REFERENCE ARCHITECTURE: PURE STORAGE SOLUTIONS FOR ORACLE APPLICATIONS UNLIMITED AND ORACLE DATABASES

Purpose

This document is intended to be a reference for the design of a storage infrastructure that supports Oracle® Applications Unlimited and Oracle® Database environments. In order to present application and database architects with architecture design options, this reference architecture (RA) is built upon the Pure Storage® block storage solution, and it also contains other aspects of Pure Storage solutions to provide a comprehensive outline of how Pure can deliver end-to-end Oracle solution stacks.

Introduction

Businesses are under pressure to optimize the way they deploy, manage, and maintain information technology (IT) solutions and reduce risks that expose their enterprises to loss of revenue or market reputation. In addition, businesses realize they need solutions that enable innovation and that are catalysts of information-driven enterprises.

IT organizations managing mission-critical business applications face many implementation and operational challenges — planned or unplanned downtime caused by infrastructure, the time it takes to refresh an environment from production, the time to restore from a backup, and the complexity to optimize the infrastructure to meet the business requirements. Many businesses face a multiple-hour adventure to refresh a test environment from production that holds many precious resources hostage for the duration of the process.

Eliminate Operational Issues Caused by Storage

Pure Storage is in a unique position to help enterprises accomplish their objectives and address their challenges by providing solutions that are true enablers of modern business transformation. For Oracle applications and database workloads, Pure Storage solutions offer industry-leading capabilities with a compelling total cost of ownership (TCO). Pure Storage solutions can enable the creation of a data platform that aims to provide enterprises with support for any data-storage needs with the highest performance and availability, while helping to dramatically reduce operating costs.

Pure Storage solutions for Oracle are designed to allow application owners and database administrators to take storage for granted. Storage should be always available, provide the performance and response times needed by business users, and be operationally efficient, requiring no manual tuning and an easy environment for cloning and refresh.

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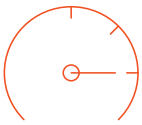
The tenets of the Pure Storage solutions for Oracle applications and databases are simple and geared toward enabling business value through differentiated storage solutions. These tenets can be summarized as:

- High performance and response times for all your workloads
- Secure and highly available by design
- Operationally efficient, enabling more agile IT
- Data reduced and protected without compromise



Performance is at the core of Pure Storage solutions. With a 100% native NVM Express® (NVMe™) architecture with Fiber Channel, Internet Small Computer System Interface (iSCSI), and NVMe over Fabrics (NVMe-oF) connectivity, Pure's 100% software-driven flash solutions deliver unprecedented performance for all workloads — mainstream enterprise workloads and next-generation web-scale applications.

Security permeates all Pure Storage solutions and is one of the central capabilities engineered into the products that is included with no additional license or cost required. All data is encrypted with the AES-256 algorithm, meeting the U.S. government's requirement for data-at-rest protection, and is always on, performed in-line as the data enters the array, with no impact on performance, and needing no administrative overhead nor key management. The operating environment running the array has been hardened for security and compliance meeting the Common Criteria and Federal Information Processing Standards (FIPS) 140-2 industry standards. This means that customers benefit from an end-to-end secure solution that sets the foundation for a secure enterprise.

99.9999%
availability[1]

Pure Storage products are designed to be highly available, enabling an always-on business. Pure Storage FlashArray™ provides 99.9999% availability, including planned and non-planned downtime.[1] Downtime to add storage, update the array controllers, or rectify an exception is a thing of the past. Storage is self-managed and self-tuned, making use of artificial intelligence (AI) for predictive support and exception management with notifications that can be accessed via Pure1® management and support.

30 Minutes
minutes to install
0 Minutes
to tune[2]

Deploying Pure Storage solutions is about as simple as deploying a desktop computer — unpack the one box containing the array, place the array in a data center rack, connect the power and network, start creating volumes, and assign them to hosts. It's that simple, and all software is pre-installed so that you can start using your array with minimal to no training using Pure1. Tuning and error management is done automatically so that all your attention can be focused on serving the applications.[2]

2-4:1[3]

Businesses need data to be stored efficiently and protected, given that data is the most important asset for modern companies. Pure reduces all data as it enters the storage array and includes both data compression and deduplication with up to 2–4 times data reduction for conventional Oracle Database data types — typically 2x better than other vendors.[3] In the case of Oracle Database, this means lower storage costs without requiring any additional licenses, such as Oracle Advanced Compression.

Complete Data **Protection**

Pure data protection is not limited to enabling hardware updates without service disruption — it is in everything Pure Storage does. Data in the array is protected by an input/output (I/O) operation–transparent RAID that is Pure Storage proprietary and optimized for flash, called RAID-HA. For volume point-in-time recovery or to protect against unlikely complete array failures or disasters on the primary data center, Pure Storage offers non-disruptive, space-saving fast snapshots that can be stored locally, to other Pure Storage arrays, or to the public Internet. Snapshots can also be replicated to the public cloud or to other arrays, not only for additional protection from complete failures in the primary array, but also for volume cloning and refreshing on the remote targets

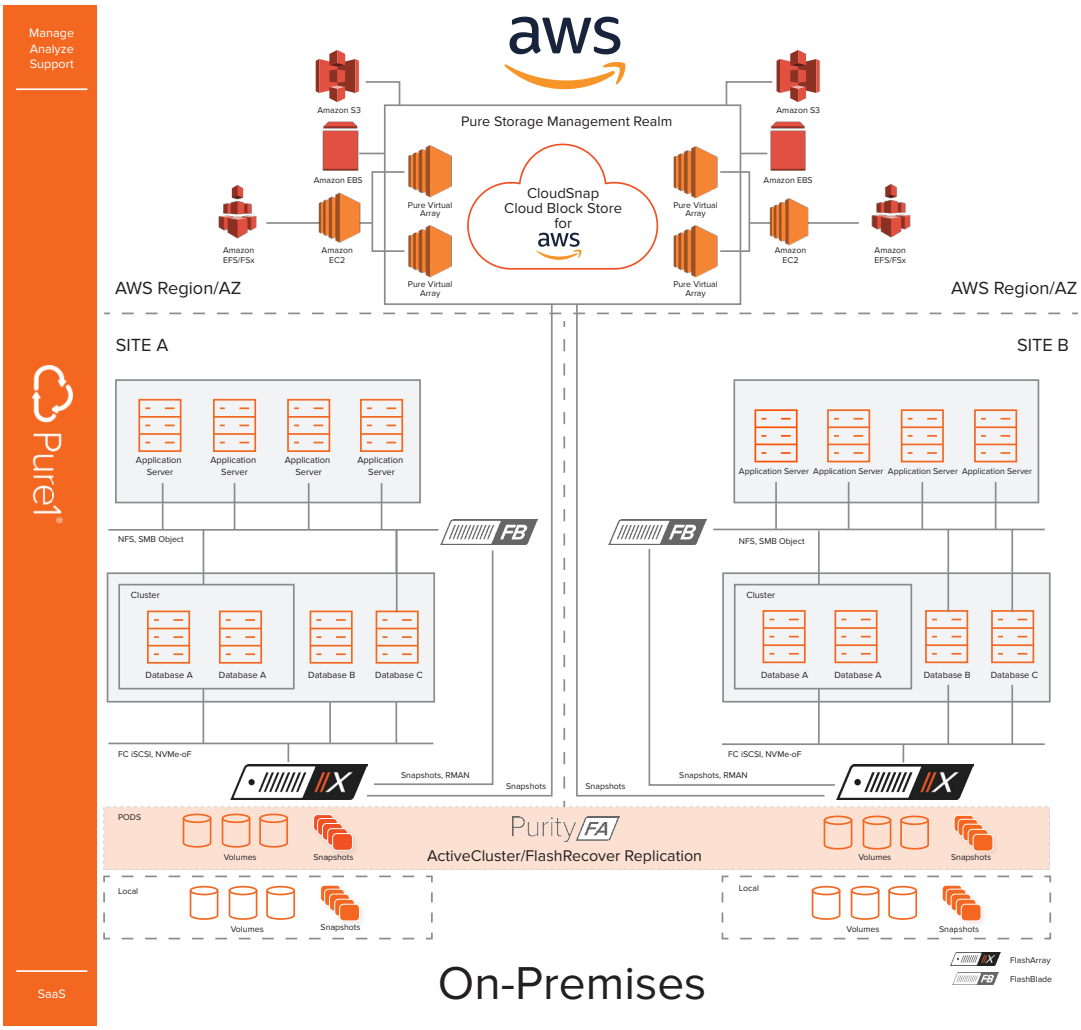
Reference Architecture

This RA is primarily a storage-infrastructure design in which the block, file, and object storage services are provided by Pure solutions. The Pure Storage array will present block devices to the servers running the application where they will be used to build volumes and file systems or be used as raw devices. An example is the Oracle Database using block devices (LUNs) presented to the database server operating system to be used for Oracle Automatic Storage Management (ASM) disk groups. For the applications that cannot directly make use of block devices, needing file access instead, this RA depicts storage presented as a file system via Network File System (NFS) or Server Message Block (SMB) protocols. The compute services to run the applications and databases are not considered in this design and are considered consumers of the storage services.

The most salient point of this RA is Pure Storage's unique ability to provide block services on premises and in the Amazon Web Services® (AWS®) public cloud using the same Pure Storage software — Purity//FA — providing high reliability, efficiency, and performance for public cloud workloads. The Pure software running in the cloud abstracts the public cloud provider storage and delivers a consistent experience both on premises and in the cloud. Pure Storage in the public cloud can be thought of as virtual Pure Storage FlashArrays, exhibiting the same enterprise capabilities as on-premises arrays including:

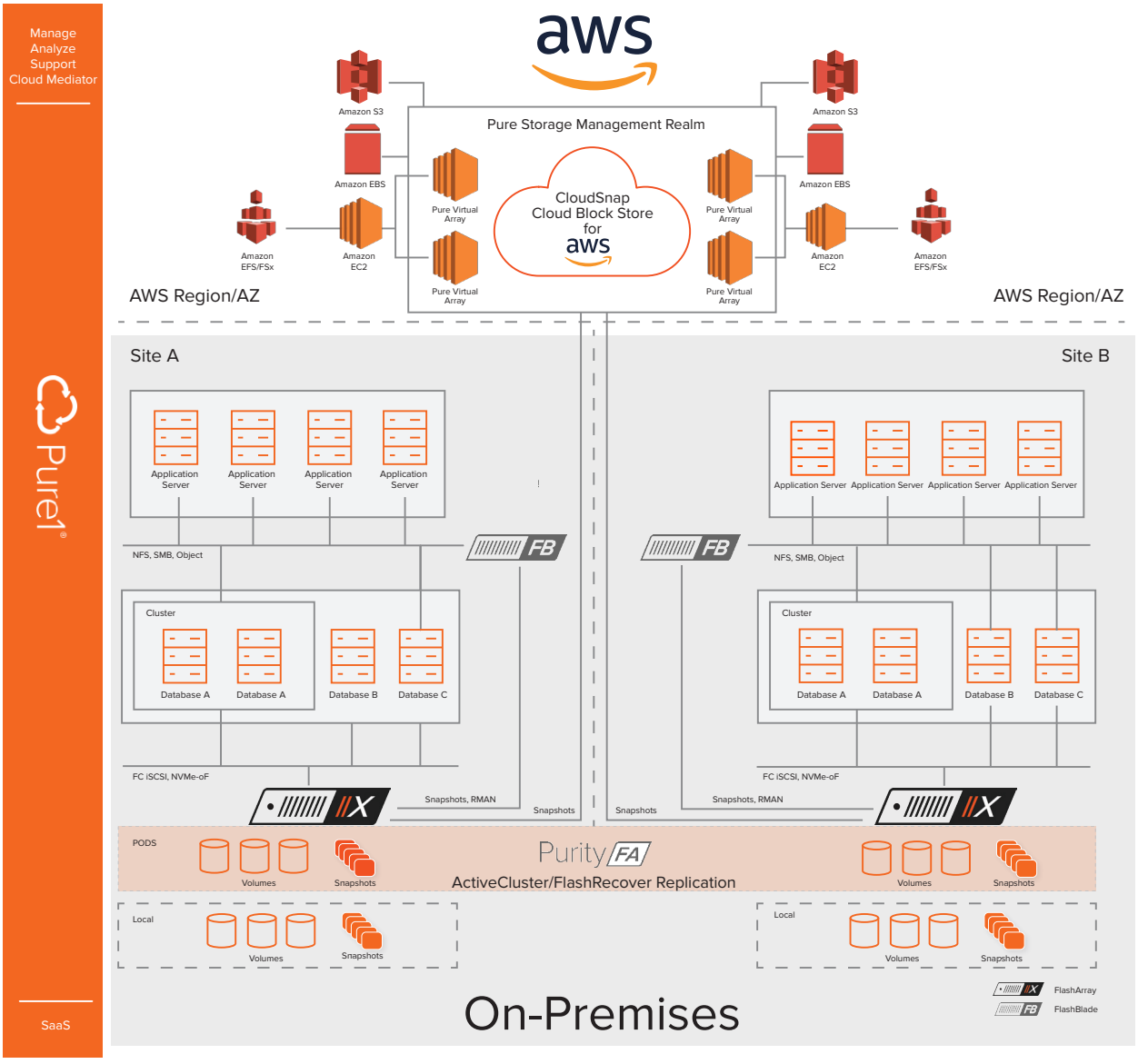
- High, predictable performance aggregating performance indicators across many cloud stores
- Enterprise reliability with non-disruptive upgrades and updates, in addition to protection against failures and high availability (HA) across availability zones
- Pure efficiency, with data always efficiently reduced — deduplicated and compressed — with space-saving snapshots
- Data always encrypted, just like on-premises storage, and data at rest is always encrypted with keys automatically managed

Consistent across the architecture, whether public cloud or on premises, is the Pure1 software-as-a-service (SaaS)-based management and support platform seamlessly managing and monitoring the Pure Storage services in the public cloud or on premises.

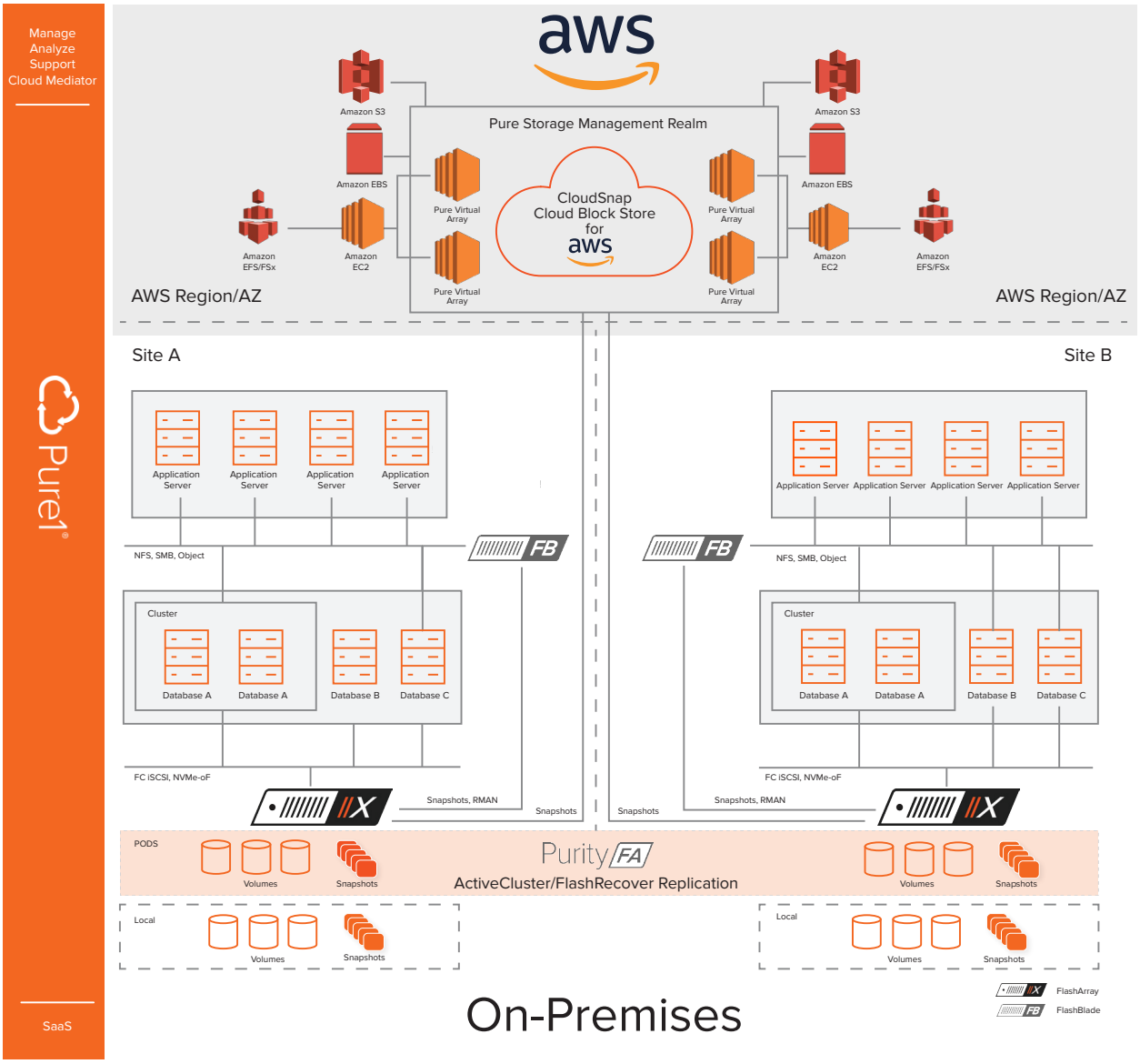


Description

This RA considers applications and services running both on premises and in the AWS public cloud. The on-premises section is divided into two sites to represent two distinct physical locations used to host the on-premises applications. The two sites could be used on a primary-standby application and database configuration such as disaster recovery (DR), for an active-active configuration with active applications and databases on both data centers, or in a hybrid configuration, where some primary applications and databases run on one of the sites with their respective DR standbys on the other site. The building blocks of this architecture are the compute servers — both application and database — with Pure Storage FlashArray providing block storage services and Pure Storage FlashBlade™ providing file and object storage services, in addition to data-protection support.



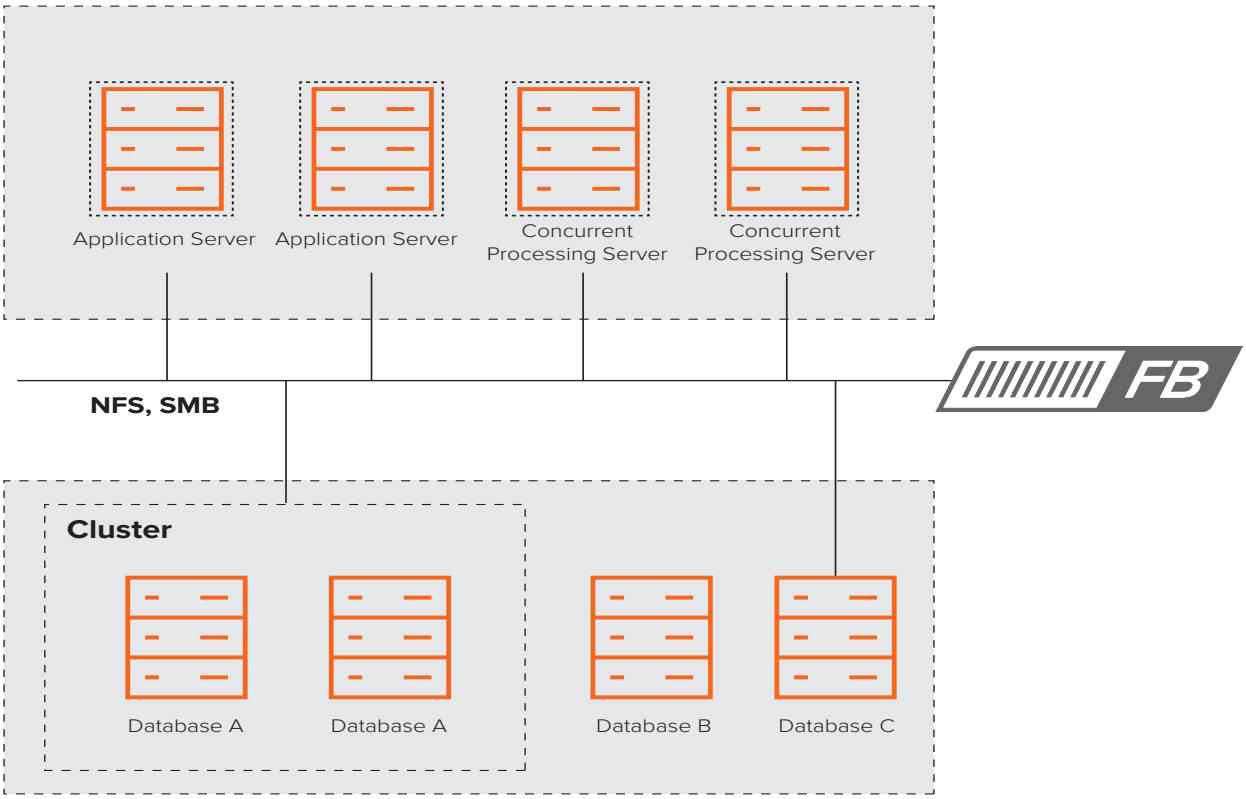
The AWS public-cloud section of this diagram depicts applications and databases running in two AWS regions/availability zones, with block storage managed and presented to Amazon® Elastic Compute Cloud (Amazon EC2®) instances by Pure Storage Cloud Block Store.[4] This is the same Pure Storage software that runs on the on-premises storage arrays now running on Amazon EC2 instances utilizing Amazon Elastic Block Store (EBS) services; these storage arrays should be considered virtual arrays with full Pure Storage capabilities. In addition, Amazon EC2 and Amazon Elastic File System (EFS) services will be used to provide native object-storage and shared-file-system services to the applications or for backups.



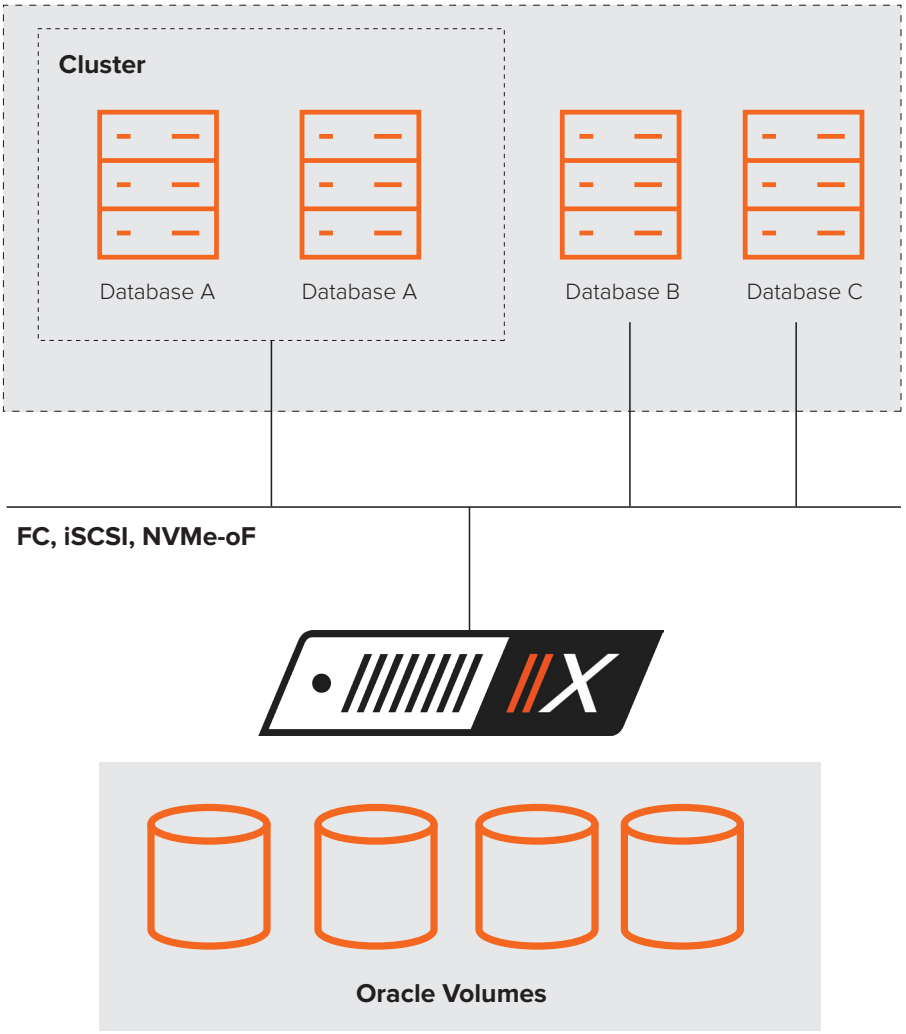
Oracle Applications and Database Topology

On-Premises

The application tier will be running on application servers depicted in the on-premises section of the diagram, while Oracle Database will run on the database servers. For Oracle E-Business Suite deployments, the application and concurrent processing servers will be hosted on the application servers with the database on the database servers, all making use of Pure Storage FlashBlade for their shared file system requirements via NFS or SMB protocols.



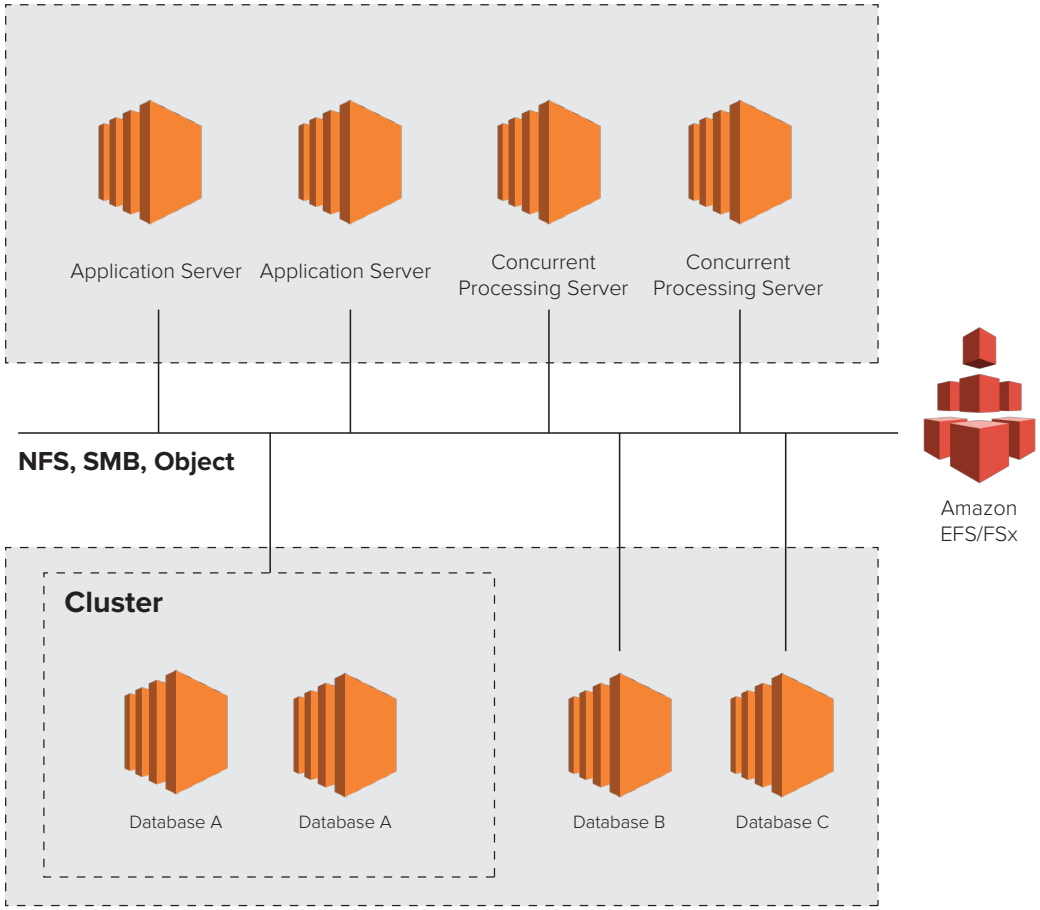
The database servers will make use of block storage provided by Pure Storage FlashArray. The Oracle databases can be single instances or Oracle Real Application Clusters (RAC), and they can be configured using Oracle ASM or other Oracle Database–supported volume managers and file systems.



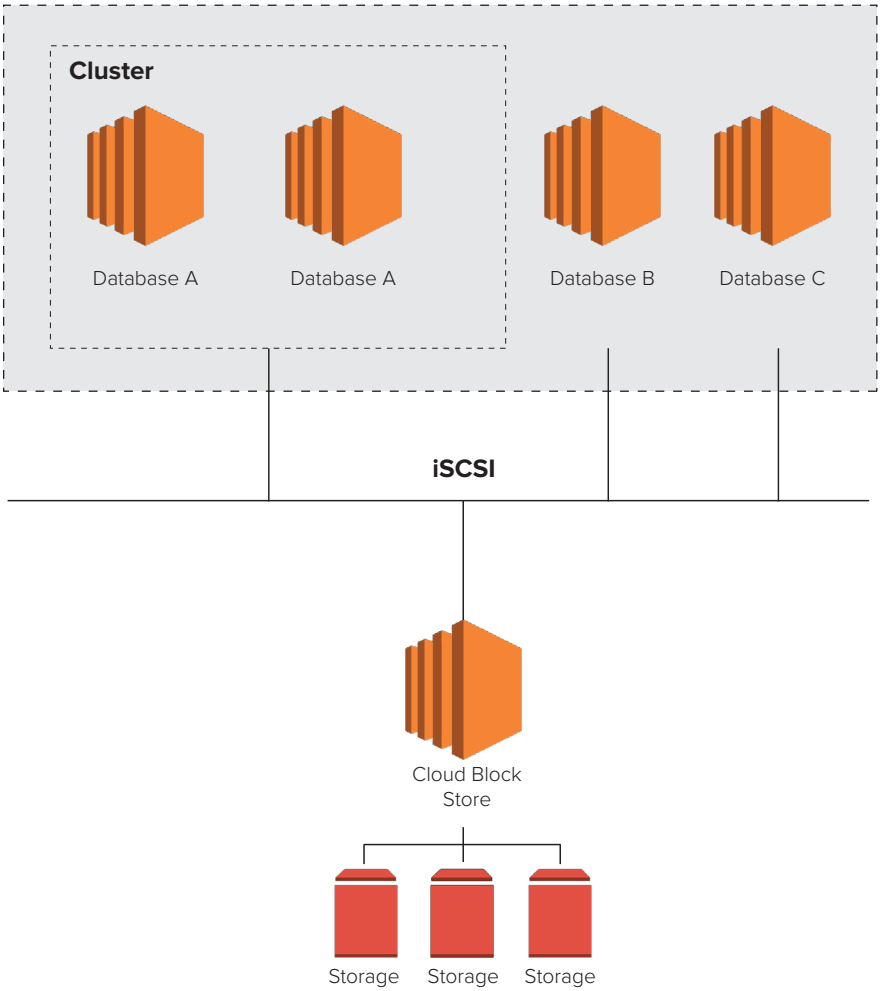
Making use of native FlashArray and FlashBlade data-services capabilities, Pure Storage adds significant value for Oracle applications and database customers. The ability to provide high I/O performance, combined with data reduction, 99.9999% availability with FlashArray, including both planned and unplanned downtime, and low-touch management allows IT to increase efficiency and reduce TCO of their storage subsystems while providing high value to the business.[1] In addition, because the database servers spend less time processing and waiting for I/O operations to complete, there is a potential opportunity to reduce the quantity of Oracle Database core licenses, which can provide substantial cost savings.

Cloud

The Oracle application tier will be hosted using Amazon EC2 instances — both application and concurrent processing servers. For the shared file system, Amazon EFS or Amazon FSx for Windows® will be used. A database cluster is depicted, but Oracle RAC are not supported at AWS; a solution not certified by Oracle is available for self-service implementations based on FlashGrid® (**www.flashgrid.io**).



Making use of all the FlashArray capabilities on AWS, block storage for the database servers will be provided by Pure Storage Cloud Block Store. Using Cloud Block Store, you can realize the benefits of the Pure Storage solution in the cloud, including management, FlashRecover snapshot replication, and Purity ActiveCluster™. The Pure Storage software — Purity//FA — is deployed in Amazon EC2 instances with AWS block storage attached. With the Purity//FA software, these instances become virtual FlashArrays, providing storage to the Amazon EC2 instances that are the Oracle Database servers.



The benefits to Oracle applications and databases of Pure's cloud offerings are efficiency and simple mobility between on-premises and the public cloud. This opens the possibility of deploying true hybrid architectures with ease of data movement — for example, the production environment could be on premises, and its associated DR environment in the public cloud — with minimum storage configuration required.

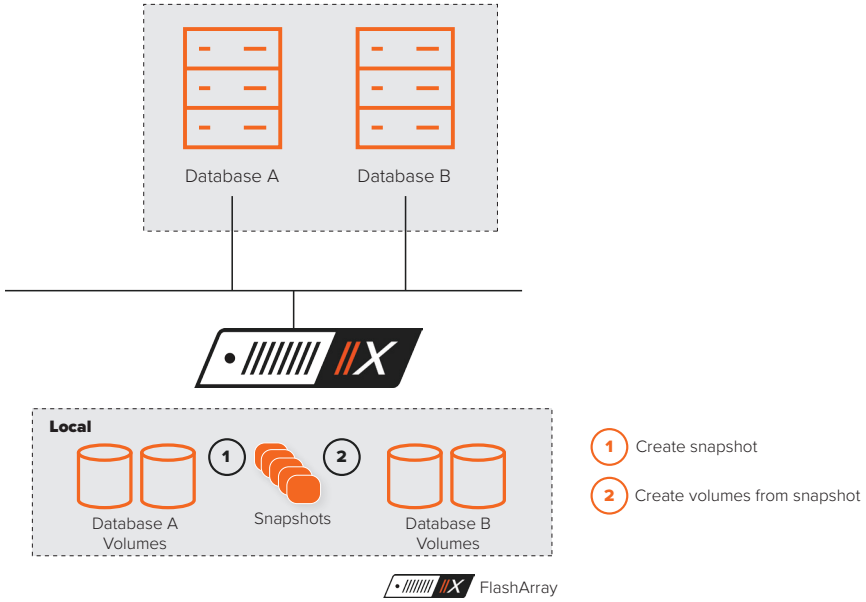
Cloning and Refresh

The value of the Pure Storage RA is not limited to delivering performance, availability, and low-touch management; it is amplified by the capabilities the RA introduces in support of daily IT operations activities. One of the most common and critical IT operations activities in Oracle applications environments is the cloning or refresh of non-production environments. These activities are time consuming and, in many cases, difficult to perform in reasonable timeframes, often requiring complex and manual solutions.

Pure simplifies cloning and refresh activities by easily enabling the creation of storage-level copies of the databases. Volume or protection-group snapshots are at the core of Pure's cloning and refresh capabilities that truly enable users to effectively create a copy of a database in a matter of minutes, regardless of size and number of volumes. Snapshots are self-contained images of a volume or a group of volumes in a protection group that represent the state of the database when the snapshots were taken, and they consume virtually no space when they are taken.

Snapshots are portable, because they contain the metadata and storage block information required to represent the volume or protection group at the time the snapshots were taken — all created instantaneously, with zero overhead. Snapshots can be taken in the array where the volumes exist, and they are used to either enable restoring the source volume or protection group to a specific point in time or to create a new volume or protection group that will look like the source when a snapshot was taken. When a snapshot is taken, no data blocks are copied, only the metadata is created. When data changes in the source volume, new data blocks are created with the new data, and the source volume will point to the new blocks while the snapshot points to the original unmodified ones. This enables significant space savings in storage density and maintains snapshot data consistency.

An Oracle applications database can be cloned or refreshed quickly by taking a snapshot of the source volume or protection group and then creating a new volume from it. This can be done either by following the process described below or by making use of Pure Storage's Copy Automation Tool (CAT). The snapshots are crash consistent even across LUNs. In other words, the data in the snapshots enables database recovery consistent with a recovery from a power outage. Every write that has been acknowledged to the database server is guaranteed to be present in the snapshot and the data on the volumes will be time consistent. The database itself does not need to be in backup mode and, furthermore, does not need to have media recovery enabled.



The complete process to clone an Oracle Database depends on several factors and whether ASM is used or not. Without ASM, the process can be summarized as follows:

1. Verify that target volumes are not mounted.
2. Create a snapshot of the source volumes.
3. Copy the snapshot to the corresponding target volumes.
4. Mount the target volumes on the database server.
5. Start the target database instance.

With ASM, the process can be summarized as:

1. Dismount the ASM disk groups of the target database.
2. Create a snapshot of the source volumes.
3. Copy the snapshot to the corresponding target volumes.
4. Mount the ASM disk groups on the target database server.
5. Start the target database instance.

The processes above describe the high-level steps to clone a database in the same FlashArray; but, often, there is a need to clone to a different FlashArray or to the AWS public cloud using Cloud Block Store for AWS. This could be done in support of a DR environment running on a different data center or to refresh an environment in AWS. While the cloning process is identical, the FlashRecover replication needs to be used to replicate the database to the target. Snapshots of the source volumes would still be created, but they would be replicated to the target. The first transfer, known as the baseline, is a transfer of the entire contents of the volumes, and all subsequent transfers will only include the incremental changes since the previously transferred snapshot. Once the replication takes place, the target volumes will be identical to the source volumes as of the last replication. This replication is extremely network efficient and can be done in a declarative way, with no coding required.

To Oracle applications and database environments, these cloning and refresh capabilities provide significant value. It is now possible to clone or refresh an Oracle applications database in a matter of minutes, regardless of the database size. Through the use of snapshots and snapshot replication, these operations are not limited to the array where the source database is, but can take place with targets being other arrays or the public cloud. And all the necessary storage-level operations can be done via the Pure1 web browser–based interface, the FlashArray command-line interface (CLI), or a REST API, or other tools can be used to script the whole process, such as CAT and Ansible®.

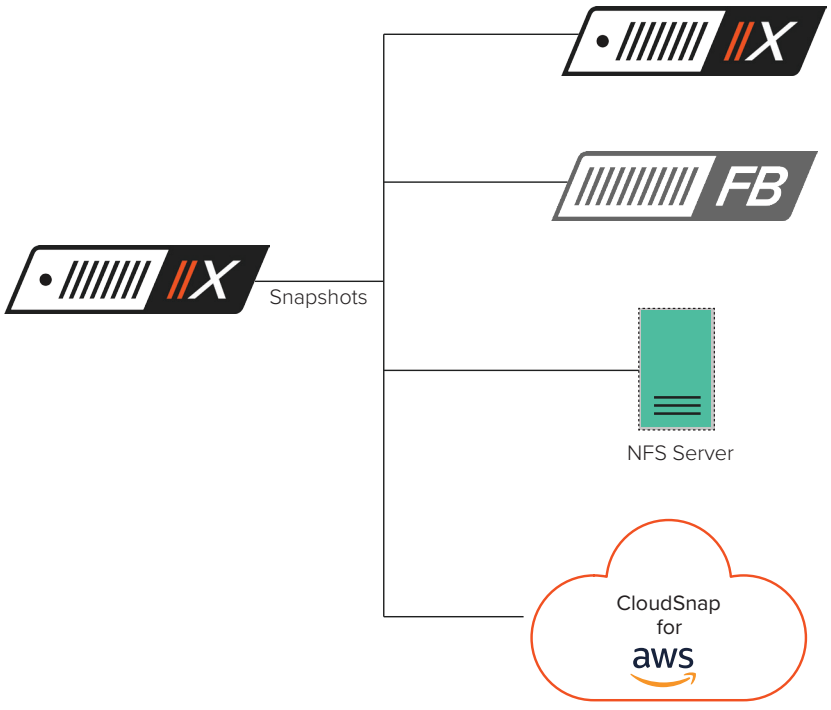
Data Protection

Data is the most important asset in an enterprise, and Pure Storage provides comprehensive data-protection capabilities that provide options for data's protection. Covering key capabilities such as fast backups, disaster recovery, and fast restore, enterprises can design the solution that best fits their data-protection needs.

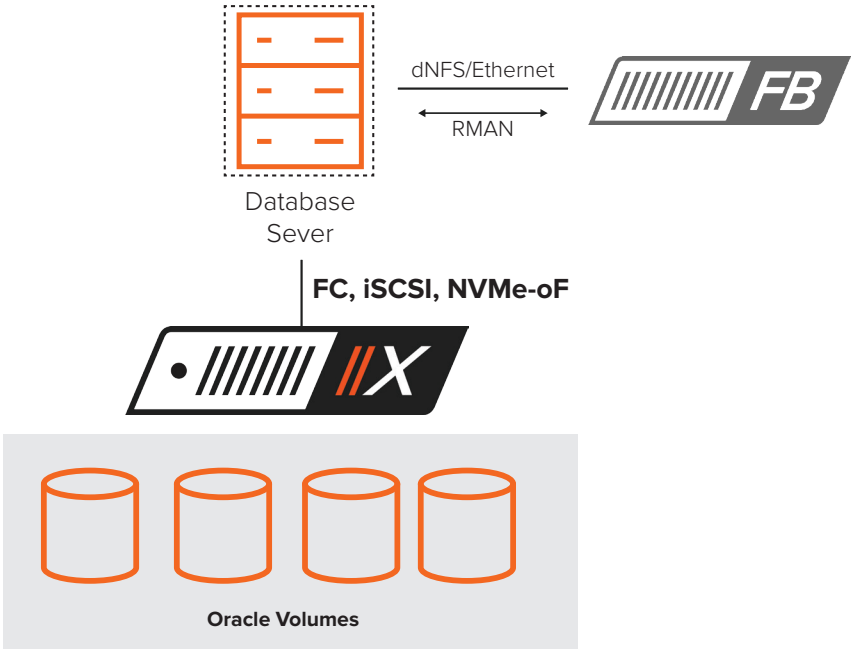
It all starts by protecting the data at rest in a storage array. Pure Storage FlashArray provides 99.9999% availability, including support for non-disruptive upgrades and updates.[1] This allows uninterrupted storage services — including no performance impact — while adding capacity, upgrading controllers, or replacing components. The data in a storage array is also protected by a Pure Storage custom RAID implementation (RAID-HA) that is optimized for flash, delivering the highest data protection without impacting performance, protecting data against loss due to flash read errors and device failures.

As discussed earlier, snapshots can be taken to capture a crash-consistent image of the Oracle databases running on FlashArray. The use case for keeping the snapshots local to the array where they were taken would be to enable point-in-time recovery of the volumes and to build other databases on the same array. As mentioned in the Oracle Database cloning and refreshing discussion, snapshots can be replicated to other FlashArrays, which could be done to create the source database either for a DR or any other environment. Furthermore, if the source database needs to be restored from a snapshot on another array, it can be copied back and used for such purpose. The target for the snapshot replication does not necessarily have to be another FlashArray (including a Pure Storage Cloud Block Store for AWS), it can also be a FlashBlade, a general purpose NFS server, or, using Pure Storage Purity CloudSnap™ for AWS, Amazon Simple Storage Service (Amazon S3). The benefits of replicating snapshots to other targets are:

- Enable the creation of cloned environments or refresh existing ones if the target of the replication is another FlashArray or Cloud Block Store
- Realize cheaper long-term retention of the snapshots that would be replicated back to the source FlashArray if needed to perform a point-in-time recovery



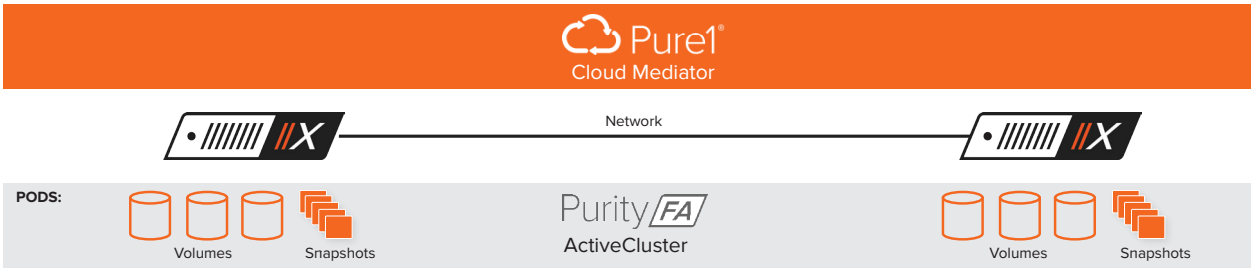
Using Oracle Recovery Manager (RMAN) for backup and recovery is a standard way to back up and restore Oracle databases because it is versatile, platform-agnostic, and fully supported by Oracle. However, the biggest hurdle with the RMAN approach is the time it takes to back up and restore, which makes these operations unfit if the operation window is short. Pure Storage addresses the RMAN performance challenges by using Oracle Direct NFS (dNFS) and FlashBlade, providing fast backup and fast recovery for the Oracle database. The fast performance and scalability of FlashBlade, coupled with the use of dNFS, have been tested in Pure's lab to support RMAN backups with peaks greater than 4 GB per second (GB/s). RMAN restore operations have also been tested with throughput peaks of more than 3 GB/s, with the restore target system being the bottleneck.



The data-protection and clone/refresh approaches discussed above all operate asynchronously; the FlashRecover replication will send the snapshots with the changed data on pre-configured schedules or on demand. This is appropriate for many use cases; but for some, the recovery-point objective (RPO) might not tolerate the data loss inherently associated with an asynchronous solution, such as data credit-card transaction databases.

For demanding RPO use cases, while there are still physical obstacles that are hard to overcome, such as the network latency, there is a possibility to define volumes between FlashArrays that are kept consistent synchronously. This is done using ActiveCluster, a Pure Storage technology that provides synchronous data replication between two FlashArrays with minimum overhead and setup. The volumes in this configuration are in an active-active mode; writes can take place in either array and will be synchronously replicated to the other. Volumes are defined as being part of a stretched pod and will exist in both arrays participating in the cluster. Any FlashArray can have local volumes and volumes that are part of a stretched pod.

In a typical scenario, two FlashArray devices connected via a network have volumes that are configured to be in an active-active cluster; any write to one volume will be sent to the other array synchronously and transparently to the application. A write operation coming from the application to any of the arrays is successfully confirmed only when the write is successfully committed to the NVRAM of both arrays. ActiveCluster uses Pure1 Cloud Mediator to monitor and manage the availability of the arrays in the cluster and mediate cluster failover, avoiding split-brain situations for the volumes that are part of pods.



The ActiveCluster configuration between two FlashArrays is rather simple and can be summarized by the following key steps:

1. Connect the two arrays.
2. Create the volumes to be part of the synchronous replication (active-active).
3. Put them in a management container called a pod and stretch it to the other array via a declarative command. This causes the volume to be replicated to the other array asynchronously. When the replication is complete, both arrays automatically transition to the synchronous I/O mode in which every write to one from a client application will be sent to the other, and both have to acknowledge the successful write to NVRAM for the original application write to be confirmed.

The two key use cases for Purity ActiveCluster are near-site protection and fast local failover. Near-site protection is the architecture model in which the database's volumes are part of an ActiveCluster between two arrays in different locations but within the same metropolitan area, where network latency is not too severe. This model aims to provide data protection from localized data center outages with no data loss, but the scope of incidents would not include metro-level incidents that would impact both data centers.

The second use case is identical to the first one, but both databases would reside in the same data center, on different physical arrays. The scope of protection would be an unlikely array failure enabling fast failover to the surviving array. This approach could be used as an Oracle RAC alternative for fast recovery; it will not protect the database service as Oracle RAC does — all database clients would be impacted instead of only the clients connected to the failed node — but it would provide fast recovery without the need of Oracle RAC licenses.

Specifically for Oracle database protection, ActiveCluster is a storage-level, high-performance capability that is included in FlashArray at no additional license cost and that is an active-active alternative to Oracle Data Guard configured in maximum protection mode for situations in which the network latency between FlashArrays or database servers is low. ActiveCluster, however, is not an alternative to the licensable Oracle Active Data Guard option, as the database can only be open in one of the FlashArray arrays in the ActiveCluster case, unlike Oracle Active Data Guard, in which the standby can be open for read operations.

Near-site protection and fast local failover architecture models make use of ActiveCluster for failure protection without data loss and with the opportunity to reduce costs by not licensing Oracle RAC if the service-level agreements (SLAs), capacity, and performance requirements permit it.

If network latency is not overly significant, ActiveCluster could also be used as the foundation for Oracle RAC on extended distance (stretched) environments. These stretched Oracle RAC environments are typically considered for metro environments, not too distant from each other, in which nodes reside in different locations.

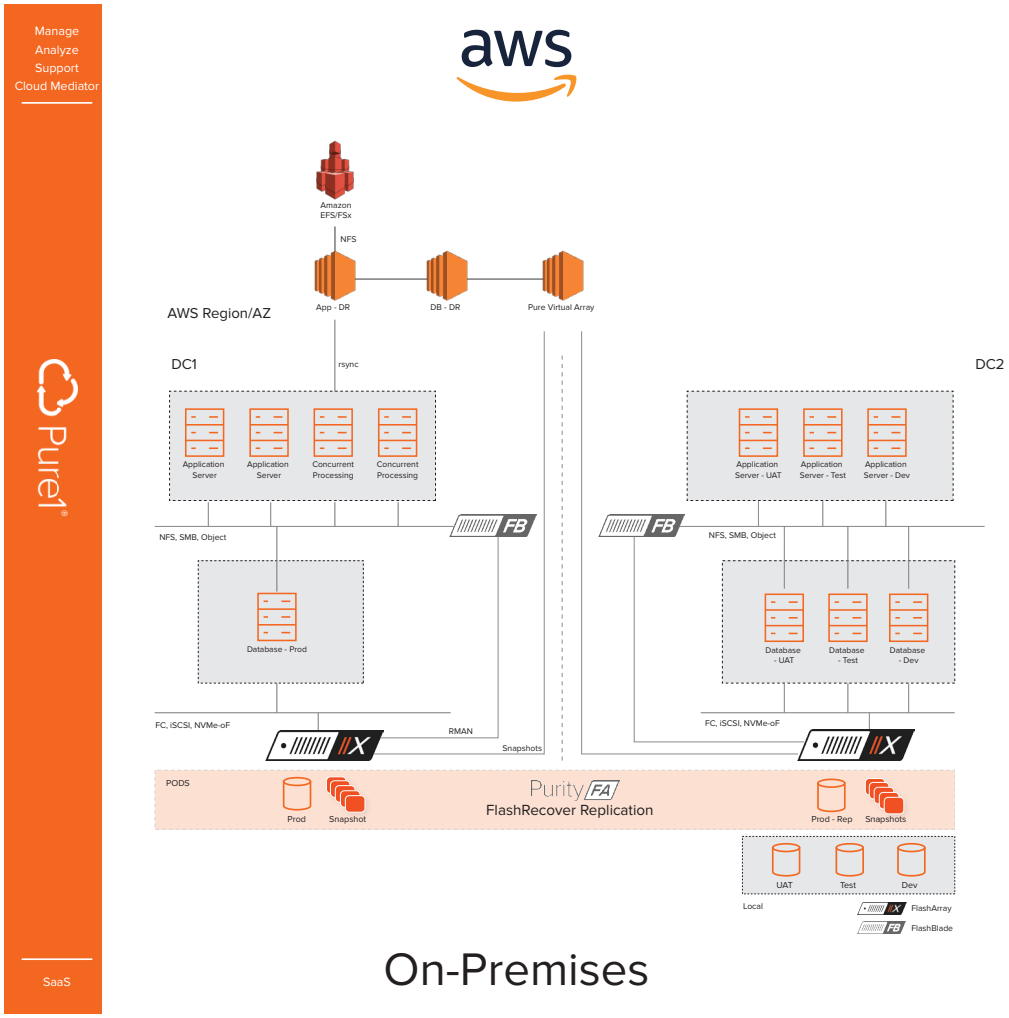
Pure Storage's data-protection capabilities provide Oracle applications and database customers with unparalleled native levels of availability, in addition to capabilities that allow easy implementation of multi-site, multi-array data protection with minimal to no need for custom scripts and manual input.

Sample Use Case

For the purpose of illustrating the capabilities described in this document, let's assume the following use case:

- Oracle applications environment — Oracle E-Business Suite R12.2
- Oracle Database 12c Release 1
- Production in the primary data center, DC1
- Three non-production environments in the secondary data center, DC2
- Non-production environment databases need to be refreshed from production every other week
- DR environment in AWS
- RMAN backups for backup portability
- FlashBlade used to provide NFS services to be used for the Oracle E-Business Suite shared file system installation

Architecture



Description

The production environment runs on the DC1 data center and is comprised of four application and concurrent processing servers running the Oracle E-Business Suite services. They connect to a single database server and all share an NFS file system that is provided by FlashBlade. The Oracle E-Business Suite Oracle Database running on the database server will use block storage provided by FlashArray.

Similar architecture is configured in DC2 to support the user acceptance testing (UAT), test, and dev environments, with the exception that a single application server is used for each environment. In the public cloud, one Pure Storage Cloud Block Store (Pure virtual array) has been configured to provide block storage to the database server, which is an Amazon EC2 instance. Because it is a DR environment, only a single application server is used in the public cloud, but others could be provisioned in the event of a disaster.

The production database is protected by creating local snapshots for fast recovery and RMAN backups to the FlashBlade array. For DR, FlashRecover replication is set between the production FlashArray and Pure virtual array in AWS, as well as between the production FlashArray and the non-production FlashArray in the DC2 data center.

When one of the non-production databases needs to be refreshed, new volumes are created from the replicated production database, which is a fast operation, normally a few seconds. The Oracle E-Business Suite shared APPL_TOP will be manually copied from the source to the destination as FlashBlade does not support replication at this stage, with the exception of the copy between production and DR as the synchronization uses the rsync command.

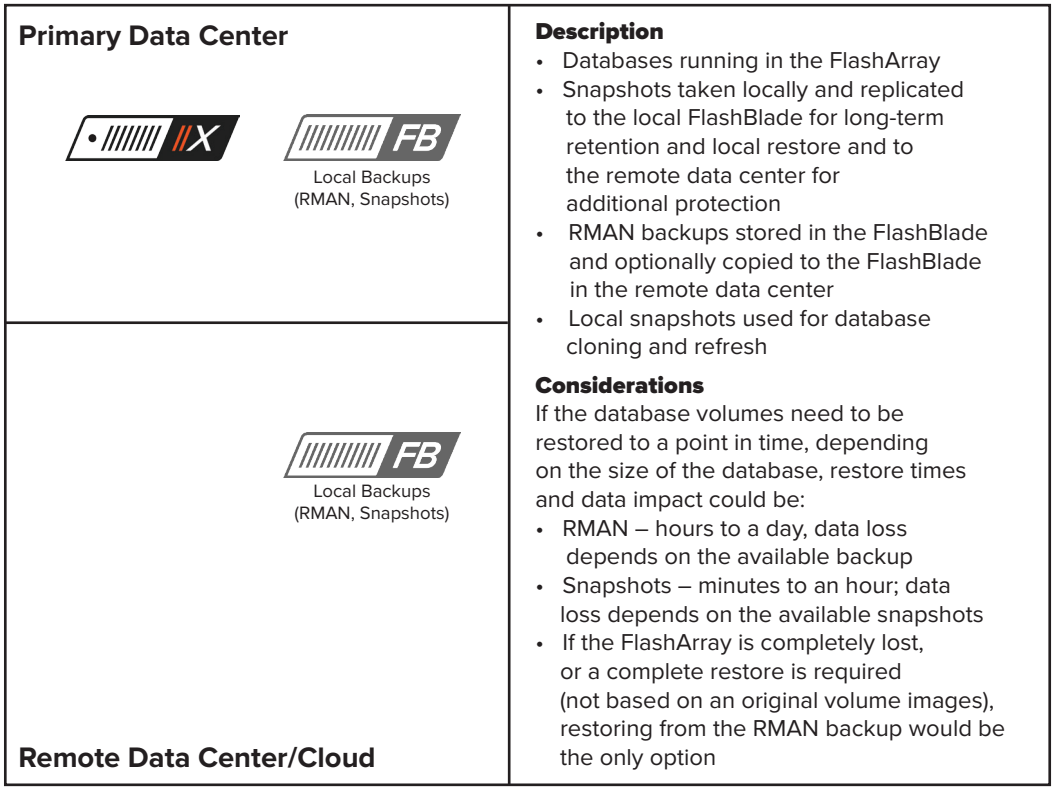
Database Downtime and Data-Loss Potential Considerations

This RA provides a reference for building Pure Storage solution–based Oracle solutions, and it provides the framework for building Oracle solutions that are aligned with the customer's business and IT objectives, making use of both Oracle and Pure Storage technologies.

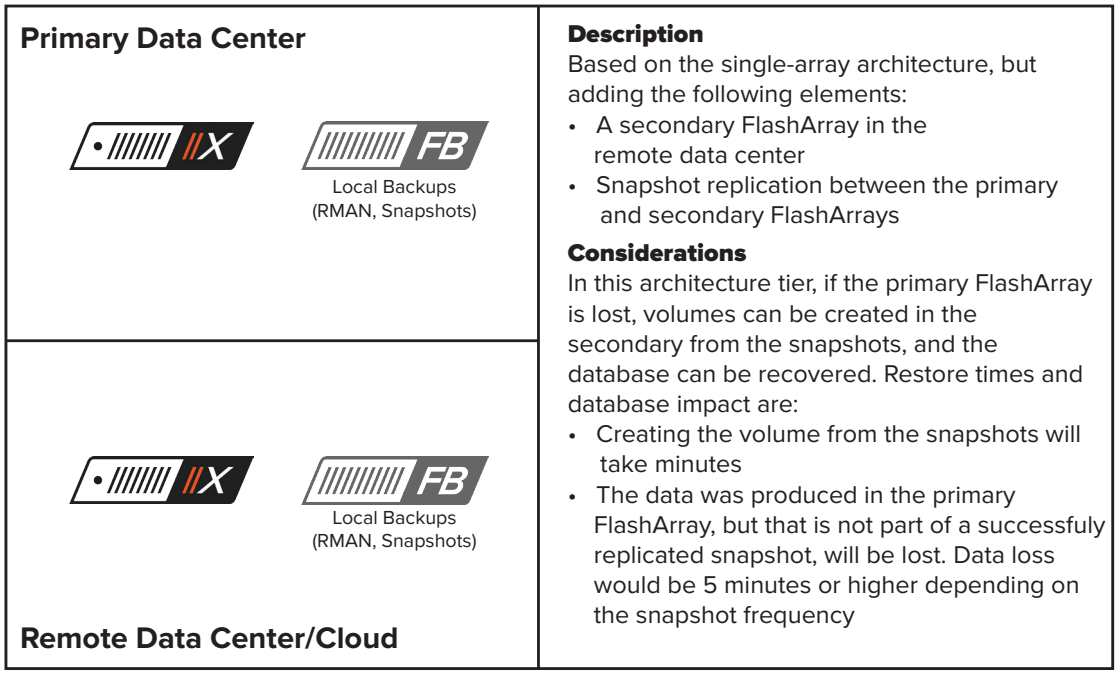
The architecture design is driven by the business and IT requirements, in addition to the application's relevant capabilities and technical architecture. For the purpose of this discussion, this paper will focus on the database availability irrespective of the application or applications using it.

The level of database downtime and data loss will be determined by several factors, but the storage architecture plays a major role. While Pure Storage solutions are highly available, offering a measured availability of 99.9999% for FlashArray, many types of events might take place compromising the availability of the database.[1] To protect that database, Pure supports several tiered architectures, each building upon the previous tier or the standard product capabilities.

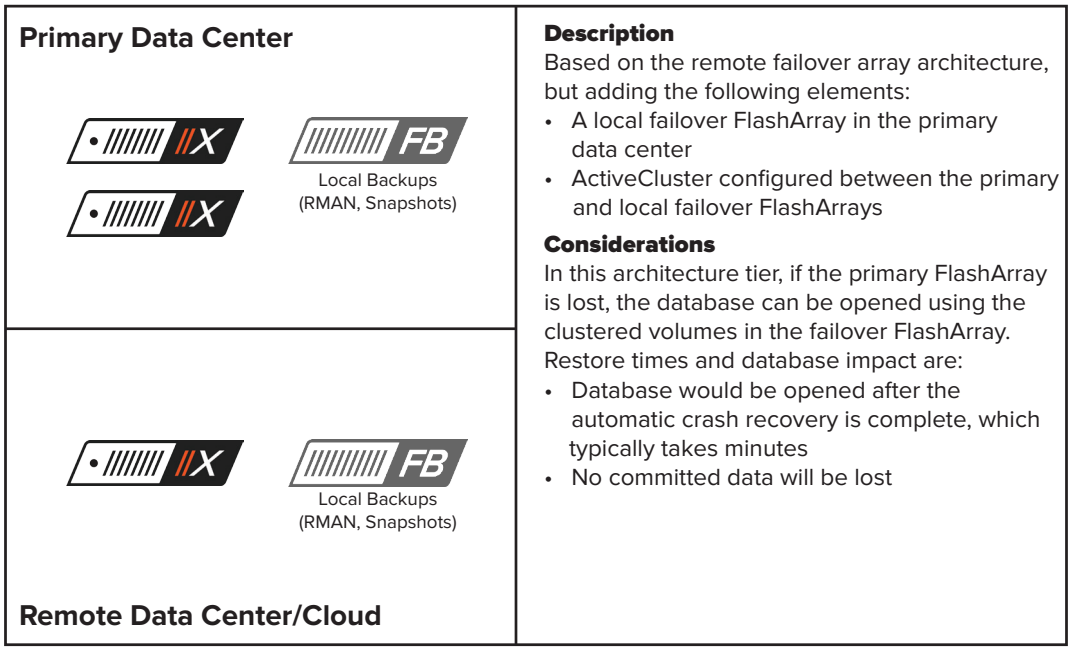
The first architecture tier — single array — provides basic protection mostly based on the FlashArray protection capabilities. If the FlashArray is compromised by, for example, a data center outage, the only opportunity would be to recover from the RMAN backups stored in the remote data center.



The second architecture tier — remote failover array — builds on the previous tier and adds a FlashArray in the remote data center. This addition provides further protection from complete impairments of the primary FlashArray, allowing fast recovery based on replicated snapshots. Data loss will be likely, and all failures of the primary FlashArray will have the same consequences as a disaster in the primary data center, causing the database and associated applications to failover to the remote data center with associated data loss.



The remote failover array architecture will provide a failover environment, but with data loss. Remote failover of databases and associated applications can be complex and, given the data loss, many customers look for alternatives. One such alternative is to provide local failover support in the primary data center, without data loss, by deploying a local failover FlashArray in the primary data center with ActiveCluster configured with the primary FlashArray. This means that the only time data will be lost due to an outage would be a disaster in the primary data center; a failure of the primary FlashArray would be handled locally with no data loss.

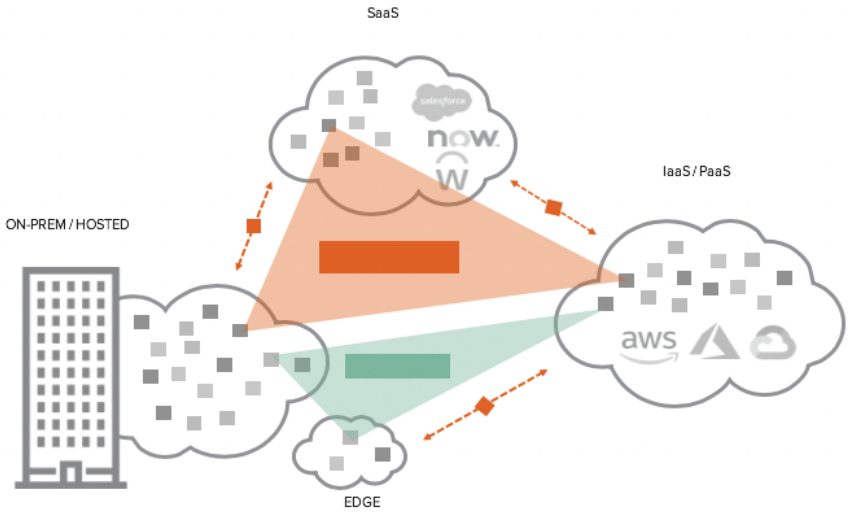


Pure Storage Solutions Summary

Cloud Block Store and Purity CloudSnap

(www.purestorage.com/solutions/cloud/data-storage.html)

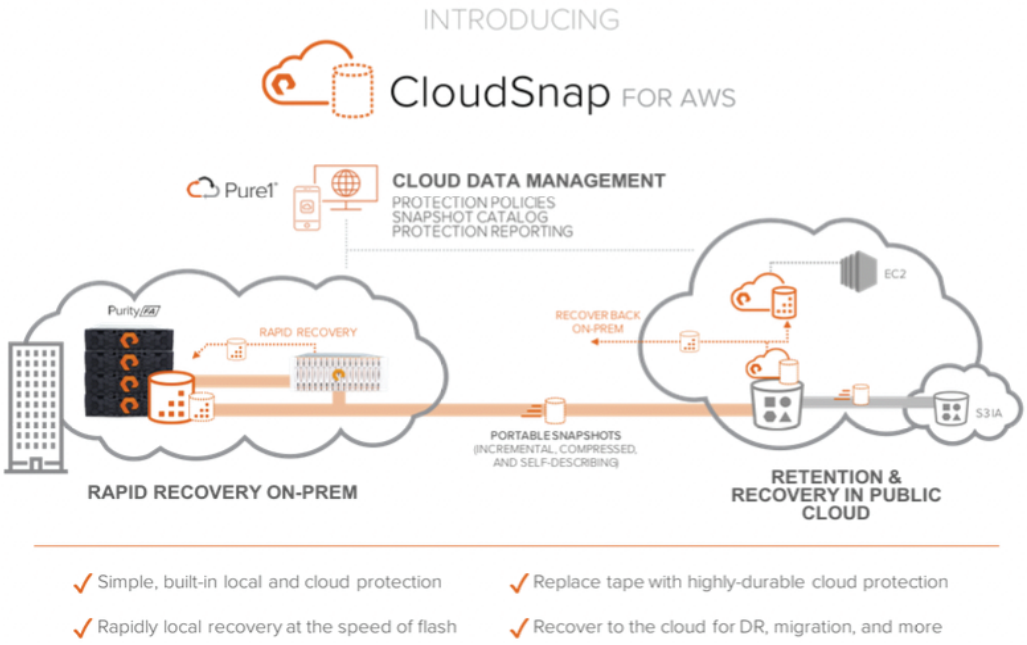
Cloud is a computing model that is a reality for many customers and is becoming more and more pervasive in enterprise IT. Of the cloud deployment models, hybrid cloud — in which IT solutions are deployed on the public cloud or on premises, with full mobility between them — is believed by many to be not only a transitional model, but the future of IT.



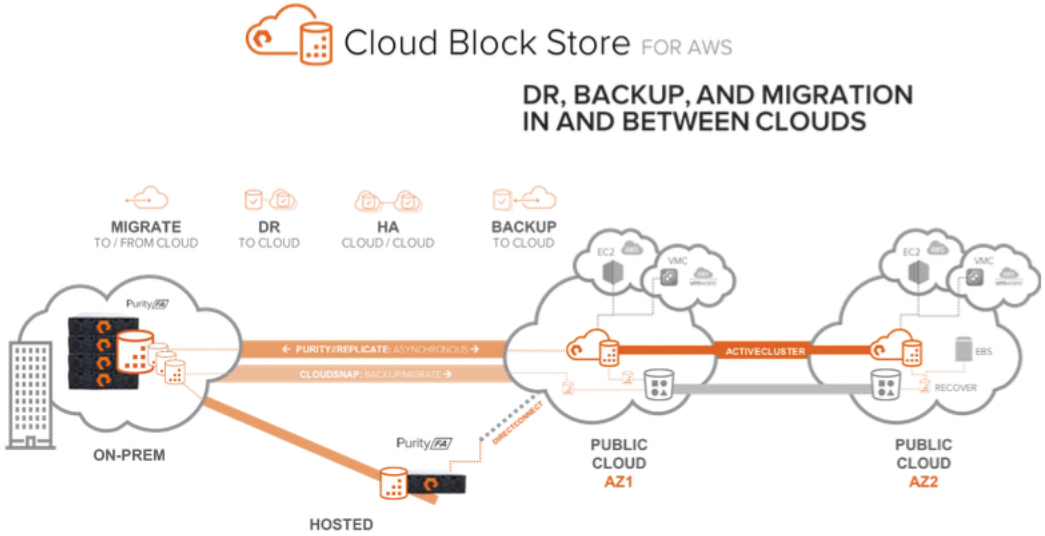
To realize a true hybrid cloud, applications and data must be able to move between the public cloud and on premises with seamless operations.

Pure Storage's vision is to enable customers to build true hybrid-cloud applications that run seamlessly across clouds. Data lies in the center of the hybrid cloud, so a data-centric architecture that delivers fast, shared data with consistent data access and APIs everywhere applications run is paramount. This means data mobility, a consistent, seamless experience managing data, and flexible data-protection options.

The Pure Storage implementation for hybrid cloud is already a reality with two offerings — Cloud Block Store for AWS and Purity CloudSnap — both offerings currently available for AWS, with other providers to follow. As mentioned earlier in this document, CloudSnap for AWS provides the ability to transparently use Amazon S3 storage as a replication target, just like another FlashArray or FlashBlade. Snapshots sent to CloudSnap for AWS can be used for long-term retention of the volumes' point-in-time images, as well as used to recover volumes if necessary.



Cloud Block Store for AWS abstracts AWS block storage and presents the same management interface and capabilities one experiences with on-premises FlashArrays. Deployed as virtual machines in AWS, they can be seen as virtual FlashArrays, running the same software used to run the on-premises arrays. This means that these virtual arrays can be part of FlashRecover replication and ActiveCluster configurations between themselves or with on-premises FlashArrays.



Converged Infrastructure with Pure Storage

(**www.purestorage.com/content/flashstack-com-live/en_us.html**)

So far in this document, the architecture did not consider compute servers, focusing instead on the data-management aspects of the architecture. For some customers or environments, however, a converged-infrastructure approach presents significant business and IT benefits. Converged infrastructure is a solution that includes computing, storage, and the necessary networking, streamlining the time to value.

FlashStack™ is a converged infrastructure engineered by Cisco and Pure Storage and comprised of Cisco UCS® servers, Cisco® networking, and Pure Storage arrays. FlashStack solutions make use of Pure Storage FlashArray or FlashBlade solutions to meet even the most demanding workloads.

A true enabler of IT as a service, FlashStack supports many infrastructure-automation frameworks, including VMware® and OpenStack®.

FlashArray

(**www.purestorage.com/products/flasharray-x.html**)

FlashArray is an enterprise-grade 100% NVMe flash storage solution designed for all applications' block-storage needs. FlashArray delivers up to 3 PB effective capacity in just 6U, supports Fiber Channel, iSCSI, and NVMe-oF protocols, and offers the greatest levels of performance and availability required by enterprise workloads. FlashArray delivers on proven 99.9999% availability, inclusive of maintenance, failures, generational upgrades, and capacity adjustments. All this comes with a consistent sub-millisecond latency for all applications.[1] FlashArray deployments take just minutes, providing an exceptional time-to-market and deployment simplicity.

FlashArray is powered by Purity//FA and provides critical capabilities at no extra cost, such as:

- Always-on data reduction with up to 10:1 total data efficiency
- Always-on data-at-rest encryption
- Local snapshots for in-array data protection, cloning, and refreshes
- Remote snapshot targets for long-term archiving, data protection, or remote array cloning or refreshes
- ActiveCluster for synchronous data replication for data clusters between arrays
- Purity CloudSnap for public cloud snapshot targets for snapshot archiving
- Cloud Block Store for remote public cloud targets for archive replication for data protection or public-cloud cloning or refreshes

FlashArray is part of the Evergreen™ Storage program, designed to maximize the ownership experience.

FlashBlade

(**www.purestorage.com/products/flashblade.html**)

Pure Storage FlashBlade is the most advanced enterprise-class file- and object-storage solution architected for use cases ranging from meeting shared file-storage application requirements to the most advanced and demanding AI and analytics needs. FlashBlade provides support for NFS, S3/Object, SMB, and HTTP protocols for the needs of all modern application workloads. With FlashBlade, there is no need for trade-offs among capacity, performance, and simplicity thanks to a modern blade-based scale-out architecture. By adding more storage blades, you can scale up to multi-petabyte capacity with significant data center space and power savings. FlashBlade is simple and fast to deploy in the data center, offering high levels of availability, including non-disruptive upgrades and N+2 blade redundancy.

Purity//FB

As with Purity//FA for FlashArray, Purity//FB is the enabler of FlashBlade performance and capacity capabilities. Storage services at every layer are elastic thanks to the distributed transaction database at the core of Purity//FB. Purity//FB provides global flash management and effortless scaling: simply add additional storage blades and the system grows in capacity and performance.

FlashBlade is part of the Evergreen Storage program, designed to maximize the ownership experience.

Pure1

(**www.purestorage.com/products/pure-1.html**)

Pure1 is Pure Storage's cloud-based intelligent data-storage management and support platform that delivers Pure Storage's vision for an autonomous data-management solution providing AI-driven management, predictive support, and full-stack analytics. Customers use Pure1 for all their monitoring, management, and support of their Pure Storage assets.

Built in the cloud, Pure1 automates data-management tasks so that administrators can benefit from a declarative approach to their management activities, such as taking snapshots or configuring Cloud Block Store instead of having to write and execute scripts. Customers can also run full-stack analytics from the virtual machine to the connected array and access comprehensive monitoring information from a global asset dashboard to monitor ActiveCluster status.

Meta

Pure1 Meta™ is the AI core of Pure1. It is the engine that enables autonomous data management and proactive support, avoiding issues that would compromise data services' availability. Data from a global network of tens of thousands of Pure Storage arrays is collected — more than 1 trillion data points per day and growing, feeding a data store larger than 7 PB — and analyzed by the AI engine. The result is an autonomous data-management solution that tunes itself and that provides you with AI-driven answers to capacity, performance, and workload placement.

Evergreen™ Storage

Evergreen Storage

(**www.purestorage.com/products/evergreen.html**)

Evergreen Storage is a subscription model that enables customers to subscribe to a storage-ownership experience that evolves over time, just like customer's needs do. With Evergreen Storage, customers can buy their storage once and upgrade or modernize it as needed, all without any disruption and re-buying of TB of storage that they already own. Through Evergreen Storage's Gold and Silver subscriptions, customers can frequently take advantage of new software capabilities and features as they are released, in addition to hardware and flash innovation, without having to wait for a hardware refresh.

Evergreen™ Storage		Evergreen Gold Subscription	Evergreen Silver Subscription	vs	Industry Standard Support	
SOFTWARE SUBSCRIPTION	All-Inclusive Array Software	✓	✓		!	**A-LA-CARTE SOFTWARE PURCHASES**
	Future Array Software Features	✓	✓		!	
HW & SW MAINTENANCE SUBSCRIPTION	Flat & Fair Maintenance	✓	✓		!	**BASIC HW WARRANTY**
	Evergreen Maintenance	✓	✓		!	
WHITE GLOVE SUPPORT SUBSCRIPTION	Predictive Analytics & Services	✓	✓		!	**BASIC SUPPORT (OR PAY A LOT MORE)**
	Instant L2 Support Access	✓	✓		!	
	Sev 1 Response SLA	15 min	15 min		60 min +	
	Support Managed Upgrades	✓	✓		!	
	On-Site Break/Fix SLAs	4HR & NBD	4HR & NBD		!	
	Mobile/SaaS-Based Monitoring	✓	✓		!	
MEDIA & CONTROLLERS SUBSCRIPTION	Evergreen Architecture	✓	✓		!	**HARDWARE RE-BUYS, AGAIN AND AGAIN...**
	Right Size & 30-Day Guarantees	✓	✓		Inferior	
	Free Every Three*	✓	!		!	
	Upgrade Flex Controllers**	Trade-in Credit	No Credit		!	
	Capacity Consolidation**	Trade-in Credit /w 4X Purchase	No Credit		!	

*See Evergreen Storage program terms **Requires purchase of qualifying capacity

With the Gold-level subscription, you have access to upgrades for the controllers every three years with the subscription renewal, in addition to many other entitlements.

1 Pure Storage. Product web page. **www.purestorage.com/products.html**.

2 Pure Storage. Effortless web page. **www.purestorage.com/why-pure/effortless.html**.

3 Pure Storage. Purity Reduce web page. **www.purestorage.com/products/purity/purity-reduce.html**.

4 Pure Storage Cloud Block Store is still in beta as of this writing, with general availability (GA) anticipated for the second half of 2019.