LVM Thin on Shared Block Storage in Proxmox VE Clusters

iSCSI, Fibre-Channel and NVMe-oF thin-provisioned in Proxmox VE Clusters
with pve-sharedlvm-thin storage module by Florian Paul Azim Hoberg @gyptazy



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We l❤️ove Open-Source.

Our commitment to open source goes beyond philosophy! It’s at the very heart of what we do and drives our innovation forward. That is why, at credativ GmbH, we actively use, promote, and develop open-source solutions of all kinds!

About me - Florian

Florian Paul Azim Hoberg



- Also known as **gyptazy** within the open-source community
- Head of Virtualization at **credativ GmbH** (Mönchengladbach, Germany)
- **FOSS Contributor**
- **FreeBSD evangelist**

Projects

Ansible

Active upstream developer of Ansible modules, focusing on Enterprise Linux, BSD, and virtualization platforms. Developing and maintaining numerous modules for RHEL, FreeBSD, and Proxmox VE.

BoxyBSD / BoxedTux

BoxyBSD is a non-profit project providing free Virtual Private Servers (VPS) running BSD-based operating systems such as FreeBSD, OpenBSD, and NetBSD for educational and testing purposes..

ProxLB



ProxLB is an intelligent load balancer for Proxmox VE that automatically distributes virtual machines across a cluster to optimize resource utilization and improve overall performance.

PegaProx

PegaProx is an open-source platform for centralized management of Proxmox VE environments, enabling administrators to manage multiple clusters through a modern, unified web interface.

Thin Provisioning and Snapshots on Shared Block Storage in Proxmox VE

Traditional LVM on shared block storage offers neither thin provisioning nor native snapshot functionality – both critical requirements of modern virtualization environments. This implementation closes exactly this gap.

Challenge

LVM Thick on shared block storage pre-allocates capacity and does not provide flexible snapshot workflows for VM disks.

Solution

A custom Proxmox VE storage implementation combines shared block storage with dedicated LVM Thin Provisioning.

Concept

Shared Block Storage + LVM Thin Pool + Proxmox VE Storage Plugin – seamlessly integrated into existing SAN architectures.



Thin Provisioning

Storage space is only consumed upon actual write access – no more upfront allocation.



Snapshot Support

Native LVM Thin Snapshots for all virtual machines on shared block storage.



SAN Compatibility

Full support for iSCSI, Fibre Channel, and NVMe-oF as shared block storage backends.



PVE Integration

Transparent integration via a custom storage plugin – no modification of the Proxmox VE core required.

Traditional LVM on Shared Block Storage

LVM Thick is a proven approach for managing VM disks on shared block storage – simple, robust, and natively supported in Proxmox VE. The architecture builds directly on the shared block device, which is provided via iSCSI, Fibre Channel, or NVMe-oF.

Architecture

The shared block device is presented to all Proxmox VE nodes. A LVM Volume Group is created on it. Each VM disk is allocated as a standalone Logical Volume – the capacity is fully reserved in advance.

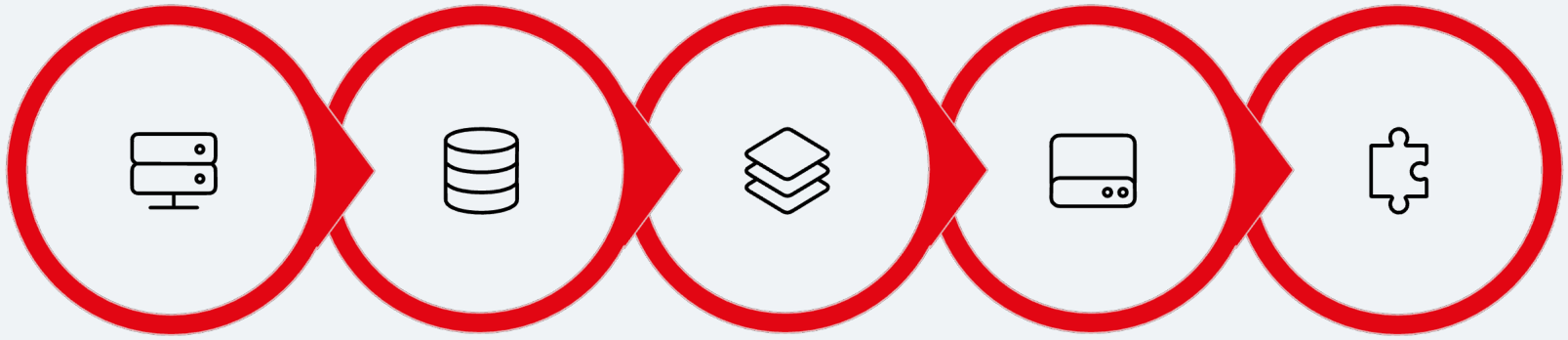
Limitations in Practice

- The full disk capacity is reserved at allocation time – regardless of the actual write volume.
- Storage efficiency suffers considerably for rarely used VMs.
- Thin Provisioning is not available with standard LVM on shared storage.
- The desired snapshot workflow for VM disks is not natively supported by classic shared LVM.

⚠ Practical example: A VM with a 500 GB virtual disk immediately allocates ~500 GB of storage – regardless of whether 10 GB or 490 GB is actually used.

Extension with LVM Thin Provisioning

The new implementation extends the proven shared block storage model with a dedicated LVM Thin architecture. Each VM gets its own thin pool – managed by a custom Proxmox VE storage plugin.



Key Design Decisions

- **Dedicated thin pools per VM** – clear isolation and simplified capacity management.
- **Shared block-level backend** – iSCSI, Fibre Channel, or NVMe-oF as the foundation.
- **Thin-provisioned disks** – storage is allocated on demand.
- **LVM Thin snapshots** – native snapshot functionality without additional tools.
- **Live-Migrations** – In theory, currently disabled & requires further adjustments in qemu.

Result in Comparison

A VM with a 500 GB virtual disk initially occupies only a fraction of that capacity – depending on the data actually written. Thin provisioning and snapshot functionality are fully provided, while the performance characteristics of block storage are preserved.

Thin provisioning and snapshots on shared block storage without compromises in performance or cluster compatibility.

LVM Thick vs. LVM Thin – Technical Comparison

A direct comparison shows the key differences between the classic LVM Thick approach and the new Custom LVM Thin implementation on Shared Block Storage.

Feature	LVM Thick	Custom LVM Thin
Shared Block Storage	✓ Yes	✓ Yes
Thin Provisioning	✗ No	✓ Yes
Storage Allocation	Upfront	On Demand
VM Snapshots	Limited / not native	✓ Native via LVM Thin
Storage Efficiency	Lower	Higher
Overprovisioning	✗ No	✓ Yes
Capacity Management	Predictable	Monitoring required
Block-Level Access	✓ Yes	✓ Yes
Proxmox VE Integration	Native	Custom Plugin
VM Disk Isolation	Logical Volumes	Dedicated Thin Pools

Key Advantages of LVM Thin

- Better utilization of expensive SAN capacity through on-demand allocation.
- Significantly reduced initial storage reservation.
- Native LVM Thin snapshot functionality for all VMs.
- Greater flexibility in VM provisioning.

Trade-off

Thin Provisioning noticeably increases the demands on capacity management. Pool utilization, metadata consumption, and out-of-space conditions must be actively monitored to avoid data loss from storage exhaustion.

⚠ Without active monitoring, a fully occupied Thin Pool can lead to VM outages.

New Possibilities for Proxmox VE

The custom implementation extends Proxmox VE with capabilities that were previously not available on classic shared block storage – and closes an important gap in the storage ecosystem.

Goals Achieved

- Thin provisioning on shared block storage.
- Dedicated thin pools per VM for clear isolation.
- Native snapshot functionality via LVM Thin.
- Seamless integration through a custom Proxmox VE storage plugin.
- Support for iSCSI, Fibre Channel, and NVMe-oF as backends.

Why It Matters

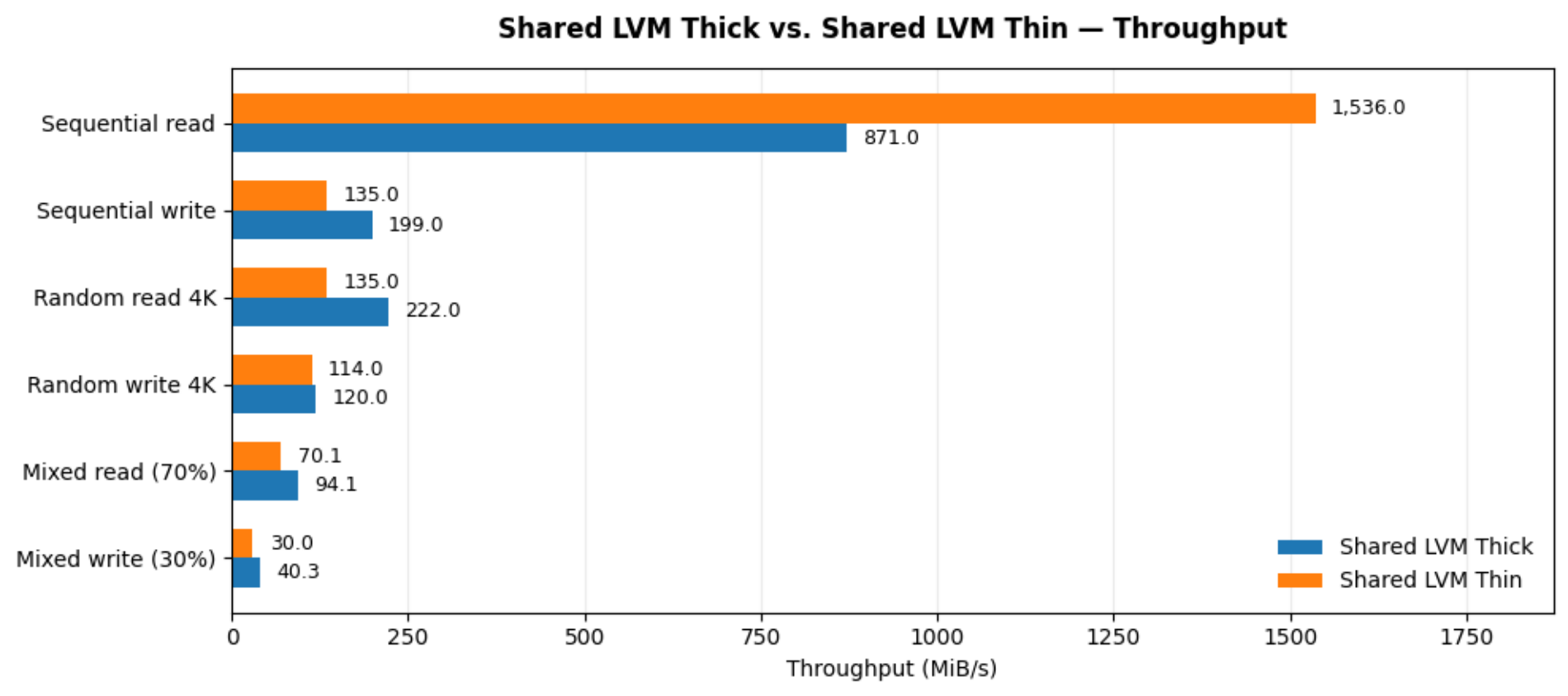
The solution combines the advantages of shared block storage – performance, cluster compatibility, availability – with the flexibility previously reserved for network-based or file-based storage backends. SAN capacity is used more efficiently, and VM snapshots become standard.

Next Steps

- Automated capacity monitoring for thin pools.
- Protection against metadata and data exhaustion.
- Improved storage utilization reporting.
- Performance benchmarking against LVM Thick.
- Extended operational testing under parallel cluster workloads.

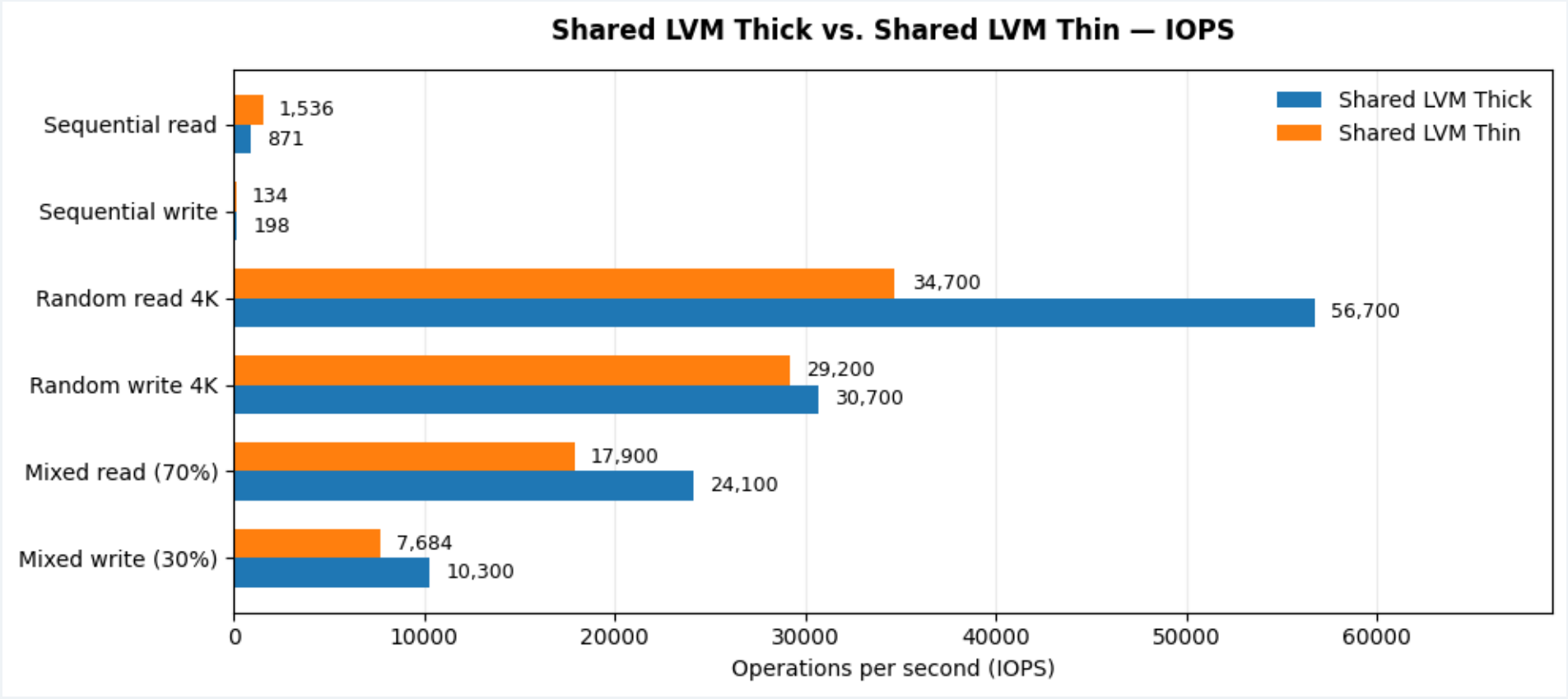
Conclusion: LVM Thin on shared block storage closes a significant gap in Proxmox VE storage capabilities – it unites shared block-level storage, efficient capacity utilization, and VM snapshot functionality in one integrated solution.

Performance LVM-Thick vs LVM-Thin: Throughput



Source: https://gyptazy.com/blog/proxmox-shared-lvm-thick-shared-thin-cetrafs-benchmark-overview/

Performance LVM-Thick vs LVM-Thin: IOPS



Source: https://gyptazy.com/blog/proxmox-shared-lvm-thick-shared-thin-cetrafs-benchmark-overview/

Demo time!


Demo Time...
We install and configure this now live in a Proxmox VE Cluster!
LVM Thin on shared iSCSI
PROXMOX VE
pve1
PROXMOX VE
pve2
PROXMOX VE
pve3
Shared iSCSI Storage
LVM Thin (thin-provisioned)
> Installing packages...
✔ Packages installed
> Configuring cluster...
✔ Cluster joined
> Adding shared iSCSI...
✔ iSCSI storage added
> Configuring LVM Thin...
✔ LVM Thin (thin-provisioned)
> Applying settings...
✔ Configuration complete
✔ Ready!

Thanks! Questions?



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