System & Boot Troubleshooting Case Studies for CloudOps Engineers

10 Real-world Boot and System Failure Scenarios with Commands, Logs, and Recovery Steps

Case 1: Kernel Panic During Boot (Missing initramfs)

Problem: Server failed to boot, displaying 'Kernel panic - not syncing: VFS unable to mount root fs'.
Investigation:
```
Booted into rescue mode.
$ ls /boot/initramfs-$(uname -r).img
ls: cannot access '/boot/initramfs-5.14.0.img': No such file or directory
$ dracut --regenerate-all --force
```
Root Cause: initramfs image missing after kernel update caused root filesystem to be unmountable.
Resolution: Rebuilt initramfs using dracut and updated GRUB configuration.
Prevention: Verify initramfs creation post kernel upgrade with `lsinitrd`.

Case 2: GRUB Misconfiguration After OS Patching

Problem: Boot halted at grub> prompt after package update.
Investigation:
```
At grub> prompt:
grub> ls (hd0,1)/boot
grub> set root=(hd0,1)
grub> linux /vmlinuz-5.14.0 root=/dev/sda1 ro
grub> initrd /initramfs-5.14.0.img
grub> boot
```
Root Cause: GRUB configuration corrupted during kernel package upgrade.
Resolution: Booted manually and regenerated GRUB config: `$ grub2-mkconfig -o /boot/grub2/grub.cfg`.
Prevention: Maintain GRUB backups and verify /boot partition UUID mappings.

Case 3: systemd Service Dependency Failure

Problem: System dropped into emergency mode during boot.
Investigation:
```
$ journalctl -xb
systemd[1]: Failed to start application.service: dependency
'network-online.target' not met.
$ systemctl list-dependencies application.service
```
Root Cause: Service dependency incorrectly defined on unavailable network target.
Resolution: Removed unnecessary dependency and enabled proper ordering with After=network.target.
Prevention: Validate systemd unit dependencies with `systemd-analyze verify` before deployment.

Case 4: Boot Hang Due to Missing Device Mapper

Problem: Boot process stuck at 'A start job is running for dev-mapper-vgdata-lvroot'.
Investigation:
```
$ lsblk
No /dev/mapper/vgdata-lvroot present
$ lvm lvscan
Inactive LV found
```
Root Cause: Missing device mapper module prevented volume activation.
Resolution: Booted into rescue mode, activated LVM with `vgchange -ay`, and rebuilt initramfs.

Prevention: Ensure dm_mod is included in initramfs for LVM-based systems.

Case 5: SELinux Relabel Causing Slow Boot

Problem: Boot took over 15 minutes after restoring a backup.
Investigation:
```
$ journalctl -b | grep 'Relabel'
SELinux: Relabeling filesystem / complete
```
Root Cause: Automatic SELinux relabel triggered due to context mismatch from backup restore.
Resolution: Allowed relabel to complete; adjusted /etc/selinux/config settings.
Prevention: Use `restorecon` selectively instead of full relabels after file restores.

Case 6: fstab Entry Preventing Boot

Problem: System entered emergency mode after adding a new mount point.
Investigation:
```
$ journalctl -xb | grep fstab
mount: can't find UUID=abcd-1234
$ cat /etc/fstab
UUID=abcd-1234 /mnt/data ext4 defaults 0 2
```
Root Cause: Incorrect or non-existent UUID caused systemd to fail mounting at boot.
Resolution: Commented faulty line and booted successfully.
Prevention: Use `blkid` to verify UUIDs before modifying /etc/fstab.

Case 7: Broken Symbolic Link in systemd Unit

Problem: Critical service failed to start due to missing ExecStart target.
Investigation:
```
$ systemctl status custom-app.service
ExecStart=/usr/local/bin/app (No such file or directory)
```
Root Cause: Symbolic link broken after directory cleanup.
Resolution: Restored target binary and updated systemd unit file path.
Prevention: Use `systemctl daemon-reload` and validation checks post-deployment.

Case 8: Failed Kernel Module Loading at Startup

Problem: Boot logs showed repeated modprobe errors.
Investigation:
```
$ dmesg | grep modprobe
modprobe: FATAL: Module overlay not found in directory /lib/modules/5.14.0
```
Root Cause: Kernel module missing from initramfs after upgrade.
Resolution: Rebuilt initramfs and verified module presence with `lsmod`.
Prevention: Include critical modules explicitly in dracut.conf.

Case 9: Corrupted Persistent Journal

Problem: System logs not available after restart; boot messages showed 'Failed to open journal'.
Investigation:
```
$ ls -l /var/log/journal
```

```
Total 0, inode corruption suspected
$ journalctl --verify
```
Root Cause: Persistent journal files corrupted due to abrupt power loss.
Resolution: Deleted corrupted logs and restarted systemd-journald service.
Prevention: Enable remote log shipping to prevent local corruption impact.

Case 10: UUID Mismatch in Swap or Root Partition

Problem: System failed to locate swap during boot.
Investigation:
```
$ blkid
UUID mismatch observed between /etc/fstab and blkid output
```
Root Cause: UUIDs changed after disk replacement but fstab not updated.
Resolution: Updated /etc/fstab with correct UUID and ran `swapon -a`.
Prevention: Automate validation of fstab entries during patch cycles.