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CEPH DAYS Berlin

12./13. November 2025

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The Need for Speed:

Accelerating OpenStack with NVMe-oF & Ceph

Kritik Sachdeva, Technical Support Professional, IBM

Who am I?

Who am I?

- Technical Support Professional @ IBM
- Explore new technologies and integrating them with each other
- A RHCA Level-XII
- By passion I am an artist - Spend time doing & teaching Calligraphy, and paper quilling

AGENDA

For today

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- Storage Gaps in the AI Data Pipeline
- Ceph & NvmeOf
- Request flow architecture in OpenStack
- Integration Demo
- Use Case

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Storage Gaps in the AI Data Pipeline

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As AI workloads evolve, storage systems built for throughput are struggling to meet the latency, consistency, and scalability demands of modern ML and analytics pipelines.

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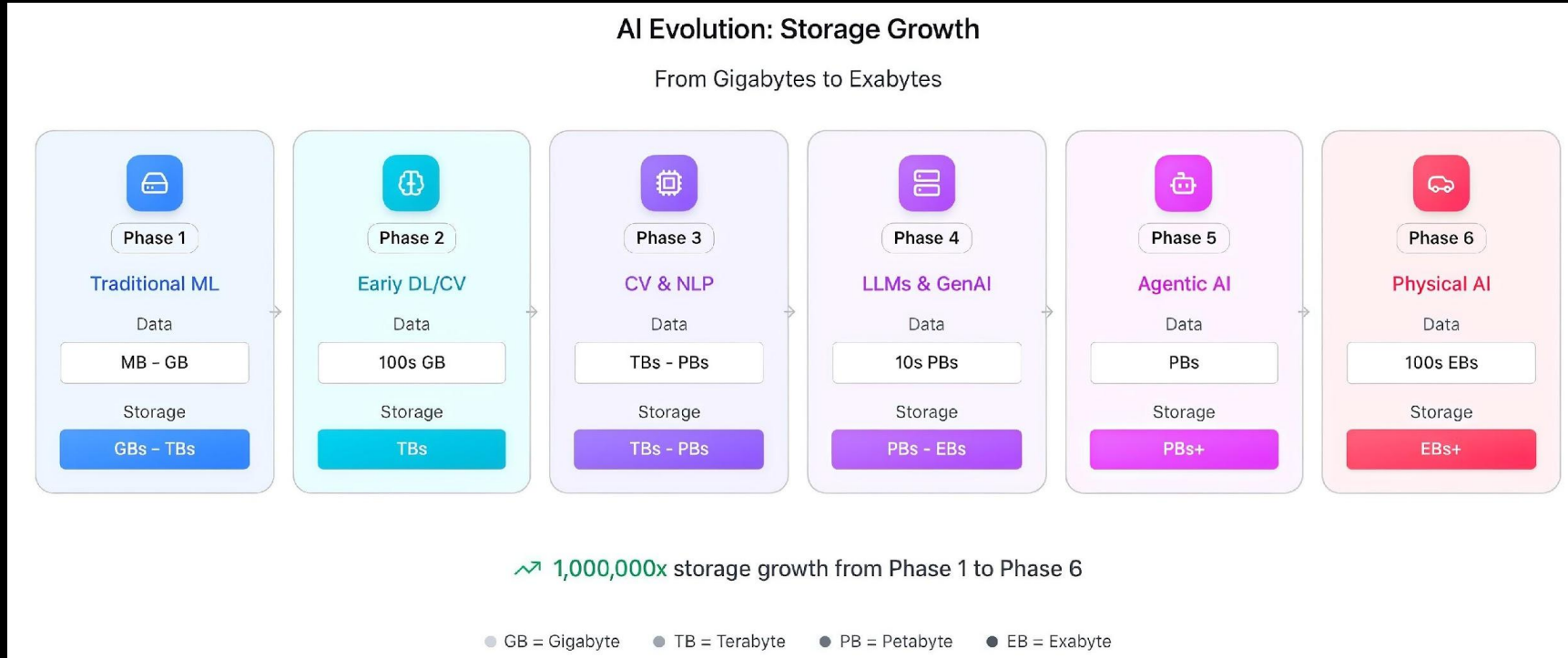

Storage Gaps in the AI Data Pipeline

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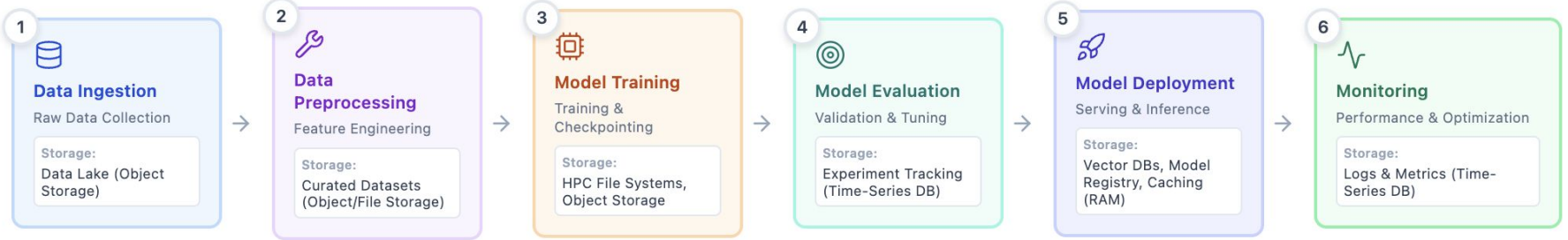
MLOps Pipeline



Storage Gaps in the AI Data Pipeline

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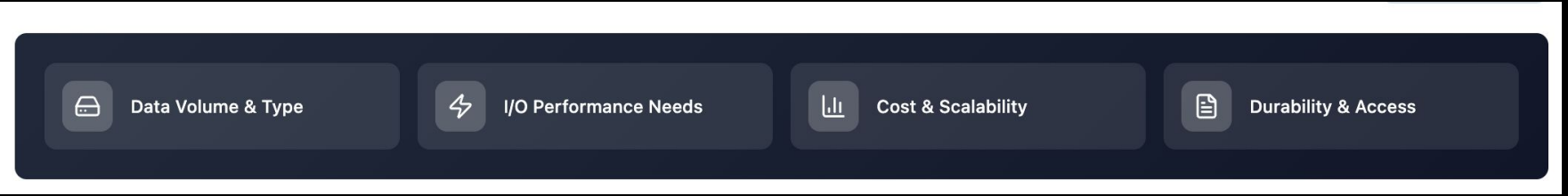
Key Storage Considerations



Storage Gaps in the AI Data Pipeline

Modern workloads demand more than ever from storage, but traditional protocols create a bottleneck.

- 🧠AI/ML Training: Requires rapid I/O for large datasets and frequent model checkpointing.
- 📊 Vector Databases (RAG): Demand ultra-low latency for real-time semantic search.
- 🧩 High-Transaction Databases: Performance is directly limited by storage IOPS.

Slow storage leaves expensive resources like GPUs waiting, throttling your cloud's potential.

Ceph & NVMe-oF

Ceph

A Software defined storage solution

Ceph

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A Software defined storage solution

Massively Scalable. Highly Resilient. Unified.

- **Elastic Scale:** Grow from TBs to PBs seamlessly.
- **Self-Healing:** Data integrity and availability built-in.
- **Multi-Protocol:** Block (RBD, NVMe-oF), File (CephFS, NFS), Object (S3).

Your flexible, future-proof data lake.

🚀 NVMe-oF/TCP – High-Speed Storage over Ethernet

NVMe-oF/tcp extends the blazing-fast performance of local NVMe SSDs across the network fabric.

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NVMe-oF/tcp extends the blazing-fast performance of local NVMe SSDs across the network fabric.

- Extends NVMe commands over **TCP/IP** networks.
- **Simple deployment –** works on existing Ethernet infrastructure.
- Ideal for **cloud-native, and OpenStack** environments.
- Think of it as: “*iSCSI for NVMe, but faster and more efficient.*”

🚀 NVMe-oF/TCP – High-Speed Storage over Ethernet

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NVMe-oF/tcp extends the blazing-fast performance of local NVMe SSDs across the network fabric.

- **Low Latency:** Bypasses legacy SCSI command sets for a more direct, efficient data path.
- **Throughput & IOPS:** Designed to saturate modern high-speed networks (TCP & RDMA).
- **Industry Standard:** A widely adopted protocol with broad support.
- It's the modern, high-performance language for network storage.

NVMe-oF Gateway in Ceph

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A Ceph service (nvmeof-gw) that exposes Ceph RBD images as NVMe/TCP devices.

NVMe-oF Gateway in Ceph

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A Ceph service (nvmeof-gw) that exposes Ceph RBD images as NVMe/TCP devices.

- Enables **block-level access** to Ceph storage over standard Ethernet networks.
- Integrated via **Ceph Orchestrator (cephadm)** for simple deployment and management.
- Both an NVMe-oF target and a Ceph client. Think of it as a “translator” between Ceph’s RBD interface and the NVME-oF protocol.
- Multi-host access & namespace isolation for scalability.
- **Dynamic configuration** via Ceph CLI or dashboard.

NVMe-oF Gateway in Ceph

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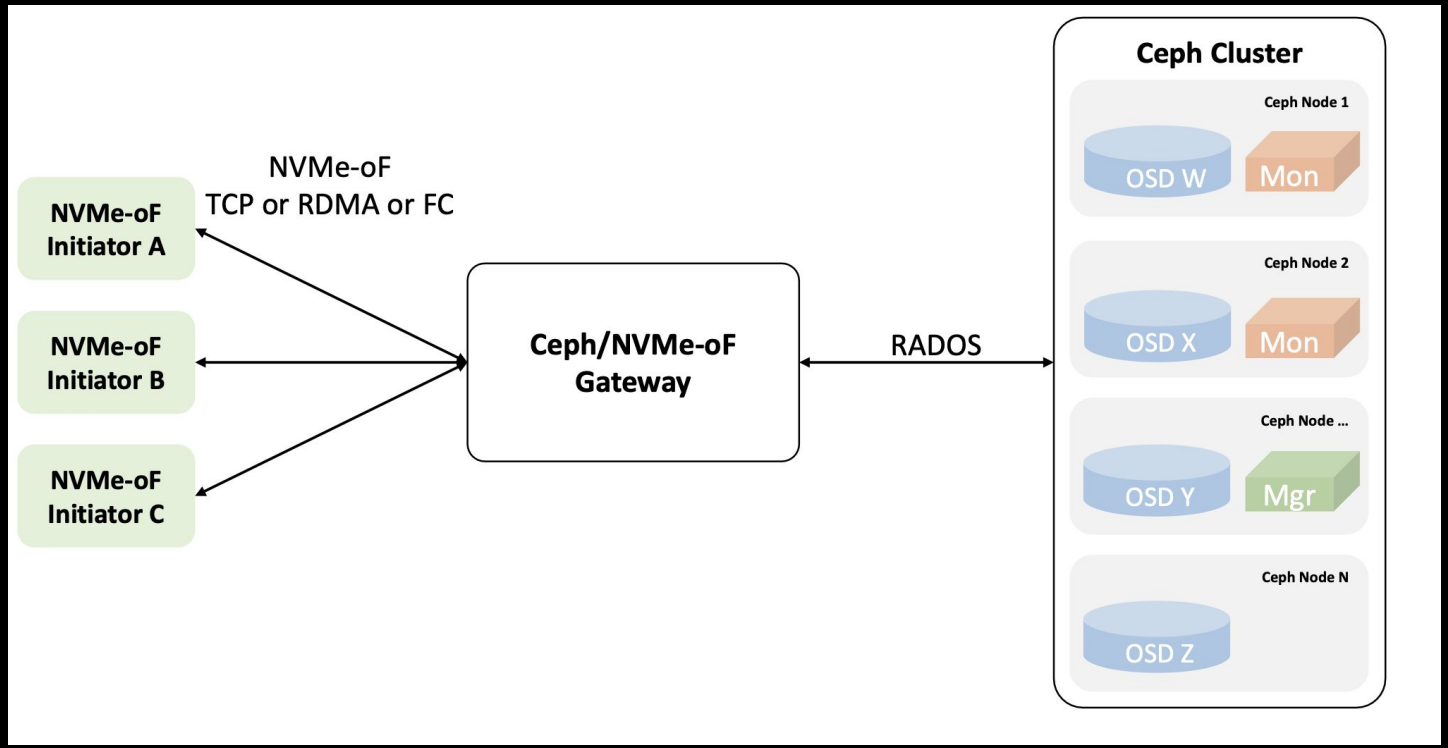

NVMe-oF Gateway in Ceph

Basic terminologies in NVMe-oF GW in Ceph

NVMe-oF Gateway in Ceph

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Basic terminologies in NVMe-oF GW in Ceph

- *Namespace*
  - NVMe equivalent to FC and iSCSI LUNs (can be thought as a volume)
  - Defined as a collection of LBAs (Logical Block Addresses)
  - In Ceph Nvme-oF GW a namespace is mapped to an RBD Image

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- *NVMe Subsystem*
  - An entity that contains Namespaces and the other NVMe elements such as NVMe controllers
  - Identify by NQN (NVMe Qualified Name) and unique access controls to which the Initiator connects to target IP/NVMe Subsystem

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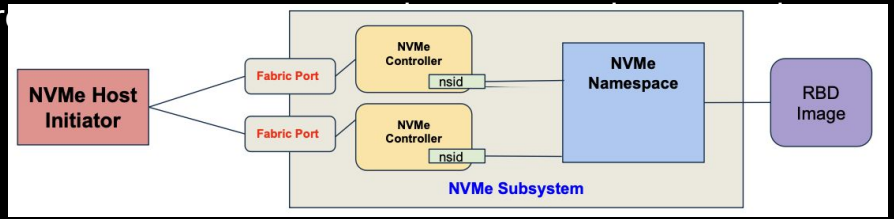
- *NVMe IO Controller*
  - Created for every connection between a host and a target NVME-oF fabric address per Subsystem.
  - Receives and pr



NVMe-oF Gateway in Ceph

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Basic terminologies in NVMe-oF GW in Ceph

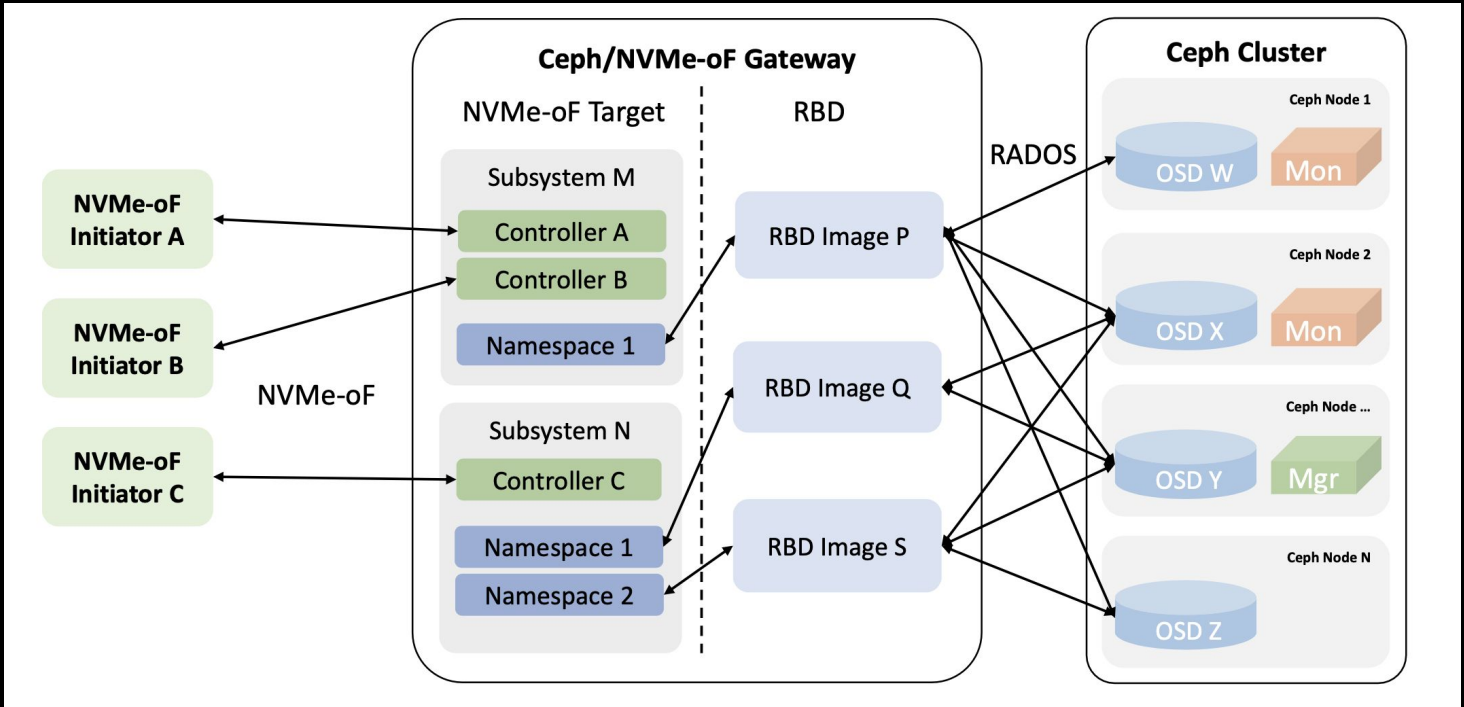
- *Listener/Transport Address*
  - The network interface (IP) and service ID (port) where the gateway listens for NVMe/TCP connections
  - A listener binds a subsystem to a reachable address.
- *Gateway Group / HA domain*
  - A logical group of gateway instances that provide redundancy and failover.
  - If one gateway fails, another in the group can take over I/O for a namespace (active/standby mode)

NVMe-oF Gateway in Ceph

Architecture and components

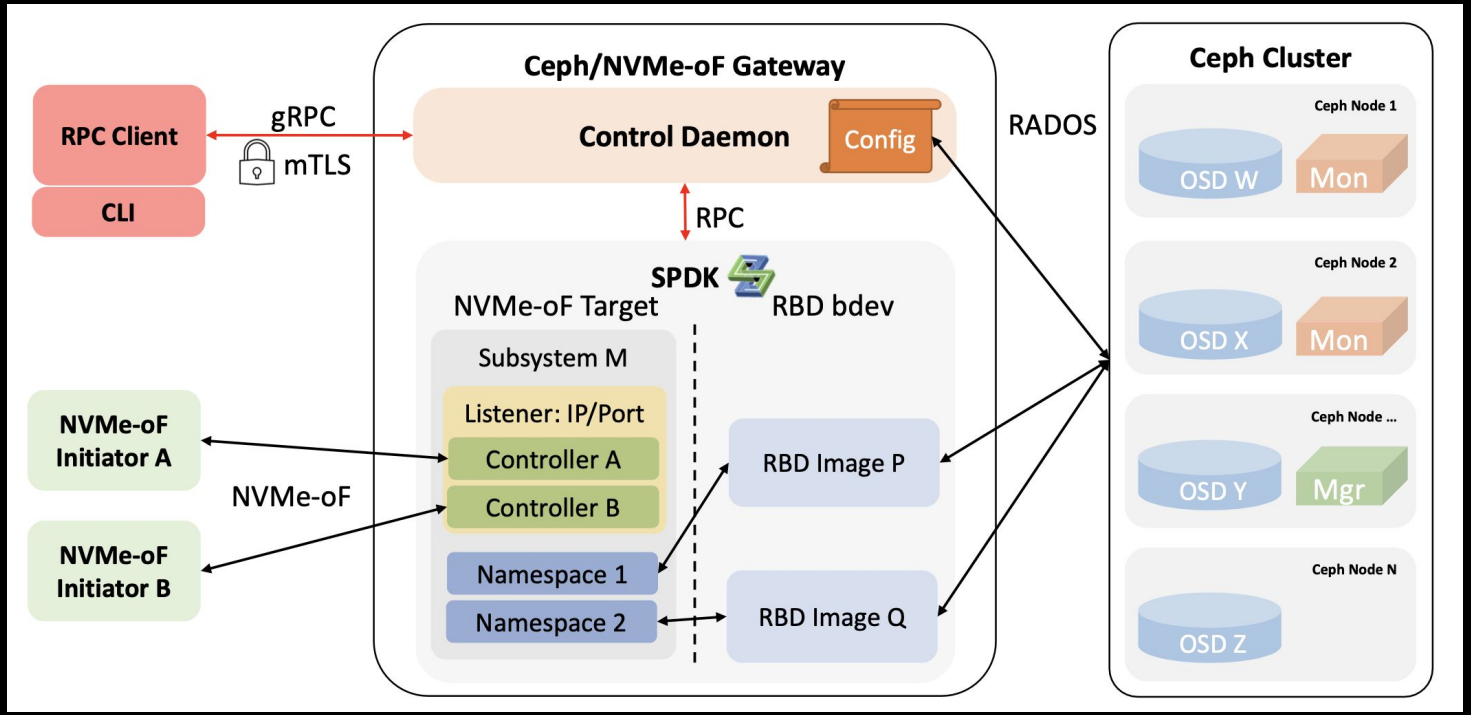
NVMe-oF Gateway in Ceph

Architecture and components



NVMe-oF Gateway in Ceph

Architecture and components



NVMe-oF Gateway in Ceph

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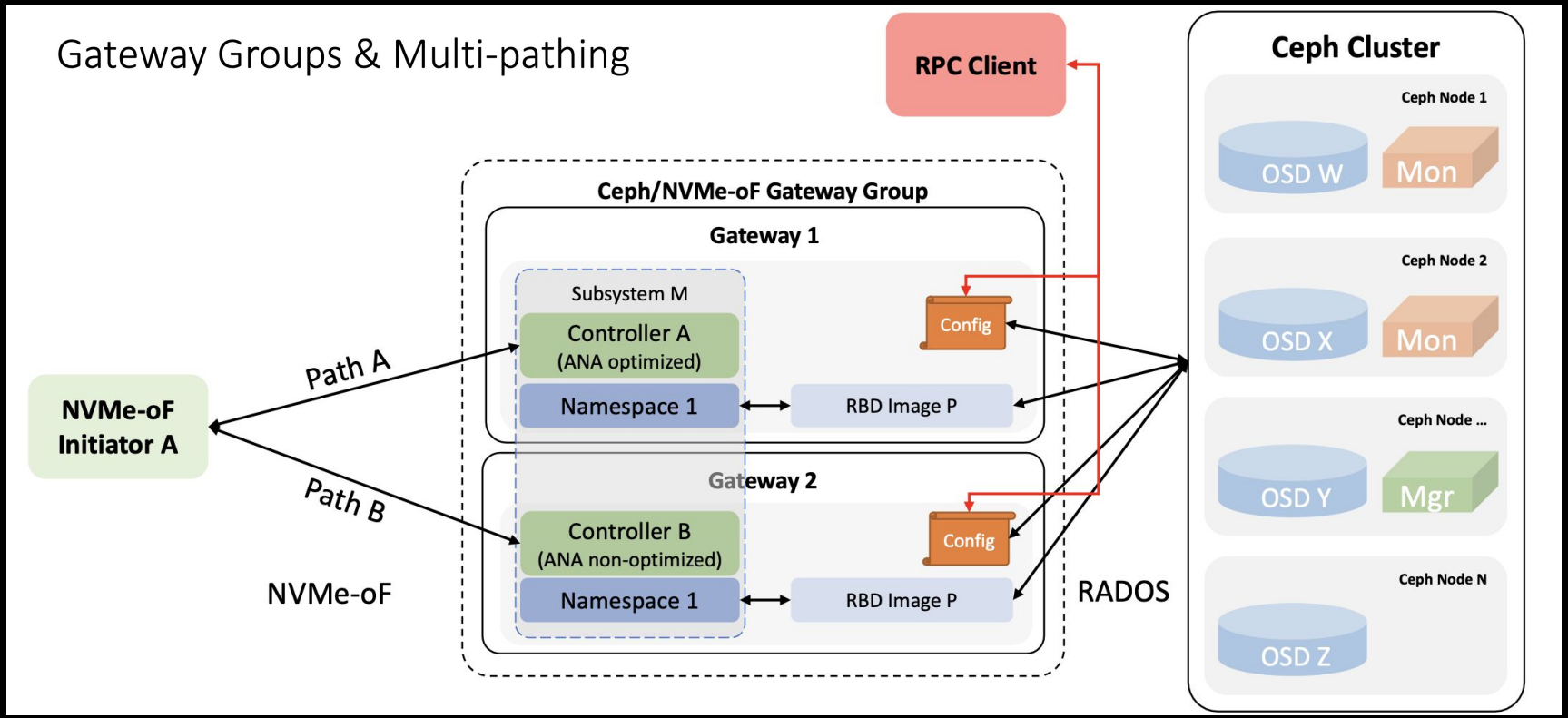

NVMe-oF Gateway in Ceph

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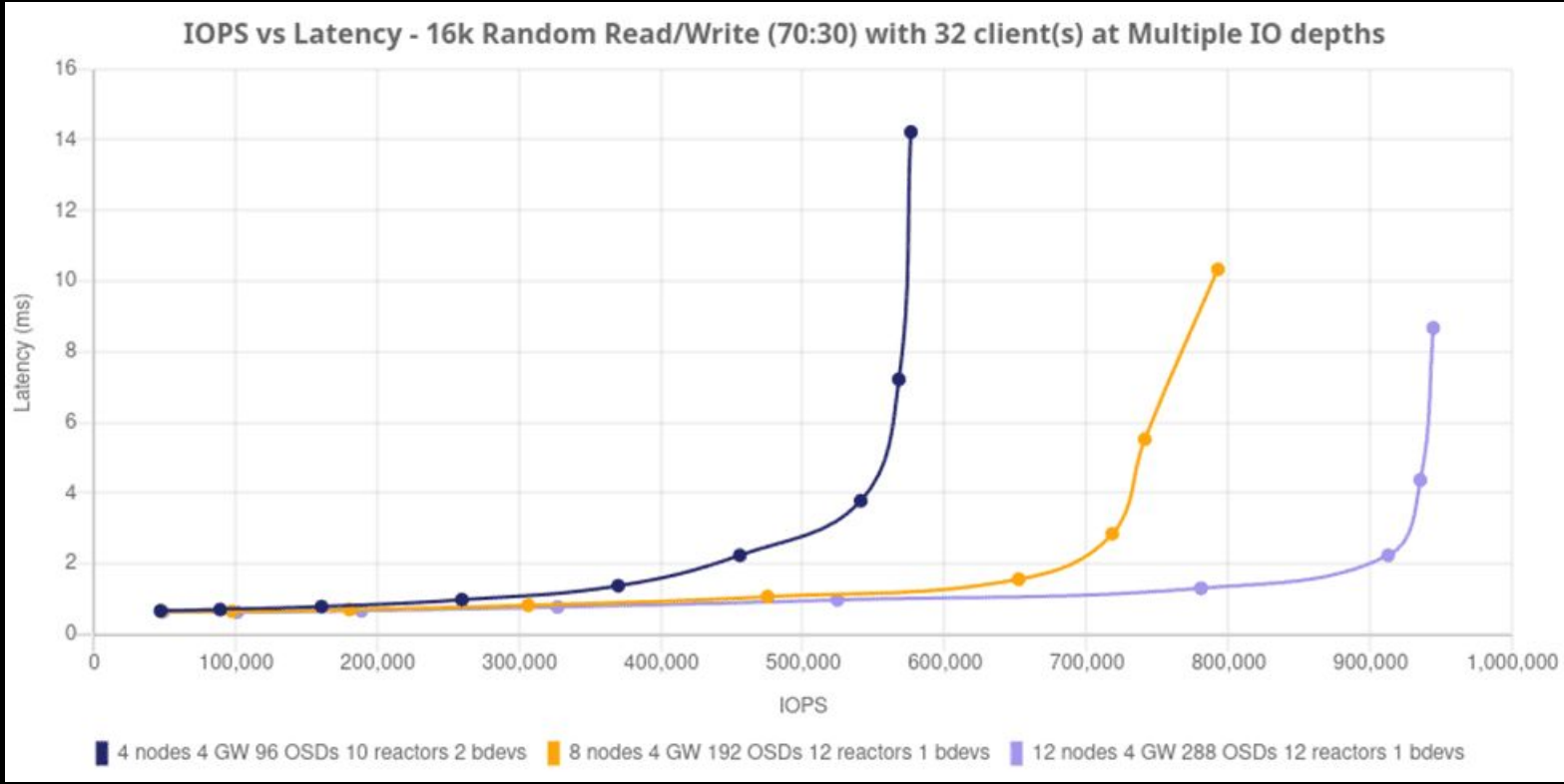
Performance



NVMe-oF Gateway in Ceph

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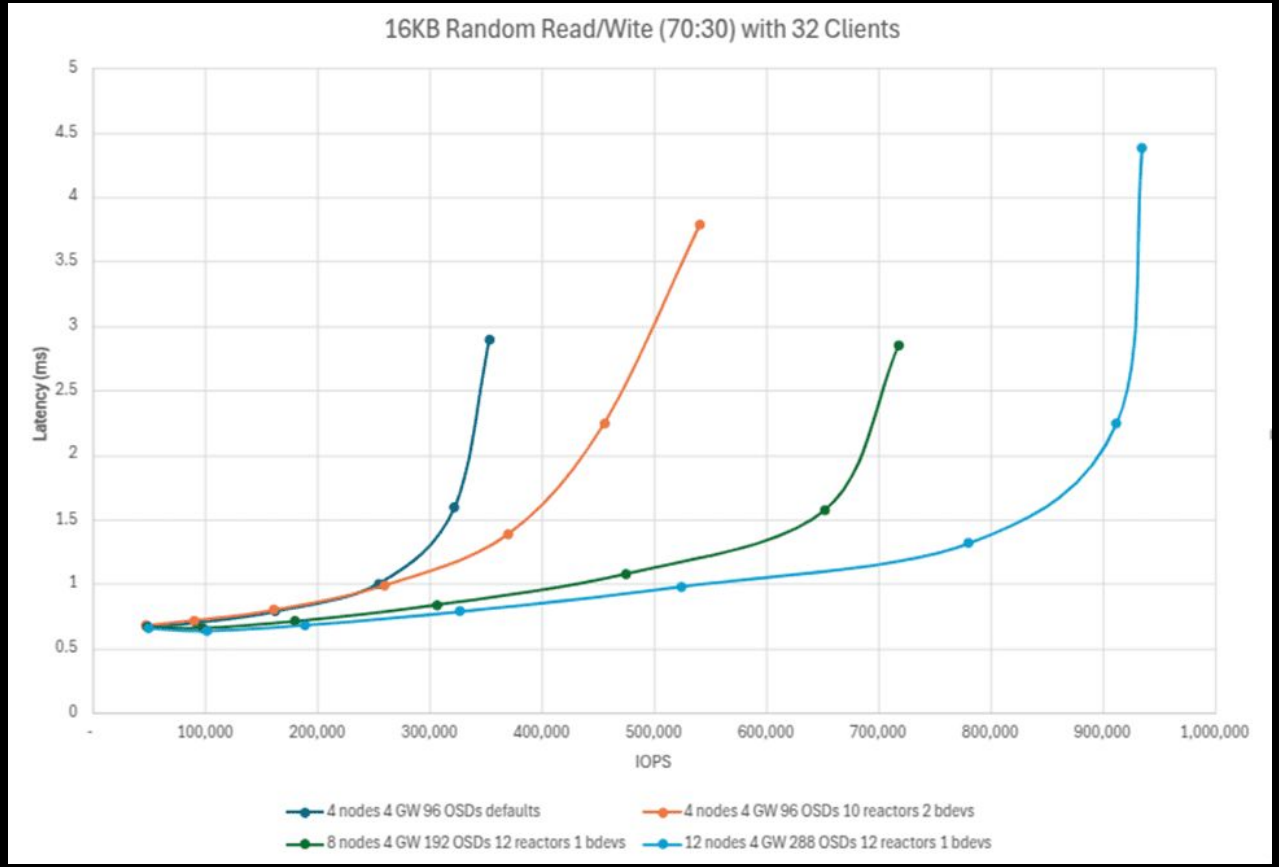
Performance



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Performance Comparison Glimpse

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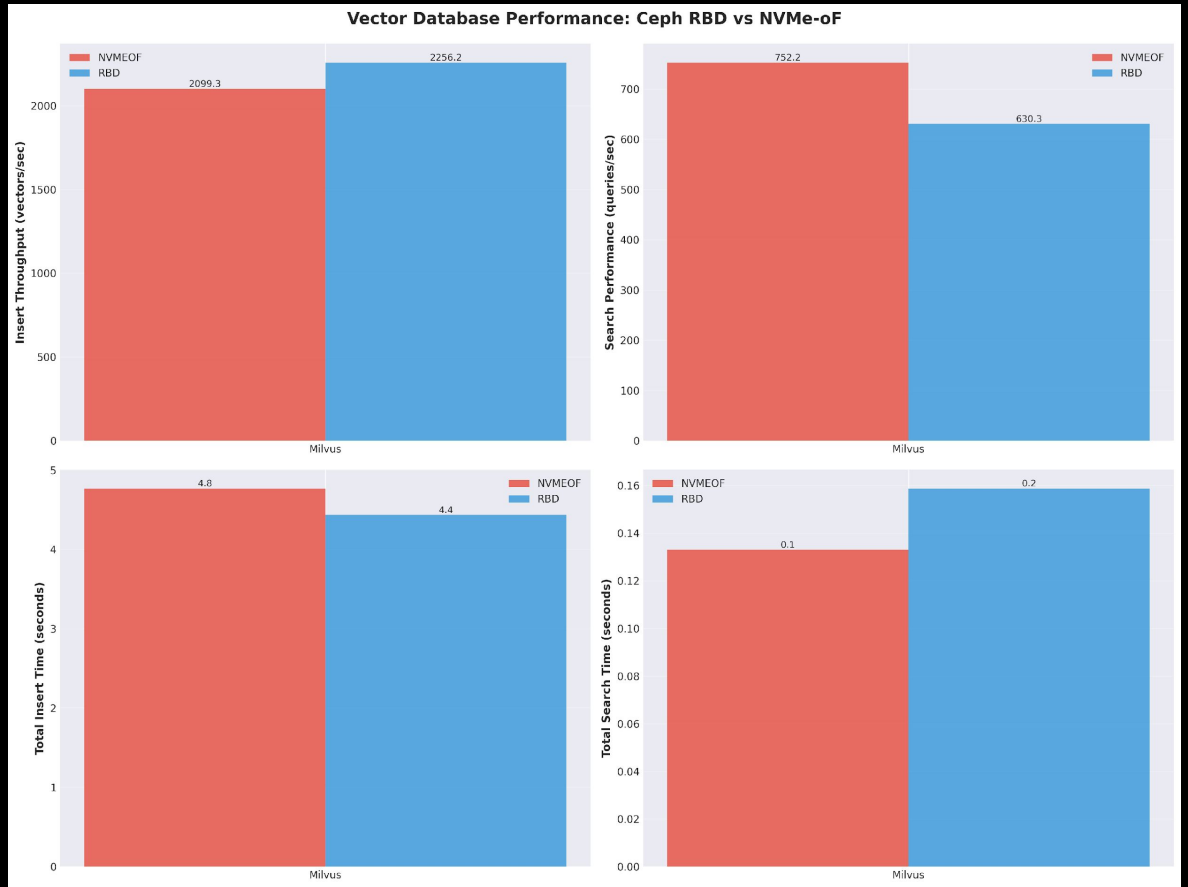
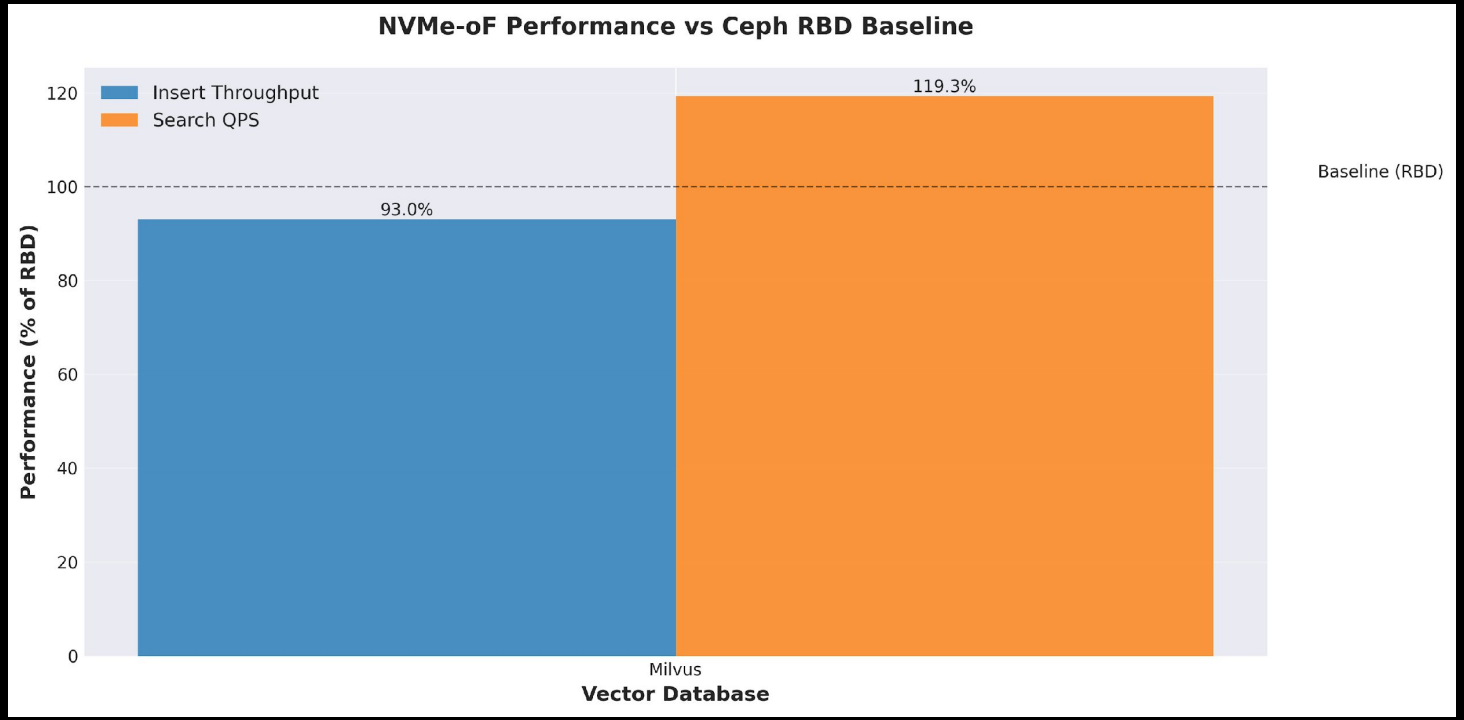


Performance Comparison Glimpse



Performance Comparison Glimpse

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Benchmark Results Summary

Database	Storage	Insert Throughput (vec/s)	Search QPS	Insert Time (s)	Search Time (s)
Milvus	NVMEOF	2099.26	752.19	4.76	0.13
Milvus	RBD	2256.17	630.29	4.43	0.16

Connecting OpenStack Volumes through Ceph NVMe-oF

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This diagram illustrates how OpenStack services (Cinder, Nova) interact with Ceph’s RBD and NVMe-oF Gateway to provision and attach block volumes over TCP.

Connecting OpenStack Volumes through Ceph NVMe-oF

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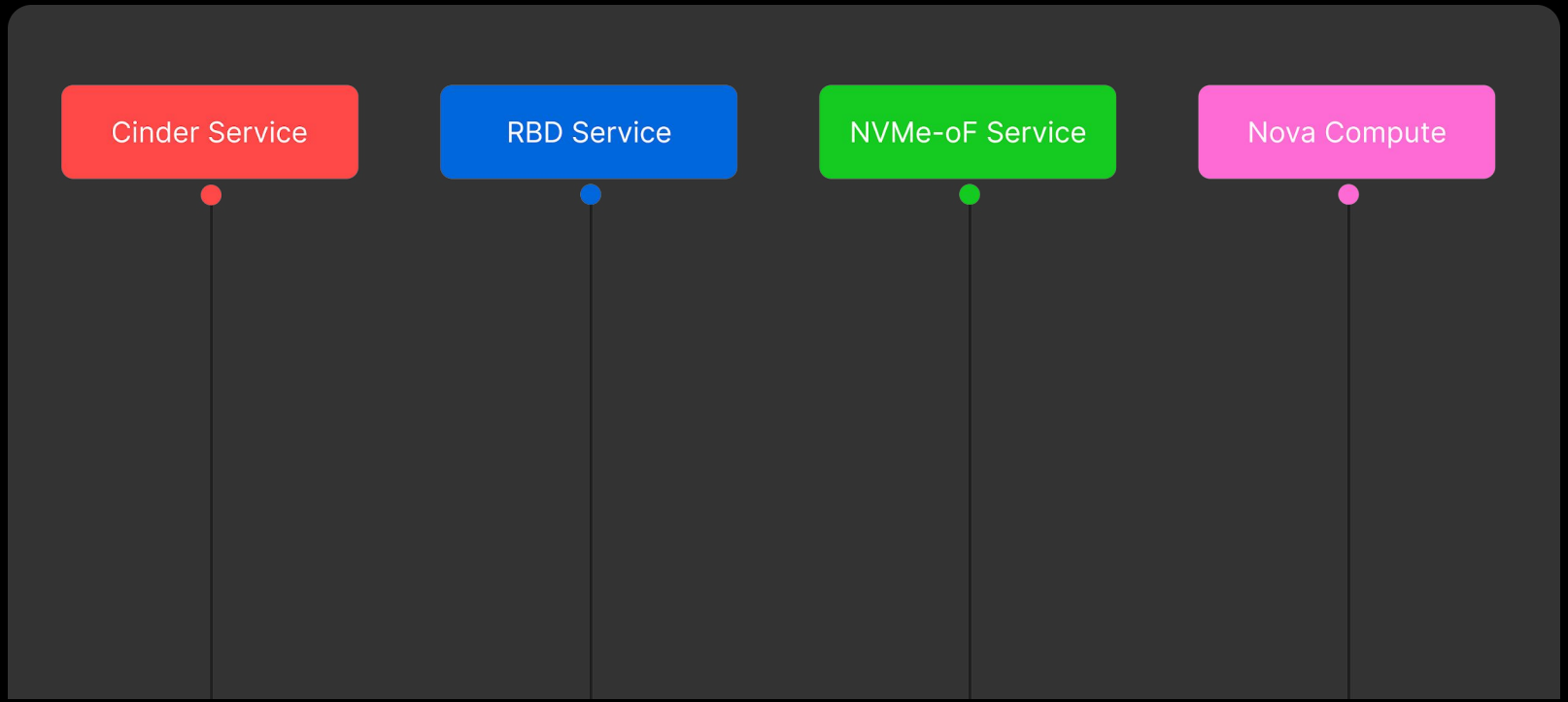
Services interact with each other in this op request flow



Connecting OpenStack Volumes through Ceph NVMe-oF

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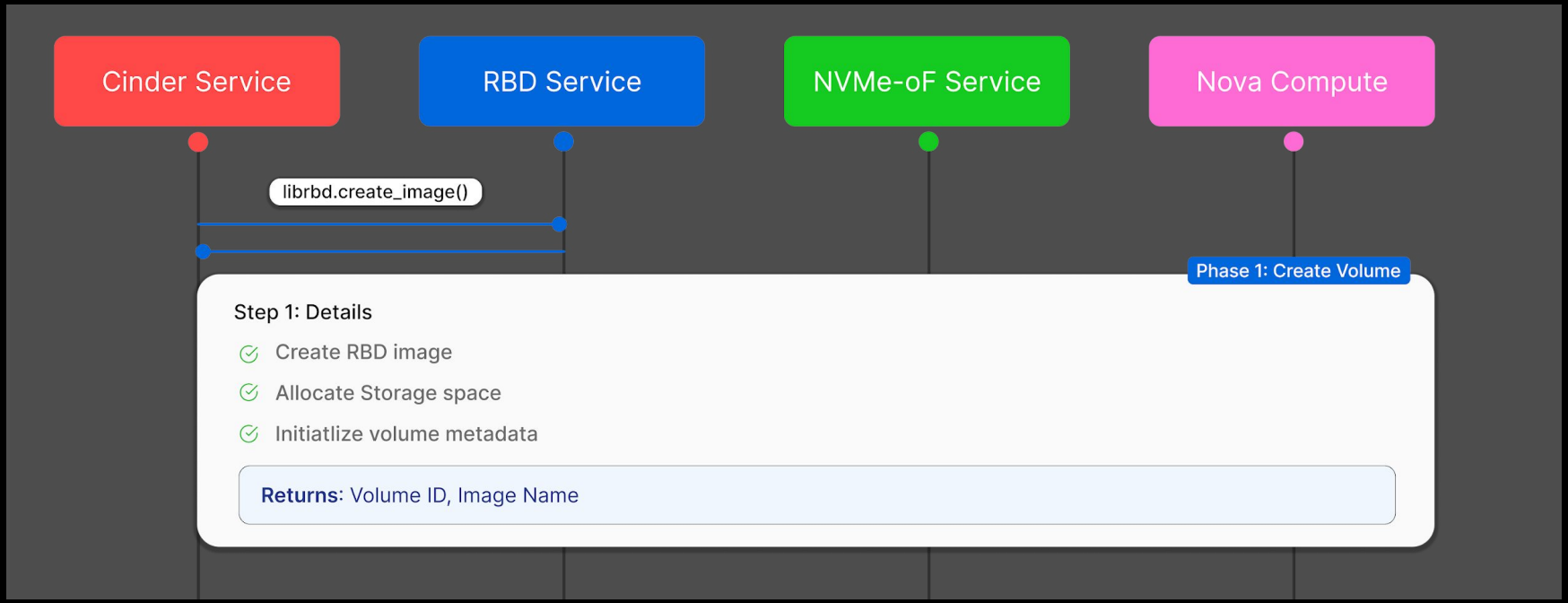
Cinder Volume create request will create an RBD image using librbd module



Connecting OpenStack Volumes through Ceph NVMe-oF

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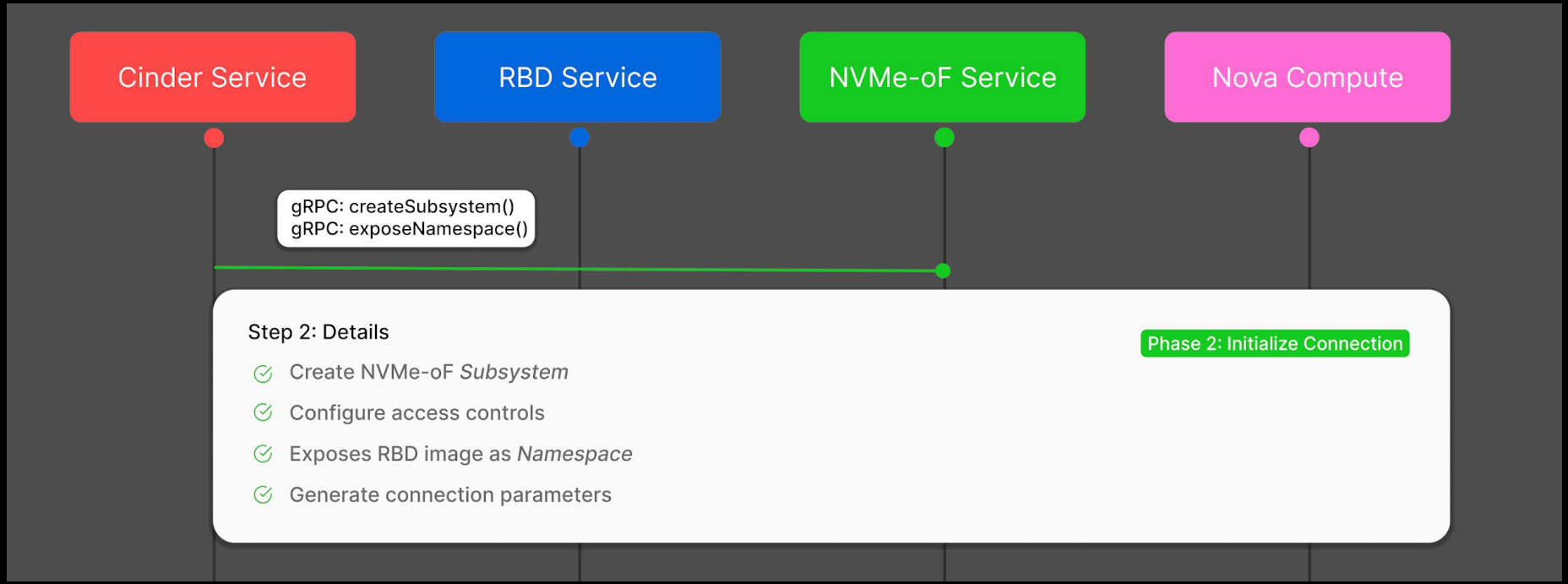
Cinder module - will create create_connection() request which will create relevant resources to attach the volume to a instance



Connecting OpenStack Volumes through Ceph NVMe-oF

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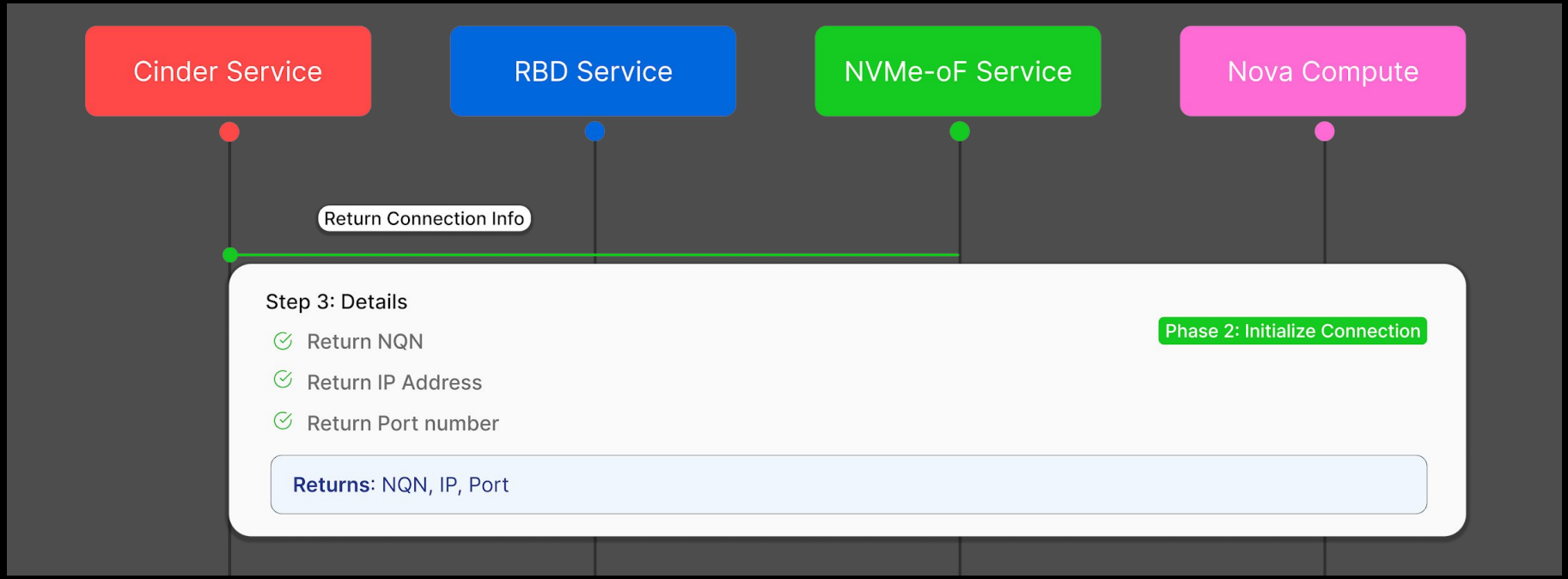
Cinder module receive the connection details from NVMeOF GW in Ceph to connect to



Connecting OpenStack Volumes through Ceph NVMe-oF

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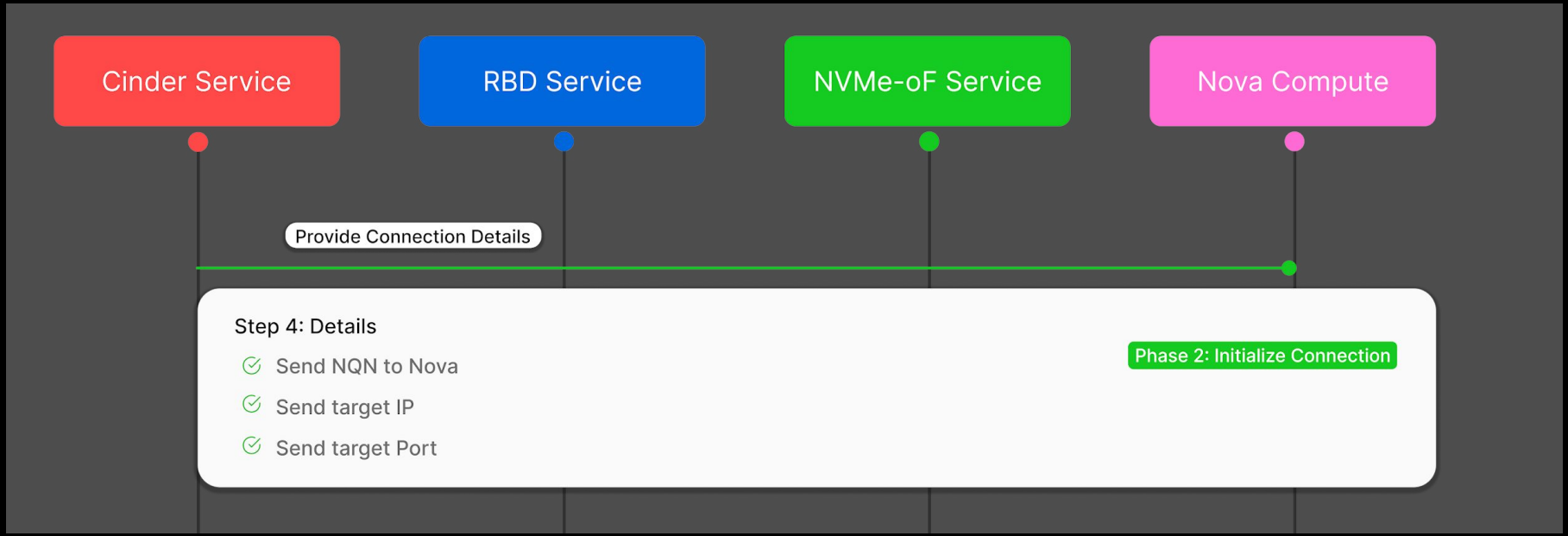
Cinder module provide the connection details received from NVMeOF GW in Ceph to Nova Service



Connecting OpenStack Volumes through Ceph NVMe-oF

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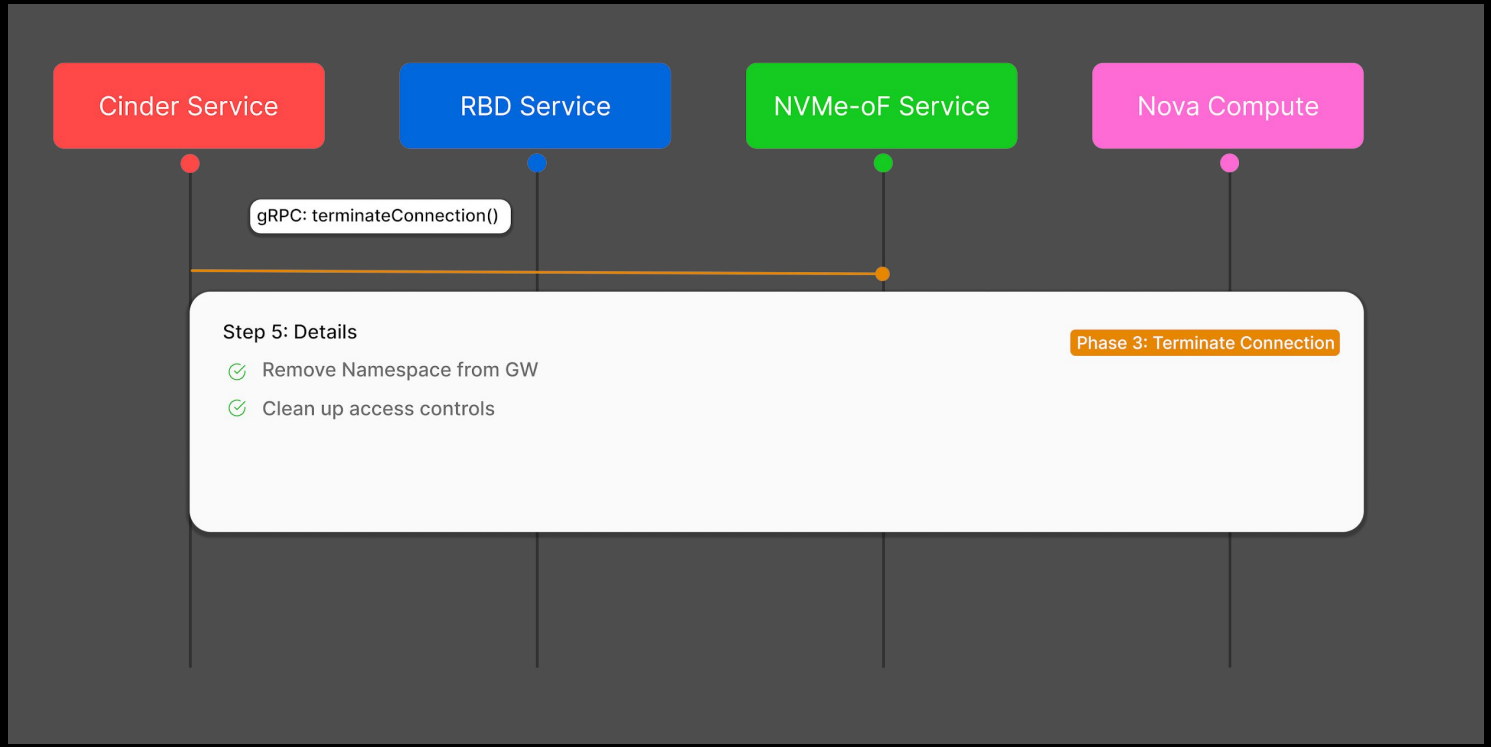
Cinder module - once volume is removed it will destroy all of the resources of NVMeOf service created earlier



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Integration Demo

Link:

Use case(s)

Use Case: 1

Powering Private Cloud Vector Databases

Use Case: 1

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Powering Private Cloud Vector Databases

Problem: Vector databases for RAG and AI search must perform similarity searches across millions of vectors in milliseconds. This requires extremely low-latency storage.

Solution: Run a vector DB on an OpenStack VM, using a Cinder NVMe-oF volume for its indexes.

Benefit:

- **Real-time Performance:** Achieve the low latency needed for interactive AI applications.
- **Scalability & Sovereignty:** Scale your database on your secure, private Ceph cluster.

🏦 Use Case: 2

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High-Performance Databases

🏦 Use Case: 2

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High-Performance Databases

Fueling Mission-Critical Applications

- **Challenge:** Traditional storage limits database transaction rates and query response times.
- **Solution:** Host database files & transaction logs on Cinder NVMe-oF volumes.
- **Impact:**
  - Higher Transactions Per Second (TPS).
  - Significantly improved query performance.

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✨ Conclusion: The Future is Fast

✨ Conclusion: The Future is Fast

- Eliminate storage bottlenecks for demanding workloads.
- Leverage Ceph's robust, distributed architecture.
- Bring cutting-edge performance to your cloud users.

Turn your OpenStack cloud into a serious data-processing engine.

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Thank you..

Any Questions

Linkedln
@kritiksachdeva

Github
@skritik098

Instagram
@theflourishart

AGENDA - Day 1 (1/2)

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9am	Welcome, Check-in, Coffee
10am	Welcome Session (Joachim Kraftmayer & Desy Management)
10.15am	Morning Keynote: Cephfs Home @ DESY (Ingo Ebel)
10.50am	Buzzword Bingo: Digital Sovereignty (Markus Wendland & Heiko Krämer)
11.25am	SURFin' the Ceph wave (Jean-Marie de Boer)
11.35am	*Coffee Break & Networking*
12.15pm	It's all about the latency, not the bandwidth! (Wido den Hollander)
12.50pm	Running a small Openstack Cluster with a full NVMe Ceph Cluster (Kevin Honka)
1.20pm	*Lunch Break & Networking*

AGENDA - Day 1 (2/2)

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2.5pm	Principles for Storage Management (Benedikt Bürk)
3.25pm	Beyond Backup: S3 Data Management with Ceph RGW Tiering, and Chorus (Sirisha Guduru & Artem Torubarov)
5.55pm	*Coffee Break & Networking*
4.35pm	How RGW Stores S3 Objects in Rados (Tobias Brunnwieser)
5.10pm	A generic Ceph sizer for the community optimizing workloads, layouts, and server configs (Matthias Münch)
5.25pm	AI, ML, and the Ceph Advantage: Scalable Storage for Smarter Workflows (Kenneth Tan)
6pm	*Network Reception in Ground Floor with Food Truck & Drinks*

AGENDA - Day 2

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9.30am	*Welcome & Good Morning Coffee*
10am	**Keynote**
10.35am	Scale Multiple Ceph-clusters Horizontally (Ansgar Jazdzewski)
11.20am	*Coffee Break & Networking*
11.10am	Ceph Rados Gateway as an Interface to Tape Storage (Stuart Hardy & Zaid Bester)
11.45am	The Need for Speed: Accelerating OpenStack with NVMe-oF & Ceph (Kritik Sachdeva)
12.20pm	Speed up your deployments using the Ansible Cephadm collection (Piotr Parczewski)
1.05pm	*Lunch Break & Networking*
2.15pm	Faster CephFS Mirroring with Bounded-Frontier Concurrency (Md Mahamudur Rahaman Sajib)
2.30pm	Ceph-CSI Support for AES-GCM: Challenges and Opportunities (David Mohren)
3pm	*Podium Discussion with Speakers, Wrap Up & Summarize*