ADVANCED STORAGE MANAGEMENT

20-Hour Professional Hands-On Workshop Outline

Course Duration: 20 Hours (10 Sessions × 2 Hours)

Target Audience: System Administrators, DevOps & Infrastructure Engineers

Prerequisites: Basic Ip and System Administration Knowledge

Delivery Format: Interactive Hands-On Workshop (Online/Lab)

Course Roadmap & Module Overview

Module	Focus Areas & Key Technologies	Duration
Module 1: Core Storage & Disk Prep	Storage Management Concepts, MBR/GPT Partitioning, Swap Space, File Systems	3 Hours
Module 2: LVM & Advanced Volumes	LVM Architecture, PV/VG/LV Creation, Dynamic Expansion & Safe Reduction	4 Hours
Module 3: Enterprise Storage Optimization	Layered Storage with Stratis, Compression & Deduplication with VDO	3 Hours
Module 4: Software RAID Implementation	RAID Concepts (0,1,5,6,10), Configuration & Recovery using mdadm	3 Hours
Module 5: Network & Shared Storage	NFSv4 Sharing, Automounting (autofs), iSCSI Target & Initiator Setup	4 Hours
Module 6: Enterprise Appliance NAS	Open-Source NAS Deployments: TrueNAS Core/SCALE & OpenMediaVault	3 Hours

Detailed Module Syllabus

Module 1: Foundations of Linux Storage & File Systems (3 Hours (Sessions 1 & 2))

Session 1: Storage Management Concepts & Disk Partitioning (1.5 Hours)

- Overview of block devices, storage architectures (DAS, SAN, NAS), and storage stacks.
- Understanding disk partitioning schemes: MBR vs. GPT.
- Hands-on disk partitioning using fdisk, gdisk, and parted.
- Managing Swap Space: Creating, enabling, and managing persistent swap partitions and swap files.

Session 2: Mounting & Managing File Systems (1.5 Hours)

- File system types (Ext4, XFS) and structural differences.
- Creating file systems using mkfs tools.
- Manual mounting and unmounting (mount, umount).
- Configuring persistent mounts via /etc/fstab and troubleshooting boot failures (emergency mode/systemd).

Module 2: Logical Volume Management (LVM) (4 Hours (Sessions 3 & 4))

Session 3: LVM Architecture & Core Operations (2 Hours)

- LVM Concepts: Physical Volumes (PV), Volume Groups (VG), and Logical Volumes (LV).
- Initializing disks and partitions as Physical Volumes (pvcreate, pvdisplay).
- Creating and managing Volume Groups (vgcreate, vgextend).
- Provisioning Logical Volumes (lvcreate) and building file systems.

Session 4: Advanced LVM Operations & Resizing (2 Hours)

- Dynamic Volume Expansion: Extending VGs and LVs on live systems (lvextend, xfs_growfs, resize2fs).
- Safe Volume Reduction: Steps and precautions for reducing Ext4 LVs (lvreduce).
- Understanding file system constraints (e.g., XFS non-reducible nature).
- LVM Snapshot management for volume backup and restore testing.

Module 3: Enterprise Storage Optimization (Stratis & VDO) (3 Hours (Sessions 5 & 6))

Session 5: Layered Storage Management with Stratis (1.5 Hours)

- Introduction to Stratis daemon, architecture, Pools, and File Systems.
- Setting up Stratis storage pools and creating Stratis file systems.
- Managing snapshots and thin provisioning with Stratis.
- Persistent mounting of Stratis file systems.

Session 6: Storage Compression & Deduplication with VDO (1.5 Hours)

- Overview of Virtual Data Optimizer (VDO) technology.
- Deploying VDO volumes to optimize block storage space.
- Monitoring deduplication and compression efficiency using vdostats.
- Integrating VDO with underlying LVM stacks.

Module 4: Software RAID Implementation (3 Hours (Session 7))

Session 7: RAID Concepts & Configuration with mdadm (3 Hours)

- Understanding RAID architecture: RAID 0, RAID 1, RAID 5, RAID 6, and RAID 10.
- Selecting appropriate RAID levels based on performance, redundancy, and capacity.
- Creating and configuring software RAID arrays using mdadm.
- Monitoring RAID health, simulating drive failures, hot-swapping, and array rebuilding.
- Maintaining persistent RAID arrays across system reboots.

Module 5: Network-Attached Storage (NAS) & Block Sharing (4 Hours (Sessions 8 & 9))

Session 8: Network File System (NFS) & Automounting (2 Hours)

- NFS Architecture: NFSv4 setup and security permission models.
- Exporting file systems (/etc/exports) and client access control.
- Mounting NFS shares on Linux clients.
- Automounting network shares using autofs for on-demand connections.

Session 9: Block-Level Storage Sharing with iSCSI (2 Hours)

- iSCSI Storage Concepts: Target, Initiator, LUNs, and IQNs.
- Configuring an iSCSI Storage Target (Server) using targetcli.
- Connecting from an iSCSI Client (Initiator).
- Discovering, logging in, formatting, and persistently mounting iSCSI LUNs.

Module 6: Open-Source Enterprise NAS Solutions (3 Hours (Session 10))

Session 10: Deploying & Managing TrueNAS & OpenMediaVault (3 Hours)

- TrueNAS (Core/SCALE): Installation, ZFS pools, datasets, snapshot policies, and SMB/NFS share creation via Web GUI.
- OpenMediaVault (OMV): Installation, storage pool setup, software RAID management, and service configurations.
- Comparing enterprise storage appliances vs. standalone storage servers.

Hands-On Practical Lab Exercises

- Lab 1: Building an expandable LVM storage pool and dynamically extending partitions on live servers.
- Lab 2: Configuring a software RAID 5 array with mdadm, simulating drive failure, and performing live rebuild.
- Lab 3: Enabling VDO deduplication and compression to maximize available storage capacity.
- Lab 4: Setting up centralized iSCSI and NFS servers and mounting shares across client nodes with automount.
- Lab 5: Deploying and configuring complete NAS appliances using TrueNAS and OpenMediaVault in lab environments.