Certification Exam Objectives (SG0-001)

INTRODUCTION

The CompTIA Storage+ Powered by SNIA Certification is a vendor-neutral credential. While there is no prerequisite requirement, CompTIA recommends that the Storage+ certification is intended to follow one of the CompTIA foundational level exams A+, Network+, or Server+.

This exam will certify that the successful candidate has the knowledge and skills required to configure basic networks to include archive, backup, and restoration technologies. Additionally, the successful candidate will be able to understand the fundamentals of business continuity, application workload, system integration, and storage/system administration, while performing basic troubleshooting on connectivity issues and referencing documentation.

The CompTIA Storage+ Powered by SNIA Certification is aimed at a Storage professional who has:
> A minimum of 12 months hands-on technical storage experience.

This examination blueprint includes domain weighting, test objectives, and example content. Example topics and concepts are included to clarify the test objectives and should not be construed as a comprehensive listing of all the content of this examination.

The table below lists the domain areas measured by this examination and the approximate extent to which they are represented in the examination:

Domain	% of Examination
1.0 Storage Components	20%
2.0 Connectivity	24%
3.0 Storage Management	26%
4.0 Data Protection	17%
5.0 Storage Performance	13%
Total	**100%**

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**Note: The lists of examples provided in bulleted format below each objective are not exhaustive lists. Other examples of technologies, processes or tasks pertaining to each objective may also be included on the exam although not listed or covered in this objectives document.

CompTIA is constantly reviewing the content of our exams and updating test questions to be sure our exams are current and the security of the questions is protected. When necessary, we will publish updated exams based on existing exam objectives. Please know that all related exam preparation materials will still be valid.

1.0   Storage Components

1.1   Describe disk types, components, and features.
- SATA
- Fibre Channel
- SAS
- SCSI
- SSD
- Spindle
- Platter
- Cylinder
- Heads
- Speeds
  - 7,200 rpm
  - 10,000 rpm
  - 15,000 rpm
- I/O vs. throughput
- Capacity vs. speed

1.2   Compare removable media types, components, and features.
- Tape
  - Size vs. speed
  - Multi-streaming and multiplexing (pros and cons)
  - Shoe-shining
  - LTO versions (LTO1, LTO2, LTO3, LTO4, LTO5)
  - Compression and encryption (hardware/software)
  - NDMP
- Other removable media
  - DVD
  - Blu-Ray
  - Flash drives
  - WORM

1.3   Given a scenario, install and maintain connectors and cable types (keeping in mind their properties).
- Fiber cables
  - Multimode (shortwave) vs. singlemode (longwave)
  - Length, speed and distance limitations
  - Connectors: LC, SC, SFP

- o   Care of cables: bend radius, stress
- Copper cables
  - o   CAT5
  - o   CAT5e
  - o   CAT6
  - o   Serial
  - o   Twinax
  - o   SAS
  - o   Length, speed and distance limitations
  - o   Connectors: RJ-45, DB-9
- SAS1 and SAS2 port speeds

1.4   Describe the uses of physical networking hardware.

- Switch and features
  - o   Trunking
  - o   ISL
  - o   Port channel
  - o   Port types: G-ports, F-ports, N-ports, E-ports, U-ports
  - o   Directors
  - o   Hot-pluggable
- HBA
- CNA
- Router

1.5   Given a scenario, install and maintain modular storage array components.

- Controller head
  - o   Single
  - o   Dual
  - o   Grid
  - o   Cache
  - o   Expansion adapters
  - o   Array port types and cabling: Fibre channel, FCoE, iSCSI, SAS
- Disk enclosure
  - o   Enclosure controllers
  - o   Monitoring cards
  - o   Enclosure addressing
  - o   Cabling
- Hot pluggable

1.6   Identify the following environmental concerns and their associated
        impacts.
- HVAC
  o Improper cooling
  o Adequate humidity control
- Fire suppression
- Floor and rack loading
- Adequate power
  o Sufficient capacity
  o Adequate division of circuits
  o Grounding

1.7   Use appropriate safety techniques during installation and maintenance of
        storage equipment**.**
- Proper lifting techniques
- Weight considerations
- Antistatic devices
- Rack stabilization

2.0   **Connectivity**

2.1   Identify common storage networking industry terms.
- Link
- Oversubscription
- Worldwide node name
- Worldwide port name
- Flow control
- N-port ID
- Buffer-to—buffer credit

2.2   Explain the following storage networking industry terms.
- Alias
- Name service
- Link
- Connection
- Initiator
- Target
- Fabric

2.3   Given a scenario, implement the following fibre channel technologies.
- Topologies
  - o   Point-to-point
  - o   Arbitrated loop
  - o   Single fabrics
  - o   Redundant fabrics
- Implementations
  - o   Zoning best practices
  - o   Zoning alias
  - o   Zone
  - o   Zone set
  - o   Hard zoning
  - o   Soft zoning
  - o   Domain IDs
  - o   NPIV
  - o   SCSI IDs
- Multipathing
  - o   Load balancing
  - o   Fail over
  - o   Number of paths to disks
  - o   Interoperability
- Physical connections vs. logical connections
- Protocols
  - o   SCSI
  - o   FCP
  - o   FCIP
  - o   iFCP

2.4   Given a scenario, implement the following Ethernet network technologies.
- Features
  - o   VLAN
  - o   WAN
  - o   MAN
  - o   LAN
- Multipathing
  - o   iSCSI
  - o   MPIO
  - o   Link aggregation
- Protocols
  - o   iSCSI

        o   NFS
        o   CIFS

2.5   Identify the basics of converged storage network technologies.
- FCoE
- DCB (DCE, CEE)
- LLDP
- Class of service
- Priority tagging
- Baby-Jumbo frames
- 10GbE

2.6   Given a scenario, use the appropriate network tools.
- TCP/IP network
  - ping
  - tracert/traceroute
  - ipconfig/ifconfig
  - nslookup
- Fibre channel network
  - Port error counters
  - fcping
  - Name server
  - Rescan

2.7   Troubleshoot the following common networking problems.
- Bad cables
- Bad ports
- Bad connectors
- Incorrect configuration on NIC
- Incorrect VLAN
- Bad NIC
- NIC improperly connected
- Incorrect firewall settings

2.8   Troubleshoot the following common fibre channel problems.
- Zoning errors
- Zoning misconfiguration
- Failed GBIC or SFP
- Failed HBA

- Intermittent HBA
- Connectivity
- Interoperability issues
- Hardware/software incompatibility
- Outdated firmware/drivers
- Failed cable
- Misconfigured fibre channel cable

2.9   Compare and contrast common storage infrastructures.
- SAN
  - Fibre channel
  - Block mode
  - File system on host
  - FC or iSCSI protocol
  - Fabric
- NAS
  - TCP/IP based
  - UNC addressable storage
  - File system on storage (NFS or CIFS)
  - Ethernet based
- DAS
  - Direct attached storage (SAS, SATA SCSI)
  - File system on host

3.0   Storage Management

3.1   Explain the following RAID levels and associated properties.
- Levels
  - 0
  - 1
  - 5
  - 6
  - 1+0 (10)
  - 0+1
- Properties
  - High read
  - High write
  - Fault tolerance
  - Rebuild times
  - Performance

        o   Failure modes

        o   Capacity overhead

3.2   Given a scenario, execute storage provisioning techniques.

- LUN provisioning
  - LUN ID
- LUN masking and sharing
  - Host-based vs. storage-based (disk/tape)
  - Load balancing
- Thin provisioning
  - Thin reclamation
- Best practices for disk provisioning

3.3   Explain volume management concepts.

- File vs. block level architecture
- Configuration layer
  - LVM
- Logical volume
- Volume group
- File system
- Mount point

3.4   Describe general virtualization concepts.

- Virtual storage
  - Tapes
  - Disk
- Virtual provisioning of the host, array and fabric
- LVM
- VSAN/Virtual fabric
- VLAN
- NPIV

3.5   Given a scenario, implement monitoring, alerting, and reporting.

- Setting thresholds
- Trending
- Forecasting/capacity planning
- Recording baseline
- Setting alerts
- Auditing log files
- Alerting methods

- o Cell phone
- o Email
- o SNMP
- o Call home

3.6 Explain management protocols, interfaces, and associated purpose.
- Management protocols
  - o SNMP
  - o SMI-S
  - o WBEM
- Administration
  - o CLI
  - o Serial
  - o Telnet
  - o SSH
  - o HTTP/S
- In-band vs. out-of-band management

3.7 Explain Information Lifecycle Management concepts.
- Data migration strategies (HSM) and storage tiers
- Archiving and purging
- Compliance and preservation
- Content Addressable Storage (CAS) / Object Oriented Storage (OOS)
- Value of data based on frequency of access

3.8 Explain the various functions and differences of de-duplication and compression.
- Inline and post-process de-duplication
- Software based vs. appliance based
- Single instance storage
- Performance and capacity implications
- Reduction ratios vs. data type

4.0 Data Protection

4.1 Explain redundancy concepts, associated purposes, and components.
- High availability
- Single point of failure

- Component redundancy
  - Power supply
  - Controller
  - Disks (hot spare)
  - Path/bus
  - Switches
  - HBA
  - NICs
  - Array
- Cache battery backup and cache mirroring

4.2 Compare and contrast different replication methods and properties.
- Synchronous and asynchronous
- Local vs. remote
- Site redundancy
- Snapshots and clones
- Replication consistency

4.3 Explain the basics of data backup concepts for long term storage.
- Recovery Point Objective (RPO) and Recovery Time Objective (RTO)
- Backup and restore methods
  - Full
  - Incremental
  - Differential
  - Progressive
- Backup implementation methods
  - LAN-free
  - Serverless
  - Server-based
- Backup targets
  - Disk-to-disk
  - Disk-to-tape
  - VTL
  - D2D2T
- Vaulting vs. e-vaulting
- Verify backups
  - Data integrity
  - Checksums

- o Application verification
- Data retention and preservation policy
  - o Rotation schemes (GFS – Grandfather, Father, Son)
  - o Corporate and legal compliance
  - o Offsite tape storage/disaster recovery plan

4.4 Explain the basic concepts and importance of data security.
- Access management
  - o ACL
  - o Physical access
  - o Multiprotocol/interoperability
- Encryption
  - o Disk encryption
  - o Tape encryption
  - o Network encryption (IPSEC)
  - o Host encryption
  - o Encryption keys
- Storage security
  - o Shared access (NFS3 vs. NFS4)
  - o Shared access (CIFS)
  - o File permissions vs. share/export permissions
  - o LUN masking

5.0 Storage Performance

5.1 Explain how latency and throughput impact storage performance.
- Cache
  - o Read vs. write traffic
  - o De-staging
  - o Cache hit and miss
- RAID type and size
  - o Number of disks
- IOPS calculations
- Random vs. sequential I/O

- Impact of replication

5.2　Identify tuning and workload balance concepts.
- Application to storage data profiling
- Tiering
  - Automatic
  - Manual
  - HSM
- Partition alignment
  - Fragmentation and impact to performance
- Queue depth

5.3　Describe storage device bandwidth properties and functions.
- Bus bandwidth/loop bandwidth
- Cable speeds
- Disk throughput vs. bus bandwidth vs. cache
- Embedded switch port speed
- Shared vs. dedicated
- Multipathing for load balancing

5.4　Describe network device bandwidth properties and functions.
- Shared vs. dedicated
- Teaming/link aggregation
- Class of service
- Jumbo frames
- TOE

5.5　Explain performance metrics, parameters, and purposes of storage/host tools.
- Baselining and data capture
- Switch
  - Port stats
  - Thresholds
  - Hops
  - Port groups
  - ISL/trunk
  - Bandwidth
- Array
  - Cache hit rate

- o CPU load
- o Port stats
- o Bandwidth
- o Throughput
- o I/O latency
- Host tools
  - o Sysmon
  - o Perfmon
  - o Iostat

Storage+ Acronym List

Acronym	Definition
ARP	Address Resolution Protocol
ATL	Active Tape Library
CEE	Converged Enhanced Ethernet
CNA	Converged Network Adapter
CAS	Content Addressable Storage
CDP	Continuous Data Protection
CIFS	Common Internet File System
CLI	Command Line Interface
CWDM	Coarse Wavelength Division Multiplexing
DAS	Direct Attached Storage
DCB	Datacenter Bridging
DCE	Datacenter Ethernet
FC	Fibre Channel
FCF	Fibre Channel Forwarder
FCIP	Fiber Channel over IP
FCoE	Fibre Channel over Ethernet
FCP	Fibre Channel Protocol
FIP	FCoE Initialization Protocol
FQDN	Fully Qualified Domain Name
GBIC	Gigabit Interface Converter
GUI	Graphical User Interface
HBA	Host Bus Adapter
HSM	Hierarchical Storage Manager
HVAC	Heating Ventilation and Air Conditioning
iFCP	Internet Fibre Channel Protocol
ILM	Information Lifecycle Management

IOPS	I/O per second
iSCSI	Internet Small Computer System Interface
ISL	Inter-Switch Link
LAN	Local Area Network
LLDP	Link Level Data Protocol
LTO	Linear Tape Open
LUN	Logical Unit Number
LVM	Logical Volume Management
MAN	Metropolitan Area Network
MPIO	Multipath I/O
MTBF	Mean Time Between Failure
MTTF	Mean Time To Failure
NAS	Network Attached Storage
NDMP	Network Data Management Protocol
NFS	Network File System
NIC	Network Interface Card
NPIV	N-Port ID Virtualization
OLTP	Online Transaction Processing
OOS	Object Oriented Storage
RAID	Redundant Array of Independent Disks
RPO	Recovery Point Objective
RSCN	Registered State Change Notification
RTO	Recovery Time Objective
SAN	Storage Area Network
SAS	Serial Attached SCSI
SATA	Serial ATA
SCSI	Small Computer System Interface
SFP	Small Form Factor Pluggable
SLA	Service Level Agreement
SLP	Service Location Protocol
SMI-S	Storage Management Initiative Specification
SMTP	Simple Mail Transport Protocol
SNMP	Simple Network Management Protocol
SSD	Solid State Disk
SSH	Secure Shell
StaaS	Storage as a Service
TCP/IP	Transmission Control Protocol/Internet Protocol
UDP	User Datagram Protocol
VLAN	Virtual LAN
VSAN	Virtual SAN
WAN	Wide Area Network
WBEM	Web-based Enterprise Management
WORM	Write Once Read Many
WWN	World Wide Name
WWPN	World Wide Port Name

Storage+ Proposed Hardware and Software List

** CompTIA has included this sample list of hardware and software to assist candidates as they prepare for the Storage+ exam. This list may also be helpful for training companies who wish to create a lab component to their training offering.

Equipment
- At least two Fibre channel switches / SFP
- At least two Ethernet switches
- Ethernet and fibre cables
- Basics server
- HBAs
- LTO tape drive
- Entry level modular storage controller with fibre channel and iSCSI connections
- NAS head
- Serial cable

Spare hardware
- Hard drives for storage system
- SFPs
- HBA

Spare parts
- LTO tapes
- Ethernet and fibre cables

Tools
- Screw driver (Philips/slotted)

Software
- Server OS (Windows/Linux)
- Hardware drivers
- Management tools/software for hardware
- SSH client
- IOstat
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Other

- Sample storage topology diagrams
- Defective cables