

A COMPARISON OF ORACLE PERFORMANCE ON PHYSICAL AND VMWARE SERVERS



INTRODUCTION

Of all the tier one applications in the data center, Oracle databases are among the last to reap the benefits of movement from physical to virtual servers. A primary reason for the very cautious migration to virtual systems is the uncertainty regarding database performance of Oracle on a virtual machine. But does Oracle perform differently on a virtual platform such as VMware? More practically, how does the performance differ, and are there ways that a DBA can monitor operation to ensure that Oracle is maintaining efficient throughput on VMware?

To evaluate any difference in Oracle operation between physical and VMware servers, a direct head-to-head comparison of transaction performance was conducted using both scenarios at separate times on the same physical server. By illustrating how a DBA can visualize the response time, query throughput, and server resources utilized in both scenarios, this paper demonstrates how a DBA team can effectively monitor Oracle on VMware to ensure continued performance. In addition, the data captured here demonstrates that Oracle performance was essentially unchanged for this application when moving from a physical to VMware server configuration.

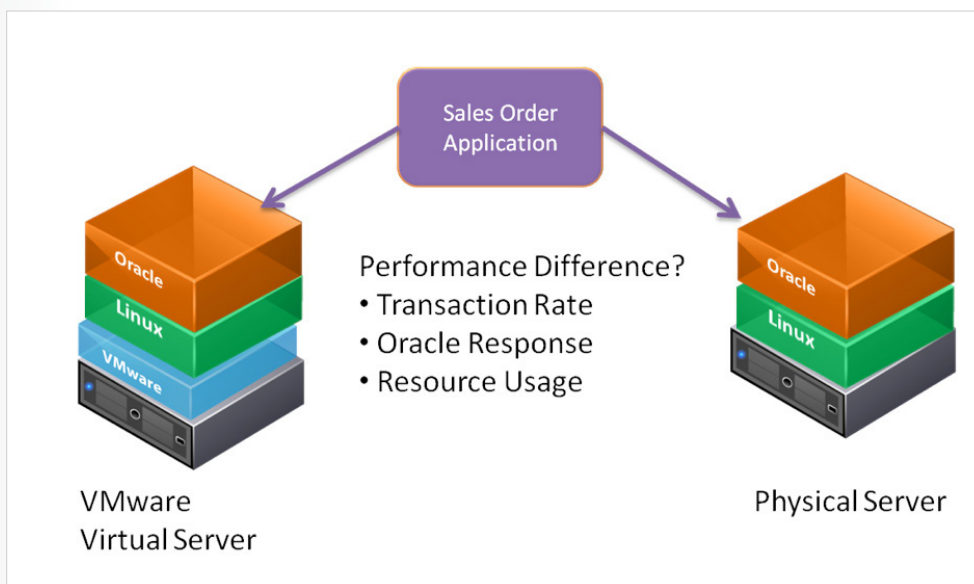


Figure 1: Head-to-head performance evaluation

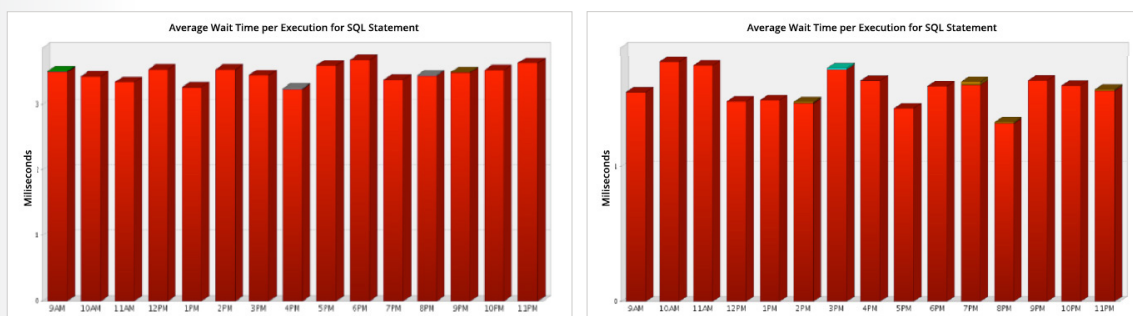
TEST SCENARIO

A transaction application, simulating order entry operations, was configured on a dedicated testbed to utilize an Oracle 11g Enterprise Edition database installed a Dell quad core Xeon server (see Appendix A for details). Over a period of days the test transactions were continuously run on the physical server while the application suite and database were tuned to deliver production quality performance. Significant adjustments to Oracle buffer configuration, transaction rates, numbers of concurrent sessions, and storage configuration were required before achieving steady state production caliber Oracle operation on the physical server. Once acceptable performance and throughput was achieved, the physical server tests ran for a 24 hour period. **SolarWinds Database Performance Analyzer (DPA)** was used to monitor database and server response.

After completing the physical tests, VMware ESX i 4.1 was installed on the same Xeon server and Oracle 11g re-installed. Four vCPUs were configured on the four core system, using only a single guest VM on the host. The same Oracle configurations that supported the physical server tests were used on the virtual server installation, and the identical test suite of transactions and sessions was launched from the same testbed as used originally. DPA with VM option was used to capture the database performance across all sessions during the complete test run.

RESULTS SUMMARY

Performance and throughput results, as experienced by the order entry application, were essentially identical for the Oracle database on the physical and VMware servers. DPA with VM Option focuses on application response time, the most important performance measure. It illustrated identical throughput of 50 transactions per second, and negligible differences in response time for the highest volume queries, with the VM actually running faster at less than 2ms per execution vs. 3ms for the physical server.



Physical server—average execution 3 ms

Virtual Server—average execution < 2ms

Figure 2: Response time comparison for high volume “Select” query (layout side by side)

Importantly, the total resource wait time for both databases was consistent, indicating that Oracle was operating efficiently and not encountering any different bottlenecks on the different servers.



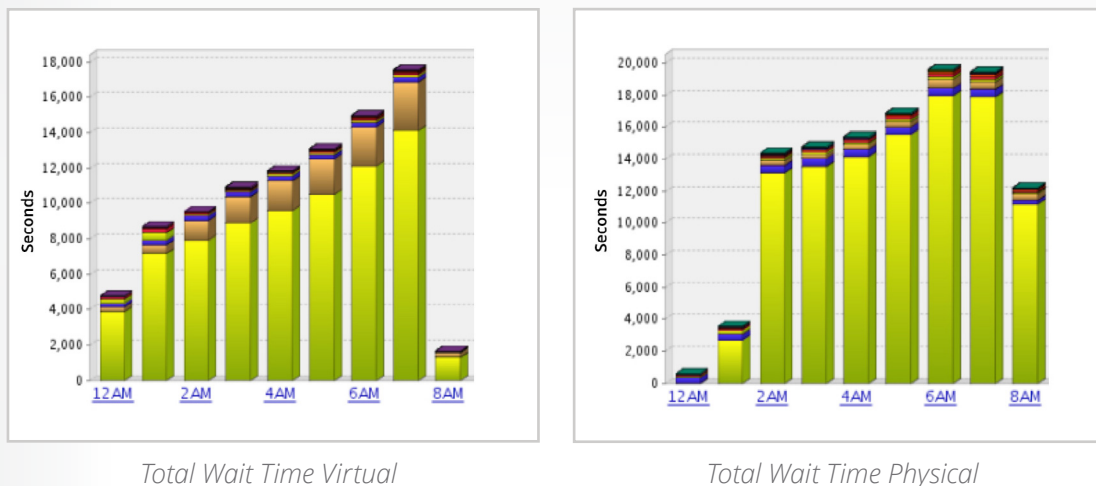


Figure 3: Total Wait Time Virtual vs. Total Wait Time Physical

The charts above give a high level picture of Oracle database response based on total resource waiting during the peak test periods. Both P and V servers rise to the level of approximately 16,000 seconds / hour of total waiting across all sessions, with the vast majority accumulating in the same query. While there are subtle differences that a DBA can drill into, and which will be investigated here, the high level conclusion from a manager concerned about changes in performance on this application is that the application is performing the same, if not slightly better, on the virtual server.

DETAILED COMPARISONS OF SERVER, THROUGHPUT AND DATABASE OPERATIONS

As described above, both servers deliver comparable results in terms of application query response time and total resource loading. DPA was used to illustrate and analyze the differences in greater depth.

An important indicator is which queries are consuming database resources. As shown in below, the Select Line Item query is by far the heaviest consumer, and dominates the wait time on both servers. One slight difference was a significant accumulation of Commit time on the VM, with the server waiting on Log file sync I/O operations. This was not present on the physical server at the same level. However the VM server was not burdened by the buildup of log file sync operations, and managed to maintain processing of the Select query at an uninterrupted rate. Other queries, such as Select Product Inventories, were far lower in resource usage, by a factor of nearly 50X. DPA notes that while there were other queries with high execution counts, no other queries have performance impact when studying the response of this application, and these are listed with informational, not warning level status.



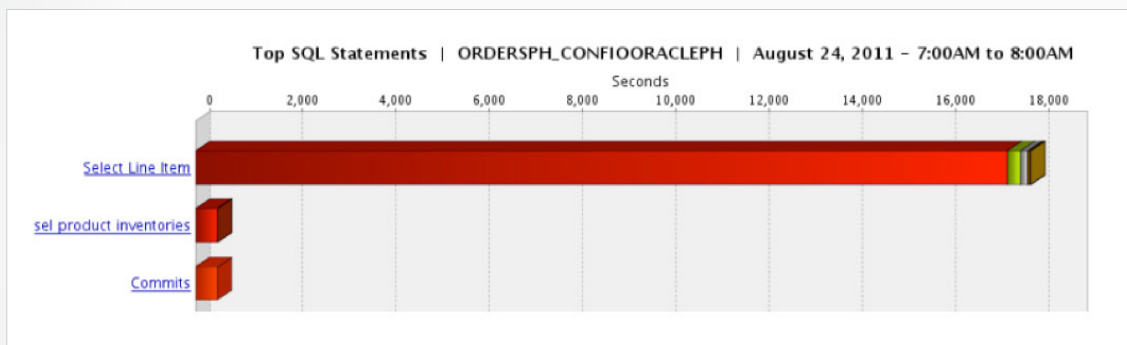


Figure 4: Top SQL chart shows only one dominant query—physical server

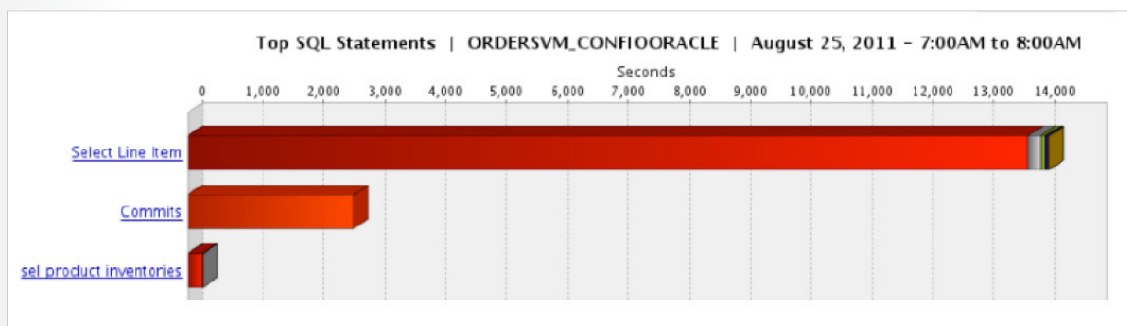


Figure 5: Top SQL Chart shows dominant query plus I/O sync wait time—virtual server

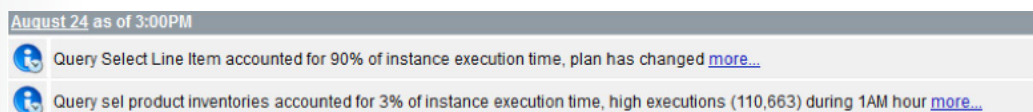


Figure 6: Physical server—90% of wait time in one query

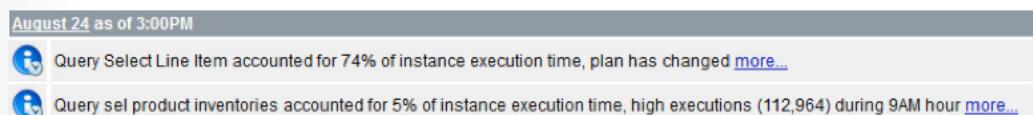


Figure 7: Virtual Server – Slightly lower concentration, 74% in dominant query

CORRELATING QUERY RESPONSE WITH SERVER PERFORMANCE

DPA captures physical server operation, and on the virtual server shows both resource usage within the guest virtual machine as well as actual resources on the physical host underlying the VM. By comparing server operations to actual available physical resources, the DBA can study the efficiency of the application on both physical and virtual platforms.

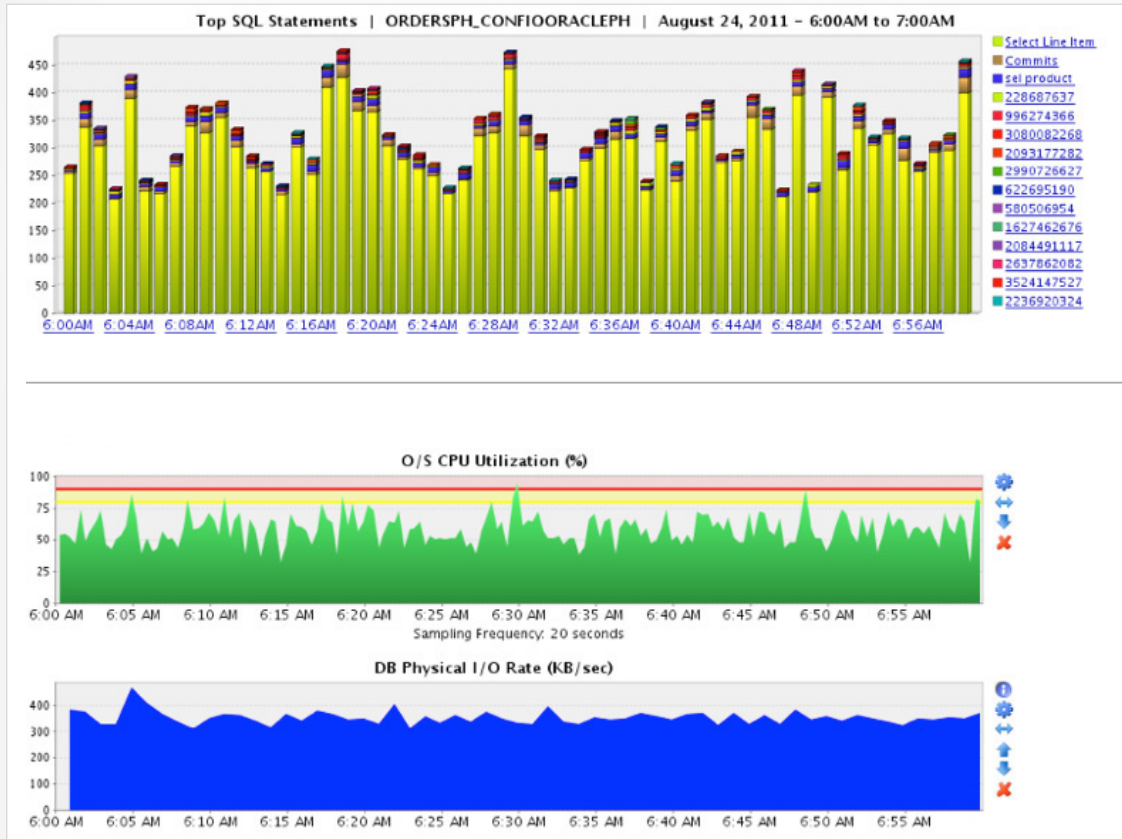


Figure 8: The relationship between query response, at one minute intervals

The layer diagram above illustrates the relationship between query response, at one minute intervals, on the physical server. Two key server capacity indicators are O/S CPU utilization and database physical I/O rate. In this case, CPU remains near 50%, with peaks just touching the warning level of 75% for very short periods. I/O is steady at 350KB/sec. This appears to be a properly sized application for Oracle on the physical server.

On the VM, analysis is typically more challenging, because standard database tools see only the assigned VM resources, which are not equivalent to actual available physical resources. DPA with VM Option shows both, giving an accurate picture of how the database is really performing on both the physical and virtual layers.

The layer diagram illustrates the CPU performance of the database averaging 65%, VM CPU utilization of the 4 virtual CPU at approximately 75%, and the host server CPU at just above 75% and spiking up to the 80% warning range. While performance metrics are different for each point of measurement, they remain consistent and comparable to the physical server, with only a slightly higher CPU introduced by the VMware layer.

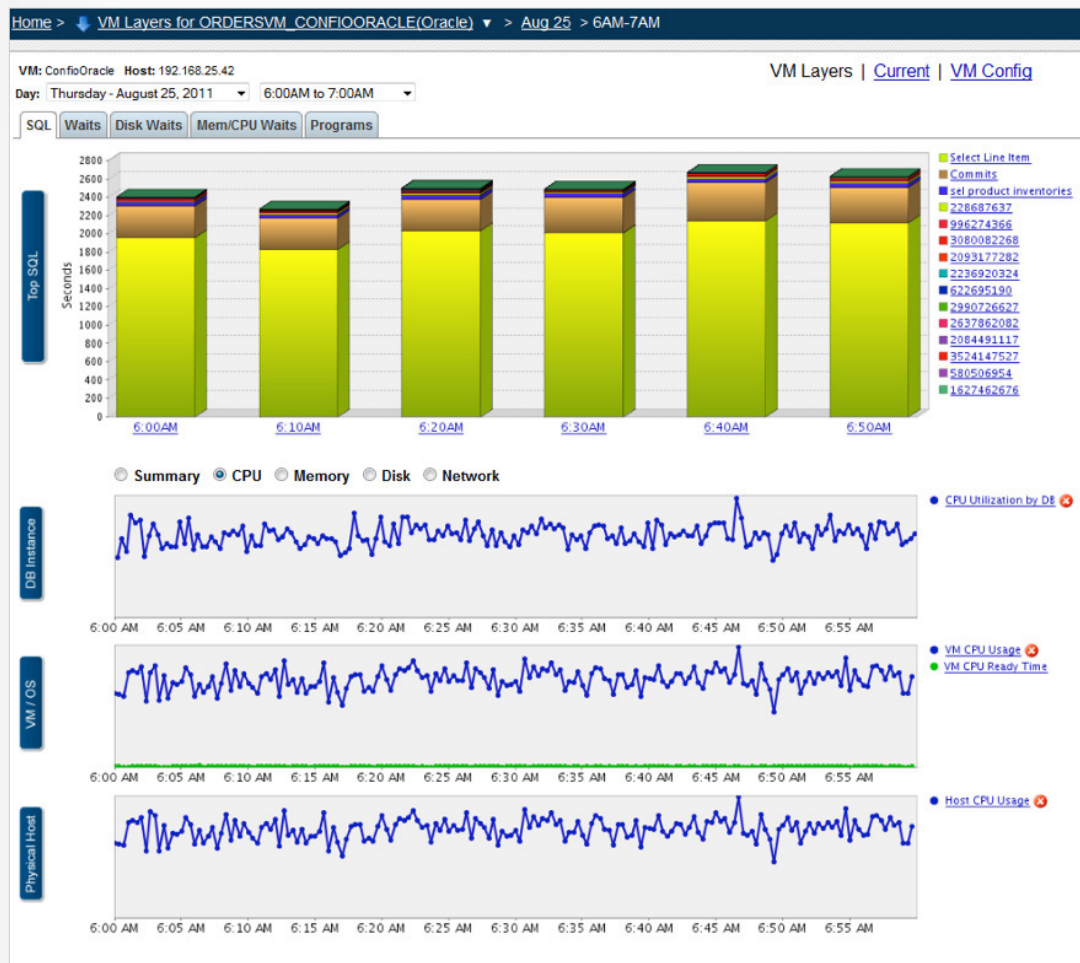


Figure 8: SQL tab

FOCUS ON VMWARE I/O

I/O operation on the VM is typically a concern, and the I/O layer diagrams from DPA with VM option illustrate exactly what is happening at each layer. Total VM I/O rate is in the range of 500 Kb/sec, slightly higher than the physical server, but steady. Most importantly, the higher I/O demands of the VM configuration appear to be handled, as there is no significant accumulation of wait time for I/O related operations.





Figure 9: Disk Waits Tab

HEAD-TO-HEAD COMPARISON SUMMARY

The statistics gathered for the two configurations are directly comparable, and show no performance advantage for physical vs. virtual server.

PERFORMANCE PARAMETER	PHYSICAL SERVER	VMWARE VIRTUAL SERVER
Total Oracle Waiting (per hour)	Peak 19,000 sec / hour	Peak 17,000 sec / hour
Transaction rate	50 transactions / sec	50 transactions / sec
Heaviest wait time query	Select Line Item	Select Line Item
Query execution time	Average 3ms / execution	Average 2ms / execution
Virtual CPU utilization	N/A	Peak 75%
Physical host CPU utilization	Peak 66%	Peak 75%
I/O data rate	Max 750 Kb/sec	Max 650 Kb/sec
Dominant I/O Wait	None	Log File Sync 15% of total
Complete Label of the Fourteenth Feature	Yes	Yes
Complete Label of the Fifteenth Feature	Yes	No



When evaluating performance across these architectures, several points are important to consider:

- » CPU statistics gathered from the database and O/S are invalid on a virtual machine. To make an accurate comparison to a physical system, evaluate the VM host system directly.
- » Compare all the layers in the architecture, ranging from query execution time, database resources, virtual server operation, underlying physical host, and storage response.
- » Response time is the most relevant basis of comparison. Server statistics do not tell the story of application response, the truest measure of Oracle performance.

The tests here confirmed that performance need not be an issue preventing a move to VMware. In this example, the flexibility and management benefits of virtualization have been achieved without any impact on total performance. Importantly, having the specialized virtualization-aware database tools are essential to monitor and ensure that no performance problems arise.

APPENDIX A: SERVER CONFIGURATION

SERVER CONFIGURATION	PHYSICAL SERVER	VMWARE VIRTUAL SERVER
Total Oracle Waiting (per hour)	Peak 19,000 sec / hour 1 quad core Xeon X3440 @ 2.53 Ghz	Peak 17,000 sec / hour 1 quad core Xeon X3440 @ 2.53 Ghz
Physical CPU	1	1
Virtual CPU	-	4
Physical memory	Peak 66%	Peak 75%
O/S Version	Linux 5.5	Linux 5.5
VMware Version	-	ESXi 4.1
SAN	Yes	Yes

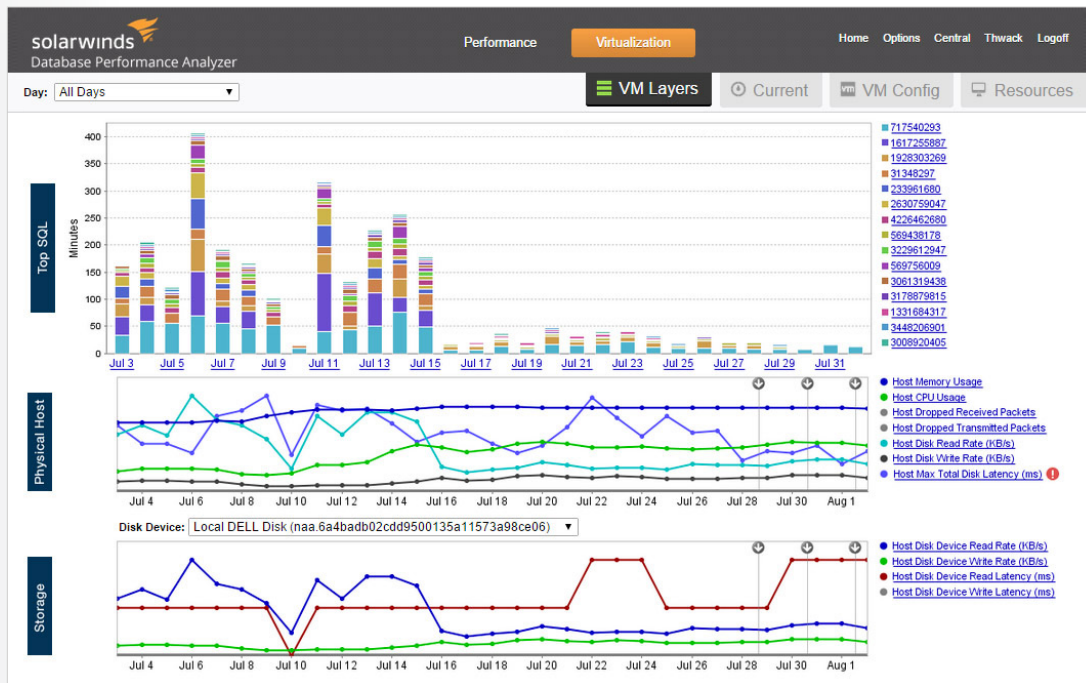


HOW CAN DATABASE PERFORMANCE ANALYZER HELP?

Database Performance Analyzer (DPA) from SolarWinds (NYSE: SWI) provides the fastest way to identify and resolve database performance issues. DPA is part of the SolarWinds family of powerful and affordable IT solutions that eliminate the complexity in IT management software. DPA's unique Multi-dimensional Database Performance Analysis enables you to quickly get to the root of database problems that impact application performance with continuous monitoring of SQL Server, Oracle, SAP ASE and DB2 databases on physical, Cloud-based and VMware servers.

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