Extreme Filesystem Sharing

Linux on Read-Only Root at Nationwide

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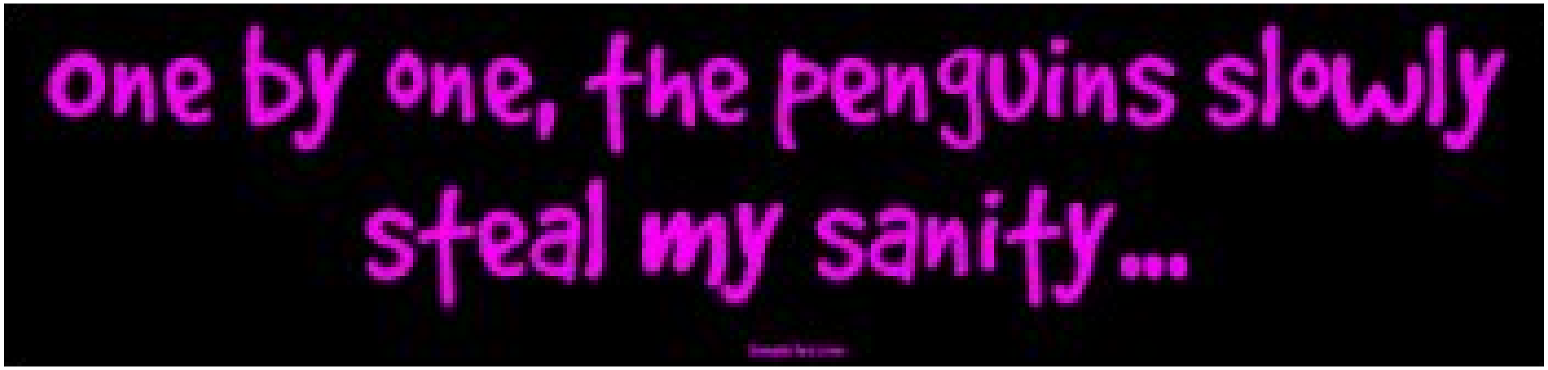
Or in other words: Your mileage may vary. “It Depends.” Results not typical. Actual mileage will probably be less. Use only as directed. Do not fold, spindle, or mutilate. Not to be taken on an empty stomach.

When in doubt, ask! Still in doubt? Test it!

Extreme Filesystem Sharing

- Herding the Flock
- Sharing Common Content
- A Shared Root Directory
- System maint and package management
- Relocatable Packages
- DASD on Demand – Disk Automounter

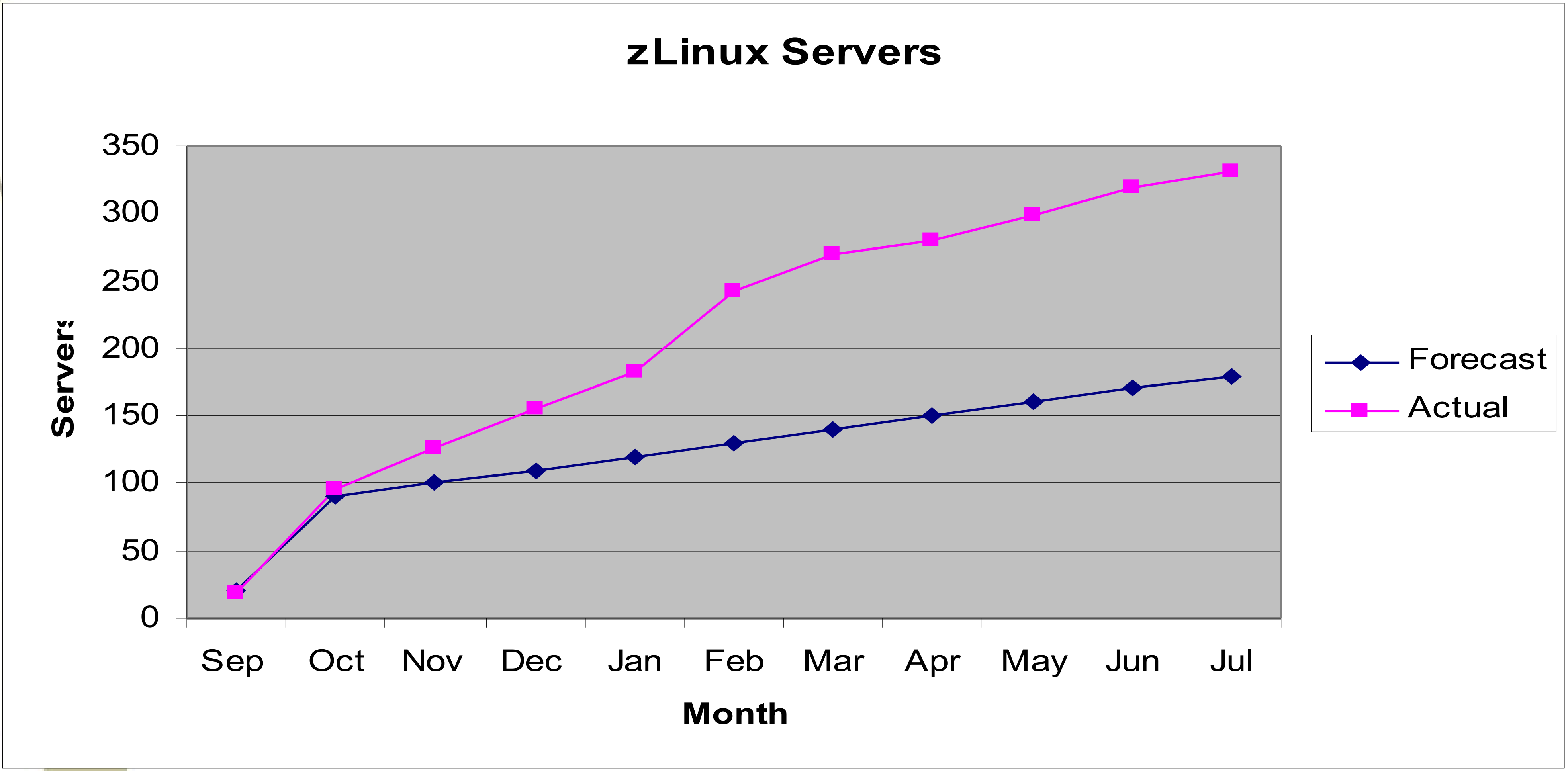
Issue: Penguins Populating



one by one, the penguins slowly steal my sanity...

Issue: Penguins Populating

*And I thought we were busy **before** we got Linux!*
Rick Barlow, Aug 1, 2006



Solution: Share More Stuff

- Install Once, Run Many
- An old Gospel, fully realized
- Sharing **`/usr`**, **`/opt`**, and others so why not also share the root?

Untouchable root? Sounds Weird

- Solaris/SunOS does NFS root including read-only **`/usr`** content
- "Live CD" Linux uses bulk R/O content
  - Knoppix, Ubuntu, Kubuntu, recovery tools
- USS does ROR already (Unix on z/OS)

Not weird, Not even new

People still ask: WHY???

Stability and Manageability

- R/O media is incorruptible
- R/O content is centrally maintained
- R/O packages are available on-demand
- Better D/R – less per-server replication

R/O zLinux no different from R/O PC Linux

Shared OpSys Partitions

- Multiple R/O shared disks
- Up to three partitions per disk
  - Remains true for CKD, FBA, and SAN
- Glacial stability

How to … reference

1b0 == boot

1b1 == root

1b5 == /local

1be == /usr

1bf == /opt

2b0-2bf == LVM phys vols and/or maint

320-33f == “User Space” LVM phys vols

100,200 == FCP “HBAs” for SAN

How to … reference

`1b0` **`==`** boot, bootable and **`/boot`**

`1b1` **`==`** root

`1b5 == /local`

Contains **`etc`**, **`dev`** and others

“personality” of the system

`1be == /usr`

`1bf == /opt`

How it Looks / How it Works

```
szvmjt005 # df
Filesystem      1K-blocks      Used Available Use% Mounted on
/dev/dasdb         278960    108424    156136  41% /
tmpfs              124696         0    124696   0% /dev/shm
/dev/dasda1         21512     18232      2172  90% /boot
/dev/dasdo        1231672    610656    558448  53% /usr
/dev/dasdp         161088       952    151820   1% /opt
tmpfs              124696         0    124696   0% /tmp
/dev/dm-0          253920     82840    157976  35% /var
/dev/dm-1          253920    121804    119012  51% /home
/dev/dasdbn1     23216172  20420196   1616660  93% /dasd/340
```

```
szvmjt005 # touch /FFFF
touch: cannot touch `/FFFF': Read-only file system
```

How it Looks / How it Works

```
szvmjt005 # df
Filesystem      1K-blocks      Used Available Use% Mounted on
/dev/dasdb         278960    108424    156136  41% /
tmpfs              124696         0    124696   0% /dev/shm
/dev/dasda1         21512     18232      2172  90% /boot
/dev/dasdo        1231672    610656    558448  53% /usr
/dev/dasdp         161088       952    151820   1% /opt
tmpfs              124696         0    124696   0% /tmp
/dev/dm-0          253920     82840    157976  35% /var
/dev/dm-1          253920    121804    119012  51% /home
/dev/dasdbn1     23216172  20420196   1616660  93% /dasd/25f

szvmjt005 # df /local
Filesystem      1K-blocks      Used Available Use% Mounted on
-                  209216     75688    122728  39% /local
/dev/dasdf         209216     75688    122728  39% /local
```

`/dev`, `/etc`, and `/root` all live under `/local`

How it Looks / How it Works

```
szvmjt005 # cat /proc/mounts
rootfs / rootfs rw 0 0
/dev/root / ext2 ro 0 0
proc /proc proc rw 0 0
sysfs /sys sysfs rw 0 0
devpts /dev/pts devpts rw 0 0
tmpfs /dev/shm tmpfs rw 0 0
tmpfs /tmp tmpfs rw 0 0

/dev/dasda1 /boot ext2 ro 0 0
/dev/dasdo /usr ext2 ro 0 0
/dev/dasdp /opt ext2 ro 0 0

/dev/dasdf /local ext3 rw 0 0
/dev/dasdf /etc ext3 rw 0 0
/dev/dasdf /root ext3 rw 0 0
/dev/dasdf /dev ext3 rw 0 0
```

How it Looks / How it Works

```
szvmjt005 # mount
/dev/dasdb on / type ext2 (ro)
proc on /proc type proc (rw)
sysfs on /sys type sysfs (rw)
devpts on /dev/pts type devpts (rw,mode=0620,gid=5)
tmpfs on /dev/shm type tmpfs (rw)
tmpfs on /tmp type tmpfs (rw)

/dev/dasda1 on /boot type ext2 (ro)
/dev/dasdo on /usr type ext2 (ro)
/dev/dasdp on /opt type ext2 (ro)

/dev/dasdf on /local type ext3 (rw)
/local/etc on /etc type bind (rw)
/local/dev on /dev type bind (rw)
/local/root on /root type bind (rw)
```

How it Looks / How it Works

for DB2/UDB …

```
Filesystem     1K-blocks      Used Available Use% Mounted on
/dev/mapper/wdvg--db2test-lvdb2bin
                 3096336    372752   2566300  13% /opt/IBM/db2
/dev/mapper/wdvg--db2test-db2fslv
                 1032088    519140    460520  53% /db2fs
/dev/mapper/wdvg--db2test-db2logfslv
                 1032088     32876    946784   4% /db2logfs
```

for WAS …

```
Filesystem     1K-blocks      Used Available Use% Mounted on
/dev/mapper/3390-3390lv01
                 3096336   1455196   1515312  49% /u01
/dev/mapper/3390-3390lv02
                 1548144    563456    906048  39% /webdata
```

What we Changed

- Move **`bp.conf`** to a non-shared place:

```
cd /usr/openv/netbackup
mv bp.conf /etc/.
ln –s /etc/bp.conf .
```

- Move LVM lock file:

  One line change to **`/etc/lvm/lvm.conf`**

What we Changed

- Move **init.d** to a shared place:

```
cd /etc
mv init.d ../sbin/.
ln –s ../sbin/init.d .
```

- Modify **/etc/init.d/boot** script:

```
#bootrc=/etc/init.d/boot.d
bootrc=/sbin/init.d/boot.d
```

What we Changed

Replace **`boot.rootfsck`** with **`boot.readonlyroot`**

- Does not check root (**`1b1`** disk)
- Checks and mounts **`/local`** (**`1b5`** disk)
- Bind mounts **`/etc`**, **`/dev`**, and **`/root`**
- Happens during the “boot” run level

This is the R/W to R/O switch

This is the point of No Return

What we Changed

`/etc/init.d/boot.d` is special

- Customer cannot change (real) **`boot.d`**
- '**`chkconfig`**' appears to work on **`boot.d`**
- Customer **`boot.d`** is R/W but not used
- Actual **`boot.d`** is in **`/sbin/init.d`**
- All other run-levels same as for R/W

/etc/init.d Overlay

```
# cd /etc/init.d/boot.d
S01boot.proc -> ../boot.proc
S02boot.shm -> ../boot.shm

S03boot.readonlyroot -> ../boot.readonlyroot

S06boot.device-mapper -> ../boot.devi…
S06boot.md -> ../boot.md
S07boot.lvm -> ../boot.lvm
S08boot.localfs -> ../boot.localfs
```

Bind Mounts

- Scripted ...

```
mount -n -o bind /local/etc /etc
mount -n -o bind /local/dev /dev
mount -n -o bind /local/root /root
```

- In **`/etc/fstab`** ...

```
/local/var /var bind bind 0 0
/local/home /home bind bind 0 0
```

Even Easier in SLES10

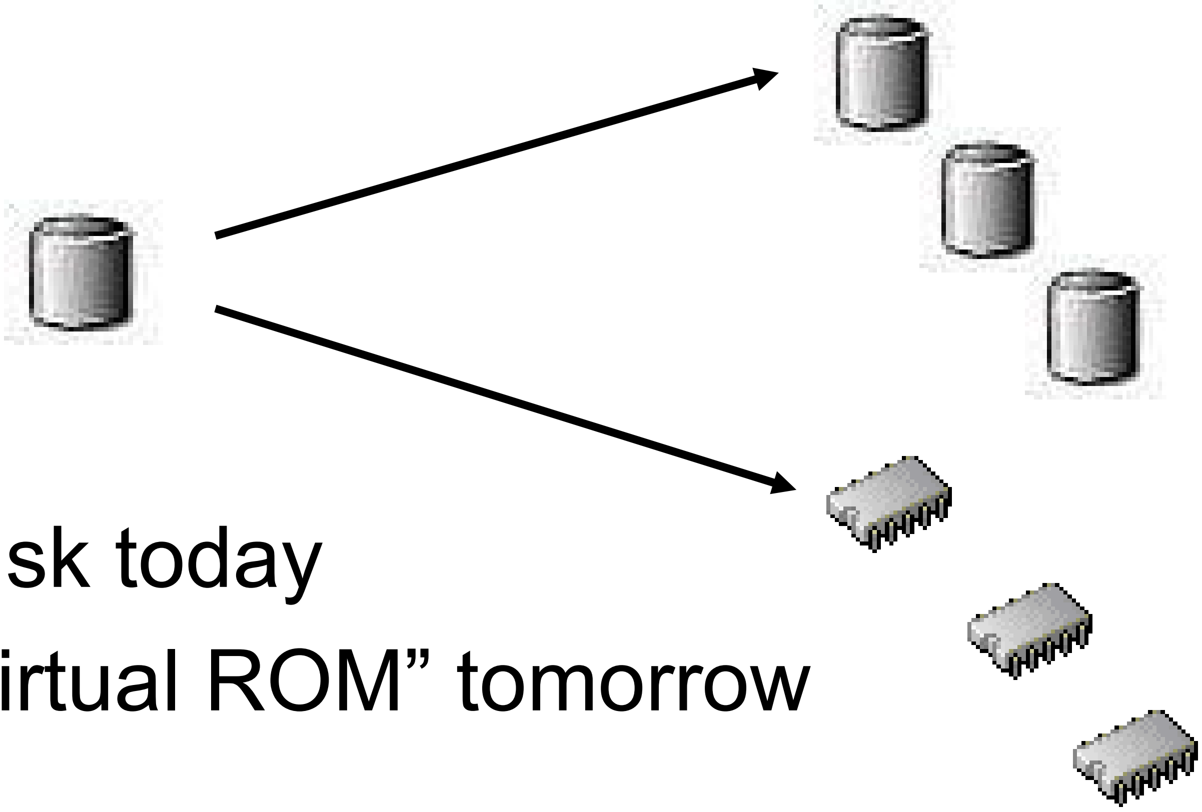
```
6c6
< # /etc/init.d/boot.rootfsck
---
> # /etc/init.d/boot.roroot
96,97c96,99
<          echo "Checking root file system..."
<         fsck $FSCK_PROGRESSBAR -a $FSCK_FORCE $ROOTFS_BLKDEV
---
> #*              echo "Checking root file system..."
> #*      fsck $FSCK_PROGRESSBAR -a $FSCK_FORCE $ROOTFS_BLKDEV
>          echo "Checking /local file system..."
>          fsck $FSCK_PROGRESSBAR -a $FSCK_FORCE /local
```

Even Easier in SLES10

```
150c152,156
<          mount -n -o remount,rw /
---
> #*             mount -n -o remount,rw /
>      mount -n /local
>      mount -n -o bind /local/etc /etc
>      mount -n -o bind /local/root /root
162c168,172
<      mount -n -o remount,rw /
---
> #*         mount -n -o remount,rw /
>      mount -n /local
>      mount -n -o bind /local/etc /etc
>      mount -n -o bind /local/root /root
```

How to Build Read-Only Root

- Start from “monolithic”



Disk today

“virtual ROM” tomorrow

How to Build Read-Only Root

- Start with monolithic distro installation
- Minor prep (see prior slides)
- Copy to eventual R/O target
- Create reference **`/local`**
- Replace **`boot.rootfsck`**

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

Reconciling RPM Database

- Initial RPM DB matches master
- “Client” systems may vary
- Master may get updates

… now what?

Reconciling RPM Database

- Extract master package list

```
# rpm -q -a > master.rpml
```

- Update client RPM database

```
# for P in `cat master.rpml` ; do
    rpm –U --justdb $P.rpm ; done
```

CYGWIN on CD-ROM

```
nw848944 # df
Filesystem     1K-blocks      Used Available Use% Mounted on
D:\CYGWIN         405150    405150         0 100% /
D:\CYGWIN\bin     405150    405150         0 100% /usr/bin
D:\CYGWIN\lib     405150    405150         0 100% /usr/lib
C:\etc          28678528  19825140   8853388  70% /etc
C:\var          28678528  19825140   8853388  70% /var
C:\tmp          28678528  19825140   8853388  70% /tmp
C:\docume~1     28678528  19825140   8853388  70% /home
C:\progra~1     28678528  19825140   8853388  70% /opt
C:\boot         28678528  19825140   8853388  70% /boot
```

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Technology · Connections · Results

Relocatable Packages

On-Demand Software, Ready to Run

Relocatable Packages

- Immediate deployment
- Simplified back-out
- Non-intrusive
- Multiple release concurrency
- Variable platform detail (per build)
- Reduced “scatter”
- Think ‘`vmlink`’

Relocatable Packages – versus today

currently (ie: read-write) …

- Packages [re]deployed on each system
- Deployment causes multiple disruptions
- Demands private (R/W) file storage
- Upgrade and/or removal is “messy”
- Installed files are vulnerable
- More things needing to be backed up

Relocatable Packages

we can (with read-only) …

- Deploy instantly
- Protected copies (R/O to each client)
- Less content to be backed up
- Non-intrusive (to the guest op sys)
- Non-disruptive (to the users and work)
- Mixed releases as needed

Relocatable Packages

sharing options …

- NFS
- SMB (SAMBA)
- VM minidisk today
- SAN future

R/O packages do not require R/O root

Relocatable Packages – How

- Separate software residence
  from software reference
- Inst must distinguish program from data
- Installation must tolerate R/O systems

Relocatable Packages – Concept

```
$APPROOT/bin
$APPROOT/lib
$APPROOT/otherstuff

APPROOT=/usr/opt/x3270-3.3
```

- Use *package–version* syntax or similar

Relocatable Packages – Build

What is the “standard recipe”?

- extract
- **`./configure --prefix=$APPROOT`**
- **`make`**
- **`make install`**

Relocatable Package Example

Build with the standard recipe:

- extract
- `./configure --prefix=/usr/opt/x3270-3.3`
- `make`
- `make install`

`/usr/opt` is ready and writable

Relocatable Package

```
$ ls -atl /home/trothr/x3270-3.3

drwxr-xr-x 6 trothr ... CYGWIN
drwxr-xr-x 6 trothr ... Linux-s390x
drwxr-xr-x 6 trothr ... Solaris-sparc
drwxr-xr-x 7 trothr ... x3270-3.3
lrwxrwxrwx 1 trothr ... src -> x3270-3.3
-rwxr--r-- 1 trothr ... makefile
-rwxr-xr-x 1 trothr ... setup
```

Relocatable Package Example

```
$ /home/trothr/x3270-3.3/setup

+ ln -s
  /home/trothr/x3270-3.3/Solaris-
  sparc /usr/opt/x3270-3.3
+ ln -s x3270-3.3 /usr/opt/x3270
+ ln -s /usr/opt/x3270/bin/x3270 /usr/bin/.
+ ln -s /usr/opt/x3270/bin/x3270if /usr/bin/.
+ ln -s /usr/opt/x3270/bin/pr3287 /usr/bin/.
```

Relocatable Pkgs – Multiple Versions

```
lrwxrwxrwx … gcc -> gcc-3.2.3   (production)
lrwxrwxrwx … gcc-3.2.3 ->
  /import/opt/gcc-3.2.3/Linux-s390x
lrwxrwxrwx … gcc-3.4 ->
  /auto/apps/gcc-3.4/Linux-2.6-s390x
```

- Simple **PATH** change to access the variant:

```
    PATH=/usr/opt/gcc-3.4/bin:$PATH
```

Disk-Based Automounter

On-the-fly Mainframe Media

© Disney

Disk Automounter: Purpose

Automate best practice media access

- z/VM supports dynamic devices
- Linux supports dynamic devices but with different semantics
- Automounter bridges the gap and eliminates operator error

Disk Automounter: Misconceptions

NOTE: DOES NOT REQUIRE NFS

- Most automounter is for networked FS
- Other FS also good for on-demand use (CD-ROM, flash media, USB disk, etc)
- No network requirement in automounter

Dynamic Disk on Linux on z/VM

How it works, manually:

- Attach the disk (‘**`hcp link`**’)
- Find where Linux slotted it
- Vary it on-line (‘**`chccwdev`**’)
- Mount it

Convoluted and error prone

Automating Disk Attachment

```
#
# /etc/auto.master
#
/home   /etc/auto.home
/misc   /etc/auto.misc
/dasd   /etc/auto.dasd
```

Automating Disk Attachment

```
# parse off the partition number, if any:
PART=`echo "$1" | awk -F. '{print $2}'`

# normalize the device number:
DASD=`echo "0000$1" \
  | awk -F. '{print $1}' \
  | tr A-Z a-z \
  | awk '{print "0.0."
            substr($1,length($1)-3,4)}'`
```

Automating Disk Attachment

```
# find the pseudo file to control this dev:
CTRL=`ls -d
  /sys/devices/css0/*/$DASD/online
  2>/dev/null | head -1`

# is the disk on-line (is it ATTACHed)?
if [ ! -f "$CTRL" ] ; then
  hcp "link * $DASD $DASD rr"
  # and re-set CTRL shell var as above
fi
```

Automating Disk Attachment

```
# vary it on-line to Linux:
echo 1 > $CTRL

# and find the block dev assigned:
BDEV=`ls -d
  /sys/devices/css0/*/$DASD/block
  2>/dev/null | head -1`
# also clean-up that file path
```

Automating Disk Attachment

```
# voi-la! create a directory and mount it
mkdir -p -m 555 $1
# mount command varies per the following
```

- Unqualified, try partition 0 or partition 1
- Qualified partition 1, 2, or 3, try as-is
- Qualified partition 0 is “the whole disk”

Disk Automounter Examples

```
zservx01:~ # df
Filesystem           1K-blocks      Used Available Use% Mounted on
/dev/dasde1            7098008    817616   5919824  13% /
tmpfs                   124700         0    124700   0% /dev/shm
/dev/dasda1              52200      8940     40568  19% /boot
```

Initial state of the system

Disk Automounter Examples

```
zservx01:~ # cd /dasd/25f/sles9
zservx01:/dasd/25f/sles9 # df
Filesystem           1K-blocks      Used Available Use% Mounted on
/dev/dasde1            7098008    817616   5919824  13% /
tmpfs                   124700         0    124700   0% /dev/shm
/dev/dasda1              52200      8940     40568  19% /boot
/dev/dasdg1           23216172  18301524   3735332  84% /dasd/25f
```

Automounter did the following:

- Found the “25F” disk, varied it on-line
- Found slot “dasdg” and partition 1
- Mounted FS in the expected location

Disk Automounter Examples

```
vst $ df
Filesystem              1K-blocks      Used Available Use% Mounted on
/dev/dasdb2                222464     98332    112648  47% /
/dev/dasda1                 20908      8948     10880  46% /boot
/dev/dasda2               2126020    531716   1486304  27% /usr
/dev/dasda3                214096     27624    175420  14% /opt
tmpfs                      124700        20    124680   1% /tmp
/local/home                104608     34944     64264  36% /home
/local/var                 104608     34944     64264  36% /var
```

Initial state (round two)

Disk Automounter Examples

```
vst $ cd /dasd/1bd.1 ; cd /dasd/1bd.2 ; cd /dasd/1bd.3
vst $ df
Filesystem           1K-blocks      Used Available Use% Mounted on
/dev/dasdb2             222464     98336    112644  47% /
/dev/dasda1              20908      8948     10880  46% /boot
/dev/dasda2            2126020    531720   1486300  27% /usr
/dev/dasda3             214096     27624    175420  14% /opt
tmpfs                   124700         0    124700   0% /tmp
/local/home             104608     34976     64232  36% /home
/local/var              104608     34976     64232  36% /var
/dev/dasdn1             849696     24752    781780   4% /dasd/1bd.1
/dev/dasdn2             566936      7140    530996   2% /dasd/1bd.2
/dev/dasdn3             948184     92696    807320  11% /dasd/1bd.3
```

The “doc disk”: **`man`**, **`info`**, **`doc`**

Summary

- The real advantage is *not* space savings but is management of myriad systems
- Start with one read-only package or directory or disk and grow from there

Thank You!!

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