

Technical Report

# NetApp for Epic Software

## Solution Design

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### **Abstract**

This document discusses how to enable NetApp® storage system for Epic software.



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# 1 Overview

Epic Systems is a healthcare company that develops software for medical groups, hospitals, and integrated organizations. Epic works with customers such as community hospitals, academic facilities, children's organizations, safety-net providers and multihospital systems.

In this document we are discussing a storage system for Epic deployments. Epic software provides a single patient-centric database that uses the InterSystems Caché database management system available on various operating systems (OS), including IBM, AIX, and Linux. We are focused on enabling the NetApp storage system to satisfy the requirements for the InterSystems Caché database used in Epic software. Generally, dedicated storage resources are provided for the production database and the shadow database shares secondary storage resources with other Epic software such as Clarity or other software storage environments.

## 1.1 About NetApp

NetApp is a leading organization for software systems and services to store and manage software associated with enterprise data. NetApp FAS is a disk storage device that owns and controls a filesystem. It presents files and directories over the network using an operating system called ONTAP®.

NetApp storage handles hardware and software solutions provided by NetApp for different organizations in various industries. Hardware and software work together to drive efficiency and reduce cost for storage equipment. NetApp's goal is to reduce enlarged space for IT storage such as Snapshot copies, failover protection, and backups.

## 1.2 Why NetApp

Leading healthcare providers and organizations depend on NetApp to store patient data and medical images reliably and efficiently. NetApp helps you to deliver high-quality patient care by providing powerful, integrated hardware and software solutions that allow fast, cost-effective, and scalable storage.

Healthcare organizations can buy and implement Epic using NetApp's architected solution with confidence, knowing that it delivers a high-performance storage platform that exceeds Epic's published SAN read and write latency requirement. Unified storage infrastructure includes SAN and NAS, flash and hybrid backup, disaster recovery, and support for moving some portions to the cloud.

The NetApp solution for an Epic environment provides consistent high-performance availability and data protection while reducing IT business costs and complexity.

# 2 Technology Requirement

This document is relevant for those who intend to setup their own Epic infrastructure. NetApp recommends that you have all configuration reviewed by your technical support team and the vendors' Epic team before placing your product server and storage order. Required hardware configuration is based on the platform, software applications, activity on storage volumes, and other parameters. NetApp recommends consulting with Epic to decide whether an updated hardware configuration is needed.

### Major Appliances Required for Epic:

- Operational database server
- Cogito Clarity reporting server
- Client device
- Presentation tier
- Service server
- Storage

Table 1) Technology requirements

Type		Requirements
Hardware	Hardware System	<ul style="list-style-type: none"> <li>• Test database server</li> <li>• Cogito Clarity</li> <li>• Multipurpose virtual servers</li> <li>• Storage</li> <li>• Citrix XenApp server (optional)</li> </ul>
	Processor Type	<ul style="list-style-type: none"> <li>• 24 Core Intel Xeon E7-8890V4</li> <li>• Intel Xeon E5-2699 v4</li> <li>• Intel Core i5-6500 processor</li> <li>• Intel Atom Z3740 processor</li> <li>• Intel Xeon E5-2699 v4</li> </ul>
	Storage	<ul style="list-style-type: none"> <li>• SAN</li> <li>• NetApp FAS8000/AFF8000 Series</li> </ul>
Software	Operating System	<ul style="list-style-type: none"> <li>• Master Patient Index (MPI)</li> <li>• Cache System Manager (CSM)</li> <li>• Red Hat Enterprises Linux7 on VMware ESXi6</li> <li>• Microsoft Windows Server 2012 R2</li> <li>• InterSystems Caché</li> </ul>
Licensing	Cache	<ul style="list-style-type: none"> <li>• Single server with shadow platform specific</li> </ul>
	ONTAP	<ul style="list-style-type: none"> <li>• Version 8.x or later</li> </ul>
Additional Requirements	Hardware	<ul style="list-style-type: none"> <li>• 1 x virtual network interface</li> <li>• VMware virtual hardware</li> <li>• Caboodle server</li> </ul>
	Software	<ul style="list-style-type: none"> <li>• Microsoft SQL Server 2014 Enterprise Edition</li> <li>• Business Objects Enterprise</li> <li>• Perl</li> <li>• VMware Tools</li> </ul>

**Note:** Hardware configuration varies based on your requirements and vendor support.

### 3 Third-Party Support

Third-party support provides:

- 24/7 hardware and OS support within 60 minutes
- Onsite availability for hardware replacement and diagnostics
- 24/7 HA support within 30 minutes and diagnostics

Table 2) Third-party support

Third-Party Support	Contacts
Production	Cisco: <a href="mailto:epic-inform@cisco.com">epic-inform@cisco.com</a> Dell: <a href="mailto:dellforepic@dell.com">dellforepic@dell.com</a> IBM: <a href="mailto:epicibm@us.ibm.com">epicibm@us.ibm.com</a> Lenovo: <a href="mailto:epic@lenovo.com">epic@lenovo.com</a> RedHat: <a href="mailto:redhatforepic@redhat.com">redhatforepic@redhat.com</a>
SAN	EMC: <a href="mailto:epic@EMC.com">epic@EMC.com</a> NetApp: <a href="mailto:epic@netapp.com">epic@netapp.com</a> Pure Storage: <a href="mailto:epic@purestorage.com">epic@purestorage.com</a> IBM: <a href="mailto:epicibm@us.ibm.com">epicibm@us.ibm.com</a>

## 4 Epic Load Analysis

Epic database read and write requests are characterized as random, generating an estimated average mix of 75% reads and 25% writes by using an 8kB request size. In addition to the workload description, Epic provides each customer with the number of read IOPS estimated for a specific environment hardware configuration.

The InterSystems Caché database implements write caching at the host level. This means that the Caché database buffers write operations in the host buffer cache and commits these write operations to storage with a large write cycle of 80-second intervals. Write cycles to the storage generate intense periods of write traffic in the hundreds of megabytes-per-second range. Along with the constant read traffic, they must be accounted for from a storage-sizing perspective.

Although the write cycles are initiated at 80-second intervals, Epic recommends that write cycles be completed in 45 seconds or less to maintain optimal performance.

$$\text{Peak write IOPS} = \text{number of write operations in 80-second write cycle} / 45 \text{ seconds}$$

The estimated worst case peak total IOPS that the storage system must handle is the sum of the read IOPS provided by Epic and the peak write IOPS.

$$\text{Total IOPS} = \text{peak write IOPS} + \text{read IOPS}$$

The total IOPS is the value used for sizing in the NetApp System Performance Modeler (SPM) tool.

Epic specifies that the required average write latency is between 1ms and 500µs and that write cycles finish in less than 45 seconds. Epic also requires average random read latency to be less than 2ms for a symmetric multiprocessor (SMP) deployment or less than 2ms for an enterprise cache protocol (ECP) deployment.

Table 3 shows the characteristics considered in sizing NetApp storage for Epic workloads.

Table 3) I/O Characteristics

Parameter	Value
Request size	8kB
Random/Sequential	100% random
Read/Write ratio (average)	75% read/25% write

Parameter	Value
Total IOPS	As provided by Epic to the customer
Read IOPS	Total IOPS × 0.75
Peak write IOPS	Assume same as read IOPS
Total IOPS (peak)	Read IOPS + peak write IOPS
Read/Write ratio (peak)	50% read/50% write
Write latency	<1ms
Average write cycle completion time	<45 seconds
Average random read latency	<2ms
Distribution of random read latency	99% < 60ms 99% < 200ms 99.99% < 600ms

## 5 Architecture

NetApp provides three reference architectures for Epic based on the size of the environment. Epic databases read/write requests are characterized as 100% random, generating an estimated average Clarity database storage mix of 75% reads and 25% write by using 8kb request size. InterSystems Caché database implements write caching at host level which means Cache database buffers write operations in the host and commits these operations to storage with a write cycle of 80-seconds interval.

NetApp can deploy the Epic production environment on all-flash array such as NetApp AFF A300 or NetApp AFF A700. AFF A300 HA pair can easily run the largest Epic instance. Suitable architecture can be determined based on required total IOPS.

### 5.1 Epic Storage Volume Setup

Table 4) Required total IOPS

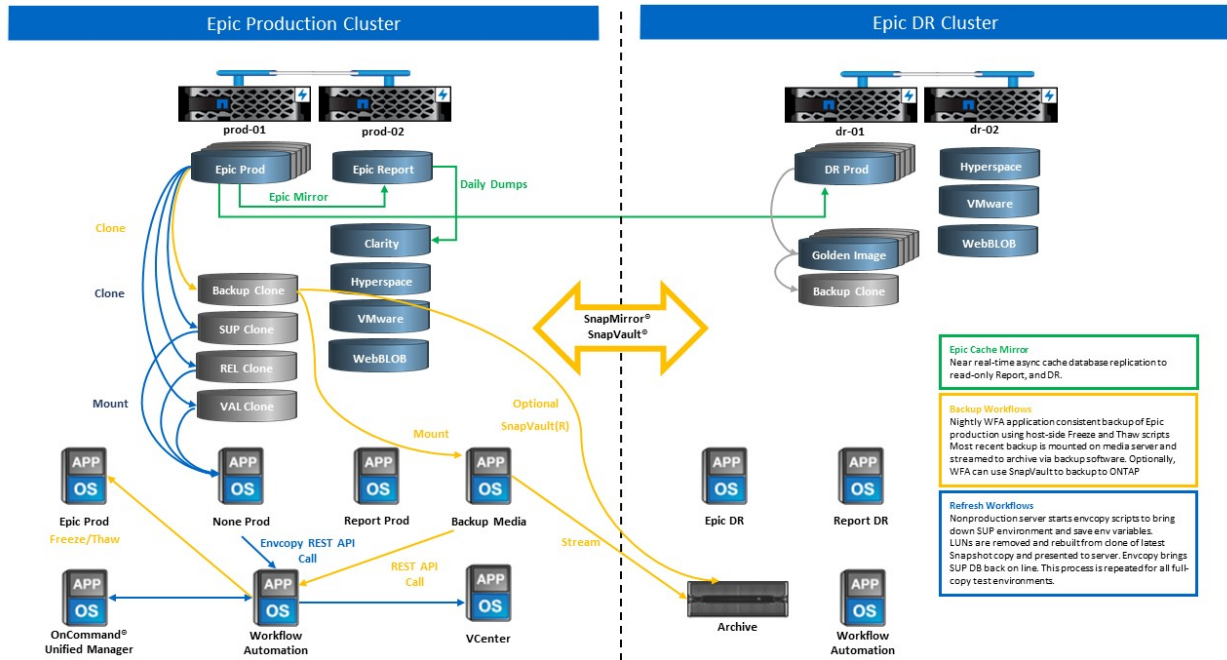
Component	Required Storage Volumes
Epic Production Database Storage	epic_prod_db1 (2TB) epic_prod_db2 (2TB) epic_prod_db3 (2TB) epic_prod_db4 (2TB) epic_prod_db5 (2TB) epic_prod_db6 (2TB) epic_prod_db7 (2TB) epic_prod_db8 (2TB)
Report Database Storage	epic_report_db1 (2TB) epic_report_db2 (2TB) epic_report_db3 (2TB) epic_report_db4 (2TB) epic_report_db5 (2TB) epic_report_db6 (2TB) epic_report_db7 (2TB) epic_report_db8 (2TB) epic_report_inst (1TB) epic_report_jrn1 (1200GB) epic_report_jrn2 (1200GB) epic_prod_inst (1TB) epic_prod_jrn1 (1200GB) epic_prod_jrn2 (1200GB)



## 5.2 Small Architecture

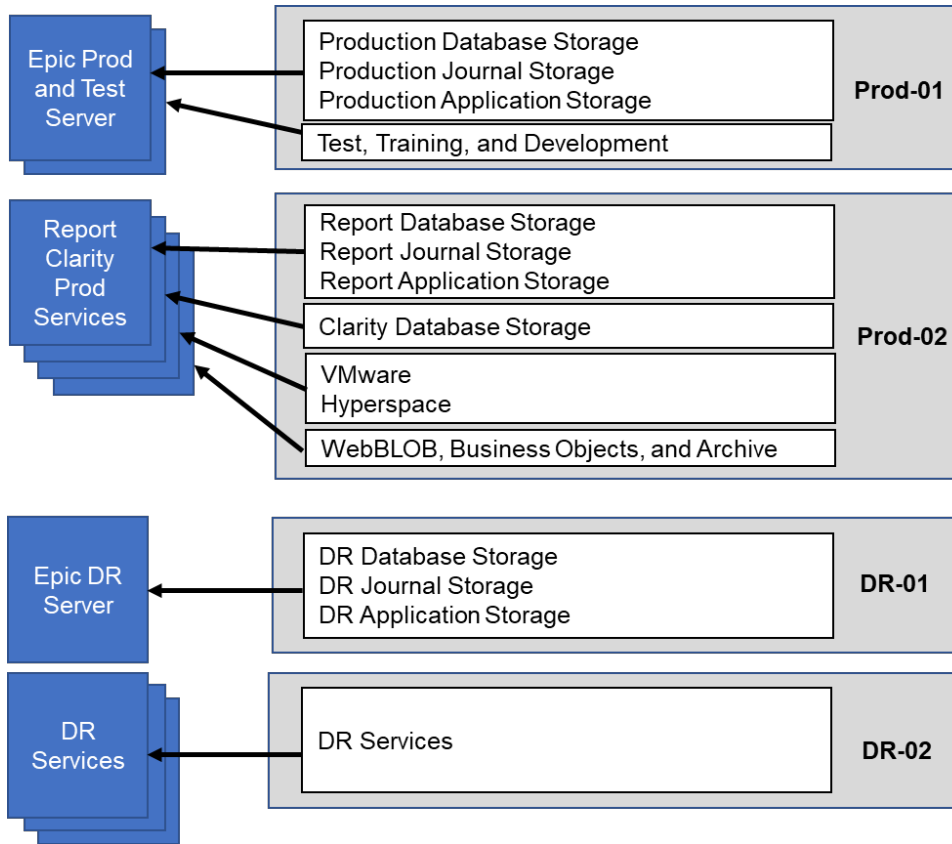
Figure 1 shows an overview of a small 4-node architecture with fewer than 5 million global references and approximately 22K in total IOPS.

Figure 1) 4-node architecture



The small reference architecture is a four-node architecture with two nodes in production and two nodes in disaster recovery. This architecture can be used by customers with fewer than 5 million global references. At this size, the separation of Report and Clarity is not required. With NetApp's unique multiprotocol support, QoS, and the ability to create fault domains in the same cluster, you can run all the production workload for disk pool1 and disk pool2 on a single HA pair and meet all of NetApp's best practices and Epic's high comfort rating requirements. All of disk pool1 would run on node1 and all of disk pool2 would run on node2. With the ability of ONTAP to segregate workloads in the same cluster, and ONTAP multiprotocol support, all the production Epic workloads (production, Report, Clarity, VMware, Citrix, CIFS, and Epic-related workloads) can be run on a single HA pair in a single cluster. This capability enables you to meet all of Epic's requirements, see Epic All-Flash Reference Architecture Strategy Handbook (Epic login required), and NetApp's best practices. Pool1 runs on node prod-01 and pool2 runs on prod-02, as shown in Figure 1. The NAS 1 workload can be placed on node 2 with NetApp multiprotocol NAS and SAN capabilities. For disaster recovery, Epic disaster recovery pool3 is split between the two nodes in the HA pair. Epic disaster recovery runs on node dr-01 and disaster recovery services run on dr-02. NetApp SnapMirror® or SnapVault® replication can be set up as needed for workloads.

Figure 2) Storage layout small architecture



### 5.3 Medium Architecture

A six-node architecture is the most common deployment in the Epic environment. More than 5 million global references are required to place separate Report and clarity. Customers with fewer than 5 million global references can go with six nodes instead of four nodes for the following advantages:

- Offloading of backup archive process from production
- Offloading of all test environments from production

Production runs on node prod-01 and Report runs on node prod-02 which is an up-to-the-minute Epic mirror copy of production. Test environments such as support (SUP), release (REL), and release validation (RELVAL) can be cloned from either Epic production, Report, or disaster recovery.

Table 5) Storage provisioning parameters for medium architecture

Parameter	Controller 1	Controller 2	Controller3	Controller4
Epic database server hostname	Epic Prod	Epic Report	Clarity	CIFS
SVM	Epic Prod	Production service	Clarity	CIFS

Parameter	Controller 1	Controller 2	Controller3	Controller4
Volume	epic_prod_db1 (2TB) epic_prod_db2 (2TB) epic_prod_db3 (2TB) epic_prod_db4 (2TB) epic_prod_db5 (2TB) epic_prod_db6 (2TB) epic_prod_db7 (2TB) epic_prod_db8 (2TB)  epic_report_inst (1TB) epic_report_jrn1 (1200GB) epic_report_jrn2 (1200GB)	epic_report_db1 (2TB) epic_report_db2 (2TB) epic_report_db3 (2TB) epic_report_db4 (2TB) epic_report_db5 (2TB) epic_report_db6 (2TB) epic_report_db7 (2TB) epic_report_db8 (2TB)	Create Clarity Volume as required	CIFS

Figure 3) 6-node architecture

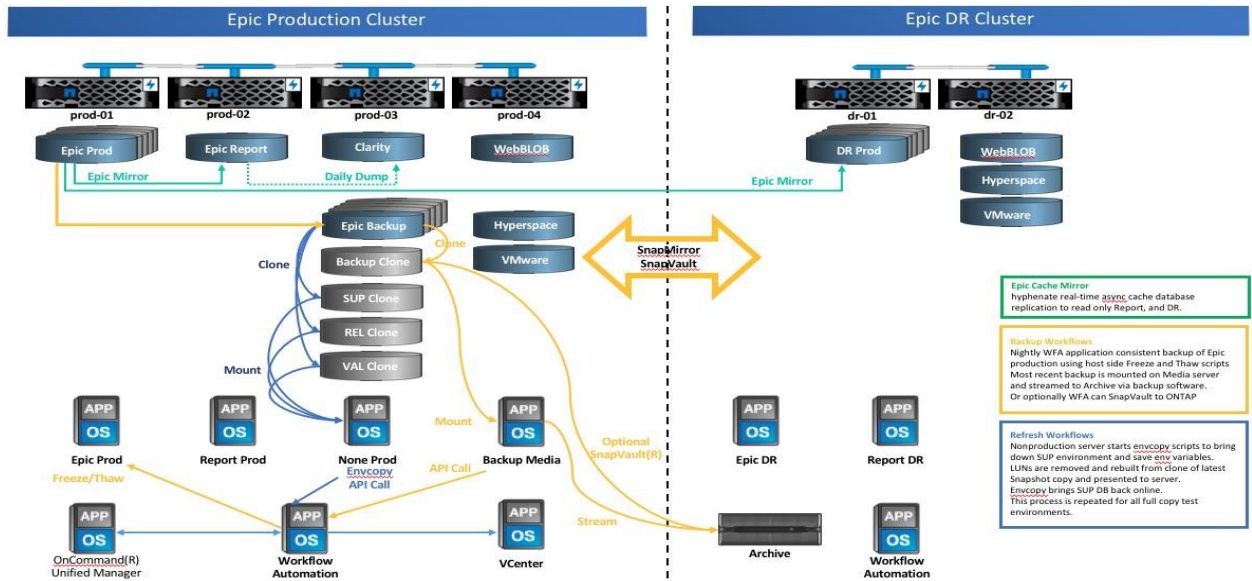
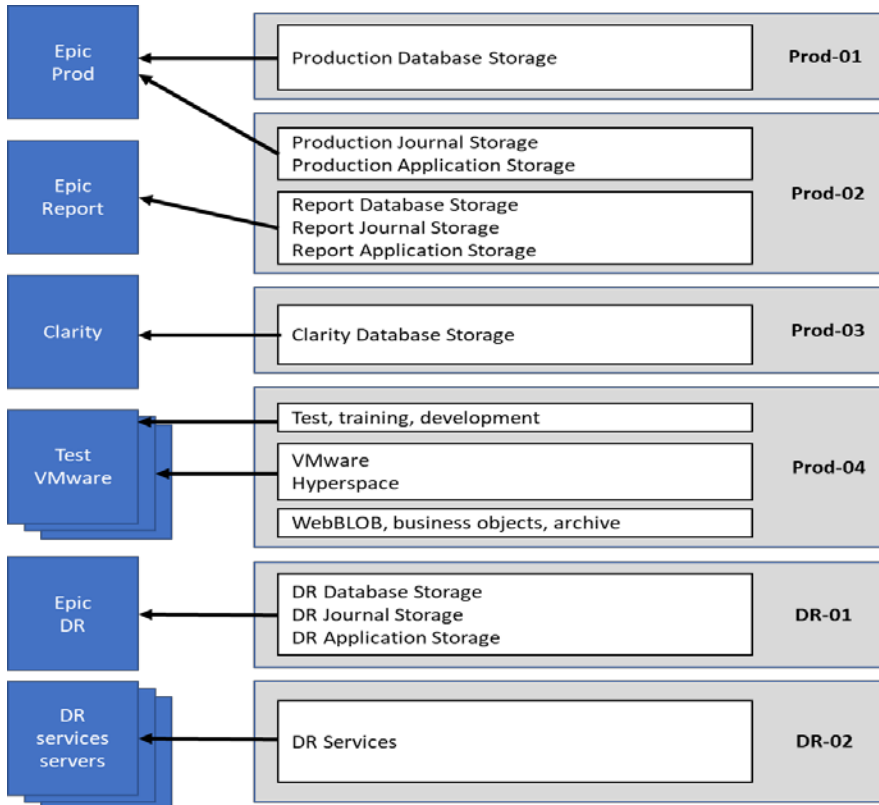


Figure 4) Storage layout medium architecture



## 5.4 Large Architecture

Large architecture is defined as greater than 10 million global references and approximately 50 thousand in total IOPS. If you have a 12-node or greater architecture with six to ten nodes in production, then you have two options:

- Stay with 6-node architecture and use the AFF A700 Controller
- Run Epic production, Report, and disaster recovery on a dedicated AFF A300 HA pair

In a larger Epic deployment, Epic production, Report, and Clarity can be placed on a dedicated HA pair with storage evenly balanced across the nodes.

Figure 5) 12-node or greater architecture

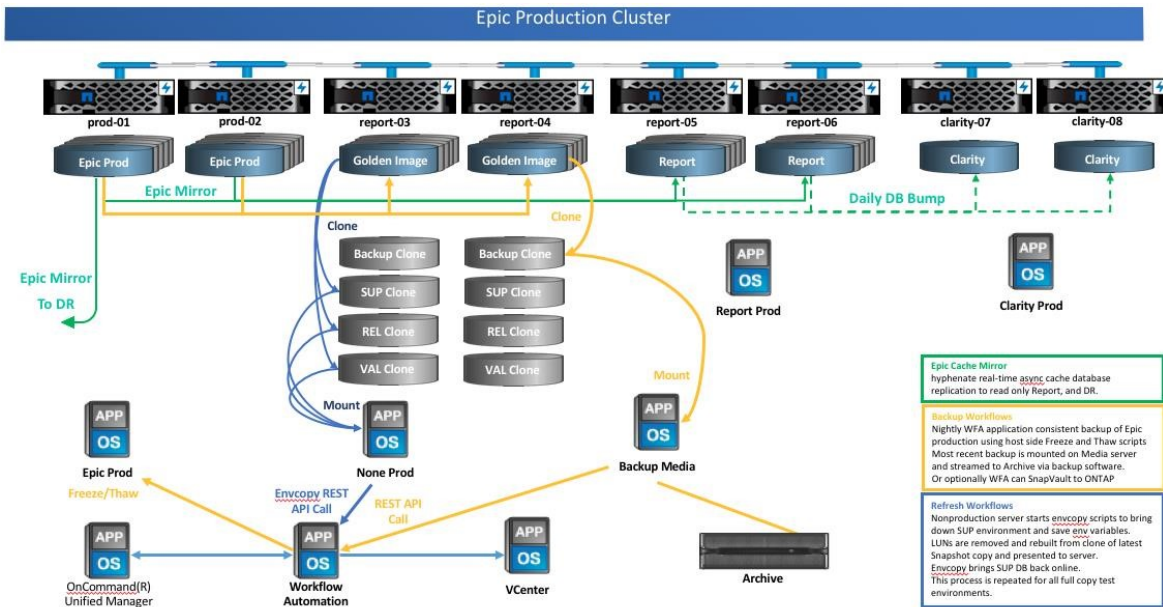
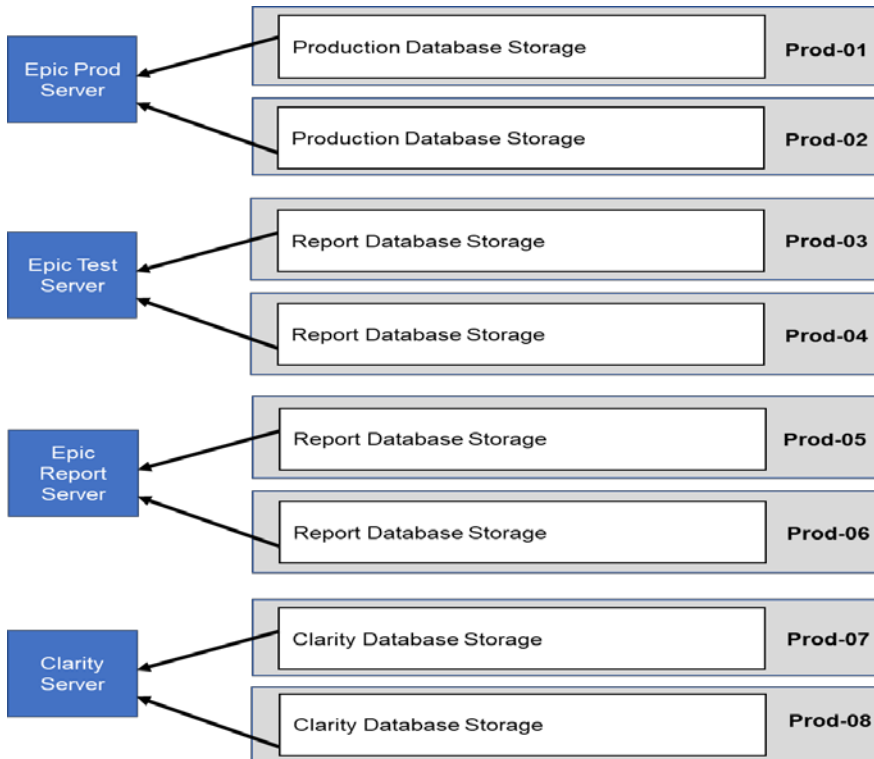


Figure 6) Storage layout large architecture



## 6 Deployment: Setup, Installation and Configuration

This section describes how to deploy the NetApp storage solution for Epic.

## 6.1 Setup

When NetApp storage is deployed for Epic software it uses the storage controller in HA pair configuration. Storage must be presented from both controllers to the Epic database servers over the protocols NFS, ICASI, and FC. This configuration presents storage from both controllers to evenly balance the application load during normal operation.

### Storage Provisioning for Small Reference Architecture

When deploying a production system, the storage requirements are different. In each case NetApp works with you to review the updated database storage layout recommendation from Epic and finalize the storage requirement. Storage provisioning can be done using either the system manager GUI or CLI.

Table 6) Storage provisioning parameters for small architecture

Parameter	Controller 1	Controller 2
Controller host name	prod-cluster-1	prod-cluster-2
Aggregates ONTAP	aggr0_cluster1-01 (ADP 11-partitions)	aggr0_cluster1-02 (ADP 11-partitions)
Aggregates data	cluster1-01_aggr1 (22-partitions)	cluster1-02_aggr1 (22-partitions)
Volumes (size)	epic_prod_db1 (2TB) epic_prod_db2 (2TB) epic_prod_db3 (2TB) epic_prod_db4 (2TB) epic_prod_db5 (2TB) epic_prod_db6 (2TB) epic_prod_db7 (2TB) epic_prod_db8 (2TB)	epic_report_db1 (2TB) epic_report_db2 (2TB) epic_report_db3 (2TB) epic_report_db4 (2TB) epic_report_db5 (2TB) epic_report_db6 (2TB) epic_report_db7 (2TB) epic_report_db8 (2TB) epic_report_inst (1TB) epic_report_jrn1 (1200GB) epic_report_jrn2 (1200GB) epic_prod_inst (1TB) epic_prod_jrn1 (1200GB) epic_prod_jrn2 (1200GB)
LUN paths (size)	/epic_prod_db1/epic_prod_db1 (1.4TB) /epic_prod_db2/epic_prod_db2 (1.4TB) /epic_prod_db3/epic_prod_db3 (1.4TB) /epic_prod_db4/epic_prod_db4 (1.4TB) /epic_prod_db5/epic_prod_db5 (1.4TB) /epic_prod_db6/epic_prod_db6 (1.4TB) /epic_prod_db7/epic_prod_db7 (1.4TB) /epic_prod_db8/epic_prod_db8 (1.4TB)	/epic_prod_db1/epic_prod_db1 (1.4TB) /epic_prod_db2/epic_prod_db2 (1.4TB) /epic_prod_db3/epic_prod_db3 (1.4TB) /epic_prod_db4/epic_prod_db4 (1.4TB) /epic_prod_db5/epic_prod_db5 (1.4TB) /epic_prod_db6/epic_prod_db6 (1.4TB) /epic_prod_db7/epic_prod_db7 (1.4TB) /epic_prod_db8/epic_prod_db8 (1.4TB) /epic_report_inst/epic_report_inst (700GB) /epic_report_jrn1/epic_report_jrn1 (800GB) /epic_report_jrn2/epic_report_jrn2 (800GB) /epic_prod_inst/epic_prod_inst (700GB) /epic_prod_jrn1/epic_prod_jrn1 (800GB) /epic_prod_jrn2/epic_prod_jrn2 (800GB)

FC initiator group (igroup) name	ig_epic_prod	ig_epic_report
Host operating system	AIX	AIX
Epic database server hostname	epic_prod	epic_report
SVM	svm_prod	svm_ps (production services) svm_cifs

After the provisioned storage is presented, FC LUNs are accessible from the host operating system. An example host-side storage presentation is shown in Table 7.

**Table 7) Host-side storage for small architecture**

Type	Description
Controller host name	cluster1-01
LVM physical volumes (PVs)	8 x 1400GB LUNs for production database data files 2x 800GB LUNs for production database journal files
LVM volume groups (VGs)	prdv (10560GB) prdjrv (1600GB)
LVM logical volumes (LVs)	lv_db1 (1320GB) lv_db2 (1320GB) lv_db3 (1320GB) lv_db4 (1320GB) lv_db5 (1320GB) lv_db6 (1320GB) lv_db7 (1320GB) lv_db8 (1320GB) lv_jr (1600GB)
File systems	JFS2 mounted at /epic/prd1 JFS2 mounted at /epic/prd2 JFS2 mounted at /epic/prd3 JFS2 mounted at /epic/prd4 JFS2 mounted at /epic/prd5 JFS2 mounted at /epic/prd6 JFS2 mounted at /epic/prd7 JFS2 mounted at /epic/prd8 JFS2 mounted at /epic/prdjrv

## Storage Aggregates

### CLI for Storage Aggregates

CLI is typically the preferred method for provisioning storage aggregates during initial setup. Commands can be staged ahead of time and executed very quickly to speed up deployment. One large aggregate per node is created, which evenly distributes the disk between the nodes in each HA pair.

1. Run the following command to automatically set up aggregates using auto-provisioning:

```
cluster1::> storage aggregate auto-provision
```

2. Run the following command to view and verify aggregate configuration:

```
cluster1::> storage aggregate show
```

### System Manager GUI Storage Aggregates

For aggregates that are not aligned with the autoprovisioned approach, the GUI can be used to create custom aggregates.

ONTAP has made rapid storage provisioning very simple. You can provision storage very quickly based on either application or a tiering policy. In System Manager, go to Storage > Aggregates and Disk > Aggregates and click Create to add a new aggregate.

## Storage Virtual Machines

In ONTAP, storage is virtualized in the form of a storage virtual machine (SVM). Hosts and clients no longer access the physical storage hardware. Instead, ports and storage are provisioned on the SVM and presented to hosts and clients through virtual ports called logical interfaces (LIFs). You can run all workloads in one SVM with all the protocols.

### System Manager GUI for SVMs

1. In System Manager, go to Storage > SVMs and click Create to follow the instructions and set up the SVM.
2. After the SVM is created, click SVM Settings and start the protocol

**Note:** You cannot access any storage until the protocol is started.

### CLI for SVMs

1. Create the SVM.

```
vserver create -vserver epic-prod -aggregate cluster1_01_aggr1
```

2. Configure the protocols and aggregate access.

```
vserver modify -vserver epic-prod -allowed-protocols protocolname -aggr-list cluster1_01_aggr1
```

3. Add FC ports.

```
net int create -vserver epic-prod -lif epic-prod-n1-0d -role data -data-protocol protocolname -  
home-node cluster1-01 -home-port 0d  
net int create -vserver epic-prod -lif epic-prod-n1-0e -role data -data-protocol protocolname -  
home-node cluster1-01 -home-port 0e  
net int create -vserver epic-prod -lif epic-prod-n2-0d -role data -data-protocol protocolname -  
home-node cluster1-02 -home-port 0d  
net int create -vserver epic-prod -lif epic-prod-n2-0e -role data -data-protocol protocolname -  
home-node cluster1-02 -home-port 0e
```

4. Each zone contains only one initiator and the target worldwide port name (WWPN) on the controller. A zone uses the port name and not the node name. To gather WWPN for zoning, run the following command:



```
net int create show
```

**Note:** Vserver in the command line refers to an SVM

## LUN Configuration

### System Manager GUI for LUN Configuration

NetApp has simplified the provisioning of LUNs in one easy-to-follow wizard in System Manager. NetApp recommends using this method to create LUNs. The wizard includes all the steps to provision a LUN. This includes setting up the containing volume, setting up the LUN, and using an existing igroup or allowing you to create a new igroup to map the LUN to the igroup.

An igroup contains the WWPN of the server initiators and is used to map a LUN to a server for access.

In System Manager, go to Storage > Aggregates and Disk > Array LUNs and click Create to provision a new LUN. Follow the instructions to provision a LUN.

### CLI for LUN Configuration

To provision a LUN from the command line, run the following commands for production:

1. If the igroup does not exist for the server, you must create one with this command:

```
igroup create -igroup epic-prod -protocol fcp -ostype aix -initiator 01:02:03:04:0a:0b:0c:0a  
01:02:03:04:0a:0b:0c:0b
```

2. To verify, run the following command:

```
igroup show
```

3. Create the volume.

**Note:** Storage efficiency and data protection features are set by default on the volume. We can optionally turn on volume encryption and quality-of-service (QoS) policies on the volume by running the `vol modify` command.

```
vol create -vserver epic-prod -aggregate cluster1_01_aggr1 -volume epic_prod_db01 -size 2t  
autosize-mode grow_shrink -space-guarantee none  
vol create -vserver epic-prod -aggregate cluster1_01_aggr1 -volume epic_prod_db02 -size 2t  
autosize-mode grow_shrink -space-guarantee none  
vol create -vserver epic-prod -aggregate cluster1_01_aggr1 -volume epic_prod_db03 -size 2t  
autosize-mode grow_shrink -space-guarantee none  
vol create -vserver epic-prod -aggregate cluster1_01_aggr1 -volume epic_prod_db04 -size 2t  
autosize-mode grow_shrink -space-guarantee none  
vol create -vserver epic-prod -aggregate cluster1_01_aggr1 -volume epic_prod_db05 -size 2t  
autosize-mode grow_shrink -space-guarantee none  
vol create -vserver epic-prod -aggregate cluster1_01_aggr1 -volume epic_prod_db06 -size 2t  
autosize-mode grow_shrink -space-guarantee none  
vol create -vserver epic-prod -aggregate cluster1_01_aggr1 -volume epic_prod_db07 -size 2t  
autosize-mode grow_shrink -space-guarantee none  
vol create -vserver epic-prod -aggregate cluster1_01_aggr1 -volume epic_prod_db08 -size 2t  
autosize-mode grow_shrink -space-guarantee none  
vol create -vserver epic-prod -aggregate cluster1_01_aggr1 -volume epic_prod_inst -size 1t  
autosize-mode grow_shrink -space-guarantee none  
vol create -vserver epic-prod -aggregate cluster1_01_aggr1 -volume epic_prod_jrn1 -size 1.2t  
autosize-mode grow_shrink -space-guarantee none  
vol create -vserver epic-prod -aggregate cluster1_01_aggr1 -volume epic_prod_jrn2 -size 1.2t  
autosize-mode grow_shrink -space-guarantee none
```

**Note:** The volumes must be large enough to contain the LUNs and Snapshot copies. To protect the volume from capacity issues, turn on the `autosize` and `autodelete` options.

4. Create the LUN.

```
lun create -vserver epic-prod -path /vol/epic_prod_db06/epic_prod_db06 -size 1.4t -ostype aix
space-reserve disabled
lun create -vserver epic-prod -path /vol/epic_prod_db07/epic_prod_db07 -size 1.4t -ostype aix
space-reserve disabled
lun create -vserver epic-prod -path /vol/epic_prod_db08/epic_prod_db08 -size 1.4t -ostype aix
space-reserve disabled
lun create -vserver epic-prod -path /vol/epic_prod_inst/epic_prod_inst -size 700g -ostype aix
space-reserve disabled
lun create -vserver epic-prod -path /vol/epic_prod_jrn1/epic_prod_jrn1 -size 800g -ostype aix
space-reserve disabled
lun create -vserver epic-prod -path /vol/epic_prod_jrn2/epic_prod_jrn2 -size 800g -ostype aix
space-reserve disabled
```

## 5. Map the LUNs to the igroup.

```
lun map -igroup epic-prod -vserver epic-prod -path /vol/epic_prod*
```

## 6.2 Installation

To install Epic software on data center, refer to <https://www.epic.com/software> for different Epic software.

## 7 Cloud Extensibility and Scaling

This section discusses the various cloud solutions provided by NetApp.

### 7.1 Cloud

NetApp Cloud Volumes ONTAP® is a data management software solution that runs NetApp ONTAP storage software, offering you control of your data with the power of an enterprise storage software solution. It provides nondisruptive, secure, and proven NFS, CIFS, and iSCSI data management for the cloud.

Cloud Volumes ONTAP is deployed and managed from OnCommand® Cloud Manager giving you a simple point-and-click environment to manage the software and underlying cloud infrastructure for your cloud storage solution. For a nondisruptive environment, Cloud Volumes ONTAP HA allows you to build a two-node solution with failover support in the case that one node fails (whether unplanned or for planned upgrade purposes).

Cloud Volumes ONTAP HA requires two Cloud Volumes ONTAP instances and a failover controller in order to operate. As with a single instance of Cloud Volumes ONTAP, OnCommand Cloud Manager is required for setup, configuration, and management of the environment. Cloud Volumes ONTAP takes the EBS storage, manages it with the ONTAP storage operating system, and provides numerous advanced features on top of the storage advanced features that Cloud Volumes ONTAP offers:

- Multiprotocol (NFS, CIFS, iSCSI)
- Data protection (snapshot copies, SnapMirror, SnapVault)
- Storage efficiency (data deduplication, compression, thin provisioning) can reduce the amount of EBS storage you must purchase
- FlexClone® volumes
- Management (Unified Manager, System Manager, WFA, Insight, and so on)

Cloud Manager software is a centralized management environment for ONTAP software-based hybrid cloud storage environment, including the Cloud Volumes ONTAP, AFF, and FAS storage systems. Cloud Manager is the deployment environment for Cloud Volumes ONTAP and provides installation, resource assignment, and provisioning of data.

Cloud Manager provides day-to-day management activities for your Data Fabric endpoints and can automate your data movement to and from AWS. Cloud Manager integrates seamlessly with your cloud environment, allowing you to insert credentials that enable Cloud Manager to gather the resources

necessary to meet your storage requirements. With visibility into the resources consumed by each instance, Cloud Manager monitors and provides valuable feedback to the administrator about the cost of resources over time. This information helps you to decide when to move workloads to the most cost-efficient environment.

## 7.2 NetApp Cloud Volumes ONTAP for AWS

Cloud Volumes ONTAP is deployed and managed from NetApp Cloud Manager as a software-only solution on Amazon EC2 compute instances managing Amazon EBS storage. This capability enables customers to build a virtual storage solution directly on Amazon resources. Building your cloud storage environment on Cloud Volumes ONTAP provides advanced data management features for your cloud storage. ONTAP allows you to provision both NAS and SAN storage for your application environment with SMB, NFS, and iSCSI support. You also get zero-impact NetApp Snapshot copies that provide near-instantaneous point-in-time backup and recovery copies of your data without consuming additional storage resources or affecting your application performance. There are two models available:

- ONTAP Cloud for AWS - the pay-as-you-go solution purchased on the AWS Marketplace
- ONTAP Cloud for AWS (BYOL) - the bring your own license version sold by NetApp

## Application Environments and Workload Characteristics

Table 8) Application environments and workload characteristics

	Cloud Volumes ONTAP for AWS (Single Node)		Cloud Volumes ONTAP for AWS (HA)	
	Pay-as-you-go	BYOL	Pay as you go	BYOL
Licensing	Pay-as-you-go	BYOL	Pay as you go	BYOL
High availability	No	No	Yes	Yes
Multiprotocol	NFS, SMB, iSCSI	NFS, SMB, iSCSI	NFS, SMB, iSCSI	NFS, SMB, iSCSI
Data protection	Snapshot SnapMirror SnapVault®	Snapshot SnapMirror SnapVault	Snapshot SnapMirror SnapVault	Snapshot SnapMirror SnapVault
FlexClone volumes	Yes	Yes	Yes	Yes
Tiering to S3	Yes	Yes	Yes	Yes
Encryption	ONTAP encryption AWS encryption with default key or external keys	ONTAP encryption AWS encryption with default key or external keys	ONTAP encryption AWS encryption with default key or external keys	ONTAP encryption AWS encryption with default key or external keys
VMware cloud support	Yes	Yes	Yes	Yes
AWS regions	All	All plus GovCloud	All	All plus GovCloud
EBS volume types	GP2, ST1, SC1, and IO1	GP2, ST1, SC1, and IO1	GP2, ST1, SC1, and IO1	GP2, ST1, SC1, and IO1
Procurement (license)	AWS Marketplace	NetApp	AWS Marketplace	NetApp

	Cloud Volumes ONTAP for AWS (Single Node)		Cloud Volumes ONTAP for AWS (HA)	
Solution capabilities	M4.XL: <ul style="list-style-type: none"> <li>Up to 2TB</li> </ul> M4.2XL, R4.XL: <ul style="list-style-type: none"> <li>Up to 10TB</li> </ul> M4.4XL, C4.4XL, C4.8XL, R4.2XL: <ul style="list-style-type: none"> <li>Up to 368TB</li> </ul>	M4.4XL, C4.4XL, C4.8XL, R4.2XL: <ul style="list-style-type: none"> <li>Up to 360TB</li> </ul>	M4.XL: <ul style="list-style-type: none"> <li>Up to 2TB</li> </ul> M4.2XL, R4.XL: <ul style="list-style-type: none"> <li>Up to 10TB</li> </ul> M4.4XL, C4.4XL, C4.8XL, R4.2XL: <ul style="list-style-type: none"> <li>Up to 368TB</li> </ul>	M4.4XL, C4.4XL, C4.8XL, R4.2XL: <ul style="list-style-type: none"> <li>Up to 360TB</li> </ul>
Support	Software support plan	Software support plan	Software support plan	Software support plan

Figure 7) Application properties

APP LOCATION	NETAPP SOLUTION	APPLICATION PROPERTIES
On premises	AFF/FAS/E-Series	Application usage pattern and resource requirements are well known, with long-term steady-state usage.
Near the cloud	NPS for Cloud	Application has high governance and/or high-performance requirements but with variable usage patterns.
In the cloud	Cloud Volumes ONTAP	Applications have variable usage and variable storage patterns, or applications can benefit from rapid spin-up and/or rapid spin-down of storage.

## 8 Host Settings

While the NetApp storage engineer is not required to configure the Epic application host, there are some key items that must be understood and verified by the NetApp storage engineer for the successful integration of presented NetApp storage with the Epic application host.

### Host Utilities Kit

You must install the NetApp host utilities kit on the host operating system. This kit provides support software and documentation for connecting. NetApp host utilities kit provides several host-side utilities for interacting with NetApp storage. In particular, the sanlun utility allows each LUN to be identified by its ONTAP LUN path name and owning controller. The associated host operating system device names for each LUN can then be used as input parameters for host-side disk aggregation, such as the logical volume manager.

### Host-Side Disk Aggregation

NetApp storage is presented to the host as multiple LUNs. Therefore, some form of host-side disk aggregation such as LVM must be used to group the presented storage and to partition it into logical volumes for use by the Epic application.

Each Epic database includes multiple files that can be spread across multiple logical volumes to realize the benefits of parallel disk access in the underlying storage hardware. The layout and size of database files are determined by Epic software and are not dependent on the underlying storage geometry.

## File System Mount Options

Per Epic requirements, make sure that each file system for the Epic database is mounted with unbuffered I/O. For example, for an AIX host, the JFS2 file systems should be mounted with the cio (concurrent I/O) mount option and have an inline log for all production database file systems.

## Where to Find Additional Information

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

- TR-3930i: NetApp Sizing Guidelines for Epic (requires NetApp portal access)  
<https://fieldportal.netapp.com/content/192412>
- TR-3928 - NetApp Best Practices for Epic  
<https://www.netapp.com/us/media/tr-3928.pdf>
- TR-3446 - Snap Mirror Async Overview and Best Practices Guide  
<https://www.netapp.com/us/media/tr-3446.pdf>
- TR-4017 - Fibre Channel SAN Best Practices  
<https://www.netapp.com/us/media/tr-4017.pdf>
- TR-4133 - NetApp Private Storage for AWS  
<https://www.netapp.com/us/media/tr-4133.pdf>
- NetApp Product Documentation  
<https://docs.netapp.com>
- ONTAP 9 Documentation Center  
<http://docs.netapp.com/ontap-9/index.jsp>
- ONTAP 9 Software Setup Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.dot-cm-ssg/home.html>
- ONTAP 9 Disks and Aggregates Power Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.dot-cm-psmg/home.html>
- ONTAP 9 SAN Administration Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.dot-cm-sanag/home.html>
- ONTAP 9 SAN Configuration Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.dot-cm-sanconf/home.html>
- ONTAP 9 FC Configuration for Red Hat Enterprise Linux Express Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.exp-fc-rhel-cg/home.html>
- ONTAP 9 FC Configuration for Windows Express Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.exp-fc-cpg/home.html>
- ONTAP 9 FC SAN Optimized AFF Setup Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.cdot-fcsan-optaff-sg/home.html>
- ONTAP 9 High-Availability Configuration Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.dot-cm-hacg/home.html>
- ONTAP 9 Logical Storage Management Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.dot-cm-vsmg/home.html>
- ONTAP 9 Performance Management Power Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.pow-perf-mon/home.html>
- ONTAP 9 SMB/CIFS Configuration Power Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.pow-cifs-cg/home.html>

- ONTAP 9 SMB/CIFS Reference  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.cdota-famg-cifs/home.html>
- ONTAP 9 Data Protection Power Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.pow-dap/home.html>
- ONTAP 9 Data Protection Tape Backup and Recovery Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.dot-cm-ptbrg/home.html>
- ONTAP 9 NetApp Encryption Power Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.pow-nve/home.html>
- ONTAP 9 Network Management Guide  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.dot-cm-nmg/home.html>
- Commands: Manual Page Reference for ONTAP 9.3  
<http://docs.netapp.com/ontap-9/topic/com.netapp.doc.dot-cm-cmpr-930/home.html>

## Version History

Version	Date	Document Version History
Version 1.0	February 2019	Initial Release

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