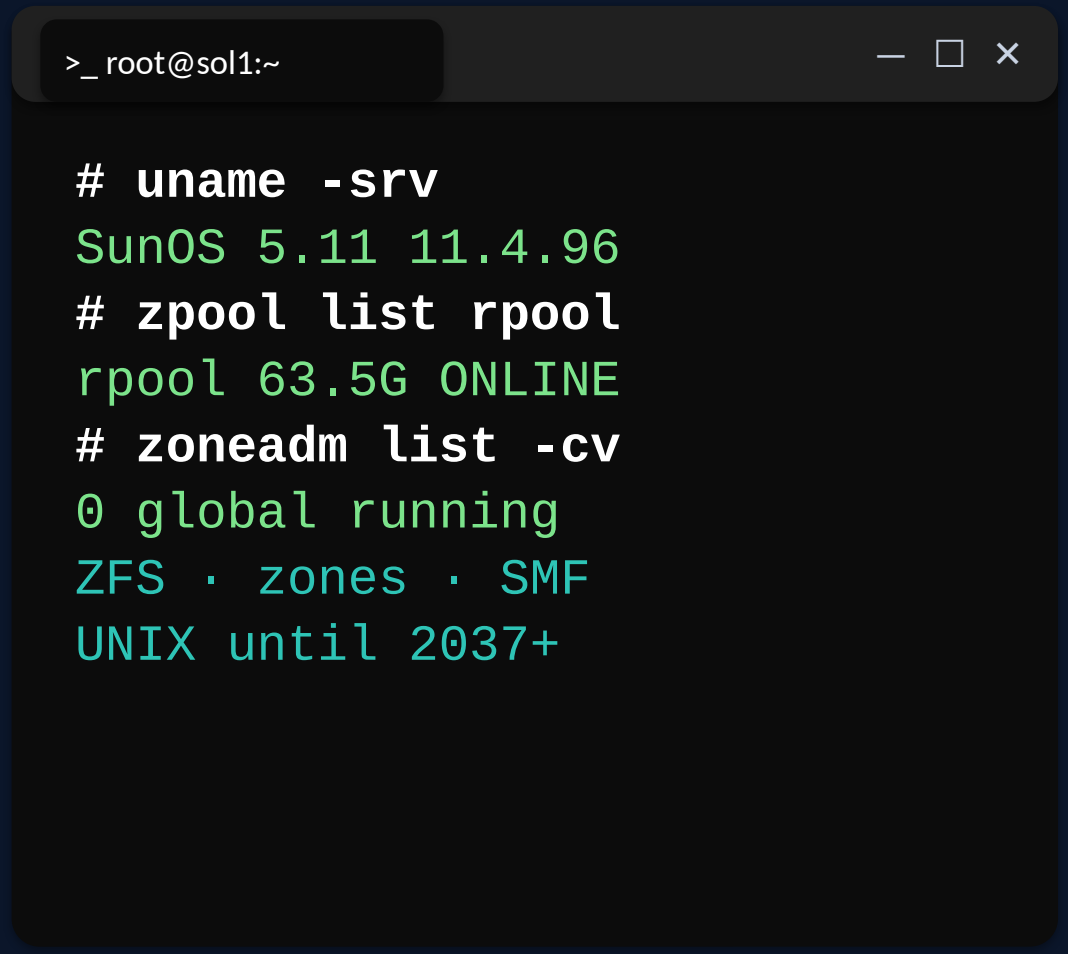


FULL COURSE · 12 LESSONS

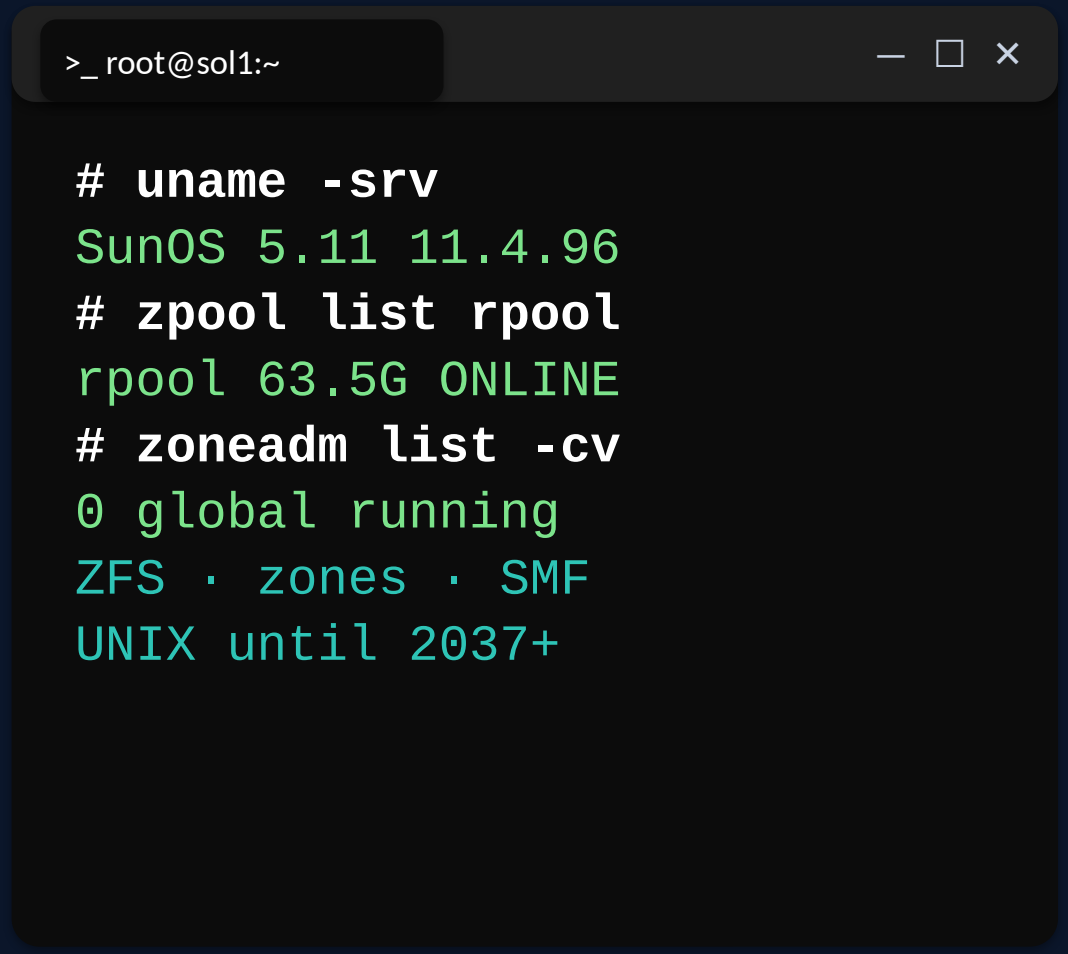
Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

IPS, SMF, ZFS, Zones, LDoms, OLVM & DTrace

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

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LESSON 1 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

Oracle Solaris Today: History, SRUs, Support to 2037 & the Free CBE

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 1

- From SunOS to Oracle Solaris 11.4: a short history
- Continuous delivery: one release, many SRUs
- The 2026 SRU cadence: CPU + feature release each quarter
- Support timeline: Premier to 2031, Extended to 2037
- Oracle VM family: SPARC (LDoms), x86 and OLVM
- The free CBE release and our VirtualBox lab
- Course map: 12 lessons

From SunOS to Solaris 11.4

1982	Sun Microsystems founded; SunOS (BSD-based)
1992	Solaris 2 = SunOS 5 (System V Release 4)
2005	Solaris 10: ZFS, zones, DTrace, SMF
2010	Oracle acquires Sun
2011	Solaris 11: IPS packages, boot environments
2018	Solaris 11.4: continuous delivery begins
2026	SRU93+: two updates per quarter; new CBE
2037+	Committed support for 11.4

Continuous Delivery and the 2026 SRU Cadence

Term	Meaning
Solaris 11.4	The single current release — no Solaris 12; features arrive in updates
SRU	Support Repository Update: cumulative update (SRU 96 = 11.4.96)
CPU SRU	Quarterly Critical Patch Update: security fixes (SRU 93, 96…)
Feature SRU	About 6 weeks later: new features (SRU 95: nvmeadm, zpool monitor)
Since SRU 93 (Jun 2026)	Two planned SRUs per quarter instead of three monthly ones
Support repository	pkg.oracle.com — needs a support contract (certificate + key)
Release repository	Free GA/CBE content; no SRU updates

Support Timeline (Nov 2026)

Product	Status
Solaris 11.4	Premier Support to Nov 2031 · Extended to 2037 · Sustaining: indefinite
Solaris 11.3 / 10	Extended Support ends 2027 — plan migration now
OVM Server for SPARC 3.6	Bundled with 11.4; supported with Solaris 11.4
Oracle VM Server for x86	Sustaining Support only since July 1, 2024
Replacement for OVM x86	Oracle Linux KVM + OLVM 4.5 (oVirt-based)
Hardware	SPARC T8, M8, S7, Fujitsu M12; Oracle/third-party x86

Oracle Virtualization Family

Technology	What it is
Zones	OS-level containers sharing one Solaris kernel
Kernel zones	Zones with their own kernel (own SRU level)
OVM Server for SPARC (LDoms)	Firmware hypervisor; ldm command; logical domains
Dynamic Domains / PDoms	Hardware partitions on M-series servers
Oracle VM Server for x86	Xen-based, legacy — migrate away
Oracle Linux KVM + OLVM	Modern x86 virtualization, managed by OLVM
VirtualBox	Desktop hypervisor — our lab

Our Lab: Solaris 11.4 CBE in VirtualBox

Item	Value
Download	oracle.com/solaris → Solaris 11.4 CBE (free Oracle account)
License	Free for developers and non-production personal use
Latest CBE	March 2026 (content near SRU 90)
VM sol1	x86, 4 GB RAM, 2 vCPU, 40 GB disk — 192.168.56.51
VM sol2	Optional second VM for replication — 192.168.56.52
SPARC / LDoms	Needs real SPARC hardware — shown on slides
OLVM lab	Oracle Linux 9 VMs (free) — lesson 10

Course Map

#	Lesson
1–3	Solaris today · Installing the CBE · IPS, SRUs and boot environments
4–6	SMF and FMA · ZFS · Networking with dladm and ipadm
7–8	Users, RBAC and security · Zones and kernel zones
9–10	Oracle VM Server for SPARC (LDoms) · OVM x86 to Oracle Linux KVM and OLVM
11–12	DTrace and troubleshooting · Migrating to 11.4, Solaris vs Linux, next steps

Summary and Homework

- Solaris = SunOS 5.x (SVR4); 11.4 is the one current release
- SRUs are cumulative; since SRU 93 two per quarter (CPU + feature)
- 11.4 supported to at least 2037; 11.3 and 10 end in 2027
- OVM x86 is legacy; Oracle Linux KVM + OLVM replaces it
- CBE: free for developers and non-production use
- Homework: create an Oracle account and download the 11.4 CBE x86 text-install ISO

Thank You! 🙏

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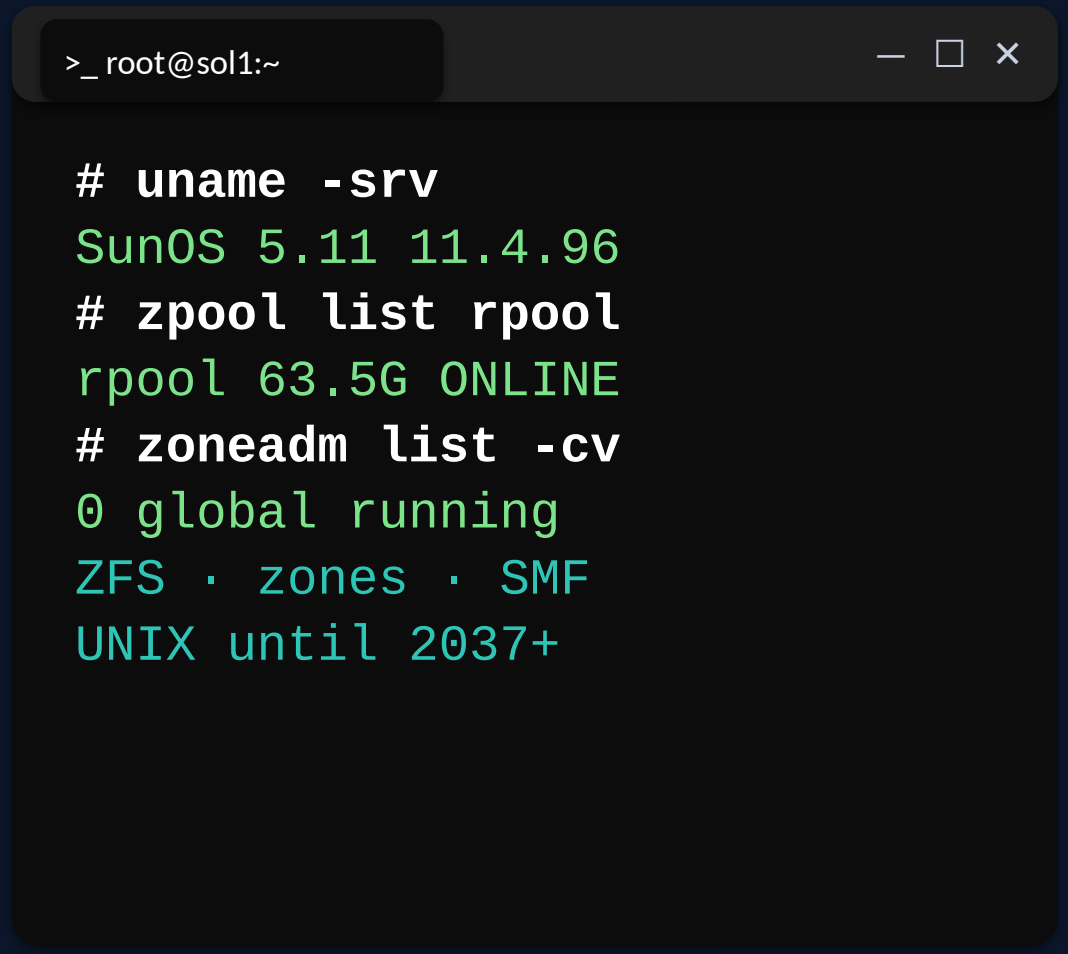
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Book: The Direct Path to Linux Ubuntu (Amazon · Barnes & Noble)

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LESSON 2 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

Installing Solaris 11.4 CBE: Text Installer, VirtualBox & Automated Installer

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 2

- Install images: text installer, live media, Automated Installer
- VirtualBox VM settings for Solaris 11.4 x86
- The text installer: disk, network, time zone, users
- First boot: root is a role, the first user gets it
- Post-install checks and VirtualBox Guest Additions
- Enterprise installs: AI server, manifests, unified archives
- Installing on SPARC: OpenBoot (ok prompt)

Choosing an Install Image

Image	Use it for
Text Install ISO (x86 / SPARC)	Servers, minimal VMs — our lab (solaris-large-server group)
Live Media ISO (x86)	GNOME desktop, try before install
Automated Install (AI) boot image	Network installs driven by an AI server
Unified Archive (.uar)	Clone or recover a whole system or zone
Pre-built VM template	Quick start on VirtualBox / OCI where offered
CBE packages	Free; update from the CBE release repository

VirtualBox VM Settings

Setting	Value
Type / Version	Solaris · Oracle Solaris 11 (64-bit)
Memory / CPUs	4096 MB (2 GB minimum) · 2 vCPUs
Disk	40 GB VDI, dynamically allocated (ZFS rpool)
Adapter 1	NAT — internet for pkg
Adapter 2	Host-only vboxnet0 — 192.168.56.51 static
Firmware	BIOS or EFI (both supported on x86)
Optical	Attach sol-11_4-cbe-text-x86.iso (name may vary)

The Text Installer

```
Oracle Solaris 11.4 Text Installer
  1  Install Oracle Solaris
  2  Install Additional Drivers
  3  Shell
  4  Terminal type (currently xterm)
  5  Reboot
Disks: c1t0d0  40.0GB  Use the whole disk (GPT)
Network: sol1 · Manually  net0 (NAT DHCP)  net1 192.168.56.51/24
Time zone: America / Los_Angeles     Locale: en_US.UTF-8
Users: root password · user student (gets root role)
Installing... 100%   Installation complete.  F8 Reboot
```

First Boot: root Is a Role

```
sol1 console login: student
Oracle Corporation      SunOS 5.11      11.4    November 2026
student@sol1:~$ su -                  # works: student has the root role
root@sol1:~# roles student
root
root@sol1:~# exit
student@sol1:~$ sudo -l | tail -1  # sudo is also configured for the first user
student@sol1:~$ pfexec svcs -x     # run with profile rights
# ssh root@sol1  -> denied: a role cannot log in directly
```

Post-install Checks

```
root@sol1:~# uname -a ; cat /etc/release | head -2
root@sol1:~# pkg info entire | grep -i version
root@sol1:~# zpool status rpool ; zfs list -r rpool | head
root@sol1:~# svcs -x                    # no output = all services OK
root@sol1:~# ipadm create-ip net1
root@sol1:~# ipadm create-addr -T static -a 192.168.56.51/24 net1/v4
root@sol1:~# ipadm show-addr
root@sol1:~# pkg publisher              # solaris  origin  (CBE repo)
root@sol1:~# pkg install --accept system/virtualbox/additions   # if offered
```

Enterprise Installs: Automated Installer

Piece	Role
AI server	installadm service: boot images + DHCP + manifests
AI manifest (XML)	Disks, packages, publishers, boot environment
SC profile (XML)	System config: hostname, IP, users, time zone (sysconfig create-profile)
Criteria	Match clients by MAC, IP range, architecture, memory
Unified Archive	archiveadm create: clone/recovery image of system or zones
IPS repo mirror	Local copy of the package repository for fast installs

SPARC: OpenBoot and Unified Archives

```
{0} ok printenv auto-boot?
{0} ok devalias
{0} ok boot cdrom                    # install from DVD/ISO (via ILOM)
{0} ok boot net:dhcp - install       # Automated Installer over the network
{0} ok boot -L                       # list boot environments

root@sol1:~# archiveadm create -r /var/tmp/sol1-recovery.uar
root@sol1:~# archiveadm info /var/tmp/sol1-recovery.uar
```

Summary and Homework

- Text installer for servers; live media for desktops; AI for fleets
- VM: 4 GB RAM, 2 vCPU, 40 GB disk, NAT + host-only
- root is a role: log in as your user, then su - or pfexec
- Check: pkg info entire, zpool status, svcs -x, ipadm
- AI = installadm + manifests + SC profiles; archiveadm for clones
- Homework: install sol1, set 192.168.56.51, record pkg info entire

Thank You! 🙏

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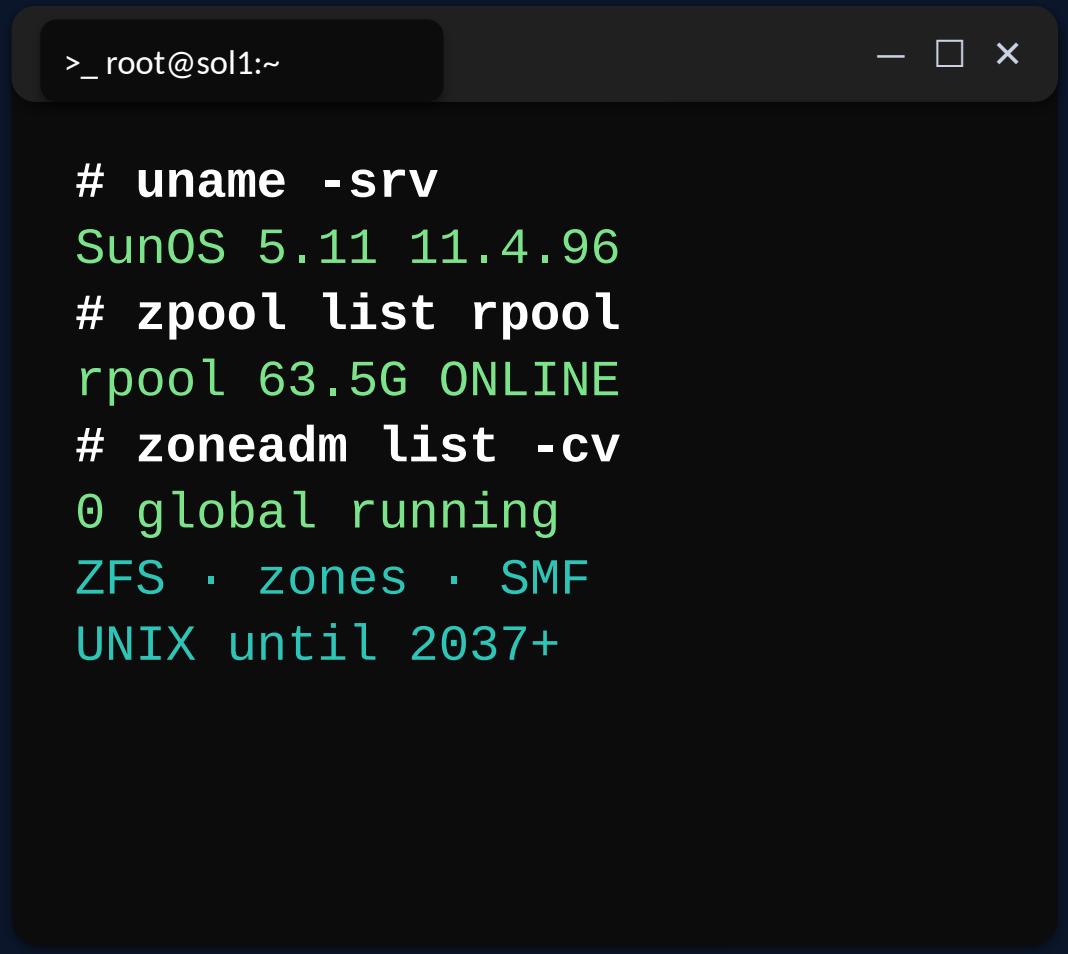
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LESSON 3 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

IPS Packages, SRU Updates & Boot Environments

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 3

- IPS concepts: packages, FMRIs, publishers, groups
- Everyday pkg: search, info, install, uninstall, verify
- Publishers: release, support and CBE repositories
- Applying an SRU with pkg update
- Boot environments with beadm: create, activate, roll back
- Package mediators, facets and the entire incorporation
- Local repositories for offline sites

IPS Concepts

Term	Meaning
Package	Named, versioned set of files and dependencies
FMRI	pkg://solaris/web/server/apache-24@2.4.66,11.4-11.4.96.0.1.2.0
Publisher	Source of packages (solaris, a vendor, your own)
Repository	Where a publisher's packages live (HTTP or a directory)
Group package	group/system/solaris-large-server, …-desktop
entire	Incorporation that locks the whole OS to one SRU
Image	The installed system (global zone, zone, or alternate root)

Everyday pkg

```
root@sol1:~# pkg search -p tmux              # which package has it?
root@sol1:~# pkg info -r tmux                # info from the repository
root@sol1:~# pkg install tmux git            # install (BE only if needed)
root@sol1:~# pkg install -nv group/system/solaris-desktop   # dry run
root@sol1:~# pkg list -u                     # updates available?
root@sol1:~# pkg contents -t file -o path tmux | head -3
root@sol1:~# pkg search -l /usr/bin/ssh      # who owns this file?
root@sol1:~# pkg verify -v openssh           # check files
root@sol1:~# pkg fix openssh                 # repair damaged files
root@sol1:~# pkg uninstall tmux ; pkg history | tail -3
```

Publishers and Repositories

```
root@sol1:~# pkg publisher
PUBLISHER  TYPE    STATUS P LOCATION
solaris    origin  online F https://pkg.oracle.com/solaris/release/

# Support contract: download key + certificate from pkg-register.oracle.com
root@sol1:~# pkg set-publisher -k /root/pkg.key.pem -c /root/pkg.cert.pem \
      -G '*' -g https://pkg.oracle.com/solaris/support/ solaris

# Free CBE system: keep the release/CBE origin from your CBE instructions
root@sol1:~# pkg set-publisher -P -g file:///export/repo/myapps myapps
root@sol1:~# pkg refresh --full
```

Applying an SRU Safely

```
root@sol1:~# pkg update -nv                          # preview: what changes?
root@sol1:~# pkg update --be-name sru96 --accept   # new BE, current one untouched
...
A clone of 11.4.90 exists and has been updated and activated.
On the next boot the Boot Environment sru96 will be mounted on '/'.
root@sol1:~# beadm list
BE       Flags Mountpoint Space  Policy Created
solaris  N     /          312M   static 2026-11-20 21:04
sru96    R     -          8.9G   static 2026-11-20 21:40
root@sol1:~# init 6                                  # reboot into sru96
root@sol1:~# pkg update 'entire@11.4-11.4.96'      # or pin a specific SRU
```

Boot Environments with beadm

```
root@sol1:~# beadm create before-apache          # snapshot-based, seconds
root@sol1:~# beadm list
root@sol1:~# beadm mount before-apache /mnt      # look inside an old BE
root@sol1:~# beadm unmount before-apache
root@sol1:~# beadm activate solaris              # roll back: choose old BE
root@sol1:~# init 6
root@sol1:~# beadm destroy -F sru96              # remove an unwanted BE
root@sol1:~# beadm rename sru96 sru96-prod
# GRUB menu (x86) / boot -L at ok prompt (SPARC) also lists BEs
```

Mediators, Facets and Avoid

Feature	Example
Mediator	pkg set-mediator -V 3.13 python (which python is default)
Facet	pkg change-facet facet.locale.de=false (skip optional parts)
Variant	variant.arch=i386 / sparc; variant.opensolaris.zone
Avoid	pkg avoid gnome-media (do not pull in via group)
Freeze	pkg freeze openssl (hold a version — use with care)
entire	Always update entire with the rest — never mix SRU levels

Local Repository for Offline Sites

```
root@sol1:~# zfs create -o mountpoint=/export/repo rpool/export/repo
# From the downloaded SRU repository zip files (My Oracle Support):
root@sol1:~# unzip -q 'p*_11.4.96*_1of*.zip' -d /var/tmp/sru96
root@sol1:~# pkgrecv -s /var/tmp/sru96/repo -d /export/repo '*'
root@sol1:~# pkgrepo rebuild -s /export/repo
root@sol1:~# svccfg -s pkg/server setprop pkg/inst_root=/export/repo
root@sol1:~# svcadm refresh pkg/server ; svcadm enable pkg/server
# Clients:
root@sol2:~# pkg set-publisher -G '*' -g http://192.168.56.51/ solaris
```

Summary and Homework

- IPS: packages, FMRIs, publishers; entire locks the SRU level
- pkg search / info / install / list -u / verify / fix / history
- SRUs need the support repository (key + certificate)
- pkg update --be-name X: new BE, reboot, roll back if needed
- beadm create / list / activate / destroy
- Homework: create a BE, install tmux, roll back, check beadm list

Thank You! 🙏

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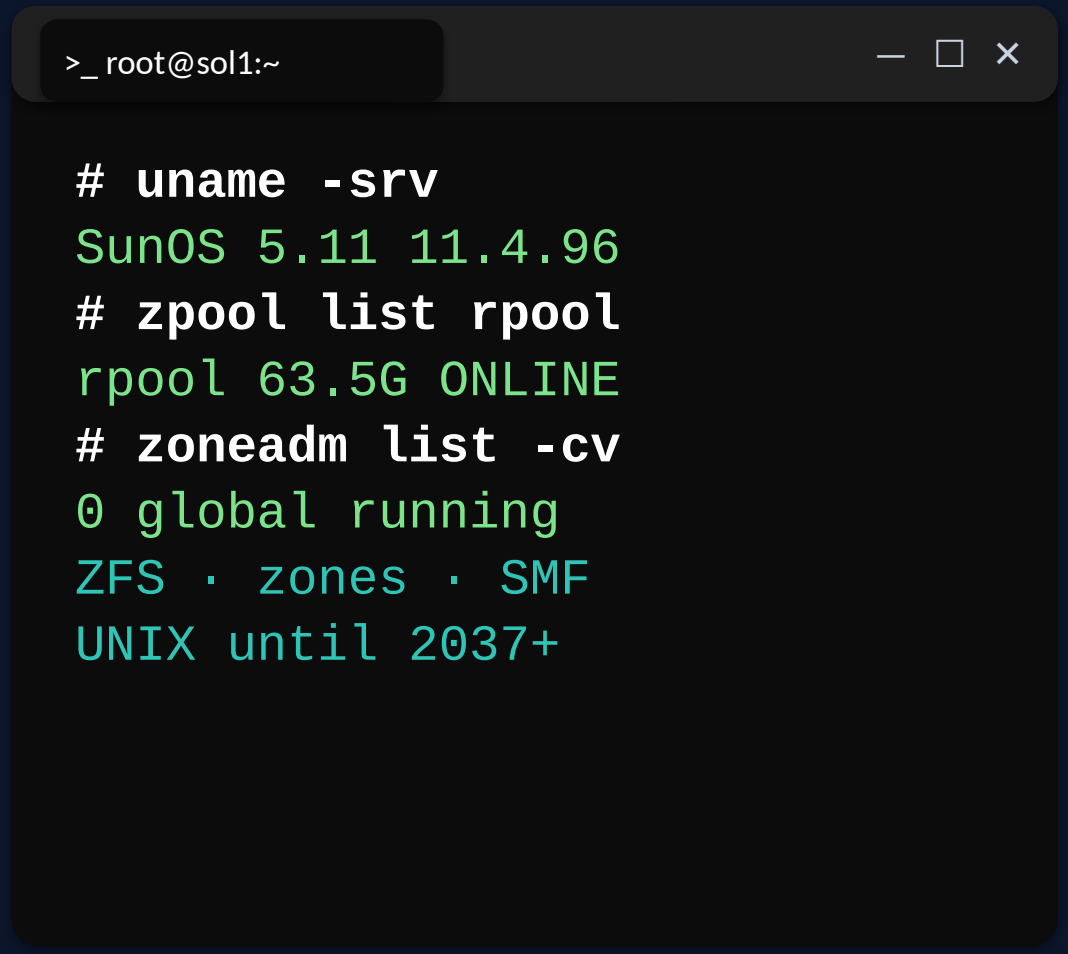
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LESSON 4 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

SMF Services & the Fault Management Architecture

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 4

- SMF concepts: services, instances, FMRIs, states
- svcs: list, explain (-x), dependencies (-d / -D)
- svcadm: enable, disable, restart, clear, refresh
- svccfg and svcprop: properties and configuration
- Writing a manifest for your own service
- Milestones and boot troubleshooting
- FMA: fmadm faulty, fmdump, and repair

SMF Concepts and States

Term	Meaning
Service FMRI	svc:/network/ssh:default (service + instance)
online	Running normally
disabled	Turned off by the administrator
offline	Enabled but waiting for a dependency
maintenance	Failed too often — needs you: fix, then svcadm clear
degraded	Running with reduced capability
Restarter	svc.startd (daemons) or inetd (on-demand services)
Repository	/etc/svc/repository.db — all service configuration

svcs: What Is Running and Why Not

```
root@sol1:~# svcs | head -4
STATE          STIME    FMRI
online         21:04:11 svc:/system/svc/restarter:default
online         21:04:15 svc:/network/ssh:default
root@sol1:~# svcs -a | grep -c disabled
root@sol1:~# svcs -x
svc:/network/http:apache24 (Apache 2.4 HTTP server)
 State: maintenance since November 20, 2026 at 09:52:13 PM PST
Reason: Start method exited with $SMF_EXIT_ERR_CONFIG.
   See: /var/svc/log/network-http:apache24.log
root@sol1:~# svcs -l ssh ; svcs -d ssh ; svcs -D ssh ; svcs -p ssh
```

svcadm: Control Services

```
root@sol1:~# svcadm enable -r apache24       # -r: also enable dependencies
root@sol1:~# svcadm disable -t sendmail      # -t: temporary, until reboot
root@sol1:~# svcadm restart ssh
root@sol1:~# svcadm refresh ssh              # re-read configuration
root@sol1:~# tail -5 /var/svc/log/network-http:apache24.log
root@sol1:~# vim /etc/apache2/2.4/httpd.conf  # fix the real problem first
root@sol1:~# svcadm clear apache24           # leave maintenance
root@sol1:~# svcs apache24
online         22:01:47 svc:/network/http:apache24
root@sol1:~# svcadm milestone -d all          # default boot milestone
```

svccfg and svcprop: Properties

```
root@sol1:~# svcprop -p config network/dns/client
root@sol1:~# svccfg -s network/dns/client
svc:/network/dns/client> setprop config/nameserver = net_address: (192.168.56.1)
svc:/network/dns/client> setprop config/search = astring: ("lab.local")
svc:/network/dns/client> listprop config
svc:/network/dns/client> exit
root@sol1:~# svcadm refresh dns/client
root@sol1:~# svccfg -s name-service/switch setprop config/host = astring: "files dns"
root@sol1:~# svcadm refresh name-service/switch
root@sol1:~# svccfg -s ssh listcust           # what did admins change?
```

Your Own Service: a Manifest

```
root@sol1:~# svcbundle -o /var/tmp/myapp.xml \
      -s service-name=site/myapp -s model=daemon \
      -s start-method='/opt/myapp/bin/myapp --serve' \
      -s rc-script=  -s enabled=true
root@sol1:~# svccfg validate /var/tmp/myapp.xml
root@sol1:~# cp /var/tmp/myapp.xml /lib/svc/manifest/site/
root@sol1:~# svcadm restart manifest-import
root@sol1:~# svcs myapp
online         22:14:03 svc:/site/myapp:default
root@sol1:~# pkill myapp ; sleep 2 ; svcs -p myapp   # SMF restarted it
```

Milestones and Boot Troubleshooting

Tool	Use
milestone/single-user	Minimal system; boot -m milestone=single-user
milestone/multi-user-server	Normal server state (default: all)
boot -m verbose	Show each service as it starts (x86: add in GRUB)
boot -s	Single-user shell for repairs
svcs -x / svcs -xv	First command after any boot problem
/lib/svc/bin/restore_repository	Recover a damaged SMF repository
/var/svc/log/*.log	Per-service logs

FMA: The Fault Manager

```
root@sol1:~# fmadm faulty
--------------- ------------------------------------  -------------- ---------
TIME            EVENT-ID                              MSG-ID         SEVERITY
Nov 20 22:31:07 7f3c...e21a                           ZFS-8000-D3    Major
Problem in: zfs://pool=datapool/vdev=3a1f...  Status: faulted
Action: Run 'zpool status -x' and replace the bad device.
root@sol1:~# fmdump                 # fault log    ; fmdump -e : error telemetry
root@sol1:~# fmdump -v -u 7f3c...e21a
root@sol1:~# fmadm repaired zfs://pool=datapool/vdev=3a1f...   # after the fix
root@sol1:~# fmstat ; svcs fmd
```

Summary and Homework

- States: online, disabled, offline, maintenance, degraded
- svcs -x explains problems; svcs -d / -D / -p for details
- svcadm enable -r / disable -t / restart / refresh / clear
- Configuration in properties: svcprop, svccfg setprop, refresh
- svcbundle writes manifests; SMF restarts dead daemons
- FMA: fmadm faulty, fmdump, fmadm repaired
- Homework: create site/myapp, kill it, watch SMF restart it

Thank You! 🙏

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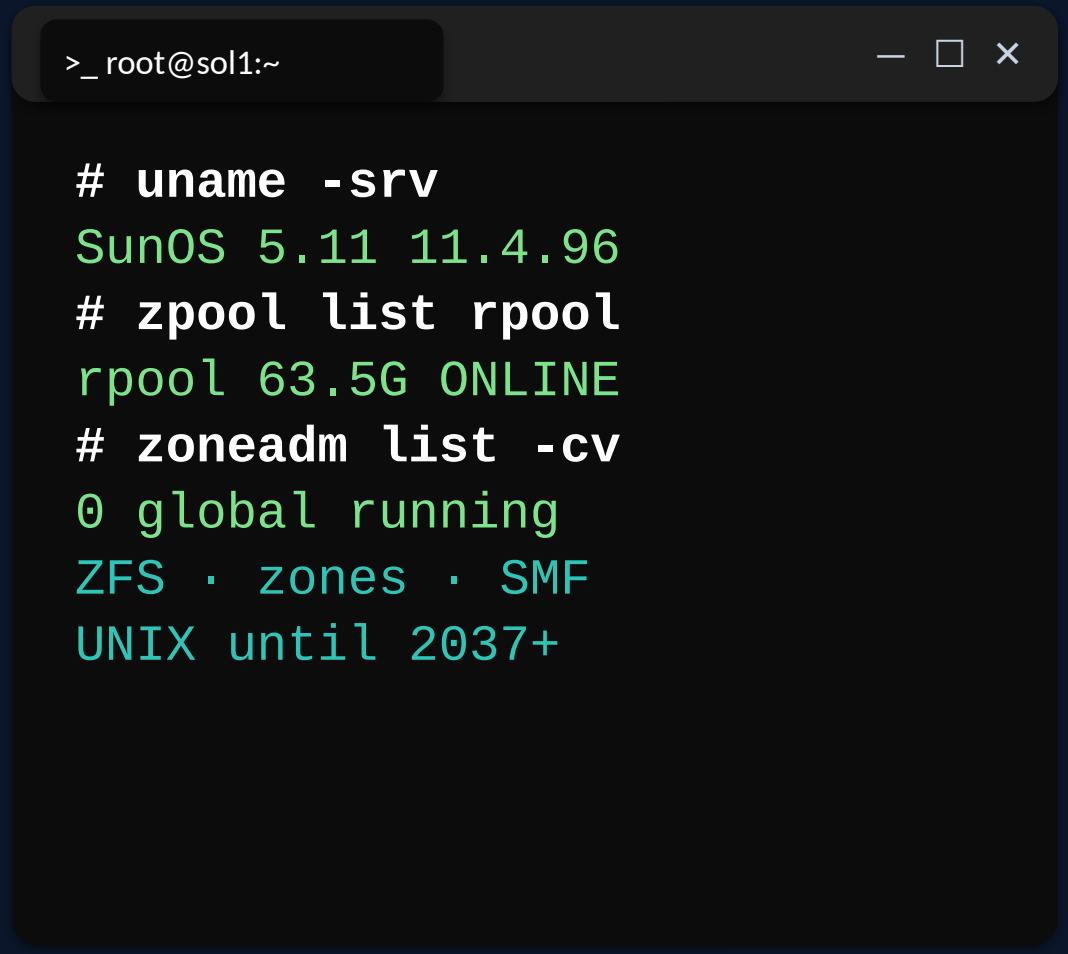
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LESSON 5 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

ZFS: Pools, Datasets, Snapshots & Replication

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 5

- ZFS ideas: pooled storage, copy-on-write, checksums
- Pool layouts: mirror, raidz1/2/3, log, cache, spare
- zpool create, status, scrub, replace, monitor
- Datasets and properties: compression, quota, encryption
- Snapshots, rollback and clones
- zfs send / receive for backup and replication
- ZFS volumes, sharing (NFS/SMB) and the ARC

ZFS Ideas

Idea	What it means for you
Pooled storage	Disks form a pool; datasets share its space — no partitions to resize
Copy-on-write	Never overwrites live data — no fsck, always consistent
Checksums	Every block verified; bad copies healed from mirror/raidz
Snapshots	Instant, read-only, cost only changed blocks
Properties	Compression, quota, encryption, mountpoint per dataset
Boot environments	Root on ZFS makes lesson 3's safe updates possible

Pool Layouts

Layout	Survives / Notes
mirror (2–3 disks)	1–2 disk failures; best random I/O — rpool is a mirror
raidz1	1 failure per vdev; avoid with large disks
raidz2 / raidz3	2 / 3 failures per vdev — common for big data pools
log (SLOG)	Fast SSD for synchronous writes (NFS, databases) — mirror it
cache (L2ARC)	SSD read cache — after you add RAM
spare	Hot spare that FMA activates automatically
Rule	Redundancy lives in vdevs; a pool is lost if any vdev is lost

Creating and Caring for a Pool

```
root@sol1:~# format < /dev/null                # list disks: c2t1d0 c2t2d0 ...
root@sol1:~# zpool create datapool mirror c2t1d0 c2t2d0 mirror c2t3d0 c2t4d0
root@sol1:~# zpool add datapool spare c2t5d0
root@sol1:~# zpool status datapool
  pool: datapool
 state: ONLINE
  scan: none requested
root@sol1:~# zpool list ; zpool iostat -v datapool 5 2
root@sol1:~# zpool scrub datapool              # verify every block
root@sol1:~# zpool monitor -t scrub datapool 5  # progress (SRU 95 feature)
root@sol1:~# zpool attach rpool c1t0d0 c1t1d0   # turn rpool into a mirror
```

Replacing a Failed Disk

```
root@sol1:~# zpool status -x
  pool: datapool
 state: DEGRADED
status: One or more devices has been removed by the administrator.
        c2t3d0  REMOVED   0     0     0
        c2t5d0  INUSE (spare activated by FMA)
root@sol1:~# zpool replace datapool c2t3d0 c2t6d0
root@sol1:~# zpool monitor -t resilver datapool
root@sol1:~# zpool status datapool | grep state
 state: ONLINE
root@sol1:~# fmadm faulty      # confirm FMA closed the case
```

Datasets and Properties

```
root@sol1:~# zfs create -o compression=lz4 datapool/projects
root@sol1:~# zfs create -o quota=20G -o reservation=5G datapool/projects/web
root@sol1:~# zfs create -o encryption=on -o keysource=passphrase,prompt \
      datapool/secret
Enter passphrase for 'datapool/secret': ********
root@sol1:~# zfs set mountpoint=/srv/web datapool/projects/web
root@sol1:~# zfs get compression,compressratio,used,available datapool/projects
root@sol1:~# zfs set dedup=off datapool        # dedup needs lots of RAM
root@sol1:~# zfs set atime=off datapool/projects
root@sol1:~# zfs list -o name,used,avail,quota,mountpoint -r datapool
```

Snapshots, Rollback and Clones

```
root@sol1:~# zfs snapshot -r datapool/projects@before-upgrade
root@sol1:~# zfs list -t snapshot -o name,used,creation
root@sol1:~# ls /srv/web/.zfs/snapshot/before-upgrade/   # browse old files
root@sol1:~# cp /srv/web/.zfs/snapshot/before-upgrade/index.html /srv/web/
root@sol1:~# zfs rollback datapool/projects/web@before-upgrade
root@sol1:~# zfs clone datapool/projects/web@before-upgrade datapool/web-test
root@sol1:~# zfs diff datapool/projects/web@before-upgrade
root@sol1:~# zfs destroy datapool/projects/web@before-upgrade
# Automatic snapshots: svc:/system/filesystem/zfs/auto-snapshot (Time Slider)
```

Replication with send and receive

```
# Full copy to sol2 (192.168.56.52) over SSH
root@sol1:~# zfs snapshot datapool/projects@rep1
root@sol1:~# zfs send -R datapool/projects@rep1 | \
      ssh student@192.168.56.52 pfexec zfs receive -F backup/projects
# Next day: only the changes (incremental)
root@sol1:~# zfs snapshot datapool/projects@rep2
root@sol1:~# zfs send -R -i @rep1 datapool/projects@rep2 | \
      ssh student@192.168.56.52 pfexec zfs receive -F backup/projects
# Backup to a file
root@sol1:~# zfs send datapool/projects@rep2 | gzip > /backup/projects-rep2.zfs.gz
```

Volumes, Sharing and the ARC

Feature	Command
ZFS volume (zvol)	zfs create -V 20G datapool/vol1 → /dev/zvol/dsk/datapool/vol1
Swap / dump	rpool/swap and rpool/dump are zvols
NFS share	zfs set share.nfs=on datapool/projects
SMB share	zfs set share.smb=on datapool/projects (needs smb/server)
ARC (RAM cache)	kstat -p zfs:0:arcstats:size ; tune with user_reserve_hint_pct
Pool upgrade	zpool upgrade -v — only after all BEs can read the new version

Summary and Homework

- Pool = vdevs (mirror, raidz2…); redundancy lives in each vdev
- zpool create / status -x / scrub / replace / monitor
- Datasets with properties: compression, quota, encryption
- Snapshots, .zfs/snapshot, rollback, clone, diff
- zfs send | receive (full and -i incremental) for replication
- Homework: add 4 small VirtualBox disks, build two mirrors, snapshot, send to sol2 or a file

Thank You! 🙏

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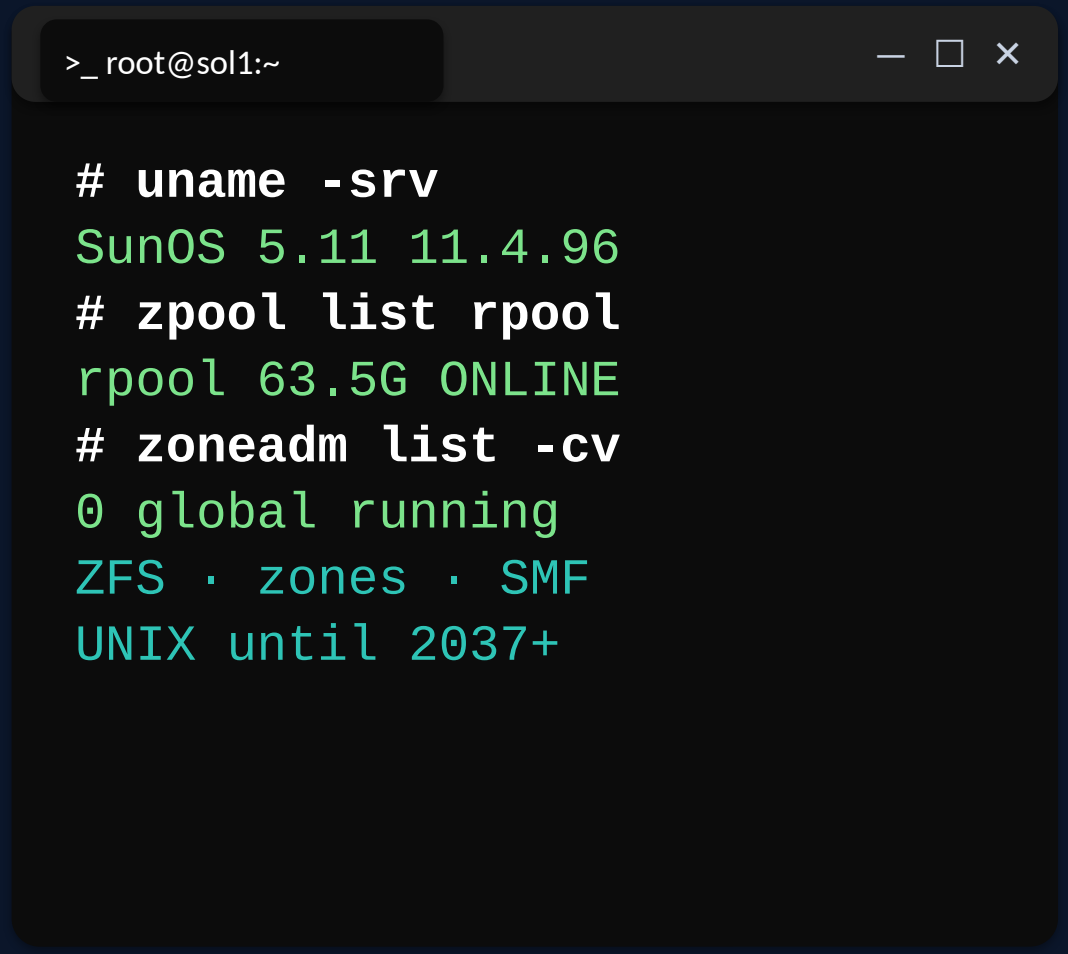
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LESSON 6 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

Networking: dladm, ipadm, Link Aggregation & Packet Filter

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 6

- Layers: physical NIC → datalink (net0) → IP interface → address
- dladm: show-phys, show-link, rename, VNICs, etherstubs
- ipadm: interfaces, static / DHCP / IPv6 addresses
- DNS, name service switch and routes
- Resilience: link aggregation, DLMP and IPMP
- Packet Filter (pf) firewall
- Troubleshooting: ping, traceroute, snoop, netstat

dladm: Data Links

```
root@sol1:~# dladm show-phys
LINK    MEDIA     STATE  SPEED  DUPLEX  DEVICE
net0    Ethernet  up     1000   full    e1000g0
net1    Ethernet  up     1000   full    e1000g1
root@sol1:~# dladm show-link
root@sol1:~# dladm show-phys -L          # physical location of each port
root@sol1:~# dladm rename-link net1 lab0  # meaningful names (when unused)
root@sol1:~# dladm show-linkprop -p mtu,speed net0
root@sol1:~# dladm set-linkprop -p mtu=9000 net0   # jumbo frames, if switch allows
```

ipadm: Interfaces and Addresses

```
root@sol1:~# netadm list                          # NCP: DefaultFixed = manual
root@sol1:~# ipadm create-ip net1
root@sol1:~# ipadm create-addr -T static -a 192.168.56.51/24 net1/v4
root@sol1:~# ipadm create-addr -T dhcp net0/dhcp
root@sol1:~# ipadm create-addr -T addrconf net1/v6      # IPv6 link-local + SLAAC
root@sol1:~# ipadm show-addr
ADDROBJ    TYPE     STATE   ADDR
lo0/v4     static   ok      127.0.0.1/8
net0/dhcp  dhcp     ok      10.0.2.15/24
net1/v4    static   ok      192.168.56.51/24
root@sol1:~# ipadm delete-addr net1/v4 ; ipadm show-if
```

DNS, Name Service and Routes

```
root@sol1:~# svccfg -s dns/client setprop config/nameserver = net_address: \
      "(192.168.56.1 8.8.8.8)"
root@sol1:~# svccfg -s dns/client setprop config/search = astring: "lab.local"
root@sol1:~# svccfg -s name-service/switch setprop config/host = astring: "files dns"
root@sol1:~# svcadm refresh dns/client name-service/switch ; svcadm enable dns/client
root@sol1:~# getent hosts oracle.com
root@sol1:~# route -p add default 10.0.2.2       # -p = persistent
root@sol1:~# route -p add -net 10.20.0.0/16 192.168.56.1
root@sol1:~# netstat -rn ; route -p show
root@sol1:~# svccfg -s system/identity:node setprop config/nodename = sol1
```

Resilience: Aggregation, DLMP, IPMP

Technology	How it works
Trunk aggregation (LACP)	Ports bundled to one switch; more bandwidth; needs switch config
DLMP aggregation	Ports to different switches; no switch config; failover
IPMP	IP-level group; test addresses or link-based probe; any switch
Use in zones/LDoms	VNICs on top of an aggregation inherit its resilience

Creating an Aggregation and IPMP

```
# DLMP aggregation over two ports (on a real server)
root@sol1:~# ipadm delete-ip net2 ; ipadm delete-ip net3
root@sol1:~# dladm create-aggr -m dlmp -l net2 -l net3 aggr0
root@sol1:~# ipadm create-ip aggr0
root@sol1:~# ipadm create-addr -T static -a 10.10.0.21/24 aggr0/v4
root@sol1:~# dladm show-aggr -x aggr0
# IPMP group
root@sol1:~# ipadm create-ip net4 ; ipadm create-ip net5
root@sol1:~# ipadm create-ipmp -i net4 -i net5 ipmp0
root@sol1:~# ipadm create-addr -T static -a 10.10.1.21/24 ipmp0/v4
root@sol1:~# ipmpstat -g ; ipmpstat -i
```

Virtual Networks: VNICs and Etherstubs

```
root@sol1:~# dladm create-vnic -l net1 vnic0              # VNIC on a real link
root@sol1:~# dladm create-etherstub stub0                 # internal virtual switch
root@sol1:~# dladm create-vnic -l stub0 web_vnic0
root@sol1:~# dladm create-vnic -l stub0 db_vnic0
root@sol1:~# dladm set-linkprop -p maxbw=200M web_vnic0   # bandwidth limit
root@sol1:~# dladm show-vnic
LINK         OVER   SPEED  MACADDRESS        MACADDRTYPE
vnic0        net1   1000   2:8:20:4a:1c:9e   random
web_vnic0    stub0  200    2:8:20:7d:33:10   random
root@sol1:~# flowadm add-flow -l net1 -a transport=tcp,local_port=443 https1
```

Packet Filter (pf) Firewall

```
root@sol1:~# pkg install network/firewall
root@sol1:~# vim /etc/firewall/pf.conf
set skip on lo0
block in log all
pass out all keep state
pass in proto tcp from 192.168.56.0/24 to any port 22 keep state
pass in proto tcp to any port { 80 443 } keep state
pass in inet proto icmp all
root@sol1:~# pfctl -nf /etc/firewall/pf.conf     # syntax check
root@sol1:~# svcadm enable firewall
root@sol1:~# pfctl -s rules ; pfctl -s states | head
```

Troubleshooting the Network

```
root@sol1:~# dladm show-phys ; ipadm show-addr      # link up? address ok?
root@sol1:~# ping -s 192.168.56.52 56 3
root@sol1:~# traceroute -n 8.8.8.8
root@sol1:~# netstat -an -f inet | grep LISTEN
root@sol1:~# netstat -s -P tcp | grep -i retrans
root@sol1:~# snoop -d net1 -c 20 host 192.168.56.52 port 22
root@sol1:~# snoop -o /var/tmp/cap.snoop -d net1   # save; open in Wireshark
root@sol1:~# dlstat show-link -i 5 net1            # live traffic counters
root@sol1:~# svcs -xv network/physical network/routing-setup
```

Summary and Homework

- dladm = links (net0, VNICs, aggr); ipadm = IP interfaces and addresses
- Static / DHCP / addrconf addresses; route -p for persistent routes
- DNS and nsswitch are SMF properties
- Resilience: trunk (LACP), DLMP, IPMP
- Etherstubs + VNICs = private virtual networks; flowadm for QoS
- pf firewall: /etc/firewall/pf.conf, pfctl, svcadm enable firewall
- Homework: build stub0 with two VNICs, write a pf.conf that allows SSH only from 192.168.56.0/24

Thank You! 🙏

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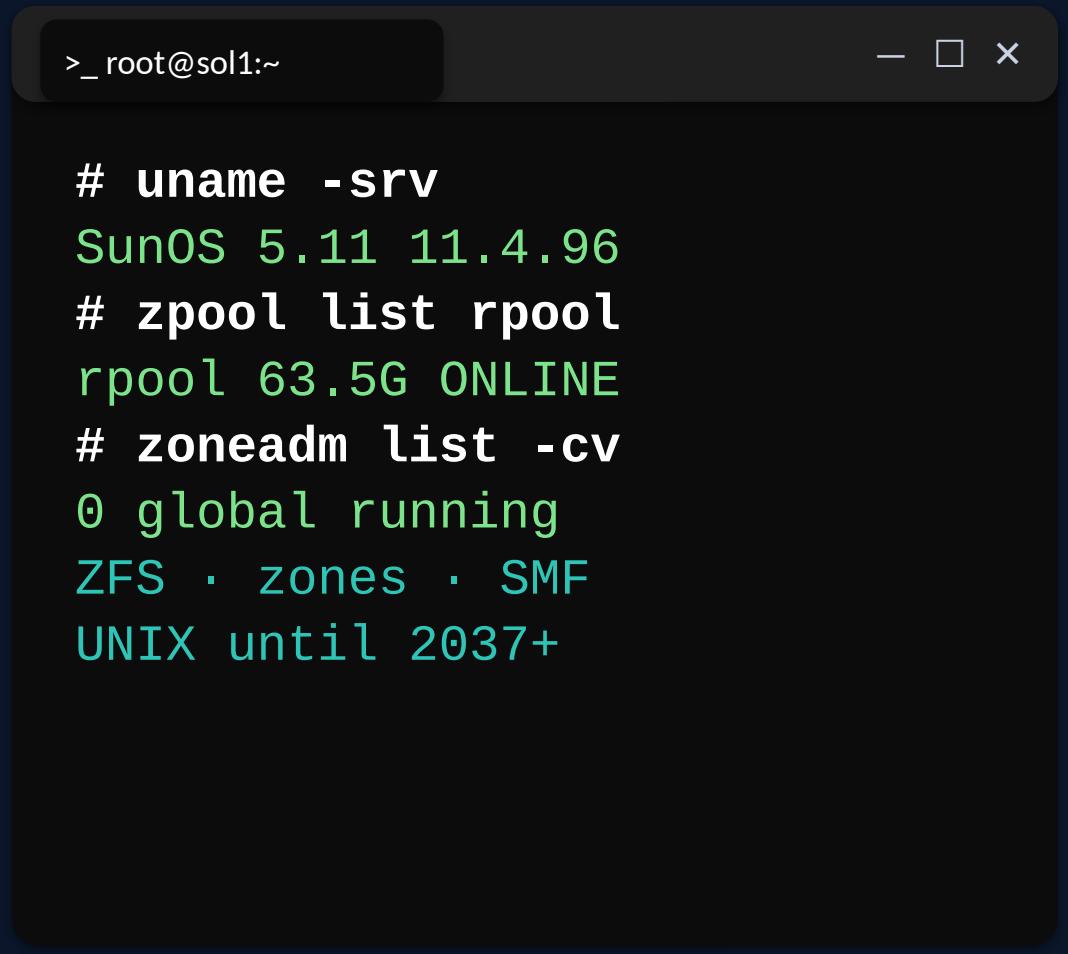
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LESSON 7 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

Users, RBAC, Compliance & Solaris Security

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 7

- Users and groups: useradd, passwd, home directories on ZFS
- RBAC: authorizations, rights profiles, roles
- pfexec, profiles, roles, and sudo on Solaris
- Password policy and account lockout
- compliance: assess and report against benchmarks
- Security extensions: sxadm (ASLR, NXstack…), verified boot
- Auditing and file integrity (bart)

Users and Groups

```
root@sol1:~# groupadd -g 2001 webteam
root@sol1:~# useradd -m -u 2101 -g webteam -c 'Ali Ahmadi' -s /usr/bin/bash ali
root@sol1:~# passwd ali
root@sol1:~# zfs list | grep export/home        # each home is its own dataset
rpool/export/home/ali   35K  30.1G  35K  /export/home/ali
root@sol1:~# zfs set quota=5G rpool/export/home/ali
root@sol1:~# usermod -G webteam,staff ali ; id -a ali
root@sol1:~# passwd -s ali                      # password status
root@sol1:~# passwd -l ali ; passwd -u ali       # lock / unlock
root@sol1:~# userdel -r olduser
```

RBAC Building Blocks

Piece	Meaning / Example
Authorization	Permission for an action: solaris.smf.manage.apache
Privilege	Fine-grained kernel right: net_privaddr, file_dac_read
Rights profile	Bundle of commands, auths, privileges: 'Service Management'
Role	Special account with profiles; users assume it with su
Databases	/etc/security/prof_attr, exec_attr, auth_attr; /etc/user_attr
Principle	Least privilege: give profiles, not the root password

Rights Profiles and pfexec

```
root@sol1:~# getent prof_attr | grep -i 'Service Management'
root@sol1:~# profiles -p 'Network Management' info
root@sol1:~# usermod -P +'Service Management' ali     # add a profile to ali
root@sol1:~# usermod -A +solaris.smf.manage.apache ali
ali@sol1:~$ profiles
Service Management
Basic Solaris User
ali@sol1:~$ pfexec svcadm restart apache24     # allowed by the profile
ali@sol1:~$ pfbash                              # profile shell: no pfexec needed
ali@sol1:~$ ppriv $$                            # show process privileges
```

Roles and sudo

```
root@sol1:~# roleadd -m -P 'Network Management,Network Security' netadm
root@sol1:~# passwd netadm
root@sol1:~# usermod -R +netadm ali             # ali may assume netadm
ali@sol1:~$ roles
netadm
ali@sol1:~$ su - netadm                         # role password (or user's: roleauth)
netadm@sol1:~$ ipadm show-addr                  # role shell has the profiles
root@sol1:~# rolemod -K roleauth=user netadm    # authenticate with own password
# sudo also exists: visudo / /etc/sudoers.d — RBAC is the Solaris-native way
root@sol1:~# usermod -K type=role root          # root stays a role (default)
```

Password Policy and Lockout

File / Setting	Example
/etc/default/passwd	MINWEEKS=1 MAXWEEKS=13 PASSLENGTH=12 MINDIGIT=1 HISTORY=10
/etc/security/policy.conf	LOCK_AFTER_RETRIES=YES ; CRYPT_DEFAULT=6 (SHA-512)
/etc/default/login	RETRIES=3 ; CONSOLE=/dev/console (root logins)
usermod -K lock_after_retries=no	Exception for a service account
passwd -f user	Force change at next login
logins -p / logins -x	Find accounts without passwords, show details

compliance: Assess and Report

```
root@sol1:~# pkg install security/compliance
root@sol1:~# compliance list -p
Benchmarks:  pci-dss  solaris
Profiles for solaris:  Baseline  Recommended
root@sol1:~# compliance assess -b solaris -p Recommended -a recommended-nov
root@sol1:~# compliance report -a recommended-nov -f html -o /var/tmp/report.html
root@sol1:~# compliance report -a recommended-nov -s fail | head
root@sol1:~# compliance tailor -t mysite            # create a tailored profile
root@sol1:~# svccfg -s compliance-assess:default setprop ... # schedule assessments
```

Security Extensions and Verified Boot

```
root@sol1:~# sxadm status
EXTENSION  STATUS                    CONFIGURATION
aslr       enabled (tagged-files)    default (tagged-files)
nxstack    enabled (all)             default (all)
nxheap     enabled (tagged-files)    default (tagged-files)
root@sol1:~# sxadm enable -c model=all aslr      # stronger: all processes
# Verified boot: kernel modules checked against Oracle signatures
root@sol1:~# svccfg -s boot-config listprop config/verified_boot   # policy
# SPARC: set policy in ILOM / OBP; x86: UEFI Secure Boot
root@sol1:~# elfsign verify -e /usr/kernel/drv/amd64/vboxdrv
```

Auditing and File Integrity (bart)

```
root@sol1:~# auditconfig -getflags
root@sol1:~# auditconfig -setflags lo,ex,ua,as   # logins, exec, user/admin
root@sol1:~# audit -s ; auditconfig -getcond
root@sol1:~# auditreduce -c lo -a 20261120 | praudit -l | tail -3
# bart: baseline of system files, then compare later
root@sol1:~# bart create -R /etc > /var/tmp/etc.bart.0
root@sol1:~# vim /etc/motd
root@sol1:~# bart create -R /etc > /var/tmp/etc.bart.1
root@sol1:~# bart compare /var/tmp/etc.bart.0 /var/tmp/etc.bart.1
/motd:
  size  control:43  test:61
```

Summary and Homework

- useradd -m: each home is a ZFS dataset (quotas, snapshots)
- RBAC: authorizations + privileges → rights profiles → roles
- usermod -P / -A / -R; pfexec, pfbash, profiles, roles
- Password policy: /etc/default/passwd, policy.conf
- compliance assess / report; sxadm; verified boot
- Auditing with auditconfig/praudit; bart create / compare
- Homework: give ali 'Service Management', run a Recommended compliance report

Thank You! 🙏

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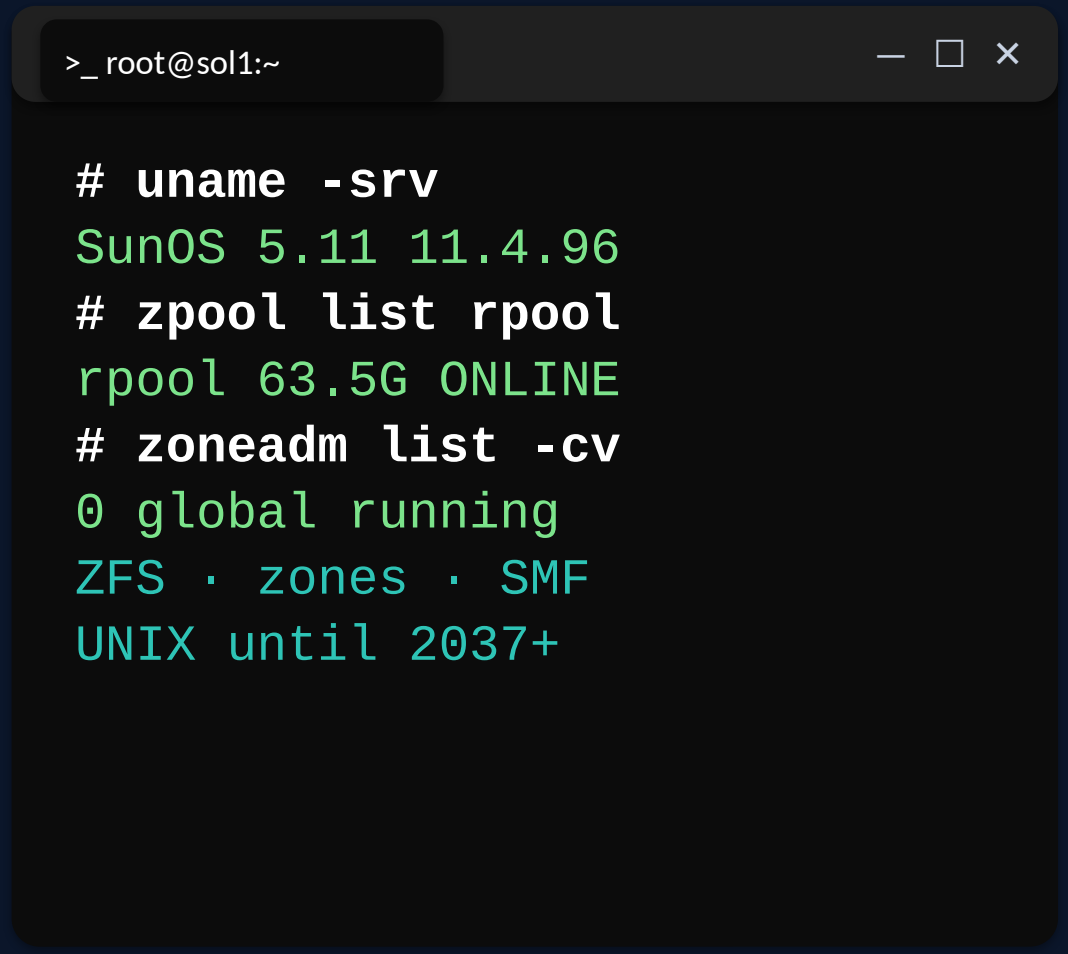
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LESSON 8 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

Zones: Non-global, Kernel & Immutable Zones

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 8

- Zone types: global, non-global, kernel, Solaris 10 branded
- zonecfg: configure a zone with an automatic VNIC
- zoneadm: install, boot, halt, clone, uninstall
- zlogin: work inside a zone; the zone console
- Resource controls: CPU caps, memory, ZFS quotas
- Immutable zones (read-only root)
- Kernel zones and live migration

Zone Types

Type	What it is / When to use
Global zone	The host OS; manages all other zones
Non-global (solaris brand)	Container sharing the global kernel — lightest, fastest
Kernel zone (solaris-kz)	Own kernel and SRU level; live migration; needs HW virtualization
solaris10 branded zone	Run old Solaris 10 apps on 11.4 hardware
Immutable zone	Read-only root (file-mac-profile); also for the global zone
Density	Hundreds of non-global zones per server

zonecfg: Configure a Zone

```
root@sol1:~# zonecfg -z web1
Use 'create' to begin configuring a new zone.
zonecfg:web1> create                    # template SYSdefault: auto VNIC on net0
zonecfg:web1> set zonepath=/system/zones/web1
zonecfg:web1> set autoboot=true
zonecfg:web1> select anet linkname=net0
zonecfg:web1:anet> set lower-link=net1    # use the lab link
zonecfg:web1:anet> end
zonecfg:web1> add dataset ; set name=datapool/projects/web ; end
zonecfg:web1> verify ; commit ; exit
root@sol1:~# zonecfg -z web1 info
```

Install, Boot and Log In

```
root@sol1:~# zoneadm -z web1 install            # from the same publisher/SRU
Progress being logged to /var/log/zones/zoneadm.20261120T223015Z.web1.install
       Image: Preparing at /system/zones/web1/root.
Done: Installation completed in 98.4 seconds.
root@sol1:~# zoneadm -z web1 boot
root@sol1:~# zlogin -C web1                      # console: answer sysconfig once
~.                                              # leave the console
root@sol1:~# zoneadm list -cv
  ID NAME     STATUS     PATH                       BRAND    IP
   0 global   running    /                          solaris  shared
   1 web1     running    /system/zones/web1         solaris  excl
```

Inside the Zone

```
root@sol1:~# zlogin web1
root@web1:~# zonename ; uname -v
web1
11.4.90
root@web1:~# ipadm show-addr | grep net0
net0/v4    static   ok      192.168.56.61/24
root@web1:~# pkg install apache-24 ; svcadm enable apache24
root@web1:~# ps -ef | wc -l                    # only this zone's processes
root@web1:~# exit
root@sol1:~# ps -efZ | grep httpd | head -2    # global zone sees everything
root@sol1:~# zlogin web1 svcs -x               # run one command
```

Clone, Resources and Lifecycle

```
root@sol1:~# zonecfg -z web1 'add capped-cpu; set ncpus=1.5; end'
root@sol1:~# zonecfg -z web1 'add capped-memory; set physical=2g; set swap=3g; end'
root@sol1:~# zoneadm -z web1 apply             # live: no reboot needed
root@sol1:~# zonestat -z web1 5 2               # CPU / memory / network usage
root@sol1:~# zonecfg -z web2 create -t web1     # copy configuration
root@sol1:~# zoneadm -z web1 shutdown
root@sol1:~# zoneadm -z web2 clone web1         # ZFS clone: seconds
root@sol1:~# zoneadm -z web1 boot ; zoneadm -z web2 boot
root@sol1:~# zoneadm -z oldzone halt ; zoneadm -z oldzone uninstall -F
root@sol1:~# zonecfg -z oldzone delete -F
```

Immutable Zones

```
root@sol1:~# zonecfg -z web1 set file-mac-profile=fixed-configuration
root@sol1:~# zoneadm -z web1 reboot
root@sol1:~# zlogin web1
root@web1:~# touch /usr/bin/evil
touch: cannot create /usr/bin/evil: Read-only file system
root@web1:~# exit
# Admin changes: the Trusted Path — temporarily writable
root@sol1:~# zlogin -T web1                          # or: zoneadm -z web1 boot -w
# Profiles: strict, fixed-configuration, flexible-configuration
# Global zone too: zonecfg -z global set file-mac-profile=... (then reboot)
```

Kernel Zones and Live Migration

```
root@sol1:~# virtinfo                          # can this host run kernel zones?
root@sol1:~# zonecfg -z kz1 create -t SYSsolaris-kz
root@sol1:~# zonecfg -z kz1 'select virtual-cpu; set ncpus=2; end'
root@sol1:~# zonecfg -z kz1 'select capped-memory; set physical=4g; end'
root@sol1:~# zoneadm -z kz1 install ; zoneadm -z kz1 boot
root@sol1:~# zlogin kz1 pkg info entire         # its own SRU level
# Live migration to another host with the same CPU family
root@sol1:~# zoneadm -z kz1 migrate ssh://student@192.168.56.52
root@sol1:~# zoneadm -z kz1 suspend ; zoneadm -z kz1 boot   # suspend/resume
# In VirtualBox: needs nested VT-x/AMD-V (may be unavailable)
```

Summary and Homework

- Global zone manages non-global, kernel and solaris10 zones
- zonecfg create → anet lower-link → commit
- zoneadm install / boot / clone / halt / uninstall; zlogin, zlogin -C
- capped-cpu, capped-memory, zoneadm apply, zonestat
- Immutable: file-mac-profile; maintenance with zlogin -T
- Kernel zones: own SRU, migrate, suspend
- Homework: build web1, run Apache in it, clone web2, make web1 immutable

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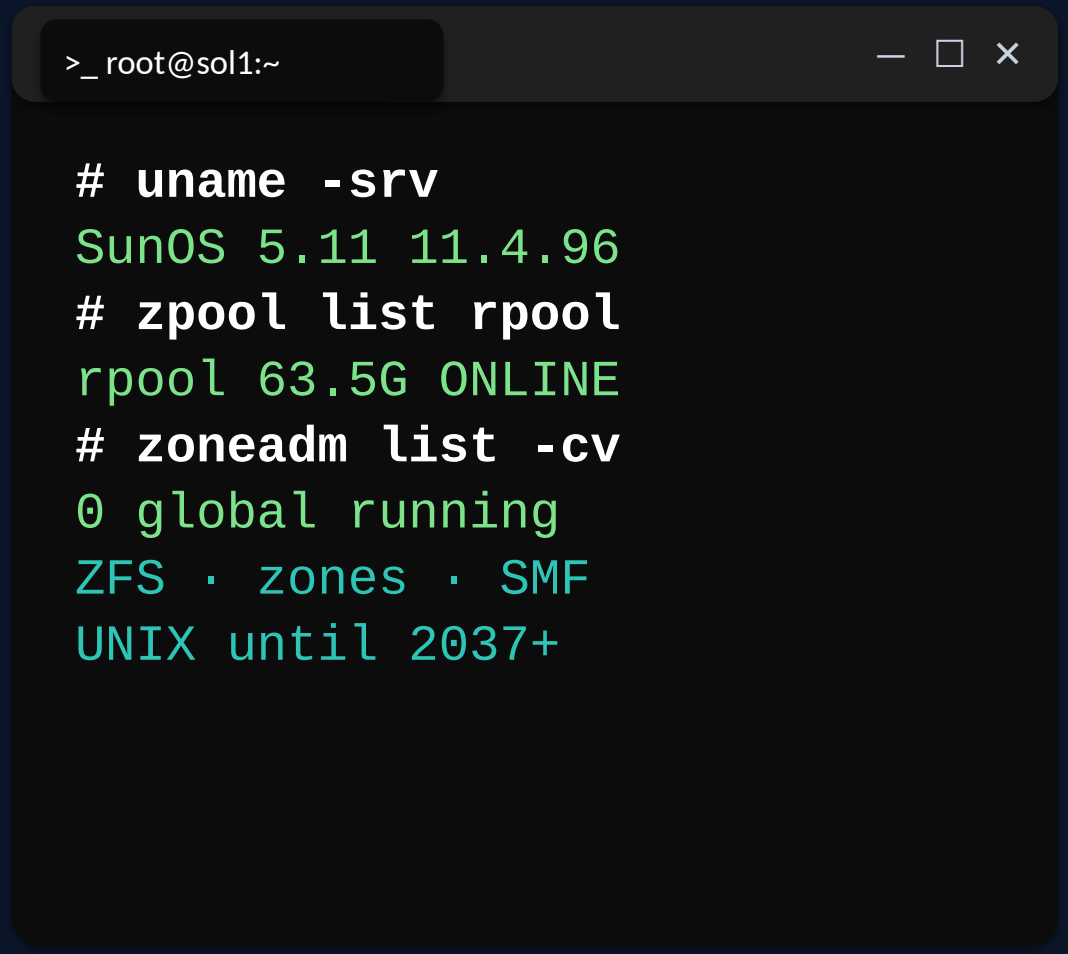
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LESSON 9 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

Oracle VM Server for SPARC (LDoms)

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 9

- Architecture: hypervisor in firmware, control / service / I/O / guest domains
- Supported servers: SPARC T4 and later, S7, T8, M8, Fujitsu M12
- Setting up the control domain (primary)
- Virtual services: vds (disk), vsw (switch), vcc (console)
- Creating, binding and starting a guest domain
- Live migration and dynamic reconfiguration
- Saving configurations to the service processor

Domain Roles

Role	Job
Hypervisor	Thin layer in SPARC firmware; partitions CPU threads and memory
Control domain (primary)	Runs ldmd and the ldm command; needs Solaris 11.4
Service domain	Provides virtual disk, network and console to guests
I/O / root domain	Owns PCIe buses or SR-IOV functions directly
Guest domain	Runs applications; uses virtual devices; Solaris 10 or 11
Key idea	CPU threads are dedicated, not time-shared — predictable performance

Control Domain Setup

```
primary# pkg list ldomsmanager ; svcs ldmd
primary# ldm list
NAME     STATE   FLAGS   CONS  VCPU  MEMORY  UTIL  UPTIME
primary  active  -n-c--  UART  256   511G    0.4%  2d 4h
primary# ldm add-vcc port-range=5000-5100 primary-vcc0 primary
primary# ldm add-vds primary-vds0 primary
primary# ldm add-vsw net-dev=net0 primary-vsw0 primary
primary# ldm set-core 4 primary              # whole cores for primary
primary# ldm set-memory 32G primary
primary# ldm add-spconfig initial            # save to the service processor
primary# shutdown -i6 -g0 -y ; svcadm enable vntsd
```

Virtual Services

Service	Name / Purpose
vds	Virtual disk server: exports ZFS volumes, LUNs, files as vdisks
vdsdev	One exported backend: ldm add-vdsdev <backend> vol@vds
vsw	Virtual switch on a physical NIC or aggregation
vnet	A guest's virtual NIC on a vsw
vcc + vntsd	Console concentrator; telnet localhost <port>
Multipathing	mpgroup for disks, IPMP / DLMP for vnets across 2 service domains

Creating a Guest Domain

```
primary# zfs create -V 40G rpool/ldoms/ldg1-disk0
primary# ldm add-domain ldg1
primary# ldm set-core 2 ldg1
primary# ldm set-memory 16G ldg1
primary# ldm add-vnet vnet0 primary-vsw0 ldg1
primary# ldm add-vdsdev /dev/zvol/dsk/rpool/ldoms/ldg1-disk0 ldg1-disk0@primary-vds0
primary# ldm add-vdisk disk0 ldg1-disk0@primary-vds0 ldg1
primary# ldm add-vdsdev options=ro /export/iso/sol-11_4-text-sparc.iso iso@primary-vds0
primary# ldm add-vdisk iso iso@primary-vds0 ldg1
primary# ldm set-var auto-boot\?=false ldg1
primary# ldm bind ldg1 ; ldm start ldg1
```

Console, Install and Daily Commands

```
primary# ldm list ldg1
NAME   STATE   FLAGS   CONS  VCPU  MEMORY  UTIL  UPTIME
ldg1   active  -t----  5000  16    16G     6.2%  1m
primary# telnet localhost 5000
{0} ok devalias                        # disk0, iso, vnet0
{0} ok boot iso                        # text installer (lesson 2)
primary# ldm list -l ldg1 | less       # full details
primary# ldm list-bindings ; ldm list-devices -a
primary# ldm stop ldg1 ; ldm unbind ldg1
primary# ldm remove-domain ldg1
```

Live Migration and Dynamic Reconfiguration

```
primary# ldm set-core 4 ldg1              # add cores while running (DR)
primary# ldm set-memory 24G ldg1          # memory DR
primary# ldm add-vdisk disk1 data1@primary-vds0 ldg1   # hot-add disk
# Live migration to another SPARC server (same storage visible there)
primary# ldm migrate-domain -n ldg1 root@sparc2   # -n = dry run
primary# ldm migrate-domain ldg1 root@sparc2
Target Password:
Migration of domain ldg1 completed.
primary# ldm set-domain perf-counters=global ldg1
primary# ldm list -o cpu,memory ldg1
```

Saving and Backing Up Configurations

```
primary# ldm list-spconfig
factory-default
initial
prod-nov2026 [current]
primary# ldm add-spconfig prod-nov2026-b       # save after every change
primary# ldm list-constraints -x ldg1 > /var/tmp/ldg1.xml
primary# ldm add-domain -i /var/tmp/ldg1.xml   # recreate from XML
primary# ldm list-constraints -x > /var/tmp/all-domains.xml
# Also back up guest data: zfs snapshot / send of rpool/ldoms/*
# Manage many servers: Oracle Enterprise Manager
```

Summary and Homework

- LDoms = firmware hypervisor; primary runs ldm (Solaris 11.4, OVM SPARC 3.6)
- Roles: control, service, I/O / root, guest; dedicated CPU threads
- Services: vcc + vntsd, vds + vdsdev, vsw + vnet
- add-domain → set-core/memory → add-vnet/vdisk → bind → start
- DR and migrate-domain (-n first); save with add-spconfig
- Homework: draw a 2-guest design; write the ldm commands for ldg2 with 1 core, 8 GB, one disk

Thank You! 🙏

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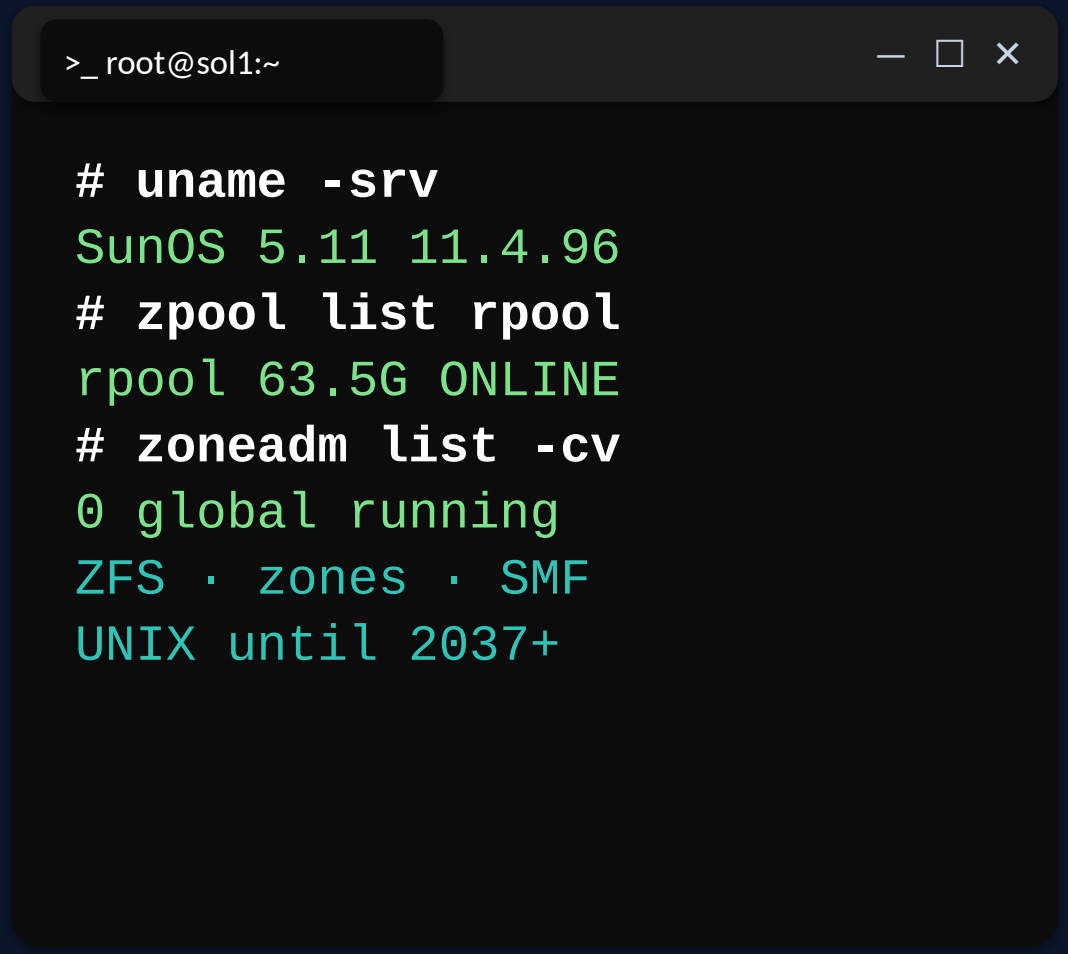
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LESSON 10 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

Oracle VM x86 to Oracle Linux KVM & Virtualization Manager

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 10

- Why migrate: OVM x86 3.4 in Sustaining Support since July 2024
- OLVM architecture: engine, KVM hosts, VDSM, data centers, storage domains
- Lab: one engine VM + one KVM host on Oracle Linux 9 (UEK 8)
- Installing the engine: oracle-ovirt-release-45-el9, engine-setup
- Adding hosts, storage and networks; creating VMs
- Migrating OVM VMs: export OVA, import, virt-v2v
- Solaris and Oracle Linux guests on KVM

Oracle VM x86 vs OLVM

	Oracle VM Server for x86	OLVM 4.5
Hypervisor	Xen 4.4 + dom0	KVM in Oracle Linux (UEK)
Management	Oracle VM Manager (Java)	oVirt engine web portal + REST API
Support	Sustaining only (since Jul 2024)	Active; OL8 and OL9 hosts
Hardware	No new server support	Current x86 servers
Migration path	Export VMs (OVA) / convert	Import OVA; virt-v2v
Cost	Free to use; support optional	Free to use; support with Oracle Linux Premier

OLVM Architecture

Component	Role
Engine (Manager)	ovirt-engine + PostgreSQL; web Administration Portal, VM Portal, REST API
Self-hosted engine	Engine runs as a VM on the KVM hosts it manages (HA)
KVM host	Oracle Linux + UEK + VDSM agent + libvirt / QEMU
Data center / cluster	Logical groups; cluster = hosts with compatible CPUs
Storage domain	NFS, iSCSI, Fibre Channel, Gluster or local — holds VM disks
Logical network	ovirtmgmt (management) + VM networks, VLANs

Lab: Install the Engine (Oracle Linux 9)

```
# olvm-engine: OL 9.6+ Minimal, 4 vCPU, 16 GB RAM, 192.168.56.70, FQDN in DNS/hosts
[root@olvm-engine ~]# dnf install -y oracle-ovirt-release-45-el9
[root@olvm-engine ~]# dnf repolist | grep -i ovirt
[root@olvm-engine ~]# dnf install -y ovirt-engine
[root@olvm-engine ~]# engine-setup
  Configure Engine on this host (Yes, No) [Yes]:
  Host fully qualified DNS name of this server [olvm-engine.lab.local]:
  Engine admin password: ********
  ...
[ INFO  ] Execution of setup completed successfully
# Browse: https://olvm-engine.lab.local/ovirt-engine  (user admin@ovirt)
```

Prepare a KVM Host and Add It

```
# kvm1: OL 9.6+ Minimal on hardware or nested VM (VT-x/AMD-V), 192.168.56.71
[root@kvm1 ~]# dnf install -y oracle-ovirt-release-45-el9
[root@kvm1 ~]# uname -r                          # UEK 8 kernel expected
[root@kvm1 ~]# dnf install -y kernel-uek-modules-extra ; reboot
[root@kvm1 ~]# grep -cE 'vmx|svm' /proc/cpuinfo   # > 0 = virtualization ready
# Administration Portal: Compute > Hosts > New
#   Name kvm1 · Address 192.168.56.71 · root password · OK
#   Engine installs VDSM, configures ovirtmgmt bridge -> Status: Up
# Storage > Domains > New Domain: NFS 192.168.56.70:/exports/data
# Network > Networks > New: vmnet (VLAN optional)
```

Creating and Managing VMs

Task	Where / How
Upload ISO	Storage > Disks > Upload, or an ISO domain
New VM	Compute > Virtual Machines > New: OS type, memory, CPUs, disk, vNIC
Console	noVNC in browser or SPICE/VNC with remote-viewer
Templates	Make a template from a sealed VM; create many VMs fast
Live migration / HA	Move running VMs between hosts; restart on failure
Snapshots / backup	VM snapshots; backup via REST API or partner tools
Automation	REST API, Ansible ovirt collection, Terraform provider

Migrating Oracle VM x86 VMs

```
# 1. Inventory in Oracle VM Manager: OS, PV/HVM mode, disks, NICs, owners
# 2. Prepare guest: update OS; PV guests -> ensure virtio drivers (Linux: dracut)
# 3. Export: Oracle VM Manager > VM > Export to Virtual Appliance (OVA)
# 4. Copy OVA to a KVM host, e.g. /var/tmp/app01.ova
# 5a. OLVM: Compute > Virtual Machines > Import > Source: Virtual Appliance (OVA)
# 5b. Or convert with virt-v2v:
[root@kvm1 ~]# dnf install -y virt-v2v
[root@kvm1 ~]# virt-v2v -i ova /var/tmp/app01.ova -o local -os /var/tmp/out
# 6. Boot, check network names, remove Xen tools, test, then switch over
# Windows guests: install VirtIO drivers before export
```

Solaris and Oracle Linux Guests on KVM

Guest	Notes
Oracle Linux 8 / 9 / 10	Best support; virtio, qemu-guest-agent, UEK or RHCK
Oracle Solaris 11.4 x86	Supported as a KVM guest — check the current certification list
Windows Server	VirtIO drivers + guest tools; check certification
Solaris on SPARC	Stays on SPARC: LDoms (lesson 9) or Solaris zones
Containers	Oracle Linux + Podman / Kubernetes (OCNE) as another option
Cloud	OCI: Oracle Linux, Solaris images, OLVM-like features as a service

Summary and Homework

- OVM x86 (Xen) is Sustaining-only since July 2024 — plan the move
- OLVM 4.5 = oVirt engine + KVM hosts (VDSM); OL8 or OL9 (UEK 8)
- Engine: dnf install oracle-ovirt-release-45-el9 ovirt-engine; engine-setup
- Portal: add hosts, storage domains, networks; create VMs, templates
- Migration: inventory → virtio → export OVA → import / virt-v2v → test
- Homework: build olvm-engine + kvm1 (or read the docs), write a 10-VM migration plan

Thank You! 🙏

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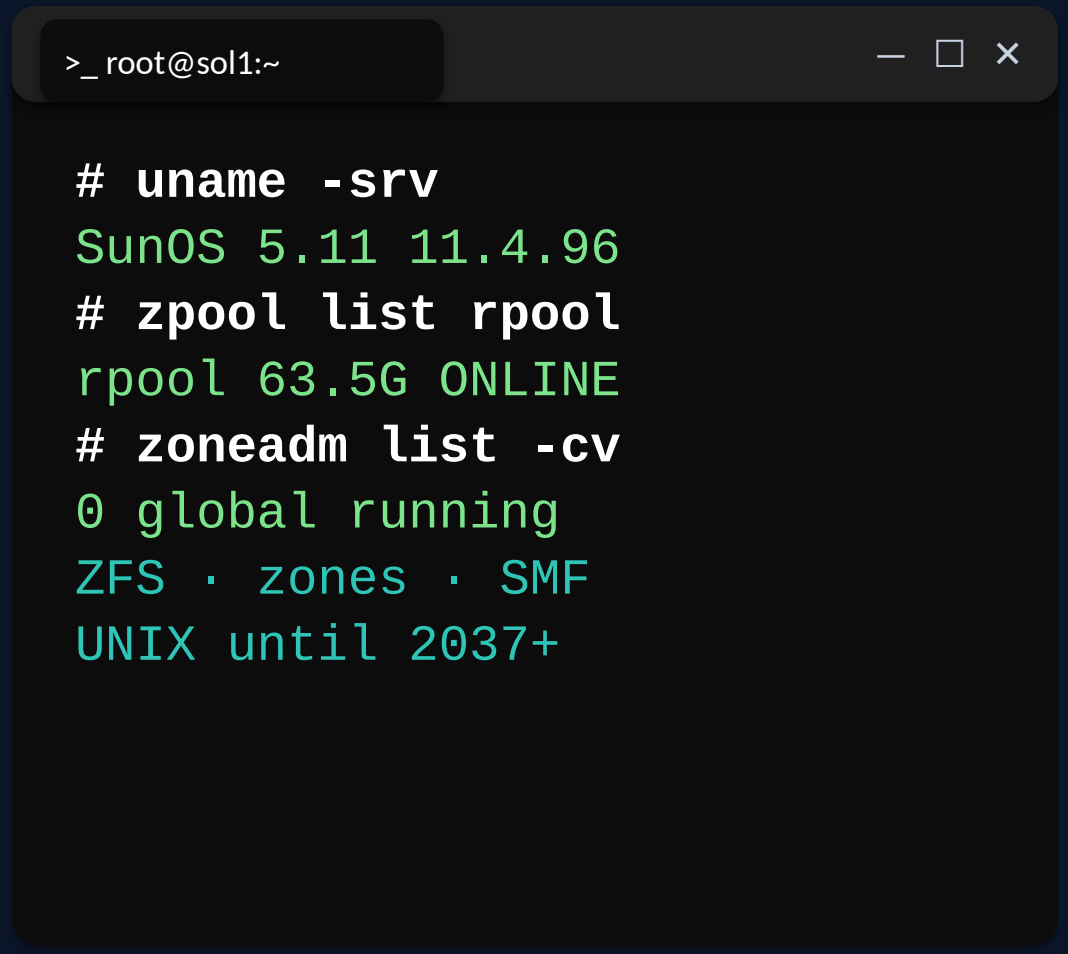
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LESSON 11 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

Observability & Troubleshooting: DTrace, FMA, mdb & Logs

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 11

- A method: USE (utilization, saturation, errors) and the first 60 seconds
- Performance tools: prstat, vmstat, mpstat, iostat, zonestat
- Process tools: pfiles, pstack, ptree, truss, pmap
- DTrace: probes, providers, predicates, aggregations
- Useful DTrace one-liners and scripts
- Logs, crash dumps (dumpadm, savecore) and mdb
- Explorer and Oracle Support data collection

The First 60 Seconds

```
root@sol1:~# uptime                              # load averages
root@sol1:~# svcs -x ; fmadm faulty              # broken services? hardware faults?
root@sol1:~# tail -20 /var/adm/messages          # recent system messages
root@sol1:~# vmstat 1 5                          # r=run queue, free, sr=scan rate
root@sol1:~# mpstat 1 3                          # per-CPU usr/sys/idle
root@sol1:~# iostat -xnz 1 3                     # %b busy, asvc_t latency per disk
root@sol1:~# prstat -s cpu -n 10 1 3             # top processes; prstat -Z per zone
root@sol1:~# zpool status -x ; df -h | sort -k5 -r | head -3
root@sol1:~# dlstat show-link -i 1 net1          # network traffic
```

Process Tools

Tool	Shows
ptree <pid>	Parent/child tree of a process
pfiles <pid>	Open files and sockets (with ports)
pstack <pid>	Stack trace of every thread — where is it stuck?
pmap -x <pid>	Memory map: heap, stack, libraries
pargs / penv <pid>	Arguments / environment
truss -f -p <pid>	System calls live (like strace); -c for a summary
pwdx / pkill / pgrep	Working directory; find and signal processes
prstat -mL -p <pid>	Microstates per thread: CPU, lock wait, sleep

DTrace Concepts

Concept	Example
Probe	provider:module:function:name e.g. syscall::read:entry
Providers	syscall, proc, sched, io, fbt (kernel), pid (user), profile
Predicate	/execname == "httpd"/ — filter when the action runs
Action	printf(), trace(), stack(), ustack()
Aggregation	@[execname] = count(); quantize(), avg(), sum()
Safety	Runs in kernel, but cannot crash it; ~zero cost when off
Rights	root, or dtrace_proc / dtrace_user / dtrace_kernel privileges

DTrace One-liners

```
root@sol1:~# dtrace -l | wc -l                    # how many probes?
# Who is making system calls?
root@sol1:~# dtrace -n 'syscall:::entry { @[execname] = count(); }'
# Which files are being opened, by whom?
root@sol1:~# dtrace -n 'syscall::openat:entry { printf("%s %s", execname, copyinstr(arg1)); }'
# New processes as they start
root@sol1:~# dtrace -n 'proc:::exec-success { trace(curpsinfo->pr_psargs); }'
# Disk I/O size distribution per process
root@sol1:~# dtrace -n 'io:::start { @[execname] = quantize(args[0]->b_bcount); }'
# What is on CPU? (sample kernel stacks 997 times a second)
root@sol1:~# dtrace -n 'profile-997 /arg0/ { @[stack()] = count(); }'
```

A DTrace Script: Slow Reads in httpd

```
root@sol1:~# cat /var/tmp/slowread.d
#!/usr/sbin/dtrace -s
#pragma D option quiet
syscall::read:entry /execname == "httpd"/ { self->ts = timestamp; }
syscall::read:return /self->ts/ {
    @lat["read latency (ns)"] = quantize(timestamp - self->ts);
    self->ts = 0;
}
tick-10s { printa(@lat); exit(0); }
root@sol1:~# chmod +x /var/tmp/slowread.d ; /var/tmp/slowread.d
# Ready-made scripts: /usr/demo/dtrace, DTrace Toolkit, 'dtrace -h' for USDT
```

Logs, Crash Dumps and mdb

```
root@sol1:~# tail /var/adm/messages ; dmesg | tail
root@sol1:~# svcs -L apache24 | xargs tail -5      # SMF log of a service
root@sol1:~# dumpadm                               # dump device, savecore dir
      Dump content: kernel with ZFS metadata
       Dump device: /dev/zvol/dsk/rpool/dump (dedicated)
Savecore directory: /var/crash
root@sol1:~# coreadm -e global -g /var/cores/core.%f.%p   # app core files
root@sol1:~# ls /var/crash/data/*/                 # after a panic: vmdump.0
root@sol1:~# savecore -vf vmdump.0 ; mdb 0
> ::status
> ::msgbuf ! tail
> ::panicinfo
> $q
```

Getting Help from Oracle Support

Tool	Use
Oracle Explorer	Collects config + logs: /usr/sbin/explorer (support/explorer pkg)
sosreport-style data	explorer -w default ; attach the .tar.gz to the SR
Crash dump	vmdump.N from /var/crash; upload with the SR
fmdump -eV	Error telemetry for hardware cases
My Oracle Support	SR, knowledge docs, SRU readmes (needs contract)
CBE users	Oracle Solaris community forums; docs.oracle.com

Summary and Homework

- First 60 s: uptime, svcs -x, fmadm faulty, vmstat, mpstat, iostat -xnz, prstat
- P tools: ptree, pfiles, pstack, pmap, truss, prstat -mL
- DTrace: provider:module:function:name, predicates, aggregations
- One-liners for syscalls, opens, new processes, I/O, CPU stacks
- Logs, dumpadm/savecore, mdb ::status ::msgbuf ::panicinfo
- Explorer + crash dump + fmdump for Oracle Support
- Homework: run three one-liners while installing a package; write slowread.d for sshd

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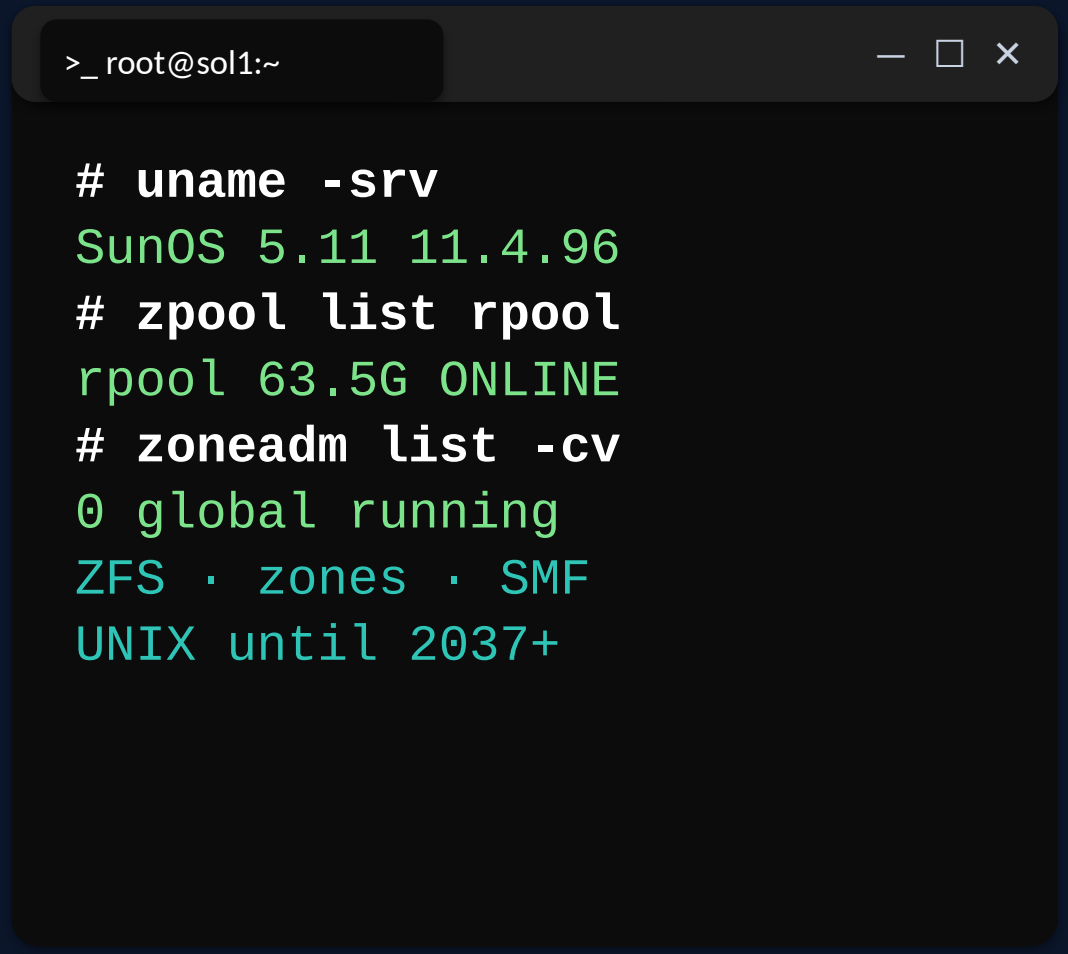
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LESSON 12 OF 12

Oracle Solaris 11.4

ZFS · Zones · SMF · LDoms · OLVM

Migrating to 11.4, Solaris vs Linux & Next Steps

Full Course · Solaris 11.4 SRU96 · OVM (Nov 2026)

What You Will Learn in Lesson 12

- Why move now: 10 and 11.3 Extended Support ends 2027
- 11.3 → 11.4: pkg update with a new boot environment
- Solaris 10 → 11.4: solaris10 branded zones, P2V and V2V
- SPARC hardware refresh and LDoms migration
- Solaris vs Linux: what maps to what
- Choosing a platform: stay, modernize, or move
- Learning path, certification and careers

Migration Paths

From	To 11.4 — how
Solaris 11.3	pkg update to 11.4 in a new BE (check driver/app support)
Solaris 11.0–11.2	Update to 11.3 first, then to 11.4
Solaris 10 (physical)	P2V into a solaris10 branded zone on 11.4
Solaris 10 zone	V2V: move the zone into a solaris10 zone on 11.4
Old SPARC server	LDoms migrate-domain or zone migration to T8/M8/S7
Apps that need rebuild	Recompile on 11.4; Studio / GCC; test in a clone

11.3 → 11.4 Upgrade

```
root@old113:~# pkg info entire | grep Version        # e.g. 0.5.11-0.175.3.x
root@old113:~# pkg publisher                         # support repo for 11.4
root@old113:~# beadm create pre-11.4 ; zfs snapshot -r rpool@pre-11.4
root@old113:~# pkg update -nv --accept entire@latest  # preview
root@old113:~# pkg update --accept --be-name s11.4-sru96
root@old113:~# init 6
root@new114:~# uname -v ; svcs -x ; zoneadm list -cv
# Non-global zones are updated with the global zone
# Problem? beadm activate pre-11.4 ; init 6
```

Solaris 10 → solaris10 Branded Zone (P2V)

```
# On the old Solaris 10 system: create a flash archive
bash-3.2# flarcreate -S -n s10app -L cpio /net/nfs1/archives/s10app.flar
# On Solaris 11.4: install the brand and configure a zone
root@sol1:~# pkg install system/zones/brand/brand-solaris10
root@sol1:~# zonecfg -z s10app 'create -t SYSsolaris10; set zonepath=/system/zones/s10app'
root@sol1:~# zoneadm -z s10app install -a /net/nfs1/archives/s10app.flar -u
root@sol1:~# zoneadm -z s10app boot ; zlogin s10app uname -r
5.10
# Source system must meet the documented minimum Solaris 10 patch level
```

Solaris vs Linux: What Maps to What

Solaris 11.4	Linux (RHEL / Oracle Linux)
IPS: pkg install / update	dnf install / update
Boot environments (beadm)	Snapper / bootc / image mode
SMF: svcs, svcadm	systemd: systemctl
ZFS (native)	XFS + LVM, Stratis; OpenZFS (add-on)
Zones / kernel zones	Podman containers / KVM VMs
dladm / ipadm	nmcli / ip
RBAC (pfexec, roles)	sudo, polkit; SELinux
DTrace, mdb	bpftrace / eBPF, perf, crash
FMA (fmadm)	rasdaemon, mcelog, kdump

Choosing a Platform

Situation	Common choice
Stable Solaris app, vendor-certified	Stay on 11.4 — supported to 2037+
Old Solaris 10 app, no source	solaris10 branded zone on 11.4
SPARC M-series / Oracle DB on SPARC	Refresh to M8/T8 with LDoms
New cloud-native development	Oracle Linux / RHEL + containers
Oracle VM x86 estate	OLVM (lesson 10) or another KVM platform
Skills and staffing	Plan training; Solaris experts are rare and valued

Learning Path and Careers

Step	Resource / Role
Practice	Solaris 11.4 CBE in VirtualBox; redo every homework
Docs	docs.oracle.com/en/operating-systems/solaris (11.4 library)
Community	Oracle Solaris blog and community forums
Certification	Check Oracle University for current Solaris 11 exams
Linux too	RHEL, Rocky, Oracle Linux courses on MyWebUniversity
Roles	UNIX/Solaris administrator, SPARC/virtualization engineer, migration consultant
Industries	Banks, telecoms, government, airlines, ERP/database hosting

Course Summary

- 1–3: Solaris today, CBE install, IPS, SRUs, boot environments
- 4–6: SMF and FMA, ZFS, dladm / ipadm / pf networking
- 7–8: RBAC, compliance, security; zones, immutable and kernel zones
- 9–10: LDoms on SPARC; OVM x86 to Oracle Linux KVM + OLVM
- 11–12: DTrace and troubleshooting; migration and careers
- Final project: sol1 with ZFS pool, web zone, pf, RBAC role, compliance report

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