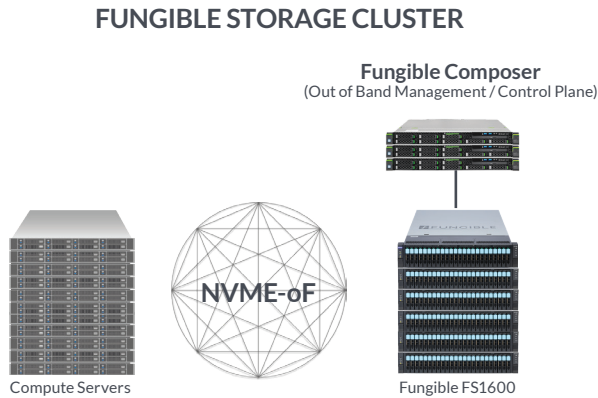# FUNGIBLE COMPOSER

The Fungible Composer is a centralized management solution developed to configure, manage, orchestrate, control and deploy a cluster of disaggregated FS1600 storage nodes. The combined deployment of the Fungible Composer managing the cluster of FS1600 storage nodes is known as the Fungible Storage Cluster (FSC).

## FUNGIBLE STORAGE CLUSTER



**Fungible Composer**
*(Out of Band Management / Control Plane)*

NVME-oF

Compute Servers        Fungible FS1600

The Fungible Composer operates on a control plane that is distinct from the FS1600s' storage data plane. It runs on a 3-node self-contained quorum-based cluster for scalability and high availability. Such separation of control and data plane allows for linear scalability in capacity and performance on FSC.

The Fungible Composer consists of five services; a storage service, a network management service, a telemetry service, a node management service responsible for log collection, and an API gateway that provides external access to the services provided by the Fungible Composer.

## STORAGE SERVICES

The Storage Service is responsible for creating and managing storage volumes and enabling storage data service capabilities along four axes - data durability, data security, data reduction, and QoS or performance isolation.
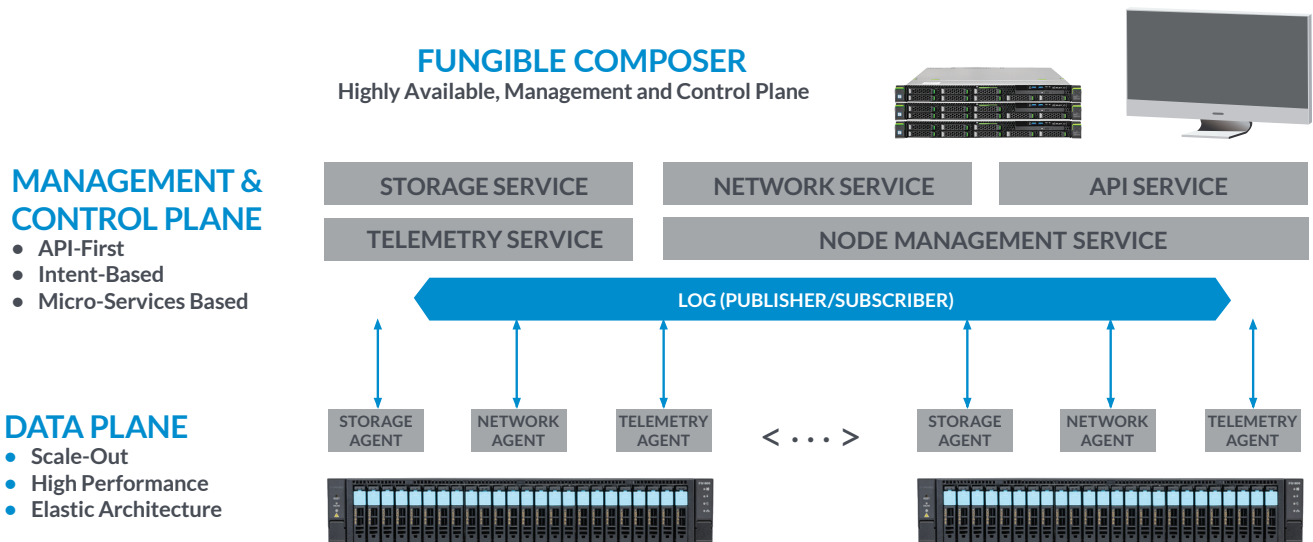
It does so by providing an intent-driven API to configure, monitor and control the storage resources in a cluster of FS1600s. As an example, the intent for a volume creation request describes the required capacity, performance and level of resilience to failures. The Storage Service then manages the allocation of resources in the cluster to match the intent.

The Storage Service supports NVMe as the native access protocol for volumes. Each volume can be mapped as an NVMe namespace for access by a host server. Access control and flexible sharing models are supported. Further, the Storage Service has an integrated NVMe Discovery Service to simplify host configuration.

The intent-driven API also supports configuring data service capabilities on a per-volume basis.

Users can easily select the data durability scheme; from raw volumes with no durability for ephemeral storage, to erasure-coded or replicated volumes with configurable protection to recover from an arbitrary number of failures, all on a per-volume basis.

Data security is provided by seamless volume encryption with per volume encryption keys and support for centralized key management via Key Management Interoperability Protocol (KMIP.)Specifically, each volume can be encrypted at rest using a unique key. Keys are securely retrieved from an external Key Management System (KMS) system using the KMIP.

## FUNGIBLE COMPOSER
**Highly Available, Management and Control Plane**



**MANAGEMENT & CONTROL PLANE**
- API-First
- Intent-Based
- Micro-Services Based

STORAGE SERVICE    NETWORK SERVICE    API SERVICE

TELEMETRY SERVICE    NODE MANAGEMENT SERVICE

LOG (PUBLISHER/SUBSCRIBER)

**DATA PLANE**
- Scale-Out
- High Performance
- Elastic Architecture

STORAGE AGENT   NETWORK AGENT   TELEMETRY AGENT    < ... >    STORAGE AGENT   NETWORK AGENT   TELEMETRY AGENT

For data reduction, the storage service provides a variety of selectable compression algorithms and data deduplication on a per-volume granularity.

Finally, performance isolation can be implemented on a per-volume basis as well, delivering fine-grained Quality of Service support.

Unlike other storage arrays that create siloed combinations of durability, security, data reduction and performance isolation and force data volumes to belong to one of the combinations, the Fungible Storage Cluster truly enables each volume to be independently configured along all four axes. This provides comprehensive customization necessary for multi-tenant data centers.

Scalability is another key aspect of the storage service as the Fungible Storage Cluster is designed to scale to a large number of volumes and storage nodes. The volume topology is safely stored in a scale-out database that can be backed up for disaster recovery.

## NETWORK MANAGEMENT SERVICES

Ease-of-setup is particularly important in the context of a data center scale storage cluster. The Fungible Composer's network service (NS) automatically detects a newly attached FS1600 storage node and uses zero-touch provisioning to add it to an existing Fungible Storage Cluster, making cluster expansion a seamless operation.

## TELEMETRY SERVICE

The Fungible Composer includes a comprehensive telemetry engine that provides fine-grain statistics and customized aggregate measures to gain better insights into the storage data path. The Telemetry Service (TMS) provides a sophisticated data gathering and distribution engine for telemetry data and metrics gathered by the Fungible DPUs.

To access the vast amount of telemetry data coming from the Fungible DPU, the telemetry service operates using a subscription model: once the metric has been subscribed, the data points for that metric are periodically uploaded from the DPUs to the telemetry service, allowing users to query these metrics. For example, in a query, it is possible to specify a time range, a group of metrics (via a pattern match), and a precision level for the data points returned.

The telemetry service supports two kinds of metrics: primitive metrics and derived metrics. Primitive metrics are uploaded from a DPU. Examples of primitive metrics are "DPU usage", "number of bytes transmitted" or "number of writes done". Derived metrics are defined as part of the subscription. It can be an integration of a group of metrics and it can be the outcome of an applied function to the group such as sum, min, max or average. For example, users can ask for the sum of the used data capacities for volumes 1, 3, 15 and 29 because they belong to the same customer.

Data from the telemetry service also monitors the health of the Fungible Storage Cluster as a whole. See section on Scalability and High Availablity.

## NODE MANAGEMENT SERVICE

The Node Management Service (NMS) centralizes the collection of information and management tasks across all Fungible software and hardware components. Log files generated by the FS1600 and the Fungible Composer nodes can be collected in a single operation via the Fungible Composer UI for easy archiving or analysis by Technical Support. When developing custom clients for the API Gateway, additional options including granularity of log collections and software or firmware inventories are also available.

## SCALABILITY & HIGH AVAILABILITY

The Fungible Composer runs on a three-node quorum-based cluster for scalability and high availability. Its core architecture is built on a scalable cloud-native distributed architecture based on stateless microservices, with all state confined to fully replicated databases and messaging services. Internal load balancers are used to steer control plane load across service instances to ensure smooth operation under data center scale load.

The Fungible Composer monitors its own health and the lifecycle of all components under its care including software, servers, storage and network. When failures are detected, the Fungible Composer automatically initiates failure recovery.

Since the Fungible Composer operates on the control plane, storage operations on volumes running on the data plane are not impacted by failures occurring on the Fungible Composer.

## ABOUT FUNGIBLE

Silicon Valley-based Fungible is reimagining the performance, economics, reliability and security of today's data centers.

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