



White Paper

Enabling the Path to Private Cloud: Service Analytics

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Abstract

As organizations evolve from virtualized infrastructures to private clouds, IT management must measure success by the efficiencies of the infrastructure in providing end users with flexible and cost-effective services and service levels. NetApp® OnCommand® Insight storage resource management software provides service analytics that help enterprises manage the complexity of this transition. OnCommand Insight provides a holistic view into complex multivendor and multiprotocol storage services and powerful analytics to help organizations fully leverage the promise of cloud computing.

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1 Private Cloud White Paper Series

Enterprise IT departments are under extreme pressure to reduce capital and operating expenses, driving them to virtualize infrastructures to improve hardware utilization and scalability and move toward the enhanced operational efficiency and flexibility of cloud computing. The cloud landscape includes private, public, and hybrid clouds. A private cloud is a shared virtualized infrastructure that remains within the control of the enterprise's IT organization behind a firewall. IT departments in a private cloud essentially take on the role of brokers of services in delivering applications, storage, and server resources to internal customers as services. A hybrid cloud is when a company uses a combination of private and public clouds.

Many organizations have virtualized portions of their infrastructures but are not sure how to navigate the next steps toward a fully automated, service-driven model that enables them to further reduce costs, improve efficiency, and deliver IT as a service. The transition to cloud computing is a multiyear and multiphase effort, and most enterprises are still in the early stages of data center transformation. This transformation involves a fundamental shift in focus from the infrastructure optimization provided by virtualization to the service optimization necessary for the cloud.

NetApp has helped many industry-leading firms deliver data and applications as an on-demand service delivery model built on clustered Data ONTAP®. This model can evolve from a private cloud to a hybrid cloud on a single platform. Based on NetApp's experience with countless IT environments, we have identified some fundamental elements that organizations of all types and sizes should include as they move to a private cloud. These elements are captured and explained in the NetApp private cloud white paper series shown in Table 1. These white papers explain how NetApp helps enterprises transition from a shared virtualized infrastructure to a private cloud. Each paper describes the design, deployment, and benefits of one of the key elements as it relates to a service-oriented infrastructure.

An important point: These papers are not focused on NetApp hardware. Instead, they explore the NetApp management software that enables policy-driven service efficiency as well as many advanced storage efficiency capabilities. They also describe how NetApp APIs integrate with third-party or customized orchestration solutions at each step, enabling organizations not only to deliver comprehensive storage management, but also to select other cloud resources tailored to their needs as part of their automated, end-to-end service fulfillment capabilities.

The NetApp private cloud white papers do not necessarily have to be read in sequence. In addition, some elements described in the documents overlap and can be deployed together.

Table 1) NetApp private cloud white papers.

Service Analytics	Optimize your services with centralized monitoring, metering, and chargeback to enhance visibility into both costs and service-level agreement (SLA) management
Automation	Rapidly deploy new services by automating storage processes and integrating with third-party orchestrators for automated end-to-end service delivery
Self-Service	Empower IT and users by allowing service requests to be fulfilled through a self-service portal

2 Introduction

2.1 Why Service Analytics Are an Essential Element of Cloud Services Delivery

IT is undergoing a shift toward hybrid IT infrastructures, which is driving utilization up to 70% to 80% or even higher. Virtualization and automated provisioning are enabling this shift but are also increasing the overall complexity of data center environments. Silo-centric monitoring is no longer sufficient, nor is it capable of providing the level of service assurance that critical business applications require, particularly in a shared environment. Suddenly, the visibility and insight that can be gained from in-depth, near-real-time analytics become absolutely critical to effectively manage complex infrastructures, maintain service levels at expected rates or commitments, and provide business continuity.

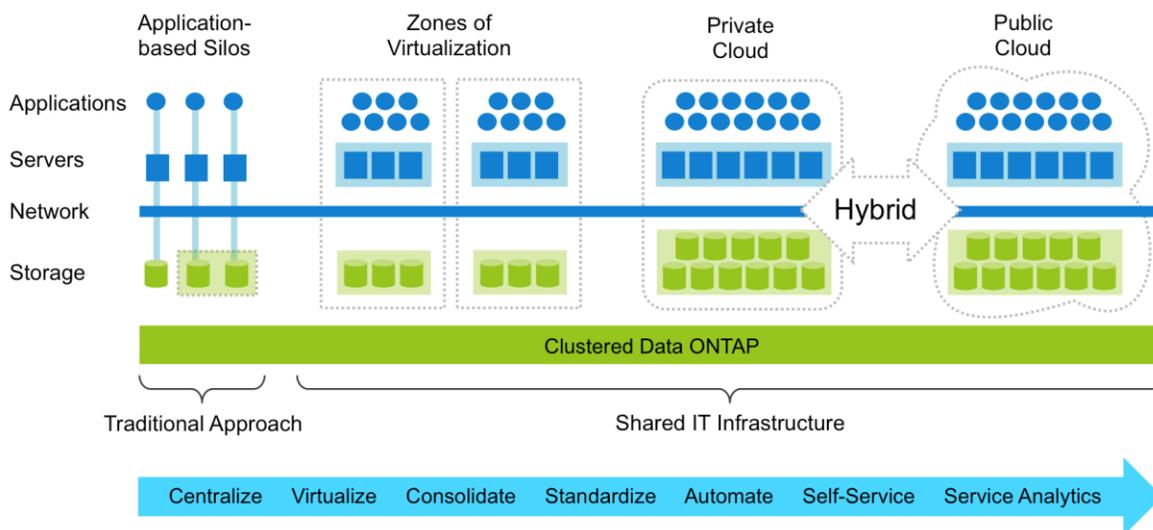
In addition, to encourage users to adopt a shared IT infrastructure model, IT organizations need to provide more visibility and be more transparent in how resources are used to deliver services. One way to do this is to show capacity or performance utilization metrics for business entities or users, which is called showback or cost awareness. Showback can help reinforce the users' level of confidence that they are receiving the same service levels and benefits in the logical silo that they received in the physical silo. Showback also provides a baseline that enables IT staff to guide users to accept and utilize more efficient and lower cost levels of service. In more advanced deployments of private clouds, some enterprises might implement a chargeback model and charge internal users for their resource consumption.

As organizations evolve toward a hybrid IT environment (see Figure 1), they need to go beyond infrastructure optimization and service optimization to service analytics. In the complex and rapidly changing construct of a private cloud, the ability to measure and analyze the entire environment end to end is absolutely necessary to deliver and improve service-level agreements (SLAs) and to realize the full benefits of improved efficiency and lower costs. Service analytics go beyond simple monitoring by enabling IT to:

- Determine service paths and confirm the redundancy of those paths
- Set policies on service paths for accessibility, performance, and availability
- Intelligently analyze data to adhere to these policies and provide optimal use of resources
- More accurately plan for capacity
- Show usage to users

Service analytics are the key to successfully manage and optimize private cloud storage services.

Figure 1) Service analytics are vital as organizations evolve their cloud computing models.



2.2 The NetApp Approach to Service Analytics

As IT organizations migrate applications from silos to virtualized infrastructures to private clouds to hybrid clouds, IT managers must measure success by the efficiency of the infrastructure in providing end users with flexible and cost-effective services and service levels. NetApp's objective in offering service analytics is to help enterprises manage the complexity of this transition and provide the tools to efficiently manage private cloud services. This is accomplished with NetApp OnCommand Insight storage resource management software, which provides:

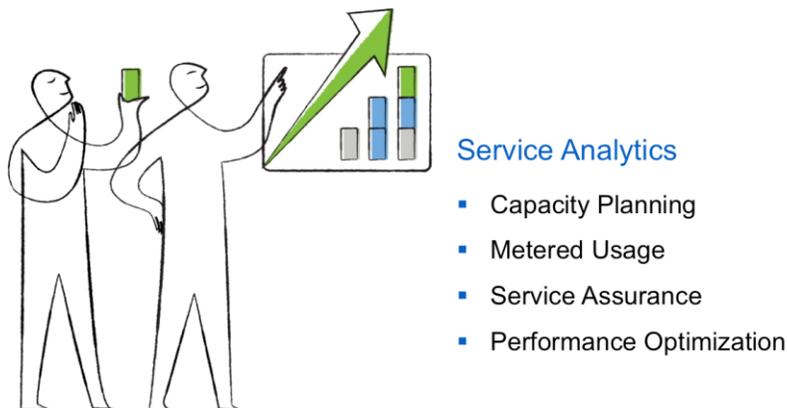
- Transparency, visibility, and management of the cloud infrastructure
- Information that makes sure service levels are being met
- Planning for capacity management and forecasting capabilities
- Service analytics to measure and balance performance for higher service efficiencies

Virtual and storage services are primary components of the private cloud. Storage services play a very large role, not only for application data but also as boot devices and storage for virtualized environments. This results in additional complexity that encompasses far more than the usual application data use cases. The role of monitoring and analytics is to provide the ability to correlate across these different use cases. OnCommand Insight delivers this capability.

OnCommand Insight provides a holistic view of virtual and storage infrastructure as a unified set of services. This view is created using analysis, discovery, correlation, service paths, simulation, and root-cause analysis. OnCommand Insight also provides the following:

- **Key performance indicators.** Some products simply provide a lot of data, but end users and cloud IT administrators really want guidance to help them make the right decisions. OnCommand Insight provides the intelligence to guide management decisions for private cloud deployments.
- **Multivendor support.** There are very few true greenfield (those lacking prior constraints) deployments. Even in new data centers, companies typically leverage existing investments. To be effective, any solution must be able to monitor end to end across the assortment of multivendor technologies that make up the infrastructure stack. The solution also needs to interact with the different tools and databases that exist in the management ecosystem.
- **Virtual and physical infrastructure.** Private clouds are deployed on a virtual infrastructure. However, certain applications might still need to be hosted on a physical infrastructure. IT needs to enable service levels across the entire infrastructure, both physical and virtual.

Figure 2) Service analytics are powered by NetApp OnCommand Insight analytic capabilities.



3 How NetApp OnCommand Insight Addresses Common Use Cases

An effective way to illustrate how OnCommand Insight provides value in private cloud deployments is to discuss how it can be used to address a number of common private cloud use cases and the subtasks within these use cases, including:

- Identify and troubleshoot performance issues
- Balance and optimize virtual machines (VMs) and storage workloads in a virtual infrastructure
- Provide storage service availability, impact, and configuration compliance
- Forecast capacity more accurately with trending and enable showback and/or chargeback

3.1 Identifying and Troubleshooting Performance Issues

OnCommand Insight provides performance analysis and load balance information that can help quickly identify disk contention, performance patterns, congestion, and topology issues.

This scenario highlights how real-time correlation analytic capabilities could quickly help identify the root cause of a performance problem in a simulated real-world environment. The environment included many server, networking, and storage data sources, but focus was put on a virtual machine that shared the same underlying storage as another VM, commonly referred to as the “noisy neighbor” problem.

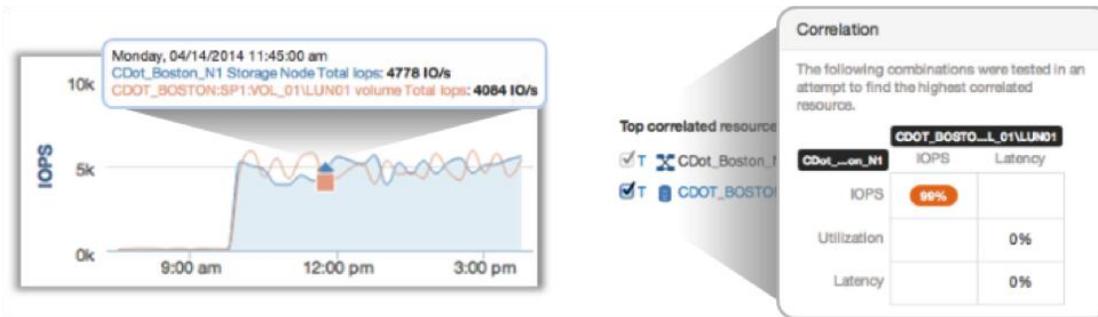
The simulated problem was identified as a severe spike in latency in a virtual machine running a Microsoft® Exchange database. After selecting the Exchange VM from the available data source list, focus was placed on the top correlated resources. This list includes resources that share a similar pattern of activity as the resource originally identified as having a problem. In this example, a second storage volume was found to have a similar spike in latency within the same time frame as the Exchange VM volume. The volume was automatically identified as a top correlated resource with a correlation score of 94% (see Figure 3).

Figure 3) Correlation of latency spike.



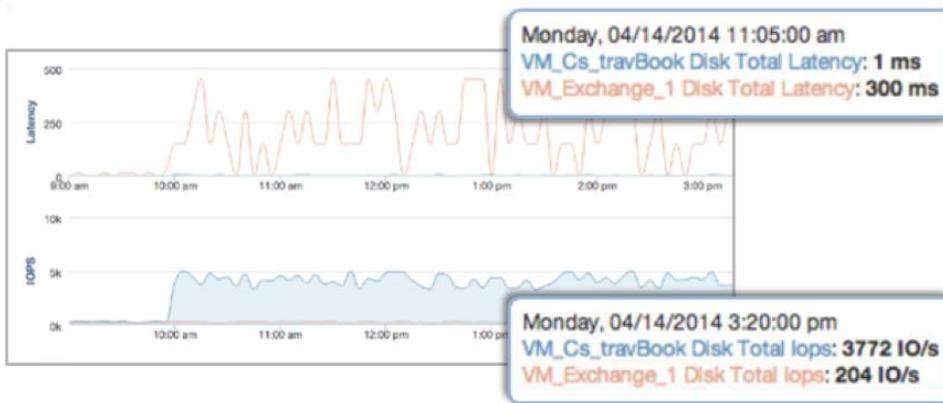
From there, you are guided by OnCommand Insight through related data sources based on latency, utilization, and IOPS correlation suggestions. For each data source that was identified as being highly correlated to the problem, performance metrics could be layered on top of one another to make sure that the performance spikes occurred at the same time. Figure 4 shows a spike in IOPS of a storage volume that is 99% correlated to the IOPS load of a storage node.

Figure 4) Identify similar performance spikes.



The underlying problem resided on a seemingly unrelated VM running a travel application that shared the same storage subsystem. A spike in IOPS in the travel application had caused the latency spike in the Exchange VM, and this final correlation is shown in this screen shot. From this point, the owners of the travel application can be notified of the problem and can take action to remedy the situation, whether that means allocating more storage to the VM or moving the travel application to a different server or storage resource.

Figure 5) Root cause identification.

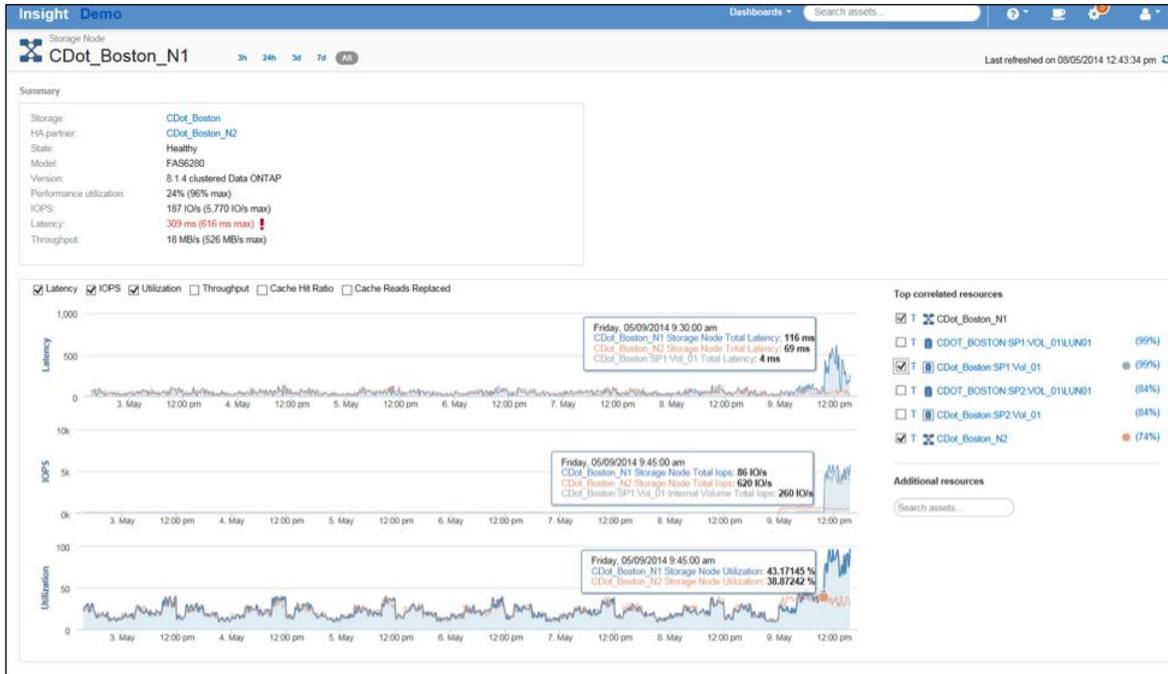


Identifying performance problems and then pinpointing the root cause in a massive IT infrastructure is a complex task for any IT administrator. Through this example, we were able to identify a latency spike in one VM and follow the resource path to the underlying storage node with a correlating performance spike and then back to another VM causing the problem.

3.2 Balancing and Optimizing VMs and Storage Workloads in a Virtual Infrastructure

OnCommand Insight provides performance analysis and load balance information that can help you quickly identify disk contention, performance patterns, congestion, and topology issues. OnCommand Insight displays historical performance peaks and valleys (ebbs and flows), helps remediation efforts by identifying resources with available headroom, and enables benchmarking of workloads on multivendor tiers of storage.

Figure 6) Analyzing load performance to identify issues such as disk contention, performance patterns, congestion, and topology issues.

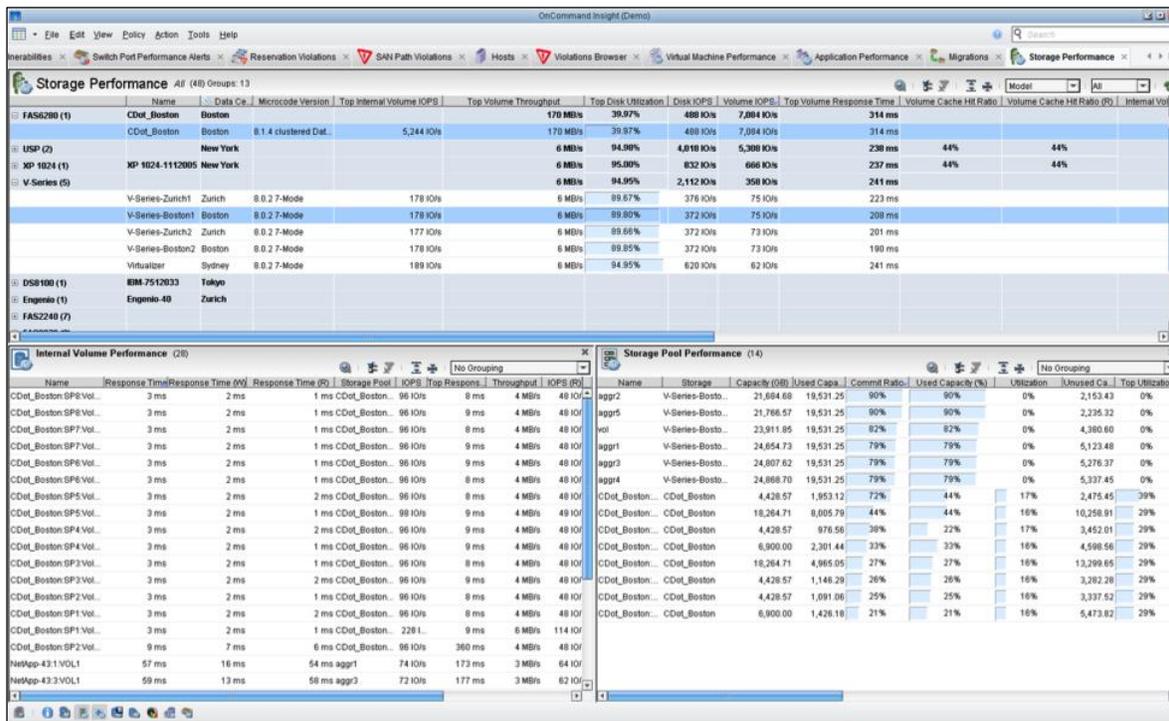


Optimizing the Infrastructure

Effective storage service delivery relies not only on capacity, but also on having enough performance to satisfy the needs of the applications running in the cloud. Tracking and understanding performance are critical to maintaining and improving service quality. In the past, a method of trial and error might have been acceptable because you had more time to deliver a service. In the fast-paced environment of a private cloud, you need accurate and timely reports and alerts to adequately assign resources to workloads. You also need a strong understanding of the actual (not perceived) performance requirements of workloads in order to assign the correct tier of storage.

OnCommand Insight provides visibility into a wide range of performance characteristics of the critical storage paths through Fibre Channel (FC) switches and into arrays. This visibility can help you balance storage and increase application availability. OnCommand Insight collects performance data such as latency, IOPS, throughput, CPU utilization, and memory utilization and maps the data to a discovered service path, enabling troubleshooting detection of infrastructure congestion (bottlenecks); array contention (hot spots); or low, inefficient use of storage and compute resources. Using the detailed traffic visibility into storage usage provided by OnCommand Insight (Figure 7), you can implement a cost-effective tiering plan that also allows you to repurpose or decommission expensive storage.

Figure 7) Performance view into your critical storage paths through FC switches and arrays.



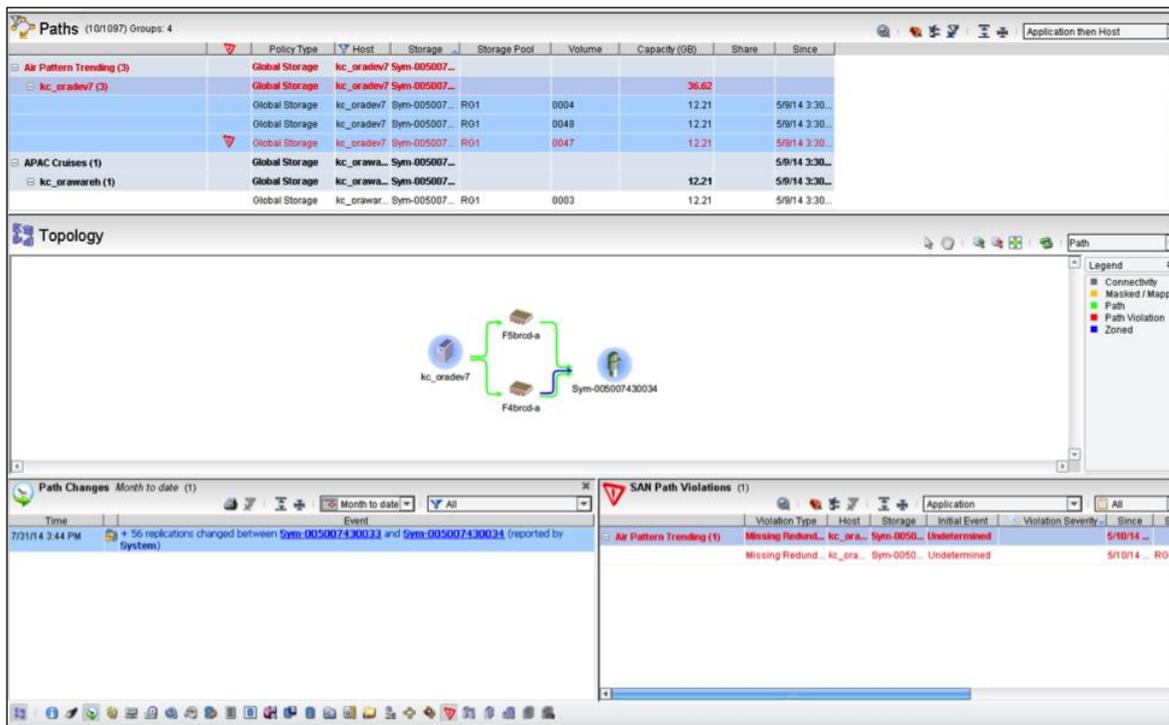
3.3 Providing Storage Availability, Impact, and Configuration Compliance

Setting and Conforming to Policies to Enable Access, Availability, and Performance of Service Paths

To deliver cost-effective, efficient services, you need complete visibility into how storage resources are connected to your users. You can only accomplish this by discovering and correlating components between endpoints. When one resource is correlated to another, it is possible to measure performance and perform impact analysis and capacity planning. OnCommand Insight enables you to gain end-to-end visibility into heterogeneous storage infrastructure availability, performance, and utilization service levels in the context of applications and business units. OnCommand Insight does this with a comprehensive view of physical and virtual infrastructure. In addition, OnCommand Insight can identify orphaned volumes that are too often attached to unused VMs as a result of VM sprawl. These volumes can then be reclaimed and added into the pool of available storage, thereby deferring future storage costs.

OnCommand Insight agentlessly discovers both the physical and logical constructs of the SAN/NAS infrastructure and is equipped with a global and exception-based alerting policy engine. OnCommand Insight allows users to set monitoring policies based on best practices and SLAs for customers, business entities, projects, and applications. Automatically generated topologies and in-depth service path information provide end-to-end details and easy identification of VMs and hosts connected to NetApp and third-party storage vendors. OnCommand insight monitors and reports on newly discovered infrastructure violations and risks based on global or exception-based policies and tracks changes in near real time, as illustrated in Figure 8.

Figure 8) Automatic discovery of your service path, including VM to host to fabric to storage paths.



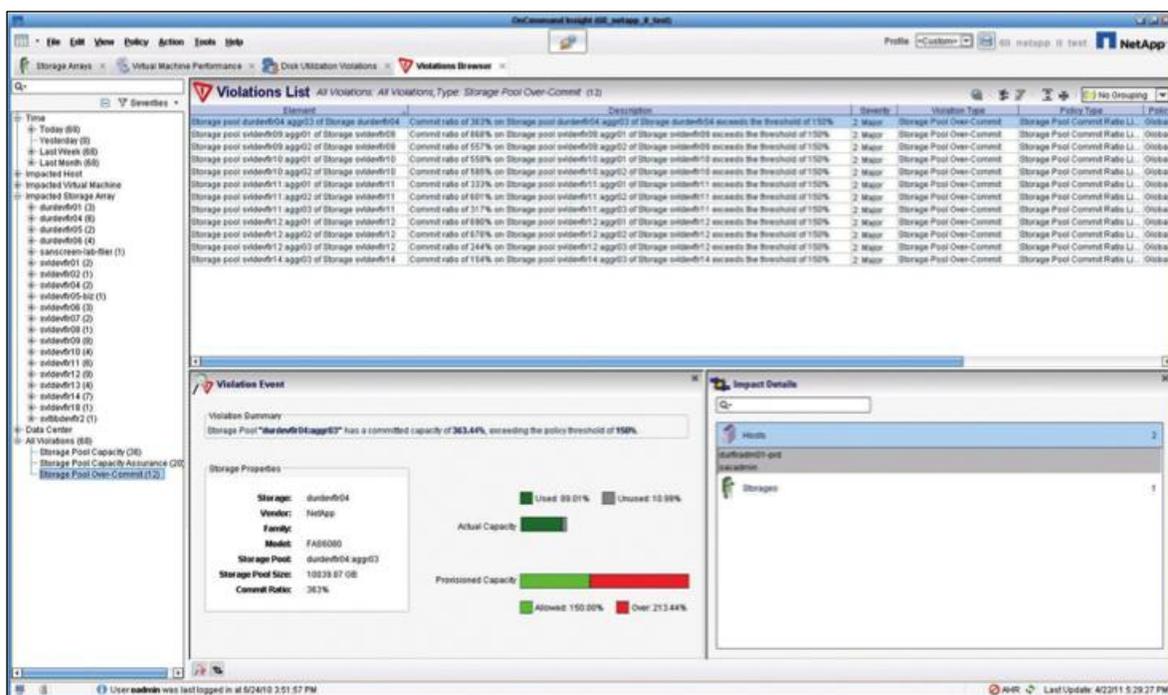
For example, you might want to define a service path and policies from a logical unit number (LUN) to a VMware® vCenter™ datastore. You specify these two endpoints, and then OnCommand Insight discovers all of the logical and physical components that intersect the path between the endpoints. In this case, the LUN might be connected to a storage controller in an array, then to a SAN switch, and then to an FC port on the vCenter server. The discovery process collects data on all of these components. Data collected for the storage controller exposes volumes, LUNs, interfaces, and performance metrics. Data for the FC switch includes switch port data such as the worldwide name. All of this data is correlated to form a service path. OnCommand Insight can then help you to define a set of global application, host, or path-based policies and best practices to help provide the expected levels of access, performance, and availability of the service.

Setting Smart Thresholds and Alerts for Thin Provisioning

Thin provisioning and deduplication are frequently implemented in private cloud environments to extract the most utilization from existing and new storage resources. Thin provisioning is highly efficient because only consumed storage is actually allocated. The downside of this model is that eventually, if everyone requests more capacity on the same day, you might not have the capacity to respond. Intelligent monitoring can provide the safety net needed to help you always honor existing requests and maximize efficiency.

OnCommand Insight provides real-time information about available resources to accelerate application provisioning with an accurate, repeatable, and end-to-end provisioning process that minimizes rework. With OnCommand Insight, you can set thresholds and proactively monitor and generate exception reporting on configurations and usage of thin provisioning and deduplication technologies (see Figure 9). To enable accurate monitoring and risk mitigation, you can set parameters specifying the percentage of storage pool overcommit, free space, and so on from the device, storage pool, and business-level perspective. In addition, OnCommand Insight provides what-if monitoring, detailed storage efficiency reporting, and reporting about thin provisioning to help you proactively manage the virtual environment.

Figure 9) Set thin provisioning and deduplication thresholds and report on exceptions.



Enabling Conformance

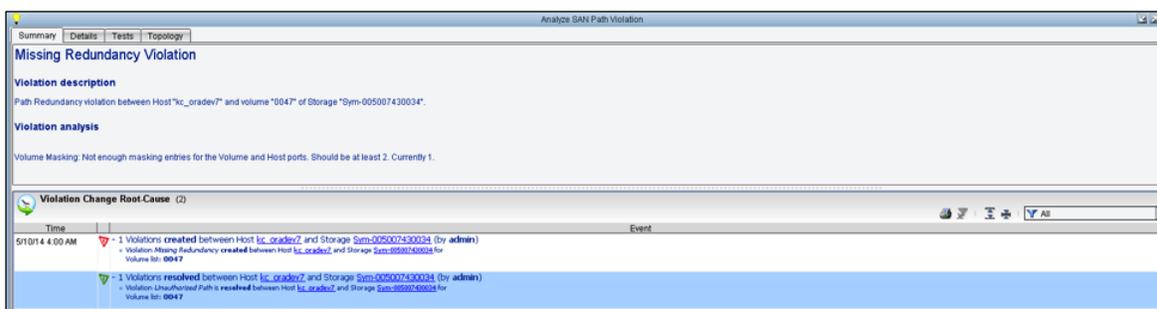
Measuring adherence to process and policy is critical to delivering a high quality of service and achieving efficiency in a private cloud. OnCommand Insight helps keep your private cloud infrastructure in conformance by comparing all real-time storage paths and changes with the established policies for those service paths and sending alerts on all violations. This information can also be used in support of corporate compliance initiatives.

Because OnCommand Insight audits and logs all changes, when a change occurs that affects a service path, OnCommand Insight automatically sends an alert and provides root-cause analytics around the problem. For example, a root cause might be:

- **Active path conflict.** Misconfigured virtual hosts in an active-passive configuration
- **Inconsistent LUNs.** LUNs that are not equally assigned to members of the same cluster (which could cause an application to go down if a failover occurs)
- **Missing redundancy.** Service paths that violate the minimum number of redundant paths required for an application (illustrated in Figure 10)
- **Missing virtual cluster path.** When there is a missing path to storage from one of the members of a virtual cluster (which could cause the application to go down if a failover occurs)
- **Path outage.** When a service path component becomes unavailable and disrupts the flow of data

In addition, OnCommand Insight can report on violations by event. In general, most violations are caused by events, such as an outage, or changes that often trigger multiple violations, as shown in Figure 10. By reporting on an event, OnCommand Insight enables you to identify and fix one issue and thus clear multiple violations at the same time.

Figure 10) Report on violations by event so you can take immediate corrective action.



In a private cloud, where storage is allocated only when needed, it's more important than ever for users to understand how much storage they use. OnCommand Insight can send user alerts (e-mail) to all users who exceed their disk or file quota limits. In addition, the provisioning policy in OnCommand Insight contains two threshold parameters—nearly full threshold and full threshold—that are defaulted to 80% and 90%, respectively. When these thresholds are reached, warnings and errors display in OnCommand Insight.

OnCommand Insight helps enable provisioned datasets to be in conformance with storage service levels. For example, if a SnapVault® action is not occurring, then the dataset is out of conformance, because the primary storage is not being backed up. In this case, OnCommand Unified Manager will detect this violation and alert the user.

Making Changes with Confidence

In a siloed environment, changes to hardware, firmware, or software affect only the application running on that system. In a private cloud environment, in which many applications share resources, one change has the potential to cripple your business. You need the ability to make changes quickly to respond to increasing demands and reap the benefits of cloud computing, but you also must determine that changes do not have an adverse effect on the environment as a whole. OnCommand Insight provides tools to help you plan, simulate, analyze, validate, and implement changes, so you deliver private cloud services with confidence.

OnCommand Insight change management capabilities enable you to plan minor or major changes in your environment and test them so you can correct any potential issues before implementation. This can be something as simple as upgrading firmware in a switch or as complex as moving all application storage from one array to another. OnCommand Insight provides what-if scenarios to simulate planned configuration changes and accurately determine the service impact on applications, so you can eliminate the risk of violations and catastrophic human errors during the actual changes and accelerate the time it takes to complete them.

After you're confident that the changes are sound, the tools help you build a detailed, actionable task list that you can use to make the actual changes (Figure 11). During the change window, the change management tools dynamically monitor and validate each change you make in real time, so you gain immediate confidence that you are completing the changes according to plan and without issues.

Figure 11) Task list to implement your tested change.

The screenshot displays the OnCommand Insight interface. At the top, there is a 'Task list (5)' section with a table containing the following data:

ID	Ticket	Name	Owner	State	Status	Pre-Validation	Termin
admin 2010/03/18 14:06		jkj,jj	admin	Planning	Not completed	Passed	
admin 12/11/2006 18:06	124	Add Host kc_oradev7	admin	Planning	Not completed	Passed	
admin 12/11/2006 18:06	127	Shutdown switch F5brcd-a	admin	Planning	Not completed	Passed	
admin 12/11/2006 18:06	129	Shutdown Switch hcis200	admin	Planning	Not completed	Passed	
oadmin 01/08/2007 15:38	170	Replace HBA Clearcase1		Planning	Not completed	Failed	

Below the task list is an 'Actions (9)' section with a table:

#	State	Description	Owner
1	<input checked="" type="checkbox"/>	Remove Zone Member Port 10:80..24 of Host Clearcase1 (192.1.168.9) from Zone	oadmin
2	<input checked="" type="checkbox"/>	Remove masking from Hosts Clearcase1 for Storage IBM TotalStorage DS8100 2107	oadmin
3	<input checked="" type="checkbox"/>	Disconnect Port 10:80..24 of Host Clearcase1 from Portfc1 of Switch hbrcd1	oadmin
4	<input checked="" type="checkbox"/>	Remove HBA 40:A0:00:00:00:24 from Host Clearcase1	oadmin
5	<input type="checkbox"/>	Add a 1-port HBA to Host Clearcase1 (192.1.168.9)	oadmin
6	<input type="checkbox"/>	Connect Port 10:00..90 of Host Clearcase1 to Portfc1 of Switch hbrcd1	oadmin

At the bottom, there is a 'Future Changes' section with a table:

Violation Type	Action	Event
exchange_nj1 - XP 1024-12002 (8) Path outage		+ 8 Violations created between Host exchange_nj1 and Storage XP 1024-12002 (by oadmin)
jp_nas_1 - USP600_22113 (4) Missing Redundancy		+ 4 Violations created between Host jp_nas_1 and Storage USP600_22113 (by oadmin)
jp_nas_1 - USP600_22114 (2) Path outage		+ 2 Violations created between Host jp_nas_1 and Storage USP600_22114 (by oadmin)
jp_nas_2 - USP600_22113 (8) Missing Redundancy		

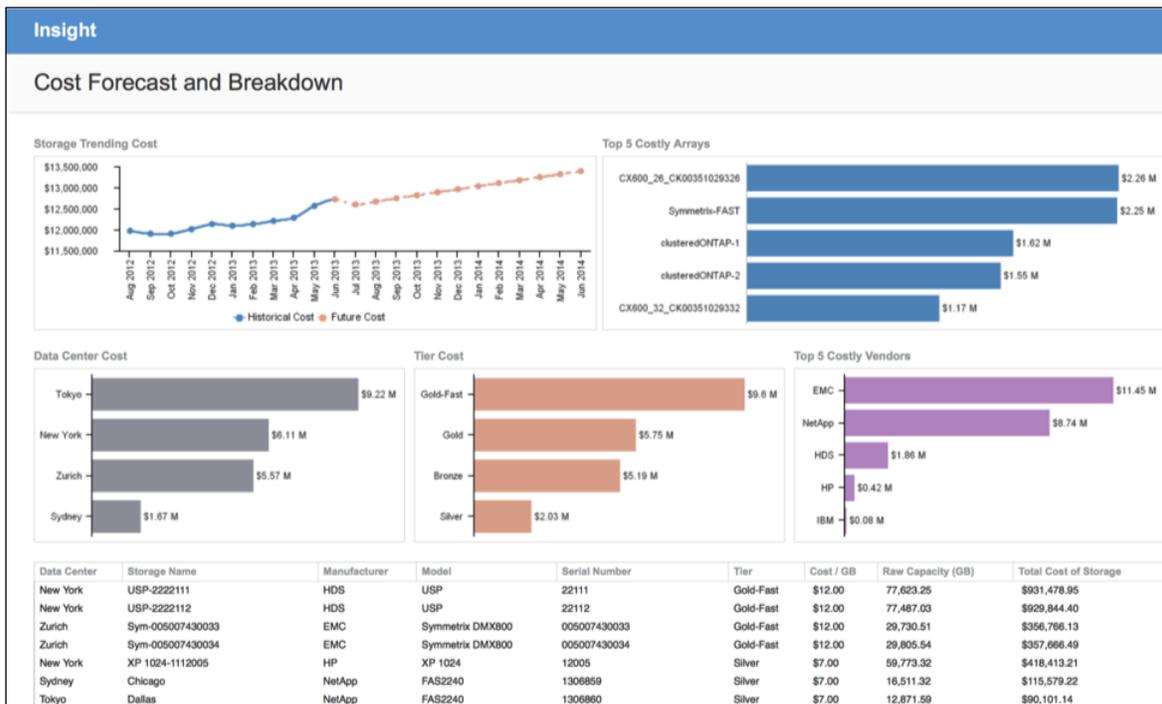
Along with making changes to the infrastructure, you can also use OnCommand Insight to plan and optimize the alignment of VMs and storage or further optimize your storage tiers by identifying tiering candidates by more accurately assessing usage over time. With this information you can better predict future storage needs across storage tiers, enabling you to make more intelligent and cost-conscious decisions when purchasing additional hardware. Another excellent use of the change-planning features is to plan, test, and validate applications before you consolidate and migrate them to the private cloud.

3.4 Forecasting Capacity More Accurately with Trending and Enabling Showback

Creating Cost Awareness

OnCommand Insight reporting capabilities (Figure 12) are highly configurable, enabling you to view detailed business-level usage reporting by application, business unit, tenant, project, tier, data center, and so on. For example, you can manage capacity on a set basis, say, monthly, so that enough storage is allocated and provisioned to accommodate growth in the cloud. Imagine a scenario in which your expensive tier 1 array shows 80% full. Just because an array is 80% full does not mean the array is 80% used. Actual utilization is usually significantly lower. Additional analysis shows that the actual traffic through that array is only around 25% utilization. Conducting further analysis on the applications using that array, you find that although the applications use a lot of storage, they do not require the speed for the amount of actual access to that storage. With this information, you can move these applications to tier 2 or tier 3 storage and immediately validate that there is no negative effect on the performance of the applications. Using the reports, you can intelligently and proactively manage the storage service requirements by application, not simply by array type, and provide a more realistic business approach to service delivery. This correlation can now be used to provide business-level metrics for showback/chargeback and for optimizing/planning storage needs.

Figure 12) Dashboard showing cost forecast and breakdown by data center, tier, and vendor.



Reporting on Costs

Controlling costs is particularly important in a private cloud in which users and business units share resources. To manage cost against need, you need to be able to show the actual usage of cloud resources. Cost awareness can be used for budgetary reasons to justify your IT budget and requests for new purchases. It can also help end users understand the costs of storage and virtual infrastructure that their applications consume. As mentioned earlier in this paper, in more advanced deployments of private cloud, some enterprises might also implement a chargeback model to charge internal users, departments, business units, and so on for their consumption of resources.

OnCommand Insight contains all of the data about the storage infrastructure that was discovered when defining service paths. OnCommand Insight also has integration with OnCommand Unified Manager, enabling reporting for chargeback and capacity planning.

Figure 13) Add data source.

The screenshot shows a window titled "Add data source" with a close button in the top right corner. The window is divided into several sections. The top section is labeled "Settings" and contains the following fields: a text input for "*Name", a dropdown menu for "Vendor" currently set to "NetApp", a dropdown menu for "Model" which is open and showing a list of options including "Clustered Data ONTAP 8.1.1+", "Clustered Data ONTAP 8.1.1+ (Unified Manager 6.0+)", "Data ONTAP 7-Mode", "E-Series (Firmware 5.x)", "E-Series (Firmware 6.x)", "E-Series (Firmware 7.x+)", and "UM 5.2-5.3 Annotations (SQL)", a text input for "Where to run", and a checkbox for "What to collect" which is checked. Below the "Settings" section is a "Configuration" section with a "Configure" button and a dropdown arrow. Underneath are two tabs: "Advanced configuration" and "Test". At the bottom of the window are "Cancel" and "Save" buttons.

You can annotate and align this information with business-level elements to provide business-level reporting on usage by application, business unit, and data center. Typical alignment use cases include:

- Aligning application and end users or business units (data owners) with servers and storage
- Establishing and aligning tiers to the loaded cost per gigabyte
- Aligning VM usage with application and customer or business unit
- Associating and reporting application cost to end user or business unit by multiple levels, including tiers, storage devices, storage pools, volumes, storage network, protocols (FC, NFS, iSCSI, FCoE), and VMs

For example, tiers and costs can be aligned with storage usage by business applications at four primary levels: storage array, storage pool, internal volumes, and LUNs. Tier characteristics can be further defined within storage pools and volumes by these characteristics: disk type, disk size, disk speed, RAID protection, and volume type. Top-level graphic reporting automatically consolidates storage and VM usage by application, business unit, data center, and so on. These reports can drill down to show the quarterly cost of each business unit and its applications, tier usage, capacity, and total cost per quarter to provide valuable insight into the cost of the applications within a virtualized private cloud environment. The reports show actual usage by application—including actual utilization of data, Snapshot™ copies, thin provisioning, and deduplication—regardless of the underlying virtual technologies. A sample report is shown in Figure 14.

Figure 14) Cost report on usage by application in a virtualized environment.

Cloud Services Chargeback Report									
Includes cost of VM +Storage usage by each Application and BU									
Tier: Silver									
Cloud Customer Name	Application	VM	VM Cost	Data Store	Actual Capacity GB	Tier	Tier Cost	Storage Cost	Cloud Services Cost
Customer Support	Dev Test	SE-VM2	\$17.00	SE-DATASTORE	0.005	Silver	7	\$0.03	\$17.03
	Dev Test	SE-VM3	\$17.00	SE-DATASTORE	0.005	Silver	7	\$0.03	\$17.03
	Dev Test	SE-VM4	\$17.00	SE-DATASTORE	0.005	Silver	7	\$0.03	\$17.03
	Dev Test	SE-VM5	\$17.00	SE-DATASTORE	0.005	Silver	7	\$0.03	\$17.03
	Dev Test	SE-VM6	\$17.00	SE-DATASTORE	0.005	Silver	7	\$0.03	\$17.03
	Dev Test	SE-VM7	\$17.00	SE-DATASTORE	0.005	Silver	7	\$0.03	\$17.03
	Dev Test	SE-VM8	\$17.00	SE-DATASTORE	0.005	Silver	7	\$0.03	\$17.03
	Dev Test	SE-VM9	\$17.00	SE-DATASTORE	0.005	Silver	7	\$0.03	\$17.03
Customer Support		36	\$612.00		2.123			\$14.86	\$626.86
Dev	Dev/test	N/A	\$17.00	nas datastore 0	1.995	Silver	7	\$13.97	\$30.97
	Dev/test	N/A	\$17.00	nas datastore 1	1.995	Silver	7	\$13.97	\$30.97
	Dev/test	N/A	\$17.00	nas datastore 10	1.995	Silver	7	\$13.97	\$30.97
	Dev/test	N/A	\$17.00	nas datastore 11	1.995	Silver	7	\$13.97	\$30.97
	Dev/test	N/A	\$17.00	nas datastore 12	1.995	Silver	7	\$13.97	\$30.97

Enabling Showback

Showback calculations need to include temporary VMs, development and test VMs, labs, and other nonproduction elements so end users can understand the full cost of services and make business decisions based on all usage, not just production environments. You can also add charges for administration costs, overhead, facilities, and so on to help form a complete cost accounting report.

There are many showback models on which you can report. Two common models are a simple model and a loaded model. A simple model is one in which you show costs per gigabyte in terms of the raw gigabytes of the storage allocated to an end user. This is based purely on the cost of the storage array divided by the number of gigabytes and does not include the cost of tiering, protection, configuration, or support overhead. For example, 100GB of raw storage with RAID 1 yields 50GB of allocated storage. The report shows the cost for 100GB of raw storage, but only 50GB is usable because of the protection requested.

With a loaded model, you can show the cost of storage per gigabyte but also combine the cost of all support and overhead. The loaded model is typically more realistic and thus used to more accurately report the true cost of storage to end users. OnCommand Insight enables you to easily create automated chargeback or showback reports using the drag-and-drop features of the data warehouse. You can also create your own customized reports using MySQL queries against the OnCommand data warehouse. With these reports and the feedback from your end users, you can make better business-level storage allocation decisions based on the capacity usage and cost of applications as compared to the business value the application provides.

4 Ecosystem Integration

NetApp realizes that it takes many technologies to implement and manage a successful private cloud and that many organizations would like to utilize their existing applications, or other applications, in this environment. NetApp's ecosystem integration approach includes open APIs and SDKs to enable you to share data with these applications. NetApp's differentiator is that we integrate with higher level management platforms through strategic partnerships with leading infrastructure management providers, such as BMC Software, CA, DynamicOps, Microsoft, and others. Through NetApp's open interfaces, third-party management platforms or your in-house management tools are allowed the same level of access as NetApp's management tools. This enables integration at a much higher level of abstraction and empowers you to perform policy-based automation tasks for storage from your existing tools.

OnCommand service-centric data repositories are aligned with broader IT service management (ITSM) technologies through a variety of integration techniques. By leveraging OnCommand Insight information, ITSM solutions such as ServiceNow can integrate storage service data to round out the view of infrastructure for enterprise reporting and analysis. OnCommand Insight is also integrated with VMware vCenter and Microsoft System Center. This integrated functionality provides VM server and storage administrators with deep visibility across the data center infrastructure into storage and VM environments.

The vCenter plug-in sends OnCommand Insight service path, configuration, performance, and violation information so it can be viewed by VM server teams from within vCenter. This valuable information is *not* natively available in vCenter. Additionally, all of the VM capacity and performance information is provided back to OnCommand, which provides the storage management team with insight into the performance, capacity, and usage of the VM environment and how it relates to external storage usage. This provides you with complete end-to-end visibility of storage usage for each of the VMs, including arrays, volumes, tiers, capacity, and other information.

Another key NetApp advantage is the ability to integrate with many higher level orchestration frameworks such as Apache ODE, Oracle® BPEL Process Manager, TIBCO BusinessWorks, and more. By leveraging the NetApp Manageability SDK and open APIs, you can create a self-service portal and use third-party ITSM platforms, virtualization management solutions, your in-house management tools, or third-party analytics to gain the same level of access to NetApp storage technologies as you can directly using NetApp OnCommand Insight.

5 Conclusion

As your organization moves to a hybrid IT environment that includes virtualization, private cloud, public cloud, and even a hybrid cloud, the NetApp OnCommand suite of products can help optimize the efficiency of the infrastructure in providing the end user with flexible and cost-effective services and service levels. OnCommand Unified Manager provides in-depth monitoring for NetApp systems. OnCommand Insight provides service analytics for shared, virtualized, heterogeneous IT infrastructures. OnCommand Insight provides the key performance indicators, in-depth visibility into complex multivendor and multiprotocol storage services, and powerful analytics to help you fully leverage the promise of private cloud computing.

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

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