



# FUNGIBLE DATA CENTER TECHNICAL FAQ

Release 2.0



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## FUNGIBLE DATA CENTER OVERVIEW

### 1. What is a Fungible Data Center (FDC)?

The Fungible Data Center is an on-premises, comprehensive, turn-key solution offering multi-tenant and secure data centers, delivering bare-metal performance at the cost efficiencies and simplicity of hyperscale data centers.

It comprises pre-configured racks of disaggregated compute and storage servers powered by the Fungible DPU™, managed by the Fungible Data Center Composer (DCC) software.

### 2. How does the FDC transform data centers from rigid, complex, and expensive silos to simple, highly efficient, and on-demand powerhouses?

The FDC transforms data centers by enabling a hyperdisaggregated composable infrastructure, first by disaggregating compute (CPU, GPU, other accelerators) and storage resources and then composing the exact infrastructure needed for specific workloads in just a few minutes. The FDC also enables bare-metal performance, i.e. no performance degradation caused by software virtualization overhead, while fully utilizing all the available resources and preserving security postures across tenants.

### 3. How does FDC help Data Center admins?

Data Center admins have historically expended massive capital to acquire different compute and storage resources to handle each workload's peak requirements under deployment individually. FDC enables data center admins to reduce the number of such resource types by leveraging the statistical multiplexing benefits of disaggregated pooling and dynamically rebalancing resource usage. Data center administrators can now enjoy virtualization-like flexibility, manageability, elasticity in bare metal and at unlimited scale while enjoying between bare-metal performance levels.

### 4. How are the fluid resources managed and composed into bare-metal servers FDC?

The Fungible Data Center Composer (DCC) – a software solution stack developed by Fungible–, manages all the features and functionalities.

### 5. What is the Fungible Data Center Composer?

The Fungible Data Center Composer (DCC) is a comprehensive software solution that supports bare-metal data center composition, provisioning, management, and orchestration. It is a fully web-based, single-pane-of-glass management software that manages the entire Fungible Data Center environment. It is designed with simplicity in mind to handle discovery, initialization, registration, and decommissioning of hardware resources, identity management, monitoring of telemetry data, management of failures, firmware updates, and many other functions.

### 6. What levels of administrative controls are present in FDC?

There are two levels of administrative controls for FDC users:

- Data Center Administrator (DCA) – a role that manages the overall Fungible Data Center.
- Logical Partition Administrator (LPA) – a role that supports the tenant to which the partition is allocated. The LPA uses the resources allocated by the DCA to compose bare-metal servers based on the requirements of application workloads. The LPA is also responsible for deploying these application workloads within the Logical Partition.

### 7. How do I deploy a bare-metal server in the FDC platform?

Once your account is created and authorized with resources, you are ready to create your bare-metal servers. You use the DCC UI or use API calls to indicate how many compute

resources and the amount/type of storage you wish to launch. You can specify the required operating system for the workload. The OS can be installed as part of the bare-metal composition.

### 8. What happens when FDC composes a bare-metal server or instance?

- The DCC selects a general-purpose diskless and NIC-less server that matches the compute specifications of that profile.
- The DCC composes disks and NICs per the storage and network specifications of that profile.
- The DCC then powers on the server (if it is not already powered on) and, when it comes to selecting a boot device, provides the disks and NICs by attaching them to the general-purpose server to create bare-metal instance.

### 9. Can customers disconnect servers from a composed storage and network and reconnect to the same storage and network?

FDC supports disconnecting or detaching first by shutting down the composed instance and then disconnecting the general-purpose server while preserving its entire state i.e., the state of the disks, the NICs, including their MAC and IP addresses. This detached instance state is known as a “staged” instance.

To bring this staged instance back to life, customers can use DCC to attach this to another or the same general-purpose diskless and NIC-less server.

### 10. Can I create my workload template and host it in the marketplace?

The FDC offers a hierarchical marketplace of application templates. The FDC supports an application template marketplace managed by the Data Center Administrator. Templates in this marketplace are available to all tenants of the Data Center. Each Logical Partition (a tenant of the data center) has its own unique application marketplace. Templates in an LP marketplace are available to administrators of that LP only. An LPA can create a template and promote it to the DCA. If the DCA approves that promotion, that template is copied to the DCA's marketplace.

### 11. What kind of performance can I expect from FDC storage?

Performance testing is underway. The results will be updated soon.

### 12. What are the maximum compute, storage, or network components to which FDC can be scaled?

FDC is enabled by the Fungible DPU, which offers linear scalability at hyperscale. The scalability numbers will be added in the future release.

### 13. Does FDC come with a software developer kit (SDK)?

The Fungible Data Center provides a comprehensive REST API, documented in OpenAPI (e.g., Swagger) format. This makes it straightforward for customers to generate API clients in their choice of framework or language.

### 14. What applications are best suited to be run on FDC and why?

The FDC can host most generic Linux applications. See supported OSes for more details. However, the applications that will benefit most from the FDC architecture are data-intensive, cloud-native, scale-out applications that leverage distributed microservices.

### 15. How can I get started with FDC?

To sign up for a demo and to get hands-on experience, please contact [sales@fungible.com](mailto:sales@fungible.com).

## FUNGIBLE DATA CENTER COMPONENTS

FDC is comprised of the following:

### FUNGIBLE FS1600 STORAGE NODES

#### 1. What is the FS1600?

It is a high-performance, secure scale-out storage array, delivering 15M IOPS, 60GB/s throughput, 110µs of latency, 184 TB of raw capacity in a 2RU box.



Refer to the FSC Technical FAQ for more details.

#### 2. What type of volumes are supported with the FDC?

Current: RAW

Roadmap: Erasure Code (4+2, 8+2), RAW with Replication

#### 3. What are the differences between servers with direct attached storage (DAS) and the storage solution in FDC?

- The hardware configuration of a server with DAS, once procured, is immutable for all practical purposes. Changing the configuration of the disks (e.g., capacity) is not easy and rarely done.
- The DAS disks are raw and do not come with any storage services, such as replication, compression, or snapshots. The services need to be enabled by 3rd party software and require CPU cycles which can cause performance issues.
- In the FDC, a server can be provided with local disks of arbitrary geometries as and when they are needed. They can be modified, detached, or reattached on the fly.
- In the FDC, the compute server's disks come with a comprehensive set of storage services, such as compression and protection, all offered by the Fungible DPU, so the software on the x86 is not burdened with these intensive operations.
- The FDC provides flexibility, performance, and higher utilization compared to DAS.

## COMPUTE SERVERS POWERED BY FUNGIBLE DATA SERVICES PLATFORM

#### 1. Can we use our own compute servers?

Yes, you can use your own servers as long as they are in the pre-qualified list of supported FDC servers.

#### 2. Which compute servers have you qualified as part of the FDC solution?

Below is the list of servers on our qualification list.

Pre-qualified servers:

- SM X11 SYS 1029U TR4, SM X11 SYS 6019U TR4

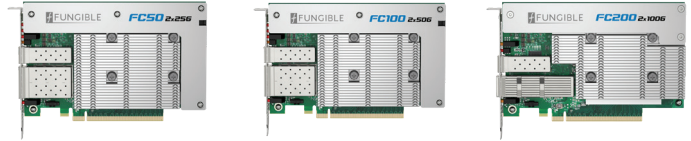
Roadmap:

- Dell R440, Dell R640

#### 3. Is there any form of storage in the compute server? What about boot drives?

The compute servers are diskless, i.e. they do not have any drives inside them. All compute servers boot using a boot volume composed and served from the FS1600 storage platform.

#### 4. How are the storage and networking functions enabled in the compute server?



The Fungible Data Services Platform (DSP) dual ported PCIe cards, namely the FC50, FC100, and FC200, enable the storage, networking, and security functions. The full height, half-length PCIe cards are powered by the Fungible S1 DPU.

#### 5. What are the Ethernet speeds of the different FC cards?

FC50 supports 2\*25 GbE. FC100 supports 2\*50GbE, FC200 supports 2\*100GbE for data traffic.

#### 6. What features are offered by FC50?

Features include:

- Storage Initiator
  - Remote boot of the host
- High-performance bare-metal NIC with multiple accelerators:
  - NVMe/TCP Storage Initiator offload
  - IP/TCP/UDP inner and outer checksum offload
  - LSO/TSO offload
  - Receive Side Steering (RSS)
  - VXLAN Encapsulation/Decapsulation
- Security Accelerators:
  - Lookaside Crypto (PF)

## FUNGIBLE DATA CENTER COMPOSER (DCC)

#### 1. What functions are performed by the DCC?

The functions performed by DCC include:

- Bare-Metal Composition for Right-Sized, On-Demand Data Centers
  - Composition without requiring virtualization software or a hypervisor.
  - Load balancing of resource allocations to address inevitable hot spots in data centers.
- Effortless Workload Provisioning for Seamless and Rapid Deployment
  - One-click deployment of complex, scale-out workloads via pre-configured templates from an application marketplace.
- Simplified and Secure Management
  - Multi-Tenancy and Customer Isolation

A Data Center admin can create completely isolated partitions to support a multi-tenant environment. Security and access control are achieved through role-based access. The role-based access system supports two roles with independent management and authentication planes: One for data center administrators and one for each tenant, i.e., logical partition administrators.

- **Identity Management**  
A Data Center admin can create customizable integration with existing or new Active Directory, LDAP, and other standard Identity Providers.
- **Hardware Lifecycle Management and Monitoring**  
The FDC offers complete hardware lifecycle management (Fungible FS1600s storage nodes, the Fungible Data Services Platform PCIe cards and servers) and monitoring capabilities (health status, telemetry data, failure data, and other exception issues in the hardware assets).
- **Environment Deployment and Integration with Industry-Standard Orchestration Tools**  
The DCC is built on a cloud-native design, leveraging an API-first approach and supports APIs for the entire infrastructure, allowing deep application integration and automation opportunities for infrastructure management.  
  
LPAs can create environments from scratch or instantiate environments from existing templates. In either case, LPAs can deploy environments using industry-leading orchestration automation technologies, such as Ansible and Terraform. The First-boot configuration is managed via Cloud-init.
- **Flexible Networking Control**  
The DCC also enables easy integration with existing networks via a built-in network controller or a customer's existing network controller. The FDC provides a complete set of networking capabilities to manage a data center via a built-in network controller that operates in conjunction with data center Virtual Routing & Forwarding (VRFs).

## TOP-OF-THE RACK SWITCHES

### 1. Can customers use their own switch?

Yes, you can use your own switch as long as it is in the pre-qualified list of supported FDC switches.

### 2. Which ToRs have been qualified as part of FDC?

Below is the list of qualified networking interconnects

- BMC & Management TORs
  - Juniper QFX-5110-48S
- Data TOR
  - Juniper QFX - QFX5210-64C
  - Juniper QFX - QFX5200-32C (will be used for PoCs)
- Gateway / Egress
  - Juniper MX 204 supporting BGP-EVPN
  - Junos OS version 18.4

## FUNGIBLE DATA CENTER NETWORKING

### 1. How are the networking capabilities managed in the Fungible Data Center?

The FDC provides a full set of networking capabilities to manage a data center via a built-in network controller that operates in conjunction with data center Virtual Routing & Forwarding (VRFs).

### 2. What kind of networks can be deployed in FDC?

Current: Virtual network  
Roadmap: Physical or passthrough mode

### 3. What are virtual networks?

Virtual networks in the FDC are overlay networks created and managed by the Fungible network controller. Virtual networks

are created for segmenting tenant or workload traffic according to business requirements and policies. They are built on top of underlay data networks.

### 4. Can I use my existing network controller with FDC?

You can use an existing network controller by enabling Passthrough Network Mode in the deployment.

### 5. How is my existing network managed in the Passthrough Network Mode?

You can create a single passthrough network, which can then be managed via your own network controller.

## FUNGIBLE DATA CENTER SOLUTION

### 1. Can you describe if and how the FDC is compatible with containerized environments? Will FDC only serve bare-metal environments?

FDC composes bare-metal servers. This composition is at the hardware level without any changes to the operating system or x86 processors running on the compute nodes or the applications running on the bare-metal servers. The FDC is focused on bare-metal and modern platforms and environments such as containers.

### 2. Which data center components can be composed as part of the bare-metal servers?

Servers can be composed with the following resources: storage volumes and networks. In the future, GPUs will be added as resources. All resources need to be enabled by the Fungible DPU.

### 3. How is security handled by FDC?

Security is multi-dimensional. It involves compute, storage, and network security. FDC is built on Fungible DPUs which have in-built security features securing all dimensions without imposing any CPU processing tax. First, FDC requires admin input of hardware serial numbers, passwords, and security certifications before initializing and managing both **compute and storage devices**.

**Compute:** Each compute device is enabled by the Fungible Data Service Platform family of PCIe cards that implement security holistically.

- As an NVMe Storage Initiator, it encrypts data in-flight with AES-GCM/XTS cryptographic algorithm.
- The various hardware accelerators present in the DPU support multiple security levels starting with hardware root-of-trust and secure boot process. (RegEx engine for Deep Packet Inspection and data analytics, cryptographic, and hashing engines to secure and compress packets to/from the compute and the applications running standards-based security protocols for various cloud, edge, and telco/SP use cases.)

**Storage:** Each FS1600 node implements 256bit AES-GCM/XTS cryptographic algorithms, the best available, at a sustained throughput of 250 GB/s. It supports per volume encryption, and data is encrypted in-flight and at rest to protect within-system and cross-system data traffic, with no impact to performance. FS1600 also has a secure enclave and a physically unclonable function (PUF).

**Network:** The FDC provides robust micro-segmentation using overlay networks. The Data Center Administrator can segment an entire logical partition or tenant behind a VRF or overlay network. The logical partition administrator can isolate one or more application workloads behind overlay networks.

### 4. How is the FDC set up to handle inter-node communication?

The FDC is powered by the Fungible DPU, which enables a highly efficient hyperdisaggregated solution. This is made possible by having a DPU in every compute and storage node.

- The compute node is powered by the Fungible S1 DPU based Data Services Platform (DSP) card offloading the storage and networking functions from the x86 processor.
- The FS1600 storage node is powered by the Fungible F1 DPU, providing a high-performance, secure, scale-out NVMe-oF storage node.
- The network across every compute, and storage node is powered by TrueFabric™ which is the industry's first focused attempt to deliver a single, unified network technology based on open standards that has all of the properties needed to build high performance, economical, reliable, and secure data centers across a wide range of scales.

**5. Why did Fungible choose to debut with Ethernet as the physical interface in the data center vs. FC or IB?**

Ethernet was chosen for seamless ease-of-insertion. With Ethernet, there is no need for proprietary interconnects like FC or IB.

**6. Why did Fungible choose TCP as the Fabric in NVMe-over-Fabric?**

Fungible provides a high-performance TCP network based on industry standards. We also support Fabric Control Protocol

(TrueFabric) as it provides the ultimate performance with predictable low latency at the data center scale.

**7. Does FDC support GPU disaggregation?**

Yes. We will add the support in future releases.

**8. How is the composer software protected against failures?**

The Fungible Data Center Composer has built-in HA capability.

**9. Does FDC support integration with VMware?**

Not at this moment.

**10. Which operating system environments are supported?**

The following Linux distributions, releases, and kernel versions supported:

VENDOR	RELEASE	KERNEL
Ubuntu	20.04.1 LTS	5.4.0.59.62
	18.04.5 LTS	4.15.0-136
Red Hat / CentOS	8.3	4.18.0-240.11

**11. What are the different configuration options of FDC?**

	Compute.tiny	Compute.medium	Compute.large	Compute.xlarge
Storage.tiny	<ul style="list-style-type: none"> <li>• (2) FS1600, 92TB</li> <li>• (4) Compute Nodes, 2*8x3.1Ghz, 256GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (2) FS1600, 92TB</li> <li>• (8) Compute Nodes, 2*8x3.1Ghz, 512GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (2) FS1600, 92TB</li> <li>• (32) Compute Nodes, 2*12x2.1Ghz, 512GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (2) FS1600, 92TB</li> <li>• (32) Compute Nodes, 2*20x2.1Ghz, 1.5TB RAM</li> <li>• Fungible DCC nodes</li> </ul>
Storage.small	<ul style="list-style-type: none"> <li>• (2) FS1600, 92TB</li> <li>• (4) Compute Nodes, 2*8x3.1Ghz, 256GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (2) FS1600, 92TB</li> <li>• (8) Compute Nodes, 2*8x3.1Ghz, 512GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (2) FS1600, 92TB</li> <li>• (32) Compute Nodes, 2*12x2.1Ghz, 512GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (2) FS1600, 92TB</li> <li>• (32) Compute Nodes, 2*20x2.1Ghz, 1.5TB RAM</li> <li>• Fungible DCC nodes</li> </ul>
Storage.medium	<ul style="list-style-type: none"> <li>• (3) FS1600, 138TB</li> <li>• (4) Compute Nodes, 2*8x3.1Ghz, 256GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (3) FS1600, 138TB</li> <li>• (8) Compute Nodes, 2*8x3.1Ghz, 512GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (3) FS1600, 138TB</li> <li>• (32) Compute Nodes, 2*12x2.1Ghz, 512GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (3) FS1600, 138TB</li> <li>• (32) Compute Nodes, 2*20x2.1Ghz, 1.5TB RAM</li> <li>• Fungible DCC nodes</li> </ul>
Storage.large.perf	<ul style="list-style-type: none"> <li>• (7) FS1600, 323TB</li> <li>• (4) Compute Nodes, 2*8x3.1Ghz, 256GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (7) FS1600, 323TB</li> <li>• (8) Compute Nodes, 2*8x3.1Ghz, 512GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (7) FS1600, 323TB</li> <li>• (32) Compute Nodes, 2*12x2.1Ghz, 512GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (7) FS1600, 323TB</li> <li>• (32) Compute Nodes, 2*20x2.1Ghz, 1.5TB RAM</li> <li>• Fungible DCC nodes</li> </ul>
Storage.large.density	<ul style="list-style-type: none"> <li>• (7) FS1600, 1290TB</li> <li>• (4) Compute Nodes, 2*8x3.1Ghz, 256GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (7) FS1600, 1290TB</li> <li>• (8) Compute Nodes, 2*8x3.1Ghz, 512GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (7) FS1600, 1290TB</li> <li>• (32) Compute Nodes, 2*12x2.1Ghz, 512GB RAM</li> <li>• Fungible DCC nodes</li> </ul>	<ul style="list-style-type: none"> <li>• (7) FS1600, 1290TB</li> <li>• (32) Compute Nodes, 2*20x2.1Ghz, 1.5TB RAM</li> <li>• Fungible DCC nodes</li> </ul>

Note: The capacity listed is RAW capacity

**12. What can customers do if they run out of compute or storage resources?**

You can procure more compute resources by speaking to your Fungible or partner account manager. Unlike other solutions, customers are not bound by the need to procure storage as you expand your compute. Likewise, the same applies if you run out of storage.

**FUNGIBLE DATA CENTER DEPLOYMENT****1. Does our current IT team require special training to deploy and manage FDC?**

The FDC is straightforward to deploy and manage. We have a clear, simple, and intuitive management software UI that automates, orchestrates, and composes physical computer systems from pools of bare-metal resources and manages the entire infrastructure.

**2. Do customers have access to a marketplace for workload templates for composition and deployment?**

As part of the FDC, customers will have access to pre-built templates for bare-metal composition and workload provisioning.

**3. How quickly does it take for the FDC to compose a server and have it running?**

FDC can compose servers very quickly. Booting an existing instance is primarily bounded by the amount of time it takes for the server to power on and initialize. On the fastest servers, this can be accomplished in under a minute. For other server models, it can take 3-5 minutes.

The creation of a new instance is constrained by several factors: creation of volumes, creation of BMV NICs, server power on initialization time, and the time required to do any disk imaging. Volume and NIC creation occur in seconds. Because the Fungible DPU is so fast and efficient, disk imaging also occurs very quickly. But, depending on the disk's size to be imaged, this can still take several minutes. Once imaged, boot time is constrained by the initialization time of the server.

**4. How quickly can customers scale the capacity up and down?**

When recomposing a server, FDC first powers down the machine. This can take several minutes, depending on the host. Next, FDC reassociates the server from the old instance to the new instance, which is nearly instantaneous. Next, FDC boots the new instance, which is constrained by the same time as noted in question 3.

**ABOUT FUNGIBLE**

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

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