FUNGIBLE STORAGE CLUSTER
TECHNICAL FAQ
Release 1.2
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUNGIBLE STORAGE CLUSTER OVERVIEW</td>
<td>3</td>
</tr>
<tr>
<td>FUNGIBLE STORAGE CLUSTER COMPONENTS OVERVIEW</td>
<td>3</td>
</tr>
<tr>
<td>FUNGIBLE FS1600 STORAGE NODE</td>
<td>3</td>
</tr>
<tr>
<td>FUNGIBLE COMPOSER</td>
<td>3</td>
</tr>
<tr>
<td>FUNGIBLE STORAGE CLUSTER NETWORKING</td>
<td>4</td>
</tr>
<tr>
<td>FUNGIBLE STORAGE CLUSTER SOFTWARE AND STORAGE SERVICES</td>
<td>4</td>
</tr>
<tr>
<td>FUNGIBLE STORAGE CLUSTER PERFORMANCE</td>
<td>4</td>
</tr>
<tr>
<td>FUNGIBLE STORAGE CLUSTER COMPATIBILITY MATRIX</td>
<td>5</td>
</tr>
<tr>
<td>FUNGIBLE STORAGE CLUSTER FAILURE SCENARIOS</td>
<td>5</td>
</tr>
</tbody>
</table>
**FUNGIBLE STORAGE CLUSTER OVERVIEW**

1. **What is a Fungible Storage Cluster?**
   
The Fungible Storage Cluster (FSC) is the world’s fastest All-Flash NVMe-oF disaggregated storage cluster. Designed to overcome every legacy limitation and address the most demanding requirements of modern applications, the FSC delivers best-in-class performance characteristics for IOPS, latency, and throughput, in the smallest footprint and lowest power envelope.

   The FSC comprises a cluster of two or more Fungible FS1600 storage target nodes and three Fungible Composer nodes.

**FUNGIBLE STORAGE CLUSTER COMPONENTS OVERVIEW**

There are two principal components of the FSC:

**FUNGIBLE FS1600 STORAGE NODE**

1. **What is Fungible FS1600 Storage Node?**
   
   It is a high performance, secure scale-out, storage array, delivering 15M IOPS, 60GB/s throughput, 110μs of latency, 184 TB of raw, in a 2RU box.

2. **What are the physical dimensions of an FS1600?**
   
   H x W x D: 3.5” (88 mm) x 17.4” (440 mm) x 30.6” (776 mm)

3. **What is the weight of an FS1600?**
   
   43.4 lb (20 Kg) without SSDs

4. **What are the rack mounting dimensions for an FS1600?**
   
   FS1600 is 2U form factor, and fits in a standard 19-inchwide and 24-inch-deep rack.

5. **How many Fungible DPU embeded in an Fungible FS1600?**
   
   2 per FS1600

6. **How many power supplies are present in each Fungible FS1600?**
   
   2 PSU active active configuration. FS1600 can function with 1 PSU.

7. **How many fans are present in an FS1600?**
   
   5

8. **What type of SSDs are supported by FS1600?**
   
   FS1600 supports 24 U.2 NVMe solid-state drives.

9. **Does FS1600 support hot-pluggable SSDs?**
   
   Yes

10. **What are the SSD configurations supported by FS1600?**

    FS1600 supports 6, 12, 18, and 24 SSD configurations.

11. **Do FS1600 support Gen4 SSDs?**

    FS1600 was designed to support Gen4 SSDs. Engineering is working on qualifying Gen4 SSDs.

12. **What is the maximum power consumption of an FS1600?**

    Typical: 750W

    Peak: 850W

13. **Are there any x86 processors in FS1600?**

    No there are no x86 or CPU’s processors in FS1600.

**FUNGIBLE COMPOSER**

1. **How many nodes does the Fungible Composer have?**

   The Fungible Composer consists of three Fungible Composer nodes and provides a highly available management network for the Fungible Storage Cluster.

2. **What functionalities does the Fungible Composer consists of?**

   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.

3. **What are the services supported by the Fungible Composer?**

   The Fungible Composer comprises the following services:

   - User interface (UI): Web-based UI for managing the cluster of FS1600s
   - Storage services: Includes volume creation and configuration and data services
   - Network configuration: Includes Zero Touch Provisioning (ZTP) and setting network configuration options for the data network
   - Telemetry service: Includes monitoring metrics from FS1600 nodes and allows external clients to obtain these metrics
   - Fungible Storage Cluster management services: Includes system hardware inventory, system health status monitoring, power control, and system logs
   - NVMe discovery service: Implements the NVMe discovery controller and enables multipath IO through Asynchronous Namespace Access (ANA)
   - API gateway service: Fungible REST API to manage, control, and monitor the DPUs. These REST APIs can be integrated into standard or third-party orchestration systems such as Kubernetes CSI plugins, OpenStack, OpenShift, etc.
4. What are the dimensions of the composer node?
   H x W x D: 1.7” (43 mm) x 17.2” (437 mm) x 28.5” (724 mm)

5. What is the weight of the Fungible Composer node?
   Net: 26 lb (11.8 kg) / gross: 41 lb (18.6 kg)

6. How much power is consumed by the Fungible Composer node?
   700 W (peak)

7. How many RU’s is a Fungible Composer node?
   1 RU

8. What are the network ports in the Fungible Composer node?
   4 x 1 G (4 x RJ-45 GbE ports), 2 x 10/25G NIC

9. How many Fungible Composer nodes are required in the FSC?
   For HA, 3 nodes are required.

10. What are the operating and non-operating temperatures and humidity?

    |                      |                          |
    |----------------------|--------------------------|
    | Operating temperature| 50°F – 95°F (10°C – 35°C) |
    | Nonoperating temperature| −40°F – 158°F (−40°C – 70°C) |
    | Operating relative humidity| 8% – 90% (non condensing) |
    | Non-operating relative humidity| 5% – 95% (non condensing) |

FUNGIBLE STORAGE CLUSTER NETWORKING

1. How many 100Gbps ports are present in an FS1600?
   Usable 6ports/DPU, 12 in total in a 2 RU.

2. What are the networking requirements for FS1600?
   100G ports on the switch
   LACP or bonded ports for more than 1 ports from each controller

3. What kind of optics are supported?

    | LENGTH | Mfg. Part Number |
    |--------|------------------|
    | MOLEX  | AMPHENOL         | FS    |
    | 1M     | 1002971101        | NDAAFG-0001 | Q28-PC01 |
    | 2M     | 1002971201        | NDAAFG-0002 | Q28-PC02 |
    | 3M     | 1002971301        | NDAAFG-0003 | Q28-PC03 |

4. What is the speed of the management interface for FS1600?
   It can be configured in either 1G or 10G. By default, its set to 1GbE.

FUNGIBLE STORAGE CLUSTER SOFTWARE AND STORAGE SERVICES

1. Which storage access protocols are supported by FSC?
   **Current:** Block

2. What are the storage services offered by FSC?
   a) Compression with Durable Volumes
   b) Encryption for RAW and Durable Volumes
   c) Erasure Coding across the network
   d) Volumes with replication factor = 2

3. Which protocols are supported by FSC?
   NVMe over TCP
   Roadmap: NVMe over RoCEv2, NVME over TrueFabric™

4. What are the types of volumes supported by FSC?
   a) RAW
   b) Durable with replication factor = 2
   c) Erasure Coded (NETWORK PROTECTED across SSDs across 6 storage nodes)

5. Do customers need to install or make any changes to the OS to mount volumes from FS1600?
   Customers need to upgrade their OS (Refer to Compatibility matrix) to Linux 5.x kernel, which has the industry standard NVMe drivers. No other changes are required on the host side. Standard NVMe drivers can be used to the volumes on FS1600.

6. What are the available options for configuration and management for FS1600?
   GUI, CLI, and API

7. What are the methods used for volume creation in FS1600?
   GUI, CLI, API, and CSI-plugin

8. How many volumes are supported for FS1600?
   RAW: 2024/FS1600
   DURABLE: 128/FS1600, ROADMAP: 1024/FS1600

9. How many hosts are supported by a single FS1600?
   256/FS1600

10. What is the minimum and maximum size of the volume supported by FSC?

    | Raw Volume Capacity (Min, Max) | 1GB, 4TB |
    | Durable EC Volume Capacity (Min, Max) | 1GB, 2TB |

FUNGIBLE STORAGE CLUSTER PERFORMANCE

1. What is the maximum read and write IOPS?

    | NODE              | READ IOPS (M) | WRITE IOPS (M) |
    |-------------------|---------------|----------------|
    | 1 Node-RAW Volumes| 15            | 3              |
    | 7 Nodes-RAW Volumes| 105          | 21             |
    | 6 Nodes-Durable (EC 4+2) | 19.2  | 6.6           |

2. What is the maximum read and write throughput?

    | NODE              | READ (GB/S) | WRITE (GB/S) |
    |-------------------|-------------|--------------|
    | 1 Node-RAW Volumes| 60          | 12           |
    | 7 Nodes-RAW Volumes| 420         | 84           |
FUNGIBLE STORAGE CLUSTER COMPATIBILITY MATRIX

1. Which version of NVMe are FSC compatible with? NVMe 1.4
2. Which host OS does FS1600 support?

<table>
<thead>
<tr>
<th>OS</th>
<th>FS1600</th>
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</thead>
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<tr>
<td>RHEL 7.x with 5.x kernel to support NVMe-oF</td>
<td>✓</td>
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<tr>
<td>CentOS 7.x with 5.x kernel to support NVMe-oF</td>
<td>✓</td>
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<tr>
<td>Ubuntu 14.04 with 5.x kernel to support NVMe-oF</td>
<td>✓</td>
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<tr>
<td>Ubuntu 16.04 with 5.x kernel to support NVMe-oF</td>
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<tr>
<td>Ubuntu 18.04 with 5.x kernel to support NVMe-oF</td>
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<tr>
<td>Ubuntu 19.04 with 5.x kernel to support NVMe-oF</td>
<td>✓</td>
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FUNGIBLE STORAGE CLUSTER FAILURE SCENARIOS

1. How much network utilization do you expect to be consumed by the rebuild in case of drive failures with Erasure Coded volumes? When the rebuild is done at high priority, rebuild takes about 10 minutes per TB to rebuild and has a very low impact in performance to the running workloads. With FSC, rebuilding happens in parallel and involves many FS1600s. So, each volume on the failed SSD can have a different set of plex’s or FS1600s that are used to drive the rebuild operation, which means they may not even be hitting the same TORs or networks. The larger the cluster, the less the network impact due to parallelism.

2. Can you replicate or do network EC across sites? Yes, this can be done, however, write performance will be a function of the bandwidth available between the sites. We also have some additional patented techniques to avoid performance degradation for remote replication or EC coming in the future in our roadmap. Async remote replication using our snapshots capability is another feature we plan to have.

ABOUT FUNGIBLE

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

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