpm
module-init-tools-3.4-70.6.1.s390x.rpm
```

For this paper, the kernel was upgraded by adding an additional software repository through **yast**. This software repository is maintained at the corporate level and includes the latest maintenance. You may choose another method of upgrading the kernel.

- Invoke the **yast** command then choose **Software** => **Software Repositories** on the main screen.
- Use the **Tab** key to move to **Add**.
- Access the repository through FTP by selecting **FTP...** then **Next**.
- The software repository added in this example was on the server named **ftp3.linux.ibm.com** and the directory was **suse/catalogs/SLES11-Updates/sle-11-s390x**. The repository was accessed through FTP and the credentials were also included:

```
Server and Directory
 ...
Repository Name
_____________________________________________________________________________
              (x) Edit Parts of the URL  ( ) Edit Complete URL
 ┌Protocol──────────────────────────────────────────────────────────────────┐
 │       (x) FTP       ( ) HTTP       ( ) HTTPS       ( ) SMB/CIFS        │
 └──────────────────────────────────────────────────────────────────────────┘
Server Name
ftp3install.linux.ibm.com_____________________________________________________
Directory on Server
suse/catalogs/SLES11-Updates/sle-11-s390x_____________________________________
 ┌Authentication────────────────────────────────────────────────────────────┐
 │[ ] Anonymous                                                             │
 │User Name                                                                 │
 │mikemac___________________________________________________________________│
 │Password                                                                  │
 │******____________________________________________________________________│
 └──────────────────────────────────────────────────────────────────────────┘
```

- Tab to **Next** and the repository should be added.
- Select **OK**.

Now that the SLES 11 updated repository is being pointed at, **yast** can again be used to update the kernel:

- Choose **Software** => **Software Management** on the main screen.
- Enter a *Search Phrase* of **kernel-default**. Three items should be found.
- Press the space bar to select **kernel-default**, **kernel-default-base** and **kernel-default-man**.
- Reboot the system – mkinitrd and zipl are not needed :

```
# shutdown -r now

Broadcast message from root (pts/0) (Fri Sep 11 15:16:22 2009):

The system is going down for reboot NOW!
```

- After the system comes back start an SSH session as root. Use the **rpm** command to show the updated kernel:

```
# rpm -qa | grep kernel
kernel-default-man-2.6.27.42-0.1.1
kernel-default-2.6.27.42-0.1.1
kernel-default-base-2.6.27.42-0.1.1
```


5.7.2 Copying the files associated with this paper

Earlier you staged the tar file on another Linux or UNIX system to copy the z/VM files. Copy the tar file **ror-s11.tgz** to **/usr/local/** on the S11CLONE machine and untar it.

```
# cd /usr/local
...Copy the tar file ...
# tar xzvf ror-s11.tgz
README.txt
sbin/
sbin/boot.rootfsck.S11
sbin/rwtab.S11
sbin/cloneprep.sh
sbin/clonerw.sh
sbin/rw2ro.sh
sbin/boot.findself
sbin/bak2pri.sh
sbin/pri2bak.sh
sbin/fstab.S11
sbin/rorfuncs.sh
sbin/readonly-root.S11
sbin/clonero.sh
vm/
vm/sles11.exec
vm/sample.parm-s11
vm/profile.exec
vm/profile.xedit
```

The files in the **sbin/** sub-directory will be used in the construction of the read-only root system.

The files staged on the initial Linux or UNIX system are no longer needed.

5.7.3 Setting kernel modules to be loaded

Two modules are set to be loaded at boot time:

1. The **cmm** module in conjunction with configuration changes on z/VM allows possible significant performance gains.
2. The **vmcp** module allows CP commands to be issued from Linux.

One module is set to be built into the initial RAMdisk: the **dcssblk** module allows System z Linux to utilize DCSSs for swap spaces and file systems.

The modules are added to the file **/etc/sysconfig/kernel**:

```
# cd /etc/sysconfig
# vi kernel           // modify two lines ...
## Path:        System/Kernel
## Description:
## Type:        string
## Command:     /sbin/mkinitrd
#
# This variable contains the list of modules to be added to the initial
# ramdisk by calling the script "mkinitrd"
# (like drivers for scsi-controllers, for lvm or reiserfs)
#
INITRD_MODULES="jbd ext3 dcssblk"

## Type:        string
## Command:     /sbin/mkinitrd
```



```
#
# This variable contains the list of modules to be added to the initial
# ramdisk that is created for unprivilegd Xen domains (domU); you may need
# drivers for virtual block and network devices in addition to filesystem
# and device-mapper modules.
#
DOMU_INITRD_MODULES="xennet xenblk"

## Type:               string
## ServiceRestart:     boot.loadmodules
#
# This variable contains the list of modules to be loaded
# once the main filesystem is active
# You will find a few default modules for hardware which
# can not be detected automatically.
#
MODULES_LOADED_ON_BOOT="cmm vmcp"
...
```

5.7.4 Setting the dcssblk module parameter

Add a line to **/etc/modprobe.conf.local** specifying the name of the parameters passed to the **dcssblk** driver. The DCSSs will be named **SWAPPING**, **S11ROOT1**, **S11RPM1** and **S11SHAR1**:

```
# cd /etc
# vi modprobe.conf.local
#
# please add local extensions to this file
#
options dcssblk "segments=SWAPPING,S11ROOT1,S11RPM1,S11SHAR1"
```

Bring these changes online:

```
# mkinitrd

Kernel image:   /boot/image-2.6.27.29-0.1-default
Initrd image:   /boot/initrd-2.6.27.29-0.1-default
Root device:    /dev/disk/by-path/ccw-0.0.0100-part1 (/dev/dasda1) (mounted on / as ext3)
Kernel Modules: jbd mbcache ext3 dcssblk dasd_mod dasd_eckd_mod
Features:       block dasd
14538 blocks
...
# zipl
...
```

Shutdown the Linux system:

```
# shutdown -h now
...
```

The Linux system running on the S11CLONE user ID should now be configured.

5.8 Creating a DCSS for swapping

DCSSs can provide a fast *device* for swapping when a guest is memory constrained but z/VM is not. It allows the reduction of guest virtual memory size while maintaining acceptable performance for peak workloads (move overcommitment to guest level). It can provide lower overhead than VDISKs as the data movement is all done by the guest without interaction with the hypervisor. It also avoids the expense of building I/O programs since it is a memory-to-memory move. Because of these efficiencies, a higher swap rate can be achieved with a DCSS swap device than a VDISK swap device.

Important - swap to VDISKs or DCSSs?

Other publications recommend using VDISK for swap spaces, for example, the Redbook *z/VM and Linux on IBM System z: The Virtualization Cookbook for SLES 10 SP2*, on the Web at :

http://www.redbooks.ibm.com/abstracts/sg247493.html

DCSSs can offer better performance as just described, especially when significant swapping occurs (1000s per second). However, there are potential downsides to swapping to DCSS, as doing so can:

- Increase the negative effect of Page Reorder. Processing can cause delays where the virtual machine appears to not run for a period of time. This is a result of increasing the number of private pages associated with the virtual machine that would potentially come into play with Reorder processing.
- Increase the negative effect of demand scan being handled in the Emergency Pass due to virtual machines not going to the z/VM dormant list even when they have no real work to do. This increase is a result of additional pages being associated with the virtual machine as opposed to being in a separate virtual address space as a VDISK would be.
- Remove the ability from z/VM monitoring to determine how much memory is required for the virtual machine, how much swapping space is actively being used, and swapping activity. In a VDISK environment, one would see z/VM data that shows both the VDISK activity and the virtual machine memory usage. In the DCSS case, only the virtual machine memory usage would be shown and you cannot differentiate between the swap DCSS and the normal virtual machine memory.

As a result of these factors and others, VDISKs are recommended for swapping unless a small virtual machine, as seen in the example, is acceptable and it is not running software that prohibits the virtual machine from going to the dormant list, and there is no desire to view details of swapping from z/VM performance tools.

The SLES install process does not recognize DCSS devices at install-time. Thus, these steps are done after the installation.

The **dcssblk** device driver now supports mixed EW/EN segments. EW means exclusive read/write access and EN means exclusive read/write access, no data saved.

The overall steps to creating a DCSS swap space are as follows:

1) Define a DCSS name SWAPPING from CMS
2) Boot Linux to prepare loading the new DCSS
3) Reboot Linux to load the new DCSS
4) Create a swap space on the DCSS
5) Add the swap space to the system on S11CLONE
6) Prepare the golden image for the swap space
7) Reboot the golden image to load the swap space

5.8.1 Defining a DCSS for swapping

To define a DCSS for a swap space, perform the following steps:

- Log on to S11CLONE. Do not IPL Linux. Set the storage to 3GB so the swap space DCSS can be addressed. Then reIPL CMS:

```
==> def stor 3G
00: STORAGE = 3G
00: Storage cleared - system reset.
==> ipl cms
IPL CMS
z/VM V5.4.0    2008-10-22 15:36

DMSACP723I A (191) R/O
DMSACP723I C (592) R/O
Do you want to IPL Linux from DASD 100? y/n
n
```

- Define a 1 GB DCSS named **SWAPPING** using the **DEFSEG** command:

```
==> defseg swapping 80000-80000 ew 80001-bffff en
00: HCPNSD440I Saved segment SWAPPING was successfully defined in fileid 0076.
```

  The first page (80000) is writable so the swap signature can be written to it. The rest of the DCSS is used for the swap data, so it never has to be saved.

- Save the segment with the **SAVESEG** command:

```
===> saveseg swapping
00: HCPNSS440I Saved segment SWAPPING was successfully saved in fileid 0176.
```

- Query the new DCSS:

```
==> q nss name swapping map
00: FILE FILENAME FILETYPE BEGPAG         ENDPAG         TYPE CL #USERS
00: 0176 SWAPPING DCSSG    0000000080000  0000000080000   EW  A  00000
00:                        0000000080001  00000000BFFFF   EN
```

The DCSS for Linux swap spaces is now defined. Any Linux virtual machine will be able to use it.

5.8.2 Booting Linux to load the new DCSS

To boot Linux, perform the following steps:

- Reset the virtual machine size to 256M, then start Linux.

```
==> def stor 256m
00: STORAGE = 256M
00: Storage cleared - system reset.
==> ipl 100
...
```

- When the system comes up, start an SSH session as root. Query that the DCSS named SWAPPING was loaded:

```
# ls /sys/devices/dcssblk
SWAPPING  add  remove  uevent
```

You should see a file named **SWAPPING**. This shows that the swap space was loaded by the **dcssblk** driver. If not, then you must determine what went wrong.

Note: When booting this system, it may take a number of minutes to load the DCSSs. The boot process may appear to freeze

at this point:

```
...
Freeing initrd memory: 2842k freed
audit: initializing netlink socket (disabled)
type=2000 audit(1265918190.194:1): initialized
HugeTLB registered 1 MB page size, pre-allocated 0 pages
```

5.8.3 Creating a swap space on the DCSS

It is recommended that you run the following commands from a 3270 emulator session as additional informational messages are sent to the console.

- Create a swap space on the new DCSS using the **mkswap** command:

```
# mkswap /dev/dcssblk0
Setting up swapspace version 1, size = 1048572 KiB
no label, UUID=6dc50623-2430-42fa-93b8-aa67625990e0
```

- Save the swap space. You should see messages on the console informing you of the DCSS file ID that is saved. In this example it is 177:

```
# echo 1 > /sys/devices/dcssblk/SWAPPING/save
00: HCPNSD440I Saved segment SWAPPING was successfully defined in  fileid 0177.
00: HCPNSS440I Saved segment SWAPPING was successfully saved in fileid 0177.
dcssblk.9a4530: All DCSSs that map to device SWAPPING are saved
```

It is important to note that the **mkswap** command need only be performed once. The swap signature is written to the DCSS and is then memory mapped to each Linux virtual machine that loads it using the **dcssblk** driver.

5.8.4 Adding the swap space to S11CLONE

Perform the following steps to add the swap space to the golden image:

- Backup the **/etc/fstab** file, then add a line to it to specify that a swap space is at **/dev/dcssblk0** :

```
# cd /etc
# cp fstab fstab.orig
# vi fstab
/dev/disk/by-path/ccw-0.0.0100-part1 /           ext3       acl,user_xattr        1 1
/dev/dcssblk0        swap                swap       defaults              0 0
proc                 /proc               proc       defaults              0 0
sysfs                /sys                sysfs      noauto                0 0
debugfs              /sys/kernel/debug   debugfs    noauto                0 0
devpts               /dev/pts            devpts     mode=0620,gid=5       0 0
```

- Test the addition to **/etc/fstab** with the **swapon** command. The first **swapon -s** command shows that there is no swap space. The **swapon -a** command turns all swap spaces on, so the **/etc/fstab** file is read. The second **swapon -s** command shows that the DCSS swap space is now active.

```
# swapon -s
Filename                                Type            Size    Used    Priority
# swapon -a
# swapon -s
Filename                                Type            Size    Used    Priority
/dev/dcssblk0                           partition       2096120 0       -1
```

- Reboot the system to verify that the swap space is also loaded at boot time:

```
# reboot
...
```

- When the system comes back start an SSH session as root. The **swapon -s** command should show that the swap space is active:

```
# swapon -s
Filename                                Type            Size    Used    Priority
/dev/dcssblk0                           partition       2096120 0       -1
```

The Linux system on S11CLONE should now be customized with a DCSS swap space.

5.9 Customizing the golden image on S11RWGLD

The following configuration changes to the golden image on S11RWGLD are recommended:

- Upgrade the kernel
- Change the parameter line and menu delay in **/etc/zipl.conf**.
- Install the CMS file system (**cmsfs**) package.
- Set additional kernel modules to be loaded at boot time.
- Set the parameters to be passed to the **dcssblk** driver
- Set the system to halt when z/VM is shut down, and set the default run level to 3.
- Update **/etc/fstab** with a swap space and a **/tmp/** file system of type tmpfs
- Copy some scripts used later for cloning and read-only root systems.
- Optionally, create mount points under **/opt/** for the possibility of mounting middleware.

Note to implementers: Again, please resist the urge to add or delete steps. Certain steps such as modifying zipl.conf, adding the cmsfs package, loading the vmcp module, and copying boot.findself are required for the entire solution to work.

5.9.1 Upgrading the kernel

To upgrade the kernel, perform the following steps

- Start an SSH session to the golden image (S11RWGLD). Observe the kernel level:

```
# uname -a
Linux gpok222 2.6.27.19-5-default #1 SMP 2009-02-28 04:40:21 +0100 s390x s390x s390x
GNU/Linux
```

- Upgrade the kernel as described in section 5.7.1, Upgrading the Linux kernel on page 19. In this example, it is upgraded to 2.6.27.42. The commands **mkinitrd** and **zipl** should be automatically run as part of the RPM upgrade so they don't have to be run separately. Reboot the system

```
# reboot
...
```

- Start a new SSH session when the system comes back up. Verify the upgrade is complete with the **uname -a** command:

```
# uname -a
Linux gpok222 2.6.27.42-0.1-default #1 SMP 2010-01-06 16:07:25 +0100 s390x s390x
s390x GNU/Linux
```

- Verify that the **zipl.conf** file has been modified whereby the name associated with the boot kernel has changed to

LinuxV1 (from Linux):

```
# grep Linux /etc/zipl.conf
[LinuxV1]
    1 = LinuxV1
```

5.9.2 Modifying zipl.conf

Modify the file **/etc/zipl.conf** in two ways:

- In the **[LinuxV1]** section, add the parameter **vmpoff=LOGOFF** and **vmhalt=LOGOFF** so that VM user IDs are logged off after Linux is shut down.
- In the **:menu** section, reduce the timeout from 10 seconds to 3 so Linux IPLs more quickly with no user input.

Back up the latest **zipl.conf** then make the following changes:

```
# cd /etc
# cp zipl.conf zipl.conf.orig
# vi zipl.conf
# Modified by YaST2. Last modification on Fri Feb 12 14:20:53 UTC 2010
[defaultboot]
defaultmenu = menu

###Don't change this comment - YaST2 identifier: Original name: linux###
[LinuxV1]
    image = /boot/image-2.6.27.42-0.1-default
    target = /boot/zipl
    ramdisk = /boot/initrd-2.6.27.42-0.1-default,0x2000000
    parameters = "vmpoff=LOGOFF vmhalt=LOGOFF root=/dev/disk/by-path/ccw-0.0.0103-part1
TERM=dumb"


:menu
    default = 1
    prompt = 1
    target = /boot/zipl
    timeout = 3
    1 = LinuxV1
    2 = ipl
...
```

The **zipl** command will be run later.

5.9.3 Installing the CMS file system package

Add the **cmsfs** RPM with the **zypper install** command. This RPM will be needed by the **boot.findself** script to obtain the correct IP address and host name from the 191 (CMSCLONE 192) disk at *first boot*.

```
# zypper install cmsfs
Loading repository data...
Reading installed packages...
Resolving package dependencies...

The following NEW package is going to be installed:
  cmsfs
```

```
Overall download size: 33.0 K. After the operation, additional 148.0 K will be used.
Continue? [YES/no]: yes
Retrieving package cmsfs-1.1.8-6.2.s390x (1/1), 33.0 K (148.0 K unpacked)
Installing: cmsfs-1.1.8-6.2 [done]
```

5.9.4 Setting additional kernel modules to be loaded

As with the S11CLONE virtual machine, three modules are set to be loaded at boot time:

1. dcssblk: this module allows DCSS swap spaces and file systems to be utilized
2. cmm: when the cmm module is loaded, in conjunction with configuration changes on z/VM, significant performance gains are possible.
3. vmcp: the vmcp module allows CP commands to be issued from Linux.

Add these modules to the file **/etc/sysconfig/kernel** in the variables **INITRD_MODULES** (for the **dcssblk** driver) and **MODULES_LOADED_ON_BOOT**:

```
# cd /etc/sysconfig
# cp kernel kernel.orig
# vi kernel           // modify two lines
INITRD_MODULES="dcssblk"

## Type:        string
## Command:     /sbin/mkinitrd
#
# This variable contains the list of modules to be added to the initial
# ramdisk that is created for unprivilegd Xen domains (domU); you may need
# drivers for virtual block and network devices in addition to filesystem
# and device-mapper modules.
#
DOMU_INITRD_MODULES="xennet xenblk"

## Type:                string
## ServiceRestart:      boot.loadmodules
#
# This variable contains the list of modules to be loaded
# once the main filesystem is active
# You will find a few default modules for hardware which
# can not be detected automatically.
#
MODULES_LOADED_ON_BOOT="cmm vmcp"
...
```

5.9.5 Passing parameters to the dcssblk module

Add a line to **/etc/modprobe.conf.local** specifying the name of the parameter passed to the **dcssblk** driver. Additionally the DCSSs named **S11ROOT1**, **S11RPM1** and **S11SHAR1** are added, which will be used later.

```
# cd /etc
# vi modprobe.conf.local
#
# please add local extensions to this file
#
options dcssblk "segments=SWAPPING,S11ROOT1,S11RPM1,S11SHAR1"
```


Make these and previous changes available to the **/boot/** file system with the **mkinitrd** and **zipl** commands:

```
# mkinitrd

Kernel image:   /boot/image-2.6.27.42-0.1-default
Initrd image:   /boot/initrd-2.6.27.42-0.1-default
Root device:    /dev/disk/by-path/ccw-0.0.0103-part1 (/dev/dasda1) (mounted on / as ext2)
Kernel Modules: dcssblk mbcache ext2 dasd_mod dasd_eckd_mod
Features:       block dasd
13980 blocks
# zipl
Using config file '/etc/zipl.conf'
Building bootmap in '/boot/zipl'
Building menu 'menu'
Adding #1: IPL section 'LinuxV1' (default)
Adding #2: IPL section 'ipl'
Preparing boot device: dasdc (0100).
Done.
```

5.9.6 Modifying the /etc/inittab file

Make two changes to the **/etc/inittab** file. Change the default run level from 5 (graphical interface) to **3** (command line interface). Rather than rebooting, (shutdown -r), set the system to halt (**shutdown -h**) when the shutdown signal is trapped as a Ctrl-Alt-Del signal:

```
# cd /etc
# cp inittab inittab.orig
# vi inittab // change shutdown -r to shutdown -h
...
# The default runlevel is defined here
id:3:initdefault:
...
# what to do when CTRL-ALT-DEL is pressed
ca::ctrlaltdel:/sbin/shutdown -h -t 4 now
...
```

5.9.7 Modifying /etc/fstab

Two lines are added to the **/etc/fstab** file

- The line to load the DCSS swap space.
- The **/tmp/** file system need not be persistent across reboots, per the Filesystem Hierarchy Specificaiton (FHS). Therefore it can be of type **tmpfs** which is an in-memory file system.

To accomplish this, add the following two lines to **/etc/fstab**:

```
# cd /etc
# cp fstab fstab.orig
# vi fstab
/dev/disk/by-path/ccw-0.0.0103-part1 /               ext2       acl,user_xattr        1 1
/dev/disk/by-path/ccw-0.0.0100-part1 /boot           ext2       acl,user_xattr        1 2
/dev/disk/by-path/ccw-0.0.0102-part1 /usr/local      ext3       acl,user_xattr        1 2
/dev/disk/by-path/ccw-0.0.0101-part1 /usr/share      ext2       acl,user_xattr        1 2
/dev/dcssblk0       swap                swap       defaults              0 0
tmpfs               /tmp                tmpfs      defaults              0 0
proc                /proc               proc       defaults              0 0
sysfs               /sys                sysfs      noauto                0 0
```

```
debugfs              /sys/kernel/debug    debugfs    noauto                0 0
devpts               /dev/pts             devpts     mode=0620,gid=5       0 0
```

These changes will be effected after the next reboot.

5.9.8 Copying scripts to the golden image

The following scripts associated with this paper are copied to the golden image:

File	Location	Description
boot.findself	**/usr/local/sbin**	A new script run at *first boot* by **/etc/init.d/boot.local** to set the IP address and host name
cloneprep.sh	**/usr/local/sbin/**	A new script run before cloning to clean up unnecessary files
setup-block.sh	**/lib/mkinitrd/scripts/**	A modified script that allows **mkintrd** to recognize the **dcssblk** module
boot.rootfsck	**/etc/init.d/**	A modified script run at each boot allow for a read-only root file system
boot.local	**/etc/init.d/**	A modified script to call **boot.findself** at first boot then rename it so it is only run once

Copy the *new* shell scripts using the **scp** command from *the cloner.* In this example, the IP address of the Linux running on S11CLONE is 9.60.18.226:

```
# cd /usr/local/sbin
# scp 9.60.18.226:/usr/local/sbin/cloneprep.sh .
The authenticity of host '9.60.18.225 (9.60.18.225)' can't be established.
RSA key fingerprint is e2:20:51:93:10:47:25:83:86:08:3a:92:d1:24:e9:9b.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '9.60.18.225' (RSA) to the list of known hosts.
Password:
cloneprep.sh                                  100% 2280     2.2KB/s   00:00
# scp 9.60.18.226:/usr/local/sbin/boot.findself .
Password:
boot.findself                                 100% 6106     6.0KB/s   00:00
...
```

Copy the *modified* shell scripts using the **scp** command from *the cloner.*

```
# cd /lib/mkinitrd/scripts
# mv setup-block.sh setup-block.sh.orig
# scp 9.60.18.226:/usr/local/sbin/setup-block.sh.S11 setup-block.sh
Password:
setup-block.sh.S11                            100% 4480     4.4KB/s   00:00
# diff setup-block.sh setup-block.sh.orig    // observe only small differences
79,81d78
<             dcss*)
<                 echo dcssblk
<                 ;;
# cd /etc/init.d
# mv boot.rootfsck boot.rootfsck.orig
# scp 9.60.18.226:/usr/local/sbin/boot.rootfsck.S11 boot.rootfsck
Password:
boot.rootfsck.S11                             100% 8745     8.5KB/s   00:00
# diff boot.rootfsck boot.rootfsck.orig     // observe substantial differences
...
```



```
# mv boot.local boot.local.orig
# scp 9.60.18.226:/usr/local/sbin/boot.local.S11 boot.local
Password:
boot.local.S11                                100%  698     0.7KB/s   00:00
# diff boot.local boot.local.orig          // observe one addition
15,20c15
< if [ -f /usr/local/sbin/boot.findself ]; then # this is first boot
<   /usr/local/sbin/boot.findself               # run it to set IP@ & hostname
<   if [ $? = 0 ]; then                         # then success => rename
<     /bin/mv /usr/local/sbin/boot.findself /usr/local/sbin/boot.findself.hasrun
<   fi
< fi
---
>
```

The two new and the three modified scripts should now be copied. They are essential to the environment.

5.9.9 Creating empty mount points

Mounting middleware binaries read-only is beyond the scope of this paper. However, if there is a possibility that you may run WebSphere® Application Server, DB2 UDB, or MQ Series, you may wish to create the following, or other, empty mount points for other software:

- **/opt/IBM/WebSphere/**
- **/opt/mqm/**
- **/opt/IBM/db2/**

In this fashion, all cloned servers will have empty mount points for possibly mounting software.

```
# cd /opt
# mkdir mqm IBM
# cd IBM
# mkdir WebSphere db2
```

5.9.10 Testing the changes

The system can be rebooted and tested.

```
# reboot
...
```

The system may take a number of minutes to reboot as the DCSSs are being loaded. When it is back, start an SSH session as root and verify the changes made in this section.

View the file systems with the **df -h** command:

```
# df -h
Filesystem            Size  Used Avail Use% Mounted on
/dev/dasda1           2.3G  1.7G  487M  78% /
udev                  499M  148K  499M   1% /dev
/dev/dasdb1            40M   14M   24M  37% /boot
/dev/dasdd1           1.2G   34M  1.1G   4% /usr/local
/dev/dasdc1           1.1G  765M  288M  73% /usr/share
tmpfs                 499M     0  499M   0% /tmp
```

View the change to the kernel parameters:

```
# cat /proc/cmdline
```



```
vmpoff=LOGOFF vmhalt=LOGOFF root=/dev/disk/by-path/ccw-0.0.0103-part1 TERM=dumb
init=/linuxrc BOOT_IMAGE=0
```

Use the **rpm -q** command to show that the **cmsfs** package was added:

```
# rpm -q cmsfs
cmsfs-1.1.8-6.2
```

Use the **lsmod** and **egrep** commands to show that the additional modules have been added:

```
# lsmod | egrep "cmm|vmcp|dcssblk"
vmcp                    5704  0
cmm                    12184  0
smsgiucv                5408  1 cmm
dcssblk                16056  5
```

Use the **swapon -s** command to show that the DCSS swap space is being used:

```
# swapon -s
Filename                                Type            Size    Used    Priority
/dev/dcssblk0                           partition       2096120 0       -1
```

5.9.11 Preparing the system for cloning

Now the **cloneprep.sh** script can be run to prepare the system for cloning. The output should be similar to the following:

```
# cloneprep.sh
rm: cannot remove `/var/log/*.gz': No such file or directory
System should be ready for shutdown and cloning
```

5.10 Backing up the golden image

You should now backup the golden image. Shutdown the golden Linux running on S11RWGLD and log off so the system can be copied.

```
# shutdown -h now

Broadcast message from root (pts/0) (Thu Nov  5 15:49:05 2009):

The system is going down for system halt NOW!
...
```

To back up the golden image, perform the following steps:

- Start an SSH session as root on the Linux running on S11CLONE.
- Copy the primary minidisks at addresses 100-103 to the backup minidisks at addresses 200-203 with **pri2bak.sh**:

```
# pri2bak.sh
Are you sure you want to back up disks 100-103 to 200-203? (y/n): y

Copying S11RWGLD 100 to S11RWGLD 200 ...
Command complete: FLASHCOPY 1100 0 59 TO 2200 0 59
FLASHCOPY succeeded
DASD 1100 DETACHED
DASD 2200 DETACHED
```



```
Copying S11RWGLD 101 to S11RWGLD 201 ...
Command complete: FLASHCOPY 1101 0 1608 TO 2201 0 1608
FLASHCOPY succeeded
DASD 1101 DETACHED
DASD 2201 DETACHED

Copying S11RWGLD 102 to S11RWGLD 202 ...
Command complete: FLASHCOPY 1102 0 1668 TO 2202 0 1668
FLASHCOPY succeeded
DASD 1102 DETACHED
DASD 2202 DETACHED

Copying S11RWGLD 103 to S11RWGLD 203 ...
Command complete: FLASHCOPY 1103 0 3337 TO 2203 0 3337
FLASHCOPY succeeded
DASD 1103 DETACHED
DASD 2203 DETACHED
```

A copy of the golden image is now on the backup disks. You may want to test making a change to the existing golden image, restoring from the backup with the **bak2pri.sh** script and seeing that the change is gone because of the rollback.

5.11 Cloning a read-write Linux system

You should now be ready to clone a read-write system. The **clonerw.sh** script copies the necessary minidisks from S11RWGLD system to a target user ID that must be specified.

To clone a read-write system, perform the following steps:

- Create a new target user ID
- Create a new parameter file
- Grant access to the VSWITCH
- Clone a new read-write system

5.11.1 Creating a new target user ID

Create a new user ID LNX227 with the same size minidisks as the golden image with the same virtual device addresses:

```
USER LNX227 PASSWD 256M 1G G
  INCLUDE LNXDFLT
  OPTION APPLMON
  MDISK 0100 3390 5068 0060 DM63CA MR PASSWD PASSWD PASSWD
  MDISK 0101 3390 5128 1609 DM63CA MR PASSWD PASSWD PASSWD
  MDISK 0102 3390 6737 1669 DM63CA MR PASSWD PASSWD PASSWD
  MDISK 0103 3390 0001 3338 DM63CB MR PASSWD PASSWD PASSWD
```

Bring the directory changes online.

5.11.2 Creating a new parameter file

Create a parameter file on the CMSCLONE 192 disk (which will become the Linux user ID's read-only 191 disk). By default CMS accesses the 192 disk as D. The S11RWGLD parameter file on CMSCLONE's D disk is copied as a template, and the host name and IP address are modified:

```
===> copy s11rwgld parm-s11 d lnx227 = =
===> x lnx227 parm-s11 d
ramdisk_size=65536 root=/dev/ram1 ro init=/linuxrc TERM=dumb
HostIP=9.60.18.227 Hostname=gpok227.endicott.ibm.com
```



```
Gateway=9.60.18.129 Netmask=255.255.255.128
Broadcast=9.60.18.255 Layer2=0
ReadChannel=0.0.0600  WriteChannel=0.0.0601  DataChannel=0.0.0602
Nameserver=9.0.2.11
portname=whatever
portno=0
Install=nfs://9.60.18.133/nfs/sles11/dvd1
UseVNC=1  VNCPassword=12345678
InstNetDev=osa OsaInterface=qdio OsaMedium=eth Manual=0
```

By using the SLES 11 parameter file to maintain the IP address and host name, there is a side effect. If for some reason you need to install Linux manually, or even use the install process as a rescue system, this file will be available and the same IP/DNS information will be used.

5.11.3 Granting access to the VSWITCH

Grant the new user ID access to the VSWITCH. The following statement is put in AUTOLOG1's **PROFILE EXEC**:

```
'cp set vswitch vsw1 grant lnx227'
```

This command is also run interactively from the command line for the current z/VM session.

5.11.4 Cloning a new read-write system

The read-write Linux system is cloned to the LNX227 user ID with the **clonerw.sh** shell script from the system running on S11CLONE.

Run the **clonerw.sh** script specifying the target user ID:

```
# clonerw.sh lnx227
Are you SURE you want to clone a read-write system to LNX227 (y/n): y

Copying S11RWGLD 100 to LNX227 100 ...
Command complete: FLASHCOPY 1100 0 59 TO 2100 0 59
FLASHCOPY succeeded
DASD 1100 DETACHED
DASD 2100 DETACHED

Copying S11RWGLD 101 to LNX227 101 ...
Command complete: FLASHCOPY 1101 0 1608 TO 2101 0 1608
FLASHCOPY succeeded
DASD 1101 DETACHED
DASD 2101 DETACHED

Copying S11RWGLD 102 to LNX227 102 ...
Command complete: FLASHCOPY 1102 0 1668 TO 2102 0 1668
FLASHCOPY succeeded
DASD 1102 DETACHED
DASD 2102 DETACHED

Copying S11RWGLD 103 to LNX227 103 ...
HCPLNS116I NOTE: Cylinders 0 through 3337 of minidisk 1103 are the
HCPLNS116I       source for FlashCopy relationship 00000000.
Command complete: FLASHCOPY 1103 0 3337 TO 2103 0 3337
FLASHCOPY succeeded
```



```
DASD 1103 DETACHED
DASD 2103 DETACHED
Success! You should be able to IPL the read-write system on LNX227
```

You can ignore any **HCPLNS116I** messages you might get.

Log on to the newly created LNX227 and IPL from 100. At the initial log on, be sure there are no errors related to minidisks nor VSWITCH access:

```
LOGON LNX227
00: NIC 0600 is created; devices 0600-0602 defined
00: z/VM Version 5 Release 4.0, Service Level 0801 (64-bit),
00: built on IBM Virtualization Technology
00: There is no logmsg data
00: FILES:   NO RDR,   NO PRT,   NO PUN
00: LOGON AT 15:48:15 EST FRIDAY 11/06/09
z/VM V5.4.0    2008-10-22 15:36

DMSACP723I A (191) R/O
DMSACP723I C (592) R/O
00: DASD 0100 3390 DM63CA R/W         60 CYL ON DASD  63CA SUBCHANNEL = 0000
Do you want to IPL Linux from 100? y/n
y
00: zIPL v1.8.0 interactive boot menu
00:
00:  0. default (LinuxV1)
00:
00:  1. LinuxV1
00:  2. ipl
00:
00: Note: VM users please use '#cp vi vmsg <number> <kernel-parameters>'
00:
00: Please choose (default will boot in 3 seconds):
00: Booting default (LinuxV1)...
...
```

A few screens later, you should see the modified **/etc/init.d/boot.rootfsck** issue a message that the **READONLY** variable is not set for this server:

```
..doneROR: READONLY = no
Activating swap-devices in /etc/fstab...
..
```

The script **/usr/local/sbin/boot.findself** should be called by **/etc/init.d/boot.local** and access the 191 disk, read the parameter file and set the TCP/IP address and host name. It does this by modifying the files **/etc/hosts**, **/etc/HOSTNAME** and **/etc/sysconfig/network/ifcfg-eth0**. You should see informational messages similar to the following:

```
...
System Boot Control: Running /etc/init.d/boot.local

/usr/local/sbin/boot.findself: changing (escaped) gpok222\.endicott\.ibm\.com to
 gpok227.endicott.ibm.com in /etc/HOSTNAME
/usr/local/sbin/boot.findself: changing gpok222 to gpok227 and IP address in /et
c/hosts
/usr/local/sbin/boot.findself: changing (escaped) 9\.60\.18\.222 to 9.60.18.227
in /etc/sysconfig/network/ifcfg-eth0
...
```

These messages show that the **boot.findself** script ran and modified the IP address and host name. You should now be able to start an SSH session with the cloned system at the correct IP address.

At the end of the boot messages, you should see sshd creating new SSH keys (they were deleted by **boot.findself**):


```
...
Generating /etc/ssh/ssh_host_rsa_key.
Generating public/private rsa key pair.
Your identification has been saved in /etc/ssh/ssh_host_rsa_key.
Your public key has been saved in /etc/ssh/ssh_host_rsa_key.pub.
The key fingerprint is:
c1:25:5d:68:30:d5:d0:1c:42:cb:03:19:49:19:37:da root@gpok227
The key's randomart image is:
+--Ý RSA 1024¨----+
|       .O@OBo.   |
|       .+X+++    |
|        +.E      |
|         . .     |
|        S        |
|                 |
|                 |
|                 |
|                 |
+-----------------+
Starting SSH daemon..done
Starting CRON daemon..done
Starting INET services. (xinetd)..done
Master Resource Control: runlevel 3 has been reached
Skipped services in runlevel 3:  Ý80C Ý30Dsmbfs nfs smartd splash


Welcome to SUSE Linux Enterprise Server 11 (s390x) - Kernel 2.6.27.29-0.1-defaul
t (ttyS0).


gpok227 login:
```

You can view the file systems with the **df -h** command (the Used sizes should be approximately the same):

```
# df -h
Filesystem            Size  Used Avail Use% Mounted on
/dev/dasda1           2.3G  1.7G  492M  78% /
udev                  122M  140K  122M   1% /dev
/dev/dasdb1            40M   14M   24M  37% /boot
/dev/dasdd1           1.2G   34M  1.1G   4% /usr/local
/dev/dasdc1           1.1G  765M  288M  73% /usr/share
tmpfs                 122M     0  122M   0% /tmp
```

This shows the file system layout of a cloned read-write Linux system. You have now cloned a read-write Linux system.

Section 6: Creating a read-only cloning system

You should now have a read-write Linux system with tools to maintain copies of Linux for test, maintenance and cloning. It is now time to create a read-only root system. The first three DCSSs are created for file systems. This only has to be done once.

In section 6.2 on page 38, the steps to manually create a read-only reference system on S11ROGLD are described. This section will enable you to more fully understand the process of converting a read-write to a read-only root system.

In section 6.4 on page 50, a script named **rw2ro.sh** is described that will automate the process of moving from the golden image to the read-only root system. This will allow you to more quickly and reliably implement the process.

With either of these two approaches, you must first create the three DCSSs manually. But this has to be done only once.

6.1 Creating DCSSs for read-only file systems

The root file system, the **/var/lib/rpm/** and **/usr/share/** directories will be stored in DCSSs The **/boot/** file system will become a Named Saved System (NSS).

6.1.1 Creating the DCSSs

The DCSSs are created on the S11CLONE virtual machine. Shutdown the Linux system on S11CLONE and define storage to 8G:

```
# halt

Broadcast message from root (ttyS0) (Mon Sep 28 12:40:22 2009):

The system is going down for system halt NOW!
INIT: Switching to runlevel: 0
 ...
 00: HCPGSP2629I The virtual machine is placed in CP mode due to a SIGP stop from
 CPU 00.

==> def stor 8G
00: STORAGE = 8G
00: Storage cleared - system reset.

==> ipl cms
z/VM V5.4.0    2008-10-22 15:36

DMSACP723I A (191) R/O
DMSACP723I C (592) R/O
Do you want to IPL Linux from 100? y/n
n
...
```

Define and save a DCSS of type SR with the name **S11ROOT1** . The **SAVESEG** command saves the DCSS. The **SR** parameter means the DCSS will have shared read-only access. The **LOADNSHR** parameter indicates that any user may load a non-shared copy of the saved segment.

```
==> defseg s11root1 C0000-13FEFF sr loadnshr
00: HCPNSD440I Saved segment S11ROOT1 was successfully defined in fileid 0178.
==> saveseg s11root1
00: HCPNSS440I Saved segment S11ROOT1 was successfully saved in fileid 0178.
```

Note: Tthe **SAVESEG** command can take a few minutes to complete.

Define and save a DCSS with the name **S11RPM1** :

```
==> defseg s11rpm1 13FF00-142EFF sr loadnshr
00: HCPNSD440I Saved segment S11RPM1 was successfully defined in fileid 0179.
==> saveseg s11rpm1
00: HCPNSS440I Saved segment S11RPM1 was successfully saved in fileid 0179.
```

Define and save a DCSS with the name **S11SHAR1** :

```
==> defseg s11shar1 142F00-181EFF sr loadnshr
00: HCPNSD440I Saved segment S11SHAR1 was successfully defined in fileid 0180.
==> saveseg s11shar1
```



```
00: HCPNSS440I Saved segment S11SHAR1 was successfully saved in fileid 0180.
```

Note: This **SAVESEG** command can also take a few minutes to complete.

Observe the new DCSSs:

```
==> q nss
00: OWNERID  FILE TYPE CL RECS DATE  TIME     FILENAME FILETYPE ORIGINID
…
00: *NSS     0177 NSS  A  0003 11/05 14:37:01 SWAPPING DCSSG    S11CLONE
00: *NSS     0178 NSS  A  524K 11/06 15:57:03 S11ROOT1 DCSSG    S11CLONE
00: *NSS     0179 NSS  A  012K 11/06 16:04:31 S11RPM1  DCSSG    S11CLONE
00: *NSS     0180 NSS  A  258K 11/06 16:05:47 S11SHAR1 DCSSG    S11CLONE
```

Now that the DCSSs are defined, the Linux system running on S11CLONE can use them. Set the storage back to 256MB and boot Linux:

```
==> def stor 256m
00: STORAGE = 256M
00: Storage cleared - system reset.
==> ipl 100
00: zIPL v1.8.0 interactive boot menu
...
```

The DCSSs for the read-only file systems have now been created.

6.2 Manually creating a read-only root system

This section describes the steps to move from a read-write system on S11RWGLD to a read-only root system on S11ROGLD. Later this can be done with the **rw2ro.sh** script because there are a large number of steps.

The main steps are as follows:

1. Set up the basic environment.
2. Enable the source disks.
3. Enable the target DCSSs.
4. Enable the target file systems.
5. Copy the root file system to the target.
6. Mount the remaining source file systems.
7. Format and mount the remaining target file systems.
8. Copy the remaining file systems from source to target.
9. Modify the target system to be read-only.
10. Clean up - unmount file systems, disable and detach devices.
11. Save the three DCSSs.
12. Create an NSS.

6.2.1 Setting up basic environment

Perform the following steps to set up the basic environment:

- Shutdown and log off the source and target systems, S11RWGLD and S11ROGLD. The work is done from the "cloner", S11CLONE.
- Verify that the new DCSSs have been loaded:

```
# ls /sys/devices/dcssblk
S11ROOT1  S11RPM1  S11SHAR1  SWAPPING  add  remove  uevent
```

- Create a mount point below the **/mnt/** directory for the source (**src/**) and the target (**tgt/**) systems. Create a third mount point for the target DCSS, S11RPM1, that will contain the **/var/lib/rpm/** directory. No attempt is made to mount over **/mnt/tgt/var/lib/rpm/** because this would add complexity, and this directory need not be mounted to "chroot" into the target environment. Create three mount points: **/mnt/src/**, **/mnt/tgt/**, and **/mnt/rpm/**:

```
# cd /mnt
# mkdir src tgt rpm
```

6.2.2 Enabling the source disks

Perform the following steps to enable the source disks on S11RWGLD:

- Link to the four source disks read-only using the CP **LINK** command, using virtual device addresses with a prefix of 1:

```
# vmcp link s11rwgld 100 1100 rr
# vmcp link s11rwgld 101 1101 rr
# vmcp link s11rwgld 102 1102 rr
# vmcp link s11rwgld 103 1103 rr
```

- Enable the four disks using the **chccwdev** command:

```
# chccwdev -e 1100
Setting device 0.0.1100 online
Done
# chccwdev -e 1101
Setting device 0.0.1101 online
Done
# chccwdev -e 1102
Setting device 0.0.1102 online
Done
# chccwdev -e 1103
Setting device 0.0.1103 online
Done
```

  You should see messages on the console that the disks are enabled.

6.2.3 Enabling the target DCSSs

Perform the following steps to enable the three target DCSSs:

- Enable each of the DCSSs for read-write access by echoing a **0** to the file **shared** in the **/sys/** file system. This sets the DCSSs to "not shared" which means they can be written to:

```
# echo 0 > /sys/devices/dcssblk/S11ROOT1/shared
# echo 0 > /sys/devices/dcssblk/S11RPM1/shared
# echo 0 > /sys/devices/dcssblk/S11SHAR1/shared
```

> **Important**: Because some of the DCSS are large, these steps may take some number of minutes. This will also probably have the effect of freezing the z/VM system. The entire z/VM system is not really frozen. Rather, while saving or loading is in progress, NSS commands, DCSS commands, or diagnose functions for NSS and DCSS that are issued from any guest operating system of the same z/VM will be delayed.

- Make an ext2 file system of the three DCSSs:

```
# mke2fs /dev/dcssblk1
mke2fs 1.41.1 (01-Sep-2008)
...
# mke2fs /dev/dcssblk2
mke2fs 1.41.1 (01-Sep-2008)
...
# mke2fs /dev/dcssblk3
mke2fs 1.41.1 (01-Sep-2008)
...
```

- Mount the root file system DCSS over **/mnt/tgt/**:

```
# mount /dev/dcssblk1 /mnt/tgt
```

6.2.4 Enabling the target file systems

Perform the following steps to enable the target file systems:

- Link the target mindisks 100 (**/boot/**) and 102 (**/usr/local/**) file systems read-write using virtual device addresses with a prefix of 2:

```
# vmcp link s11rogld 100 2100 mr
# vmcp link s11rogld 102 2102 mr
```

- Enable the target disks:

```
# chccwdev -e 2100
Setting device 0.0.2100 online
Done
# chccwdev -e 2102
Setting device 0.0.2102 online
Done
```

6.2.5 Copying the root file system

Perform the following steps to copy the root file system:

- The device number of the source root file system is 1103 and this should map to **/dev/dasde1**. Verify this with the **lsdasd** command, then mount it over **/mnt/src/** with the read-only option (**-o ro**) so there will be no attempt to write to the file system journal:

```
# lsdasd
Bus-ID     Status      Name      Device  Type  BlkSz  Size      Blocks
==============================================================================
0.0.0100   active      dasda     94:0    ECKD  4096   2255MB    577440
0.0.1100   active      dasdb     94:4    ECKD  4096   42MB      10800
0.0.1101   active      dasdc     94:8    ECKD  4096   1131MB    289620
0.0.1102   active      dasdd     94:12   ECKD  4096   1173MB    300420
0.0.1103   active      dasde     94:16   ECKD  4096   2347MB    600840
0.0.2100   active      dasdf     94:20   ECKD  4096   42MB      10800
0.0.2102   active      dasdg     94:24   ECKD  4096   1173MB    300420

# mount -o ro /dev/dasde1 /mnt/src
```

- Recursively copy **/mnt/src/** to **/mnt/tgt/**. This copies the golden image's root file system to the DCSS named **S11ROOT1**. This may take a few minutes as there is a fair amount of data to copy:

```
# cp -a /mnt/src/* /mnt/tgt
```


This step will take a few minutes.

6.2.6 Mounting the remaining source file systems

Perform the following steps to mount the remaining source file systems:

- Issue the **lsdasd** command and observe that the target **/boot/** and **/usr/local/** file systems are active:

```
# lsdasd
Bus-ID     Status      Name      Device  Type  BlkSz  Size      Blocks
==============================================================================
0.0.0100   active      dasda     94:0    ECKD  4096   2255MB    577440
0.0.1100   active      dasdb     94:4    ECKD  4096   42MB      10800
0.0.1101   active      dasdc     94:8    ECKD  4096   1131MB    289620
0.0.1102   active      dasdd     94:12   ECKD  4096   1173MB    300420
0.0.1103   active      dasde     94:16   ECKD  4096   2347MB    600840
0.0.2100   active      dasdf     94:20   ECKD  4096   42MB      10800
0.0.2102   active      dasdg     94:24   ECKD  4096   1173MB    300420
```

- Mount the remaining source file systems as type ext2: **/dev/dasdb1** (**/boot/**), **/dev/dasdc1** (**/usr/share**) and **/dev/dasdd1** (**/usr/local/**) :

```
# mount -o ro /dev/dasdb1 /mnt/src/boot
# mount -o ro /dev/dasdc1 /mnt/src/usr/share
# mount -o ro /dev/dasdd1 /mnt/src/usr/local
```

You should now have the golden image mounted over **/mnt/src/**.

6.2.7 Formatting and mounting the remaining target file systems

Perform the following steps to format and mount the remaining target file systems:

- Mount the remaining target DCSSs: **/dev/dcssblk2** (**/var/lib/rpm/**) and **/dev/dcssblk3** (**/usr/share/**):

```
# mount /dev/dcssblk2 /mnt/rpm
# mount /dev/dcssblk3 /mnt/tgt/usr/share
```

- Format, create a single partition and make an ext2 file system on the target disk **/dev/dasdf** (**/boot/**):

```
# dasdfmt -b 4096 -y -f /dev/dasdf
...
# fdasd -a /dev/dasdf
...
# mke2fs /dev/dasdf1
...
```

- Format, create a single partition and make an ext3 file system on the target disk **/dev/dasdg** (**/usr/local/**):

```
# dasdfmt -b 4096 -y -f /dev/dasdg
...
# fdasd -a /dev/dasdg
...
# mke2fs -j /dev/dasdg1
...
```

- Mount the newly formatted target file systems:

```
# mount /dev/dasdf1 /mnt/tgt/boot/
# mount /dev/dasdg1 /mnt/tgt/usr/local
```

You should now have all target file systems prepared for copying.

6.2.8 Copying remaining file systems

Perform the following steps to copy the remaining file systems:

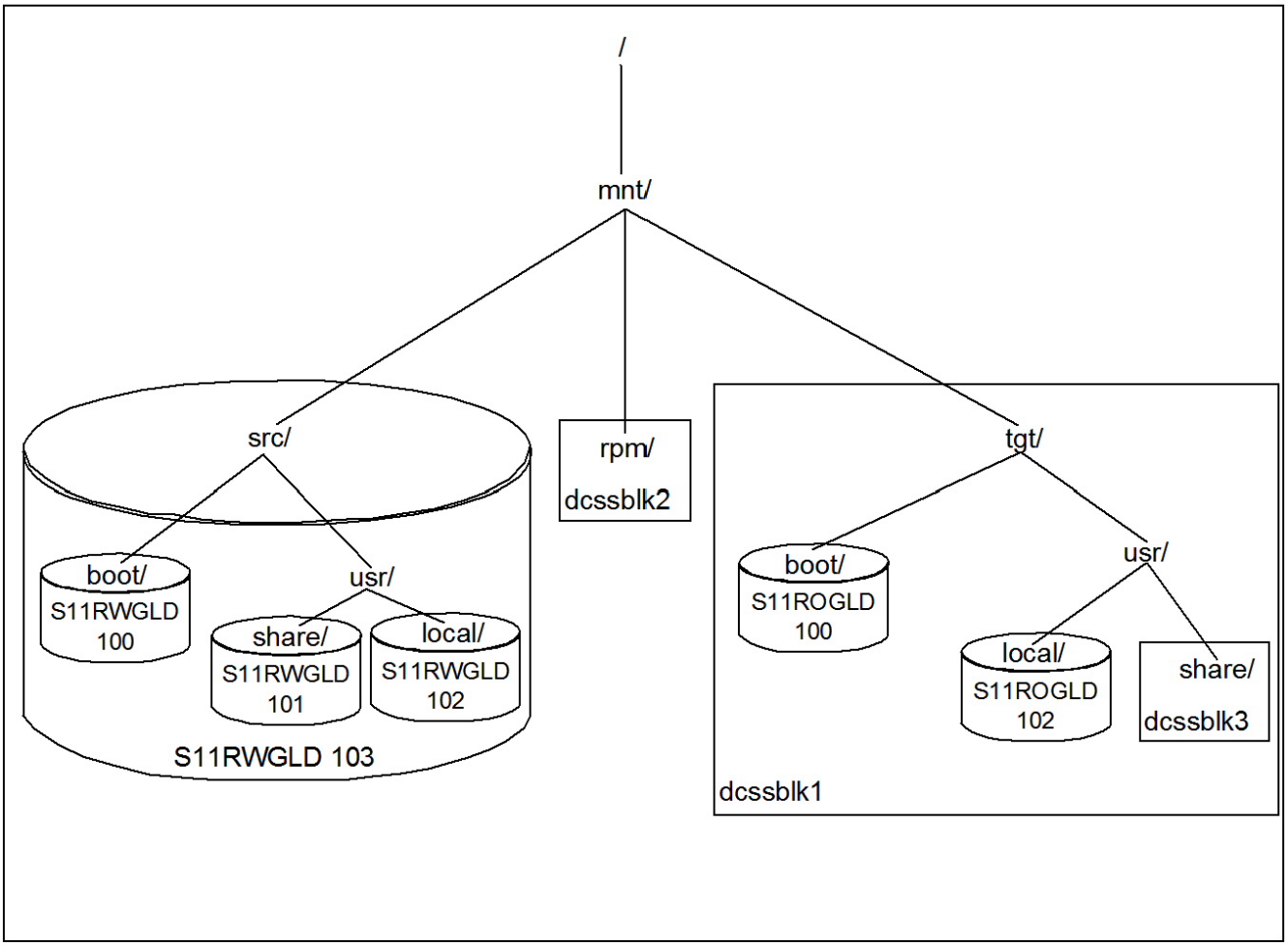
- Recursively copy **/mnt/src/var/lib/rpm** to **/mnt/rpm/**. This copies the golden image's RPM database to the DCSS named **S11RPM1**:

  ```
  # cp -a /mnt/src/var/lib/rpm/* /mnt/rpm
  ```

- Recursively copy the source **/boot/**, **/usr/share/** and **/usr/local/** file systems:

  ```
  # cp -a /mnt/src/boot/* /mnt/tgt/boot
  # cp -a /mnt/src/usr/share/* /mnt/tgt/usr/share
  # cp -a /mnt/src/usr/local/* /mnt/tgt/usr/local
  ```

You should now have a copy of the Linux golden image mounted over **/mnt/tgt/**. The following figure is a block diagram of the mounted file system and DCSS hierarchy.



File system and DCSS hierarchy

6.2.9 Making the gold image read-only

In this section the target root file system DCSS is modified so it can be mounted read-only.

Certain files are bind-mounted read-write from **/usr/local/** over the read-only **/etc/** file system so they can be modified:

- **/etc/lvm/.cache** – Contains the LVM cache if logical volumes are used
- **/etc/hosts** - Contains the clone's host name
- **/etc/HOSTNAME** – Contains the clone's host name
- **/etc/sysconfig/network/ifcfg-eth0** – Contains the clone's IP address
- **/etc/sysconfig/network/routes** – Contains the default gateway

These files and other directories are listed in the file that will be copied to **/etc/rwtab**. For reference, view it in the **/usr/local/sbin/** directory:

```
# cat /usr/local/sbin/rwtab
dirs    /root
dirs    /srv
dirs    /var
dirs    /etc/ssh
files   /etc/fstab
files   /etc/resolv.conf
files   /etc/lvm/.cache
files   /etc/hosts
files   /etc/HOSTNAME
files   /etc/sysconfig/network/ifcfg-eth0
files   /etc/sysconfig/network/routes
```

In addition to copying these files, the **/etc/mtab** file becomes a symbolic link to **/proc/mounts**. This is not an ideal solution as it affects the output of the **df** and **mount** commands. But it is better than trying to bind-mount a read-write **/etc/mtab** file as the **mount** command tries to write a temporary file to **/etc/**. When it cannot write to **/etc/** the **mount** fails (To Linux developers: a better solution would be to modify the **mount** command so that it writes temporary files to **/tmp/** rather than **/etc/**.)

To modify the target root file system, perform the following steps:

- Back up and copy the modified **/etc/fstab** file so the DCSSs are mounted and not the minidisks. The changes to the file are in bold:

```
# cp /mnt/tgt/etc/fstab /mnt/tgt/etc/fstab.orig
# cp /usr/local/sbin/fstab.S11 /mnt/tgt/etc/fstab
# cat /mnt/tgt/etc/fstab
/dev/dcssblk1         /       ext2 ro,xip,noatime,nodiratime,acl,user_xattr 1 1
/dev/disk/by-path/ccw-0.0.0102-part1 /usr/local ext3  acl,user_xattr        0 0
/dev/dcssblk2    /var/lib/rpm ext2 ro,xip,noatime,nodiratime,acl,user_xattr 0 0
/dev/dcssblk3    /usr/share   ext2 ro,xip,noatime,nodiratime,acl,user_xattr 0 0
tmpfs               /tmp                 tmpfs      defaults              0 0
proc                /proc                proc       defaults              0 0
sysfs               /sys                 sysfs      noauto                0 0
debugfs             /sys/kernel/debug    debugfs    noauto                0 0
devpts              /dev/pts             devpts     mode=0620,gid=5       0 0
```

- Back up and modify the **/etc/zipl.conf** file so the root file system is the DCSS, not a disk

```
# cp /mnt/tgt/etc/zipl.conf /mnt/tgt/etc/zipl.conf.orig
# vi /mnt/tgt/etc/zipl.conf
# Modified by YaST2. Last modification on Fri Feb 12 14:20:53 UTC 2010
[defaultboot]
defaultmenu = menu

###Don't change this comment - YaST2 identifier: Original name: linux###
[LinuxV1]
```

```
image = /boot/image-2.6.27.42-0.1-default
target = /boot/zipl
ramdisk = /boot/initrd-2.6.27.42-0.1-default,0x2000000
parameters = "vmpoff=LOGOFF vmhalt=LOGOFF root=/dev/dcssblk1 TERM=dumb"
```

- Copy the new **/etc/rwtab** file. This is the file that specifies the directories and files to bind-mount read-write over the read-only root file system:

```
# cp /usr/local/sbin/rwtab /mnt/tgt/etc
```

- Copy the new **/etc/sysconfig/readonly-root** file. This is the configuration file for read-only root processing. Note that the variable **READONLY** is set to yes:

```
# cp /usr/local/sbin/readonly-root /mnt/tgt/etc/sysconfig
# grep READONLY  /mnt/tgt/etc/sysconfig/readonly-root
READONLY=yes
# or on the block device labeled RW_LABEL. Implied by READONLY
```

- Delete the /**etc/mtab** file and replace it with a symbolic link to **/proc/mounts**, as discussed previously:

```
# cd /mnt/tgt/etc
# rm mtab
# ln -s /proc/mounts mtab
```

- Mount the /**dev/**, /**proc/** and /**sys/** file systems, then use the **chroot** command to change root into the target environment:

```
# mount --bind /dev /mnt/tgt/dev
# mount -t proc none /mnt/tgt/proc
# mount --bind /sys /mnt/tgt/sys
# chroot /mnt/tgt
```

- In the target environment, recursively copy the source directories **/root/**, **/srv/** and **/var/** to **/usr/local/**. These directories will later be bind-mounted read-write over their respective locations:

```
# cd /usr/local
# cp -a /root /srv /var .
# ls
bin    include  lib64       man   sbin   src  var
games  lib      lost+found  root  share  srv
```

- Copy the files in **/etc/** that will need to be bind-mounted:

```
# mkdir /usr/local/etc/
# cd /etc
# cp HOSTNAME hosts fstab resolv.conf /usr/local/etc
# cp -a ssh /usr/local/etc
```

- Make a directory under **/usr/local/** then copy two files in **/etc/sysconfig/network/**:

```
# mkdir -p /usr/local/etc/sysconfig/network
# cd /etc/sysconfig/network
# cp ifcfg-eth0 routes /usr/local/etc/sysconfig/network
```

- Make a directory under **/usr/local/** then copy one file in **/etc/lvm/**:

```
# mkdir /usr/local/etc/lvm
# cp /etc/lvm/.cache /usr/local/etc/lvm
```

- Make a directory under **/usr/local/** then copy the **/var/lib/rpm/** directory:

```
# mkdir -p /usr/local/etc/var/lib
# cp -a /var/lib/rpm /usr/local/etc/var/lib
```


- Under the chroot'ed **/mnt/tgt/** environment, delete the contents of **/root/**, **/srv/** and **/var/** because these directories will later be “over-mounted”. This will save some space.

```
# rm -r /root/* /srv/* /var/*
```

- Run **zipl** in the chroot'ed environment to write the boot record to /boot/

```
# zipl
Using config file '/etc/zipl.conf'
Building bootmap in '/boot/zipl'
Building menu 'menu'
Adding #1: IPL section 'LinuxV1' (default)
Adding #2: IPL section 'ipl'
Preparing boot device: dasdf (2100).
Done.
```

6.2.10 Cleaning up

Exit the chroot'd environment, sync the file system, change directory to root's home and unmount the mounted file systems:

```
# exit
# sync
# cd
# umount /mnt/tgt/usr/local
# umount /mnt/tgt/usr/share
# umount /mnt/tgt/boot
# umount /mnt/tgt/dev
# umount /mnt/tgt/proc
# umount /mnt/tgt/sys
# umount /mnt/tgt
# umount /mnt/src/usr/share
# umount /mnt/src/usr/local
# umount /mnt/src/boot
# umount /mnt/src
# umount /mnt/rpm
```

- Disable and detach the linked target disks:

```
# chccwdev -d 2100
Setting device 0.0.2100 offline
Done
# chccwdev -d 2102
Setting device 0.0.2102 offline
Done
# vmcp det 2100
DASD 2100 DETACHED
# vmcp det 2102
DASD 2102 DETACHED
```

- Disable and detach the linked source disks:

```
# chccwdev -d 1100
Setting device 0.0.1100 offline
Done
# chccwdev -d 1101
Setting device 0.0.1101 offline
Done
# chccwdev -d 1102
Setting device 0.0.1102 offline
Done
# chccwdev -d 1103
Setting device 0.0.1103 offline
Done
# vmcp det 1100
```

```
DASD 1100 DETACHED
# vmcp det 1101
DASD 1101 DETACHED
# vmcp det 1102
DASD 1102 DETACHED
# vmcp det 1103
DASD 1103 DETACHED
```

6.2.11 Saving the *DCSSs*

To save the DCSSs, perform the following commands:

```
# echo 1 > /sys/devices/dcssblk/S11ROOT1/save
# echo 1 > /sys/devices/dcssblk/S11RPM1/save
# echo 1 > /sys/devices/dcssblk/S11SHAR1/save
```

> **Important**: You may lose your SSH session on one or more of the above commands. This may have the appearance of freezing the z/VM system. The entire z/VM system is not really frozen. Rather, while saving or loading is in progress, NSS commands, DCSS commands, or diagnose functions for NSS and DCSS that are issued from any guest operating system of the same z/VM will be delayed. Internally to z/VM development, PITS 2U02367 exists with an analysis of this issue.

The modified read-only golden image, now on two minidisks and three DCSSs, should now be ready to boot from S11ROGLD.

6.2.12 Making an NSS

The files in the boot file system are now used to create a Named Saved System (NSS). Then the read-only golden Linux image can be booted by referring to a name, such as **S11LNX1**, rather than a virtual device address, such as **100**.

To accomplish this, perform the following steps.

- Start a 3270 session to the S11ROGLD user ID.
- IPL the 100 disk with the **SAVESYS=S11LNX1** parameter. You should see informational messages showing that the NSS has been saved:

```
==> ipl 100 parm savesys=s11lnx1
00: zIPL v1.8.0 interactive boot menu
00:
00:  0. default (LinuxV1)
00:
00:  1. LinuxV1
00:  2. ipl
00:
00: Note: VM users please use '#cp vi vmsg <number> <kernel-parameters>'
00:
00: Please choose (default will boot in 3 seconds):
00: Booting default (LinuxV1)...
00: HCPNSD440I The Named Saved System (NSS) S11LNX1 was successfully defined in
fileid 0184.
00: HCPNSS440I Named Saved System (NSS) S11LNX1 was successfully saved in fileid
 0184.
...
```

- Login as root, shut down the system again, then IPL from the newly created NSS to test it:

```
login: root
Password:
```



```
# shutdown -h now
...
==> ipl S11LNX1
Initializing cgroup subsys cpuset
Initializing cgroup subsys cpu
Linux version 2.6.27.29-0.1-default (geeko@buildhost) (gcc version 4.3.2 Ýgcc-4_
3-branch revision 141291¨ (SUSE Linux) ) #1 SMP 2009-08-15 17:53:59 +0200
setup.1a06a7: Linux is running as a z/VM guest operating system in 64-bit mode
Zone PFN ranges:
  DMA      0x00000000 -> 0x00080000
  Normal   0x00080000 -> 0x00080000
...
```

6.2.12.1 Debugging the reference read-only root system

There are many manual steps in the previous section and thus a high possibility for errors. To help in debugging two helper scripts are provided:

mounttgt.sh A script to link, activate and mount the target disks

cleantgt.sh A script to umount, deactivate and detach the target disks and DCSSs

If the **rw2ro.sh** script fails, a useful command to immediately issue is:

```
# echo $?
```

which prints the return code. There are almost no error messages, however, there are unique return codes. Look at the failing return code and you will be able to quickly find where the process is stopping. The file systems are left mounted so you can interrogate the status of the source and target systems. If you want to run the **rw2ro.sh** script again, first clean up with the **cleantgt.sh** script. Alternatively, you may want to manually mount the target environment to interrogate specific files or directories. This is made easier with the **mounttgt.sh** script.

6.3 Cloning a read-only Linux

Now that you have a reference read-only system running on S11ROGLD, you can now clone your first read-only Linux. The high level steps are as follows. Details are only given for using the **clonero.sh** script, and logging onto the new clone:

- Shutdown the read-only golden image on S11ROGLD.
- Define a new virtual machine with just a 102 disk for **/usr/local/**. Following is the example that will be used:

```
USER LNX231 PASSWD 256M 1G G
   INCLUDE LNXDFLT
   OPTION APPLMON
   MDISK 0102 3390 3339 1669 DM63CB MR PASSWD PASSWD PASSWD
```

- Create a corresponding parameter file on the CMSCLONE 192 disk.
- Allow the new virtual machine access to the VSWITCH.
- Use the **clonero.sh** script from S11CLONE. Following is an example of cloning a read-only system to the LNX231 virtual machine:

```
# clonero.sh lnx231
Are you SURE you want to clone a read-only system to LNX231 (y/n): y

Copying S11ROGLD 102 to LNX231 102 ...
Command complete: FLASHCOPY 1102 0 END TO 2102 0 END
FLASHCOPY succeeded
DASD 1102 DETACHED
DASD 2102 DETACHED
```

- Log on to the new virtual machine.

```
LOGON LNX231
00: NIC 0600 is created; devices 0600-0602 defined
```



```
00: z/VM Version 5 Release 4.0, Service Level 0801 (64-bit),
00: built on IBM Virtualization Technology
00: There is no logmsg data
00: FILES:   NO RDR,   NO PRT,   NO PUN
00: LOGON AT 10:41:38 EST FRIDAY 12/04/09
z/VM V5.4.0    2008-10-22 15:36

DMSACP723I A (191) R/O
DMSACP723I C (592) R/O
00: HCPQVD040E Device 0100 does not exist
Do you want to IPL Linux from S11LNX1? y/n
y
Initializing cgroup subsys cpuset
Initializing cgroup subsys cpu
Linux version 2.6.27.29-0.1-default (geeko@buildhost) (gcc version 4.3.2 Ýgcc-4_
3-branch revision 141291¨ (SUSE Linux) ) #1 SMP 2009-08-15 17:53:59 +0200
setup.1a06a7: Linux is running as a z/VM guest operating system in 64-bit mode
Zone PFN ranges:
  DMA      0x00000000 -> 0x00080000
  Normal   0x00080000 -> 0x00080000
Movable zone start PFN for each node
early_node_mapÝ2¨ active PFN ranges
    0: 0x00000000 -> 0x00000100
    0: 0x00000600 -> 0x00010000
Built 1 zonelists in Zone order, mobility grouping on.  Total pages: 63232
Kernel command line: vmpoff=LOGOFF vmhalt=LOGOFF ro root=/dev/dcssblk1 TERM=dumb
  init=/linuxrc BOOT_IMAGE=0
Initializing cgroup subsys memory
Initializing cgroup subsys devices
Initializing cgroup subsys freezer
cpu.33a262: 2 configured CPUs, 0 standby CPUs
...
```

- The boot process will stop here for a while as the DCSSs are loaded.

```
doing fast boot
extmem.aa62ff: DCSS SWAPPING of range 0000000080000000 to 00000000bfffffff and t
ype EW/EN-MIXED loaded in shared access mode
dcssblk.f259b2: Loaded SWAPPING with total size 1073741824 bytes and capacity 20
97152 sectors
extmem.aa62ff: DCSS S11ROOT1 of range 00000000c0000000 to 000000013fefffff and
ype SR loaded in shared access mode
dcssblk.f259b2: Loaded S11ROOT1 with total size 2146435072 bytes and capacity 41
92256 sectors
extmem.aa62ff: DCSS S11RPM1 of range 000000013ff00000 to 0000000142efffff and ty
pe SR loaded in shared access mode
dcssblk.f259b2: Loaded S11RPM1 with total size 50331648 bytes and capacity 98304
 sectors
extmem.aa62ff: DCSS S11SHAR1 of range 0000000142f00000 to 0000000181efffff and t
ype SR loaded in shared access mode
dcssblk.f259b2: Loaded S11SHAR1 with total size 1056964608 bytes and capacity 20
64384 sectors
Creating device nodes with udev
…
..doneROR: In modified /etc/init.d/boot.rootfsck
ROR: READONLY = yes
Activating swap-devices in /etc/fstab...
..doneROR: Checking /usr/local file system...
fsck 1.41.1 (01-Sep-2008)
Ý/sbin/fsck.ext3 (1) -- /usr/local¨ fsck.ext3 -a /dev/disk/by-path/ccw-0.0.0102-
part1
/dev/disk/by-path/ccw-0.0.0102-part1: clean, 2111/75200 files, 39869/300396 bloc
ks
..doneROR: mounting dirs/files from /usr/local ...
ROR: processing bind-mount file /etc/rwtab
```



```
Mounting dir /usr/local/root over /root
Mounting dir /usr/local/srv over /srv
Mounting dir /usr/local/var over /var
Mounting dir /usr/local/etc/ssh over /etc/ssh
Mounting file /usr/local/etc/fstab over /etc/fstab
Mounting file /usr/local/etc/resolv.conf over /etc/resolv.conf
Mounting file /usr/local/etc/lvm/.cache over /etc/lvm/.cache
Mounting file /usr/local/etc/hosts over /etc/hosts
Mounting file /usr/local/etc/HOSTNAME over /etc/HOSTNAME
Mounting file /usr/local/etc/sysconfig/network/ifcfg-eth0 over /etc/sysconfig/ne
twork/ifcfg-eth0
Mounting file /usr/local/etc/sysconfig/network/routes over /etc/sysconfig/networ
k/routes
Setting up the system clockSetting up timezone data/usr/sbin/zic: Can't link fro
m /usr/share/zoneinfo/America/New_York to /etc/localtime: No such file or direct
ory
..failed
..done
Activating device mapper...
...
```

- There will be some error messages that are expected because of the read-only root file system:

```
Checking all file systems.
..donerm: cannot remove `/etc/nologin': Read-only file system
rm: cannot remove `/nologin': Read-only file system
rm: cannot remove `/fastboot': Read-only file system
rm: cannot remove `/forcefsck': Read-only file system
rm: cannot remove `/success': Read-only file system
..failed
Mounting local file systems...
mount: according to mtab, /proc is already mounted on /proc

mount: according to mtab, sysfs is already mounted on /sys

mount: according to mtab, debugfs is already mounted on /sys/kernel/debug

mount: according to mtab, udev is already mounted on /dev

mount: according to mtab, devpts is already mounted on /dev/pts

mount: /dev/disk/by-path/ccw-0.0.0102-part1 already mounted on /usr/local
/dev/dcssblk2 on /var/lib/rpm type ext2 (ro,noatime,nodiratime,xip,acl,user_xat
r)
/dev/dcssblk3 on /usr/share type ext2 (ro,noatime,nodiratime,xip,acl,user_xattr)

tmpfs on /tmp type tmpfs (rw)
..failedLoading fuse module ..done
Mounting fuse control filesystem..done
Activating remaining swap-devices in /etc/fstab...
..doneSetting current sysctl status from /etc/sysctl.conf..done
Enabling syn flood protection..done
Disabling IP forwarding..done
Disabling IPv6 forwarding..done
Disabling IPv6 privacy..done
..done
Turning quota on
Checking quotas. This may take some time.
..done
dasd(eckd): 0.0.0191: 3390/0A(CU:3990/01) Cyl:100 Head:15 Sec:224
dasd(eckd): 0.0.0191: (4kB blks): 72000kB at 48kB/trk linux disk layout
 dasdb:CMS1/  CMS192: dasdb1
Creating /var/log/boot.msg
..donerm: cannot remove `/var/lib/rpm/__db*': Read-only file system
mktemp: failed to create file via template `/etc/resolv.conf.nYz9kG': Read-only
file system
mktemp: failed to create file via template `/etc/yp.conf.psSTgU': Read-only file
 system
```

```
chmod: invalid argument: `'
/etc/netconfig.d//nis: line 148: : No such file or directory
Setting up hostname 'gpok222'..done
Setting up loopback interface     lo
    lo        IP address: 127.0.0.1/8
              IP address: 127.0.0.2/8
..done
System Boot Control: The system has been set up
System Boot Control: Running /etc/init.d/boot.local

/usr/local/sbin/boot.findself: changing (escaped) gpok222\.endicott\.ibm\.com to
 gpok231.endicott.ibm.com in /etc/HOSTNAME
/usr/local/sbin/boot.findself: changing gpok222 to gpok231 and IP address in /et
c/hosts
/usr/local/sbin/boot.findself: changing (escaped) 9\.60\.18\.222 to 9.60.18.231
in /etc/sysconfig/network/ifcfg-eth0
..done INIT: Entering runlevel: 3
...

Welcome to SUSE Linux Enterprise Server 11 (s390x) - Kernel 2.6.27.29-0.1-defaul
t (ttyS0).


gpok231 login:
...
```

6.4 Automatically creating a read-only root Linux system

Now that you have manually created a read-only system, the script **rw2ro.sh** and some additional files have been made available to help facilitate creating a read-only root system from a conventional read-write Linux system.

The script is run from the worker Linux system running on S11CLONE. The global variables and functions calls are at the bottom of the script. Here is the first set of global variables:

```
# Global variables specifying user IDs, DCSS and NSS names
srcID="RWGLD"           # source read-write golden image minus the prefix
tgtID="ROGLD"           # target read-only golden image minus the prefix
DCSS1="ROOT"            # root file system DCSS minus prefix and suffix
DCSS2="RPM"             # /var/lib/rpm/ DCSS minus prefix and suffix
DCSS3="SHAR"            # /usr/share/ DCSS minus prefix and suffix
NSS="LNX"               # name of the NSS minus prefix and suffix
```

Following are additional descriptions:

- **srcID**: The source user ID of the read-write golden image. A three character prefix is added in the parseArgs() function. The default is **S11**, thus the default source ID is S11RWGLD.
- **tgtID**: The target user ID of the golden image modified for read-only root and DCSSs. Again a three character prefix is added.
- **DCSS1**: The root file system DCSS. A three character prefix and a one character suffix are added. The defaults are **S11** and **1**, thus the default DCSS1 is S11ROOT1.
- **DCSS2**: The DCSS for the RPM database - **/var/lib/rpm/**.
- **DCSS3**: The DCSS for the **/usr/share/** file system
- **NSS**: Proposed name of the NSS. The script does not create it, but issues a message with the command to do so.

Here is the second set of global variables:

```
# Global variables specifying files that must exist in /usr/local/sbin
rootfsckFile="/usr/local/sbin/boot.rootfsck.S11" # modified from /etc/init.d
```



```
mkinitrdFile="/usr/local/sbin/72-block.sh.S11"  # mod'd from /lib/mkinitrd/setup
fstabFile="/usr/local/sbin/fstab.S11"            # modified from /etc
rwtabFile="/usr/local/sbin/rwtab"                # new /etc/ file
readonlyrootFile="/usr/local/sbin/readonly-root" # new /etc/sysconfig file
```

The function calls are as follow:

```
. rorfuncs.sh           # "source" the common functions
parseArgs $@            # parse arguments
checkIDs                # verify source and target IDs exist & are logged off
setUpEnv                # verify DCSSs, create mount points
enableSourceEnv         # enable and mount the source root file system
enableTargetDCSSs       # enable the target DCSSs
enableTargetFSs         # enable the target file systems
copyRootFileSystem      # copy source root file system to target
mountRemaining          # mount remaining file systems
copyRemaining           # copy remaining file systems from source to target
modifySystem            # modify target system to be read-only
cleanUp                 # unmount FSs, disable and detach devices
saveDCSSs               # save DCSS1, DCSS2 and DCSS3
```

See The rw2ro.sh script on page 79 for a complete listing of script. Here is a high level description of the functions.

- The first line loads the common functions in the **rorfuncs.sh** file.
- **parseArgs()** parses the arguments: a **-p** flag for the distribution prefix and a **-s** flag for a counter suffix
- **checkIDs()** verifies that the source and target user IDs exist and are logged off.
- **setUpEnv()** sets up the environment by creating mount points under /mnt/ if necessary
- **enableSourceEnv()** links the S11RWGLD 100-103 disks read-only and enables them
- **enableTargetDCSSs()** sets the three DCSSs to not shared and makes file systems out of them
- **enableTargetFSs()** links the S11ROGLD 100 and 102 disks read-write and enables them
- **copyRootFileSystem()** copies the source root file system (**/mnt/src/**) to the target. (**/mnt/tgt/**).
- **mountRemaining()** mounts the remaining source and target file systems once the root has been copied.
- **copyRemaining()** copies the remaining file systems:
  - **/boot/**
  - **/usr/share/**
  - **/usr/local/**
  - **/var/lib/rpm/**
- **modifySystem()** backs up and modifies the configuration files described previously. Also the file **/etc/rwtab** is processed to bind-mount all directories and files listed from **/usr/local/** over the corresponding location in the root file system.
- **cleanUp()** unmounts file systems then disables and detaches devices that were linked to previously.
- **saveDCSSs()** saves the changes to the three target DCSSs that will become file systems

6.4.1 Running the rw2ro.sh script

Start an SSH session to S11CLONE as root. It is recommended that you leave your 3270 session up as messages from the DCSS block driver are often sent to the console. However, you may have to clear the screen many times.

Run the **rw2ro.sh** script. This performs all the steps automatically that were described in section 6.2 , Manually creating a read-only root system on page 38.


```
# time rw2ro.sh
The DCSSs will be S11ROOT2, S11RPM2 and S11SHAR2
The NSS should be named S11LNX2
The source and target user IDs are S11RWGLD and S11ROGLD

Checking source ID ...
HCPCQU045E S11RWGLD not logged on
Error: non-zero CP response for command 'QUERY S11RWGLD': #45
Checking target ID ...
HCPCQU045E S11ROGLD not logged on
Error: non-zero CP response for command 'QUERY S11ROGLD': #45

Setting up environment ...

Linking source disks ...

Enabling source disks ...
Setting device 0.0.1100 online
Done
Setting device 0.0.1101 online
Done
Setting device 0.0.1102 online
Done
Setting device 0.0.1103 online
Done

Setting DCSSs to not shared ...

Making ext2 file systems on the DCSSs ...
mke2fs 1.41.1 (01-Sep-2008)
mke2fs 1.41.1 (01-Sep-2008)
mke2fs 1.41.1 (01-Sep-2008)

Linking target disks ...

Enabling target disks ...
Setting device 0.0.2100 online
Done
Setting device 0.0.2102 online
Done

Copying the root file system (this might take a few minutes) ...

Mounting remaining source file systems ...

Formatting and mounting remaining target file systems ...

Formatting and mounting /dev/dasdf1 over /mnt/tgt/boot ...
mke2fs 1.41.1 (01-Sep-2008)
mke2fs 1.41.1 (01-Sep-2008)

Formatting and mounting /dev/dasdg1 over /mnt/tgt/usr/local ...
mke2fs 1.41.1 (01-Sep-2008)
mke2fs 1.41.1 (01-Sep-2008)

Copying /boot ...
```



```
Copying /usr/share (this might take a few minutes) ...

Copying /usr/local ...

Copying /var/lib/rpm ...

Copying modified boot.rootfsck script ...

Backing up and copying modified /etc/fstab file ...

Backing up and copying modified /etc/zipl.conf file ...

Backing up and copying /lib/mkinitrd/setup/72-block.sh file ...

Backing up and modifying /etc/modprobe.conf.local file ...

Copying /etc/rwtab file ...

Copying /etc/sysconfig/readonly-root file ...

Making /etc/mtab a symbolic link to /proc/mounts ...
/usr/local/sbin

Running zipl in target environment ...

Kernel image:   /boot/image-2.6.27.29-0.1-default
Initrd image:   /boot/initrd-2.6.27.29-0.1-default
Root device:    /dev/dcssblk1 (mounted on / as ext2)
Kernel Modules: dcssblk mbcache ext2
Features:       block
13248 blocks
Using config file '/etc/zipl.conf'
Building bootmap in '/boot/zipl'
Building menu 'menu'
Adding #1: IPL section 'LinuxV1' (default)
Adding #2: IPL section 'ipl'
Preparing boot device: dasdf (2100).
Done.

Copying files and directories in /etc/rwtab ...
Copying dir /mnt/tgt/root/* to /mnt/tgt/usr/local/root ...
Created directory /mnt/tgt/usr/local/root
Copying dir /mnt/tgt/srv/* to /mnt/tgt/usr/local/srv ...
Created directory /mnt/tgt/usr/local/srv
Copying dir /mnt/tgt/var/* to /mnt/tgt/usr/local/var ...
Created directory /mnt/tgt/usr/local/var
Copying dir /mnt/tgt/etc/ssh/* to /mnt/tgt/usr/local/etc/ssh ...
Created directory /mnt/tgt/usr/local/etc/ssh
Copying file /mnt/tgt/etc/fstab to /mnt/tgt/usr/local/etc/fstab ...
Copying file /mnt/tgt/etc/resolv.conf to /mnt/tgt/usr/local/etc/resolv.conf ...
Copying file /mnt/tgt/etc/lvm/.cache to /mnt/tgt/usr/local/etc/lvm/.cache ...
Created directory /mnt/tgt/usr/local/etc/lvm
Copying file /mnt/tgt/etc/hosts to /mnt/tgt/usr/local/etc/hosts ...
Copying file /mnt/tgt/etc/HOSTNAME to /mnt/tgt/usr/local/etc/HOSTNAME ...
Copying file /mnt/tgt/etc/sysconfig/network/ifcfg-eth0 to
/mnt/tgt/usr/local/etc/sysconfig/network/ifcfg-eth0 ...
Created directory /mnt/tgt/usr/local/etc/sysconfig/network
Copying file /mnt/tgt/etc/sysconfig/network/routes to
/mnt/tgt/usr/local/etc/sysconfig/network/routes ...
```

```
Cleaning up target disks ...

Disabling target disks ...
Setting device 0.0.2100 offline
Done
Setting device 0.0.2102 offline
Done

DETACHing target disks ...
DASD 2100 DETACHED
DASD 2102 DETACHED

Cleaning up source disks ...

Disabling source disks ...
Setting device 0.0.1100 offline
Done
Setting device 0.0.1101 offline
Done
Setting device 0.0.1102 offline
Done
Setting device 0.0.1103 offline
Done

DETACHing source disks ...
DASD 1100 DETACHED
DASD 1101 DETACHED
DASD 1102 DETACHED
DASD 1103 DETACHED

Saving S11ROOT2 (this takes some time) ...

Saving S11RPM2 ...

Saving S11SHAR2 (this takes some time) ...
To create an NSS, logon to S11ROGLD and: ipl 100 parm savesys=S11LNX2

real    19m12.441s
user    0m18.897s
sys     0m32.819s
```

The system on S11ROGLD should now have a “hybrid” read-only system utilizing DCSSs and it should be ready to write an NSS. You can again clone a read-only server. The results should be identical, or at least very similar to the results of running through the manual steps.

Section 7: Maintaining systems

There is a simple model for maintaining read-write Linux systems: those systems cloned after a modification to the golden image will pick up the change. Systems cloned previous to the change will have to be modified manually. There is nothing new here.

There is something new with the addition of DCSSs – they add an approach to maintaining read-only root systems. After the golden image is changed, the DCSSs can be updated with the **rw2ro.sh** script. Running that script will immediately change the contents of the DCSSs (S11ROOT1, S11SHAR1 and/or S11RPM1 in this example). However, the read-only root Linux “clones” will not immediately pick up the changes. Rather they will continue to use their memory-mapped copy of the

DCSSs until they are rebooted. This model should simplify maintenance – to pick up changes, the read-only clones should only have to be recycled.

However, you may wish to have a new set of DCSSs while still maintaining the old set. This will be more complex but may be necessary if multiple versions of Linux distributions must be concurrently supported, for example, SLES11 and SLES11 SP1.

The simple approach to maintenance is described in section 7.1 , Modifying systems without creating new DCSSs immediately following. The approach using multiple sets of DCSSs is described in section 7.2 , Modifying systems by creating new DCSSs on page 57.

7.1 Modifying systems without creating new DCSSs

As an example of applying some maintenance, a simple modification is made: some services that are configured to be started are turned off.

1. Boot the golden image on S11RWGLD.
2. Use the **chkconfig** command to show which services start in run level 3:

```
# chkconfig --list | grep 3:on
cron                    0:off  1:off  2:on   3:on   4:off  5:on   6:off
cups                    0:off  1:off  2:on   3:on   4:off  5:on   6:off
dbus                    0:off  1:off  2:on   3:on   4:off  5:on   6:off
earlysyslog             0:off  1:off  2:on   3:on   4:off  5:on   6:off
fbset                   0:off  1:on   2:on   3:on   4:off  5:on   6:off
haldaemon               0:off  1:off  2:on   3:on   4:off  5:on   6:off
irq_balancer            0:off  1:on   2:on   3:on   4:off  5:on   6:off
network                 0:off  1:off  2:on   3:on   4:off  5:on   6:off
network-remotefs        0:off  1:off  2:on   3:on   4:off  5:on   6:off
nfs                     0:off  1:off  2:off  3:on   4:off  5:on   6:off
nscd                    0:off  1:off  2:off  3:on   4:off  5:on   6:off
postfix                 0:off  1:off  2:off  3:on   4:off  5:on   6:off
random                  0:off  1:off  2:on   3:on   4:off  5:on   6:off
rpcbind                 0:off  1:off  2:off  3:on   4:off  5:on   6:off
smartd                  0:off  1:off  2:on   3:on   4:off  5:on   6:off
smbfs                   0:off  1:off  2:off  3:on   4:off  5:on   6:off
splash                  0:off  1:on   2:on   3:on   4:off  5:on   6:off  S:on
splash_early            0:off  1:off  2:on   3:on   4:off  5:on   6:off
sshd                    0:off  1:off  2:off  3:on   4:off  5:on   6:off
syslog                  0:off  1:off  2:on   3:on   4:off  5:on   6:off
xinetd                  0:off  1:off  2:off  3:on   4:off  5:on   6:off
```

The output shows that 21 services are set to start in run level 3.

3. It is decided that the services **cups**, **postfix**, **smbfs** and **xinetd** should not be started. Use the following **for** loop to turn these services off:

```
# for service in cups postfix smbfs xinetd
> do
>   chkconfig $service off
> done
```

Shut down the golden image:

```
# shutdown -h now
...
```

The system should shut down and the user ID be logged off automatically. The golden image has now been updated to run fewer services in run level 3.

7.1.1 Creating a new read-write clone

From S11CLONE, create a new read-write clone with the **clonerw.sh** script. In this example, the existing LNX227 user ID is cloned over:

```
# clonerw.sh lnx227
...
```

Log on to LNX227 and IPL Linux. When the system comes up you should see that these four services are off:

```
# chkconfig --list | grep 3:on
cron                    0:off  1:off  2:on   3:on   4:off  5:on   6:off
dbus                    0:off  1:off  2:on   3:on   4:off  5:on   6:off
earlysyslog             0:off  1:off  2:on   3:on   4:off  5:on   6:off
fbset                   0:off  1:on   2:on   3:on   4:off  5:on   6:off
haldaemon               0:off  1:off  2:on   3:on   4:off  5:on   6:off
irq_balancer            0:off  1:on   2:on   3:on   4:off  5:on   6:off
network                 0:off  1:off  2:on   3:on   4:off  5:on   6:off
network-remotefs        0:off  1:off  2:on   3:on   4:off  5:on   6:off
nfs                     0:off  1:off  2:off  3:on   4:off  5:on   6:off
nscd                    0:off  1:off  2:off  3:on   4:off  5:on   6:off
random                  0:off  1:off  2:on   3:on   4:off  5:on   6:off
rpcbind                 0:off  1:off  2:off  3:on   4:off  5:on   6:off
smartd                  0:off  1:off  2:on   3:on   4:off  5:on   6:off
splash                  0:off  1:on   2:on   3:on   4:off  5:on   6:off  S:on
splash_early            0:off  1:off  2:on   3:on   4:off  5:on   6:off
sshd                    0:off  1:off  2:off  3:on   4:off  5:on   6:off
syslog                  0:off  1:off  2:on   3:on   4:off  5:on   6:off
```

More simply, the output of the previous command can be piped to the **wc** command, word count, to see that there are now 17 services that will start in run level 3:

```
# chkconfig --list | grep 3:on | wc -l
     17
```

This shows that a newly-cloned read-write Linux server picked up the change to the golden image.

7.1.2 Updating the read-only golden image

Update the read-only golden image on S11ROGLD and the DCSSs from the read-write image on S11RWGLD. This is done from the cloner on S11CLONE using the **rw2ro.sh** script:

```
# rw2ro.sh
...
```

This will copy the change from the golden image on S11RWGLD to the two disks on S11ROGLD and the read-only DCSSs, S11ROOT1, S11SHAR1 and S11RPM1.

7.1.3 Creating a new read-only clone

Create a new read-write clone with the **clonerw.sh** script. In this example, a new user ID, LNX232 is defined. It has a directory entry copied from LNX231. It is given access to the VSWITCH and a SLES 11 parameter file is created with the correct IP address and host name:

```
# clonero.sh lnx232
...
```

Log on to LNX232 and IPL Linux from the S11LNX1 NSS. When the system comes up you should see that these four

services are off:

```
# chkconfig --list | grep 3:on | wc -l
     17
```

This shows that a newly-cloned read-only Linux server picked up the change to the modifed read-only golden image.

7.1.4 Updating an existing read-only clone

The system running on LNX231 still has a copy of the original root file system, that starts 21 services.

```
# chkconfig --list | grep 3:on | wc -l
21
```

To pick up the modified DCSS, simply shut the virtual machine down:

```
# shutdown -h now
```

The system should be automatically logged off. Log back on to LNX231 and IPL Linux from the S11LNX1 NSS. The four services should now be off:

```
# chkconfig --list | grep 3:on | wc -l
     17
```

This shows that the original DCSSs were in memory and still being used, then when the system was recycled the modified DCSSs were loaded.

It should be noted that significant changes to the system could be such that the read-write directories and files no longer work properly with the read-only system. However, since there are relatively few read-write components that interact with the system (**/var/** and a handful of **/etc/** files), this possibility should be minimized. Of course adequate testing is required before rolling out any changes.

7.2 Modifying systems by creating new DCSSs

In the above scenario, it is basically a one way trip from the golden image that starts 21 services to the one that starts 17 (you could restore the original system from the S11RWGLD 20x disks, and re-run the **rw2ro.sh** script as an effective rollback).

But perhaps you would like to keep some servers at the current golden image, but move others forward. A second maintenance example is used: certain servers need the **nmap** RPM, but others do not, due to security reasons. Existing read-only clones can be left running the S11xxxx1 DCSSs, but the servers to get the nmap package would require a new set of DCSSs.

First let's look at the available spool space:

```
==> q alloc spool
                EXTENT     EXTENT  TOTAL  PAGES   HIGH    %
VOLID  RDEV      START        END  PAGES IN USE   PAGE USED
------ ---- ---------- ---------- ------ ------ ------ ----
DV6153 6153          1       3338 600840 288643 600840  48%
DS61A0 61A0          0      10016  1761K 958084  1244K  53%
DS632F 632F          0       3338 601020 433830 598471  72%
                                  ------ ------        ----
SUMMARY                            2934K  1641K         55%
USABLE                             2934K  1641K         55%
```

It is 55% used and there should be enough space to add a second set of DCSSs.

Perform the following steps to add the nmap DCSS:

- Boot the golden image from S11RWGLD

- Query the number of RPMs on the golden image with the rpm and wc commands:

```
# rpm -qa | wc -l
    883
```

  This shows that there are 883 RPMs (your value may vary).

- Add the **nmap** RPM with the **zypper** command:

```
# zypper install nmap
Loading repository data...
Reading installed packages...
Resolving package dependencies...

The following NEW packages are going to be installed:
  libdnet1 liblua5_1 nmap


Overall download size: 1.1 M. After the operation, additional 4.8 M will be used.
Continue? [YES/no]:
Retrieving package liblua5_1-5.1.4-1.15.s390x (1/3), 79.0 K (217.0 K unpacked)
Installing: liblua5_1-5.1.4-1.15 [done]
Retrieving package libdnet1-1.11-87.17.s390x (2/3), 23.0 K (68.0 K unpacked)
Installing: libdnet1-1.11-87.17 [done]
Retrieving package nmap-4.75-1.26.s390x (3/3), 1.0 M (4.5 M unpacked)
Installing: nmap-4.75-1.26 [done]
```

- Note that zypper installed two co-requisite RPMs. Again query the number of RPMs on the system:

```
# rpm -qa | wc -l
    886
# halt
...
```

  There are now 886.

- Shut the system down:

```
# halt
...
```

7.2.1 Creating new DCSSs

Create three new DCSSs on the S11CLONE virtual machine.

- Start a 3270 emulator session, shutdown the Linux system on S11CLONE,
- Define storage to 8G and IPL CMS:

```
==> def stor 8G
00: STORAGE = 8G
00: Storage cleared - system reset.

==> ipl cms
z/VM V5.4.0    2008-10-22 15:36

DMSACP723I A (191) R/O
DMSACP723I C (592) R/O
Do you want to IPL Linux from 100? y/n
n
...
```

- Define and save a DCSS of type SR with the name **S11ROOT2** . The **SAVESEG** command saves the DCSS:


```
==> defseg s11root2 C0000-13FEFF sr loadnshr
00: HCPNSD440I Saved segment S11ROOT2 was successfully defined in fileid 0303.
==> saveseg s11root2
00: HCPNSS440I Saved segment S11ROOT2 was successfully saved in fileid 0303.
```

- Define and save a DCSS with the name **S11RPM2** :

```
==> defseg s11rpm2 13FF00-142EFF sr loadnshr
00: HCPNSD440I Saved segment S11RPM2 was successfully defined in fileid 0304.
==> saveseg s11rpm2
00: HCPNSS440I Saved segment S11RPM2 was successfully saved in fileid 0304.
```

- Define and save a DCSS with the name **S11SHAR2** :

```
==> defseg s11shar2 142F00-181EFF sr loadnshr
00: HCPNSD440I Saved segment S11SHAR2 was successfully defined in fileid 0305.
==> saveseg s11shar2
00: HCPNSS440I Saved segment S11SHAR2 was successfully saved in fileid 0305.
```

- Observe the new DCSSs:

```
==> q nss
...
*NSS     0300 NSS  A  524K 11/30 14:20:41 S11ROOT1 DCSSG    S11CLONE
*NSS     0301 NSS  A  012K 11/30 14:27:58 S11RPM1  DCSSG    S11CLONE
*NSS     0302 NSS  A  258K 11/30 14:28:09 S11SHAR1 DCSSG    S11CLONE
*NSS     0303 NSS  A  524K 11/30 16:24:26 S11ROOT2 DCSSG    S11CLONE
*NSS     0304 NSS  A  012K 11/30 16:32:03 S11RPM2  DCSSG    S11CLONE
*NSS     0305 NSS  A  258K 11/30 16:32:39 S11SHAR2 DCSSG    S11CLONE
```

- Set the memory size back to 256 MB.

```
==> def stor 256m
STORAGE = 256M
Storage cleared - system reset.
```

- IPL Linux on S11CLONE.

```
==> ipl 100
00: zIPL v1.8.0 interactive boot menu
...
```

- Start an SSH session as root to S11CLONE.
- The new DCSSs must be loaded. Modify the **/etc/modprobe.conf.local** file to specify the new DCSSs :

```
# cd /etc
# vi modprobe.conf.local
#
# please add local extensions to this file
#
options dcssblk "segments=SWAPPING,S11ROOT2,S11RPM2,S11SHAR2"
```

- Run the **mkinitrd** and **zipl** commands to write the changes to the **/boot/** directory:

```
# mkinitrd

Kernel image:   /boot/image-2.6.27.42-0.1-default
Initrd image:   /boot/initrd-2.6.27.42-0.1-default
Root device:    /dev/disk/by-path/ccw-0.0.0100-part1 (/dev/dasda1) (mounted on / as
ext3)
Kernel Modules: jbd mbcache ext3 dcssblk dasd_mod dasd_eckd_mod
Features:       block dasd
14515 blocks
# zipl
Using config file '/etc/zipl.conf'
Building bootmap in '/boot/zipl'
Building menu 'menu'
```

```
Adding #1: IPL section 'LinuxV1' (default)
Adding #2: IPL section 'ipl'
Preparing boot device: dasda (0100).
Done.
```

- Reboot the system:

```
# reboot
...
```

- When the system comes back up, verify that the new DCSSs that are loaded:

```
# ls /sys/devices/dcssblk/
S11ROOT2  S11RPM2  S11SHAR2  SWAPPING  add  remove  uevent
```

  This shows that the new DCSSs can be loaded.

- Use the **rw2ro.sh** script with the **-s** flag to specify DCSS suffix of **2**. Note the new DCSS names are echoed in the first line of output:

```
# rw2ro.sh -s 2
The DCSSs will be S11ROOT2, S11RPM2 and S11SHAR2
The NSS should be named S11LNX2
The source and target user IDs are S11RWGLD and S11ROGLD

Checking source ID ...
...
Saving S11ROOT2 (this takes some time) ...

Saving S11RPM2 ...

Saving S11SHAR2 (this takes some time) ...
To create an NSS, logon to S11ROGLD and: ipl 100 parm savesys=S11LNX2
```

- Look at the spool space:

```
==> q alloc spool
                EXTENT     EXTENT  TOTAL  PAGES   HIGH    %
VOLID  RDEV      START        END  PAGES IN USE   PAGE USED
------ ---- ---------- ---------- ------ ------ ------ ----
DV6153 6153          1       3338 600840 600840 600840 100%
DS61A0 61A0          0      10016  1761K  1233K  1245K  70%
DS632F 632F          0       3338 601020 601020 601020 100%
                                  ------ ------         ----
SUMMARY                            2934K  2407K         82%
USABLE                             2934K  2407K         82%
```

  In this example, the spool space is 82% used. There would probably have to be more added in order to go beyond two sets of DCSSs

- Log on to S11ROGLD and create a new NSS names S11LNX2:

```
==> ipl 100 parm savesys=S11LNX2
00: zIPL v1.8.0 interactive boot menu
00:
00:  0. default (LinuxV1)
00:
00:  1. LinuxV1
00:  2. ipl
00:
00: Note: VM users please use '#cp vi vmsg <number> <kernel-parameters>'
```



```
00:
00: Please choose (default will boot in 3 seconds):
00: Booting default (LinuxV1)...
00: HCPNSD440I The Named Saved System (NSS) S11LNX2 was successfully defined in
fileid 0309.
00: HCPNSS440I Named Saved System (NSS) S11LNX2 was successfully saved in fileid
 0309.
Initializing cgroup subsys cpuset
...
```

- Shutdown Linux running on S11ROGLD.
- Start a 3270 session on LNX231 and IPL the updated system with the command **IPL S11LNX2**:

```
LOGON LNX231
00: NIC 0600 is created; devices 0600-0602 defined
00: z/VM Version 5 Release 4.0, Service Level 0903 (64-bit),
00: built on IBM Virtualization Technology
00: There is no logmsg data
00: FILES:   NO RDR,   NO PRT,   NO PUN
00: LOGON AT 14:22:36 EST FRIDAY 02/19/10
z/VM V5.4.0    2009-12-17 10:13

DMSACP723I A (191) R/O
DMSACP723I C (592) R/O
00: HCPQVD040E Device 0100 does not exist
Do you want to IPL Linux from S11LNX1? y/n
n
==> ipl s11lnx2
...
```

- The system should boot relatively cleanly. Start an SSH session and use the rpm -qa command to verify there are now three more RPMs and that the **nmap** command works:

```
# rpm -qa | wc -l
    886
# nmap -v -A scanme.nmap.org

Starting Nmap 4.75 ( http://nmap.org ) at 2009-12-01 20:54 UTC
Initiating Ping Scan at 20:54
Scanning 64.13.134.52 [2 ports]
Completed Ping Scan at 20:54, 0.06s elapsed (1 total hosts)
...
```

You should now have two systems that can be IPLed by NSS name:

NSS name	Number of services started	Number of RPMs
S11LNX1	17	883
S11LNX2	21	886

This section has shown how to maintain multiple golden images in DCSSs with a very simple example.

In the remaining sections that follow, all source code and configuration files used in this environment are listed.

Section 8: z/VM source code

This section contains listings of the following z/VM source code files included with the associated tar file

- **SLES11.EXEC**

- **SAMPLE.PARM-S11**
- **PROFILE.XEDIT**
- **PROFILE.EXEC**

8.1 The SLES11 EXEC

Following is the EXEC to start a SLES 11 installation, **SLES11.EXEC**:

```
/* EXEC to punch SLES-11 install system to reader and IPL from it */
Address 'COMMAND'
'CP SPOOL PUN *'
'CP CLOSE RDR'
'CP PURGE RDR ALL'
'PUNCH SLES11     KERNEL * (NOHEADER'
'PUNCH' Userid() 'PARM-S11 * (NOHEADER'
'PUNCH SLES11     INITRD * (NOHEADER'
'CP CHANGE RDR ALL KEEP'
'CP IPL 00C CLEAR'
```

8.2 The file SAMPLE.PARM-S11

Following is the sample SLES 11 parameter file, **SAMPLE.PARM-S11**:

```
ramdisk_size=65536 root=/dev/ram1 ro init=/linuxrc TERM=dumb
HostIP=9.60.18.222 Hostname=gpok222.endicott.ibm.com
Gateway=9.60.18.129 Netmask=255.255.255.128
Broadcast=9.60.18.255 Layer2=0
ReadChannel=0.0.0600  WriteChannel=0.0.0601  DataChannel=0.0.0602
Nameserver=9.0.2.11
portname=whatever
portno=0
Install=nfs://9.60.18.133/nfs/sles11/dvd1
UseVNC=1  VNCPassword=12345678
InstNetDev=osa OsaInterface=qdio OsaMedium=eth Manual=0
```

8.3 The PROFILE EXEC

Following is the **PROFILE EXEC** to be used by Linux virtual machines:

```
/* PROFILE EXEC for Linux virtual servers                          */
Address 'COMMAND'
'CP SET RUN ON'
'CP SET PF11 RETRIEVE FORWARD'
'CP SET PF12 RETRIEVE'
'ACCESS 592 C'
'PIPE CP QUERY' Userid() '| VAR USER'
Parse Value user With id . dsc .
iplDisk = 100                  /* /boot/ is on minidisk 100     */
iplNSS  = S11LNX1              /* or it is an NSS               */
'CP QUERY VIRTUAL' iplDisk     /* does this ID have an IPL disk */
If (rc = 0) Then               /* IPL disk exists               */
  iplDevice = iplDisk
Else                           /* assume NSS is IPL device      */
```



```
  iplDevice = iplNSS
If (dsc = 'DSC') Then          /* user is disconnected          */
  'CP IPL' iplDevice
Else Do                        /* user is interactive -> prompt */
  Say 'Do you want to IPL Linux from' iplDevice'? y/n'
  Parse Upper Pull answer .
  If (answer = 'Y') Then
    'CP IPL' iplDevice
  End
Exit
```

8.4 The XEDIT PROFILE

Following is an XEDIT profile to be used on the CMSCLONE virtual machine.

```
********** THIS IS THE REAL THING ***********
SET NUM ON
SET NULLS ON
SET CASE M I
SET SERIAL OFF
SET PF3 QUIT
SET PF7 BACK
SET PF8 FORWARD
SET PF9 SPLTJOIN
SET PF10 RIGHT 10
SET PF11 LEFT 10
SET PF12 ?
SET PF23 SPLTJOIN
SET CMDLINE BOTTOM
SET CURLINE ON 3
SET SCALE OFF
SET STAY ON
```

Section 9: Linux source code

This section contains listings of the Linux source code which are all bash shell scripts:

- bak2pri.sh Script to rollback the backup golden image to the primary
- boot.findself Script to set the IP address and host name at first boot - see page 64.
- boot.local Modified script to invoke boot.findself at first boot – see page 67
- boot.rootfsck Modified SLES 11 script to set up either a read-write or read-only root Linux system - see page 67
- cloneprep.sh Script to prepare system before cloning - see page 72
- clonero.sh Script to clone a read-only Linux - see page 72
- clonerw.sh Script to clone a read-write Linux - see page 73
- pri2bak.sh Script to back up the primary golden image - see page 74
- rorfuncs.sh Common functions used by other scripts - see page 75
- rw2ro.sh Script to create R/W golden image on S11RWGLD to R/O system on S11ROGLD - see page 79
- 72-block.sh Modified script so initrd will recognize the dcssblk driver – see

9.1 The bak2pri.sh script

Following is **bak2pri.sh** script.

```
#!/bin/bash
. rorfuncs.sh                   # load the common functions
userID="S11RWGLD"               # set the source and target user ID

# verify that the user ID is logged off
checkID $userID
if [ $? != 0 ]; then exit 1; fi # not logged off => exit

# copy the three backup 20x minidisks to the primary 10x minidisks
copyDisk $userID 200 to $userID 100
copyDisk $userID 201 to $userID 101
copyDisk $userID 202 to $userID 102
```

9.2 The boot.findself script

Following is **boot.findself** script.

```
#!/bin/bash
#
# /etc/init.d/boot.findself
#
### BEGIN INIT INFO
# Provides:          boot.findself
# Required-Start:    boot.localfs
# Required-Start:
# Required-Stop:
# Default-Start:     B
# Default-Stop:
# Description:       upon first boot find/modify IP@ + hostname, gen SSH keys
### END INIT INFO
#
# This script requires two SLES 11 parameter files to exist on the user ID's
# 191 disk: (1) the file S11RWGLD PARM-S11 and (2) $userid PARM-S11 where
# $userid is the ID of the user that is running the script. It then modifies
# the IP address, Host name and fully qualified domain name in three
# configuration files that contain this info. It also regenerates SSH keys.
# The script then turns itself off via "chkconfig" so it only runs once.
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# LEGAL THEORIES.
#
#+-----------------------------------------------------------------------------+
function findID()
# Get my VM user ID - don't find self on S11ROGLD or S11RWGLD
#+-----------------------------------------------------------------------------+
 {
  myID=$(cat /proc/sysinfo | grep "VM00 Name" | awk '{print $3}')
  if [ $myID = "S11RWGLD" ] || [ $myID = "S11ROGLD" ]; then # do nothing
    exit 1
  fi
 }

#+-----------------------------------------------------------------------------+
function enableAdisk()
# Enable my 191 (A) disk
#+-----------------------------------------------------------------------------+
 {
  /sbin/chccwdev -e 191 > /dev/null 2>&1
  rc=$?
  if [ $rc != 0 ]; then # unable to enable 191 disk
    echo "$0: Unable to enable 191, rc from chccwdev = $rc"
    exit 1
  fi
  sleep 1    # wait a sec to be sure disk is ready
  Adisk=/dev/$(egrep '^0.0.0191' /proc/dasd/devices | awk '{print $7}')
 }

#+-----------------------------------------------------------------------------+
function findSourceIP()
# Get the source IP address and hostName
#+-----------------------------------------------------------------------------+
 {
  sourceParm="$sourceID.$parmType"
  /usr/bin/cmsfslst -d $Adisk | grep $sourceID | grep $parmType > /dev/null
  rc=$?
  if [ $rc != 0 ]; then
    echo "$0: $sourceParm not found on 191 minidisk. Exiting"
    exit 2
  fi
  export local $(/usr/bin/cmsfscat -a -d $Adisk $sourceParm)
  # set global variable names escaping any dots (.) in the strings
  sourceName=$(echo "$Hostname" | sed -e 's:\.:\\\.:g')
  sourceHost=${Hostname%%.*}  # Chop domain name off to leave host name
  sourceIP=$(echo "$HostIP" | sed -e 's:\.:\\\.:g')
  sourceOSA=$(echo "$ReadChannel " | sed -e 's:\.:\\\.:g')
 }

#+-----------------------------------------------------------------------------+
function findTargetIP()
# Get my new IP address and hostname
```

```
#+-----------------------------------------------------------------------+
 {
  targetParm="$myID.$parmType"
  /usr/bin/cmsfslst -d $Adisk | grep $myID | grep $parmType > /dev/null
  rc=$?
  if [ $rc != 0 ]; then
    echo "$0: $targetParm not found on 191 minidisk. Exiting"
    exit 3
  fi
  export local $(/usr/bin/cmsfscat -a -d $Adisk $targetParm)
  targetName=$Hostname
  targetHost=${Hostname%%.*}  # Chop domain name off to leave host name
  targetIP=$HostIP
 }

#+-----------------------------------------------------------------------+
function modifyIP()
# Modify IP address and host name in /etc/HOSTNAME, /etc/hosts and
#  /etc/sysconfig/network/ifcfg-qeth-bus-ccw-$ReadChannel
#+-----------------------------------------------------------------------+
 {
  # TODO: this function should also modify, DNS, Gateway, broadcast, etc.
  eth0file="/etc/sysconfig/network/ifcfg-eth0"
  echo ""
  echo "$0: changing (escaped) $sourceName to $targetName in /etc/HOSTNAME"
  /usr/bin/sed -e "s/$sourceName/$targetName/g" /etc/HOSTNAME > /usr/local/HOSTNAME
  /bin/cp /usr/local/HOSTNAME /etc
  /bin/rm /usr/local/HOSTNAME
  echo "$0: changing $sourceHost to $targetHost and IP address in /etc/hosts"
  /usr/bin/sed  -e "s/$sourceHost/$targetHost/g" \
                -e "s/$sourceIP/$targetIP/g" /etc/hosts > /usr/local/hosts
  /bin/cp /usr/local/hosts /etc
  /bin/rm /usr/local/hosts
  echo "$0: changing (escaped) $sourceIP to $targetIP in $eth0file"
  /usr/bin/sed -e "s/$sourceIP/$targetIP/g" $eth0file > /usr/local/ifcfg-eth0
  /bin/cp /usr/local/ifcfg-eth0 /etc/sysconfig/network
  /bin/rm /usr/local/ifcfg-eth0
  /bin/hostname $targetHost
 }

# main()
# global variables
sourceID="S11RWGLD"       # VM user ID where first Linux was installed
parmType="PARM-S11"       # File type of parameter file on 191 disk

# function calls
findID
enableAdisk
findSourceIP
findTargetIP
modifyIP
rm /etc/ssh/ssh_host_*    # Delete SSH keys so sshd will recreate new ones
```


9.3 The boot.local script

Following is the modified **/etc/init.d/boot.local** script.

```
#! /bin/sh
#
# Copyright (c) 2002 SuSE Linux AG Nuernberg, Germany.  All rights reserved.
#
# Author: Werner Fink <werner@suse.de>, 1996
#         Burchard Steinbild, 1996
#
# /etc/init.d/boot.local
#
# script with local commands to be executed from init on system startup
#
# Here you should add things, that should happen directly after booting
# before we're going to the first run level.
#
if [ -f /usr/local/sbin/boot.findself ]; then # this is first boot
  /usr/local/sbin/boot.findself               # run it to set IP@ & hostname
  if [ $? = 0 ]; then                         # then success => rename
    /bin/mv /usr/local/sbin/boot.findself /usr/local/sbin/boot.findself.hasrun
  fi
fi
```

9.4 The boot.rootfsck script

Following is the modified **/etc/init.d/boot.rootfsck** script.

```
 #! /bin/sh
#
# Copyright (c) 2001-2002 SuSE Linux AG, Nuernberg, Germany.
# All rights reserved.
#
# /etc/init.d/boot.rootfsck
#
### BEGIN INIT INFO
# Provides:          boot.rootfsck
# Required-Start:    boot.udev
# Required-Stop:     $null
# Default-Start:     B
# Default-Stop:
# Short-Description: check and mount root filesystem
# Description:       check and mount root filesystem
### END INIT INFO

. /etc/rc.status

# to get max number of parallel fsck processes
. /etc/sysconfig/boot

export FSCK_MAX_INST

rc_reset

case "$1" in
  start)
        # ROR: add read-only root processing
```

```
 if [ -f /etc/sysconfig/readonly-root ]; then
   . /etc/sysconfig/readonly-root
 else # no config file, assume no
   READONLY=no
 fi
 cat /proc/cmdline | grep "readonlyroot" >/dev/null
 if [ $? = 0 ]; then
   READONLY=yes
 fi
 if [ -z "$RW_MOUNT" ]; then # string is empty => set it
    RW_MOUNT=/usr/local
 fi
 cat /proc/cmdline | grep "noreadonlyroot" >/dev/null
 if [ $? = 0 ]; then # "noreadonlyroot" parm trumps "readonlyroot"
   READONLY=no
 fi
 if [ "$READONLY" = "yes" ]; then
  echo "ROR: In modified $0"
   ROOTFS_FSCK="" # don't bypass fsck
 fi
 echo "ROR: READONLY = $READONLY"
 # ROR: end block
#
# fsck may need a huge amount of memory, so make sure, it is there.
#
echo "Activating swap-devices in /etc/fstab..."
swapon -ae &> /dev/null
rc_status -v1 -r

#
# do fsck and start sulogin, if it fails.
#
FSCK_RETURN=0
MAY_FSCK=1

# we may get ROOTFS_BLKDEV passed from initrd, skip extra actions
if [ -n "$ROOTFS_BLKDEV" ]  ; then
    if [ -n "$ROOTFS_REALDEV" ]  ; then
       ROOTFS_BLKDEV=$ROOTFS_REALDEV
    fi
else
    # if not booted via initrd, /dev is empty.
    # use private devnode with proper permissions
    ROOTFS_BLKDEV="/dev/shm/root"
    rootcpio=`echo / | /bin/cpio --quiet -o -H newc`
    rootmajor=0x${rootcpio:62:8}
    rootminor=0x${rootcpio:70:8}
    if [ $((rootmajor)) -ne 0 ] ; then
       echo /bin/mknod -m600 $ROOTFS_BLKDEV b $((rootmajor)) $((rootminor))
       /bin/mknod -m600 $ROOTFS_BLKDEV b $((rootmajor)) $((rootminor))
    fi
 fi
# common options for file system check
FSCK_OPTS="-a"
if test -f /forcefsck -o "$DO_FORCEFSCK" = "yes" ; then
    # force file system check if forced is specified
    FSCK_OPTS="$FSCK_OPTS -f"
```



```
    ROOTFS_FSCK=""
  fi
if test "$ROOTFS_FSCK" = "0" ; then
    # already checked and ok, skip the rest
     MAY_FSCK=0
  else
    ROOTFS_TYPE=`stat -f -c "%T" /`
    case $ROOTFS_TYPE in
      aufs|tmpfs|afs|cifs|nfs|novell|smb|UNKNOWN*) MAY_FSCK=0 ;;
      *)
          if test -x /usr/bin/on_ac_power ; then
             # skip fsck if running on battery
             /usr/bin/on_ac_power -q || MAY_FSCK=0
          fi
      ;;
    esac
  fi

if test ! -f /fastboot -a -z "$DO_FASTBOOT" -a $MAY_FSCK -eq 1 ; then
    # If we use a serial console, don't use the fsck progress bar
    if test "$REDIRECT" = "/dev/tty1" ; then
         FSCK_OPTS="$FSCK_OPTS -C"
    else
         FSCK_OPTS="$FSCK_OPTS -V"
    fi
    # on an umsdos root fs this mount will fail,
    # so direct error messages to /dev/null.
    # this seems to be ugly, but should not really be a problem.
    mount -n -o remount,ro / 2> /dev/null
    if test $? = 0; then
       if test -n "$ROOTFS_FSCK" ; then
           FSCK_RETURN=$ROOTFS_FSCK
       else
              # ROR: in readonly root env, fsck just /usr/local
              if [ "$READONLY" = "yes" ]; then
             echo "ROR: Checking $RW_MOUNT file system..."
             fsck $FSCK_OPTS $RW_MOUNT
              else
             echo "Checking root file system..."
             fsck $FSCK_OPTS $ROOTFS_BLKDEV
              fi
              # ROR: end block
           # A return code of 1 indicates that file system errors
           # were corrected, but that the boot may proceed.
           # A return code of 2 or larger indicates failure.
           FSCK_RETURN=$?
       fi
       test $FSCK_RETURN -lt 4
       rc_status -v1 -r
       if test $FSCK_RETURN -gt 1 -a $FSCK_RETURN -lt 4 ; then
           # if appropriate, switch bootsplash to verbose
           # mode to make text messages visible.
           test -f /proc/splash && echo "verbose" > /proc/splash
           echo
           echo "fsck succeed, but reboot is required."
           echo
           sleep 1
           sync
           reboot -f
```

```
elif test $FSCK_RETURN -gt 3; then
    # if appropriate, switch bootsplash to verbose
    # mode to make text messages visible.
    test -f /proc/splash && echo "verbose" > /proc/splash
    # Stop blogd since we reboot after sulogin
    test -x /sbin/blogd && killproc -QUIT /sbin/blogd
    if test -x /etc/init.d/kbd ; then
       /etc/init.d/kbd start
    fi
     echo
     echo "fsck failed.  Please repair manually and reboot. The root"
     echo "file system is currently mounted read-only. To remount it"
     echo "read-write do:"
     echo
     echo "   bash# mount -n -o remount,rw /"
     echo
     echo "Attention: Only CONTROL-D will reboot the system in this"
     echo "maintanance mode. shutdown or reboot will not work."
     echo
     PS1="(repair filesystem) # "
     export PS1
     /sbin/sulogin /dev/console

     # if the user has mounted something rw, this should be umounted
     echo "Unmounting file systems (ignore error messages)"
     umount -avn

     # on umsdos fs this would lead to an error message.
    # so direct errors to /dev/null
     mount -no remount,ro / 2> /dev/null

     sync
     reboot -f
 fi
 sync
  # ROR: process /etc/rwtab file
  if [ "$READONLY" = "yes" ]; then
    echo "ROR: mounting dirs/files from $RW_MOUNT ..."
    /bin/mount -n $RW_MOUNT
    if [ $? != 0 ]; then # can't mount
      echo "ROR: Error, can't mount $RW_MOUNT"
    else
      for file in /etc/rwtab /etc/rwtab.d/* ; do
        if [ -f $file ]; then # this is a file
          echo "ROR: processing bind-mount file $file"
          cat $file | while read type path
          do
            case "$type" in
              empty) # clear out the dir first? Hmm - dangerous
                # /bin/rm -fr "$RW_MOUNT$path"
                /bin/mount -n --bind "$RW_MOUNT$path" $path
                ;;
              files) # bind mount the file
                /bin/mount -n --bind "$RW_MOUNT$path" $path
                ;;
              dirs) # bind mount the directory
                /bin/mount -n --bind "$RW_MOUNT$path" $path
```

```
                              ;;
                            *) # no-op for every other value
                              ;;
                          esac
                        done
                      fi # if this is a file
                    done # looping through all files
                  fi # else mount of R/W disk was successful
                 else # READONLY is not set to "yes"
                  mount -n -o remount,rw /
                 fi
                 #ROR: end block
               test $FSCK_RETURN -gt 0 && > /fsck_corrected_errors
            else
               echo
                  # ROR: chg 1
                  if [ "$READONLY" = "yes" ]; then
                 echo '*** ERROR!  Cannot fsck because $RW_MOUNT is not read-only!'
                  else
                 echo '*** ERROR!  Cannot fsck because root is not read-only!'
                  fi
               echo
            fi
        else
            if test "$ROOTFS_FSCK" != "0" ; then
                # ROR: don't check RW_MOUNT file system
                if [ "$READONLY" = "yes" ]; then
               echo "ROR: $RW_MOUNT file system is NOT being checked."
                else
               echo "root file system (/) is NOT being checked."
                fi
                # ROR: end block
            fi
        fi
          # start with a clean mtab and enter root fs entry
          # ROR: del 3 - don't delete /etc/mtab, don't mount /
          if [ "$READONLY" = "no" ]; then
           rm -f /etc/mtab*
           > /etc/mtab
           mount -f /
          fi
          # ROR: end block
        ;;
    stop)
        ;;
    restart)
        rc_failed 3
        rc_status -v
        ;;
    status)
        rc_failed 4
        rc_status -v
        ;;
    *)
        echo "Usage: $0 {start|stop|status|restart}"
        exit 1
        ;;
esac
```

```
rc_exit
```

9.5 The cloneprep.sh script

Following is the **cloneprep.sh** script that prepares the golden image to be cloned.

```
#!/bin/bash
#
# ... disclaimer ...
#
# Script to clean up files before cloning
#+-----------------------------------------------------------------------------+
function cleanFile()
# delete file, create empty file and set permission mode
# arg 1: file to delete and create
# arg 2: mode to set empty file to
#+-----------------------------------------------------------------------------+
 {
  if [ -f $1 ]; then
    rm $1
  fi
  touch $1
  chmod $2 $1
 }

# main()
# clean up certain files in /var/log
rm /var/log/YaST2/y2log-*
rm /var/log/*.gz
cleanFile /var/log/authlog 600
cleanFile /var/log/faillog 600
cleanFile /var/log/lastlog 644
cleanFile /var/log/secure 600
cleanFile /var/log/secure 600
cleanFile /root/.bash_history 600

echo "System should be ready for shutdown and cloning"
```

9.6 The clonero.sh script

Following is the **clonero.sh** script that clones a read-only Linux system.

```
#!/bin/bash
. rorfuncs.sh
srcID="S11ROGLD"

# Verify that there is one argument
if [ $# != 1 ]; then #
  echo "Error: target user ID is missing"
  echo "Usage: $0 targetID"
  echo "  where targetID is the user ID that $srcID will be cloned to"
  exit 1
fi
```



```
tgtID=`echo $1 | tr '[a-z]' '[A-Z]'` # fold target user ID to upper case

echo -n "Are you SURE you want to clone a read-only system to $tgtID (y/n): "
read ans
if [ $ans != "y" ]; then
  exit 2
fi

# Verify the source and target user IDs are logged off
checkID $srcID
if [ $? != 0 ]; then exit 1; fi # not logged off => exit
checkID $tgtID
if [ $? != 0 ]; then exit 2; fi # not logged off => exit

copyDisk $srcID 102 to $tgtID 102
rc=$?
if [ $rc = 0 ]; then
  echo "Success! You should be able to IPL the read-only system on $tgtID"
else
  echo "Error: copyDisk $srcID 102 to $tgtID 102 failed with $rc"
fi
```

9.7 The clonerw.sh script

Following is the **clonerw.sh** script that clones a read-write Linux system.

```
#!/bin/bash
. rorfuncs.sh
srcID="S11RWGLD"

# Verify that there is one argument
if [ $# != 1 ]; then #
  echo "Error: target user ID is missing"
  echo "Usage: $0 targetID"
  echo "  where targetID is the user ID that $srcID will be cloned to"
  exit 1
fi
tgtID=`echo $1 | tr '[a-z]' '[A-Z]'` # fold target user ID to upper case

# Verify the source and target user IDs are logged off
checkID $srcID
if [ $? != 0 ]; then exit 1; fi # not logged off => exit
checkID $tgtID
if [ $? != 0 ]; then exit 2; fi # not logged off => exit

echo -n "Are you SURE you want to clone a read-write system to $tgtID (y/n): "
read ans
if [ $ans != "y" ]; then
  exit 2
fi

# copy four disks
copyDisk $srcID 100 to $tgtID 100
rc=$?
if [ $rc != 0 ]; then
  echo "Error: copyDisk $srcID 100 to $tgtID 100 failed with $rc"
  exit $rc
fi
```

```
copyDisk $srcID 101 to $tgtID 101
rc=$?
if [ $rc != 0 ]; then
  echo "Error: copyDisk $srcID 101 to $tgtID 101 failed with $rc"
  exit $rc
fi
copyDisk $srcID 102 to $tgtID 102
rc=$?
if [ $rc != 0 ]; then
  echo "Error: copyDisk $srcID 102 to $tgtID 102 failed with $rc"
  exit $rc
fi
copyDisk $srcID 103 to $tgtID 103
rc=$?
if [ $rc = 0 ]; then
  echo "Success! You should be able to IPL the read-write system on $tgtID"
else
  echo "Error: copyDisk $srcID 103 to $tgtID 103 failed with $rc"
fi
```

9.8 The pri2bak.sh script

Following is the **bak2pri.sh** script that backs up the golden image.

```
#!/bin/bash
. rorfuncs.sh                   # load the common functions
userID="S11RWGLD"               # set the source and target user IDs

# verify that the user ID is logged off
checkID $userID
if [ $? != 0 ]; then exit 1; fi # not logged off => exit

# copy the three primary 10x minidisks to the backup 20x minidisks
echo -n "Are you sure you want to back up disks 100-103 to 200-203? (y/n): "
read ans
if [ $ans != "y" ]; then
  exit 2
fi
copyDisk $userID 100 to $userID 200
rc=$?
if [ $rc != 0 ]; then
  echo "Error: copyDisk $userID 100 to $userID 200 failed with $rc"
  exit $rc
fi
copyDisk $userID 101 to $userID 201
rc=$?
if [ $rc != 0 ]; then
  echo "Error: copyDisk $userID 101 to $userID 201 failed with $rc"
  exit $rc
fi
copyDisk $userID 102 to $userID 202
rc=$?
if [ $rc != 0 ]; then
  echo "Error: copyDisk $userID 102 to $userID 202 failed with $rc"
  exit $rc
fi
```



```
copyDisk $userID 103 to $userID 203
rc=$?
if [ $rc != 0 ]; then
  echo "Error: copyDisk $userID 103 to $userID 203 failed with $rc"
  exit $rc
fi
```

9.9 The rorfuncs.sh source file

Following is the **rorfuncs.sh** source file that contains functions common to many other scripts.

```
#!/bin/sh
# rorfuncs.sh - functions for the SLES 11 ROR paper
# Functions:
#   CPcmd()         Issue a CP command
#   checkID()             Verify that a user ID exists and is logged off
#   copyDisk()            Copy a minidisk using FLASHCOPY or dasdfmt/dd
#   cleanUp()       Unmount file systems, disable and detach devices
#
#+-------------------------------------------------------------------------+
function CPcmd()
# Run a CP command and invoke it via the vmcp module/command
#   Arg1-n: the command to issue
#   Return: the command's return code
#+-------------------------------------------------------------------------+
 {
  if [ "$verbose" = 2 ]; then  // echo extra output
    echo "Invoking CP command: $@"
  fi
# parse output to get return code: awk -F# splits line at '#' with rc at end
  output=$(vmcp $@ 2>&1)
  if [ ${#output} != 0 -a "$verbose" != 0 ]; then # echo the output
    echo "$output"
  fi
  retVal=0
  retVal=$(echo $output | grep "Error: non-zero CP" | awk -F# '{print $2}')
  return $retVal
 }

#+-------------------------------------------------------------------------+
function checkID()
# Verify user ID exists and is logged off
# Arg 1: user ID to check
#+-------------------------------------------------------------------------+
 {
  userID=$1
  verbose=0
  CPcmd QUERY $userID
  rc=$?
  case $rc in
    0)  # user ID is logged on or disconnected
      echo "Error: $userID is logged on"
      return 1
      ;;
    3)  # user ID does not exist
      echo "Error: $userID does not exist"
      return 2
```

```
        ;;
     45) # user ID is logged off - this is correct
        ;;
     *) # unexpected
        echo "Error: unexpected rc from CP QUERY $userID - $rc"
        return 3
   esac
   verbose=1
   return 0
  } # checkID()

#+-------------------------------------------------------------------------+
function copyDisk()
# Try to use z/VM FLASHCOPY to copy one disk to another. If that fails then use
#   dasdfmt and dd
# Arguments:
#   Arg 1: Source user ID
#   Arg 2: Source virtual address
#   Arg 3: the word "to"
#   Arg 4: Target user ID
#   Arg 5: Target virtual address
# Return codes
#   0: success
#   1: user ID is not logged off
#   2: user ID does not exist
#   3: unexpected rc from QUERY user ID
#   4: LINK source disk failed
#   5: chccwdev -e source disk failed
#   6: LINK target disk failed
#   7: chccwdev -e source disk failed
#   8: can't find source disk in /dev/dasd/devices
#   9: can't find target disk in /dev/dasd/devices
#  10: dasdfmt failed
#  11: dd failed
#+-------------------------------------------------------------------------+
 {
  srcUserID=$1
  srcVdev1=$2
  tgtUserID=$4
  tgtVdev1=$5

  echo ""
  echo "Copying $srcUserID $srcVdev1 to $tgtUserID $tgtVdev1 ..."

  # link to the source disk in read mode as virtual address vaddr+1000
  let srcVdev2=srcVdev1+1000
  CPcmd LINK $srcUserID $srcVdev1 $srcVdev2 RR
  rc=$?
  if [ $rc != 0 ]; then # LINK failed
    echo "Error: CP LINK $srcUserID $srcVdev1 $srcVdev2 RR failed with $rc"
    return 4
  fi

  # link to the target disk in read-write mode as virtual address vaddr+2000
  let tgtVdev2=tgtVdev1+2000
  CPcmd LINK $tgtUserID $tgtVdev1 $tgtVdev2 MR
  rc=$?
```



```
  if [ $rc != 0 ]; then # LINK failed
    echo "Error: CP LINK $tgtUserID $tgtVdev1 $tgtVdev2 MR failed with $rc"
    return 6
  fi

  # try to copy the disk using FLASHCOPY
  sync # be sure all buffers are written to disk
  udevadm settle # be sure all events in the udev event queue are handled
  CPcmd FLASHCOPY $srcVdev2 0 END $tgtVdev2 0 END
  rc=$?
  if [ $rc = 0 ]; then # FLASHCOPY succeeded
    echo "FLASHCOPY succeeded"
    CPcmd DETACH $srcVdev2
    CPcmd DETACH $tgtVdev2
    return 0
  fi

  # if we fall through, then FLASHCOPY failed
  echo "FLASHCOPY $srcVdev2 0 END $tgtVdev2 0 END failed with $rc"
  echo "Using dasdfmt and dd"

  # enable the source and target disks
  chccwdev -e $srcVdev2
  rc=$?
  if [ $rc != 0 ]; then # chccwdev failed
    echo "Error: chccwdev -e $srcVdev2 failed with $rc"
    return 5
  fi
  chccwdev -e $tgtVdev2
  rc=$?
  if [ $rc != 0 ]; then # chccwdev failed
    echo "Error: chccwdev -e $tgtVdev2 failed with $rc"
    return 7
  fi
  udevadm settle

# get device name of source disk
  srcDev=`cat /proc/dasd/devices | grep "$srcVdev2(ECKD)" | awk '{ print $7 }'`
  if [ ${#srcDev} = 0 ]; then # error
    echo "Error: can't find source $src in /proc/dasd/devices"
    cat /proc/dasd/devices
    # clean up
    chccwdev -d $srcVdev2
    CPcmd DETACH $srcVdev2
    chccwdev -d $tgtVdev2
    CPcmd DETACH $tgtVdev2
    return 8
  fi

# get device name of target disk
  tgtDev=`cat /proc/dasd/devices | grep "$tgtVdev2(ECKD)" | awk '{ print $7 }'`
  if [ ${#tgtDev} = 0 ]; then # error
    echo "Error: can't find $tgtVdev2(ECKD) in /proc/dasd/devices"
    cat /proc/dasd/devices
    # clean up
    chccwdev -d $srcVdev2
    CPcmd DETACH $srcVdev2
    chccwdev -d $tgtVdev2
    CPcmd DETACH $tgtVdev2
```

```
      return 9
    fi

  # dasdfmt target disk
    echo "Invoking command: dasdfmt -b 4096 -y -f /dev/$tgtDev"
    dasdfmt -b 4096 -y -f /dev/$tgtDev
    udevadm settle
    rc=$?
    if [ $rc != 0 ]; then # dasdfmt failed
      echo "Error: dasdfmt -b 4096 -y -f /dev/$tgtDev failed with $rc"
      # clean up
      chccwdev -d $srcDev
      CPcmd DETACH $srcVdev2
      chccwdev -d $tgtDev
      CPcmd DETACH $tgtVdev2
      return 10
    fi

  # copy source disk to target disk with dd
    echo "Invoking command: dd bs=1M if=/dev/$srcDev of=/dev/$tgtDev"
    dd bs=1M if=/dev/$srcDev of=/dev/$tgtDev
    rc=$?
    if [ $rc != 0 ]; then # dd failed
      echo "Error: dd bs=4096 if=/dev/$srcDev of=/dev/$tgtDev failed with $rc"
      # clean up
      chccwdev -d $srcVdev2
      CPcmd DETACH $srcVdev2
      chccwdev -d $tgtVdev2
      CPcmd DETACH $tgtVdev2
      return 11
    fi
    sync # sync disks
    chccwdev -d $srcVdev2
    CPcmd DETACH $srcVdev2
    chccwdev -d $tgtVdev2
    CPcmd DETACH $tgtVdev2
    echo "Copying disk via dasdfmt and dd succeeded ..."
    return 0
   } # copyDisk()

  #+-----------------------------------------------------------------------+
  function cleanUp()
  # Unmount source and target file systems and detach minidisks
  #+-----------------------------------------------------------------------+
   {
    echo ""
    echo "Cleaning up target disks ..."
    umount /mnt/tgt/usr/local
    umount /mnt/tgt/usr/share
    umount /mnt/tgt/boot
    umount /mnt/tgt/proc
    umount /mnt/tgt/sys
    umount /mnt/tgt/dev
    umount /mnt/rpm
    umount /mnt/tgt
    echo ""
    echo "Disabling target disks ..."
```



```
  chccwdev -d 2100
  chccwdev -d 2102
  echo ""
  echo "DETACHing target disks ..."
  vmcp det 2100
  vmcp det 2102
  echo ""
  echo "Cleaning up source disks ..."
  umount /mnt/src/usr/local
  umount /mnt/src/usr/share
  umount /mnt/src/boot
  umount /mnt/src
  echo ""
  echo "Disabling source disks ..."
  chccwdev -d 1100
  chccwdev -d 1101
  chccwdev -d 1102
  chccwdev -d 1103
  echo ""
  echo "DETACHing source disks ..."
  vmcp det 1100
  vmcp det 1101
  vmcp det 1102
  vmcp det 1103
 }
```

9.10 The rw2ro.sh script

Following is the **rw2ro.sh** script that converts the read-write golden image on S11RWGLD to a read-only root system on S11ROGLD:

```
#!/bin/sh
# rw2ro.sh - script to create a read-only root system on target user ID
# Hard-coded virtual device addresses - the first five will become read-only:
#  100 - /boot
#  101 - /usr/share
#  102 - /usr/local
#  103 - /
#
# Source disks are linked as 110x
# Target disks are linked as 210x
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#+-----------------------------------------------------------------------+
function giveHelp()
# give help
#+-----------------------------------------------------------------------+
 {
  script=`basename $0`
  echo ""
  echo "Usage: $script [-p prefix] [-s suffix]"
  echo ""
  echo "Synopsis:"
  echo "  Convert R/W golden image on source ID to R/O on DCSSs and target ID"
  echo ""
  echo "Optional arguments:"
  echo "  -p prefix: optional 3 character DCSS prefix, default is 'S11'"
  echo "  -s suffix: optional 1 character DCSS suffix, default is '1'"
  echo ""
  echo "Example: $script -s 2"
  echo "  write to target ID S11ROGLD, and DCSSs S11ROOT2, S11SHAR2 and S11RPM2"
  exit 1
 } # giveHelp()

#+-----------------------------------------------------------------------+
function parseArgs()
# Parse any arguments
# Args: All arguments passed to this script
# Arguments parsed: only one optional 1 character DCSS suffix
#+-----------------------------------------------------------------------+
 {
  prefix=S11
  suffix=1
  while [ -n "$1" ]; do
    case $1 in
      -p)            # prefix follows
        shift
        prefix=$1
        let prelen=${#prefix}
        if [ $prelen -lt 1 -o $prelen -gt 3 ]; then # error
          echo "Error: prefix must be one, two or three characters"
          giveHelp
        fi
        shift
        ;;
      -s)            # suffix follows
        shift
        suffix=$1
        let suflen=${#suffix}
        if [ $suflen != 1  ]; then # error
          echo "Error: suffix must be one character"
          giveHelp
        fi
```



```
        shift
        ;;
      *)              # unrecognized arg
      giveHelp
      ;;
    esac
  done
  DCSS1="$prefix$DCSS1$suffix"
  DCSS2="$prefix$DCSS2$suffix"
  DCSS3="$prefix$DCSS3$suffix"
  NSS="$prefix$NSS$suffix"
  srcID="$prefix$srcID"
  tgtID="$prefix$tgtID"
  echo "The DCSSs will be $DCSS1, $DCSS2 and $DCSS3"
  echo "The NSS should be named $NSS"
  echo "The source and target user IDs are $srcID and $tgtID"
 } # parseArgs()

#+-----------------------------------------------------------------------+
function checkIDs()
# Parse any arguments
# Args: All arguments passed to this script
# Arguments parsed: only one optional 1 character DCSS suffix
#+-----------------------------------------------------------------------+
 {
  echo ""
  echo "Checking source ID ..."
  checkID $srcID          # verify source ID exists and is logged off
  rc=$?
  if [ $rc != 0 ]; then   # error - exit
    exit $rc
  fi
  echo "Checking target ID ..."
  checkID $tgtID          # verify target ID exists and is logged off
  rc=$?
  if [ $rc != 0 ]; then   # error - exit
    exit $rc
  fi
 } # checkIDs()

#+-----------------------------------------------------------------------+
function setUpEnv()
# Verify the three DCSSs are loaded and create mount points if necessary
# 101 = /
# Args: none
#+-----------------------------------------------------------------------+
 {
  echo ""
  echo "Setting up environment ..."
  if [ ! -d /sys/devices/dcssblk/$DCSS1 ]; then
    echo "Error: /sys/devices/dcssblk/$DCSS1 not found"
    exit 20
  fi
  if [ ! -d /sys/devices/dcssblk/$DCSS2 ]; then
    echo "Error: /sys/devices/dcssblk/$DCSS2 not found"
    exit 21
  fi
  if [ ! -d /sys/devices/dcssblk/$DCSS3 ]; then
    echo "Error: /sys/devices/dcssblk/$DCSS3 not found"
```

```
      exit 22
    fi

    # make 3 mount points if necessary: /mnt/src/, /mnt/tgt/ and /mnt/rpm/
    if [ ! -d /mnt/src ]; then # create it
      mkdir /mnt/src
      if [ $? != 0 ]; then exit 23; fi
    fi
    if [ ! -d /mnt/tgt ]; then # create it
      mkdir /mnt/tgt
      if [ $? != 0 ]; then exit 24; fi
    fi
    # cutting a corner here - but difficult to mount /mnt/tgt/var/lib/rpm
    if [ ! -d /mnt/rpm ]; then # create it
      mkdir /mnt/rpm
      if [ $? != 0 ]; then exit 25; fi
    fi
   } # setUpEnv()

  #+---------------------------------------------------------------------------+
  function enableSourceEnv()
  # Link read-only and enable source file systems
  # 101 = /
  # Args: none
  #+---------------------------------------------------------------------------+
   {
    echo ""
    echo "Linking source disks ..."
    CPcmd link $srcID 100 1100 rr
    if [ $? != 0 ]; then exit 26; fi
    CPcmd link $srcID 101 1101 rr
    if [ $? != 0 ]; then exit 27; fi
    CPcmd link $srcID 102 1102 rr
    if [ $? != 0 ]; then exit 28; fi
    CPcmd link $srcID 103 1103 rr
    if [ $? != 0 ]; then exit 29; fi

    echo ""
    echo "Enabling source disks ..."
    chccwdev -e 1100
    if [ $? != 0 ]; then exit 30; fi
    chccwdev -e 1101
    if [ $? != 0 ]; then exit 31; fi
    chccwdev -e 1102
    if [ $? != 0 ]; then exit 32; fi
    chccwdev -e 1103
    if [ $? != 0 ]; then exit 33; fi
    udevadm settle

    # get source device names
    dev1100=/dev/$(egrep '^0.0.1100'  /proc/dasd/devices | awk '{ print $7 }')1
    if [ ${#dev1100} -lt 7 ]; then exit 34; fi
    dev1101=/dev/$(egrep '^0.0.1101'  /proc/dasd/devices | awk '{ print $7 }')1
    if [ ${#dev1101} -lt 7 ]; then exit 35; fi
    dev1102=/dev/$(egrep '^0.0.1102'  /proc/dasd/devices | awk '{ print $7 }')1
    if [ ${#dev1102} -lt 7 ]; then exit 36; fi
    dev1103=/dev/$(egrep '^0.0.1103'  /proc/dasd/devices | awk '{ print $7 }')1
```



```
  if [ ${#dev1103} -lt 7 ]; then exit 37; fi
 } # enableSourceEnv()

#+---------------------------------------------------------------------------+
function enableTargetDCSSs()
# Enable the target DCSSs
# S11ROOT1: DCSS to store the root file system
# S11RPM1:  DCSS to store the RPM database: /var/lib/rpm/
# S11SHAR1: DCSS to store /usr/share/
# Args: none
#+---------------------------------------------------------------------------+
 {
  echo ""
  echo "Setting DCSSs to not shared ..."
  shared1=`cat /sys/devices/dcssblk/$DCSS1/shared`
  if [ "shared1" != 0 ]; then # set shared to 0
    echo 0 > /sys/devices/dcssblk/$DCSS1/shared
    if [ $? != 0 ]; then exit 38; fi
  fi
  shared2=`cat /sys/devices/dcssblk/$DCSS2/shared`
  if [ "shared2" != 0 ]; then # set shared to 0
    echo 0 > /sys/devices/dcssblk/$DCSS2/shared
    if [ $? != 0 ]; then exit 39; fi
  fi
  shared3=`cat /sys/devices/dcssblk/$DCSS3/shared`
  if [ "shared3" != 0 ]; then # set shared to 0
    echo 0 > /sys/devices/dcssblk/$DCSS3/shared
    if [ $? != 0 ]; then exit 40; fi
  fi

  echo ""
  echo "Making ext2 file systems on the DCSSs ..."
  mke2fs /dev/dcssblk1 > /dev/null
  if [ $? != 0 ]; then exit 41; fi
  mke2fs /dev/dcssblk2 > /dev/null
  if [ $? != 0 ]; then exit 42; fi
  mke2fs /dev/dcssblk3 > /dev/null
  if [ $? != 0 ]; then exit 43; fi

 } # enableTargetDCSSs()

#+---------------------------------------------------------------------------+
function enableTargetFSs()
# Enable the target file systems on S11ROGLD:
# 100 - /boot/
# 102 - /usr/local/
# Args: none
#+---------------------------------------------------------------------------+
 {
  echo ""
  echo "Linking target disks ..."
  CPcmd link $tgtID 100 2100 mr
  if [ $? != 0 ]; then exit 45; fi
  CPcmd link $tgtID 102 2102 mr
  if [ $? != 0 ]; then exit 46; fi

  echo ""
  echo "Enabling target disks ..."
  chccwdev -e 2100
```

```
    if [ $? != 0 ]; then exit 47; fi
    chccwdev -e 2102
    if [ $? != 0 ]; then exit 48; fi
    udevadm settle

    # get target device names
    dev2100=/dev/$(egrep '^0.0.2100' /proc/dasd/devices | awk '{ print $7 }')1
    if [ ${#dev2100} -lt 7 ]; then exit 49; fi
    dev2102=/dev/$(egrep '^0.0.2102' /proc/dasd/devices | awk '{ print $7 }')1
    if [ ${#dev2102} -lt 7 ]; then exit 50; fi
  } # enableTargetEnv()

#+----------------------------------------------------------------------------+
function copyRootFileSystem()
# Copy the root file system
# Args: none
#+----------------------------------------------------------------------------+
  {
    echo ""
    echo "Copying the root file system (this might take a few minutes) ..."
    mount $dev1103 /mnt/src
    if [ $? != 0 ]; then exit 51; fi
    mount /dev/dcssblk1 /mnt/tgt
    if [ $? != 0 ]; then exit 52; fi
    udevadm settle
    cp -a /mnt/src/* /mnt/tgt
    if [ $? != 0 ]; then exit 53; fi
  } # copyRootFileSystem()

#+----------------------------------------------------------------------------+
function mountTargetDisk
# Try to mke2fs and mount a disk. It has probably been dasdfmt'd. If it doesn't
# mke2fs, dasdfmt it and try again
# Arg 1: device name
# Arg 2: mount point
# Arg 3: mke2fs flag (-j = ext3, null = ext2)
#+----------------------------------------------------------------------------+
  {
    devName=$1
    mntPoint=$2
    mke2fsFlag=$3
    echo ""
    echo "Formatting and mounting $devName over $mntPoint ..."
    mke2fs $mke2fsFlag $devName > /dev/null
    rc=$?
    if [ rc != 0 ]; then # failed - try dasdfmt'ing the disk
      dasdfmt -b 4096 -y -f ${devName%%1} > /dev/null # chop off trailing 1
      if [ $? != 0 ]; then exit 54; fi
      fdasd -a ${devName%%1} > /dev/null # chop off trailing 1
      if [ $? != 0 ]; then exit 55; fi
      sync
      udevadm settle
      mke2fs $mke2fsFlag $devName > /dev/null
      if [ $? != 0 ]; then exit 56; fi
      sync
      udevadm settle
    fi
```



```
  mount $devName $mntPoint
  if [ $? != 0 ]; then exit 57; fi
 } # mountTargetDisk()

#+---------------------------------------------------------------------------+
function mountRemaining()
# Mount the remaining file systems now that root is copied
# Args: none
#+---------------------------------------------------------------------------+
 {
  sync
  udevadm settle
  echo ""
  echo "Mounting remaining source file systems ..."
  mount $dev1100 /mnt/src/boot
  if [ $? != 0 ]; then exit 58; fi
  mount $dev1101 /mnt/src/usr/share
  if [ $? != 0 ]; then exit 59; fi
  mount $dev1102 /mnt/src/usr/local
  if [ $? != 0 ]; then exit 60; fi
  echo ""
  echo "Formatting and mounting remaining target file systems ..."
  mount /dev/dcssblk2 /mnt/rpm
  if [ $? != 0 ]; then exit 61; fi
  udevadm settle
  mount /dev/dcssblk3 /mnt/tgt/usr/share
  if [ $? != 0 ]; then exit 62; fi
  mountTargetDisk $dev2100 /mnt/tgt/boot         # no arg3 = ext2 file system
  mountTargetDisk $dev2102 /mnt/tgt/usr/local -j # -j arg  = ext3 file system
 } # mountRemaining()

#+---------------------------------------------------------------------------+
function copyRemaining()
# Copy the remaining file systems
# Args: none
#+---------------------------------------------------------------------------+
 {
  echo ""
  echo "Copying /boot ..."
  cp -a /mnt/src/boot/* /mnt/tgt/boot
  if [ $? != 0 ]; then exit 63; fi
  echo ""
  echo "Copying /usr/share (this might take a few minutes) ..."
  cp -a /mnt/src/usr/share/* /mnt/tgt/usr/share
  if [ $? != 0 ]; then exit 64; fi
  echo ""
  echo "Copying /usr/local ..."
  cp -a /mnt/src/usr/local/* /mnt/tgt/usr/local
  if [ $? != 0 ]; then exit 65; fi
  echo ""
  echo "Copying /var/lib/rpm ..."
  cp -a /mnt/src/var/lib/rpm/* /mnt/rpm
  if [ $? != 0 ]; then exit 66; fi
 } # copyRemaining()

#+---------------------------------------------------------------------------+
function modifySystem()
# 0) mount target system over /mnt/tgt
# 1) Copy modified /etc/init.d/boot, /etc/init.d/boot.rootfsck and /etc/fstab
```

```
# 2) Copy source /etc/ and /root/ directories to target /local/
# 3) Move /etc/init.d under /sbin/ and create symlink to point back
#+---------------------------------------------------------------------------+
 {
  # copy boot.rootfsck, fstab, zipl.conf, rwtab and readonly-root files
  echo ""
  echo "Copying modified boot.rootfsck script ..."
  cp /mnt/tgt/etc/init.d/boot.rootfsck /mnt/tgt/etc/init.d/boot.rootfsck.orig
  if [ "$?" != 0 ]; then exit 67; fi
  cp $rootfsckFile /mnt/tgt/etc/init.d/boot.rootfsck
  if [ "$?" != 0 ]; then exit 68; fi
  echo ""
  echo "Backing up and copying modified /etc/fstab file ..."
  cp /mnt/tgt/etc/fstab /mnt/tgt/etc/fstab.orig
  if [ "$?" != 0 ]; then exit 69; fi
  cp $fstabFile /mnt/tgt/etc/fstab
  if [ "$?" != 0 ]; then exit 70; fi
  echo ""
  echo "Backing up and copying modified /etc/zipl.conf file ..."
  cp /mnt/tgt/etc/zipl.conf /mnt/tgt/etc/zipl.conf.orig
  if [ "$?" != 0 ]; then exit 71; fi
  sed -i 's:/dev/disk/by-path/ccw-0.0.0103-part1:/dev/dcssblk1:g' /mnt/tgt/etc/zipl.conf
  if [ "$?" != 0 ]; then exit 72; fi
  echo ""
  echo "Backing up and copying /lib/mkinitrd/scripts/setup-block.sh file ..."
  setupDir="/mnt/tgt/lib/mkinitrd/scripts"
  cp $setupDir/setup-block.sh $setupDir/setup-block.sh.orig
  if [ "$?" != 0 ]; then exit 74; fi
  cp $mkinitrdFile $setupDir/setup-block.sh
  if [ "$?" != 0 ]; then exit 75; fi
  echo ""
  echo "Backing up and modifying /etc/modprobe.conf.local file ..."
  modpLine="options dcssblk \"segments=SWAPPING,$DCSS1,$DCSS2,$DCSS3\""
  modpFile="/mnt/tgt/etc/modprobe.conf.local"
  cp $modpFile $modpFile.orig
  if [ "$?" != 0 ]; then exit 76; fi
  cat $modpFile.orig | sed -e '/dcssblk/d' > $modpFile # del line with dcssblk
  echo $modpLine >> $modpFile
  if [ "$?" != 0 ]; then exit 77; fi
  echo ""
  echo "Copying /etc/rwtab file ..."
  cp $rwtabFile /mnt/tgt/etc
  if [ "$?" != 0 ]; then exit 78; fi
  echo ""
  echo "Copying /etc/sysconfig/readonly-root file ..."
  cp $readonlyrootFile /mnt/tgt/etc/sysconfig
  if [ "$?" != 0 ]; then exit 79; fi
  echo ""
  echo "Making /etc/mtab a symbolic link to /proc/mounts ..."
  cd /mnt/tgt/etc
  rm mtab
  ln -s /proc/mounts mtab
  cd -

  echo ""
  echo "Running zipl in target environment ..."
  mount --bind /dev /mnt/tgt/dev
```



```
  if [ "$?" != 0 ]; then exit 80; fi
  mount -t proc none /mnt/tgt/proc
  if [ "$?" != 0 ]; then exit 81; fi
  mount --bind /sys /mnt/tgt/sys
  if [ "$?" != 0 ]; then exit 82; fi
  chroot /mnt/tgt mkinitrd
  if [ "$?" != 0 ]; then exit 83; fi
  chroot /mnt/tgt zipl
  if [ "$?" != 0 ]; then exit 84; fi

  echo ""
  echo "Copying files and directories in /etc/rwtab ..."
  cat $rwtabFile | while read type path
  do
    case "$type" in
      empty)  # TODO: there is not test for this case
        if [ ! -d /mnt/tgt$path ]; then
          mkdir /mnt/tgt$path
          if [ "$?" != 0 ]; then exit 85; fi
        fi
        ;;
      files) # bind mount the file
        echo "Copying file /mnt/tgt$path to /mnt/tgt/usr/local$path ..."
        if [ ! -d /mnt/tgt/usr/local${path%/*} ]; then
          mkdir -p /mnt/tgt/usr/local${path%/*}
          if [ "$?" != 0 ]; then exit 86; fi
          echo "Created directory /mnt/tgt/usr/local${path%/*}"
        fi
        cp /mnt/tgt/$path /mnt/tgt/usr/local/$path
        if [ "$?" != 0 ]; then exit 87; fi
        ;;
      dirs) # bind mount the directory
        echo "Copying dir /mnt/tgt$path/* to /mnt/tgt/usr/local$path ..."
        if [ ! -d /mnt/tgt/usr/local$path ]; then
          mkdir -p /mnt/tgt/usr/local$path
          if [ "$?" != 0 ]; then exit 88; fi
          echo "Created directory /mnt/tgt/usr/local$path"
        fi
        cp -a /mnt/tgt$path/* /mnt/tgt/usr/local$path
        if [ "$?" != 0 ]; then exit 89; fi
        ;;
      *) # no-op for every other value
        ;;
    esac
  done
 } # modifySystem()

#+---------------------------------------------------------------------------+
function saveDCSSs()
# Save the DCSS
#   Args: None
#+---------------------------------------------------------------------------+
 {
  echo ""
  echo "Saving $DCSS1 (this takes some time) ..."
  echo 1 > /sys/devices/dcssblk/$DCSS1/save
  if [ $? != 0 ]; then exit 90; fi
  echo ""
  echo "Saving $DCSS2 ..."
```

```
    echo 1 > /sys/devices/dcssblk/$DCSS2/save
    if [ $? != 0 ]; then exit 91; fi
    echo ""
    echo "Saving $DCSS3 (this takes some time) ..."
    echo 1 > /sys/devices/dcssblk/$DCSS3/save
    if [ $? != 0 ]; then exit 92; fi

    # Creating the NSS must be done manually
    echo "To create an NSS, logon to $tgtID and: ipl 100 parm savesys=$NSS"
  } # saveDCSSs()

# main()
# Global variables specifying user IDs, DCSS and NSS names
srcID="RWGLD"       # source read-write golden image minus the prefix
tgtID="ROGLD"           # target read-only golden image minus the prefix
DCSS1="ROOT"            # root file system DCSS minus prefix and suffix
DCSS2="RPM"             # /var/lib/rpm/ DCSS minus prefix and suffix
DCSS3="SHAR"            # /usr/share/ DCSS minus prefix and suffix
NSS="LNX"               # name of the NSS minus prefix and suffix

# Global variables specifying files that must exist in /usr/local/sbin
rootfsckFile="/usr/local/sbin/boot.rootfsck.S11" # modified from /etc/init.d
mkinitrdFile="/usr/local/sbin/setup-block.sh.S11"  # modified initrd file
fstabFile="/usr/local/sbin/fstab.S11"            # modified from /etc file
rwtabFile="/usr/local/sbin/rwtab"                # new /etc/ file
readonlyrootFile="/usr/local/sbin/readonly-root" # new /etc/sysconfig file

# function calls
. rorfuncs.sh           # "source" the common functions
parseArgs $@            # parse arguments
checkIDs                # verify source and target IDs exist & are logged off
setUpEnv                # verify DCSSs, create mount points
enableSourceEnv         # enable and mount the source root file system
enableTargetDCSSs       # enable the target DCSSs
enableTargetFSs         # enable the target file systems
copyRootFileSystem      # copy source root file system to target
mountRemaining          # mount remaining file systems
copyRemaining           # copy remaining file systems from source to target
modifySystem            # modify target system to be read-only
cleanUp                 # unmount FSs, disable and detach devices
saveDCSSs               # save DCSS1, DCSS2 and DCSS3
```

9.11 The modified script 72-block.sh

The default SLES 11 script **/lib/mkinitrd/setup/72-block.sh** does not recognize the **dcssblk** driver. A modified script is included. Following are just the differences:

```
# diff setup-block.sh.orig setup-block.sh
78a79,81
>             dcss*)
>                 echo dcssblk
>                 ;;
```


Section 10: Linux configuration files

This section contains the following Linux configuration files:

- fstab.S11 Modifed **/etc/fstab** file
- readonly-root.S11 Configuration file that goes in **/etc/sysconfig** for read-only root
- rwtab Configuration file that goes in **/etc/** for list of read-write files and directories
- zipl.conf.S11 Modified **/etc/zipl.conf** file

10.1 The modified fstab.S11 file

Following is a modified /**etc/fstab** file that is copied to S11ROGLD.

```
/dev/dcssblk1        /            ext2 noatime,nodiratime,acl,user_xattr   1 1
/dev/disk/by-path/ccw-0.0.0102-part1 /usr/local ext3 acl,user_xattr        1 2
/dev/dcssblk2        /var/lib/rpm ext2 ro,noatime,nodiratime,acl,user_xattr 0 0
/dev/dcssblk3        /usr/share   ext2 ro,noatime,nodiratime,acl,user_xattr 0 0
/dev/dcssblk0        swap                swap       defaults              0 0
tmpfs                /tmp                tmpfs      defaults              0 0
proc                 /proc               proc       defaults              0 0
sysfs                /sys                sysfs      noauto                0 0
debugfs              /sys/kernel/debug   debugfs    noauto                0 0
devpts               /dev/pts            devpts     mode=0620,gid=5       0 0
```

10.2 The readonly-root.S11 configuration file

Following is the file **readonly-root** that is copied to **/etc/sysconfig/** on S11ROGLD.

```
# Set to 'yes' to mount the system filesystems read-only.
READONLY=yes
# Set to 'yes' to mount various temporary state as either tmpfs
# or on the block device labelled RW_LABEL. Implied by READONLY
TEMPORARY_STATE=no
# Place to put a tmpfs for temporary scratch writable space
RW_MOUNT=/usr/local
# Label on local filesystem which can be used for temporary scratch space
RW_LABEL=stateless-rw
# Label for partition with persistent data
STATE_LABEL=stateless-state
# Where to mount to the persistent data
STATE_MOUNT=/.snapshot
```

10.3 The rwtab.S11 configuration file

Following is the file **rwtab** that is copied to **/etc/** on S11ROGLD.

```
dirs    /root
dirs    /srv
dirs    /var
dirs    /etc/ssh
files   /etc/resolv.conf
files   /etc/lvm/.cache
files   /etc/hosts
files   /etc/HOSTNAME
```

```
files   /etc/sysconfig/network/ifcfg-eth0
files   /etc/sysconfig/network/routes
```

10.4 The modified zipl.conf .S11file

Following is the modified **/etc/zipl.conf** file that is copied to S11ROGLD:

```
# Modified by YaST2. Last modification on Fri Oct 23 09:53:21 EDT 2009
[defaultboot]
defaultmenu = menu

###Don't change this comment - YaST2 identifier: Original name: linux###
[LinuxV1]
    image = /boot/image-2.6.27.29-0.1-default
    target = /boot/zipl
    ramdisk = /boot/initrd-2.6.27.29-0.1-default,0x2000000
    parameters = "dasd=100-10f,200-20f,300-31f vmpoff=LOGOFF vmhalt=LOGOFF ro
root=/dev/dcssblk1 TERM=dumb  init=/linuxrc"


:menu
    default = 1
    prompt = 1
    target = /boot/zipl
    timeout = 3
    1 = LinuxV1
    2 = ipl

###Don't change this comment - YaST2 identifier: Original name: ipl###
[ipl]
    image = /boot/image
    target = /boot/zipl
    ramdisk = /boot/initrd,0x2000000
    parameters = "root=/dev/disk/by-path/ccw-0.0.0101-part1 TERM=dumb"
```

