

# Storage Consolidation Best Practices Whitepaper



## How Virtual Instruments SAN Optimization Best Practices Support Data Center Storage Consolidation Initiatives

### Introduction

Information can be the most valuable asset to any organization of any size. As a result, the amount of data that is being stored and the amount of time it is kept online is growing rapidly, while the resources to manage it are not. This presents a considerable challenge to companies striving to exploit information for competitive advantage and storage administrators tasked with storing, managing, and protecting that data. Consolidation of storage systems, often as a component of data center consolidation, or a private cloud initiative, is being considered by more and more companies as a key way to address this challenge.

Today's frenetic pace of data amassment and movement results in storage requirements that grow at unpredictable rates—fueling a heightened urgency to accommodate and manage data without bottlenecks or downtime. Storage-intensive applications are driving rapid growth, with no letup on the horizon. Furthermore, the amount of time information is kept online is also growing, from months to years. Beyond just the pure growth in data storage requirements, nonstop access to information by internal and external users is more important than ever before. While it has been widely acknowledged that unscheduled downtime is unacceptable, companies are becoming more and more aware that performance is equally important in shaping their position in the competitive landscape.

The changing mix of applications and evolving data management requirements is driving major change in storage requirements. IT managers are demanding storage solutions that allow them to deploy complementary tiers of networked storage systems optimized to meet specific requirements

### SUMMARY

How VI best practices meet your consolidation needs:

- **Drastically reduced risk of performance problems due to consolidation, new infrastructures, and storage tiering**

Reports on metrics that provide definitive, real-time measurement of the effect on application latency, of any and all configuration changes

- **Single pane of glass for SAN health monitoring**

Provides all the required information on a single dashboard to clearly show whether an application performance problem is with the SAN or not, for real-time root cause analysis. Provides historical performance, error, alerts and event trending information for end-to-end application I/O conversations

- **Quick resolution of performance or component**

for performance, capacity, reliability, and cost.

One reason that storage consolidation is emerging as a solution is because it holds the promise of not only supporting increased storage needs but also simplifying operations and improving resource utilization and efficiency. It enables re-centralization and reduces space requirements.

Storage consolidation delivers budget benefits that include:

- Server capabilities are maximized
- Saves floor space
- Management costs are lowered
- The number of storage devices are reduced
- The number of management software licenses are reduced
- Hardware and software maintenance costs are decreased
- Environmental costs for power and cooling are reduced

The benefits of storage consolidation are being realized by more and more companies and seen as a way to streamline many storage-driven applications.

Virtual Instruments develops optimization solutions for managing the growth and design of storage and storage area network (SAN) -related technologies. These solutions are being deployed around the world in some of the largest datacenters, and through our experience, we can offer insight on best practices for speeding consolidation while mitigating risks and improving service levels. This paper highlights some of the challenges you will face and how Virtual Instruments can help IT managers. But first, we would like to review the challenges inherent in storage and storage network consolidation.

### Consolidation challenges for storage networks

<p><b>Growth challenge</b></p>	<p>Storage capacity is increasing rapidly, but IT head count isn't. Consolidation itself will eliminate some inefficiency, but the truth is, most "fat" has been trimmed long ago.</p> <p>Chronic over-provisioning of capacity and storage network links, partially due to uncontrolled growth, will remain a key issue and is not likely to be significantly affected unless other changes are made to planning and reporting. We typically see SAN port utilization of less than 5% in our customer deployments, so there is extreme over-provisioning occurring in just about every data center.</p>
<p><b>Complexity challenge</b></p>	<p>Consolidation alone will not add a reporting capability that ties infrastructure to quality of storage service delivered to applications. In fact, storage- and server-consolidation initiatives traditionally simplify the asset layer but move complexity of storage management to server infrastructure, with no net difference in overall effort.</p> <p>Server virtualization is a key example of complexity, since to benefit from this requires a shared storage pool for vMotion, DRS, etc. This makes ensuring that each application gets the quality of storage service required more difficult, not less.</p> <p>Mastering the different interfaces and intricacies of many point tools that don't talk to one another hugely impacts productivity and makes it difficult to handle the consolidated storage capacity.</p> <p>With consolidation, you increase the need to establish a concrete method for validating interoperability and performance on new or changed SAN devices – before introduction to the production environment.</p>

### issues for highest availability

Alerts based on trends or thresholds quickly enable IT administrators to pinpoint performance issues and intermittent failures and take the appropriate action(s) to correct the problem

- **More cost-effective network provisioning**

VirtualWisdom helps reclaim underutilized SAN ports to save on acquiring additional expensive core switch ports, storage ports, related cables, and SFPs.

- **Private cloud enabler**

Enables IT to monitor I/O through the veil of virtualization, reducing the risk of deploying cloud topologies

<b>Troubleshooting challenge</b>	<p>Changes have overtaken many IT administrators with silent footsteps. While the IT practitioner's every day is a swim through waves of invisible bits, there has long been some comfort to be found in the "physicality" and accessibility of key devices. Infrastructure consolidation will create more interdependencies between systems. For a given application, dependencies may cross multiple other applications, servers, SAN fabrics, IO adapters, and network hops. When the performance limit of a single component in one of these systems is breached, experience indicates that these I/O laden systems will not see performance gradually degrade, but rather will see latency and performance rapidly spiral out of control under a bombardment of increasingly delayed, dropped and repeated IO attempts that can no longer be queued, cached, backed-off by congestion controls, or otherwise gracefully handled. Consolidation alone will bring no view into which specific storage infrastructure issues are impacting application performance.</p>
<b>Virtualization / private cloud challenge</b>	<p>When problems arise, we have always been able to identify a switch port for examination, a server at the end of a wire that might be causing problems, an HBA for inspection, or any number of other physical things we can turn to for further examination. But in a datacenter that uses virtualization and private cloud technologies to achieve cost reduction and speedier provisioning, that comfort has vanished. In part, this is due to the virtualization of technologies surrounding us, and while this trend is spearheaded by server virtualization, the variations can include the likes of application virtualization, network device virtualization, I/O virtualization, and storage virtualization.</p> <p>While consolidation is dependent on the increase of server consolidation ratios, it is difficult to deploy virtualized mission critical applications due to a limited ability to see into the I/O subsystem. Risks are increased due to a limited ability to troubleshoot; as there is no real view into which specific storage infrastructure issues are impacting application performance.</p> <p>Because of a collapsed and centralized applications infrastructure, server admins may take more responsibility for more of the "stack", most likely with the tools they are familiar with today. And these tools are largely blind to I/O.</p> <p>In a consolidated datacenter using virtualization techniques, isolated workload peaks can cause resource conflicts, and the concentration of load can create new and potentially more serious bottlenecks.</p> <p>The use of service-level agreements (SLA's) for applications is not possible without the ability to measure and provide metrics for the full data path from server to disk system.</p>
<b>Storage network infrastructure challenge</b>	<p>A new, consolidated data center will inevitably include new, faster network infrastructures to support the greater I/O demands. While these networks are potentially beneficial from a performance perspective, transitioning to higher speeds creates some real challenges for SAN architects. In particular, there is a potential for increased data communication error rates that may result in</p>

	<p>disruption or performance degradation of mission critical applications. The physics of high-speed communication creates many new restrictions on crucial physical-layer elements such as optical cabling and optical modules. These restrictions must be understood, addressed and proactively monitored before the full value of faster infrastructures can be realized. For example, 8Gb FC SAN cabling has half the bend radius of 4Gb FC cabling. SAN cabling designed for 4Gb infrastructure may simply not work when devices are upgraded to 8Gb.</p> <p>Further, If increasing network speeds just causes other components to become bottlenecks, this can force additional unexpected expenditures (maybe faster storage, like SSD to utilize the network) fueling the 'upgrade cycle' and even higher costs.</p>
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**Next generation datacenter storage networks**

The evolution of storage networking technology is now making it possible to better align applications within a data center with the most cost-effective storage technology. Some of these storage technology innovations include:

1. Solid state memory disks
2. Multiple physical disk technologies (e.g. Fibre Channel and SAS) within a single storage array
3. Improved performance (IOPs, bandwidth) and data protection features (e.g. asynchronous replication, copy-on-write snapshots) of tier 2 storage arrays
4. Improved, application-aware tiering management software
5. Virtualization of physical storage
6. Private cloud, service-oriented management model

Related to the first five innovations – it is often possible for example, to take a tier 1 application and assign it to tier 2 storage, since the tier 2 storage technology often has the functionality to meet the business requirements (e.g. replication, snapshots and RAID protection) of the application. And you can guarantee that performance meets SLAs by measuring the effect of I/O performance on application latency.

Denser, tier 2 storage presents a smaller footprint, uses far less energy, costs less to acquire, and is usually less expensive to maintain and support. In a Gartner-assisted analysis, we found that large enterprises can save between approximately \$7,000 and \$10,000 per TB with a performance-based tiering strategy. This was based on energy costs of \$.10 per kWh, floor space of \$166 per square foot, and storage acquisition costs generally available to large enterprises through normal procurements.

Related to the fifth and sixth innovations – according to Gartner, “the primary benefit of private cloud computing is speed. Implementing a service catalog that offers standard services through a self-service interface, and automating the delivery of those offerings, can increase the speed of delivery dramatically. By themselves, standards, automation, and some form of resource pooling or virtualization will also reduce costs — but these can be done without building a complete private cloud.” Though not absolutely tied to private cloud computing, virtualization is an enabler in the majority of cases, especially when combined with consolidation initiatives. Virtualization has proven to reduce costs, while at the same time accelerating the speed which new applications can be brought online.

## How Virtual Instruments' can help with data center consolidation

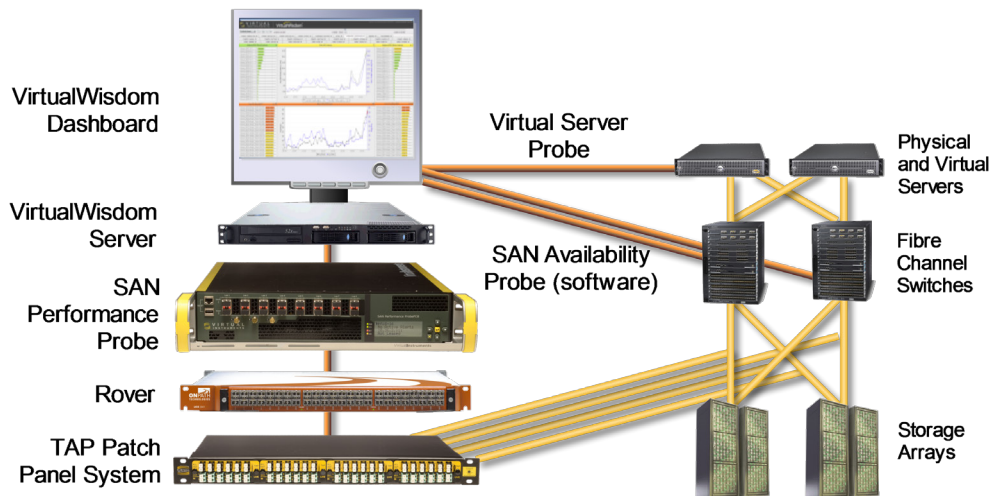
Virtual Instruments offers a Virtual Infrastructure Optimization (VIO) solution that holistically assesses the entire physical and/or virtual infrastructure, and provides the IT staff with the data necessary to make intelligent decisions about capacity, utilization, and performance for every layer of the I/O infrastructure – from the host to the storage. Components and use cases of our solution include:

### Monitoring and Measurement Best Practice

Rapid increases in the consolidation, operating speeds and general complexity of SAN technologies, exacerbated by the high change rates demanded of enterprise IT organizations, significantly increase demands on the fiber optic physical layer.

A best practices-compliant physical layer must be capable of being both *maintained* and *monitored* in order to meet those demands. Physical layer maintenance requires the ability to quickly and easily add, change, or remove links and devices. Monitoring ensures the accuracy of the changes and validates that they produce only the desired results. Physical layers that address both requirements enable the Fibre Channel SANs operating on top of them to be iteratively optimized for maximum availability, performance, and utilization.

Physical layer monitoring and measurement is the real-time acquisition and correlation of error, performance, and utilization data. This is enabled via optical splitters, called Traffic Access Points, or TAPs that allow passive access to this real-time data, and by probe instrumentation that analyzes the fibre channel frames. Virtual Instrument's SANInsight TAP Patch Panel System and VirtualWisdom SAN Performance Probe provide a range of options for monitoring and analyzing SANs.



*VirtualWisdom TAP and SAN Performance Probe*

By unifying TAP and patch functions into a single layer of physical infrastructure, SANInsight TAP Patch Panels significantly reduce the cost, complexity, and infrastructure impact of monitoring and measurement. SANInsight TAP Patch Panels facilitate the broad installation of TAPs into both new and existing physical infrastructures, fully addressing the best practices monitorability requirement and enabling complete SAN optimization.

### Tiering Management Best Practice

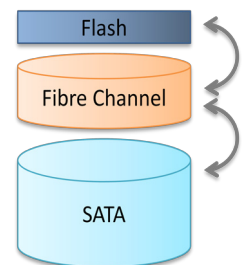
Virtual Instruments VirtualWisdom® is the missing puzzle piece of the tiering value proposition. Drive speed is only one factor in achieving the desired application performance for a storage tier and is often the smallest, most expensive performance differentiator. VirtualWisdom tracks I/O conversations to provide both real-time monitoring and trend analysis of overall performance between applications and all components of the Fibre Channel SAN – the host HBA, switches,

“With visibility in mind, access should be a “built-to” specification for all new data center infrastructure. Visibility is a mandatory best practice in the consolidating infrastructure, and you should therefore introduce improved visibility with every major system change.”

*Taneja Group  
2010*

“As a best practice, it’s advisable for larger enterprise datacenter managers to install Fibre Channel network TAPs and monitoring software to generate real time, granular transaction data when moving to new infrastructures.”

*Eric Slack  
Storage  
Switzerland  
2010*



virtualization appliances, storage ports, and LUNs. Combined with the storage vendor tools with their emphasis on storage system metrics, VirtualWisdom provides the critical missing data to enable IT organizations to more confidently use lower cost storage to provide higher tier performance. Virtual Instruments adds application latency data and other information to properly plan and optimize the environment. This is combined with alerting capabilities to prevent user impact as demands change, enabling IT to realize huge CAPEX improvements while delivering on SLAs.

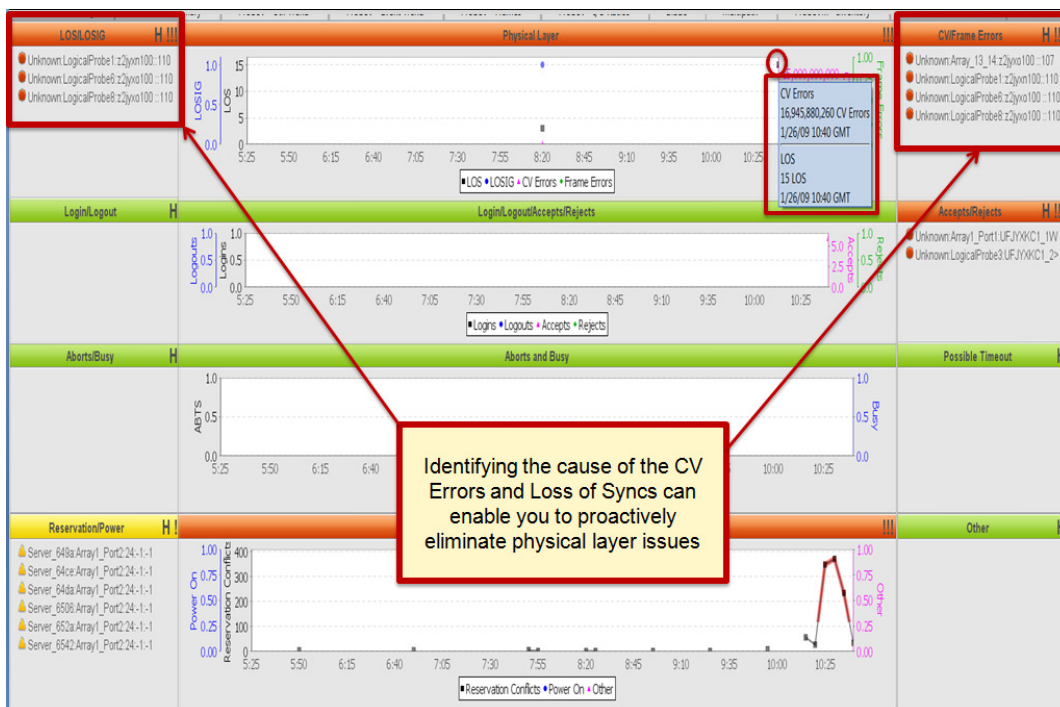
With Virtual Instruments, you are instrumenting and measuring your infrastructure to provide your organization with all of the critical information needed to reduce power consumption, air conditioning, and floor space requirements related to your SAN and virtual server infrastructure. Savings are primarily due to reduced over-provisioning and more effective use of storage. You can see total savings in the range of \$7,000 - \$10,000 per terabyte of storage by utilizing performance-based tiering.

### High Availability Best Practice

Beyond adding full I/O path awareness to let IT make more intelligent performance-based tiering decisions, VirtualWisdom also provides deep, physical-layer knowledge of the fabric to enable actual problem avoidance, accelerate troubleshooting, and help de-risk the move to a consolidated computing model.

Monitoring the IT infrastructure reduces downtime by finding hidden problems. Every network has hidden issues, from physical layer errors to configuration and load-balancing issues such as failed multipathing. By setting alerts keyed to these issues, administrators can proactively eliminate them while they are still benign, making IT administration a proactive activity rather than a series of firefighting drills. Due to the robust nature of Fibre Channel SAN technology, most problems that impact users are compound issues, thus root cause is often hard to pinpoint. Being able to effectively address potential issues before application users report problems creates a more methodical and efficient process of ensuring application availability.

In the example VirtualWisdom dashboard below, there are enabled SAN ports with nothing connected to them. This can cause millions of code violations, creating a massive CPU overhead on the SAN switch. Finding these code violations enables proactive avoidance of many application slowdowns.



VirtualWisdom dashboard example

## Problem Resolution Best Practice

Decreasing time to problem resolution is accomplished by monitoring transactions from the physical or virtual host to the LUN with VirtualWisdom. The ability to rapidly zero in on the source of the problem, proving within minutes whether the SAN is to blame for slow application performance or not, focuses the right team on the task and allows other teams to remain focused on other mission imperatives. Running historical reports to look back in time enables faster time to problem identification and resolution. In many cases, with VirtualWisdom you can “capture” the moment of failure, reducing the overall time to discover the root cause. Virtual Instruments’ customers often nickname this “DVR for the SAN”. VirtualWisdom is the only product that can monitor and send an alert about storage access times, congestion, link errors, and SCSI errors, and generate trend reports that show the behavior of a heterogeneous SAN, by host and by application. This information helps to dramatically expedite troubleshooting and allows the IT Manager to prove whether the problem is in the SAN, the application, or the server. This simple first step speeds troubleshooting by days, weeks, or even months.

## Network Provisioning Best Practice

The lack of ability to actively measure SANs means storage architects design for the very worst case. In our engagements with customers, we have consistently found that storage networks at larger data centers are significantly over-provisioned, with average network link utilization rates of less than 5%. VirtualWisdom can help reclaim underutilized SAN ports to postpone acquiring additional expensive core switch ports, storage ports, related cables, and SFPs. Real time proactive monitoring, measurement, and alerting enables high consolidation rates without impacting performance as demands change. Changes in demand and performance can be detected long before users are impacted. Running reports that show latency and throughput per port enables the optimizations that balance utilization and increase consolidation.

In the VirtualWisdom dashboard widget at the right, you can see that the average utilization of most of these top storage ports is well below 10%, suggesting that there is a huge opportunity to consolidate links when new servers or applications are provisioned.



Top Storage Ports		
Array1_Port01:Read	13.261	<div style="width: 100%;"></div>
Array2_Port11:Read	10.648	<div style="width: 100%;"></div>
Array1_Port46:Read	9.420	<div style="width: 100%;"></div>
Array2_Port15:Read	8.834	<div style="width: 100%;"></div>
Array1_Port05:Read	8.829	<div style="width: 100%;"></div>
Array2_Port32:Write	7.061	<div style="width: 100%;"></div>
Array2_Port36:Read	6.875	<div style="width: 100%;"></div>
Array1_Port26:Read	6.853	<div style="width: 100%;"></div>
Array1_Port22:Write	6.797	<div style="width: 100%;"></div>
Array2_Port13:Read	6.208	<div style="width: 100%;"></div>
Array1_Port21:Read	5.405	<div style="width: 100%;"></div>
Array1_Port03:Read	5.086	<div style="width: 100%;"></div>
Array1_Port01:Write	4.920	<div style="width: 100%;"></div>
Array1_Port40:Read	4.804	<div style="width: 100%;"></div>
Array1_Port02:Write	4.523	<div style="width: 100%;"></div>
Array2_Port31:Read	4.485	<div style="width: 100%;"></div>
Array1_Port22:Read	4.056	<div style="width: 100%;"></div>
Array2_Port32:Read	3.735	<div style="width: 100%;"></div>
Array2_Port12:Write	3.633	<div style="width: 100%;"></div>
Array1_Port29:Write	3.594	<div style="width: 100%;"></div>
Array2_Port11:Write	3.588	<div style="width: 100%;"></div>
Array1_Port07:Read	3.581	<div style="width: 100%;"></div>
Array2_Port17:Read	3.550	<div style="width: 100%;"></div>
Array2_Port50:Read	2.802	<div style="width: 100%;"></div>
Array1_Port02:Read	2.801	<div style="width: 100%;"></div>
Array1_Port20:Read	2.735	<div style="width: 100%;"></div>
Array2_Port30:Read	2.703	<div style="width: 100%;"></div>
Array1_Port21:Write	2.564	<div style="width: 100%;"></div>
Array1_Port08:Write	2.553	<div style="width: 100%;"></div>
Array2_Port18:Write	2.544	<div style="width: 100%;"></div>
Array2_Port12:Read	2.407	<div style="width: 100%;"></div>
Array2_Port31:Write	2.239	<div style="width: 100%;"></div>

*VirtualWisdom dashboard – top storage ports by % utilization*

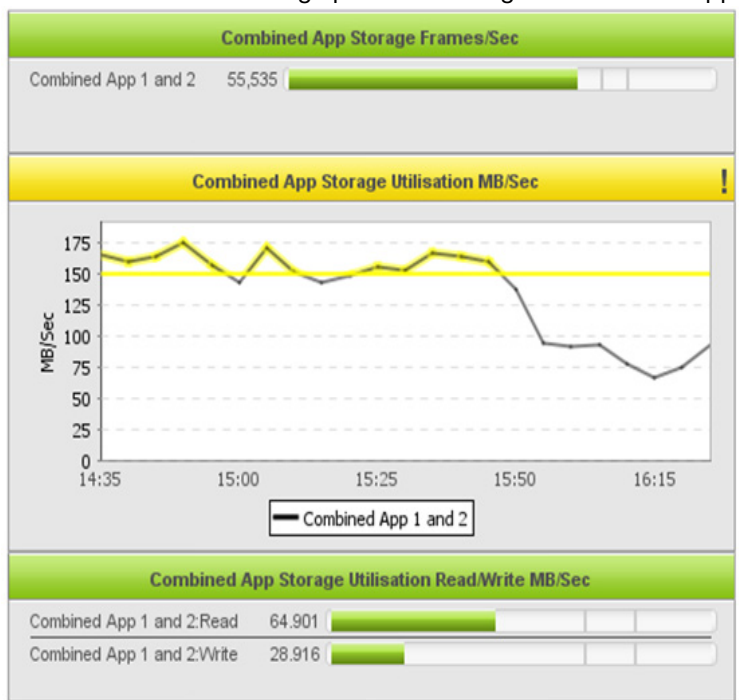
Additionally, it is nearly impossible to hold all SAN variables constant in an effort to identify how configuration changes affect performance. It is difficult to plan and deploy datacenter consolidation due to a lack of meaningful data unless your analysis tools offer a simple way to measure using

“what if” scenarios with actual production data. In the example below, VirtualWisdom shows the potential MB/s effect of a consolidation (what-if) using actual production I/O data.



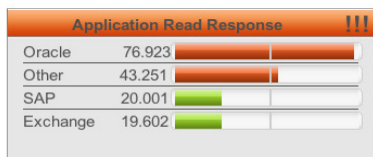
Above, two applications using two different sets of storage ports

Below, combined metrics on storage ports for a merger of those two applications

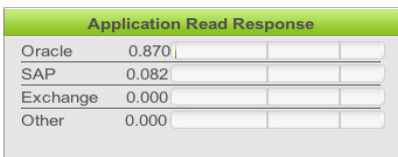


VirtualWisdom dashboard showing “what if” analysis

Finally, a properly instrumented SAN offers real-time guidance. IT staff can baseline the performance before any SAN configuration change and measure after the changes, including queue depths, zoning, LUN mapping, and VSAN modifications.



Response times are base-lined then measured in real-time after consolidation has occurred.



“Before” and “after” VirtualWisdom dashboard widgets, showing effects of a configuration change

## Private Cloud Best Practice

When you look at where people historically focus on system management, it's around capacity and utilization. Server and storage virtualization now make capacity planning relatively easy, shifting the key criteria for success in Cloud Computing to **performance**. When you look at a virtualized or private cloud environment, optimizing CPU and memory only gets you so far. For I/O-intensive applications such as those running OLTP databases, looking only at server-related metrics is simply inadequate. I/O optimization is the key as it is the third leg of the "systems optimization stool".

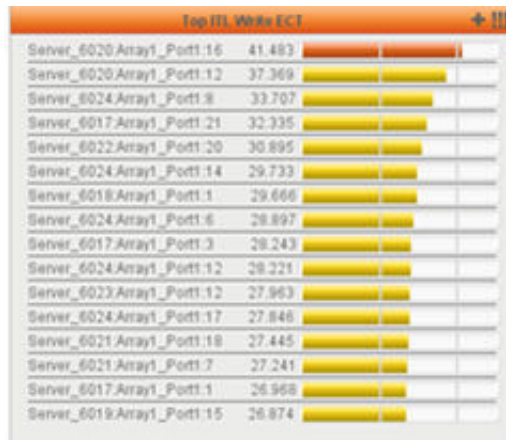
Virtual Instruments' VirtualWisdom solution assesses the entire virtual infrastructure, not just pieces. It provides IT with the data necessary to make intelligent decisions about performance for every layer of the infrastructure, from the server to the storage. What administrators need is a way to see into multiple dimensions of the infrastructure, in real or at least near real-time. They need solutions that deliver the integrated monitoring and analytics required to optimize or troubleshoot private cloud infrastructure performance in real time, and across every involved system. As industry analyst Bernd Harzog recently noted, real-time performance-based analytics, inherent in the Virtual Instruments' VirtualWisdom solution, is the required foundation for building and managing a virtual private cloud infrastructure.

In the VirtualWisdom dashboard widgets below, metrics obtained from the server shows no latency problems. The same servers, with data obtained via VirtualWisdom's hardware probe, clearly shows a problem, allowing the server and storage administrators to see effect of the SAN infrastructure on application performance.



I/O metrics data from the server, at left, shows write latencies in the 20 ms range.

I/O metrics data from VirtualWisdom at right, shows write latencies from those same servers in the 40 ms range, not adequate for most OLTP applications.



“As more companies consider deploying mission-critical applications in a virtualized environment or look into deploying private clouds, it will be imperative for them to have complete real-time visibility into the response times of their virtual and physical IT infrastructure. Without the visibility enabled by solutions such as VirtualWisdom, they will be flying blind, exposing their businesses to needless risk and wasted IT resources.”

**Bernd Harzog**  
*The Virtualization Practice*  
June 2010

VirtualWisdom's hardware monitoring is non-intrusive to the link and to the cloud component. It sees evidence of degraded behavior because it sees and measures everything, not just the upper layers of the stack, and not just what a cloud component tells it. It has a virtually unlimited ability to record and play back transactions. Hardware monitoring is like a CAT scan or MRI, only continuous and in real-time.

## Summary and next steps

The benefits of consolidation are well understood and Virtual Instruments can help by providing best practices around storage and storage networking with an advanced measuring, monitoring, analysis, and optimization solution.

Real-time proactive monitoring, measurement, correlation, and alerting enables high consolidation rates without impacting performance as demands change. It enables a true SLA, and changes in demand and performance can be detected long before users are impacted. With VirtualWisdom's "what if" capabilities, IT staff can provide extremely accurate forecasts by using actual historical data and applying configuration changes to that data. Running reports that show latency and throughput enable the comparison and recommendation of other storage options that balance

utilization and result in faster and less risky consolidation.

We hope you found this paper helpful, and we encourage you to talk with one of our Solutions Architects about your consolidation efforts.

**Additional information:**

Gartner Webinar

[De-risking Applications in your Virtualized Infrastructure](#)

July 2011

APM Experts White paper

[Infrastructure Performance Management for Virtualized Systems](#)

March 2011

Virtual Instruments Webinar

[Reduce Storage Migration Risks - Best Practices for Private Cloud Migration](#)

April 2011

IT Brand Pulse White Paper

[Virtual Instruments: Early Incumbents in the VIO Market](#)

August 19, 2010

Storage Switzerland White Paper

[Optimizing Storage I/O Latency to Maximize VMware Performance](#)

July 2010

Taneja Group White Paper

[Building the Data Center for Infrastructure Visibility](#)


April 2010

Storage Switzerland White Paper

[Maximizing Tiered Stored ROI: Performance-Based Storage Tiering](#)

April 2010

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