QxStor Cloudian Edition - HyperStore®

White paper on reference architecture

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Executive Summary

The current whitepaper describes an important reference architecture for Cloudian HyperStore®. Powered by advanced technology, Quanta Cloud Technology (QCT) integrates Cloudian HyperStore software into appliance products, offering global customers the business and operational advantages of cloud-scale, software-defined object storage with full AWS and S3-cloud compatibility.

With the popularity of rich media, the proliferation of mobile devices and the digitization of content, there has been an exponential growth in the amount of unstructured data that IT is managing—and this growth is not slowing but instead accelerating. This unprecedented growth in unstructured content is simply not sustainable for current NAS/SAN infrastructures.

Finding the best storage solutions continue to be one of the key growing pain points for enterprises. Backups and restores are taking longer. Migrations from older storage systems to new storage systems are labor intensive. Provisioning storage for users is more frequent and time consuming, and the list goes on and on.

Software-defined object storage offers an alternative approach to NAS/SAN systems. It gives enterprises the ability to leverage the latest advancements in cost-effective commodity CPU and storage technology. Cloudian HyperStore is a scale-out object storage system designed to manage massive amounts of data. It is an SDS platform which runs on any standard Linux servers – this dramatically reduces the cost for datacenter storage while still providing extreme availability and reliability.

QxStor Cloudian Edition-HyperStore® is a key solution providing a unique 100% S3 compliant multi-device cloud storage platform with which any level of SLA can be met at the right cost with dynamic migrations from one storage tier to another.

QxStor Cloudian Edition-HyperStore delivers a fully Amazon S3 API compliant, multi-tenant, and multi-datacenter hybrid cloud storage solution. HyperStore provides administrators with the ability to deploy data in different data centers or geographically separated regions. HyperStore also connects different clouds with the ability to tier data to Amazon S3, Amazon Glacier, or another HyperStore deployment. As a multi-tenant solution, HyperStore includes necessary features such as multi-currency rating plans, billing, quality of service controls and billing via GUI or RESTful APIs that enables tight integration with user's provisioning, authentication and billing systems.

For cloud service providers, this solution is suitable for deploying public clouds as well as managed private clouds; for enterprises, it is suitable for implementing private and/or hybrid clouds.

Specifically, the solution provides with a broad range of applications and is relevant for backup, device synchronization, collaboration, archiving, CDN storage, and low cost secondary tier storage in a scale out environment. For secondary storage subsystem, it also allows templates and snapshots to be accessed across availability zones, significantly improving the overall reliability of the cloud computing environment. In addition, enterprises can now run in-place Hadoop analytics, enable customers to derive meaningful business intelligence from their data efficiently and economically.

QCT and Cloudian continue to collaborate to develop industry-leading solutions to address today's explosive data growth, suitable for dynamic enterprise workloads where scalability, availability, performance, manageability, and operational efficiency are key priorities.

I. Use Cases

The current QxStor Cloudian Edition-HyperStore solution provides a broad range of applications for the following use cases:

Backup and archival for big data: As the amount of data has increased dramatically, backup windows have shrunk. QxStor Cloudian Edition-HyperStore addresses the challenges associated with big data backup for enterprises and managed solution providers.

Smart data analytics: QxStor Cloudian Edition-HyperStore is at the forefront of smart data with efficient, scalable storage. Enterprises can now run Hadoop analytics directly on our appliance.

Remote office backup: Enterprises want to enhance sharing across these remote locations, protect and secure the business data, and do this with central IT administration and control.

Enterprise file synchronization and sharing: Traditional NAS/SAN infrastructures do not support mobile devices well and do not support the distributed nature of the content. With QxStor Cloudian Edition-HyperStore, enterprises can store and access user files from any location and any device of their choice.

Private and hybrid cloud storage: Organizations are implementing Storage as a service with S3 Private Clouds, and IaaS clouds based on Cloud Platforms like CloudStack and OpenStack. QxStor Cloudian Edition-HyperStore provides the trusted, scalable storage platform to power these Private Clouds and the 100 percent S3-compliant hybrid cloud storage platform that enables IT to achieve any level of SLA at the right cost.

Service provider or Storage-as-a-Service: Traditional NAS/SAN infrastructures are better suited for small enterprise deployments and do not properly scale to handle large cloud deployments. QxStor Cloudian Edition-HyperStore includes necessary features such as multi-tenancy, multi-currency rating plans, billing QoS metrics and enforcement, as well as an API that allows service providers to integrate Cloudian into their own portals.

II. Key Features, Functions, and Benefits

Feature	Function	Benefit
1. 100% S3 API compatibility	Support all S3 applications and all S3 API calls	Continue to use Amazon's S3 SDK without any changes to S3 APIs in development.
2. Scale-out	Peer-to-peer cloud storage platform with granular storage policy management	Scale to thousands of nodes and billions of objects in a bucket.
3. Multi-tenancy	Support multiple tenants on a single shared storage infrastructure	Multiple users and applications can use and share a single scale-out storage infrastructure, with Role Based Access Control.
4. Self service	Self-service portal	Users can select and provision storage services on demand from a service catalog.
5. Quality of Service (QoS)	Dynamically set usage rate limits	Use QoS to control usage rate limits for each group or on a per user basis.
6. Quotas	Dynamically set quota limits	Dynamically control storage quotas for each group or on a per user basis.
7. Data protection	Supports Replication and Erasure Coding	Easily create logical storage policies for groups or users with either replication or erasure coding storage policies or combination.
8. Smart storage policies	Users can define their own policies for data protection	Allow IT admins to focus on providing Storage as a Service (STaaS) and giving users the self-service look and feel of an AWS S3 service.
9. Smart-tiering	Tier to Amazon S3 or Glacier or S3 compatible tape libraries	Define tiering policy on a per bucket level. Automatically tier to Amazon S3, Glacier or other S3 endpoints such as tape libraries.
10. Turnkey off-the-shelf appliances	Use off-the-shelf components and servers	Software defined and modular architecture accommodates hot-swappable, redundant and highly available components to eliminate downtime, data migration, and forklift upgrades.
11. Single or multi datacenter	Support geo-distributed model	Enables lower latency and provide better cloud services performance with a single global namespace.
12. Chargeback & accounting	Support chargeback and usage accounting	Use built-in analytics to easily perform chargeback at the group or user level. Easy reports for accounting purposes.
13. Security and encryption	Support SSl and encryption of in-flight data and data-at-rest	SSL support for secure access and supports AES 256 encryption for data-at-rest on premise and on public clouds.
14. Turnable consistency levels	Supports strong, eventual, and custom consistency levels	Configure logical storage policies with the data consistency levels to meet IT and data protection requirements.
15. Store files as objects	Metadata and file are bundled into an object	Granular metadata management at the object level and near-infinite scalability of highly available shared storage for the IoT.

Feature	Function	Benefit
16.Object lifecycle management	Flexible object lifecycle management	Users can manage their own data and object retention period under security and long term data protection.
17.Data compression	Supports data compression	Reduce storage usage and increase storage capacity savings with built-in data compression.
18.Smart redirect	Local cache copy for replication and hot spares for erasure coding	Ensure regulatory compliance and disaster recovery requirements. Minimize downtime and keep the systems running while repairs are in process.
19.Proactive rebuild	Tracks and logs signs of problems with a node, disk, network failure, and incomplete IOs	Uses Cassandra database of problem hints to quickly pinpoint the problem and rebuild the data in a matter of hours instead of days.
20.Non-disruptive rolling upgrades	Automated rolling upgrades	Use administrative APIs to automate and simplify operations. Existing HTTP S3 applications are guaranteed to work using the same AWS S3 SDK for building S3 applications.
21.Object locator	GPS locator for objects	Object Locator enables an administrator to easily locate any object and determine the number of copies that exist as well as their exact storage location across geographically dispersed data centers to meet compliance regulations.
22.Smart support	24x7 access to FAQs, how-to guides and insights from the community	Easily create, manage, and track service requests.
23.Rebuild on read	Objects are checked on a read request	Missing or out-of-date replicas are automatically replaced or updated.
24.Versioning	Supports the versioning feature of the S3 API	Users can access different revisions of the same file stored on the system with a S3 client.
25.Event notifications	Supports SNMP/JMX monitoring	Use secure SNMP traps and JMX for system monitoring and for charge back reporting.
26.Geo dispersal/ Geo clusters	Support for multi data center and multi-region deployments	Deploy multi-site clusters for disaster recovery purposes and to ensure data is highly available and always on.
27.Replication	Supports Replication to other S3 object storage platform	Provide the ability to replicate objects to other S3 endpoints for Disaster Recovery.

III. Architectural Overview

Cloudian HyperStore is an Amazon S3-compliant multi-tenant object storage system. The system utilizes a NoSQL layer for the storage and access of object metadata, thus providing maximum flexibility and scalability. HyperStore system enables any service provider or enterprise to deploy an S3-compliant multi-tenant storage cloud. The following figure illustrates an overview of QxStor Cloudian Edition-HyperStore architecture.

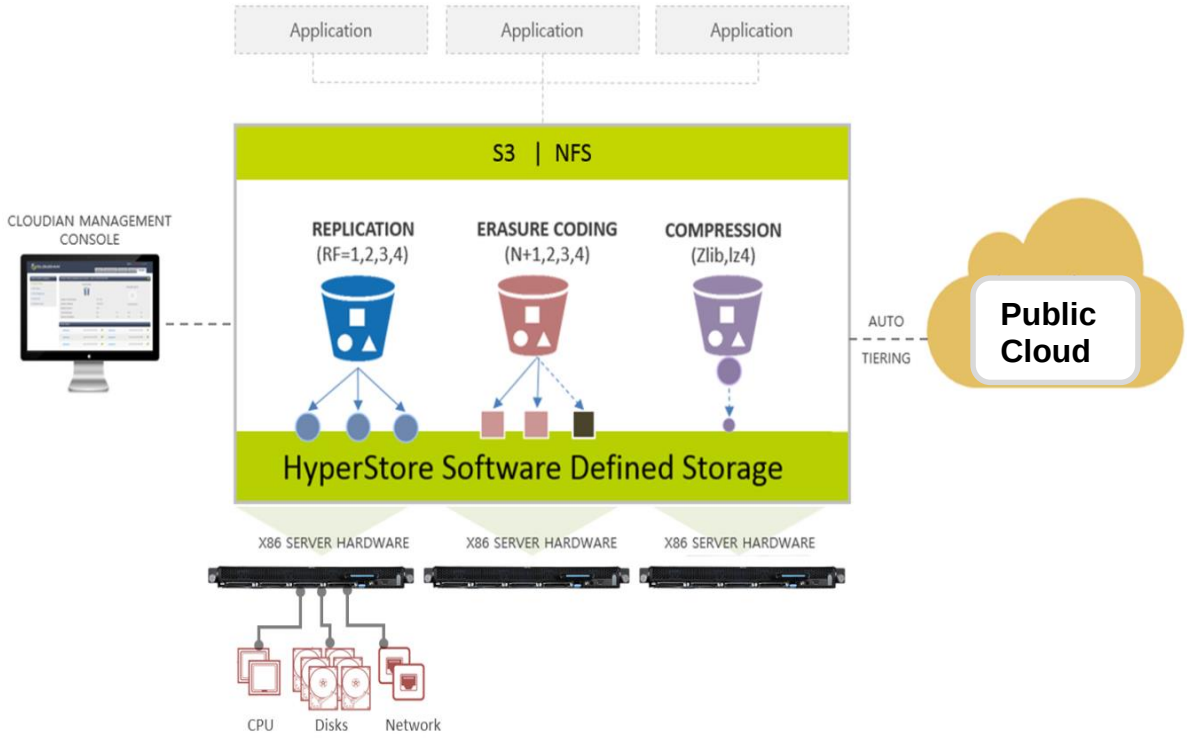


Figure 1. QxStor Cloudian Edition-HyperStore architecture

QxStor Cloudian Edition-HyperStore architecture is designed to meet the following important demands:

Amazon S3 API compliance: Fully compatible with Amazon S3's HTTP REST API. Customers' existing HTTP S3 applications will work with the Cloudian HyperStore service, and existing S3 development tools and libraries can be used for building HyperStore client applications.

Secure multi-tenancy: Provides the capability to securely have multiple users reside on a single, shared infrastructure. Data for each user is logically separated from other users' data and cannot be accessed by any other user unless access permission is explicitly granted.

Group support: A group can be created to manage individual users in a common enterprise work group. Each group member can have dedicated storage space, and can be managed by a designated group administrator.

Quality of Service (QoS) controls: Set storage quotas and usage rate limits on a per-group and per-user basis. Group administrators can set quotas and rate controls for individual members of the group.

Access control rights: Read and write access controls are supported at per-bucket and per-object granularity. Objects can also be exposed via public URLs for regular web access, subject to configurable expiration periods.

Reporting and billing: Supports usage reporting on a system-wide, group-wide, or individual user basis. Billing of groups or users can be based on storage quotas and usage rates.

Horizontal scalability: Scale up to thousands of nodes across multiple datacenters, supporting millions of users and hundreds of petabytes of data. New nodes can be added without service interruption.

High availability: Fully distributed, peer-to-peer architecture, with no single point of failure. The system is resilient to network and node failures with no data loss due to the automatic replication and recovery processes inherent to the architecture. Geo-cluster can be deployed across multiple datacenters to provide redundancy and resilience in the event of a datacenter-scale disaster.

The following figure illustrates the unique capabilities added by the solution to the basic S3 compatibility.

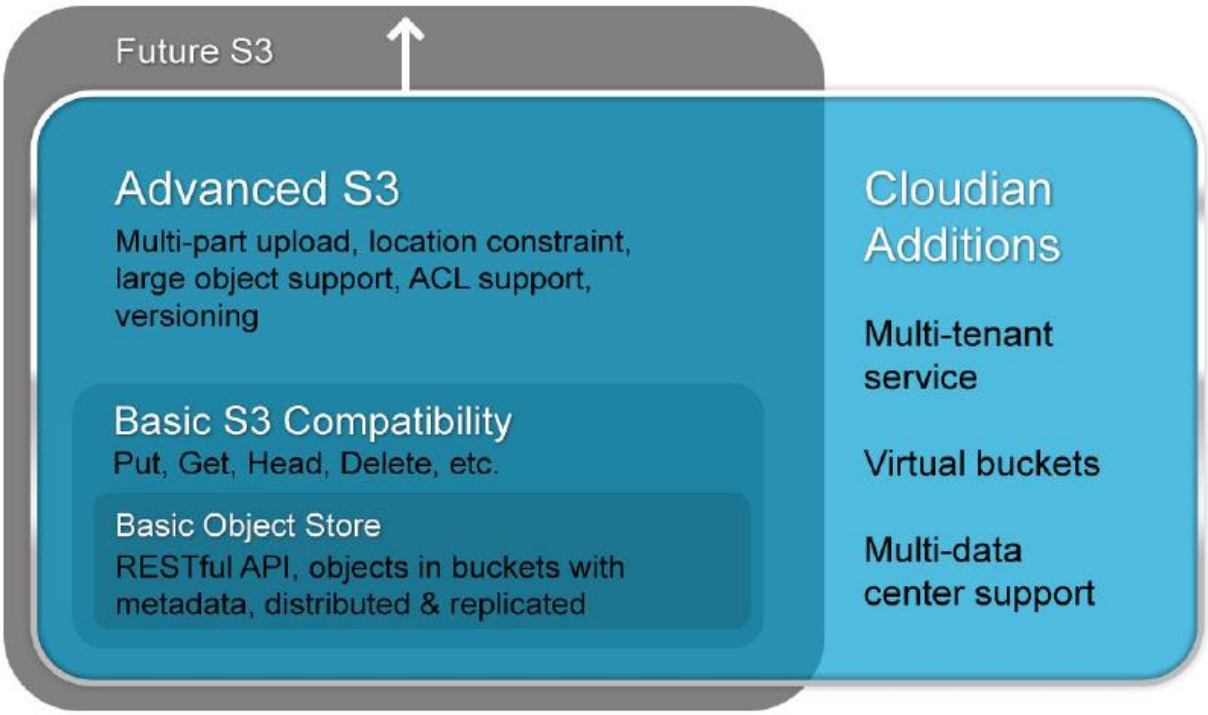


Figure 2. Cloudian HyperStore S3 environment

IV. Component Model

Cloudian HyperStore distributed architecture ensures no single point of failure (no SPOF) and provides data protection options (replication or erasure coding), data recovery upon a node failure, dynamic re-balancing upon node addition, and multi-datacenter and multi-region support.

The following figure illustrates the major components of architecture, including: Cloudian Management Console (CMC), S3 service, administrative service, storage services, Redis, and Cassandra databases.

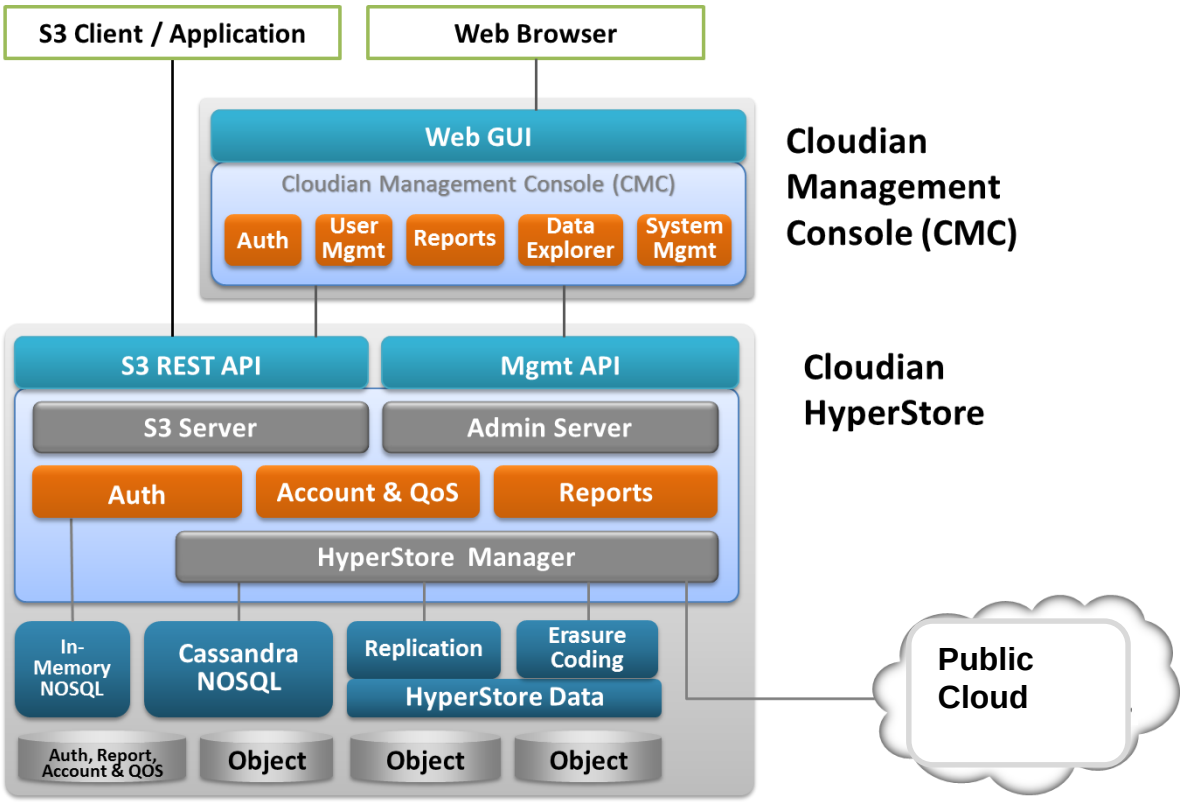


Figure 3. Cloudian HyperStore component model

Major components for reference:

Cloudian Management Console: Web-based user interface for system administrators, group administrators, and end users. The functionality available through the console depends on the user type associated with a user's login ID. Use the console to perform tasks such as:

- Provisioning groups and users;
- Managing QoS controls;
- Creating and managing rating plans;
- Generating usage data reports;
- Generating bills;
- Viewing and managing users' stored data objects;
- Setting access control rights on users' buckets and stored objects.

S3 service: Fully compatible with Amazon S3's HTTP REST API.

HyperStore service (and the HSFS): As an object store, Cassandra provides a wealth of valuable built-in functionality including data partitioning, automatic replication, easy cluster expansion, quorum calculation, etc. HyperStore system uses a hybrid storage solution where Cassandra can optionally be used for small S3 data objects while the Linux filesystem on Cassandra nodes is used for larger S3 data objects. The area of the Linux filesystem where S3 object data is stored is called the Cloudian HyperStore File System (HSFS). Within the HSFS, objects can be stored and protected in replication or erasure coding.

Cassandra database service: Uses the open source storage platform Cassandra to store several types of data. HyperStore system creates and uses several distinct key spaces within Cassandra. S3 client applications do not access Cassandra data-bases directly. All S3 access is mediated through the S3 Service.

Redis database service: Uses the lightweight, open source Redis key-value data store to store various data that supports HyperStore S3 service features:

- Redis Credentials DB: Stores user credentials and other S3 operation supporting data, such as multi-part upload session information and public URL access counters;
- Redis QoS DB: Stores user-level and group-level QoS settings that are established by system administrators. The DB is also used to keep count of user requests so that QoS limits can be enforced by the system.

Administrative service: The administrative service, together with the S3 service and the HyperStore service, are the clients to Redis databases. Communication is through a protocol called Redis Serialization Protocol. The administrative service implements a RESTful HTTP API through which the user can perform administrative operations. The administrative service is closely integrated with the S3 service.

V. Operational Model

Cloudian HyperStore software is validated to run on QCT servers and switches.

QCT QuantaPlex T21P-4U storage server is compact and versatile, based on Intel® Xeon® E5-2600 v4 processor family, equipped with 2 x sockets, up to 78 x HDDs (front and rear access, 12Gb/s, 3.5”), 16 x DDR4 memory slots, 3 x PCIe expansion slots to deliver advanced enterprise-grade performance.

Figure 4. QCT QuantaPlex T21P-4U front view

As an ultra-dense, scalable, and cost-effective disk expansion unit, major components such as hot-plug power supplies and fans are 2+2 and 9+1 redundant with high availability. The design is optimized for enterprises, service providers, and datacenters where the lowest operational cost-per-watt and smallest footprint are critical.

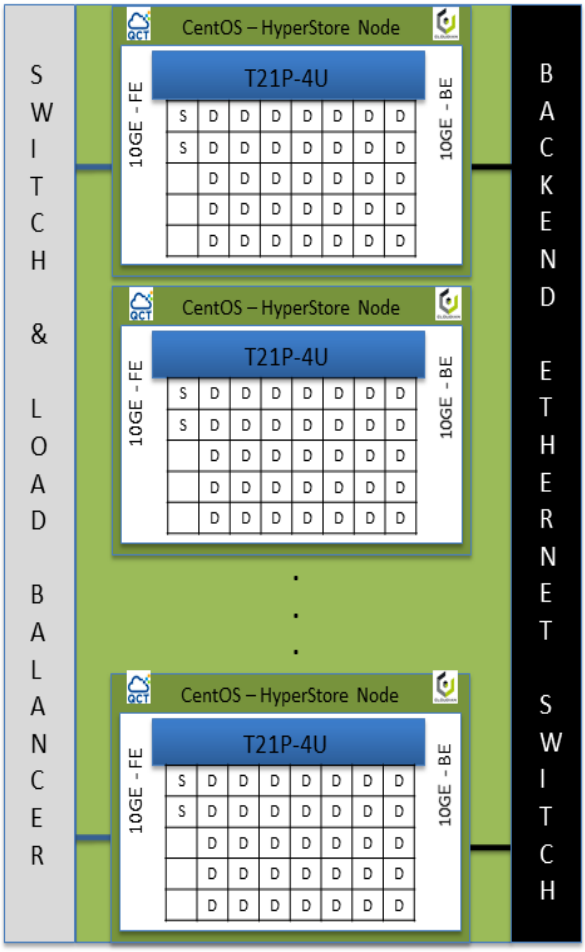
Figure 5. QCT QuantaPlex T21P-4U rear view

The current platform is built with 8 x T21P-4U servers per rack. Each of the T21P-4U servers can be flexibly populated, allowing for a production environment to expand the Cloudian HyperStore in the future by adding additional drives and compute resources (up to 78 HDDs per server). Internally mirrored SSD drives are used to host the CentOS operating system and the Cassandra NoSQL database, which stores the metadata describing the live data.

In the current platform, 1 x QCT QuantaPlex T41S-2U server is utilized as a test load generator, suitable for applications, workloads, and user connectivity to the storage platform.

The following figure illustrates the complete configurations ready for successful single data center implementation:

Cloudian HyperStore on QCT QuantaPlex T21P-4U solution



Configurations for reference:

Per node configuration

- 2 x Intel Xeon E5-2620 v4 processor
- 78 x 8 TB SAS 12Gb/s 3.5" HDD (for data)
- 128GB memory
- 2 x 480 GB SSD (for OS)
- Dual port 10GbE network card
- LSI 3008 HBA card

Per node capacity

- 1 x T21P-4U = Up to 78 x 8 TB Drives = 624 TB raw

Per rack capacity

- 8 x T21P-4U = Up to 8 x 624 TB = 4.99 PB raw

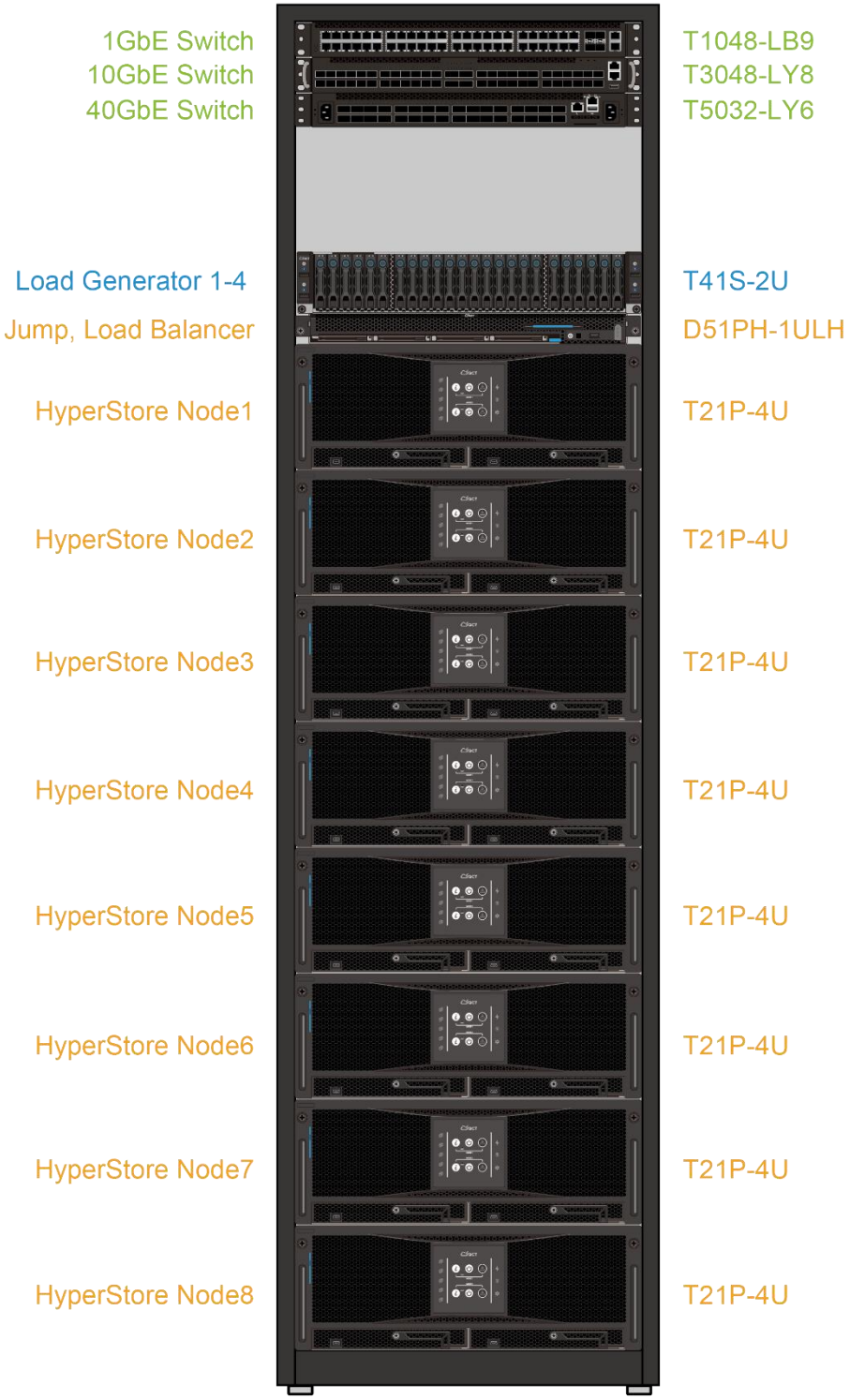
Two rack capacity

- 16 x T21P-4U = Up to 2 x 4.99 PB = 9.98 PB raw

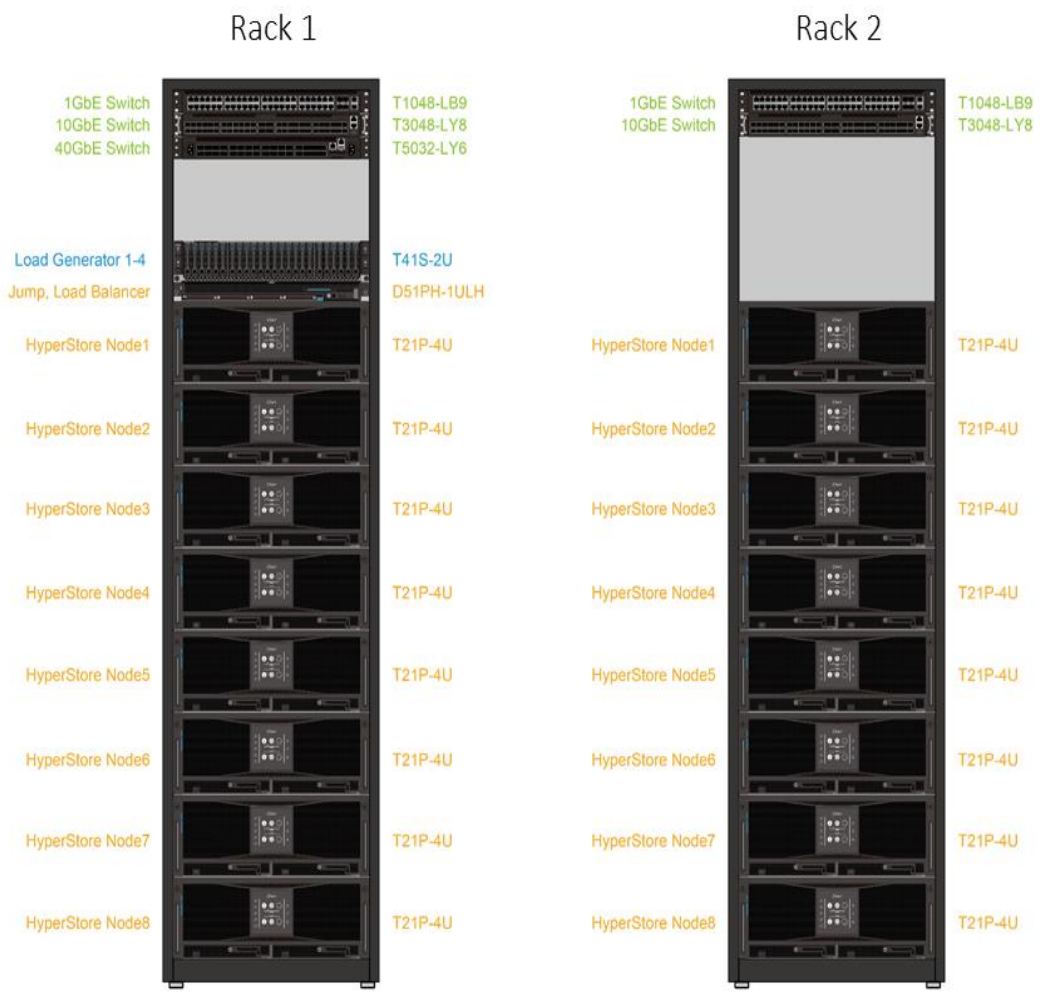
HyperStore configuration

- Required storage nodes: 3 and above
- Single and multi data center implementation
- Fully redundant cloud ready architecture

For a single rack data center environment, the configurations are illustrated as follows for reference:

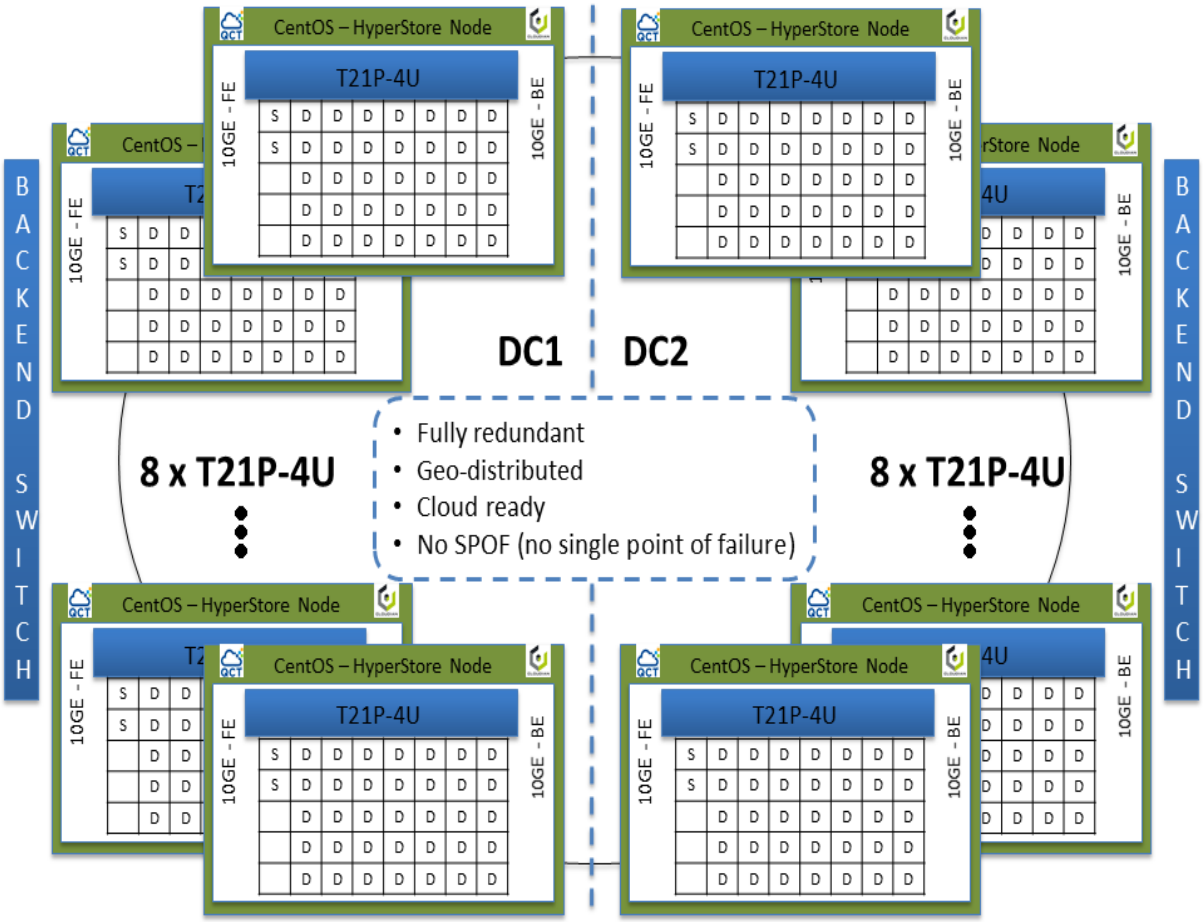


For a multi rack data center environment, the configurations are illustrated as follows for reference:



The following figure illustrates the complete configurations ready for successful single and multi data center implementation:

Single and Multi Data Center Implementation



VI. Deployment Considerations

The current section describes key considerations in deployment, such as: high availability, load balancers, backup, auto-tiering, and multi-tenancy.

High availability: Geo-cluster can be deployed across multiple datacenters to provide redundancy and resilience in the event of a datacenter-scale disaster.

Load balancers: Services that are available for load balancing are: Cloudian Management Console, S3 service, and Administrative service.

Backup: Can be backed up to other storage mechanisms, such as tape, another HyperStore deployment, or other cloud storage providers.

Auto-tiering: Objects can be automatically moved from local to a destination on a predefined schedule. The destination can be: Amazon S3, Amazon Glacier, or a different HyperStore deployment or region. Auto-tiering is configurable on a per-bucket basis.

Multi-tenancy: Configure group and user-level QoS rate limits to ensure groups and users do not exceed storage quotas or consume bandwidth in a manner that impacts other tenants. Multiple credentials per user is supported.

VII. Conclusion

The primary purpose of the current document is to outline the validation of QxStor Cloudian Edition-HyperStore.

The current platform is configured with ultra-dense extreme-performance QuantaPlex T21P-4U as storage servers, highest compute-density QuantaPlex T41S-2U as an application/workload generator, and hybrid scale-out high-computing storage server QuantaGrid D51PH-1ULH as a load balancer.

The current cloud-ready platform also utilizes QuantaMesh T5032-LY6 as a Spine/Leaf switch, QCT QuantaMesh T3048-LY8 as a Top-of-Rack (TOR) switch, and QuantaMesh T1048-LB9 as a 1G/10G Ethernet switch.

Overall, the QxStor Cloudian Edition-HyperStore platform is viewed as consistent and reliable. Deployments can flexibly start with a few nodes and then scale out as usage increases to petabyte levels of data.

Powered by advanced technology, QCT integrates Cloudian HyperStore software in its appliance products, offering global customers the business and operational advantages of cloud-scale, software-defined object storage with full AWS and S3-cloud compatibility.

As a part of the global strategy, the addition of the current validation to QCT's product portfolio expands QCT's data center solutions for cloud service providers, telecommunications companies, and other enterprises. QCT aims to offer a full spectrum of innovative, enterprise-grade infrastructure to bring massively-scalable, fully-integrated, hybrid cloud storage to customers.

For cloud service providers, this solution is suitable for deploying public clouds as well as managed private clouds; for enterprises, it is suitable for implementing private and/or hybrid clouds.

QCT and Cloudian continue to collaborate to develop industry-leading solutions to address today's explosive data growth, suitable for dynamic enterprise workloads where scalability, availability, performance, manageability, and operational efficiency are key priorities.

VIII. Cloud-Ready Platform Configurations

		Building block node-level	Building block rack-level
Storage node configuration	Description	Units per node	Units per rack
System	QuantaPlex T21P-4U	1	8
CPU	Intel Xeon E5-2620 v4	2	16
HDD	(SAS 12Gb/s) 8TB 7.2K RPM 3.5”	78	624
Memory	16G 2400MHZ DDR4	8	64
SSD	Intel S3610 480GB 2.5" 7mm	2	16
Networking	Quanta 10Gb OCP SFP+ mezzanine Intel 82599	1	8
SAS Card	QCT LSI 3008 SAS 12Gb/s mezzanine	1	8
Switch configuration	Description		Units per rack
Spine/Leaf	QuantaMesh T5032-LY6 32 QSFP+ ports		1
Top-of-Rack (TOR)	QuantaMesh T3048-LY8 48 1/10GbE SFP+ and 6 QSFP+ ports		1
1G/10G Ethernet	QuantaMesh T1048-LB9 48 100/100/1000BAE-T and 4 1/10GbE SFP+ ports		1

For More Information

For more information about

- Intel® product offerings, please visit http://www.intel.com
- Cloudian® product offerings, please visit http://www.cloudian.com
- Quanta Cloud Technology (QCT)® product offerings, please visit http://www.qct.io

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QCT (Quanta Cloud Technology) is a global datacenter solution provider extending the power of hyperscale datacenter design in standard and open SKUs to all datacenter customers.

Product lines include servers, storage, network switches, integrated rack systems and cloud solutions, all delivering hyperscale efficiency, scalability, reliability, manageability, serviceability and optimized performance for each workload.

QCT offers a full spectrum of datacenter products and services from engineering, integration and optimization to global supply chain support, all under one roof.

The parent of QCT is Quanta Computer Inc., a Fortune Global 500 technology engineering and manufacturing company.

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