White Paper

Building a cost effective, continuously available storage infrastructure; EMC VNX and EMC VPLEX

A new availability paradigm for the mid-tier

Abstract

Business requirements are placing ever increasing demands on IT infrastructure to ensure that applications are always operating at full capability. This white paper looks at how EMC's class leading mid-range storage platform, the EMC® VNX® Series, in conjunction with the class leading EMC VPLEX® storage federation solution provides a new level of service for mission critical applications that truly delivers to the paradigm of access anywhere and protect everywhere.

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EMC²

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Executive Summary

There have been various key strategic initiatives over the years in IT, none more pervasive than the ubiquitous cloud. It seems that wherever you look, vendors are all touting their value to businesses looking to embrace the cloud. The cloud is a distributable approach to delivering IT services in a cost effective manner. The core of the cloud however, and an underlying requirement in all the "Top CIO concerns" articles published over the last decade, is the constant challenge to ensure that service levels are met in an increasingly complex IT world. Fundamentally, this is the ability to provide an "Always-On" infrastructure that can scale and accommodate often changing business needs; an IT solution that maintains application availability regardless of what users, vendors or Mother Nature might throw at it. In most cases, the highest availability solutions available today replicate their data from an active site to a passive site such that when a large scale problem happens, they can initiate a failover to the passive location.

EMC is now able to provide a unique solution, with VNX and VPLEX that delivers an active/active solution across data centers which in many cases, makes traditional disaster recovery obsolete. The award winning EMC VNX Series storage platform, delivers a reliable, easy to use, scalable and efficient storage foundation, to which VPLEX adds cross data center storage federation. This combination delivers the continuous operation of business applications through technical refreshes, infrastructure upgrades, component failures and even large scale disasters. All included in a cost-effective solution that cannot be matched anywhere in the industry. Furthermore, the VNX with VPLEX solution can provide:

- Reduced operational costs through a more effective procurement model
- Flexible application protection schemes
- Improved availability through storage self remediation

When the VPLEX with VNX technologies are combined with application availability technologies such as **Oracle Real Application Clusters (RAC)** or VMware® vSphere™ HA features (**VMware High Availability / VMware Fault Tolerance / VMware Distributed Resource Scheduling**) it becomes simpler and less expensive to provide the highest levels of availability to these critical applications. This effectively makes both planned and unplanned downtime obsolete

Audience

This white paper is intended for CIO's, systems and storage architects and administrators who are responsible for architecting, managing and operating high availability IT environments.

Introduction

This paper will outline the business benefits that you will experience by deploying a VNX with VPLEX solution or adding a VPLEX to your existing VNX deployment. The core, differentiated values of this solution include:

A more effective procurement model
- Lower cost to entry (don't need to size array for 'future', size for today)
- Enables buying smaller arrays and manage them as one, masking the silos of complexity

Improved availability (Continuous Operations)
- Move data between arrays non-disruptively
- Non-disruptive hardware and software upgrades
- Tolerate component, processor, entire array and data center failures with zero downtime
- Never perform a disruptive migration again
- Active / active Datacenters

Improved efficiency and reduced cost
- Tier inside (EMC FAST VP) and outside the array
- Leverage per LUN protection schemes for application protection. A tier 1 app could be mirrored across two VNX systems, and a tier 2 app may be on a single array
- Re-balance workloads across platforms

Improved service levels
- Alleviate performance bottlenecks
- Stripe workloads across arrays

 Now let's take a high level look at the VNX and the VPLEX technologies.

VNX, class leading mid-tier storage; Product Introduction

The EMC VNX Series storage platform delivers industry-leading innovation and enterprise capabilities for File, Block and Object Storage in a scalable, easy to use solution. The VNX combines a powerful and flexible, scale-up, modular hardware architecture with advanced efficiency, management and protection software to meet the demanding needs of today's mid-size and enterprise customers. VNX is designed from the ground up to deliver 5x9's of availability through a fault tolerant "No-Single-point-of-failure design", high speed controller failover and advanced replication features for local and remote recovery in the event of disasters.

VNX leverages the concept of self optimizing storage pools, virtualizing storage management resources in a similar way to how applications and server OS's are virtualized by VMware, Hyper-V, Xen Server etc. The systems are also expressly designed to deliver the highest levels of performance by taking advantage of the latest innovations in Flash technology. As a *hybrid array*, by combining Flash storage in a single pool with SAS and NL-SAS Hard Disk Drives (HDD), VNX with its FAST VP

and FAST Cache technologies, can dynamically manage data movement at very fine levels of granularity between these tiers to ensure the data is optimally placed relative to its required service level. This is known as the FLASH 1st data strategy and is unique to EMC VNX and delivers unprecedented performance in a mid-range storage solution, at the lowest possible cost.

Self-Optimizing Storage Pools

Virtual Server Pool

Automatic Application Optimization

APP OS   APP OS   APP OS   APP OS   APP OS   APP OS

Automatic Data Optimization

Storage Pool

Storage System
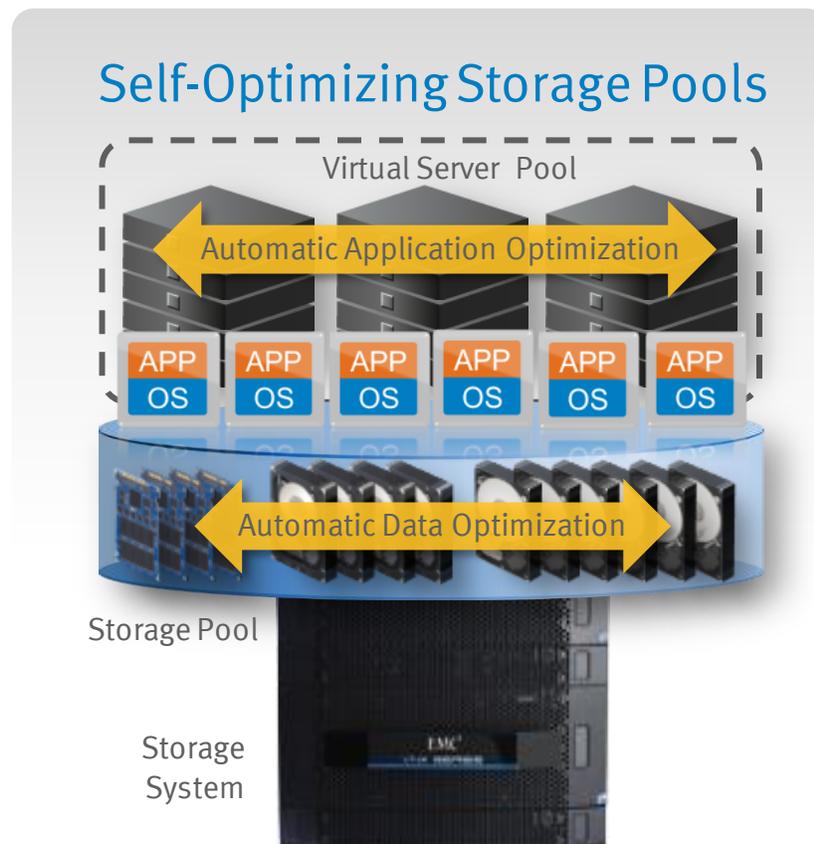
Figure 1 VNX Storage Efficiency Technologies

The VNX comes with built in features to help ensure redundant or inactive data does not consume valuable storage resources. These efficiency technologies, such as thin provisioning and data compression, ensure that physical hardware resources are optimized even further and can deliver up to 50% more useable capacity.

VNX is designed to be simple to use, extensible and at the same time powerful and flexible. Leveraging the Unisphere™ interface, VNX can visualize and manage up to 100 systems in a single, intuitive User Interface (UI). It manages current and legacy platforms as well as the RecoverPoint replication solution. In addition, VNX integrates tightly into the VMware and Windows management context and is an ideal mid-tier solution for virtualized application environments.

VPLEX, class leading storage federation solution; Product Introduction

EMC VPLEX is an Enterprise class scale out storage federation technology that aggregates and manages pools of fiber channel attached storage (EMC and third party arrays) within and across data centers. VPLEX resides between the server and a number of heterogeneous storage systems and presents local and distributed volumes to hosts. VPLEX AccessAnywhere clustering technology allows highly efficient read/write access to distributed volumes across synchronous distances up to 5 milliseconds (ms) round trip time (RTT). VPLEX is ideal for a wide range of companies (both mid-size and Enterprise) and use cases. These use cases include continuous availability by extending clusters over distance (VMware, Oracle RAC etc.), application mobility, data migration and technology refresh, and enhancing single site array availability. For the purposes of this introduction we will take a closer look at the following use cases:

- Continuous Operations - Customers performing a tech refresh and/or frequent data migrations, for example when implementing high impact storage infrastructure changes, are a great use case to start implementing VPLEX. VPLEX vastly improves asset utilization and workload rebalancing and in addition VMs, applications, and data can be moved over distance non-disruptively during migration and when refreshing technology.

- Extending VMware clusters—as discussed above, VPLEX enables immediate VMware workload mobility for multiple arrays—both locally and remotely. Customer benefits include automatic, hands-free failover, application relocation for load balancing or maintenance, elimination of CPU cycles spent on data movement, higher utilization across all arrays, and simplified, dual-site, high availability.

- True Oracle RAC over distance —VPLEX provides continuous availability for mission critical applications like Oracle RAC, enabling Zero RPO and Zero RTO over synchronous distances—even in the event of a site failure. Benefits include enhanced application availability, full utilization of dual site resources, simple management, standard Oracle RAC implementation, and full certification from Oracle. In addition to support of Oracle RAC, VPLEX can also interoperate with most third party clustering technologies, such as Linux, Unix and Windows clusters (including hyperV)

VPLEX can be deployed in one of 3 topologies, VPLEX Local, VPLEX Metro and VPLEX Geo, although we will specifically focus on VPLEX Local and Metro as Geo is not supported by Oracle and VMware today. VPLEX Local can be used in a single data center and allows the federation of multiple storage arrays, and is the basis for the non-disruptive operations use case. VPLEX Metro extends the VPLEX benefits to multiple sites at synchronous distances (Up to 5ms RTT) and introduces the idea of a distributed volume across sites, which adds the fault tolerant availability use cases for VMware and Oracle RAC that we will investigate further.
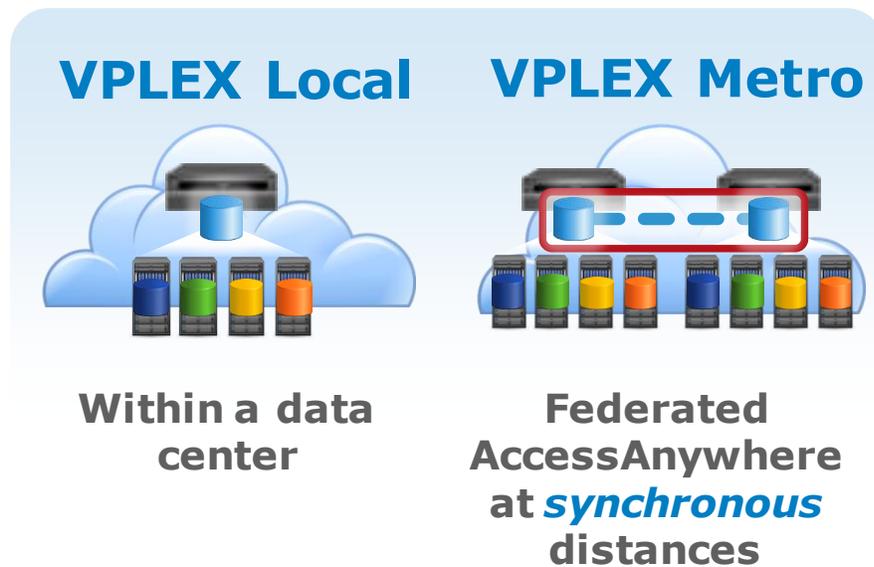
VPLEX Local   **VPLEX Metro**

Within a data center

Federated AccessAnywhere at *synchronous* distances

Figure 2 VPLEX Configuration Options

VNX and VPLEX, storage synergy

EMC's VNX platform is the storage leader in the cost-effective mid-range market. It is deployed across almost all mainstream IT applications in organizations of all sizes. It delivers 5x9's availability and has high end enterprise functionality for optimal efficiency and TCO. In certain customer environments however, additional levels of availability may be required and are available by introducing VPLEX. For example;

- Where many applications are consolidated together in a single fault domain such as large VMware deployments OR

- Where applications are so critical that any downtime is unacceptable to the business.

. The most significant value of the VNX to the VPLEX solution is that it enables EMC to offer a highly cost optimized federated active/active data access solution over distance with an entry price comparable to that of a replicated (active / passive) Tier 1.5 standalone solution. The most significant value of VPLEX to the VNX solution is that it offers significant availability benefits over distance and usability benefits, yet allows customers to continue to leverage the efficiency, protection and management features that they love so much in the VNX. In addition to this, the VPLEX also provides a Federated active/active storage access model, compared to the active/active Asynchronous Logical Unit Access (ALUA) mode of standard VNX. This further improves availability and ensures ease of use for host pathing configurations.

The combination also allows the aggregation of multiple VNX systems to provide a solution that delivers huge amounts of aggregate performance for the most demanding applications.

Although this type of solution can be used for most HA host cluster technologies, the remainder of this paper will focus on how VPLEX with VNX addresses the following use cases:

- Continuous operations
- Extending VMware clusters
- True Oracle RAC over distance

VPLEX and VNX Use Cases

Introduction

The uniqueness of VPLEX is that it offers a single view of a storage volume (LUN) at 2 different locations that can be up to 5ms RTT apart, and can be dynamically accessed at either location, while maintaining integrity and consistency of the data set. The continuous operations use case does not require specialized host software since it masks the underlying modularity of the attached arrays while enabling dynamic data migrations between them. This negates the impact of activities that historically would have required application downtime such as technical refresh on storage devices, highly impactful software upgrades and the likes.

For our second (VMware) and third use cases (Oracle), the "clustering" technologies provided by VMware HA / VMware FT and Oracle RAC respectively, work seamlessly with VPLEX distributed active/active volumes to deliver a "federated" cluster over distance.

While not expressly covered in this paper, VPLEX can interoperate with any supported third party clustering technology such as Linux, Unix or Windows clusters either locally or over geographical distances, so it's value is not strictly limited to Oracle or VMware specific clustering / HA capabilities.

Continuous Operations

Continuous operations is a term used to describe some of the core technical VPLEX with VNX value propositions that enable enterprise IT to offer improved service levels to the business. One or more of these value propositions may be sufficient to justify giving VPLEX with VNX serious considerations in your environment. All the benefits indicated in this section also apply to the VMware and Oracle use cases.

The following benefits that arise from the continuous operations use case, include:

- Never have to migrate again – VPLEX can be simply inserted into most environments (and supports ›40 heterogeneous platforms), with minimal downtime. Once installed, futures storage assets are seamlessly connected to VPLEX and LUNs are migrated non disruptively from older assets and then easily retired.

- Ride through component and even whole array failures (requires mirrored copy of LUNs) – maintain availability through almost all *unplanned* outages including site failure.
- Maintain availability through major environmental, hardware and software planned events – maintain availability throughout all *planned* events due to transparent data migration

Never have to migrate again!

Customers typically have to move data for several reasons, but one of the most onerous tasks for customers, particularly in large capacity environments, is the issue of managing a storage platform refresh. Conventional approaches use solutions like tape backups, copying data through hosts or the network, or replicating to another site. This approach is often slow (some customers are constantly in the processing of migrating data to new platforms for tech refresh, much like how the golden gate bridge is permanently being painted!), highly people intensive (therefore costly), error prone and requires much planning. Perhaps even more impactful however, is that an outage is usually required, affecting application service levels to the business and requiring coordination with multiple departments across IT and the core business. But with VPLEX and VNX, you can now solve these problems once and for all.

Using VPLEX for platform refresh use cases has several advantages over traditional solutions. The VPLEX Local cluster can be inserted into an existing storage infrastructure with a minimal amount of impact so less down time is required than manual array migrations. VPLEX supports over 40 different array types, ensuring that most environments will be able to leverage the VPLEX benefits immediately and the introduction or refresh of the VNX storage arrays are seamless. The original host LUNs are simply made available to the host in a pass through mode, although termination for the LUN takes places in VPLEX. Once you are operating in this mode, new storage systems can be added behind the VPLEX and migration jobs can be initiated. This process is seamless to the applications which continue to operate as if nothing happened. Systems can be *cost effectively* scaled by starting small and adding multiple arrays as demands require.

But what if the migration is part of a consolidation into a new data center? VPLEX Metro introduces the concept of the cooperation of two VPLEX clusters, each serving their own failure domain over synchronous distance. This is known as "Federation" and enables seamless migration between sites but also introduces the opportunity to form active/active distributed volume(s) which can be used for the other use cases in this paper.

Ride through component, array and site failures!

High availability and fault tolerance are terms that several companies will claim they can deliver, but VNX with VPLEX delivers fault tolerance at distance, changing the game and creating a new category of high availability. High availability starts with the reliability of the individual components of a solution and while individual components are usually very reliable, as those systems scale, a failure can have a

large scale impact. VPLEX adds value to individual storage arrays by offering the option to mirror data to different VNX arrays within or between different data centers. This functionality allows system failures to have no impact to the business applications, whether a component of an array, an array itself or a whole data center (with VPLEX Witness deployed) is affected

Providing continuous system level uptime for critical applications through unexpected (disaster) events has historically required a storage level replication solution, with a manual failover and restart process. These conventional solutions force companies to choose a recovery point objective or RPO – the amount of data that the business can tolerate to lose following a disaster event - and Recovery Time Objective or RTO – the amount of time it takes me to recover the application following a disaster event. But although some solutions offer small RTOs and RPOs, typically the lower the RPO/RTO the more expensive is the solution and in addition there is still some degree of down time required to recover — and for most companies, *any* downtime at all can be costly.

VPLEX with VNX is a truly differentiated and unique solution for high availability, for all or part of your environment. No manual intervention is required, and no storage level recovery or restart is necessary, removing the quandary that faces customers when deciding whether to implement the failover process or not. Within synchronous distances using this solution, VPLEX and VNX provide HA and disaster/downtime avoidance instead of just disaster recovery—because there is literally no disaster event from which to recover. In effect, VPLEX with VNX can be configured to change the way we think about disasters and instead of a replication and manual restart approach to Disaster Recovery, provides a disaster tolerant solution, where the loss of a data center is much like the loss of a redundant storage component in conventional storage architectures.

Make planned outages obsolete!

While companies spend millions of dollars on solutions intended to provide a mechanism to resume services following an unplanned disastrous event, it is in fact much more common that system availability is affected by foreseeable outages such as hardware upgrades, software or firmware upgrades or infrastructural events like power and cooling upgrades. In many conventional storage solutions, such events are timed to happen at periods of little system activity. Large, modern data centers however, cannot tolerate any down time at all. For these environments, the VPLEX technology can simply migrate workloads from one VNX system that requires maintenance to another VNX system in the VPLEX cluster, such that applications are unaffected by such upgrades. In the event that infrastructure upgrades are required that potentially impact a whole data center, a multi-site VPLEX with VNX implementation is able to seamlessly shift its operations to the second data center while the primary data center is offline and seamlessly re-activate the primary site when services are returned.

Extending VMware Clusters

Due to its core design, EMC VPLEX Metro with EMC VNX, provides the perfect foundation for VMware Fault Tolerance and High Availability clustering over distance. This solution ensures a simple and transparent deployment of stretched clusters without any added complexity. The integration of the VPLEX and VNX with VMware solution is fully certified and supported by VMware.
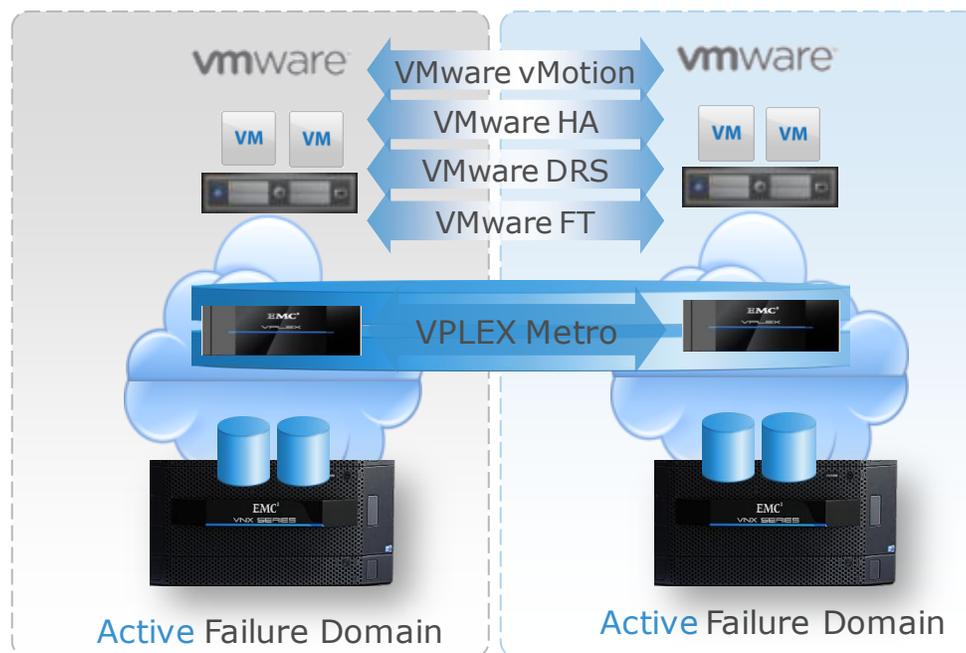

Figure 3 VNX with VPLEX Metro HA and vSphere HA solutions

VNX with VPLEX Metro HA and vSphere HA (federated HA)

VPLEX Metro takes a single "Host" block storage device in one location and "distributes" it to provide single disk semantics across two locations. This enables a "distributed" VMFS datastore to be created on that virtual volume. Using some of the cache management algorithms that EMC has built into our enterprise storage arrays over many years (such as large cache management and data read-ahead), VPLEX introduces a unique technology that's built around distributed cache coherency. It doesn't operate using cache mirroring or trying to keep cache consistent in every engine in every state, but instead operates with a very lightweight protocol that tracks who owns what data and where. That data can move, and it can exist in multiple places. This capability is the main driver that allows EMC to extend this cluster

implementation out over distance and deliver storage virtualization where it's never been able to be delivered before.

On top of this, if the layer 2 network has also been "stretched" then a single instance of vSphere (a single logical virtualized datacenter) can now also be "distributed" into more than one location and HA enabled for any given vSphere cluster! This is possible since the storage federation layer of the VPLEX is completely transparent to ESXi™. It therefore enables the user to add ESXi hosts at two different locations to the same HA cluster.

Stretching a HA failover cluster (such as VMware HA) with VPLEX creates a "Federated HA" cluster over distance. This blurs the boundaries between local HA and disaster recovery since the configuration has the automatic restart capabilities of HA combined with the geographical distance typically associated with synchronous DR.

A federated HA solution is an ideal fit if a customer has two datacenters that are no more than 5ms RTT apart, (about a 300 mile theoretical maximum in perfect laboratory conditions) and wants to enable an active/active datacenter design whilst also significantly enhancing availability.

Using this type of solution brings several key business continuity items into the solution including downtime and disaster avoidance as well as fully-automatic service restart in the event of a total site outage.

Benefit 1. Datacenter pooling using DRS with federated HA - By enabling VMware DRS (Dynamic Resource Scheduler) within the stretched cluster, the VMware vCenter™/ESXi server load can be distributed over two separate locations driving up utilization and using all available, formerly passive, assets. Effectively two physical datacenters act as a single logical datacenter.

Benefit 2. Avoiding downtime and disasters using federated HA and vMotion - Using the vMotion ability of vCenter, active VMs (or group of VMs) can be moved to any ESXi server in another (physical) datacenter. Since the vMotion ability is now federated over distance, planned downtime can be avoided for events that affect an entire datacenter location. For instance, a hurricane may be in close proximity to your datacenter, this solution provides the ability to move the VMs elsewhere avoiding any potential disaster.

With vSphere HA, the VMware recovery process at the second site results in the affected vm(s) being rebooted and application re-started. While this is an automatic process that typically takes in the order of a minute or so, it does result in an impact to the application availability. For even greater levels of availability, VMware offers vSphere FT.

VNX with VPLEX Metro and vSphere FT (federated FT)

Deploying VMware FT on top of a VPLEX Metro HA configuration goes another step beyond traditional availability (even when compared to federated HA) by enabling a "continuous availability" solution. This means that for any failure, there is no downtime whatsoever (zero RPO and zero RTO), as the primary vm has a shadow vm in full lockstep at the secondary location.

This type of solution is an ideal fit if a customer has two datacenters that are no more than 1ms (round trip latency) apart (typically associated with campus type distances). If they want to protect the most critical parts of the business at the highest tier enabling continuous availability then an active/active datacenter design can be enabled whereby one datacenter is effectively kept in full lock step with the other, delivering a new concept: **Redundant Array of Inexpensive *Datacenters (RAID).*** (To see both vSphere HA and FT in action, please see http://www.youtube.com/watch?v=Pk-1wp91i2Y)

Extended Distance VMware Availability solutions

These availability solutions are clearly intended to be used within campus distances, so what if there is a requirement to maintain a disaster recovery site beyond the distance limitations supported by VMware for VM HA or VM FT? VMware vCenter Site Recovery Manager (SRM), used in conjunction with storage level remote replication, is the preferred and recommended solution for conventional VM disaster recovery and is fully compatible with VPLEX (Local or Metro) through the EMC RecoverPoint Continuous Remote Replication (CRR) capability which integrates fully with VMware SRM, even while also providing a fully federated metro solution.
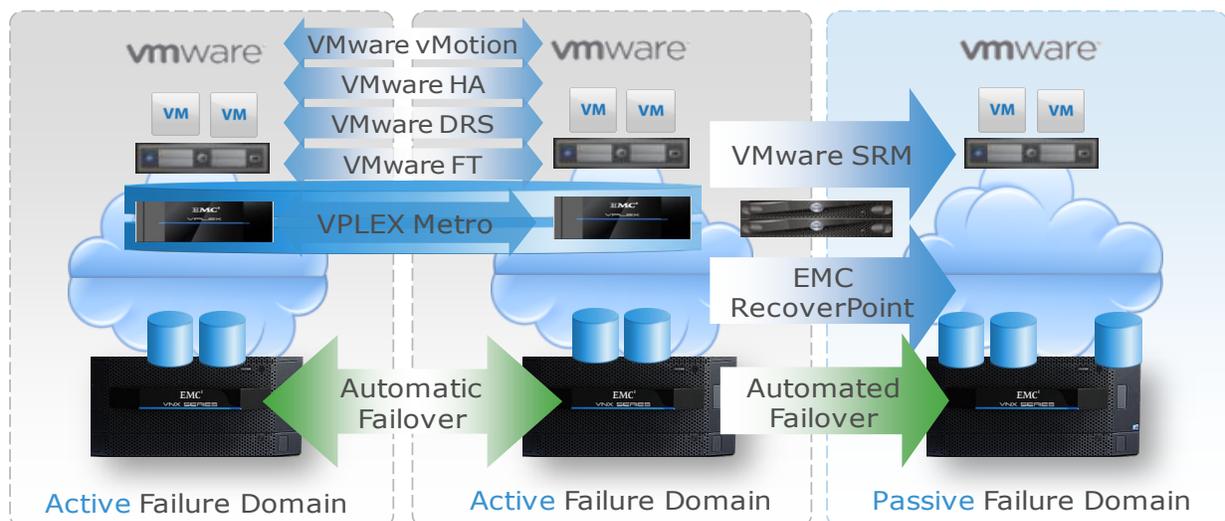

Figure 4 VNX and VPLEX Metro HA with vSphere and 3rd site for remote DR Solution

Since a VM can now be protected using different geographical protection options, a choice can now be made as to how each VM can be configured to ensure that the protection schema matches that of the business criticality. This can effectively be thought of as protection tiering.

The figure below shows the various protections tiers and how they each relate to business criticality.
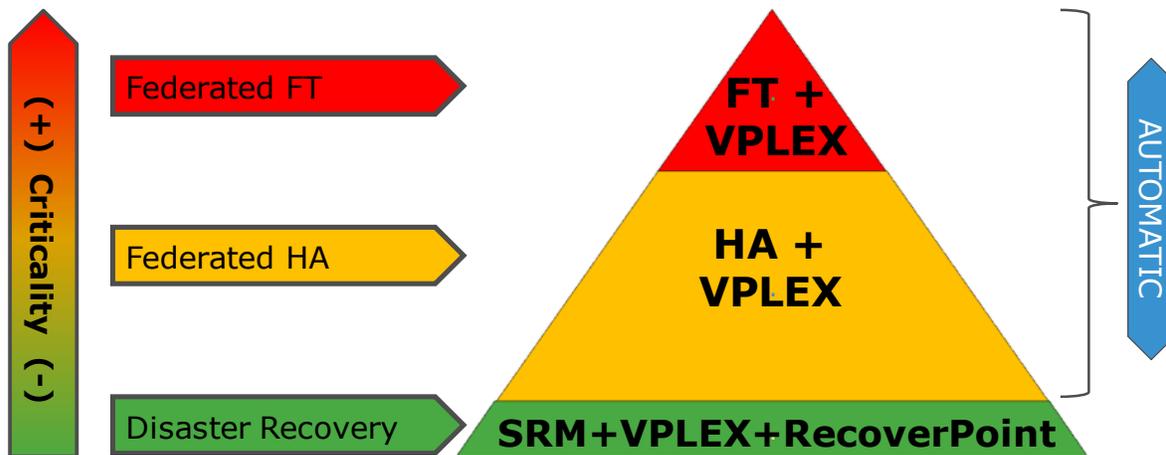
Figure 5 Protection tiering vs. business criticality

For more information regarding VMware and VPLEX, including product details, best practices as well as failure scenarios and outcomes, please see:http://powerlink.emc.com/km/live1/en_US/Offering_Technical/White_Paper/h11065-VPLEX-with-VMware-FT-HA.pdf

True Oracle RAC over Distance

More than any other application, Enterprises entrust their businesses to Oracle. Whether it is used to support transactional systems, ERP, CRM or business analytics, business processes are so tightly integrated to the ongoing running of a company that it is simply unthinkable for these applications to be unavailable. The EMC VPLEX and VNX solution provides storage infrastructure for Oracle that delivers the following core benefits:

- Fully automatic failure handling
- Increased utilization of hardware and software assets
    - Active/active use of both data centers
    - Automatic load balancing between data centers
    - Zero downtime maintenance.
- Simplified deployment of Oracle RAC on extended distance clusters
- Reduced costs by increasing automation and infrastructure utilization.

Oracle Real Application Clusters (RAC) 11g

Oracle RAC is a continuous-availability solution for Oracle database applications within the data center. It enables multiple Oracle instances on independent servers to share a copy of a database to improve availability, scalability, fault tolerance and load balancing. Oracle Automatic Storage Management (ASM) is an integrated file

system for the Oracle Database and along with Oracle Clusterware software, provides the cluster and storage management services required to run Oracle RAC. Oracle also supports RAC on extended distance clusters, whereby servers in the cluster can reside in physically separate locations. This, when combined with a federated storage solution such as VPLEX with VNX, provides the above bulleted benefits and is unique to EMC.
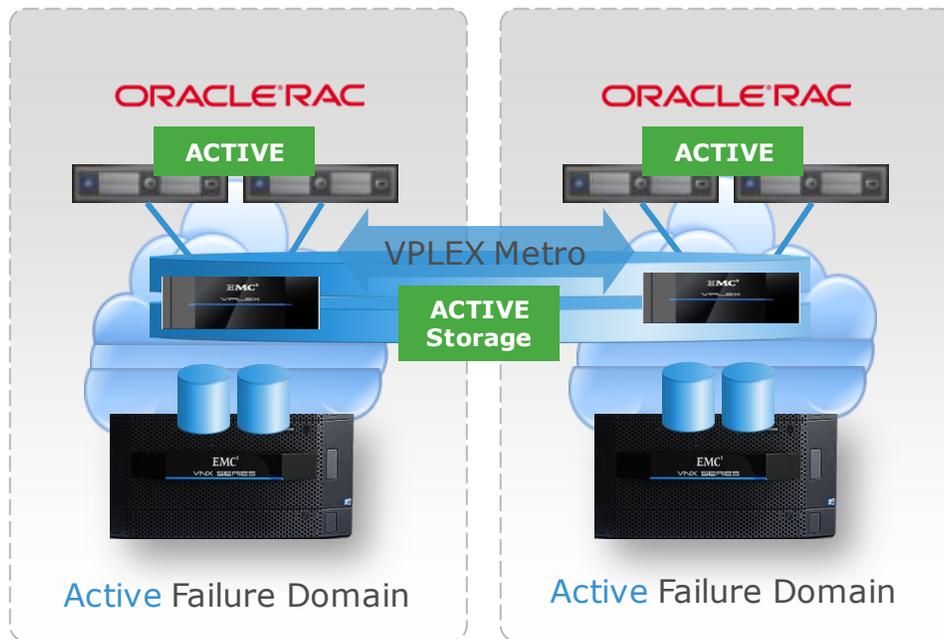

Figure 6 Contemporary Active/Active Oracle Extended RAC Solution

The recommended maximum separation for Oracle databases in the above configuration is up to 5 ms RTT (this is a recommendation from both EMC and Oracle). With conventional storage technologies, the resources in site B would be passive, waiting to be activated following a manual failover process. This process is sometimes so onerous, that for the most common types of disaster, human error or power outage, it is quicker to fix the problem at the local site than perform the failover. When adding VPLEX with VNX however, both sites are actively processing work and in the event of a temporary loss of one of the sites or its core components, the combination of the RAC clustering software, via the Oracle Transparent Application Failover feature, and the single distributed volume provided by VPLEX allows sessions to automatically failover to the surviving RAC nodes, simply riding through the issue with no downtime. This makes the solution not only incredibly available but extremely easy to manage as well.

VNX with VPLEX in Extended Oracle RAC solutions

As with the VMware solution discussed earlier, the VNX is an ideal and cost effective solution for Oracle workloads. VNX implements the FLASH 1st data management strategy via the FAST VP and FAST Cache technologies. Typical transactional workloads are ideally suited to the VNX due to the inherent skew (small capacities in a database are responsible for the majority of the IO's to the database) in the data set. This means that without any Oracle tuning, FAST VP ensures the system will dynamically move data that requires the highest levels of performance to Flash drives and the data that is no longer accessed will be moved to high capacity NL-SAS drives totally seamlessly to the Oracle application.

VNX FAST Cache ensures that should a previously "cold" piece of data become spontaneously highly active, it will be dynamically loaded into Flash SSDs within a matter of milliseconds. In internal testing, we have seen up to 4x the performance of a system using FAST VP and FAST Cache than one without these technologies (*Ref – Nashville Electric Services Customer Success Story*). With VPLEX ensuring always-on availability and VNX optimizing the performance and TCO of the system, there is nothing else in the market today that can compete with this combination of class leading storage solutions.

Extended Distance Oracle Disaster Recovery Solutions.

With EMC's recommendation that Oracle extended RAC solutions incur no more than a 5 ms round trip delay between sites, it is often required to provide a long distance "traditional" replicated DR solution. VPLEX (Local or Metro), along with EMC RecoverPoint Continuous Remote Replication (CRR) capability integrate to provide a long distance protection methodology to a third site for full DR protection. The value of the CRR solution for the Oracle use case is comparable to the extended distance DR solution discussed in the VMware section

Conclusion

Since its release, the EMC VNX platform has garnered many accolades and has proved to be a popular platform in the mid-range market. Offering class leading performance, optimal total cost of ownership thanks to the FLASH 1st strategy and with unmatched ease-of-use, it has been implemented across virtually all industries and applications. Enhancing these capabilities with the EMC VPLEX storage Federation solution, it is really a case of 1+1=3. Extending the traditional mid-range storage plays such that zero down time of your mission critical applications is truly within your grasp. VNX and VPLEX offer the following uniquely differentiated benefits:

- Delivering true continuous availability for your most mission critical applications

- Removing the need to perform data migrations

- Extended the useful life of your storage assets

- More effectively leveraging all the storage system resources

For more details on VNX and VPLEX please visit emc.com and consult the references below.

Appendix A: References

EMC VPLEX page on EMC.com (videos, white papers, solutions overviews, customer success stories)

http://www.emc.com/campaign/global/vplex/index.htm

EMC VNX page on EMC.com (videos, white papers, solutions overviews, customer success stories)

http://www.emc.com/storage/vnx/vnx-series.htm

VPLEX Data Sheet

http://www.emc.com/collateral/hardware/data-sheet/h7070-vplex-family-ds.pdf

VNX Family Data Sheet

http://www.emc.com/collateral/hardware/data-sheets/h8520-vnx-family-ds.pdf

Oracle Real Application Clusters (RAC) on Extended Distance Clusters with EMC VPLEX Metro - Best Practices Planning

http://www.emc.com/collateral/software/white-papers/h8930-vplex-metro-oracle-rac-wp.pdf

Workload Resiliency with EMC VPLEX – Best Practices Planning

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Using VMware Virtualization Platforms with EMC VPLEX – Best Practices Planning

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EMC VPLEX HA Techbook

http:/www.emc.com/collateral/hardware/technical-documentation/h7113-vplex-architecture-deployment.pdf

VMware Metro Storage Cluster White paper

http://www.vmware.com/files/pdf/techpaper/vSPHR-CS-MTRO-STOR-CLSTR-USLET-102-HI-RES.pdf

VPLEX implementation best practices
http://powerlink.emc.com/km/live1/en_US/Offering_Technical/Technical_Documentation/h7139-implementation-planning-vplex-tn.pdf

EMC RecoverPoint page on EMC.com

http://www.emc.com/replication/recoverpoint/recoverpoint.htm

EMC VPLEX with VMware FT and VMware HA on PowerLink

http://powerlink.emc.com/km/live1/en_US/Offering_Technical/White_Paper/h11065-VPLEX-with-VMware-FT-HA.pdf

Dissolving Distance: EMC VPLEX for VMware Overview - Video:
http://www.youtube.com/watch?v=hp9QDGbcCAk&feature=youtu.be

Dissolving Distance: EMC VPLEX for VMware - Video/Demonstration:
http://www.emc.com/collateral/demos/microsites/mediaplayer-video/dissolving-distance-emc-vplex-vmware.htm

VPLEX for Oracle RAC on Everything Oracle on EMC Customer Network:
https://community.emc.com/docs/DOC-18797