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Abstract

Understanding Enterprise Network Attached Storage (NAS)

With the continuous growth of unstructured data, it has become paramount for enterprise storage stakeholders to understand the features and benefits of enterprise NAS solutions, and differentiate between the values of scale-out and scale-up NAS storage. This tutorial will help the audience gain insight into the usefulness and effectiveness of some of the key differentiating features of today’s enterprise NAS offerings.
Related Tutorials

Check out SNIA Tutorial:

What's Old is New Again - Storage Tiering

Check out SNIA Tutorial:

The File Systems Evolution

Check out SNIA Tutorial:

pNFS & NFSv4.2; a Filesystem for Grid, Virtualization and Database
Agenda

- NAS Overview
- Enterprise NAS Flavors
- Enterprise NAS Requirements – Performance, Scalability
- Caching in NAS
- Storage Tiering in NAS
- Scale-Up NAS Solutions
- Scale-Out NAS Solutions
- About De-duplication
Traditional NAS – what is it?

- Storage accessible over the network, usually over IP
- From simple partition sharing to traditional file servers to dedicated NAS appliances
- Well suited for workgroups/departments, SMB environments
- Can be multi-purpose (i.e. combine with email, print, other services)
- Not scalable in performance or capacity
Enterprise NAS – what is it?

- Purpose built - to serve structured & unstructured data over one or more protocols
- Scalable in capacity and performance
- Higher performance
- Can support large number of clients
- Better redundancy
- Enterprise features - tiering, caching, de-duplication, multi-tenancy, replication, multi-protocol support, etc
- Well suited for high-performance needs, large datasets, large number of clients
NAS Overview

Types of Enterprise NAS Solutions

- Traditional Scale up (add disks and upgrade NAS "head")
  - Appliance based (with integrated or 3rd party storage)
  - Proprietary solutions (native file processing and storage)
  - Open-Source software (with commodity hardware & storage)
  - Clustered NAS

- Scale-Out
  - Software based (or software on appliance) using commodity hardware (Commercial and Open-Source)
  - Proprietary Integrated File Processing and Storage

- Special purpose
  - Some software programmed into Integrated Circuits
  - NAS Cloud Gateway

NOTE: NAS Head refers to NAS Processing Unit, wherever applicable
**NAS Overview - Examples**

- **Scale-Up Integrated NAS**
- **Scale-Up Gateway NAS**
- **Scale-Out NAS Using Commodity Servers and Storage**
- **Scale-Out NAS Using Proprietary Clustered Nodes – Each node has Disk Drives and does File & Network Processing**

Understanding Enterprise NAS
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Enterprise NAS Features – Today

- Clustered NAS (scale-up or scale-out)
- PetaByte scale, 1000s of disk drives
- Support for drive mixing
- Storage Tiering
- Enhanced Caching
- De-duplication (file or block level, or both) and compression
- Single Name Space
- Multi-Tenancy
Enterprise NAS Requirements

Performance Requirements

Types of workloads

- High Disk IOPs driven applications (disk driven)
- Very High NFS (or CIFS) Operations ('head' driven)
- Cache friendly or unfriendly workloads
- Small files Vs large files and Sequential Vs Random workflows
- Replication and Backup workloads
- De-duplication and other overheads
Performance Areas to Watch

- "Head" Vs "Disk" contention
  - Dedup, replication, backups could cause contention on head or disks or both

- Head memories - how much, where?
  - File Processing, FC, CPU, Network processing, NDMP

- Caching (more on this in other slides)
  - 'Front-end' Cache to accelerate performance (comes in various forms) could become an overhead
  - Are the workloads cache friendly?
  - Does the system allow cache utilization reporting?
  - Is it tunable?
Performance Areas to Watch

Contention on the LAN

- Load balancing across multiple 1GigE trunks using Link Aggregation
- Use 10GigE if possible, combine with 1GigE for failover
Enterprise NAS Requirements

How to gauge performance?

- Create your own performance benchmarks to find a baseline
- Find worst case and best case scenarios based on system configurations
- Put it to test for worst real-world workloads
- Do this in "production" configuration, not in test configuration
- Test for performance during a component failure scenario

Combine it with backups, replication, dedup, etc

Understand the penalties of failover of "head"
Enterprise NAS Requirements

 Enterprise NAS Requirements - Scalability

 Long Term Concerns –

- What is your growth rate?
- Can you visualize your NAS/Storage infrastructure in next 5 years?
- How do you plan to do Data Management across the entire NAS footprint?
- How would you manage your NAS Infrastructure today and in 5 years?
Enterprise NAS Requirements – Scale-Up NAS Silos

Separate NAS Entities resulting in storage inefficiencies and sprawl over time (Example capacities)
Short Term Concerns –

- Are you adding to or replacing existing solution?
  - How much performance and disk capacity are you planning for?
- How would you add more performance?
- How would you add more capacity? Independently or tied to performance?
- How much capacity is too much on a single system?
About "Front-End" Cache Implementations

Examples -
- External Caching Device - between clients and NAS
- Internal, based on PCIe SSD adapter
- Internal as a set of SSDs
- External Metadata Acceleration
- External Extended NAS configuration (hub and spoke)
"Front-End" Cache – Considerations

- Usually, 'learning' or adaptation period is involved
  - Can take minutes to weeks depending on workloads
  - Size of the cache is a factor
- Sizing front-end cache (if it's an option) against spinning disks can be challenging - due to costs
- Determine Workload suitability for "hit" rates
  - Known or predictable Vs unknown workloads can impact cache efficiency
  - Structured and unstructured data
  - Reads Vs writes, random Vs sequential
- Serves Reads, Writes, or both?
"Front-End" Cache – Considerations

- PCIe and SSD implementations have difference in performance/scalability
  - PCIe based usually is faster, but not scalable
- Is it volatile to power or system exceptions?
  - Re-learning in case of power failures (can take a long time to re-learn, volatile Vs non-volatile)
- Data promotion/eviction or maintaining multiple cache copies across cluster nodes could become an overhead for certain workloads
About Storage Tiering and Caching

- Both could be SSD implementations
- Cache is reactive, tiering can be both reactive and proactive based on policies
- Caching is to Accelerate Data, Tiering is to Manage Data
- Caching is workload dependent, Tiering is time dependent
- Caching and Tiering complement each other, not compete
Storage Tiering In NAS

- Can be block or file based, automatic or manual
- Beneficial if system intelligently places data for you
- Even better if it works across discrete systems - automatically!
- Far better if tiered storage is file-system aware
- Backup Performance in block-based tiered Storage can be a challenge
- Sizing the disk tiers for balance of performance and cost is the key - be conservative initially
Tier0 in NAS (Tier0 = SSD for this discussion)

- Best if Tier0 is space is managed automatically
- Estimating Tier0 capacity is the key
  - Estimate against lower tiers
  - Between 1 to 10% being standard
  - Significant cost differences between 3% and 10% Tier0

- Sizing active data appropriately is important
- Getting numbers from backup related stats (or replication deltas) could be useful
Storage Tiering In NAS

✧ Reporting & Monitoring of Automatic Tiering
  ✧ How effective is Tier0 (since it's most expensive)?
    › Consider Hits and Capacity Utilization
  ✧ Which workloads are being benefitted?
  ✧ Can you establish a correlation between blocks and files?
  ✧ Are there levers to fine-tune the process and policies?
Scale-up or Vertically Scalable (typically only disks)

- For high performance – cannot add large amount of disks
  - Overruns the Storage/NAS Processor
- Storage Processor and/or NAS Heads do not scale
  - Could be upgraded though
- Creates a big sprawl of independent NAS systems
  - Results in disk space inefficiencies

Good all-in-one/multi-purpose solutions

Multi-protocol support is good

Not focused on one type of workload

- Could be designed for specific workloads
Scale-Up

- Feature rich - snapshots, dedup, replication, VMware integration, etc
- Multiple storage buckets, not all in one solution
- Flexibility with tiered storage
- Block and file can be unified
- Can be open-source, commercial or a combination
- Tiering across individual NAS systems is a challenge
Scale-out or Horizontally scalable (typically capacity and performance) - usually are clustered NAS

- Multiple redundant nodes performing file processing and/or disk functions

Scale-out NAS origins

- Typical Use Cases in - Media, Entertainment, Oil & Gas exploration, Imaging (high bandwidth)
- Usually associated with High-Performance Computing

Usually distributed filesystem

Performance independent redundancy

- Data striped across multiple nodes
Scale-Out NAS

- Data and metadata could be separated
- One large storage bucket
- Could use commodity hardware and storage
- Can be open-source, commercial, or a combination
- Could provide higher aggregate performance
  - Single-client performance usually not impacted much
  - High-performance, mainly benefiting large files
- Massive scalability for disk capacity
- Usually serves a single purpose
Scale-Out NAS

- May increase networking requirements (due to more nodes)
- May increase power/cooling needs depending on the configuration
- Could get better disk utilization as the system grows
When investigating scale-out Vs scale-up, check your requirements and concerns –

- What type of performance are you looking for (small file, large file workloads)
- Snapshot capabilities
- Uptime requirements (SLAs), and vendor support
- Are you combining file and block on the same system
- Replication, Mirroring
- Protocol support (NFS, CIFS, FTP, HTTP, etc)
- Backing up the data to tape
Scale-Up Vs Scale-Out NAS

- Existing Infrastructure and protocols in place for LAN/SAN, and Application layer) – the ones that are in use and IT teams are familiar with - or not in place, i.e., additional costs to support it
- Multi-tenancy support
- De-duplication, compression, Virtualization environment integration
De-duplication & Compression

Know the differences
- Compression - removal of redundant bits
- File Dedup - removal of redundant files
- Block/Data Dedup - removal of redundant blocks

Check what is offered
- Dedup only (file or block) - good
- Dedup (file or block) + compression - better
- Dedup (File or block) + compression - best
De-duplication not for everyone

- May put performance penalty on CPU and memory
- May impact user response times on active filesystems
- Storage space gains can be realized for less active filesystems, but could be at the cost of additional data management
De-duplication on NAS

- Challenging to track on/off/status/gains for 100s of active filesystems
- Under what scenarios (backups, mirroring, snapshots) and workloads hydration is triggered
- Space gains from file Vs block dedup could vary – additional 2% gain in a large environment is significant
In Summary…

- Many Enterprise NAS flavors available today
- Know your requirements to find the right solution
- Plan for long term - scalability, stability, data management
- Scale-up and Scale-out both have their use cases
Many thanks to the following individuals for their contributions to this tutorial.
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Send any questions or comments on this presentation to SNIA: tracktutorials@snia.org