KIOXIA

KUMOSCALE™

Product Overview

Introducing KumoScale™ Software

Performant, Networked Storage at Data Center Scale for Kubernetes®, OpenStack® and Bare-Metal Infrastructures

KumoScale™ software from KIOXIA Corporation (formerly Toshiba Memory Corporation) delivers managed, native storage services based on the NVMe-oF™ protocol, with high-performance and low-latency at data center scale. It maximizes storage utilization while retaining the performance that is made possible by high-performance NVMe™ SSDs and provides scaled automation, provisioning, management and optimization of these storage resources. KumoScale software integrates deeply into Kubernetes containerized environments as well as OpenStack and bare-metal automated frameworks to dynamically allocate storage resources, and provision them to applications on demand.

Through the implementation of a fast, networked NVMe flash storage service, KumoScale software enables large scale data center operators to disaggregate their NVMe SSDs from compute nodes and share them efficiently over a network. Its native support of the NVMe-oF protocol provides centralized storage to compute nodes with input/output operations per second (IOPS) and throughput performance that is comparable to locally-attached NVMe SSDs[1] as the architecture is designed to retain the low-latency and incredible throughput of the SSDs.

Key Benefits

Product-specific:

- ***Born in the Cloud:*** *Integrates with Kubernetes, Ansible®, OpenStack and other cloud-native infrastructure software*
- **Open-source Interoperability:** *Works with any standards-compliant NVMe-oF initiator and any compliant NVMe SSD*
- ***Any Network:*** *Supports RDMA for high network performance and TCP/IP for broad network compatibility*
- ***Resilient:*** *Enables cross-domain volume replication for legacy applications and simple volumes for cloud-native applications*
- ***Analytics-driven Provisioning:*** *Provides visual representation of performance metrics in associated time frames based on storage classes, QoS and telemetry data*
- ***Any Platform:*** *Runs on standard x86-based (Intel® and AMD®) storage platforms*
- ***Trusted Supplier:*** *Designed and supported by one of the world's largest providers of flash memory solutions and NVMe SSDs, and a leading innovator of disaggregated, managed native storage services based on the NVMe-oF standard*

Application-specific:

- ***Performance:*** *Customizes storage performance for each application based on its specific requirements*
- ***Fast, Self-service Provisioning:*** *Provides rapid deployment of storage for stateful workloads*
- ***Scalability:*** *Enables stateful applications to be efficiently load-balanced and elastically scaled*

Business-specific:

- ***Utilization:*** *Saves storage capital expenditures with better flash capacity utilization across workloads*
- ***Cost Reduction:*** *Performs the same work with fewer compute nodes by blending workloads and eliminates stranded resources*
- ***Grow Revenue:*** *Increases revenue agility by rapidly adapting stateful workloads during demand peaks*
- ***IT Responsiveness:*** *Accelerates decision-making through faster ingest and analysis*
- ***Procurement Simplicity:*** *Simplifies procurement and maintenance by consolidating server SKUs*

Designed for Disaggregation

Disaggregation is a form of shared, scale-out storage where resources can be allocated to any server in the data center through a high-performance network. It provides the ability to:

- *Provision NVMe storage with performance that is comparable to locally-attached storage*
- *Automate workload mobility (highly-prized by today's orchestrators)*
- *Provide a high level of data resilience*

A 'sea change' for data centers, the NVMe-oF specification requires a rethinking of the storage infrastructure from end-to-end by enabling the disaggregation of NVMe storage and compute resources.

KumoScale Software Architectural Overview

The KumoScale software platform consists of multiple components (Figure 1):

- ***Storage Nodes:*** *Accepts NVMe-oF protocol I/O commands directed at virtual volumes and translates them into NVMe commands directed at physical SSDs installed in storage nodes*
- ***Provisioner Service:*** *Tracks the fleet of SSDs and KumoScale storage nodes, and uses analytics to map user volumes to the nodes and physical drives*
- ***Analytics:*** *Analyzes and adjusts volume mapping to optimize delivered performance and helps to reduce drive wear*

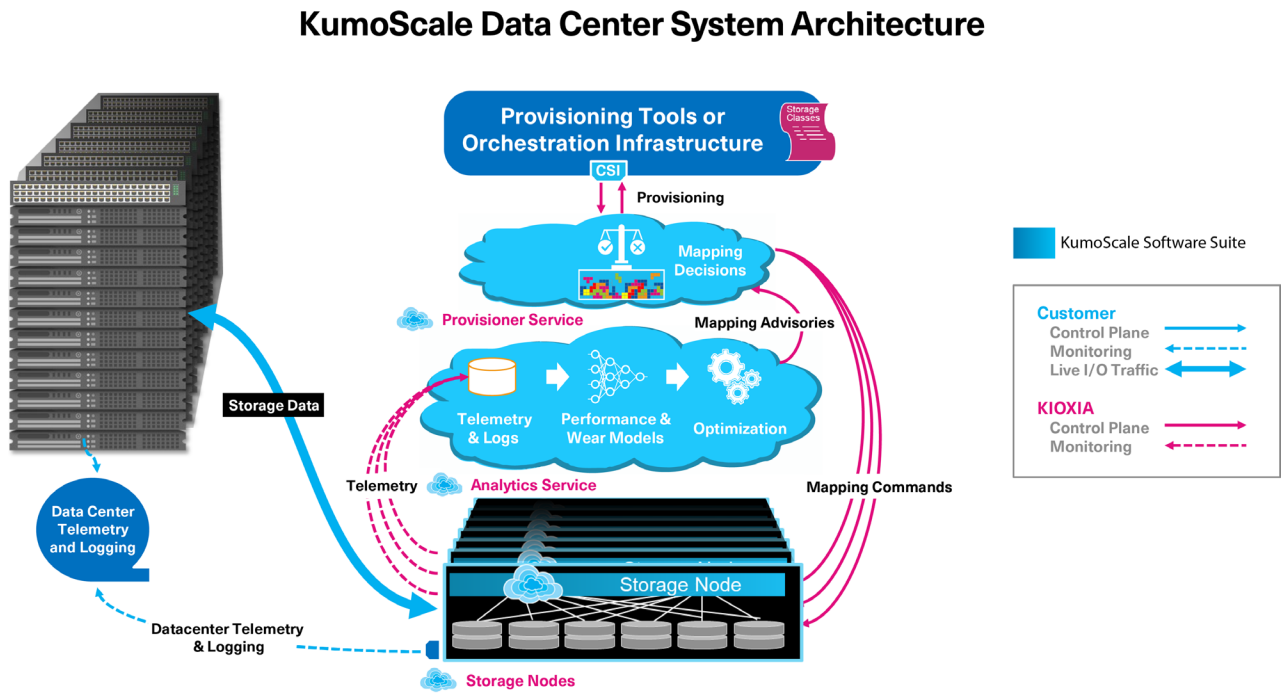

Figure 1: KumoScale software architectural overview

Performance:
In today's data center configuration, two 100 gigabit per second (Gb/s) Ethernet channels can carry roughly 23 Gb/s full duplex in an uncongested network. This is equivalent to 5.7 million, 4 kilobyte (kB) I/Os. A KumoScale storage node is capable of filling this pipe with 4kB random I/Os over a RoCE (RDMA over Converged Ethernet) network, delivering additional read latency of about 15us. This metric is relative to read performance from the same SSD that is attached to the initiator's PCIe® bus, delivering comparable local-attached speed[1].

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Platform Requirements:
KumoScale software supports Kubernetes, bare-metal and virtualized environments, supporting a wide range of industry-standard servers, and works with any compliant NVMe SSD and any compliant NVMe-oF client. Its storage nodes are standard one- or two-socket x86-based or AMD servers, with six to forty-eight NVMe bays, and one or two 100GbE to 200GbE network interface cards (NICs). For NVMe-oF RoCE v2, Linux® OS with kernel 4.9.64 x86 or newer (64-bit) is recommended. For NVMe-oF TCP, Linux OS with kernel 5.x x86 or newer (64-bit) is recommended.

KumoScale Software Features

Thin Provisioning: Allocates storage resources only when they are actually consumed by users

Volume Snapshots and Clones: Supports volume snapshots and clones for read-only or read-write volumes

Advanced Storage Class Specifications: Supports advanced features of the Container Storage Interface (CSI) classes providing the best match between the storage system and an application's requirements

Quality of Service (QoS): Defines storage volumes with QoS enforcement, such as maximum IOPS and bandwidth with desired SLAs

Target Users

Cloud Service Providers

Consumer SaaS Services

Marketplaces/Clearinghouses (travel, tickets, stock trades)

Massive Multi-player Gaming

Volume Self-healing: Repairs inconsistencies that may result from replica failures (reconnection to the target)

Virtual Clusters: Isolates storage resources between different users in a multi-tenant environment where tenants are separated by creating virtual clusters that can be given different resource quotas relating to performance and capacity

Cross Domain Data Replication: Delivers data resilience and workload mobility that follows a specific process when a resilient volume is provisioned

Automated Failure Recovery: Automates recovery from an SSD or storage node failure

Live Volume Migration: Enables the live migration of resilient online storage volumes between different storage nodes

Detailed Analytics: Assigns a storage class specification to each analytical workload profile

Flexible Volume Management: Maximizes storage utilization in how it maps virtual volumes to physical drives

Analytics-driven Mapping: Provisions storage volume requests using analytics that take into account a variety of factors to arrive at an optimal placement decision, including data resilience, topology, capacity, node utilization and SLAs

User-defined Volume Placement Attributes: Enables the physical SSDs that reside in a KumoScale storage node to be tagged by user-defined categories that can be used in volume placement decisions

RESTful API: Includes a RESTful API that can be easily adapted to any common automation framework

Security: Supports Role Based Access Control (RBAC) and NVMe-oF security protocols

Data Center Infrastructures Support:

- **Kubernetes:** CSI is the principal storage API and the CSI driver on each compute node provides connectivity setup and teardown for application pods
- **OpenStack:** OpenStack Brick provides similar functionality to the CSI driver for OpenStack storage, and utilizes the OpenStack Cinder API
- **Bare-metal:** Automation is usually provided by an external automation tool, such as Ansible playbooks, that make it easy to configure hundreds of KumoScale instances simultaneously, provision resilient volumes, manage volume and self-healing, and maintain connections to application servers

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Notes:

[1] Based on published performance specifications from NVMe SSD vendors as of September 2020.

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