



White Paper

Managing Large-Scale Storage Upgrades

Lessons from the NetApp IT Storage Lifecycle Management Program

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Abstract

Performing storage upgrades can be challenging in any environment, but especially in enterprises with large storage installations. Like many of our customers, NetApp IT has a large and complex environment that can make upgrades difficult. To minimize risk and enable smooth transitions from one storage version to another, NetApp IT developed a storage lifecycle management program. Through the program, NetApp IT was able to improve performance, manage updates on storage software and the hardware environment, and help our Engineering department create enterprise products that we can showcase to customers.

Use these helpful tips to help your next NetApp® ONTAP® upgrade go smoothly, without disruption.

TABLE OF CONTENTS

1	NetApp IT as Customer-1	3
2	The Challenges of Large-Scale Storage Upgrades	3
3	The NetApp IT FAST Program	3
4	Mitigating Risks	4
5	ONTAP Upgrade Schedule	5
6	ONTAP Upgrade Considerations	6
7	SnapMirror Data Protection and Unified Replication Relationships and Conversion	6
8	End-of-Support FAS Systems	6
9	Storage Management Software	7
10	NetApp IT ONTAP Upgrade Success	7
11	Lessons Learned	8
	Where to Find Additional Resources	8

LIST OF FIGURES

Figure 1)	FAST program steps	3
Figure 2)	NetApp IT FAST program release cadence	4
Figure 3)	ONTAP upgrade considerations	4
Figure 4)	FAST upgrade schedule	5
Figure 5)	ONTAP upgrade timeframe	8

1 NetApp IT as Customer-1

As “Customer-1” for NetApp, the internal IT team acts as the first and earliest adopters of NetApp® products. NetApp IT deploys, tests, and provides feedback on products in real production environments before the products are in general release. This feedback is particularly critical in identifying and addressing issues and features that don’t rise to the surface unless running variable loads and live data sets. Our product development team relies on the Customer-1 experience to learn more about how products perform in real-life settings and the challenges of day-to-day operational support like performing storage upgrades. The purpose of this white paper is to share our best practices for managing storage upgrades at scale.

2 The Challenges of Large-Scale Storage Upgrades

A common conundrum for IT infrastructure teams is storage lifecycle management. There are multiple challenges to maneuver, ranging from addressing compatibility issues among operating systems to minimizing the risk of business disruptions and major outages. Depending on the version, upgrades can take a long time, consume valuable resources, and cause business disruptions—particularly if you have a large storage fleet.

NetApp IT understands the challenges of large-scale storage upgrades. Like many enterprise IT departments, we have a large and complex storage environment. In June 2020, we were running over 100TB of raw storage with 450 storage controllers and 5,000 servers to support approximately 350 enterprise applications.

3 The NetApp IT FAST Program

To avoid possible gut punches from storage upgrades, Customer-1 has established a standard program to bring structure and rigor to its data infrastructure. Our storage lifecycle management program is called First Application Systems Testing (FAST). Over the past several years, we have evolved the FAST program as we traversed upgrades involving 7-Mode, clustered Data ONTAP, and ONTAP.

The NetApp IT FAST program enables NetApp IT, as Customer-1, to improve performance, conduct upgrades, and help Engineering create enterprise NetApp products that can be showcased to NetApp customers. The FAST program covers all NetApp products, including ONTAP, NetApp StorageGRID®, NetApp HCI, and NetApp E-Series.

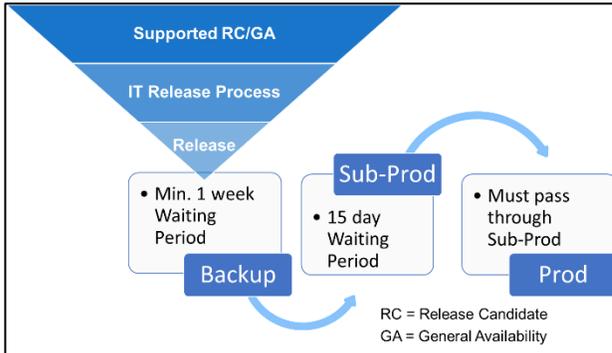
At NetApp, we have two types of product releases: release candidate (RC), which is ready to release unless significant bugs emerge, and general availability (GA), which is ready for customer use.

Figure 1) FAST program steps.



In step 1 of the FAST program, we put the product candidates (RC and GA) in our lab environment and wait 1 week to check the stability of the new code. If everything looks good after a week, we move to step 2, where we test the candidate against a backup copy of our production environment. We upgrade and test the entire backup—again for a week—before moving to sub-production (Sub-Prod) in step 3.

Figure 2) NetApp IT FAST program release cadence.



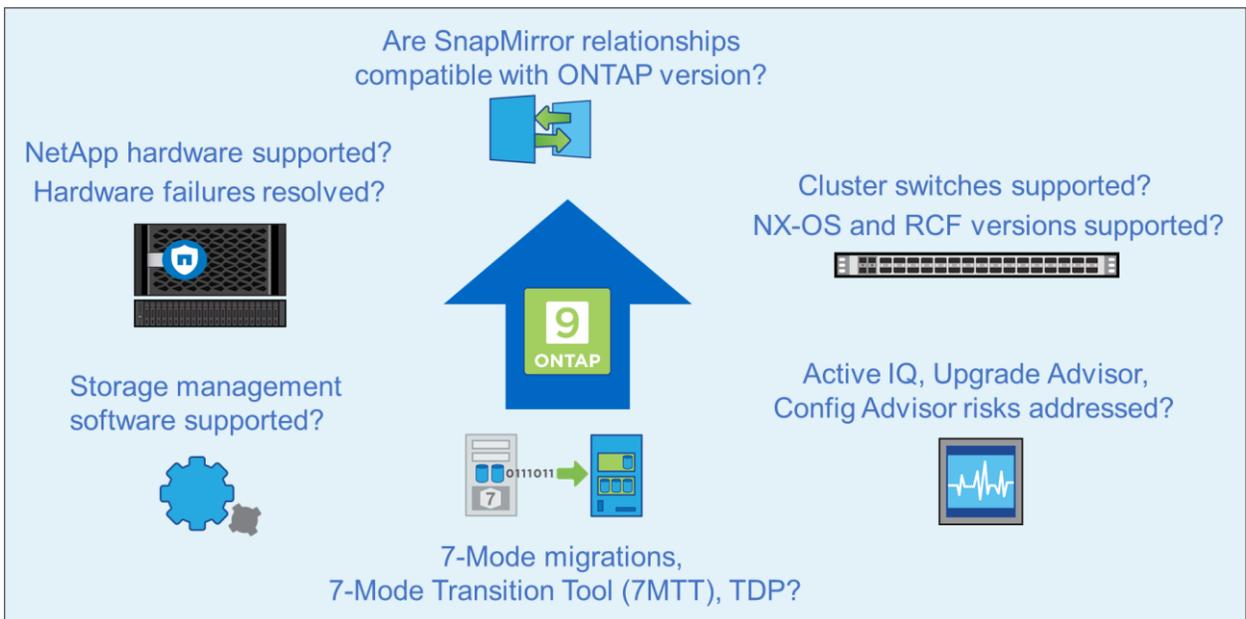
After a week has passed, Sub-Prod migration can begin. According to our FAST policies, we re-create at least the full clusters in the Sub-Prod environment before moving to production. After the Sub-Prod clusters are upgraded and observed for 2 weeks, we can move the candidate to the production phase. Because production is our critical application environment, we deploy only GA to production.

4 Mitigating Risks

In the early stages of the program, it was difficult to get agreement from application owners to perform the upgrades because of the risks associated with application outages and the business disruptions. To mitigate these risks, the program team implemented collaborative planning sessions with the corporate application owners. With proactive communications, assessments, and detailed planning, we have been able to avoid technical issues during upgrades.

As shown in Figure 3, we consider several questions to mitigate risks with ONTAP upgrades. To begin the pre-upgrade checks, we look at Upgrade Advisor, NetApp Active IQ®, and Active IQ Config Advisor for health issues or risks in our environment that we need to address before beginning the upgrade. We look at the hardware to make sure that it is supported with the target ONTAP release. Then we check for any hardware failures or issues in the environment so we can address them before we start.

Figure 3) ONTAP upgrade considerations.



We look at the external tools and utilities that we use to help manage the storage environment, specifically software that runs outside the cluster. We make sure that those tools and utilities are

supported with the target ONTAP release. We make sure that the SAN hosts are multipathed to ensure that those hosts continue to have uninterrupted access to their LUNs throughout the takeovers and givebacks which are part of the upgrade process.

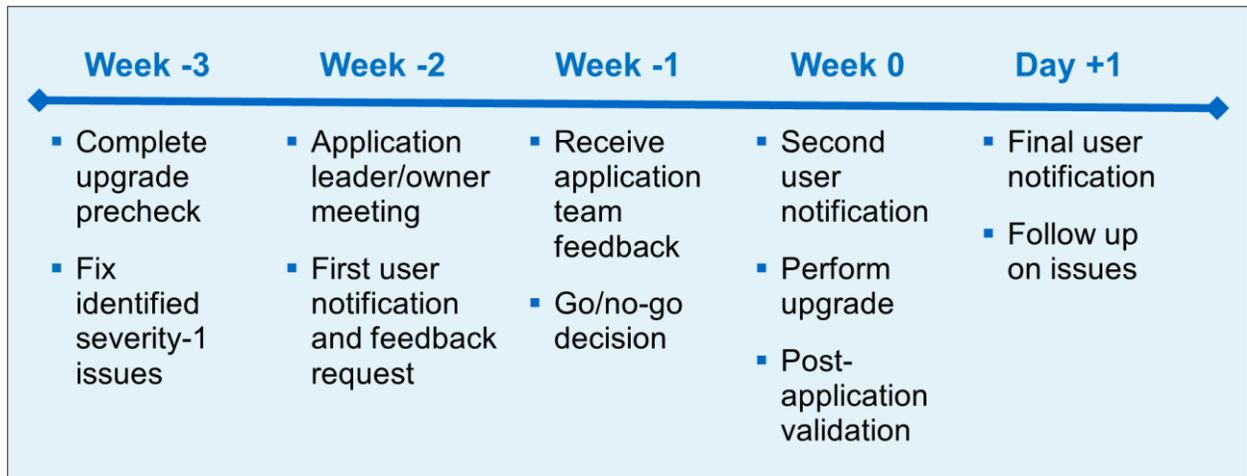
If SnapMirror is used, we make sure that we are running compatible ONTAP versions on the clusters with source and destination volumes. Cluster switches, NX-OS versions, and RCF versions all need to be supported by the target ONTAP version. We then review system shelf and disk firmware along with the ONTAP release notes to understand the changes that are being introduced with the new ONTAP version. After the storage upgrade is completed, we perform active application and database validation, and we do high-availability (HA) pair stability monitoring, before moving to the next upgrade.

The automatic, nondisruptive upgrade feature in ONTAP helps avoid any manual errors that might hinder upgrades. We use a checklist during the upgrade process, and after the upgrade is complete, we perform active post-validation on critical applications and on the standard process used for the upgrade.

5 ONTAP Upgrade Schedule

Figure 4 shows the standard upgrade schedule for NetApp ONTAP. It is usually a 4-week schedule. At week -3 (three weeks before the upgrade), we perform a complete precheck. During this precheck, we identify any technical issues that are preventing the upgrade. We immediately address any high-impact, severity-1 issues that will prevent the upgrade.

Figure 4) FAST upgrade schedule.



At week -2, we hold an application leaders and owners meeting. The program team explains the benefits of the upgrade and the schedule. Then the application team can share its release schedule for the affected application to avoid any conflict between its releases and our storage upgrade.

If there is a major application release scheduled during our upgrade window, we change our schedule. Then we send out our first user notification and request feedback. At this point, the project team then makes a "go" or "no-go" decision for the upgrades.

At week 0, we send out the second user notification and perform the upgrade. For Tier-1 applications that affect revenue and customer orders, we perform the active post-application validation with the Tier-1 application team immediately following the storage upgrade.

At day +1, we send out the final user notification regarding the status of the storage upgrade and follow up on any issues from the application teams.

6 ONTAP Upgrade Considerations

When we prepare to upgrade ONTAP, there are several things we check for to lay the foundation for a successful upgrade. Specifically, we want to make sure that:

- Our hardware is supported with the target ONTAP release
- Any hardware failures or issues have been addressed and resolved
- Where NetApp SnapMirror® is configured, we are running compatible ONTAP versions for source and destination clusters
- Cluster switches, NX-OS versions, and reference configuration file (RCF) versions are supported with the target ONTAP release
- Monitoring tools are reviewed so health issues or risks in the environment are identified and addressed
- When migrating data from systems that are running Data ONTAP operating in 7-Mode, the target ONTAP versions support transition data protection (TDP) SnapMirror
- Any external, off-box storage management software is compatible with the target ONTAP release

7 SnapMirror Data Protection and Unified Replication Relationships and Conversion

SnapMirror data protection (DP) relationships are clusters that use a version-dependent replication engine. In DP mode, SnapMirror destination volumes must run a NetApp ONTAP version that is the same or later than the version running on clusters with SnapMirror source volumes. SnapMirror unified replication relationships (extended data protection, or XDP) feature more interoperability between ONTAP versions. However, there are some exceptions.

When we upgrade to ONTAP 9.3 or later versions, any preexisting DP relationships are not automatically converted to XDP. Those relationships are still DP relationships that continue to function as they always have.

There are three reasons why we might want to consider converting those relationships to XDP:

- Interoperability is improved with different ONTAP versions for XDP relationships.
- As reported in [support document 1166096](#), clusters with SnapMirror DP destination volumes might panic or experience an unplanned takeover. That risk is avoided by converting those relationships from DP to XDP.
- Storage efficiency limitations are associated with DP relationships. With DP relationships, source volumes and destination volumes need to have identical storage efficiency configurations. Converting those relationships to XDP eliminates that limitation.

In the process of converting from DP to XDP, we make sure that the source and destination volumes have a common NetApp Snapshot™ copy. This way, when we break off the existing DP relationship and re-create a new XDP relationship in its place, we can simply resynchronize the relationship instead of having to rebaseline it.

8 End-of-Support FAS Systems

Several NetApp FAS systems and product families are no longer supported. For our upgrade from ONTAP 9.1 to 9.6, there were several storage systems in these product families that needed to be evacuated. In response, we developed a systematic approach to node evacuation.

Node evacuation effort begins with cleanup. We start by identifying any orphaned cluster configurations or other storage resources that are no longer in use. These resources might consist of anything that is inactive or has been orphaned. This identification simplifies the migration process.

Next, we look at a zero IOPS report. Volumes that have had zero IOPS for 90 days or longer can be safely considered inactive. We start the decommissioning process on those volumes.

We also enable a volume recovery queue with 360 volume delete retention hours. This gives us the opportunity to recover previously deleted volumes for 360 hours (15 days) following the volume deletion. If there ends up being no reason to recover the volume, then the volume is permanently and automatically deleted from the cluster.

After the cleanup effort is complete, we can start migrating NAS data volumes. After NAS data volumes have been migrated, we continue on with SAN volumes.

With SAN volumes, there are a few different considerations. There are several hosts with boot LUNs in our environment. In our migration, downtime was required to update the storage path in the BIOS of those hosts. We needed to update the configuration to point to the new LUN location on the new HA pair.

For data LUNs, we can migrate one path at a time by taking the LIF (logical interface) down on the old node, bringing it up on a port on the new node, and making sure that the host has access through the new path. Then we repeat the process with the redundant path.

Selective LUN mapping enables us to restrict LUN access to the HA pair, which hosts the LUN as we are preparing to migrate a SAN volume from the current HA pair to a new HA pair. We then update the LUN-mapping configuration to include the destination HA pair and the source HA pair. After we migrate the volume, we can remove the source HA pair from that mapping configuration. For Fibre Channel (FC) LUNs, we also need to update the zoning configuration to make sure that those hosts have access from their LUNs to the new HA pair.

Other considerations related to the node evacuation process include things like migrating storage virtual machine (SVM) root volumes, re-creating live secondary (LS) mirror volumes, rehomeing NAS data lifts, and rehomeing SVM management lifts.

9 Storage Management Software

Our storage management software includes the software, tools, and utilities that we run outside the cluster to help manage our storage environment. With ONTAP 9.1 and prior versions, we made extensive use of NetApp SnapDrive® for Windows and NetApp SnapManager® for Microsoft SQL Server. Note that SnapDrive for Windows is no longer supported after NetApp ONTAP 9.3.

SnapManager for SQL Server requires SnapDrive for Windows. In planning for our upgrade to ONTAP 9.6, we needed to replace this solution to back up our SnapManager and SQL Server data. We replaced those products with NetApp SnapCenter®.

SnapCenter provides application-consistent data protection for ONTAP hosted data anywhere in the hybrid cloud. The architecture consists of a centralized SnapCenter Server. Then a plug-in is installed on each of the hosts that we want to back up. Because we use this product to replace SnapDrive and SnapManager for SQL Server, its primary use is to back up SQL Server data.

The solution also provides plug-ins for other types of data, including Microsoft Exchange Server, Windows, Oracle, SAP HANA, and VMware vSphere. There is also a custom plug-in that can be configured to back up other application data types.

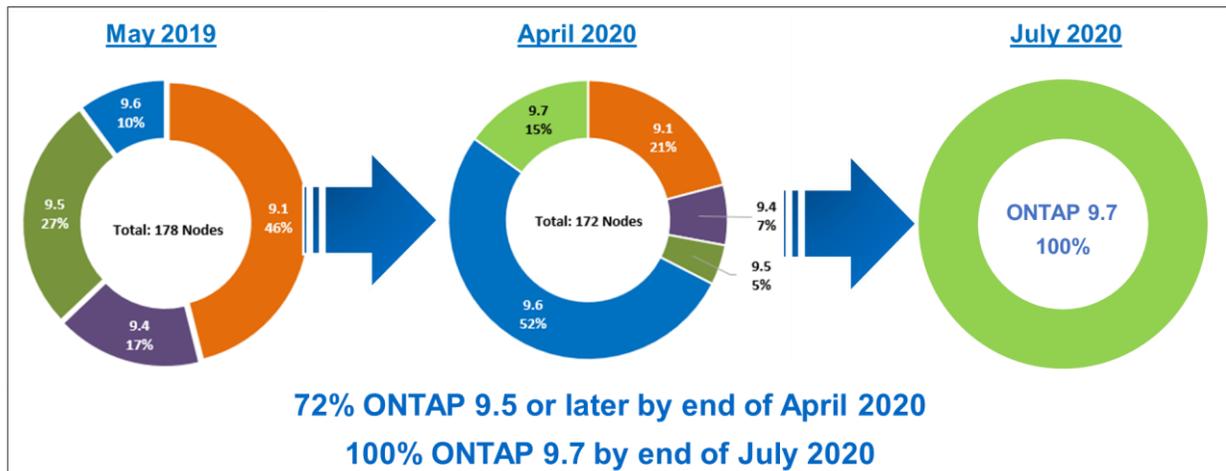
10 NetApp IT ONTAP Upgrade Success

Our NetApp ONTAP storage fleet supports the entire corporate application portfolio. In May 2019, 46% of the clusters were running on ONTAP 9.1, and 37% of the clusters were running ONTAP 9.5 or 9.6. After

12 months, 21% of the clusters were on ONTAP 9.1, and at the end of April 2020, 72% of the clusters were on ONTAP 9.5, 9.6, and 9.7. Out of those ONTAP 9.1 clusters, all data migration and SnapCenter migration was completed.

We are currently running the ONTAP 9.7 upgrade cycle, with the goal of having our entire ONTAP fleet running ONTAP 9.7 by the end of July 2020. We completed our final migrations of Data ONTAP operating in 7-Mode in June 2020 and no longer have any 7-Mode deployments.

Figure 5) ONTAP upgrade timeframe.



11 Lessons Learned

To be successful and have no impact on the applications during your ONTAP upgrade, we recommend:

- Implementing upgrades based on an accurate “upgrade precheck”
- Performing further data migrations for Data ONTAP operating in 7-Mode or for node notifications to remove the end-of-support node
- Working closely with the users’ application teams and infrastructure teams
- Maintaining the trust of your users
- Creating organized approaches and an efficient process

For some applications, like Tier-1 applications with direct impact on running the business, it is difficult to schedule downtime. We have developed Ansible automation playbooks to eliminate downtime during the cutover. We continue to improve our process to maintain our robust storage fleet and data infrastructure.

Where to Find Additional Resources

To learn more about the information that is described in this document, review the following websites:

- [Interoperability Matrix Tool](#)
- [End of Availability](#)
- [Disk Shelf Firmware](#) and [Disk Drive Firmware](#)
- [System Firmware and Diagnostics](#)
- [Cisco Cluster Network Switch NX-OS Software Download](#)
- [Cisco Cluster Network Switch Reference Configuration File Download](#)
- [NetApp Software Downloads](#)

Refer to the [Interoperability Matrix Tool \(IMT\)](#) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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