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IxChariot Virtualization Performance Test Plan

Test Methodologies

The following test plan gives a brief overview of the trend toward virtualization, and how IxChariot can be used to validate and optimize a virtualization installation. There are five tests described using two virtualization servers, and three scenarios that use the tests with different virtualization setups.

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Introduction

Data center virtualization is one of the most important IT paradigm shifts in decades. By virtualizing the hardware/software interface, the applications are freed from the constraints of the underlying hardware platform. In this new data center model hardware resources -- even server-grade platforms -- become a commodity that can be replaced or upgraded with no impact on mission-critical services.

A virtualized data center architecture results in more efficient hardware utilization and a reduced load on the IT staff by reducing both capital and operational expenditures. At the same time, the virtualization software introduces new variables with respect to server performance, which must be taken into consideration before migrating services to the virtual environment. For example, a company might not migrate all database servers to virtual architectures due to addition latency and storage access issues that lead to vast reductions in end user quality of experience (QoE).

Many hardware and software vendors are attempting to reduce the impact of the virtual software layer on network services. Virtualization software vendors constantly optimize their code to remove bottlenecks between the guest OS and the host hardware.. Virtualization "hooks" built into the hardware can streamline the performance when running under a virtualized environment.

This test plan outlines a number of basic tests that compare and quantify the performance changes expected during a migration. The tests are executable on both traditional and virtualized infrastructure components. This plan is designed to help you easily evaluate the applicability of different vendors' hardware and software performance optimizations on your virtualized services.

Table 1 summarizes the IxChariot test set discussed in this test plan.

Test Cases	Objective
1. TCP Throughput	Assess peak TCP throughput
2. UDP Throughput	Assess peak UDP throughput
3. Response Time	Measure latency introduced by virtualization
4. Enterprise Application Performance	Use simulated real-world enterprise application traffic to gauge the impact of virtualization
5. Performance vs. Buffer Size	Evaluate network performance over a range of buffer sizes
6. Performance with Different Types of NIC	Determine the impact of virtual environment and virtual device configuration on performance
7. Performance vs. Number of VM's per CPU	Find the optimum virtualization machines (VMs) to processor ratio for peak network performance
8. Performance with multiple NICs/VM	Understand the effect of multiple network interface cards (NICs) on the performance of virtual applications

Table 1. Virtualization Performance Testing – Test Cases

1. TCP Throughput

Total TCP throughput indicates the maximum network throughput of a system or network. Since TCP is the protocol of choice for most network services, it is highly optimized by the operating system stack, device drivers and hardware. Solid TCP bulk performance requires high-speed memory and tight integration between the NIC and the device drivers. This integration must extend through the virtualization layer to achieve optimal performance in a virtualized system.

Objective

Determine the maximum network throughput (Mbps) of the system using TCP.

Setup

The setup for the TCP throughput test is the foundation for the other tests. In this test setup:

- Two physical servers each run one VM,
- The VM network interface is bridged directly to the NIC on the physical host, and
- An IxChariot Performance Endpoint agent is installed on each VM.

Leave any additional VMs in a standby or off state for the test to get the cleanest baseline results. In test 7 we will investigate the impact of multiple VMs. Running tests one through five on an unvirtualized system using the same hardware and operating systems as the virualized system provides a good performance comparison.

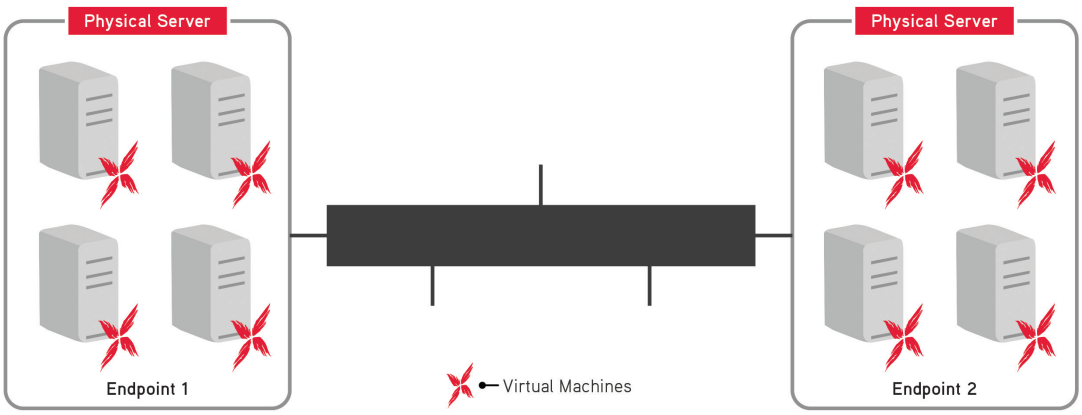

Figure 1: Basic Test Scenario for Tests 1 through 5.

Input Parameters

Parameter	Description
IxChariot Script	High_performance_throughput.scr (100 Mbps-1G) Or Ultra_high_performance_throughput.scr (10G)

Table 2. Test Parameters

Test Methodology

1. In the IxChariot console, create a single endpoint pair using the test VMs' IP addresses.
2. Select TCP from the Network Protocol drop-down menu.
3. Select the high_performance_throughput.scr script for networks running at 100M to 1Gbps, or the ultra_high_performance_throughput.scr script for networks running at 10Gbps, as shown in Figure 2.
4. Run the test.

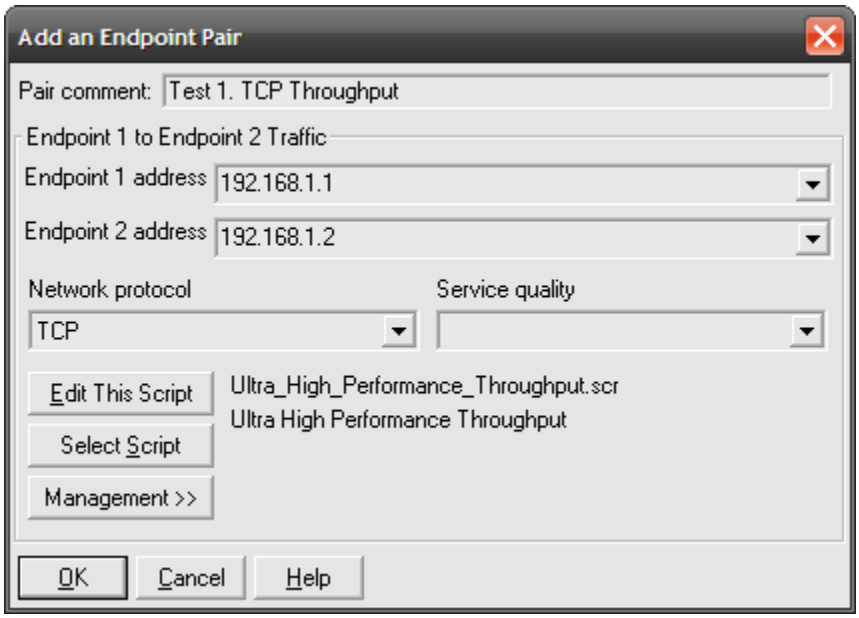

Figure 2. Pair configuration dialog for Test 1.

Results

1. Figure 3 shows a graph from a typical IxChariot TCP throughput test displaying an average throughput of 939.629 Mbps. It also shows the minimum and maximum values.
2. After running this test, click on the Raw Data Totals tab to see the CPU utilization at each endpoint.

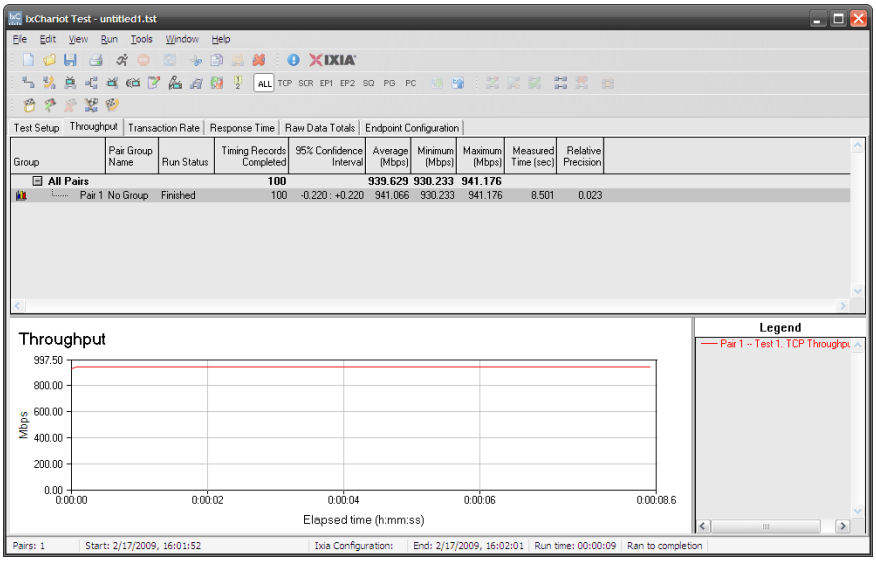

Figure 3. Results from a typical TCP performance test run.

2. UDP Throughput

Like the TCP throughput test, UDP throughput is a key indicator of basic network performance. Expect slightly lower results since UDP is not typically optimized like TCP (especially on 10G networks), due to differences in TCP and UDP datagram generation. Applications generate UDP datagrams a few kilobytes at a time, whereas NIC hardware copies and packetizes TCP data in megabyte-sized chunks.

Objective

Determine the maximum network throughput (in Mbps) of the system using UDP.

Setup

Use the TCP throughput test setup.

Input Parameters

Parameter	Description
IxChariot Script	udp_throughput.scr

Table 3. Test Parameters

Test Methodology

1. In the IxChariot console, create a single endpoint pair using the test VMs' IP addresses.
2. Select the udp_throughput.scr script.
3. If you are using jumbo frames, you edit the script and increase the send_buffer_size value to maximize the throughput. For example, with 1500 byte MTUs the maximum size is 1472 before fragmentation occurs, and on 9000-byte MTUs it's 8972. If VLANs are defined, reduce the number to be safe (for example, to 1460 or 8960).
4. Select UDP from the Network Protocol drop-down menu.
5. Run the test.

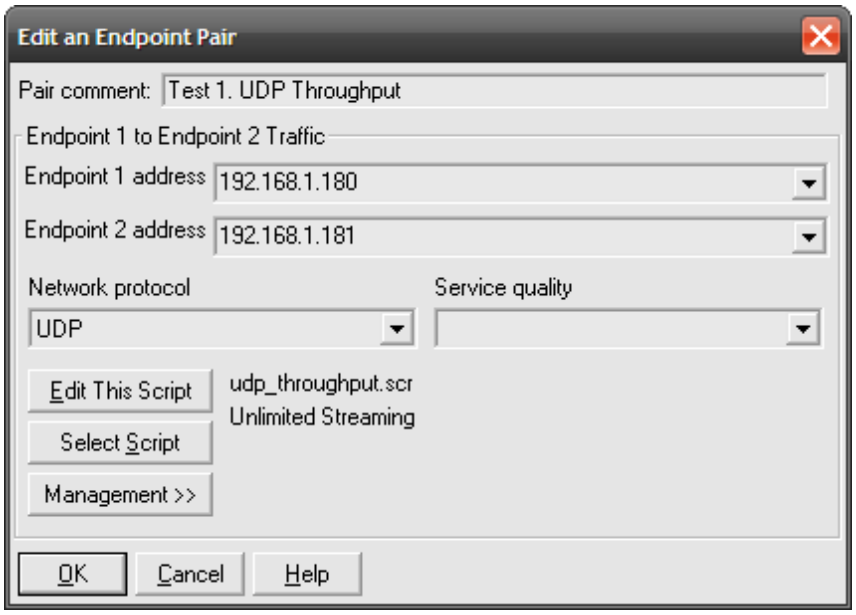

Figure 4. Pair configuration dialog for Test 2.

Results

1. Figure 5 shows a graph from a typical IxChariot UDP throughput test with an average throughput of 956.585 Mbps. It also shows the minimum and maximum values.
2. After running this test, click on the Raw Data Totals tab to see the CPU utilization for each endpoint.

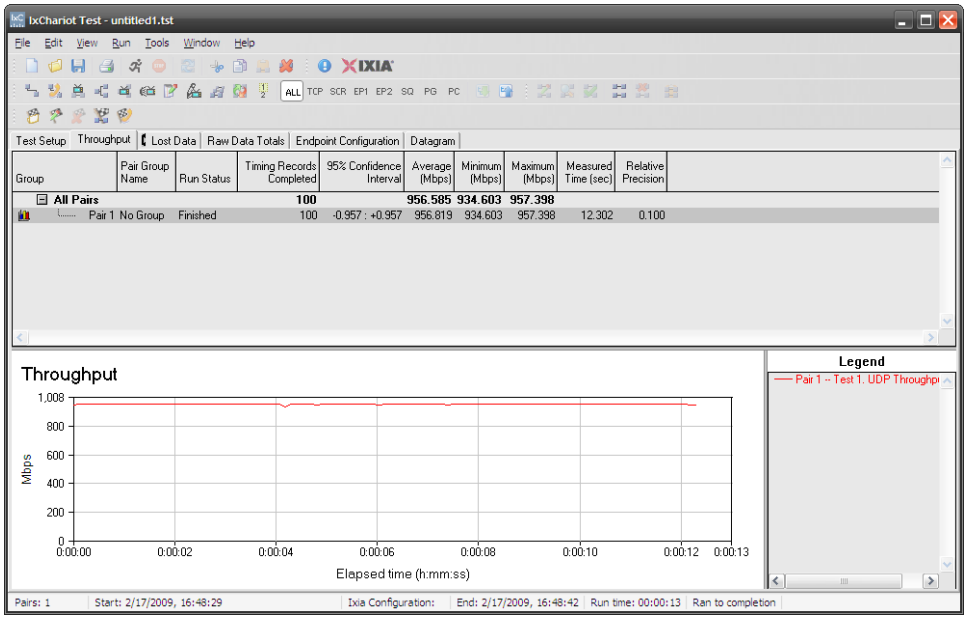

Figure 5. Results from a typical UDP performance test run.

3. Response Time

IxChariot's response time test (sometimes called a "ping-pong" test) sends 100 bytes from Endpoint 1 to Endpoint 2, which responds by sending another 100 byte packet back. By comparing the response time of two different systems, you can determine the latency incurred by adding a virtualization layer. The test indicates how virtualization impacts "chatty" network applications such as databases.

Objective

Determine the response time, or round-trip latency, between Endpoint 1 and Endpoint 2.

Setup

Use the TCP throughput test setup.

Input Parameters

Parameter	Description
IxChariot Script	Response_time.scr

Table 4. Test Parameters

Test Methodology

1. In the IxChariot console, create a single endpoint pair using the test VMs' IP addresses.
2. Select the Response_Time.scr script.
3. Select the TCP protocol from the Network Protocol drop-down menu.
4. Run the test.
5. The test finishs very quickly and pops-up a warning message similar to the one shown in Figure 6. To correct this warning, modify the script variable Loop Count as shown in Figure 7.

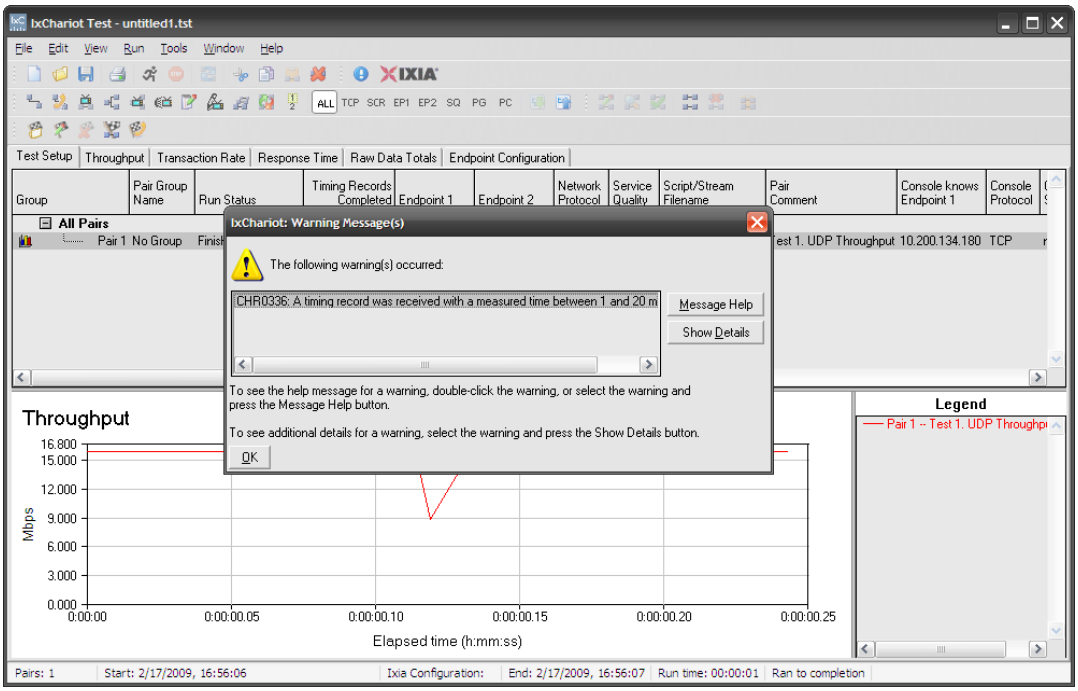

Figure 6. IxChariot CHR0336 warning message

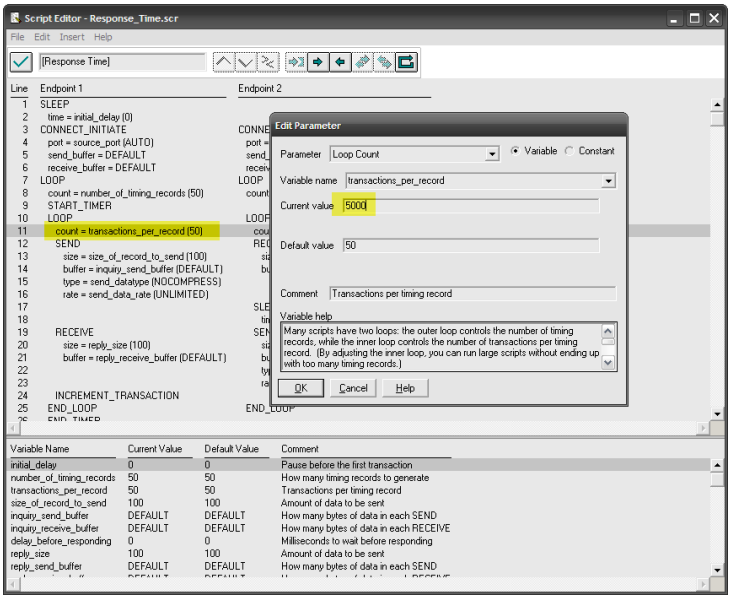

Figure 7. Changing the Loop Count variable to correct the CHR0336 warning

Results

Figure 8 shows the transaction rate for the test was 10,580.667 transactions per second. Inverting this value (1/10580.667) calculates the response time at about 94.5 microseconds. Look in the Response Time tab to see the response time is shown as 0.000 seconds. IxChariot cannot display values below 1 millisecond.

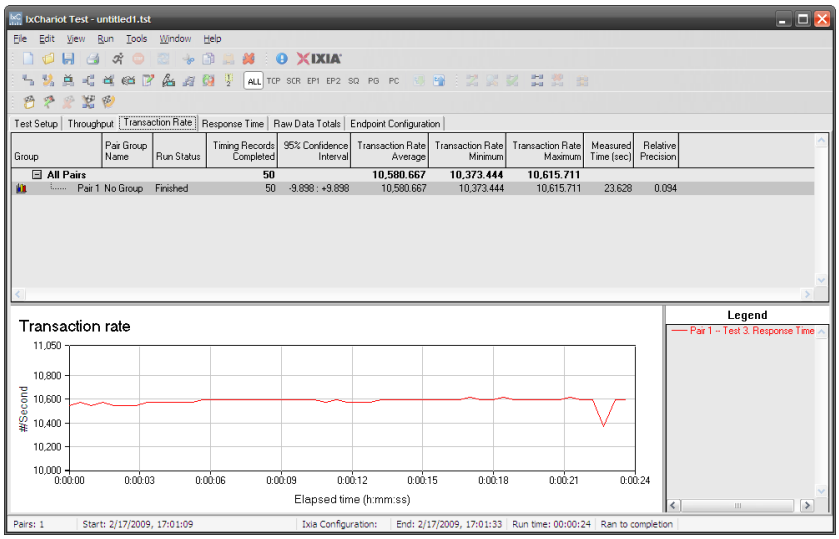

Figure 8. Results from a typical response time test.

4. Enterprise Application Performance

IxChariot uses enterprise application scripts that simulate real-world application traffic to measure the impact of latency and virtualization. In this case we'll use Citrix as an example, but many other scripts are available. Using IxProfile, you can also make your own scripts simulating custom applications.

Objective

Determine Citrix system login time with Endpoint 1 acting as the client and Endpoint 2 acting as the Citrix server.

Setup

Use the TCP throughput test setup.

Input Parameters

Parameter	Description
IxChariot Script	Citrix_ICA_Terminal_Server_Logon.scr

Table 5. Test Parameters

Test Methodology

1. In the IxChariot console, create a single endpoint pair using the test VMs' IP addresses.
2. Select the Citrix_ICA_Terminal_Server_Logon.scr script.
3. Select TCP from the Network Protocol drop-down menu.
4. Run the test.

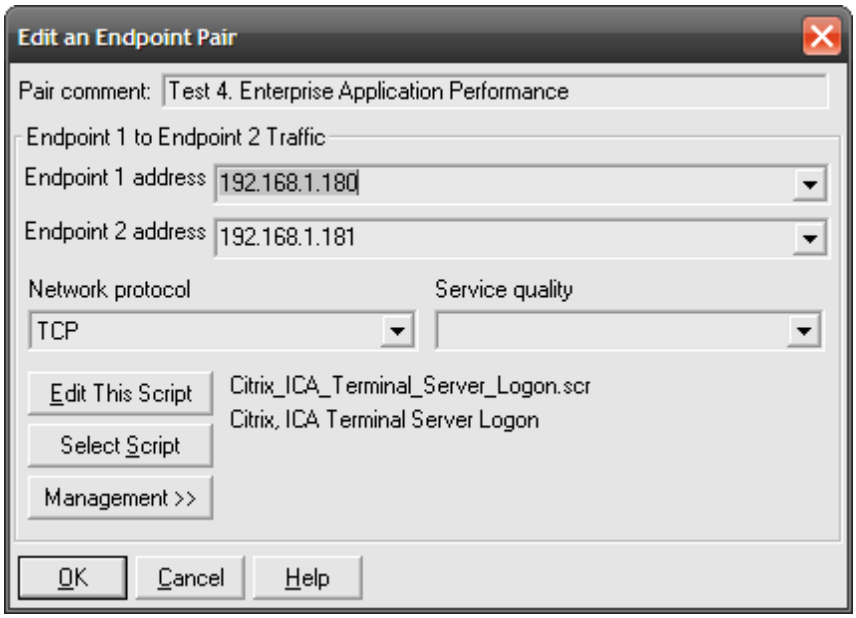

Figure 9. Choosing the Citrix Logon script from the Business/Citrix folder.

Results

Figure 8 shows the transaction rate for this test at 2.069 seconds. Each login transaction took two seconds on this network.

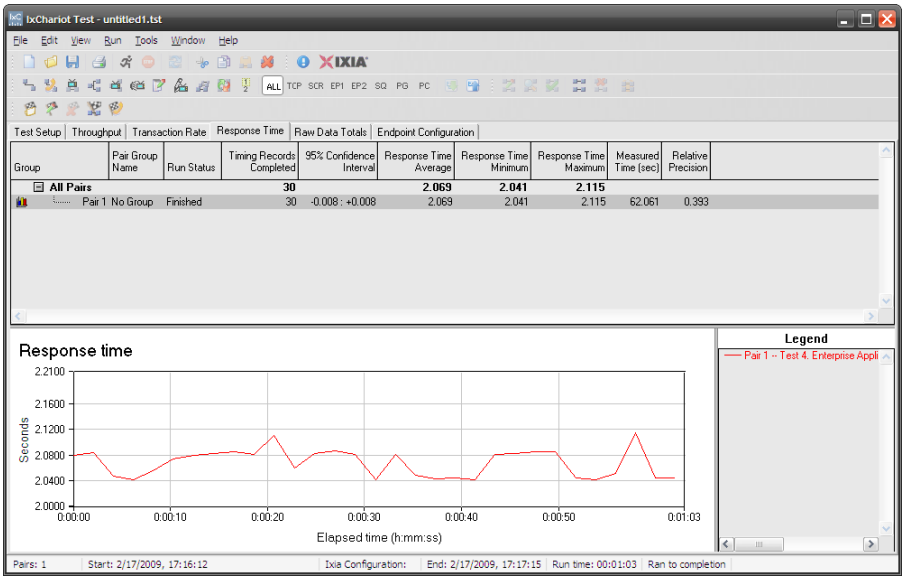

Figure 10. Results from an enterprise application test.

5. Performance vs. Buffer Size

A common variation of Test 1 measures TCP performance across a range of application send buffer sizes. This test shows how different applications perform on a system or network. An application such as FTP may use very large buffers (64KB-1MB) to send data on the network, whereas an application such as HTTP typically sends much smaller files (20KB-50KB). Applications such as Microsoft Exchange may send buffers in the tens to hundreds of bytes.

Objective

Calculate the TCP throughput over a range of application sent buffer sizes.

Setup

Use the TCP throughput test setup.

Input Parameters

Parameter	Description
IxChariot Script	Response_time.scr

Table 6. Test Parameters

Test Methodology

1. Use the methodology sequence from Test 1.
2. Modify the IxChariot script as shown in Figure 11 to adjust the send_buffer_size for each test run.

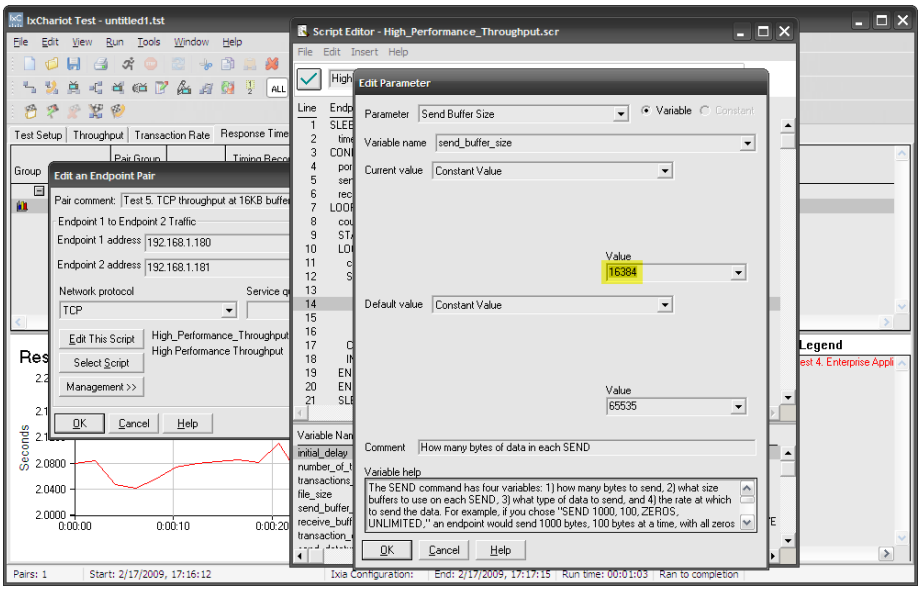

Figure 11. Adjusting the send_buffer_size to 16KB

Results

Using Excel or another graphing tool, create a graphic from the results of the successive test runs similar to Figure 12.

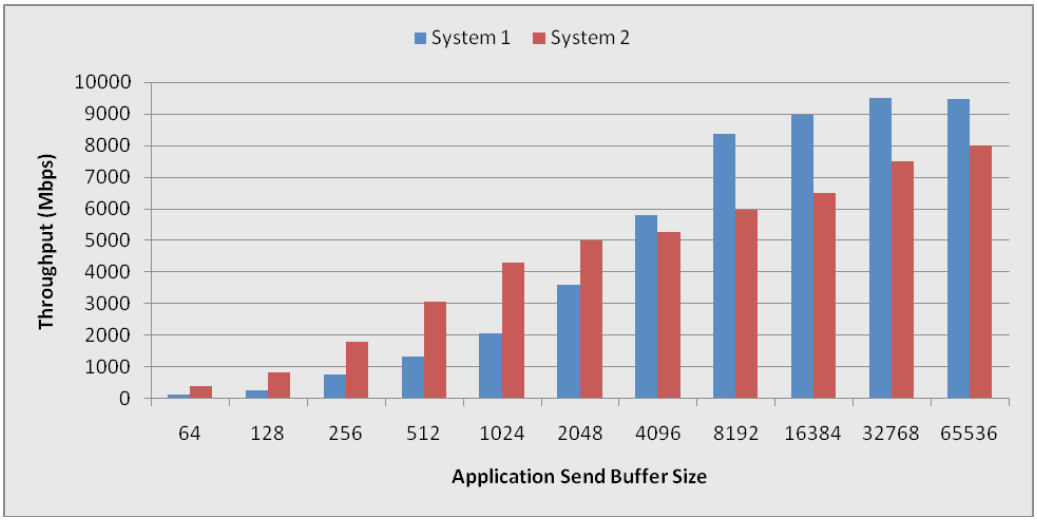

Figure 12. Results from a test run against two different systems, showing CPU utilization vs. throughput.

Special Considerations for Virtual Environments

The impact of virtualization on network performance is difficult to predict due to the broad range of applications and rapid advancements in virtualization technology. The major hypervisor vendors have made considerable efforts to optimize network performance, but each has its own unique characteristics. Hardware vendors also have worked hard to differentiate their virtualization products.

Many vendors claim their hardware works best with certain hypervisors, or provides better CPU usage benefits than their competition. With so much hype around virtualization technology, it's important to understand exactly how specific hardware, hypervisors and applications work together to deliver your users a high quality experience.

In Figure 13 shows a layered view of the virtual infrastructure. VMs are separated from the physical CPU resources by a layer of virtualized NICs, as well as a virtual switch. Each of these layers adds the possibility of increased latency and reduced throughput. Most systems are optimized for throughput, causing greatly reduced response times for latency dependent applications like databases.

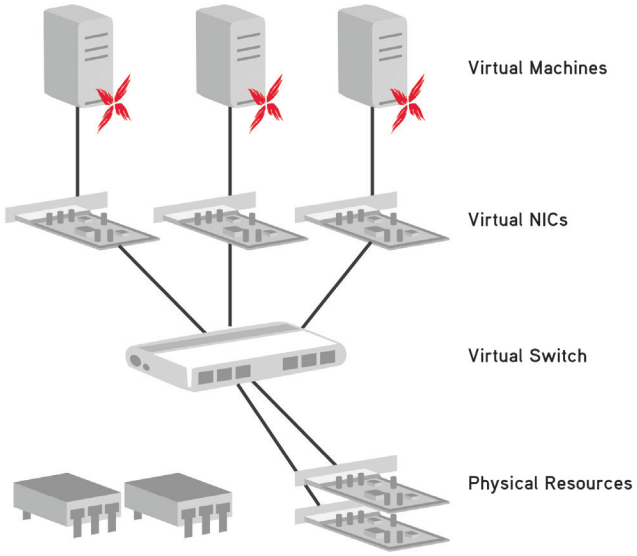

Figure 13. Layered view of virtualization infrastructure.

The final section of this test plan suggests some specific variations on the original tests to explore specific areas pertinent to planning a successful migration to a virtualized environment.

6. Assessing the Impact of Virtual NIC Settings

Each major virtualization platform possesses its own combination of custom device drivers and networking extensions designed to minimize virtualization impact on network performance. For example, VMware has three different kinds of virtual NICs: AMD Lance, Intel e1000 and vmxnet -- each with its own benefits and drawbacks. Many Microsoft Hyper-V users find that disabling TCP offloading in guest OSes give the optimal performance.

Using the test methodologies shown in tests one through five, you can now accurately measure the impact of these settings on your virtual server.

Objective

TCP throughput, UDP throughput, response time and the percentage of difference achieved by selecting different NIC options.

7. Maximizing VMs per CPU

Some published tests show that certain vendors can optimize their platforms to support more VMs per CPU/core than others. Verifying the impact of running more than two to four VMs per CPU core is critical when sizing your virtual data center.

Objective

TCP throughput, UDP throughput, response time and the percentage of difference achieved by selecting different ratios of VMs and CPUs.

8. Assigning Multiple NICs

Many virtualization products allow each VM to use multiple NICs, and assign multiple physical NICs to a single virtual switch. One published paper found that multiple NICs on a single VM increased its overall performance. Using IxChariot and the tests defined in this test plan can verify if this strategy improves your virtual network performance.

Objective

TCP throughput, UDP throughput, response time and the percentage of difference achieved by using multiple virtual NICs per VM.

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