Extreme Filesystem Sharing

Linux on Read-Only Root at Nationwide

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Disclaimer

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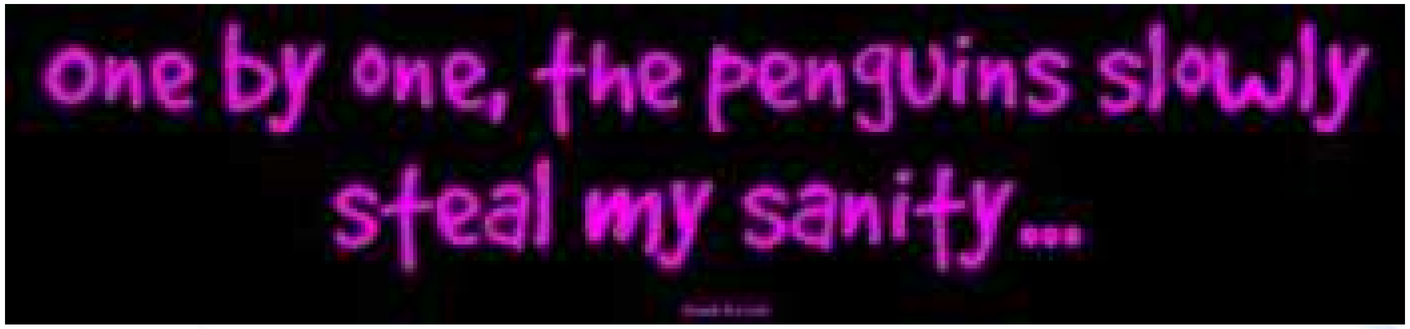
Or in other words: Your mileage may vary. “It Depends.” Results not typical. Actual mileage will probably be less. Do not fold, spindle, or mutilate. Not to be taken on an empty stomach.

When in doubt, ask!

Extreme Filesystem Sharing

- Herding the Flock
- Sharing Common Content
- A Shared Root Directory
- Relocatable Packages
- DASD on Demand – Disk Automounter

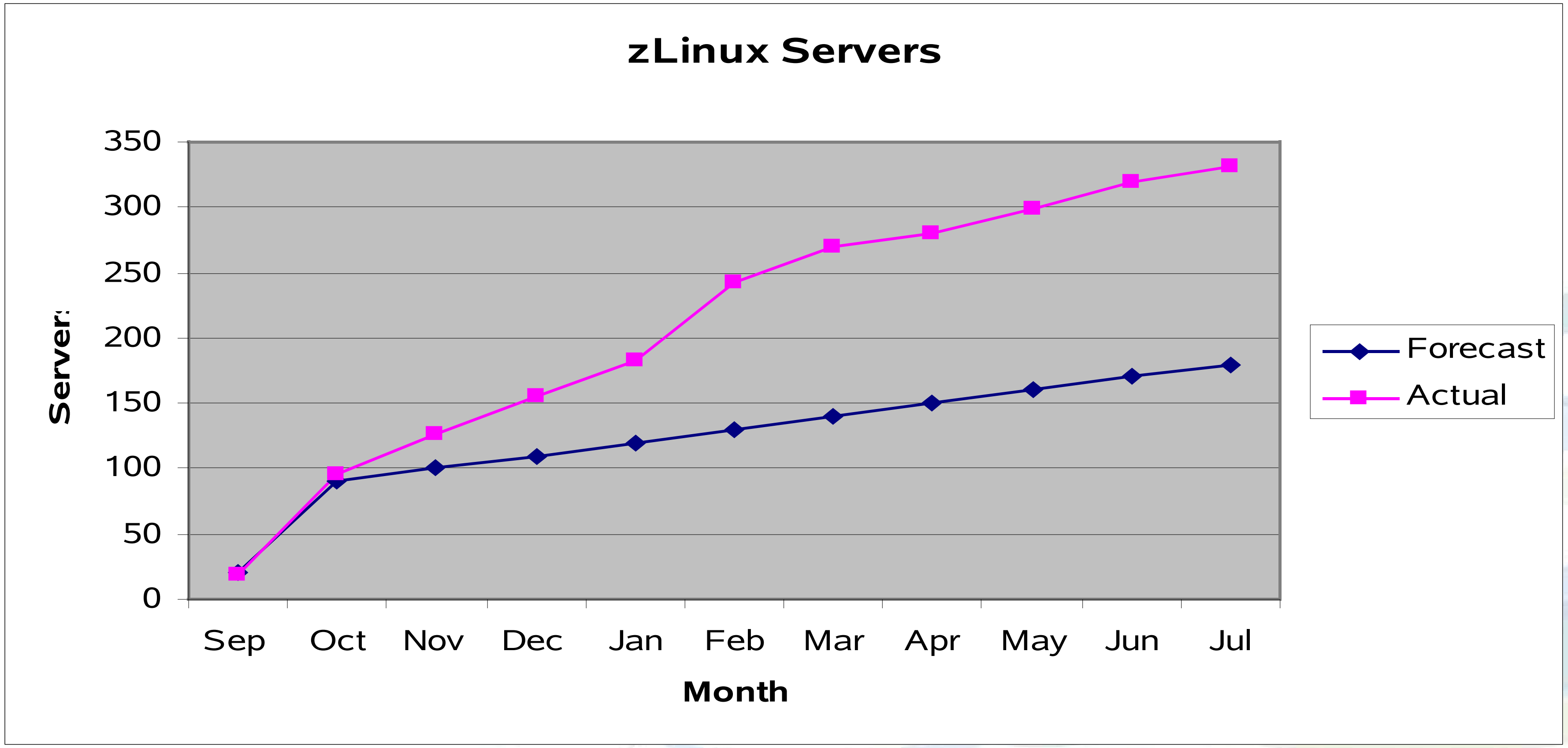
Issue: Penguins Populating



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

The real question persists: WHY???

Stability and Manageability

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

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

Shared OpSys Partitions

- Multiple R/O shared disks
- Up to three partitions per disk
  - Common 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`	==	more LVM physical volumes
`100,200`	==	FCP channels for SAN

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 # 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% /
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/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

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

```
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
```

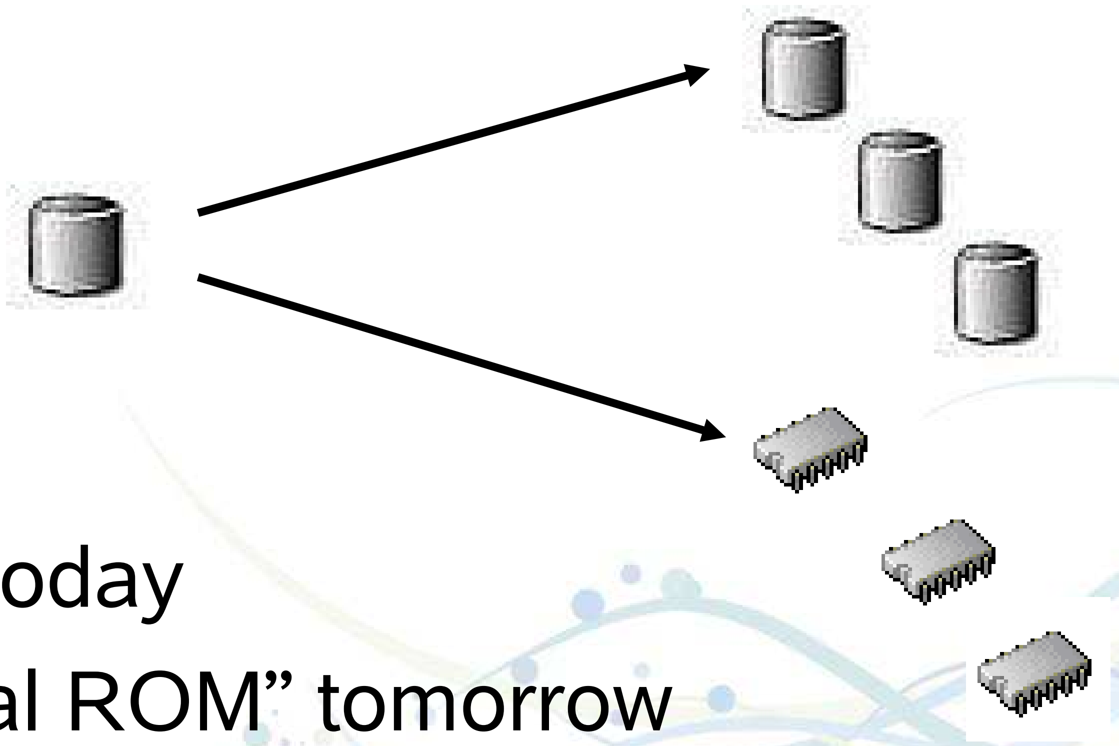
```
150c152,156
<           mount -n -o remount,rw /
---
> #*            mount -n -o remount,rw /
>       mount -n /local
>       mount -n -o bind /local/etc /etc
>       mount -n -o bind /local/root /root
162c168,172
<       mount -n -o remount,rw /
---
> #*        mount -n -o remount,rw /
>       mount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

What we Changed

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

- Customer cannot change `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

How to Build Read-Only Root



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
- Create reference `/local`
- Replace `boot.rootfsck`

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 distinguishe 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 Packages – 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
```

- Change **PATH** to get the variant:

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

Disk-Based Automounter

On-the-fly Mainframe Media

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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