Under the Hood: What Virtualization 2.0 Looks Like

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Introduction

Virtualization has evolved tremendously in just a few years. In the past, virtualization technology consisted of just the hypervisor – which provided an abstraction layer between operating systems or the underlying hardware. There were no high–availability, management or security and networking features, which limited the use of virtualization across all workloads. Virtualization has now evolved to include all those capabilities and more. The latest version of VMware vSphere® allows administrators to support and manage all types and sizes of workloads and next–gen apps — even VMs with 1TB of RAM, multiple vCPUs, and 62Tb virtual disks. Now it's easier than ever to manage large or very large VMs running heavy applications and DBs on–premises using VMware vSphere with Operations Management™ or in the cloud by using VMware vCloud® Air™.

The first wave of virtualization has been beneficial for many companies, bringing greater consolidation ratios, lowered power consumption, and an increase in CPU utilization of physical hosts. With the increased number of applications and VMs running in today's data centers, the latest in virtualization technology, virtualization 2.0, is expected to do even more for the business world, helping businesses continue to be competitive in today's changing environment.

Virtualization 2.0 provides predictive analytics, converged storage, data protection and security. Predictive analytics can adapt to real–time changes happening hourly or daily, enabling virtual environments to react to those changes by flexibly allocating new resources and balancing the load to streamline resource utilization. Backup services integrated into vSphere take care of data protection with higher efficiency, leading to lower storage needs and shorter backup windows. These capabilities are all part of virtualization 2.0 – improving agility, application performance, and overall productivity.

The challenge for most IT shops today lies in the optimization of application workflows. Virtualization 2.0 has the tools, features and products to address these challenges. Using the tools built into vSphere with Operations Management, admins have more visibility into their virtual environments and are able to predict failures and performance issues.. The tools also provide management of the virtual infrastructure to achieve greater efficiency and performance.

Things that weren't possible before are possible now with next–generation virtualization technology. Options for "fine tuning," previously only accessible with CLI commands, are now easily accessed via web–based interfaces. It's inarguable – the time to upgrade to the latest VMware vSphere with Operations Management is now.

Virtualization 2.0 — vSphere with Operations Management

The latest version of VMware vSphere with Operations Management has many products built–in. Some products are "baked" inside of the vSphere kernel and others act as add–ons and are deployed as virtual appliances via OVF prepackaged files. VMware **vCenter™ Operations Manager™** is part of vSphere with Operations Management and offers performance, capacity management and optimization capabilities with predictive analytics, as well as tools to reduce troubleshooting times. The administrator is also informed about risks. Risk and efficiency badges are calculated regularly and rely on the successful collection of performance metrics from registered instances of VMware vCenter Server™.

The main dashboard offers an overview of the environment. You can see how the various metrics provide you with an overall score for each of the three different categories – **Health, Risk** and **Efficiency**.

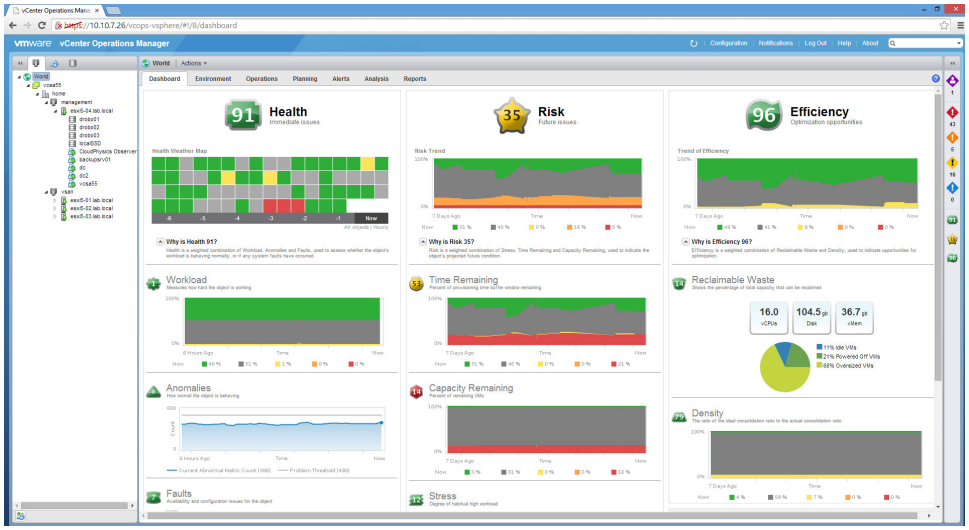


Figure 1. vSphere with Operations Management Dashboard View.

The dashboard allows you to select objects on the left–hand side. You have the option to select:

- VMware cluster
- ESX host
- Virtual Machine

By selecting any of these elements, you get presented with a dashboard on the right with values for the three main categories for that object. You can drill down in the red areas to get a deeper view of problems.

vCenter Operations Manager allows fast discovery of "slowness." When an application is slow, or some part of the infrastructure is experiencing higher than normal load, orange or red colors show the problem area in what's called a "heat map." The operator is able to see that something is wrong with a particular VM or with a particular host, datastore, or network, and can drill down by clicking the object to see the details.

The problem areas are just one point to consider. As the infrastructure grows, users will receive indicators pointing to the resources that will get exhausted first. In the example below, the host performs normally and there are no bottlenecks, but the host is bound by memory. In this example, you can see which resource will get exhausted first.

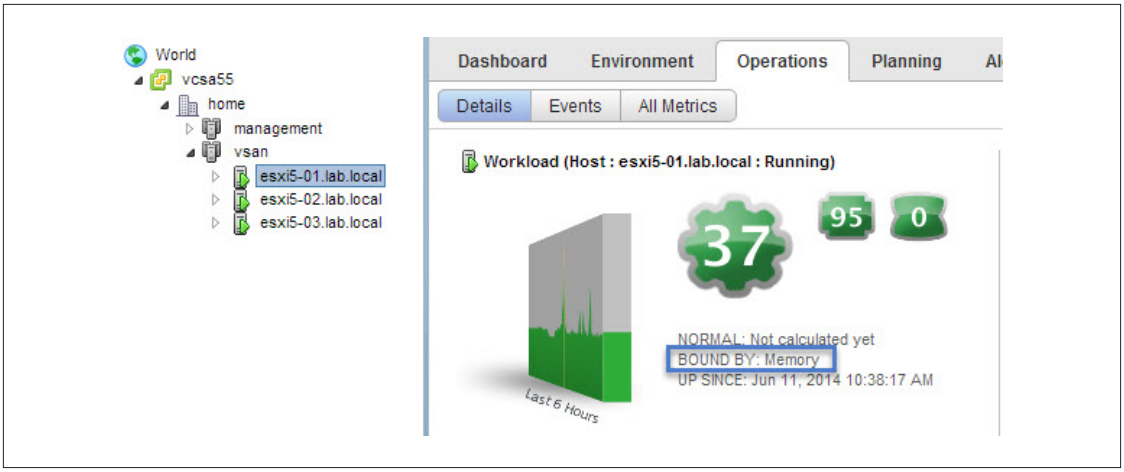


Figure 2. Potential problems are highlighted before resources are exhausted and performance is impacted.

In the past it would take much more time to find out why an application was performing slowly. One would have to **manually pinpoint** the source of the problem by going through each of the resources interacting with the application (network performance, memory, storage, CPU) to identify which resource was constrained.

Does the VM hosting the application have enough memory allocated? Does the host where the VM runs have enough physical memory, or did it start ballooning and swapping already? How about storage? What's the latency on the datastore hosting the VM, what's the throughput? Is the CPU of the VM constrained? By highlighting the resource experiencing problems (VM, datastore, host, CPU, etc.), users are able to avoid doing these manual verifications. With vCenter Operations Manager, you can verify that a VM isn't doing much ballooning, in addition to checking other eventual resource limits or contentions, which could slow down the performance.

vCenter Operations Manager gives you an overview, the "full picture," of the infrastructure – not only what's happening right now, but also historical data. All metrics from vCenter Server are pulled together to give users a clear view of the whole environment – storage, networking, memory and CPU performance metrics.

Capacity management includes establishing and maintaining a safe and reliable amount of resources to meet the business demand. Demand management is an important component to providing reliable computing services. It requires a variety of non–IT oriented skills and knowledge, and is therefore an often–neglected area. However, it is becoming significantly more important, as virtual machine growth outpaces IT staffing and infrastructure budget growth. Some organizations use spreadsheets for capacity management. vCenter Operations Manager provides information that better accounts for needed resources and capacity.

Data Protection and Disaster Recovery

Backup and recovery of VMs has been available since the early days of the ESX hypervisor. Script–based backup has evolved via vSphere Data Recovery and has been replaced by a built–in, robust solution based on EMC's Avamar technology – it's called VMware **vSphere Data Protection™**– a backup and recovery solution, that is now part of vSphere. This solution does a great job of providing backup/recovery capabilities to existing workflows with an agentless approach.

Figure 3. vSphere Data Protection is fully integrated with vSphere Web Client.

Fully integrated in the web interface, the appliance uses EMC's Avamar **variable–length segment deduplication engine** to optimize backup and recovery times. Deduplication is used not only within each VM, but across all backup jobs and all VMs being backed up by the vSphere Data Protection appliance.

Deduplication was a game changer when first implemented in products like vSphere Data Recovery. But with the backup windows shrinking and volume of data growing, the need for more efficient deduplication and deduplication engines is here. That's where the vSphere Data Protection excels. vSphere Data Protection uses change block tracking for implementing incremental backups, but the same technology is also used during restore operations, cutting down restore times.

vSphere Data Protection also has integrated management through the vSphere Web Client, which means you only need a web browser to manage the backup environment. Further, all of the infrastructure uses a single tool, making it convenient to administrate the environment from different operating systems (Mac, Linux…).

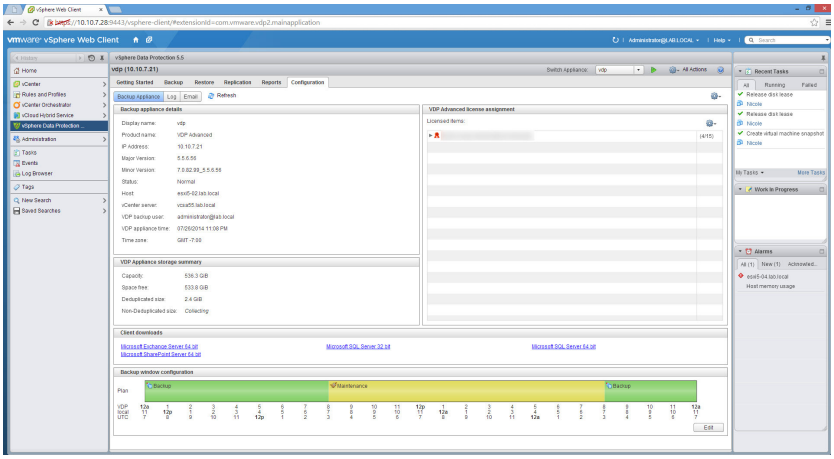


Figure 4. The vSphere Web Client provides a single pane of view.

There is a high-end version of vSphere Data Protection called **vSphere Data Protection Advanced**, which allows backup with better protection of SQL, Exchange, and Oracle or SharePoint databases, and has more backup capacity. You will need to install an agent in those systems. This is not unusual, as even other best-in-class "agent-less" backup products use agents during backup of Database VMs. A database type backup job usually needs an agent. The backup job injects those agents during the time of the backup job, but it's still an agent inside a VM.

For example, a SQL server uses a full recovery model where the transaction logs are preserved until you back it up. After a successful backup, those logs are truncated. In a disaster recovery scenario, you can combine full DB backup with incremental (or differential) backups to restore the DB to a specific point in time depending on your needs.

VMware Storage and Converged Infrastructure

The latest version of VMware vSphere provides virtual hardware capable of accommodating very large VMs (up to 62TB VMDK). VMFS 3 integrated file systems used in previous versions of vSphere can be upgraded online if every host connected to the datastore supports it.

Traditional SAN devices that have been the main piece of data center infrastructure are starting to be less advantageous, because new storage architectures that leverage a hybrid approach (SSD + HDD) have started to emerge. This hybrid approach can be found at the SAN level, where the SAN device contains both spinning disks and Flash SSDs, but also at the host level by using Direct Attached

Storage (DAS) present in each host. VMware recently came out with a new product able to transform local disks and SSDs in each host into a shared datastore.

It can be found in one of VMware's latest, major innovations – a **Hypervisor converged storage** platform, called VMware Virtual SAN and it is **built inside of the hypervisor**. Virtual SAN is a true breakthrough for the storage industry. It is the most revolutionary storage product. Some say that this VMware technology is the most important storage software technology since vSphere Storage vMotion® was introduced roughly 10 years ago.

VMware Virtual SAN uses a hybrid approach of locally attached Flash devices and spinning disks to create pooled hybrid storage that accelerates storage into datastores visible to all hosts on the Virtual SAN cluster.

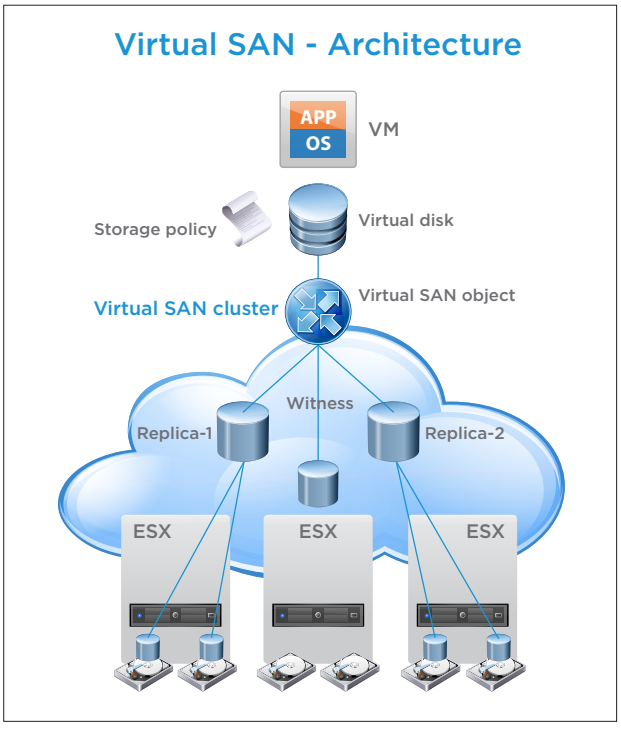
With this simple approach, it's possible to create fast clusters without a dedicated SAN device. It uses spinning disks together with SSDs, where the SSDs are used for read/write caching.

Magnetic disks enable storage capacity, whereas SSDs are used for read/write caching.

- First write to SSD cache and then to HDD.
- First read from SSD cache and then if the block isn't there, read from HDD.

Using Virtual SAN, you can set requirements for VMs or individual VMDKs in terms of policies or storage service levels. Once applied, Virtual SAN will take these requirements and ensure that those VMs (and the underlying VMDKs) that sit on the Virtual SAN datastore are always in compliance with those requirements. For example, you can set requirements for:

- **Number of disk stripes per object** – the number of HDDs across which each replica of a storage object is distributed.
- **Number of failures to tolerate** – the number of hosts, network and/or disk failures a storage object can tolerate. Example for N number of failures to be tolerated in the cluster, "N+1" copies of the storage object (VMs files) are created and at least "2N+1" hosts are required to be in the cluster.



Soon, there will be **Virtual SAN–ready nodes** on the VMware Hardware Compatibility List (HCL), but it's also possible to make existing hosts Virtual SAN–ready by choosing the right components:

- Flash devices (SSDs or PCIe cards)
- Disk controller cards (with queue depth 256 or best with 600)
- Locally attached spinning disks

Concerning hardware, it's important to note that Flash devices are categorized in five different groups based on performance levels, so depending on the size you need, you can get the performance you're looking for. The HCL is a good place to start.

Also, the queue depth of disk controller cards is crucial. The smaller ones only have a queue depth of 25, but VMware recommends a minimum 256. The same applies to magnetic disks where serial–attached storage (SAS) or near–line SAS should be the preferred option over poor performing serial ATA (SATA).

Does all of this mean the end of SANs? Possibly, but not immediately. However, a new level of "convergence" in the storage space is here. Virtual SAN can scale up to 32 hosts, which is also the cluster boundary with HA maximums.

vFlash Read Cache (VFRC) – If the existing SAN meets your capacity needs, but doesn't perform satisfactorily, then an interesting acceleration option with server side Flash is available in the latest version of VMware vSphere. The feature can be for selected VMs (or rather selected virtual hard disks) as it's based on per–VM config.

This feature, called vFlash Read Cache (VFRC), operates seamlessly without disrupting other vSphere features like vMotion®, HA, and Distributed Resource Scheduler®. VFRC does not accelerate all VMs running on a specific host, only the VMs (virtual hard drive) in which you have enabled that option. This is preferable, as those VMs move around in DRS enabled clusters anyway.

To configure VFRC, you must first add the Flash device at the cluster level. To do this, select the cluster > Actions > All vCenter actions > Add virtual flash resource capacity, and then through VM configuration select Edit settings > Virtual hardware tab > Hard disk > Virtual Flash Read Cache > click Advanced to enable. Now you can select the amount of storage (GB) that will be reserved for that particular virtual hard drive.

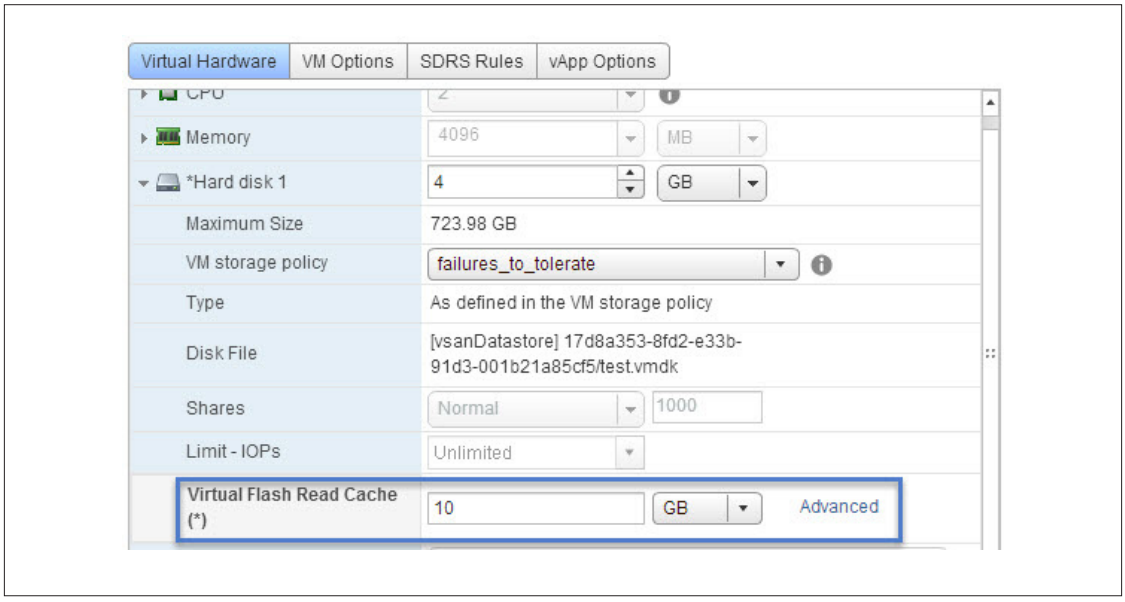


Figure 6. Easily configure storage policies and capacity.

The vFlash caching software within vSphere is tightly integrated into the hypervisor (placed into the data path) as an API. The flash devices are tightened together and formatted into a new file system called VFFS (Virtual Flash File System). Each host creates a virtual flash resource based on one (or more) flash devices, and this is pooled together host–by–host to form flash resources visible through each host.

Note: VFRC can be used together with "Host swap to SSD," introduced in earlier versions of VMware vSphere. It's possible to use half of the SSD for VFRC and the other half to host swap. Host swap is, however, only used as a last resort when overcommitting memory. It means that you'd have to heavily over commit the host's memory and exhaust the other memory optimization techniques first (transparent page sharing, memory ballooning and memory compression).

Availability

VMware vSphere High Availability (HA) was one of the first amazing features that virtualization brought to the IT market. Whether the IT environment is responding to host failure or hardware component failure, HA can manage it. What about applications? With the latest version of VMware vSphere with Operations Management, there is another new product called Application HA that is not very well known, but that has its place in a fully virtualized data center. Application HA can restart a failed application where the VM keeps running normally.

Application HA – When there is a host failure, the VM gets restarted on remaining hosts in the cluster. Without application HA, if an application crashes (service stops) the system just does nothing. Classic HA won't trigger a restart of the VM, because there is no hardware failure, there is no VM failure, just a service (application) failure.

If an application fails, then **Application HA can trigger the restart of that application!** It's policy–driven. Based on the policy set for the application, certain remediations would happen if a fault were to occur. The policy allows you to see if the application just failed occasionally or if there is a stability issue. After a few application restarts, a full VM restart is triggered.

Note: You'll need to install a small vCenter Hyperic® agent in the VM that will communicate with the Hyperic server.

During normal operations, the Hyperic agent running on the virtual machine checks the application state. If the failed service does not restart, then the remediation policy is run and vSphere App HA solution resets the virtual machine.

Most major applications are supported including: IIS, Apache, Tomcat, SQL, SharePoint, SpringSource tc Runtime, PostgreSQL, Oracle 10g2, 11g2. Application HA is designed for business critical applications, so you can decide which applications stay protected.

When an application fails there are a few policies to expect during the recovery process:

- The service is restarted according to user–defined policy.
- If the service restart fails, the VM is restarted
- A vCenter alarm is triggered
- An e–mail notification is sent

Wrap–Up

To stay competitive, businesses today need visibility into application availability, performance, data protection and security. Virtualization admins seek simplicity in this overcomplicated virtualization world, but at the same time they need to proactively gather and collect performance data, which they can use to identify root cause to improve the overall performance of their data centers. VMware vSphere with Operations Management has the necessary tools to keep businesses successful and competitive. It results in less manual interventions with automation capabilities and predictive analytics that help you avoid application failures and performance issues. Proactively monitoring capacity resources is a key factor to keep up with increasing storage demands and application load.

Keeping your workloads and data safe is just as important. That's why integrated data protection brings a very efficient deduplication engine to handle backup and recovery operations. Virtual storage evolution with the latest scalability improvements at the storage layer allows users to optimize storage space and get the best performance/price ratio.

The integration of VMware vSphere products into a unique, homogenous web–based user interface with single sign–on simplifies logins within the whole management suite and is another key reason why vSphere with Operations Management is the best virtualization platform today. Virtualization 2.0 is here – it's time for users to get onboard.

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