

Optimizing the Virtual Infrastructure: Virtual Instruments' VirtualWisdom

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As virtualization is deployed in production, experienced users are demanding production-quality performance management and optimization solutions to maintain service levels. Taneja Group has identified a new category of powerful solutions now emerging to address these demands, which we have labeled Virtual Infrastructure Optimization, or VIO.

VIO solutions extend and enhance element management and capacity planning, activities that are significantly complicated by virtualization. The mobility of virtual machines, and the dynamic nature of the connections they make to other physical and virtual resources in the IT stack, cause new types of contention and capacity problems to emerge. These are not adequately addressed by existing solutions designed for a much more static environment. In particular, storage performance issues are often the Achilles' heel of server virtualization deployments. New configuration, conflict, and contention issues arise that expose the lack of visibility across the server and storage domains. The VIO approach must be cross-domain and focus on the performance of the *entire* virtual infrastructure, including deep insight into the storage (typically SAN) tier.

In this profile we explore the drivers for VIO in depth, establish a set of key capabilities for VIO solutions, and outline the current state of the market segment. We also examine the features and benefits of one leading solution, Virtual Instruments' VirtualWisdom, and present a customer case study that validates the benefits that can be achieved today.

Virtualization Emerges from the Sandbox

Server virtualization has been proven in the development and test sandbox over the last decade, and is now considered production-ready. As enterprises deploy virtual servers into production, however, it is imperative to recognize that design and deployment strategies for production are not the same as they were in the sandbox.

Server consolidation efforts for development and test generally provided users with equivalent or somewhat improved performance, primarily due to the fact that larger, more powerful physical servers were used, shared storage was implemented, and dev/test virtual machines are often idle. Sharing actually led to better service, because the shared resources were often overprovisioned. Server consolidation ratios (enabled primarily by more efficient use of available CPU cycles) were adequate and

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generated enough capital expense reductions to justify some excess capacity in the storage or memory realms. As a result, server virtualization planning efforts to date have mainly been *capacity*-driven. Performance gains as experienced by users are often an artifact, as opposed to having been engineered. Contention, when it occurs, is typically resolved manually by moving a virtual machine or resizing it.

Capacity-only planning and reactive contention management, however, in a virtualized *production* environment, can not only mask potentially serious underlying architectural problems, but can quickly become operationally overwhelming. Early-mover enterprises that have deployed mission-critical applications on virtualized infrastructures have exposed some hidden, complex contention problems. As virtualization breaks out of the sandbox, it demands a new class of performance planning and optimization tools.

Virtually Invisible: What You Can't See Can Hurt You

In IT operations, it's well-known that you can't manage what you can't measure. Moreover, it's equally true that you can't measure what you can't even see. Traditional IT operations have focused on element management: improving visibility of the behavior of servers, switches, storage arrays, network devices, etc. Virtualization changes the game, since these elements are now mobile, dynamically reconfigured, and connected to one another on the fly. The run-time *interaction* of elements becomes as important as their individual operating

profiles. In other words, the complete virtual *infrastructure* becomes the most important element to see, measure, and manage in real-time.

Taneja Group research validates this premise. We find that lack of virtual infrastructure visibility leads a majority of enterprise customers to rely upon initial conditions testing and rules of thumb to estimate proper configurations. Moreover, lack of run-time visibility leads as many as three quarters of VMware customers to limit or disable live motion (VMotion) in production, since they have no way of determining its performance impact. These restrictions not only lessen the benefits of virtualization, but can lead to lower consolidation rates and an increase in the overall cost of virtualized applications.

The proven benefits of virtualization can themselves contribute to this lack of visibility. Virtual machine (VM) dynamic resource scheduling (such as VMware DRS) generally relies on coarse-grained thresholds and can lead to thrashing. Consolidation means that an overloaded host will affect performance of every VM running on it, often catastrophically. Dynamic VM resizing for optimal CPU and memory sharing becomes geometrically more complex with increasing consolidation ratios. And, each added layer of virtualization (server plus storage, for example) introduces new potential for bottlenecks.

Of particular importance is the lack of end-to-end visibility when server virtualization is coupled with storage virtualization. Over 70% of VMware deployments drive the

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implementation of storage virtualization (most often with a Fibre Channel SAN), and performance at the storage tier becomes integral to and inseparable from overall application performance. Storage I/O latencies are greater than server CPU and memory latencies by a factor of 10 to 100, and are therefore much more likely to impact overall infrastructure performance. Also, in many enterprises, storage is managed by a distinct operations team with unique skills and special tools. As a result, there might be adequate element visibility in each of the server and storage domains, but the data are not integrated or correlated, nor is there a clear picture of who “owns” a performance issue. Add to this a complex, multi-vendor storage infrastructure and virtual machine architectures that virtualize the I/O path, and it’s clear that storage optimization is essential.

This lack of ‘server to spindle’ visibility and correlation is more than a theoretical challenge: our research shows that many large enterprises on the forefront of production-level virtualization report issues that, if left unaddressed, threaten to take back the cost savings of server consolidation. Without a cross-domain ability to identify and quickly resolve performance problems, IT departments often purchase additional storage or switch capacity to buy time until the next failure. Without an independent source of correlated performance data, hours are wasted pointing fingers between server and storage teams. Without real-time infrastructure data, operations are always reactive, labor-intensive, and performed under duress. And without a clear picture of the root causes of performance problems,

administrators are less likely to flex the infrastructure or automate management operations.

VIO: A Cross-Domain Solution for Infrastructure Optimization

Virtual Infrastructure Optimization (VIO) is an emerging category of virtualization management solutions designed specifically to address the end-to-end, correlated performance profile of the virtual infrastructure and to support efforts to stabilize and optimize its performance. VIO solutions go beyond capacity planning, which is limited to point-in-time snapshots and rule-of-thumb estimates to size specific tiers of the virtual infrastructure. Capacity planning tools already exist in the storage tier and are emerging in the virtual server tier, but none are cross-domain or incorporate run-time metrics.

Optimization solutions are those that validate and continually verify capacity estimates by collecting, correlating, and presenting run-time performance data from each virtualized tier in the application stack. They address capacity needs at design time, by validating baseline performance assumptions, but they augment and update these at run-time as well, by tracking real performance metrics. In our view, a comprehensive VIO solution must include several key capabilities:

Independence: the solution should be independent of vendor bias within any particular virtualized application tier (server, storage, desktop, etc.) and remain a ‘neutral party’ with respect to problem diagnosis;

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Depth: the solution must provide detailed metrics, both coarse- and fine-grained, and ideally offer multiple levels of depth to suit a wide range of customer needs; it should employ real-time intelligent data management, metadata optimization and historical accuracy;

Breadth: the solution must span multiple virtualization domains and provide integrated, correlated, and composited data that makes performance dependencies clear; it should also integrate easily with existing systems monitoring and management tools and offer a broad range of industry-standard communications interfaces;

Impact: the solution should ideally be out-of-band (OOB), passive, and as non-disruptive and non-impactful as possible; it should offer deployment options that allow customers to incrementally add additional data collection modules as needed – a “pay as you grow” model;

Usability: the solution should present actionable information in the form of a customizable dashboard driven from a unified, configurable data store; it should support decision-making by cross-functional teams;

Scalability: the solution should scale to support the largest enterprises, which may have tens of thousands of servers and tens of petabytes of storage.

Virtual Infrastructure Optimization is a rapidly evolving solution category and as such, includes capabilities from related

categories (existing and/or emerging). There is a clear element of capacity planning in VIO solutions, as they are ideal for developing a performance baseline prior to deployment. While most capacity planning tools address a single virtualized tier, however, VIO solutions are cross-domain. VIO also encompasses Application Service Management (ASM) or Performance Management (APM) capabilities, which focus on optimization from the end-user or transaction perspective. ASM solutions, however, typically rely solely on IP network packet analysis.

In the sections below we will explore Virtual Instruments’ VirtualWisdom, a mature VIO solution that delivers optimization of the server and storage virtualization layers. As we have seen, these are the critical infrastructure components to optimize for many of today’s enterprise production applications. To set the stage for an in-depth look at VirtualWisdom, we’ll first explore a customer case study that validates the aforementioned conclusions.

VIO in Practice: A Case Study

Background: A major US buy-side financial services firm has been an early and aggressive user of server virtualization in its back office environment, continuing a long legacy of technology innovation. The firm employs highly skilled server, storage, and virtualization experts, and over the past two years has been deploying more and more production applications on VMware’s ESX virtual server platform. By mid-2008, SAN response times during peak application loads increased and began to regularly exceed both

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original design goals and acceptable service levels. Storage and server administration teams were unable to agree on the root cause of the performance degradation, so emergency remediation was put in place: additional storage ports were purchased and added (which failed to resolve the problems) and non-production servers were taken off line during peak load times or whenever issues were reported. This was an untenable long-term solution.

Challenges: The firm suspected that VMware VMotion events were the root cause of SAN response time issues, but lacked the tools to verify causality. A cross-functional team was assembled, including management, application, server, storage and storage vendor representatives, but diagnosis was bogged down in finger pointing. As there was no in-depth performance baseline, the team could not agree on whether the SAN issues were caused by the increase in virtual servers or were pre-existing and merely exacerbated by it. The team wrestled with several questions for more than six months:

- What is our optimal virtual server (host) to storage array port fan-out ratio?
- How can we determine optimal storage traffic balance and overhead?
- What is the storage impact per new virtual server?
- How should virtualization impact our I/O path planning?
- How can we pinpoint vendor subsystem configuration problems more quickly?

Solution: The firm deployed VirtualWisdom for one week across the virtual infrastructure, server to storage. Data was collected to

establish baseline metrics, and augmented with on-going run-time data collected during periods of both high and low demand. The VirtualWisdom dashboard was customized to show related data sets on the same screen, and to display server and storage data side by side to highlight correlated events.

Results: By combining baseline data and correlated run-time metrics, the firm was able to quickly validate suspected root causes and discover additional configuration and architectural issues. These included:

- *Overloaded storage processors:* incorrect load-balancing across storage ports;
- *Unnecessary traffic:* as much as 20-30% of traffic during peak loads was being generated by non-critical file system management processes;
- *Storage port configuration issues:* queue depth settings were sub-optimal;
- *Virtual server configuration issues:* improper VMware Host Mode configurations led to incompatibility with VMware's reservation system during VMotion events;
- *Firmware mismatches:* storage firmware version was not correct for use with VMware and there were incompatibilities between edge and core switch firmware versions;
- *Host Bus Adapter issues:* round-robin HBA configuration was causing abnormally high read latencies;

Armed with detailed run-time metrics, the team was able to agree on performance root causes (ending months of 'passing the blame'), identify and validate previously unknown problems, and re-engage

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productively with storage vendors. VirtualWisdom clearly demonstrated the benefits of virtual infrastructure optimization through:

- *Immediate Detection* of VMware configuration problems and storage I/O traffic delays;
- *Deterministic Correlation* of server and storage events with performance degradation;
- *Rapid Diagnosis* of HBA latency causes and extraneous management traffic sources; and
- *Prevention* of storage port overloads and the resulting over-provisioning costs.

VirtualWisdom: SAN I/O Intelligence for the Virtual Infrastructure

With its VirtualWisdom solution, Virtual Instruments combines a strong pedigree in SAN I/O optimization with visibility at the virtual server/cluster/machine level to instrument, measure, analyze and optimize the virtual infrastructure – from end to end. VirtualWisdom is designed to remove the barriers to large-scale virtualization by proactively identifying critical performance bottlenecks anywhere in the application stack, from the virtual server to the storage array. VirtualWisdom is a modular solution and offers:

VirtualWisdom Probes: VirtualWisdom measures three critical points of transaction traffic flow, out-of-band and transparently. ProbeVM (software) collects utilization

status from VMware ESX hosts, clusters and virtual machines via the VMware vCenter API. ProbeV (software) collects data from SAN switches via SNMP. ProbeFCX (hardware) collects detailed Fibre Channel (FC) frame transmissions from the FC link via passive network traffic analysis points, or TAPs. TAPs are regularly used for out-of-band traffic mirroring in IP networks.

ProbeFCX collects, parses, and uploads highly detailed information about 65+ FC metrics to the Portal Server, where the data is aggregated in real-time and composited dynamically with data from vCenter and SNMP. The combined solution delivers a holistic view of system traffic, with no guessing or interpolation required.

VirtualWisdom Views: Real-time report, graph and table views of consolidated and correlated performance data, including more than fifteen predefined event types such as SCSI check condition, extended-link services, and link-up.

VirtualWisdom Dashboard: A real-time summary display showing consolidated overview performance and fault metrics, fed by hardware (ProbeFCX) and software probes (ProbeV, ProbeVM). The dashboard is fully configurable and designed to expedite problem solving through rapid identification of trouble spots.

VirtualWisdom Portal Server: This independent data collection and analysis engine monitors the virtual infrastructure via the installed probes. Device conversations, link metrics, SAN fabric performance data and virtual machine utilization data are

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integrated and coalesced into periodic summaries based on user defined policies.

In our view, VirtualWisdom is a current leader in the VIO segment, based on our analysis of required capabilities:

Independence: VirtualWisdom is developed by an independent vendor with no virtualization or storage offerings and can therefore effectively mediate contention between server and storage administrators and vendors.

Depth: VirtualWisdom collects data from three critical points in the infrastructure: virtual server, storage network, and FC link. Other vendors collect from vCenter and SNMP, but are unable to drill down to the FC transaction level and therefore can only provide a 'host-level view' of latency in the storage I/O path. This significantly limits their ability to build useful correlations and identify root causes.

Breadth: VirtualWisdom spans the virtual server and storage tiers of the virtual infrastructure, which represent the most critical tiers for most production applications being virtualized today. VirtualWisdom also utilizes standard interfaces and integrates with leading management solutions from IBM, Hitachi Data Systems, Symantec, VMware, EMC, and HP.

Impact: VirtualWisdom probes operate completely out-of-band and do not require virtual appliances or other host-based components. This improves accuracy and ensures that the probes themselves have no

impact on infrastructure or application performance.

Usability: VirtualWisdom offers a customizable dashboard and a comprehensive set of reports.

Scalability: VirtualWisdom scales to the largest enterprises as many of its customers have server farms exceeding 10,000 servers and data stores of multiple petabytes.

VirtualWisdom is a young solution, but has already proven its benefits in early deployments at leading enterprises. VirtualWisdom helps:

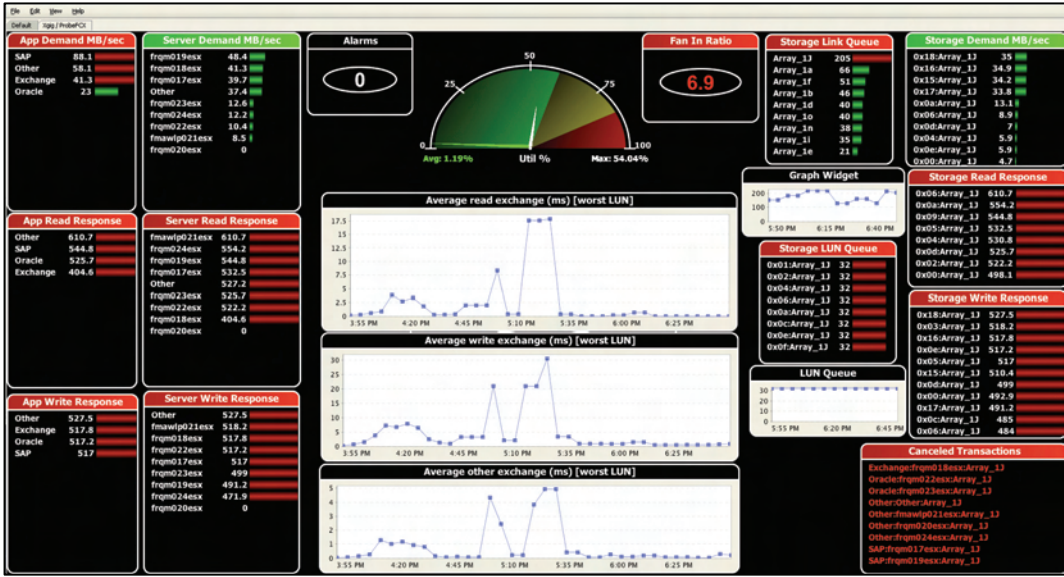
Eliminate Overprovisioning, by determining the true limiting factors in the infrastructure, identifying unused switch capacity and increasing port utilization, avoiding expensive new purchases;

Improve Productivity, enabling cross-domain teams to operate and resolve problems at the 'speed of virtualization,' reducing the number of trouble tickets and avoiding the blame game, thereby lowering operating costs;

Increase Consolidation Ratios, by providing accurate metrics and determining how I/O impacts application performance on virtual machines, lowering the overall cost per virtualized application;

Improve Service Levels, by improving the confidence and response times of administrators, by proactively identifying and alerting them to potential performance bottlenecks.

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The VirtualWisdom Dashboard

Virtual Infrastructure Optimization: The State of the Market

While the optimization market is still evolving, several vendors have begun real-world deployments that promise significant gains for the virtual infrastructure operations team. VirtualWisdom and Akorri’s BalancePoint both focus on the important interaction between the server and storage tiers. In our view, VirtualWisdom provides much deeper insight at the FC transaction level, and this will likely make it a more appropriate solution for mid-size to larger enterprises with significant investments in Fibre Channel SANs. Both vendors take an operations view of performance and stress the storage I/O path.

Also joining the market are vendors who take an end-user or application view of performance, a discipline referred to as application performance (or service) management. We include them in the VIO segment because they are making great progress toward helping map, monitor, and analyze multi-tiered virtualized applications. These solutions focus initially on automated discovery and thereby address the problem of cataloging the interactions between multiple application components when those components are mobile and reconnect to each other dynamically, as is the case with virtual resources. Then, these solutions identify bottlenecks at the IP traffic level and suggest remediation actions. BlueStripe’s FactFinder and VMware’s soon-to-be-released AppSpeed are examples.

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We feel that storage performance optimization is complementary to the user response-time optimization provided by these latter solutions, and taken together, span a wide range of storage and network transaction metrics. We've included below a high-level overview of how a few selected vendors in the VIO space compare, for reference:

Capability	Virtual Instruments VirtualWisdom	Akorri BalancePoint	VMware AppSpeed	BlueStripe FactFinder
Independence	Yes	Yes	VMware-owned	Yes
Depth	SNMP, FC TAP, vCenter. Measures I/O data in real-time.	SNMP, vCenter. Gathers I/O data by scheduled polling.	OOB IP Traffic Analyzer	VM-based IP Traffic Analyzer
Breadth	Server, Storage Integrates with all leading management frameworks	Server, Storage; Integrates with all leading management frameworks	Application, Server	Application, Server
Impact	Storage: OOB Server: OOB	Storage: Host-Based Server: Host-Based	Server: Host- Based Network: OOB	Server: VM-Based Network: VM- Based
Usability	Provides cross-domain actionable information	Provides cross-domain actionable information	Focused on application, not the infrastructure	Focused on application, not the infrastructure
Scalability	Mostly deployed in large enterprise deployments	Mostly deployed in smaller-scale, SMB environments	Unknown	Mostly deployed in smaller-scale, SMB environments

Whether a customer should explore one or more solutions depends on individual challenges. Are your virtual servers wreaking havoc in your SAN or are your consolidation ratios too low? Are you spending too much on additional SAN capacity without the confidence that it will solve your problems? Are you taking advantage of the advanced availability features of your virtual infrastructure? Or have you lost track of where your virtual machines are running and can't respond quickly to user response-time complaints? Whatever your particular virtualization pain points are, there are powerful and comprehensive diagnostic solutions available today that go beyond monitoring and enable new levels of infrastructure optimization.

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