
IOmark-VDI



HP

HP ConvergedSystem 242-HC StoreVirtual

Test Report: VDI-HC-150427-b

Test Report Date: 27, April 2015



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Executive Summary

IOmark is a storage specific workload and benchmark designed to test storage systems performance using a variety of real world, application centric workloads. The IOmark-VDI benchmark is a specific workload that measures Virtual Desktop Infrastructure (VDI) workloads against storage systems. Results are published after audit and certified approval by IOmark authorized auditors.

IOmark-VDI-HC is a benchmark that certifies Hyper-Converged systems for VDI results. The measurement criteria are storage performance, with the restriction that all storage workloads must be supported by the tested Hyper-Converged system. Although there are CPU and memory considerations, these aspects are not tested by IOmark-VDI workload.

This document is the official benchmark report for the tested configuration using HP ConvergedSystem 242-HC StoreVirtual appliance. The result of the benchmark showed the tested solution supported 640 simultaneous, fully provisioned virtual desktop instances at a cost of \$219.84 per VDI instance, meeting the storage response time requirements.

A full description of the configuration tested along with pricing information are provided in the following document, with application workload details in Appendix A.

The criteria and performance requirements are as follows:

- For all application workloads:
 - All workloads must reside entirely on the tested hyper-converged system
 - 70% of response times for I/O's must not exceed 30ms
 - The replay time must complete within 1 hour and 5 minutes for each 1 hour workload

Vendor Product Description

HP ConvergedSystem 242-HC StoreVirtual

Based on end-to-end HP and hypervisor innovation, HP ConvergedSystem 242-HC StoreVirtual is a virtualization platform for VMware vSphere that combines powerful compute, highly available storage, hypervisor, and management capabilities into a single, scale-out appliance. The compact 2U/4-node form factor allows midsize and enterprise remote office, branch office customers to virtualize a variety of workloads ranging from OLTP databases to virtual desktops. The CS 242-HC StoreVirtual is production-ready within 15 minutes and can be used for any virtualization project where simplicity is key. The HP CS 242-HC StoreVirtual features the following:

- Platform integration with VMware vSphere increases functionality and ease of use while application integration simplifies storage management for applications.
- Combines the industry's leading software-defined storage and x86-based computing platforms with robust VMware vSphere integration.
- Four individually serviceable servers and a shared storage cluster with an enterprise-class feature set serves both applications and data services within a compact, 2U footprint.
- Wizard-driven startup enables complete deployment of virtualized compute and storage infrastructure in under 15 minutes.

- Stretch cluster capabilities support business continuity by keeping applications online during appliance, rack-level, or site-wide outages.
- Centralized management of compute, storage, and virtual machines from inside VMware vCenter Server alleviates the need for specialized server, storage or virtualization expertise.

IOmark-VDI-HC Test Summary

For the tested configuration, the following data is provided

Item	Value
Testing Identifier:	VDI-HC-150427-b
Product:	HP ConvergedSystem 242-HC StoreVirtual
Test Sponsor:	Hewlett-Packard Development Company, L.P.
Auditor:	Evaluator Group Inc.

Table 1: Test Identifier Information

Item	Value
IOmark-VDI Version:	IOmark-VDI 3.4.6
Testing Completed:	March 2015
Equipment Availability:	December 2014
Audit Certification Date:	27, April 2015
Report Date:	27, April 2015

Table 2: Test Revision and Dates

IOmark-VDI-HC Results

Shown below are the IOmark-VDI-HC results for the system under test. The definition and workload characteristics of the benchmark are provided in Appendix A.

Price information provided below is explained in detail in Table 8 in this report.

A VDI user may be configured to run in one of two modes:

- Fully Provisioned (No clones - Requires at least 10 GB of thinly provisioned capacity / VDI user)
- Linked Clones (Hypervisor based clones - Requires 3.4 GB of thin capacity / VDI user)

For each configuration run, the results are reported. Tables 3, 4 and 5 below show the number of users supported (as defined in Appendix A).

VDI Mode	IOmark-VDI-HC Heavy Worker	Tested Useable Capacity	Total Price	Price / User
Fully Provisioned	320	6.72 TB	\$140,700.00	\$439.69

Table 3: IOmark-VDI-HC Workload Summary for Heavy Worker

VDI Mode	IOmark-VDI-HC Standard Worker	Tested Useable Capacity	Total Price	Price / User
Fully Provisioned	640	6.72 TB	\$140,700.00	\$219.84

Table 4: IOmark-VDI-HC Workload Summary for Standard Worker

Tested Configuration Details

Connectivity, configuration and pricing information for the system under test are provided.

Hyper-Converged System Details

Detailed server hardware features for the system under test are provided below in Table 5.

Hardware Features	Value
Rack Footprint	2U per appliance
Number of Nodes per Appliance	4 compute/storage nodes
Number of Drives per Appliance	24
CPUs	80 Cores @ 2.8 GHz
Memory	1TB DDR3 Memory for all 4 nodes
Networking Ports (1/10 GbE)	8 10GbE Ports (2 Per Node)

Table 5: Hyper-Converged Hardware Features

The IOmark-DI-HC workload certified in this report achieved a performance level of between 320 and 640 VDI users.

Typical VDI sizing guidelines recommend approximately 8 virtual CPU's for each core, and approximately 1 GB of RAM. With these guidelines, the tested Hyper-Converged system achieved the storage performance required and has sufficient computing resources to achieve the stated results.

Hypervisor Configuration for IOmark-VDI-HC Workload

- A total of 10 SCSI logical units (LUNs) were utilized on the HP CS HC-242 StoreVirtual
- VMFS datastore type, with “VMFS 5” chosen
- Each virtual machine was allocated using “thin provisioning” as VMware datastore type

Detailed hypervisor configuration parameters for the system under test, including connectivity are provided below in Table 6.

Storage System Parameter	Value
Hypervisor	VMware ESXi vSphere 5.5
Number of interfaces to the storage system:	2 Per Node (8 total)
Connectivity to the storage system:	8 @ 10Gb Ethernet
Hypervisor storage protocol used:	iSCSI (SCSI over IP Protocol)
Hypervisor version:	VMware ESXi 5.5 Update 2
Thin provisioning:	Not utilized in VMFS
Hypervisor Storage Access:	VMFS datastore
Datastore Filesystem:	VMFS 5.6 – 1 MB block size
VAAI:	VAAI supported
SATP:	VMW_SATP_ALUA
PSP:	VMW_PSP_RR (Round Robin)
Total capacity of system allocated to IOmark-VDI:	6.74 TB

Table 6: Hypervisor Configuration Parameters

Storage Configuration for IOmark-VDI-HC Workload

- A total of 10 SCSI logical units (LUNs) were utilized on the HP CS HC-242 StoreVirtual
- VMFS datastore type, with “VMFS 5” chosen
- Each virtual machine was allocated using “thin provisioning” as VMware datastore type

Storage System Parameter	Value
Storage System firmware	HP StoreVirtual OS 11.5
High Availability Access to all LUNs	Yes (active / active controllers)
Total raw capacity of system under test (SUT)	22.4 TB
Thin provisioning:	Yes - Utilized on HP StoreVirtual
RAID Level(s)	Network RAID 10 (plus disk RAID 5)
Total Cache Capacity:	8 x 2GB FBWC
Read Cache	Dynamic Read Ahead
Write Cache:	Dynamic Write Back
VAAI Features Enabled:	Yes
- Block Zero	Yes
- Full Copy	Yes
- HW Locking	Yes
- NAS Clone	No
- NAS Reserve	No
Automated tiering within the storage system:	Yes - StoreVirtual Adaptive Optimization
Deduplication or compression of data:	No
Storage system clones / writeable snapshots:	No
Type of storage system clone:	No
Storage Media Utilized:	-
- SSD's (Specify Size)	2 x 400GB/Node = 800 GB * 4(Nodes) = 3.2 TB
- 15K RPM	NA
- 10K RPM	4 x 1.2 TB/Node = 4.8 TB * 4(Nodes) = 19.2TB
- 7.2K RPM	NA

Table 7: Storage System Configuration Parameters

Configuration Diagram

The logical data layout of the test configuration is shown below in Figure 1.

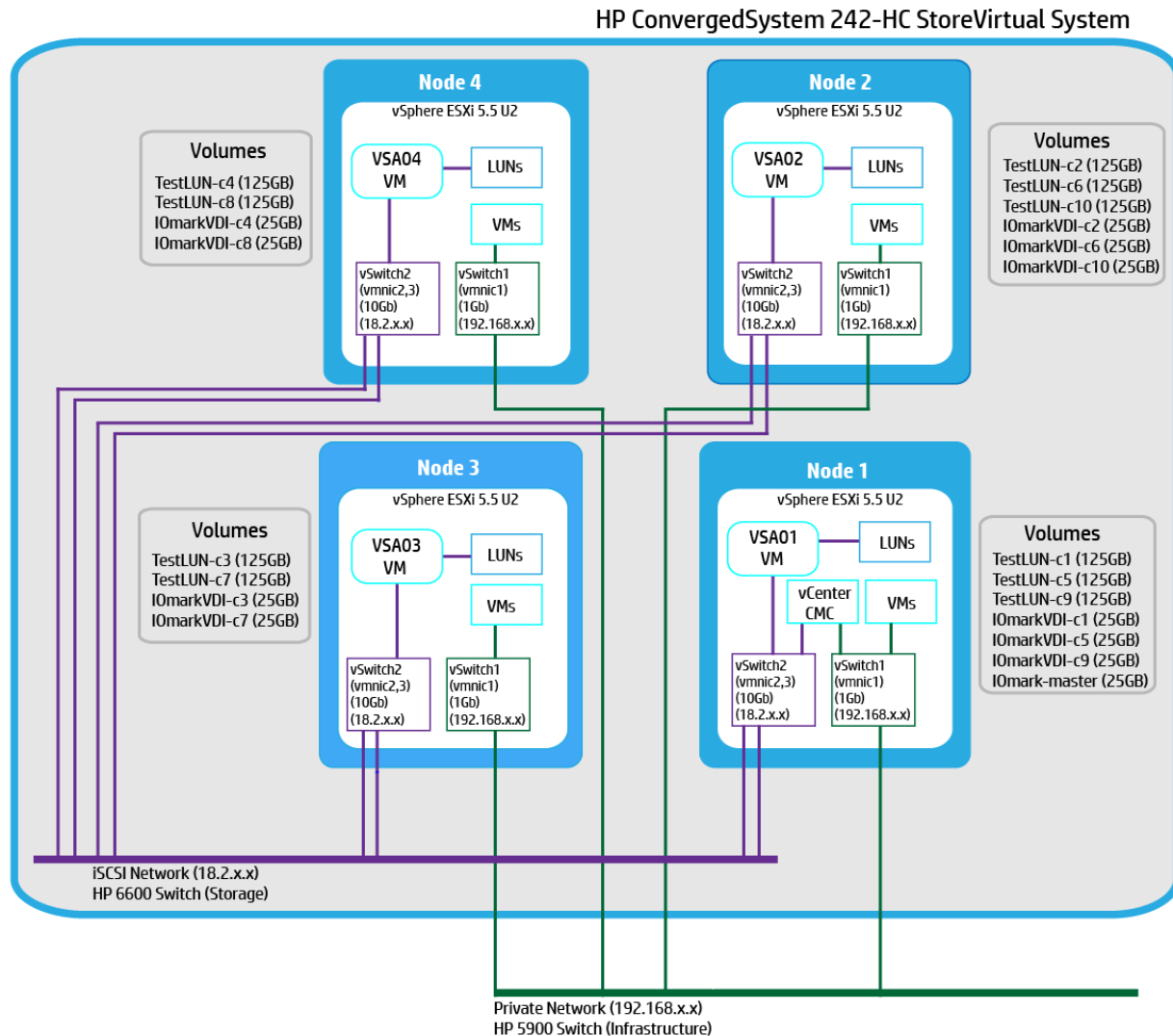


Figure 1: Logical System Configuration

Connectivity

The storage connectivity was 10GbE iSCSI. Each node used 2 10GbE links to an HP 6600 switch, for a total of 8 connections. Networking (LAN) connectivity for infrastructure services is shown highlighted in green. The iSCSI connections are shown highlighted in purple. Each node used 1 1GbE link to an HP 5900 switch, for a total of 4 connections.

A diagram is shown below in Figure 2.

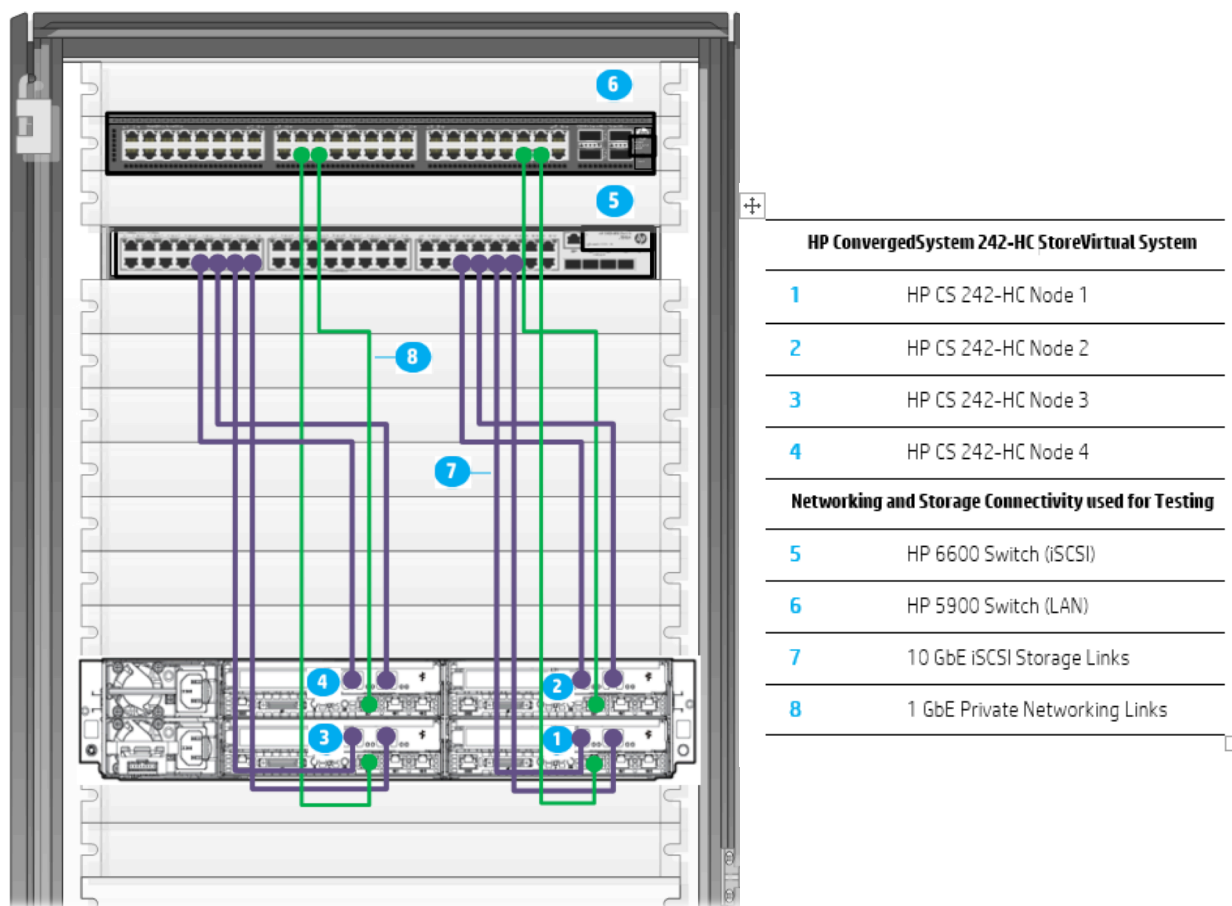


Figure 2: Physical System Connectivity

Tested Configuration Pricing

Item	Description	Qty	List Price
1	HP ConvergedSystem 242-HC StoreVirtual	1	\$140,700.00
-			
Total	List Price		\$140,700.00

Table 8: IOmark-VDI-HC Price Information

Detailed Results

IOmark-VDI performance results are measured against all VDI system workloads. The average storage response times for all VDI applications are shown below in Figure 4, plotted as a Cumulative Distribution Function (CDF) for results. The CDF is a measure of statistical probability, and indicates the probability that a response time is less than a specific value.

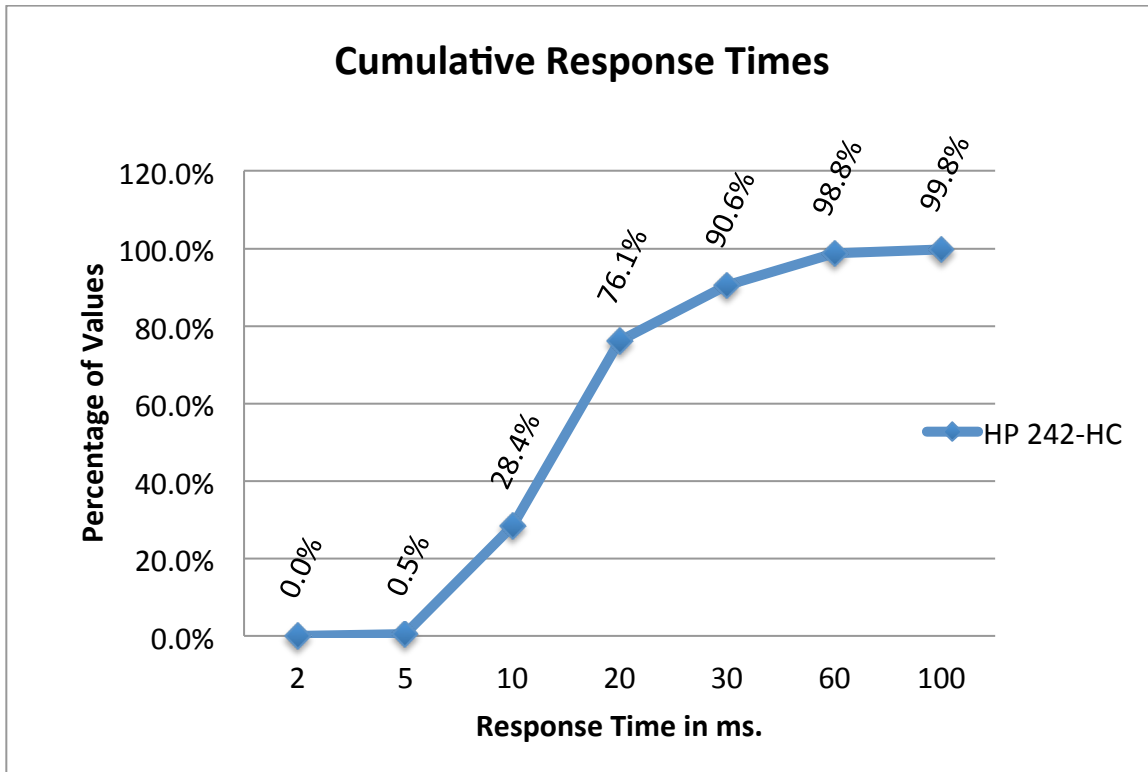


Figure 3: Response Time Results

As shown above in Figure 3, the system performance exceeded the requirements, indicating response times were lower than required (lower times are better). The primary response time of interest is:

- 90.6% of values were less than 30 ms

Appendix A - IOmark-VDI Overview

The ability to recreate a known workload is important for comparing a system against potential alternatives. Establishing a reference or benchmark workload enables system vendors as well as resellers and IT users to compare several systems utilizing a known workload.

Specifically, the IOmark-VDI benchmark recreates a storage workload that typically occurs in virtual desktop infrastructure environments. The workload is non-synthetic and recreates several applications that are commonly found in virtualized server environments.

Why the Need for IOmark-VDI

Currently, several application generators have been developed that are able to generate VDI workloads. However, there is no standard reference configuration, with the primary focus is on the server infrastructure. There are no existing benchmark workloads focusing on storage and storage system performance while running VDI applications.

By establishing a set of standard applications and capturing their I/O streams, it is possible to recreate application based storage workloads for these complex environments. IOmark-VDI is designed utilizing these concepts, and as such is the first benchmark designed to accurately generate application workloads for storage systems, enabling direct comparison of storage system configurations and their ability to support a specific number of applications.

How IOmark-VDI Operates

IOmark-VDI uses the concept of workload replay. I/O streams are captured from actual running applications and then “replayed” so that the exact sequence and I/O commands are issued. This allows the creation of a workload that is indistinguishable from an actual workload to the system under test, while being reproducible and requiring fewer resources. Additionally, the test environment is less expensive, easier and faster to create since actual applications are not required. Because CPU and memory are not consumed running applications, a much higher I/O workload may be generated with a set of server resources than is possible using native applications. This ratio is typically 10:1, but may vary.

In order to scale up the workload on a storage system, additional VDI workloads may be added to the same, or to other physical hosts. The only limitation to the scale of the test is the physical infrastructure supporting the workload. Sufficient, CPU, memory and I/O capabilities must be available to run additional workload sets.

Unlike artificial workload generation tools, IOmark-VDI recreates accurate read vs. write and random vs. sequential I/O requests. Another benefit of IOmark-VDI is the fact that it creates accurate access patterns, thus enabling storage cache algorithms to work properly.

Finally, IOmark-VDI maintains an accurate ratio of performance to capacity as workloads are scaled, ensuring that storage performance is measured with respect to storage capacity accurately. As a result, IOmark-VDI maintains an accurate ratio of I/O to capacity, producing results applicable to IT users.

Benchmark Application Workload Set

VDI Workload

1. View steady state operation
 - a. Heavy Worker Profile – Average / VDI User
 - i. 12.52 iops. / User
 - ii. 1.06 MBps / User
 - b. Standard Worker Profile – Average / VDI User
 - i. 6.26 iops. / User
 - ii. 0.53 MBps / User
2. Benchmark Criteria:
 - 80% of I/O response times must not exceed 50ms
 - All storage utilized must reside on/within the storage system under test

VDI Benchmark Parameters

- Operating System disk size is 20 GB (thinly provisioned)
- All user sessions were running Windows 7 as their guest OS
- No user data disk utilized
- VMware Linked clones may be utilized (as noted)
- Storage linked clones may be utilized (as noted)
- Heavy Profile:
 - The workload is non synthetic, actual I/O patterns are issued based on application capture
 - The size of I/O's is variable, ranging from 512, up to 2 MB transfers based on application
- Standard User Profile:
 - The workload is non synthetic, actual I/O patterns are issued as captured
 - Rates are 50% of "Heavy" user profile
 - The size of I/O's is variable, ranging from 512, up to 2 MB transfers

VDI Workload Generation

The workload generator used to generate the VDI workload was VMware View Planner. This application workload generator controlled running the 8 listed applications above, in a Windows 7 64 bit OS environment, running as a guest VM in a hypervisor environment.

VDI Workload Details

The specific applications comprising a VDI workload set are detailed below in Table 7.

Application	Storage Capacity / Instance
Guest OS (Microsoft Win 7 64bit)	20 GB
MS Office (Word, Excel, PowerPoint and Outlook)	N/A
MS Internet Explorer	N/A
Adobe Acrobat Reader	N/A
Windows Media Server	N/A
Windows 7 zip	N/A
Total VDI Guest Environment	Total = 20 GB

Table 8: IOmark-VDI Guest Application Overview

The total capacity required for each set of applications is approximately 20 GB of capacity. Each additional workload set requires an additional 20 GB of capacity.

Understanding Results

IOmark-VDI produces results indicating the response time of a storage system given a particular workload. Based on established criteria, these results indicate how many VDI sessions are supported by a specific storage configuration with a maximum allowed response time. The report is audited for accuracy and issued by Evaluator Group, Inc., an independent storage analyst firm.

Benchmark Criteria

IOmark has established the benchmark criteria for the IOmark-VDI workload. The performance requirements are established as follows:

- For all application workloads:
 - Workloads are scaled in sets of 8 workloads
 - 70% of response times for I/O's must not exceed 30ms
 - All storage must reside on the storage system under test
 - The replay time must complete within 1 hour and 15 seconds for each 1 hour workload

More Information about IOmark-VDI

For more information about the IOmark benchmark, a theory of operations guide, published results and more, visit the official website at <http://www.iomark.org>. Some content is restricted to registered users, so please register on the site to obtain all available information and the latest results.

About Evaluator Group

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