



Total cost of ownership (TCO) of Dell PowerEdge R710 and HP ProLiant DL385 G5 rack server solutions

TCO comparison

Dell Inc. (Dell) commissioned Principled Technologies (PT) to compare the total cost of ownership (TCO) of two rack server solutions, which we list in alphabetical order:

- Dell PowerEdge R710 server
- HP ProLiant DL385 G5 server

TCO includes hardware, support, management software power, cooling, network ports, and data center space. We examined the TCO of these rack server solutions at acquisition and at 1, 3, and 5 years. We compared costs by rack and by server.

KEY FINDING

- In TCO comparisons by rack and by server, the Dell™ PowerEdge™ R710 server solution had a lower TCO and yielded significant savings over the HP ProLiant DL385 G5 server solution.¹
- Dell's lower cost for management software for the Dell™ PowerEdge™ R710 server solution contributes significantly to Dell's cost savings over the HP ProLiant DL385 G5 server solution.

We also factored into our analysis the results of performance tests of these solutions that we detail in two other reports on these rack server solutions.²

Dell TCO savings per rack and server

Figures 1 and 2 estimate acquisition costs and 1-, 3-, and 5-year TCO for similar configurations of each solution.

	Savings per rack	
	Dell over HP	
Acquisition costs	\$70,350	21%
TCO for 1 year	\$71,778	21%
TCO for 3 years	\$74,634	20%
TCO for 5 years	\$91,518	20%

Figure 1: Dell offers significant savings per rack over HP in acquisition costs and 1-, 3-, and 5-year TCO.

	Savings per server	
	Dell over HP	
Acquisition costs	\$3,350	21%
TCO for 1 year	\$3,418	21%
TCO for 3 years	\$3,554	20%
TCO for 5 years	\$4,358	20%

Figure 2: Dell offers significant savings per server over HP in acquisition costs and 1-, 3-, and 5-year TCO.

We based our choice of rack server configurations for the TCO analysis on the configurations we tested for the two performance reports. Those reports compare benchmark performance and power utilization for the two server solutions using virtualized Exchange and virtualized OLTP workload performance tests run on a single server paired with a storage solution. For those tests, we paired the HP server with HP EVA 4400 storage and the Dell server with Dell EqualLogic storage. To obtain the best performance from the HP StorageWorks, we connected it to the server via Fibre Channel. To obtain the best performance from the Dell EqualLogic, we connected it to the server via iSCSI. While we do not include the costs of the storage in this TCO comparison, we do include the costs of the Fibre Channel and iSCSI connections.

We adjust the configurations used in the performance analyses to include a full rack of servers. We assume the storage arrays are already in place and do not include their costs. Figure 3 summarizes the configurations used for this TCO analysis.

¹ TCO includes hardware, support, management software, IO virtualization, power, cooling, network ports, and data center space.

² [Virtualized OLTP workload performance comparison of end-to-end solutions: Dell PowerEdge R710 with Dell EqualLogic storage vs. HP ProLiant BL385c G5 with HP StorageWorks EVA 4400 storage and Virtualized Exchange workload performance comparison of end-to-end solutions: Dell PowerEdge R710 with Dell EqualLogic storage vs. HP ProLiant BL385c G5 with HP StorageWorks EVA 4400.](#)

Configurations		
	Dell	HP
21 servers	Each server included two 2.4GHz Intel Xeon E5530 processors, two 72GB 15,000 RPM disk drives, 72 GB (6x8 GB plus 6x4GB) RAM, two Broadcom 5709s dual port Gigabit Ethernet controllers, and one 2 PCIE X8+2 riser card.	Each server included two 2.7GHz Quad-Core AMD Opteron™ Processors Model 2384, two 72GB 15,000 RPM disk drives, two Broadcom 5709s dual port Gigabit Ethernet controllers, 64 GB (8x8 GB) RAM, and one QLogic SANBlade QMH2462 4Gb PCIe x4 dual port LC FC HBA.
Management software	We included Dell Open Manage, which Dell includes at no additional cost with server.	We included costs for HP c-Class Insight Control Environment licenses for each.

Figure 3: Comparison configurations.

The Dell PowerEdge R710 solution had two 2.4GHz Intel Xeon E5530 processors and 72 GB of RAM while the HP ProLiant DL385 G5 solution had two 2.7GHz AMD Opteron 2384 processors and 64 GB of RAM.

The difference in the quantity and speed of RAM in the systems was due to the difference in system architectures and was not a factor in performance in our performance comparisons as each virtual machine (VM) was limited to 4 GB of RAM and we tested with at most 11VMs.

We provide the details that support this TCO analysis in Appendix A.

Another perspective on TCO: Performance equivalents

An enterprise seeking a solution that will deliver a desired level of performance may size its server solutions to meet that goal. This sizing process can result in solutions that vary greatly in size, complexity, and cost. Because the solution with the highest-performing servers requires the fewest servers and racks, it also costs the least for space, power, and cooling, and it thus requires fewer management software licenses and support agreements.

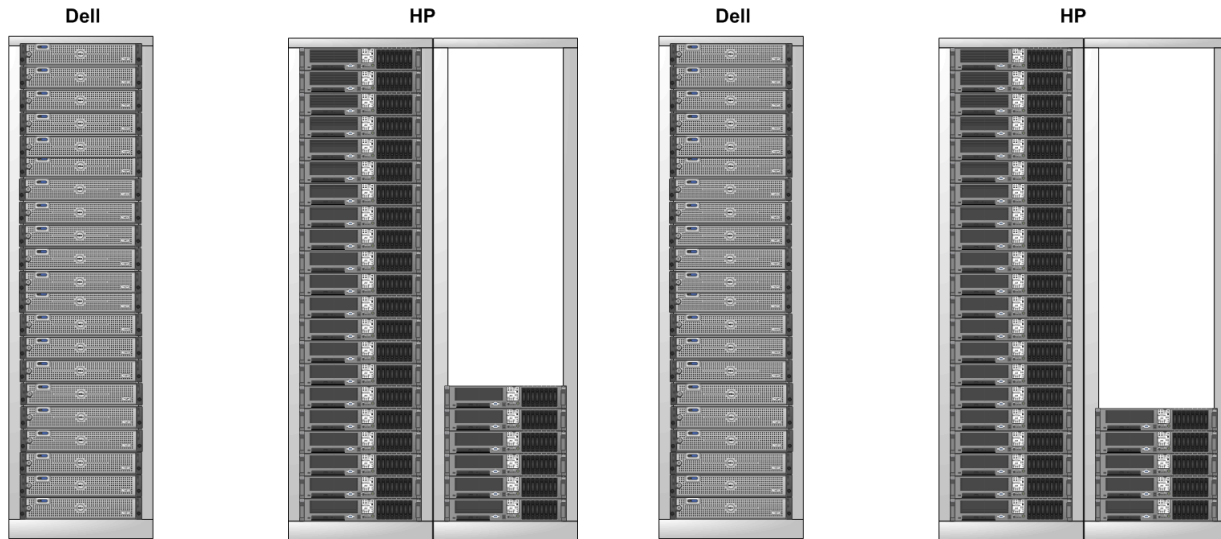
This section examines TCO from the perspective of configurations that deliver comparable performance. We used our benchmark results from the two performance analysis studies we cited earlier to estimate the size of the HP solution that would deliver performance equal to a single rack of the Dell solution.

At peak load of Microsoft Exchange LoadGen 2007, each server in the Dell solution delivered 25 percent greater performance than the HP solution.³ At peak load of the DVD Store Version 2 (DS2) test tool that we used to gauge OLTP performance, each server in the Dell solution delivered 22.5 percent greater performance than the HP solution.⁴ These differences in scores translate into a significant difference in the number of individual servers a company needs to achieve comparable performance. The difference thus also accounts for major differences in overall configuration size and cost.

Each configuration includes one rack filled to maximum server capacity, i.e., 21 servers. For the HP solution, we also added the additional servers it needed to be able to match the performance of the single Dell rack. We rounded our results up to the nearest server. We base the performance-equivalent configurations in Figure 4 on the 25 percent performance difference for the Exchange workload performance. We base the performance-equivalent configurations shown in Figure 5 on the 22.5 percent difference for the OLTP workload performance.

³ [Virtualized Exchange workload performance comparison of end-to-end solutions: Dell PowerEdge R710 with Dell EqualLogic storage vs. HP ProLiant BL385c G5 with HP StorageWorks EVA 4400.](#)

⁴ [Virtualized OLTP workload performance comparison of end-to-end solutions: Dell PowerEdge R710 with Dell EqualLogic storage vs. HP ProLiant BL385c G5 with HP StorageWorks EVA 4400 storage.](#)



21 Dell servers in one rack = 27 HP servers in two racks

21 Dell servers in one rack = 26 HP servers in two racks

Figure 4: Estimated size of solutions needed to deliver the performance equivalent of one rack of the Dell solution. We base estimates on ratios of the results of our virtualized Exchange workload performance tests, which we conducted using single servers. Smaller solutions are better.

Figure 5: Estimated size of solutions needed to deliver the performance equivalent of one rack of the Dell solution. We base estimates on ratios of the results of our virtualized OLTP workload performance tests, which we conducted using single servers. Smaller solutions are better. The performance equivalent HP configuration based on this OLTP comparison has one fewer server than the Exchange workload-based performance-equivalent comparison.

As Figures 6 and 7 show, the HP solution that delivers performance equivalent to one rack of the Dell servers has a significantly higher TCO than the Dell solution.

	Savings over Exchange workload-based performance-equivalent configurations	
	Dell over HP	
Acquisition costs	\$164,901	39%
TCO for 1 year	\$170,909	38%
TCO for 3 years	\$182,925	38%
TCO for 5 years	\$222,271	38%

Figure 6: Dell offers significant savings over performance-equivalent configurations from HP in acquisition costs and 1-, 3-, and 5-year TCO. We base costs on the costs of a rack of Dell servers and a performance-equivalent number of HP servers. We base estimates on ratios of the results of our virtualized Exchange workload performance tests.

	Savings over OLTP workload-based performance-equivalent configurations	
	Dell over HP	
Acquisition costs	\$149,142	36%
TCO for 1 year	\$154,387	36%
TCO for 3 years	\$164,876	35%
TCO for 5 years	\$200,479	35%

Figure 7: Dell offers significant savings over performance-equivalent configurations from HP in acquisition costs and 1-, 3-, and 5-year TCO. We base costs on the costs of a rack of Dell servers and a performance-equivalent number of HP servers. We base estimates on ratios of the results of our virtualized OLTP performance tests.

We provide details of this analysis in Appendix B.

Summary

We calculated the total cost of ownership (TCO) for the Dell PowerEdge R710 and the HP ProLiant DL385 G5. Our 1-, 3-, and 5-year TCO estimates included costs for hardware, support, management software, power, cooling, data center costs, and out-of-box setup.

We provided TCO comparisons using two methods of sizing solutions. Both use one rack of Dell servers as the basis of comparison:

- Same quantity – The first comparison compares one full rack of 21 servers for each solution. This comparison provides views of per-rack and per-server TCO.
- Same performance – The second comparison uses performance scores to size the HP solution so that it has the number of servers that would provide the same performance as one rack of Dell servers. In this case, the number of HP servers was 26 for the OLTP workload-based comparison and 27 for the Exchange workload-based comparison.

In our comparison, the Dell PowerEdge R710 rack server solution had the lowest TCO and thus delivered significant savings over the HP ProLiant DL385 G5 rack server solution.

Appendix A – TCO details for per rack and per server TCO

Our TCO analysis focuses on four key categories that vary among the rack server solutions and for which we can provide test results or other hard data:

- rack and server hardware and server support costs
- costs for system management software
- facilities costs, including per-rack space costs, power costs, cooling costs, and Ethernet costs
- costs for out-of-box setup

We base extrapolate out-of-box setup costs based on our hands-on comparisons of server solutions. Other cost data comes from vendor quotes or our experience.

Figure 8 shows the costs for a full rack of servers. We divide those costs by 21, the number of servers in a rack, to get the per-server costs we present in the body of this paper.

Acquisition costs include the costs to purchase the servers and racks, as well as the one-time setup costs. The 1-, 3-, and 5-year costs include the acquisition costs, support costs, plus annual facilities costs. Facilities costs include rack costs that reflect rack footprint, including clearances, power and cooling, and Ethernet and Fibre channel port costs.

	Dell	HP
Acquisition costs		
Hardware and support	\$260,473	\$319,294
Management software	\$0	\$11,529
Out-of-box setup	\$105	\$105
Acquisition cost total	\$260,578	\$330,928
1-year costs		
Facilities costs	\$14,602	\$16,030
1-year total (includes acquisition costs)	\$275,180	\$346,958
3-year costs		
Facilities costs	\$43,806	\$48,090
3-year total (includes acquisition costs)	\$304,384	\$379,018
5-year costs		
Facilities costs	\$73,010	\$80,150
Server support costs	\$32,529	\$46,557
5-year total (includes acquisition costs)	\$366,117	\$457,635

Figure 8: Per-rack TCO for hardware, support, management software, facility, and setup, organized by acquisition costs and 1-, 3-, and 5-year costs.

To calculate TCO for full racks and individual servers, we made the following assumptions about the target business environment:

- The data center has management servers in place that administrators could use to deploy management software.
- The data center fills racks to capacity and has adequate power and cooling capacity for those full racks.
- The Dell EqualLogic storage or the HP StorageWorks EVA 4400 storage solution is in place and is not a part of this cost analysis.

The rest of this section describes the individual cost categories and the cost assumptions we made specific to each of them.

Cost categories

Hardware and support costs

We configured and got cost data for the rack servers from the Dell Web site and from vendor Web sites. We used list prices for all systems, because discounts vary by buyer and by vendor; this approach provides the most level playing field possible for our comparison.

The acquisition costs include 3-year support for the servers. Our 5-year TCO includes additional costs for 5-year support.

We calculated support costs based on 24-hour-a-day, 7-day-a-week hardware support agreements with a 4-hour response time. Under these agreements, the vendor, not the data center staff, does the majority of hardware maintenance. We did not include any additional maintenance costs.

Our prices for the Dell solution include non-mission-critical support available 24 hours a day and 7 days a week with a 4-hour response time. Dell offers a higher-cost mission-critical support that provides additional coverage. The Dell non-mission critical support is a closer match to the support with 24-hour-a-day, 7-day-a-week service with a 4-hour response time that is available from the other vendors.

We included no operating system or application software costs in our analysis, because these costs would vary widely among enterprises.

Management software costs

We include costs available on each vendor's Web site for standard management software. We added the Altiris Deployment Solution to the Dell management solution, because it is a typical add-on to the standard management package. We priced the following management software:

- Dell Open Manage plus Altiris Deployment Solution for Servers for the Dell solution
- HP Insight Control Environment system management software for the HP solution, which includes Rapid Deployment Pack

To avoid having to estimate future software costs, we assumed buyers would purchase the software as a one-time cost and would not pay for software upgrades during the solution's 3-to-5-year life cycle.

Facilities costs

We include costs for space, power, and cooling. We use power consumption data from the two performance white papers we cited earlier.

Our power measurements in the performance studies included a single server. We multiply those results by 21, the number of servers in a rack, to get power measurements for a full rack of servers..

We made the following assumptions about facilities costs:

- The rack servers are busy one-third of the time and idle the remaining time, and they run all day, every day. We use power measurements we took during periods of peak performance on benchmark tests to estimate costs for the busy periods and power measurements we took while the servers were idle to estimate costs during idle times.
- For each dollar the business spends on electricity for server power, it spends an additional dollar on power to cool the server and to power auxiliary equipment.⁵ Data centers may have different proportions of these costs because cooling efficiency and technology, rack densities, and other factors affect cooling costs.

⁵Estimating Total Power Consumption by Servers in the U.S. and the World, Jonathan G. Koomey, PhD, February 15, 2007 (<http://enterprise.amd.com/Downloads/svrpwrusecompletefinal.pdf>)

- The data center costs for power and cooling are \$0.11 per KWh. We base this estimate on the Department of Energy's data⁶ on average commercial charges for October 2008, of \$0.1049; we have rounded up this rate because of rising costs and because data centers are often in regions and cities with above-average rates.
- The data center costs \$910 per rack per year for data center space. We based this on a cost of \$65 per square foot per year for data center space and an average of 14 square feet per rack, including both the space the rack occupies and the necessary clearances around it.

We include Ethernet and Fibre channel switch costs in our data center costs. These costs, which include switches, cables, support, and service, can be significant. We calculate switch acquisition costs based on the costs of switches divided by the number of supported ports and include an estimate of annual costs for the switches.

Out-of-box setup costs

To conduct the database and Microsoft Exchange performance tests that we report in the performance reports, we acquired a single server for each solution. To get out-of-box setup costs, we estimated the amount of time it takes to unbox individual servers and install them in a rack. We calculated the setup costs based on a \$100-per-hour cost. Vendors or third-party suppliers offer a range of deployment services for a fee that are an alternative to these out-of-box setup costs. We do not include time to setup software on the servers in our out-of-box-setup costs.

⁶ Energy Information Association: Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, by State
http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_a.html

Appendix B – TCO details for performance-equivalent TCO

The solutions from different vendors or product lines that deliver comparable performance vary in size, complexity, and cost.

For our performance measure, we used results from March 2009 of virtualized Exchange workload performance testing with Microsoft Exchange LoadGen 2007 and virtualized OLTP workload performance testing with DVD Store Version 2.

For the virtualized Exchange workload testing,⁷ we used Microsoft Exchange LoadGen 2007, a Microsoft-provided tool for benchmarking an Exchange Mail Server. We defined the peak number of VMs per server as the maximum number of concurrent VMs under load where each VM had acceptable performance.

The Dell PowerEdge R710 ran 10 such simultaneous VMs, while the HP ProLiant DL385 G5 ran eight such simultaneous VMs. Each VM contained 4,000 users, for a total of 40,000 users on the Dell PowerEdge R710 and 32,000 users on the HP ProLiant DL385 G5. Thus, the Dell PowerEdge R710 solution had a 25 percent performance advantage over the HP ProLiant DL385 G5 solution.

Figure 9 summarizes our results for tests with a single server running virtualized email services; see the original report for the detailed results VMware requires.

Dell	HP
10	8
<i>The Dell score was 25% percent better than the HP score.⁸</i>	

Figure 9: Peak number of virtual machines running the virtualized Exchange performance testing workloads that each server ran with acceptable performance. Higher numbers of VMs are better.

For the virtualized OLTP performance testing,⁹ we used the DVD Store Version 2 (DS2) test tool. DS2 is an open-source simulation of an online e-commerce DVD store, where customers log in, browse, and order products. Each server under test ran multiple Microsoft SQL Server 2008 workloads, one per VM. Our testing goal was to find the peak number of virtual machines running the database workload that each server ran with acceptable performance. The Dell PowerEdge R710 ran 11 such simultaneous VMs, while the ProLiant DL385c G5 ran nine such simultaneous VMs. Thus, the Dell PowerEdge R710 solution had a 22.2 percent performance advantage over the HP ProLiant DL385 G5 solution. (For more details about the DS2 tool, see <http://www.delltechcenter.com/page/DVD+Store.>)

Figure 10 summarizes our results for tests with a single server running virtualized OLTP software; see the original reports for the detailed results VMware requires.

Dell	HP
11	9
<i>The Dell score was 22.2% percent better than the HP score.¹⁰</i>	

Figure 10: Peak number of virtual machines running the virtualized OLTP performance testing workloads that each server ran with acceptable performance. Higher numbers of VMs are better.

⁷ For more information about these tests, see [Virtualized Exchange workload performance comparison of end-to-end solutions: Dell PowerEdge R710 with Dell EqualLogic storage vs. HP ProLiant BL385c G5 with HP StorageWorks EVA 4400.](#)

⁸ *Ibid.*

⁹ For more information about these tests, see [Virtualized OLTP workload performance comparison of end-to-end solutions: Dell PowerEdge R710 with Dell EqualLogic storage vs. HP ProLiant BL385c G5 with HP StorageWorks EVA 4400 storage.](#)

¹⁰ *Ibid.*

This difference in VMs translates into a significant difference in the number of individual servers a company needs to achieve comparable performance and in overall configuration size and cost.

We used our percentage comparisons of the performance testing results to estimate the number of servers each solution would require to deliver comparable performance. We used a full rack of Dell servers as the basis for our comparison. Because the Dell score on the virtualized Exchange performance testing workload was 25 percent better than the HP score, our performance-equivalent comparison for that benchmark included 25 percent more servers for the HP solution. We rounded our results up to the nearest server and show those results in Figure 11.

Dell	HP
21 servers	27 servers
<i>25% percent more HP servers than Dell servers.¹¹</i>	

Figure 11: Estimated size of the HP solution needed to deliver performance equivalent to one rack of the Dell solution. We base estimates on ratios of the results of our Microsoft Exchange LoadGen 2007 virtual machine results for the virtualized Exchange performance testing, which we conducted using a single server.

Because the Dell score on the virtualized OLTP performance testing workload was 22.2 percent better than the HP score, our performance-equivalent comparison for that benchmark included 22.2 percent more servers for the HP solution. We rounded our results up to the nearest server and show those results in Figure 12.

Dell	HP
21 servers	26 servers
<i>22.2% percent more HP servers than Dell servers.¹²</i>	

Figure 12: Estimated size of the HP solution needed to deliver performance equivalent to one rack of the Dell solution. We base estimates on ratios of the results of our DS2 virtual machine results for the virtualized OLTP performance testing, which we conducted using a single server. We rounded up the fractional result and present the result as whole numbers of servers.

We used our average TCO-per-server values from Appendix A to estimate the TCO for the server counts we show in Figures 11 and 12. As Figures 13 and 14 show, the HP solution delivering equivalent performance to one rack of the Dell servers costs significantly more than the Dell solution.

¹¹ [Virtualized Exchange workload performance comparison of end-to-end solutions: Dell PowerEdge R710 with Dell EqualLogic storage vs. HP ProLiant BL385c G5 with HP StorageWorks EVA 4400.](#)

¹² [Virtualized OLTP workload performance comparison of end-to-end solutions: Dell PowerEdge R710 with Dell EqualLogic storage vs. HP ProLiant BL385c G5 with HP StorageWorks EVA 4400 storage.](#)

Costs based on Exchange workload-based performance-equivalent configurations		
	Dell	HP
Acquisition costs		
Hardware and support	\$260,473	\$410,521
Management software	\$0	\$14,823
Out-of-box setup	\$105	\$135
Acquisition cost total	\$260,578	\$425,479
1-year costs		
Facilities costs	\$14,602	\$20,610
1-year total (includes acquisition costs)	\$275,180	\$446,089
3-year costs		
Facilities costs	\$43,806	\$61,830
3-year total (includes acquisition costs)	\$304,384	\$487,309
5-year costs		
Facilities costs	\$73,010	\$103,050
Server support costs	\$32,529	\$59,859
5-year total (includes acquisition costs)	\$366,117	\$588,388

Figure 13: TCO for performance-equivalent configurations with costs for hardware, support, management software, facility, and setup organized by acquisition costs and 1-, 3-, and 5-year costs. Rack costs are for configurations that have the Exchange workload-based performance equivalence of 21 servers, the number in the Dell solution.

Costs based on OLTP workload-based performance-equivalent configurations		
	Dell	HP
Acquisition costs		
Hardware and support	\$260,473	\$395,316
Management software	\$0	\$14,274
Out-of-box setup	\$105	\$130
Acquisition cost total	\$260,578	\$409,720
1-year costs		
Facilities costs	\$14,602	\$19,847
1-year total (includes acquisition costs)	\$275,180	\$429,567
3-year costs		
Facilities costs	\$43,806	\$59,540
3-year total (includes acquisition costs)	\$304,384	\$469,260
5-year costs		
Facilities costs	\$73,010	\$99,233
Server support costs	\$32,529	\$57,642
5-year total (includes acquisition costs)	\$366,117	\$566,596

Figure 14: TCO for performance-equivalent configurations with costs for hardware, support, management software, facility, and setup organized by acquisition costs and 1-, 3-, and 5-year costs. Rack costs are for configurations that have the OLTP workload-based performance equivalence of 21 servers, the number in the Dell solution.

About Principled Technologies

We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools. When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help you assess how it will fare against its competition, its performance, whether it's ready to go to market, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.



Principled Technologies, Inc.
1007 Slater Road, Suite 250
Durham, NC 27703
www.principledtechnologies.com
info@principledtechnologies.com

Principled Technologies is a registered trademark of Principled Technologies, Inc.
All other product names are the trademarks of their respective owners

Disclaimer of Warranties; Limitation of Liability:

PRINCIPLED TECHNOLOGIES, INC. HAS MADE REASONABLE EFFORTS TO ENSURE THE ACCURACY AND VALIDITY OF ITS TESTING, HOWEVER, PRINCIPLED TECHNOLOGIES, INC. SPECIFICALLY DISCLAIMS ANY WARRANTY, EXPRESSED OR IMPLIED, RELATING TO THE TEST RESULTS AND ANALYSIS, THEIR ACCURACY, COMPLETENESS OR QUALITY, INCLUDING ANY IMPLIED WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE. ALL PERSONS OR ENTITIES RELYING ON THE RESULTS OF ANY TESTING DO SO AT THEIR OWN RISK, AND AGREE THAT PRINCIPLED TECHNOLOGIES, INC., ITS EMPLOYEES AND ITS SUBCONTRACTORS SHALL HAVE NO LIABILITY WHATSOEVER FROM ANY CLAIM OF LOSS OR DAMAGE ON ACCOUNT OF ANY ALLEGED ERROR OR DEFECT IN ANY TESTING PROCEDURE OR RESULT.

IN NO EVENT SHALL PRINCIPLED TECHNOLOGIES, INC. BE LIABLE FOR INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH ITS TESTING, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. IN NO EVENT SHALL PRINCIPLED TECHNOLOGIES, INC.'S LIABILITY, INCLUDING FOR DIRECT DAMAGES, EXCEED THE AMOUNTS PAID IN CONNECTION WITH PRINCIPLED TECHNOLOGIES, INC.'S TESTING. CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES ARE AS SET FORTH HEREIN.