# Dell PowerEdge R920 System Powers High Performing SQL Server Databases and Consolidates Databases

This white paper discusses OLTP database performance improvements using the Dell PowerEdge R920 system.

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# Revisions

| Date | Description |
|---|---|
| March 2012 | Initial release |
| | |

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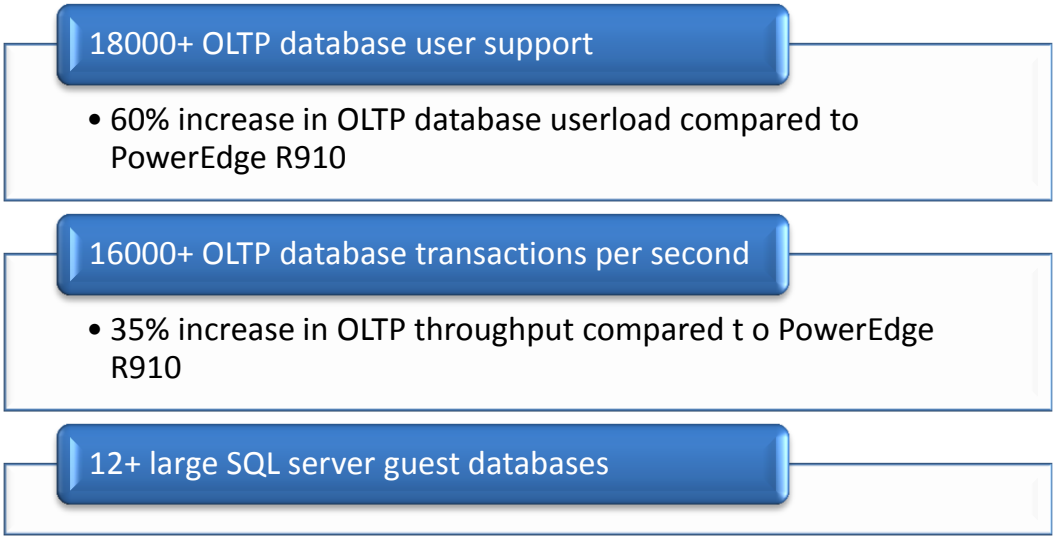
# Executive Summary

If you are in a business that includes  online transaction processing (OTLP), you are aware that as databases keep on increasing and businesses evolve, there is a constant requirement for technology that can augment that growth.

In this whitepaper, you are introduced to the Dell PowerEdge R920 system. You are presented with test results proving that if you are looking for a high-performance, compute-intensive server with scalable memory and powerful IO for large databases and demanding workloads, the PowerEdge R920 is a perfect match for your business.

The key results of this white paper are included in the snapshot below:

Figure 1-1: Advantages PowerEdge R920 Can Deliver for OLTP



# 1 Introduction

Technology should always enable businesses. In today's business scenario, you require servers with huge computing power, large memory support, many IO slots, and in-built SSD drives to support the requirements of your growing business.

The PowerEdge R920 server which support latest Intel Xenon E7 V2 product family, up to 6TB memory, up to 8 optional front loaded SSD drives, up to ten PCIe Gen3 IO slots and an in built system management software is a perfect answer for intensive workloads.

The objectives of this white paper are:

- Determine how many distributed legacy environment running OLTP workloads can be consolidated on a single PowerEdge R920 system.
- Achieve the benefits of consolidation and virtualization.
- Explore the processing capabilities of the PowerEdge R920 server in comparison with a previous generation 4-socket system.
- Calculate how many large OLTP SQL database virtual machines can be scaled up on a single PowerEdge R920 system

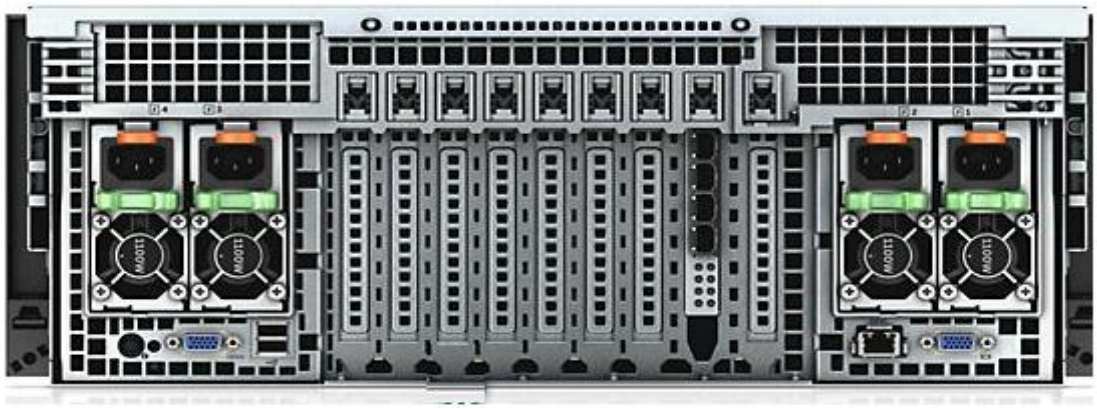
This study is not intended to be a comprehensive analysis of virtualization performance between Dell PowerEdge platforms. The PowerEdge R920 was chosen to characterize the relative gains in performance and power efficiency by comparing two generations of four-socket servers.

# 2 Dell PowerEdge R920 Overview

The Dell PowerEdge R920 is powered by next generation of Intel® Xeon® processor E7 v2 product family[1]. It is a 4-socket 4U rack server ideal for mission critical applications and high performing workloads.

Figure 2-1: PowerEdge R920 Front View

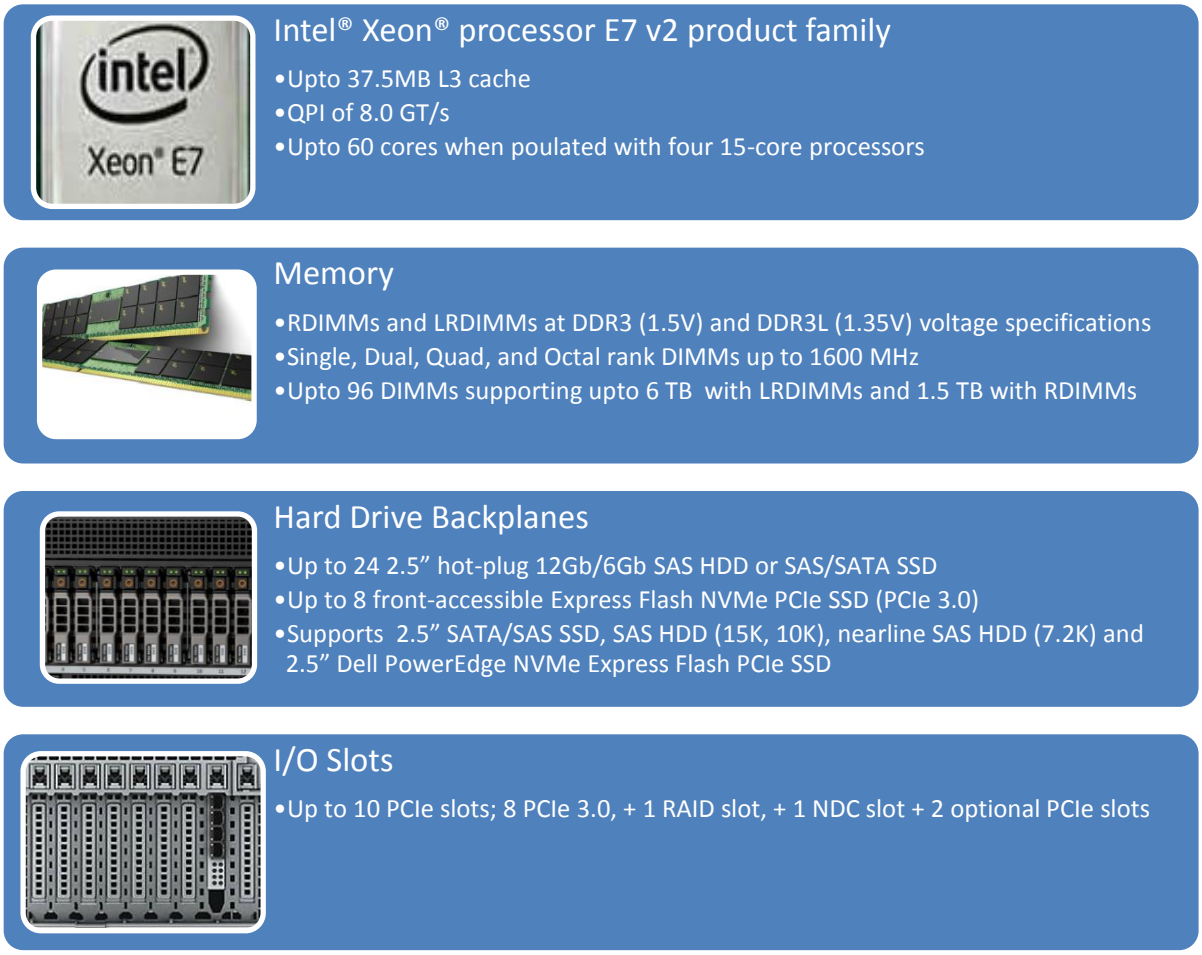
Figure 2-2: PowerEdge R920 Back View



For detailed specifications, see the product page.

[1] http://ark.intel.com/products/family/78584/Intel-Xeon-Processor-E7-v2-Family/server

Figure 2-3 PowerEdge R920 Specifications Snapshot




## 2.1 PowerEdge R920 Support for Large OLTP Businesses

- Memory intensive applications such as databases get benefitted with huge memory capacity and deliver more performance in less time. This amount of memory capacity enables the PowerEdge R920 to run many more virtual machines seamlessly on a single host.
- The support for PCIe SSD drives enables the PowerEdge R920 to deliver high storage IOPS which in turn boost the performance of mission critical applications such as databases.
- The PowerEdge R920 with support up to ten PCIe slots provide the flexibility to get started with a minimal number of network cards and then scale up when required. This helps to reduce the network latencies and improve the network bandwidth.

# 3 Hardware Comparisons Between PowerEdge R920 and PowerEdge R910

PowerEdge R910[2] is the previous generation 4-socket server based on Intel® Nehalem/Westemere processors.

Table 3-1: PowerEdge R910 and R920 Hardware Support Configuration

| Component | Dell PowerEdge R910 | Dell PowerEdge R920 |
|---|---|---|
| **Processors & Chipset** | 4x Intel Xenon (Nehalem –Ex/ Westmere –EX) Boxboro –EX | 4x Intel Xenon (IvyBridge –EX) Patsburg –C600j |
| **CPU Interconnect** | Intel QuickPath Interconnect (QPI) @ 6.4GT/S | Intel QuickPath Interconnect QPI up to 8GT/s |
| **Memory** | 64-DIMMs Max Memory: 2TB | 96-DIMMs Max Memory: 6TB |
| **Backplane Options** | 4-drives bay: SAS only<br>16- drives bay: SAS only | 4-drives bay: SAS only<br>24-drives bay: SAS only<br>24-drives bay: 16-SAS + 8-PCIe SSD |
| **RAID** | 6Gbps PERC-7 Series cards | 12Gbps PERC-9 series cards |
| **PCIe SSD ( Express Flash) cards** | Not Supported | Up to 8x PCIe SSD hot plug drives |
| **IO support** | 7 PCIe Gen2 slots (base) or Ten PCIe (with expansion risers) | 8 PCIe Gen3 slots (Two X8 + Six X16) or Ten PCIe Gen3 slots (with Expansion risers) |

The following sections will explain the test methodology, configuration details and observations of the comparison study.

[2] http://www.dell.com/us/business/p/poweredge-r910/pd?refid=poweredge-r910&baynote_bnrank=0&baynote_irrank=0&~ck=baynoteSearch&isredir=true

# 4 Performance Comparison with Previous Generation Server

To understand the performance improvements that PowerEdge R920 can bring when compared to previous generation 4-socket server PowerEdge R910, several experiments were conducted to analyze and compare the performance of PowerEdge R920 with PowerEdge R910.

In this comparison study, a CPU performance comparison study was done between half populated (two-sockets) PowerEdge R920 and PowerEdge R910 systems with OLTP database workloads in the virtual environment. The results were extrapolated for fully populated configurations based on the performance behavior and trends that were observed for half socket configurations.

## 4.1 Test Configuration

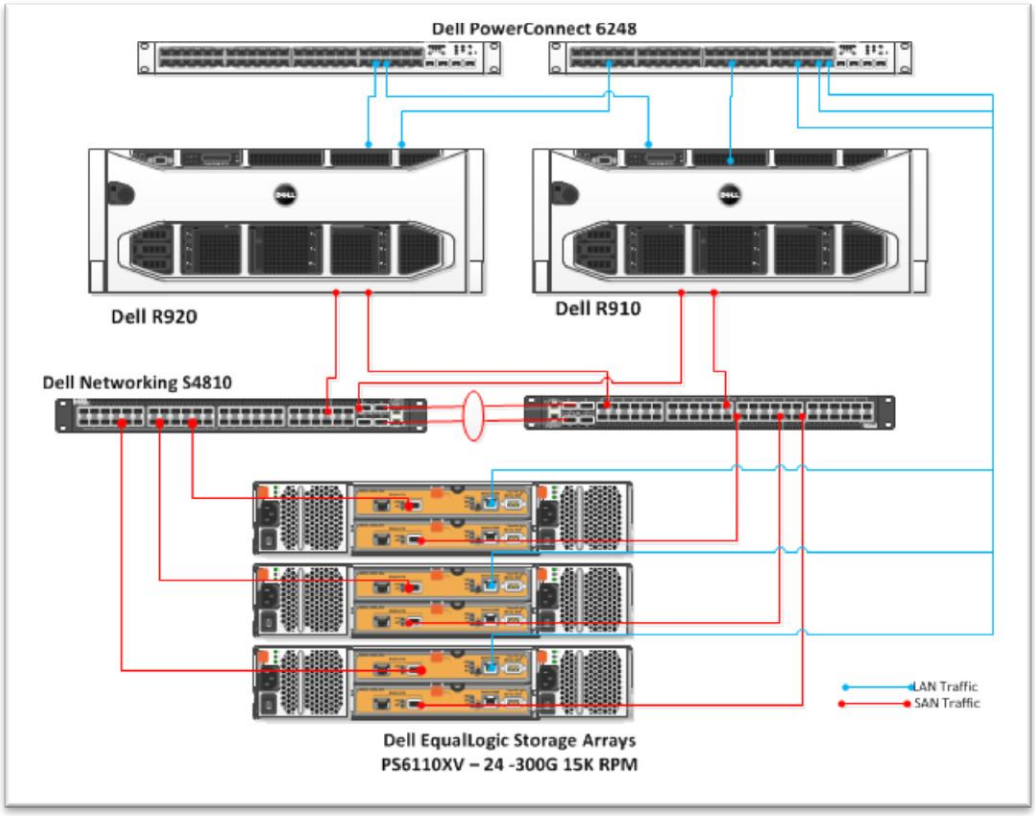
The below table describes the test configuration details of PowerEdge R910 and PowerEdge R920.

Table 4-1 PowerEdge R920 and R910 Reference Configuration used for Performance Comparison Study

| Component | Dell PowerEdge R910 | Dell PowerEdge R920 |
|---|---|---|
| **Processors** | 2x Intel Xenon CPU E7-4870 @2.40 GH/z 10C | 2x Intel Xenon CPU E7-8857V2 @3.00 GHz 12C |
| **Cores per processor** | 10 | 12 |
| **Memory** | 128GB @1066MHz | 512GB @1333Mhz |
| **IO Network Cards** | Two-Intel Dual Port 10Gbps SFP+ cards | Two-Intel Dual Port 10Gbps SFP+ cards |
| **Storage** | Dell EqualLogic Arrays - PS6110XV with 300G 15k RPM Drives | Dell EqualLogic Arrays - PS6110XV with 300G 15k RPM drives |
| **Networking Switches** | Dell Networking S4810 | Dell Networking S4810 |
| **OS & Hypervisor** | Windows 2012 Hyper-V | Windows 2012 Hyper-V |

The following diagram provides high level reference configuration that we used for the performance study.

Figure 4-1: PowerEdge R920 and R910 Reference Configuration




Microsoft Windows 2012 Hyper-V hypervisor is installed on PowerEdge R920 and R910 systems and both are clustered together to provide high availability to the guests. Multiple Dell EqualLogic storage arrays are used to store guest virtual machines and guest SQL server database in order to remove the IO bottleneck which is an issue in an OLTP environment. Clustered Shared Volume (CSV) is used to store the Guest VHD files.

## 4.2 Test Methodology

The test scenarios are implemented to analyze the processing capabilities of PowerEdge R920 and R910 systems in the virtual environment using Windows 2012 Hyper-v hypervisor. A standalone Microsoft SQL server database is installed on a guest and configured with resources as shown in the below table 4-3. Pass-Through disks are carved out and directly exposed to guets to store SQL Server database data files and Log files.

Table 4-2 Guest Configuration for Performance Comparison

| Component | Dell PowerEdge R910 | Dell PowerEdge R920 |
|---|---|---|
| **VCPUs#** | 10 | 12 |
| **Memory** | 120 GB @1066MHz | 150 GB @1333Mhz |
| **Database Size** | 350GB | 350GB |
| **Concurrent Users** | Up to 3000 | Up to 4750 |
| **Workload & Bench Mark Used** | OLTP workload and Dell Quest Benchmark (with 50$^{th}$ reduction in Key-in Time) | OLTP workload and Dell Quest Benchmark (with 50$^{th}$ reduction in Key-in Time) |

The following steps were implemented in the performance study:

1. Stress the guest running on PowerEdge R910 with 3000 user load.
2. Note the hypervisor CPU utilization on the PowerEdge R910.
3. Note the Transaction per second (TPS), response time, and other required performance metrics from the guest.
4. Move the same guest to PowerEdge R920.
5. Stress the guest with the same user load (3000).
6. Note the hypervisor CPU utilization on PowerEdge R920 and the metrics mentioned in step 3.
7. Calculate the CPU utilization difference between PowerEdge R920 and PowerEdge R910.
8. To calculate out how much more user load the guest running R920 can take up, continue the tests on the PowerEdge R920.
9. Increase the user load on the guest running on the PowerEdge R920 until the PowerEdge R920 hypervisor CPU utilization matches the PowerEdge R910 CPU utilization of 3000 users.
10. Note the Transaction per second (TPS), response time, and other required performance metrics from the guest.

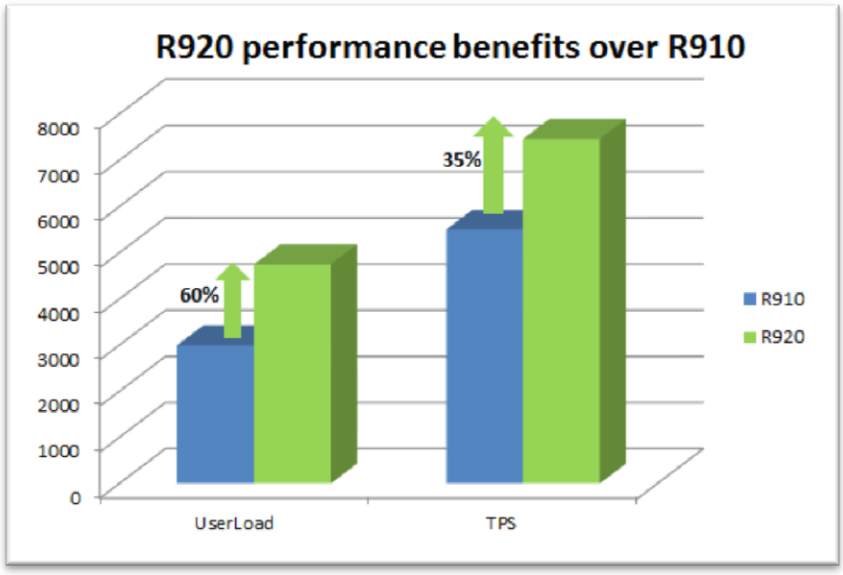
## 4.3 Observations and Results

- When stressed the SQL Server database with 3000 concurrent database users when the guest is running on the PowerEdge R910 system, an 87% CPU utilization on the guest and 52% CPU utilization on the hypervisor was observed.
- Moved the same guest to the PowerEdge R920 and repeat the experiment with the same workload of 3000 users. An 82% CPU utilization on the guest and only 43% CPU utilization on the hypervisor on was observed on R920.
- To match the 52% CPU utilization on the hypervisor, more resources like 12 VCPUs and 150GB memory was added to the guest running on PowerEdge R920. The guest was stressed with more user load of 4750. An 84% CPU utilization on guest and 50.33% CPU utilization on hypervisor was observed for the PowerEdge R920.

When the guest running on PowerEdge R910 and PowerEdge R920 was stressed up to around 52% CPU utilization of the hypervisors, we observed that the guest running on the PowerEdge R920 could support around 60% more users and around 35% more throughput when compared to the guest running on PowerEdge R910.

The chart below details the performance benefits observed when the half populated PowerEdge R920 and PowerEdge R910 were stressed up to 52% CPU utilization on the respective hypervisors. The same performance benefits may be observed in the fully populated configurations (4-socket).

Figure 4-2 PowerEdge R920 Performance Benefits over PowerEdge R910




The above performance numbers are based on the specific configuration mentioned in the table 4-1

# 5 Scalability Through SQL Server Database Consolidation on PowerEdge R920

Workload consolidation in virtual environment offers benefits such as effective resource utilization and high availability etc. Consolidating many guests on a single host leads to data center efficiency as well as easy administration. As we add more and more number of guests on the same host, the host must be able to deliver the consistent performance within the acceptable response time.

The following sections explore how the PowerEdge R920 behaves and delivers consistent performance as we scale up the guests on the single host.

## 5.1 Test Configuration for PowerEdge R920 Scalability Test

The following table describes the hardware and software components used to create the test bed.

Table 5-1 PowerEdge R920 Configuration for Scalability Test

| Component | Description |
|---|---|
| **Server** | PowerEdge R920 |
| **CPUs** | Four - Intel® Xenon ® CPU E7-8857V2 @3.00 GHz 12C |
| **Total Cores** | 48 |
| **Memory** | 512GB @1333MHz |
| **Network Card** | Two Intel SFP+ Dual Port cards |
| **SAN Switches** | Two Dell Networking S4810 |
| **Storage** | Dell EqualLogic PS6110-XV arrays with 24 300G 15K SAS drives |
| **OS and Hypervisor** | Windows 2012 and Hyper-V |
| **Database** | SQL Server 2012 |

## 5.2 Test Methodology

The objective behind the test exercise was to derive the maximum number of virtual machines can be run simultaneously on single PowerEdge R920 server platform and observe how R920 behaves and deliver the consistent performance as we run more guests.

To analyze the scalability behavior of R920, we consolidated multiple guests running Microsoft SQL Server databases. The guest configurations are described in the below table.

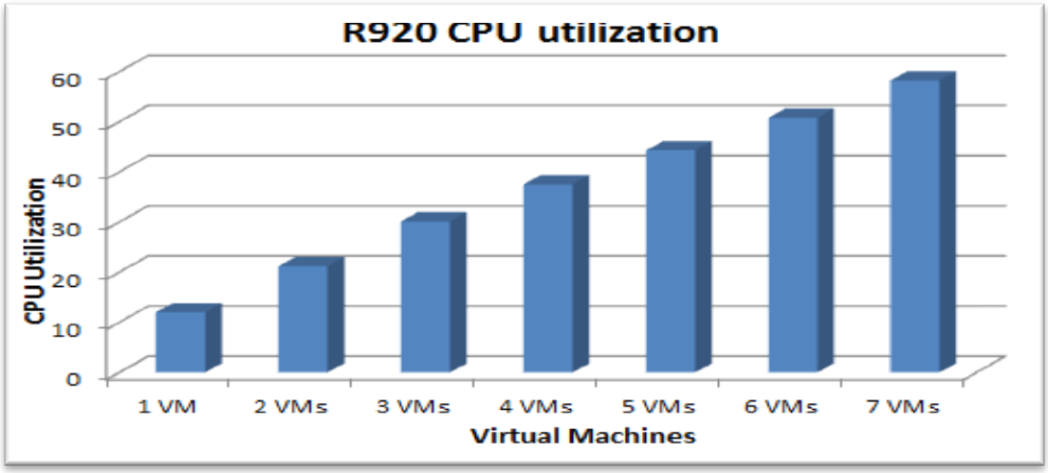
Table 5-2 Guest Configuration for Scalability Test

| Component | Description |
|---|---|
| **VCPUs** | 6 |
| **Memory** | 40GB |
| **Database Size** | 350GB |
| **Concurrent Users** | 1500 |
| **Workload & Bench Mark Used** | OLTP workload and Dell Quest Benchmark (with 50th reduction in Key-in Time) |

## 5.3 Observations and Results

The configuration was tested with up to seven virtual machines. Similar CPU utilization trend on the PowerEdge R920 was observed as the number of virtual machines was increased from one to seven as shown below.

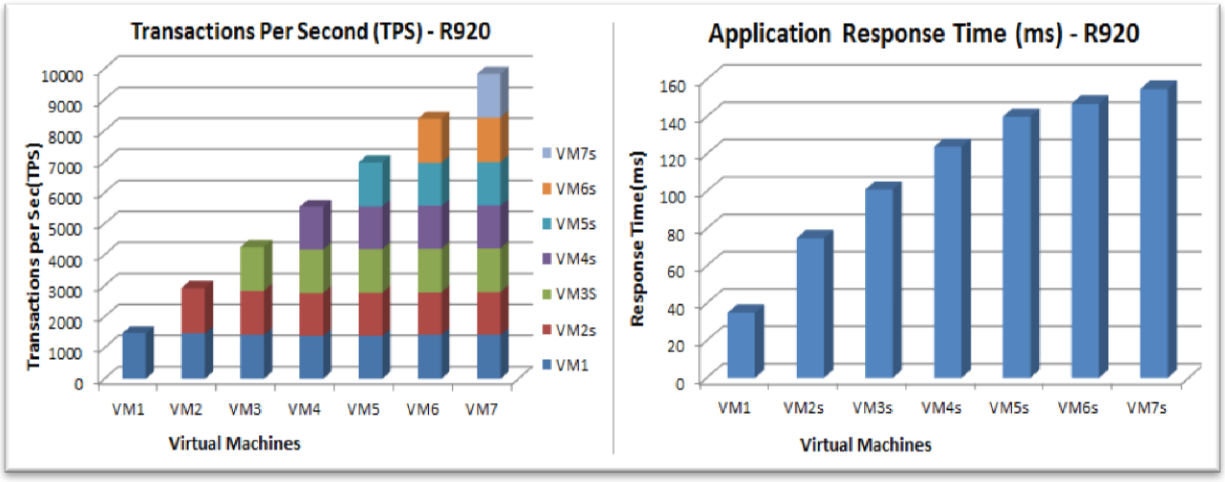
Figure 5-1 PowerEdge R920 CPU Scalability Behavior




From the above figure, only 60% CPU is utilized when the PowerEdge R920 was stressed with seven large database guests. There was enough room to accommodate more guests. From the CPU utilization trend of seven guests, it can be extrapolated to be said that a single PowerEdge R920 can support ten to twelve large database guests.

The following figure describes how the PowerEdge R920 delivered consistent performance as we scale up the number of virtual machines. Each guest was observed to deliver around 1400 Transactions per Second with acceptable response time (<200ms). The same trend was observed from each guest as more guests were run on single R920.

Figure 5-2 PowerEdge R920 Scalability and Performance Behavior




As more virtual machines were run on the PowerEdge R920, it was made sure that there were no IO bottle necks. This was done by expanding the storage.

# 6 Conclusion

The experiments prove conclusively that the PowerEdge R920 can outperform the PowerEdge R910. The PowerEdge R920 supports more user load and delivers more throughout without any sacrifices on response times.

Table 6-1 PowerEdge R920 Performance Benefits Summary

| Performance metric | % improvement |
|---|---|
| **Database user load** | PowerEdge R920 can support around 60% more database users than PowerEdge R910 |
| **Transactions per Sec** | PowerEdge R920 can deliver around 35% more throughput than the PowerEdge R910 with acceptable response time. |

The scalability study tests shows the guests running large databases can be scaled up to deliver consistent performance as more and more database workload run on the host. The outcome of the experiments conducted on scalability of the PowerEdge R920 is given below. A single PowerEdge R920 server:

- Delivers more than 16000 transactions per second at less than 200ms response time
- Supports more than 18,000 database users.
- Supports ten to twelve large database virtual machines.