Centralized vs. Distributed
A Great Storage Debate

Live Webcast
September 11, 2018
10:00 am PT
SNIA-At-A-Glance

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Today’s Agenda

- The Rules of the Debate
- The “Whats and Hows”
  - Centralized Storage
  - Distributed Storage
- The Trade-Off Debate
The Rules of The Debate

- Spoiler Alert: There is no “winner”
  - This is all about the “sweet spot”
- Participants:
  - Define the technologies
  - How they work
  - Discuss the trade-offs

No hitting below the belt
Storage Has One Job!

- One main job
  - “Give me back the correct bit I asked you to hold for me.”
- Everything we do in storage (including storage networking) is based around completing that job safely, securely, reliably, and without error

You had one job!
All Storage

- Needs to:
  - Protect data
  - Keep data secure
  - Stay within regulatory compliance
  - Be manageable
  - Be backed up!

- May need to:
  - Be scalable
  - Be sharable
  - Be very fast
Criteria for Choosing

- **Items to consider in choice of storage**
  - *Access* — what protocols can I use?
  - *Performance* — will my applications & hence users be happy?
  - *Availability* — can I tolerate periods without access?
  - *Capacity* — how big do I need?
  - *Protection* — how do I ensure my data’s integrity?
  - *Durability* — how long do I need to store my data?
  - *Security & Privacy* — will sensitive data be OK here?
  - *Cost* — is it cheaper than the alternatives?

- Let’s discuss some of these
John Kim

CENTRALIZED STORAGE
Definitions

- Direct Attached Storage (DAS)
  - Storage directly attached to just one server
- Storage Area Network (SAN)
  - Centralized block storage system connected to multiple hosts using networks such as Fibre Channel, iSCSI, NVMe-oF, or InfiniBand
- Network Attached Storage (NAS)
  - Centralized or distributed file storage connected to multiple hosts using file protocols, usually using Ethernet networking
- Hyperconverged Infrastructure (HCI)
  - Set of servers each with compute and storage resources, often sharing those resources with each other
First There was Local Storage

- Local storage for each server
  - Inside the server or directly attached to one server (DAS)
- Easy to buy, set up, and consume
  - Server vendor/integrator can install
  - All operating systems/hypervisors can use
  - No special drivers or networking required
- But…
  - Inefficient and difficult to manage at scale
  - Issues with backup, failover, utilization, sharing
Then Centralized Storage

- Consolidate storage into centralized systems
  - Each supports multiple servers
  - Connect via PCIe, SAS, SAN, NAS or Object

- Easier to share and protect data
  - Higher utilization
  - Easier backup, recovery, failover, sharing
Comparing Storage Models

Internal vs. DAS vs. SAN/NAS

Internal Storage

Server
- SAS/SATA
- HBA
- HDD/SSD
- PCIe bus
- HDD/SSD
- NVMe SSD

DAS

Server
- HBA (SAS, SATA, FC, IB)
- JBOD / JBOF

SAN / NAS (Centralized Storage)

Server

Switch

Storage Array
## Comparing Storage

<table>
<thead>
<tr>
<th>Type</th>
<th>Location</th>
<th>Connection</th>
<th>Sharing Level</th>
<th>Distributed?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>Inside server</td>
<td>SAS/SATA/PCIe</td>
<td>None</td>
<td>No</td>
</tr>
<tr>
<td>DAS</td>
<td>Attached to 1 server</td>
<td>SAS/SATA/PCIe, FC, IB</td>
<td>None</td>
<td>No</td>
</tr>
<tr>
<td>SAN</td>
<td>Centralized array</td>
<td>FC, Ethernet, IB</td>
<td>Array</td>
<td>Rarely</td>
</tr>
<tr>
<td>NAS</td>
<td>Centralized array(s)</td>
<td>Ethernet</td>
<td>File</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Object</td>
<td>Multiple arrays</td>
<td>Ethernet</td>
<td>Object</td>
<td>Yes</td>
</tr>
<tr>
<td>HCI</td>
<td>In each server, or…</td>
<td>Ethernet</td>
<td>depends</td>
<td>Usually</td>
</tr>
</tbody>
</table>
Alex McDonald

DISTRIBUTED STORAGE
Distributed Storage: a definition

- Difficult to precisely define
  - Data stored on many systems which behave as a single entity
  - Geographically or regionally dispersed rather than local to a data center
  - Accessed over LAN or WAN, commonly Ethernet
  - Cloudy-ish; often implemented on shared resources

- Well, I give up…
  - Not centralized or hyperconverged (HCI)
  - Scales out (horizontally) rather than up (vertically)
Access to & Performance of Distributed Storage

- Network connectivity & performance criteria
  - Bandwidth & Latency
    - “Bandwidth problems can be cured with money. Latency problems are harder because the speed of light is fixed - you can’t bribe God.”
  - Compute location
    - Low bandwidth & poor latency tolerable if the compute is next to the data, and we only need to send/receive small amounts
  - Flash technologies? SSD? NVMe?
    - Yes; this isn’t just about cheap spinning disk any more

- Protocols; tend to be application driven
  - Object type storage (S3, CDMI, Swift)
  - LAN/WAN protocols (SMB, NFS)
  - Block (iSCSI)

- Rule of thumb
  - The less “cloudy” or “WANny” the access, the less likely the application will tolerate high latency and/or low bandwidth
Data Security & Privacy

- **Security vs. Privacy**
  - Security is making sure only the right people/systems have access to the data
  - Privacy ensures that the data isn’t misused

- **Security measures**
  - Identification & authentication systems
    - e.g. Kerberos & NFS, LDAP & SMB
  - End-to-end encryption (including devices)
  - Storing data in the right place & knowing how the data is managed
    - Replicas, mirroring, cloud brokering, backups can all be in different places and differently secured
Scaling out rather than up

- **Capacity can be seen as infinite**
  - “It’s just a matter of cost…”
  - More capacity tends to exacerbate these issues:
    - More cold data
    - Higher bandwidth, especially to distributed storage
    - Harder to avoid putting compute with the data
    - Increased data amnesia
    - Harder systems management problems
Distributed storage uses a variety of techniques

- Standard RAID technologies
- Mirroring & replication
  - 2 or 3 location copies
- Erasure coding

For a detailed Q&A on these techniques and an on-demand introductory webcast visit: [http://sniaesfblog.org/storage-basics-qa-and-no-ones-pride-was-hurt/](http://sniaesfblog.org/storage-basics-qa-and-no-ones-pride-was-hurt/)

Or CAP

- Consistent, Available, Partitioned; pick 2

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Future of Distributed Storage

- Distributed storage offers new & interesting solutions
- New database technologies
  - NoSQL, key/value, tabular, document...
- On-disk compute
  - Key/value stores directly on the drive
  - Processing on the drive
    - Data classification, analysis, automated metadata
  - Brought together by “consolidating” applications
- IoT (Internet of Things)
  - Big data generators
  - Data at the edge
Status Check - Midway Summary

- Centralized
  - More efficient storage utilization
  - Simpler storage management
- Distributed
  - Scales out, not up
  - Latency a secondary consideration
So… what are the trade-offs?
Is Data Locality Really Important?

- **Centralized Storage**
  - Need servers and storage in same data center
  - WAN links = too much latency
  - Install storage near users (i.e. ROBO, cloud)
- **Object and file can support remote access**
  - But then usually set up as distributed storage
Is Data Locality Really Important?

- Distributed Storage
  - At scale, data locality hard to achieve
  - Data has mass & inertia
    - Easiest to process where it’s born, centralize the summaries
    - Partial compute at the edge
  - New technologies prevent extreme centralization
    - IoT, blockchain & distributed ledgers, datatypes like video & image, etc.
How to Scale Centralized?

- Performance scaling
  - Array performance limits
  - Network limits
  - May require locality
- Capacity Scaling
  - Adding more arrays
  - Management burden
How to Scale Distributed?

- Just add more!
- Limits of scaling may constrain the solution
  - Economics: cost, bandwidth, latency
  - Legal: data placement & security
  - Technical: bandwidth, latency
- Application plays a part
  - Not all distributed systems can scale out to infinity
  - CAP limitations ensure that
Shared Resources

- Centralized
  - Arrays not shared
  - Network & admins sometimes shared
  - Might share management tools
- Different arrays for different workloads
  - More flexibility in features
  - Extra management headaches
Shared Resources

- Distributed
  - Data location is a moveable feast
    - Backups, mirroring, sharding
  - Recovery scenarios can be complex
    - Who & what is impacted by failure & restores?
  - Fully understand security & privacy
    - Authentication & authorization
    - Safe Harbor & GDPR important here
  - Impacts on performance & capability
    - “Noisy neighbors”
Centralized Storage

- Complex to deploy, manage
  - Need reliable network
  - Might need special drivers
  - Array/network mgmt. skills
  - Security
- Challenges at large scale
  - Managing many arrays
  - Balancing capacity & workloads
  - May be difficult to automate
Installation, Configuration, Management

- Distributed Storage
  - A range of tools
    - Installation & sizing tools
    - Capacity, performance, application usage, user usage, chargeback & showback
    - OpenStack, Docker, Kubernetes…
  - Offer management consoles & dashboards
    - Software defined configurations
    - Compute, network & storage virtualization on one pane of glass

- New DevOps tools “understand” applications
  - Ansible, Chef, Puppet…

- Issues:
  - Data amnesia; forgetting what was put where it is a big issue
  - Data migration from system to system can be a challenge
  - Data can suffer from “container lock in”
  - Many dashboards are product specific & can be incompatible with each other
  - Too much choice in DevOps tools?
What’s the Cost/Economic Profile?

Centralized

- Usually custom (bespoke) hardware
  - Dedicated storage platforms
  - Often uses dedicated network
  - Less likely to be SDS or cloud
- More likely to be Cap/Ex
  - Op/Ex model available through leasing, cloud
What’s the Cost/Economic Profile?

- Distributed
  - Cap/Ex or Op/Ex? - “It’s the economy, stupid!”
  - Cost is a big factor
    - Consider a longer term cost profile
    - Largely due to scale
    - Future unknown, but historical $/byte cost has fallen pretty consistently
  - For applications to be of value, their cost components have to be manageable and smaller than the benefits
  - Pressure of
    - Systems management costs
    - New application models (like container, serverless)
Backup and Data Protection

Centralized

- Easy to backup, fast restores
  - A big reason to go centralized
- Usually includes RAID, snapshots, clones
- Replication and remote backup options
  - To local system, remote system, or the cloud

Snapshots: point-in-time copies of your data

Storage clones: start identical, change over time
Backup and Data Protection

- Distributed
  - Backup can be harder
    - Backup implies a complete redundant copy
    - Remember CAP & eventually consistent
  - Durability
    - Not all data needs to be durable
    - But when it must be, avoiding “bit rot” & “device obsolescence” requires data to be moved
  - Long term data retention especially an issue

Register for: “The 100 Year Archive Survey Results”
October 10, 2018
https://www.brighttalk.com/webcast/663/335255
Debate Summary

- Centralized makes each array the center of attention
  - Each array handles backup, security, management
  - At scale, requires lots of attention, management
- Distributed spreads performance and capacity across multiple systems
  - Easy scalability, often lower costs
  - Security and backup can be more complex
- Both ways have advantages
More Webcasts

- Other Great Storage Debates
  - FCoE vs. iSCSI vs. iSER
    https://www.brighttalk.com/webcast/663/318003
  - Fibre Channel vs. iSCSI:
    https://www.brighttalk.com/webcast/663/297837
  - File vs. Block vs. Object Storage:
    https://www.brighttalk.com/webcast/663/308609
  - RoCE vs. iWARP: https://www.brighttalk.com/webcast/663/329518
- On-Demand “Everything You Wanted To Know About Storage But Were Too Proud To Ask” Series
  - https://www.snia.org/forums/esf/knowledge/webcasts-topics
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- This webcast and a PDF of the slides will be posted to the SNIA Ethernet Storage Forum (ESF) website and available on-demand at www.snia.org/forums/esf/knowledge/webcasts
- A full Q&A from this webcast, including answers to questions we couldn't get to today, will be posted to the SNIA-ESF blog: sniaesfblog.org
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Thank You!