Scalability Analysis of the Dell PowerEdge 2850 vs. Dell PowerEdge 2650

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John D'Agati

Citrix Systems, Inc.
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**ABSTRACT**

The Single Server Scalability test is designed to quantify the maximum number of client sessions that can be connected to a MetaFrame Presentation server with acceptable performance. In this test, the scalability results from an Intel 3.0GHz Xeon EM64T dual processor system are compared to an Intel 3.0GHz Xeon dual processor system running on the latest generation Dell PowerEdge servers. The purpose of this test was to measure the difference in performance between processor architectures and how it relates to user capacity on MetaFrame Presentation Server.

**ABOUT THE INTEL XEON EM64T**

The Intel® EM64T processor is an enhancement to Intel's IA-32 processor architecture which allows the processor to execute legacy 32-bit and new 64-bit instructions. When coupled with a 64-bit operating system the system allows access to larger amounts of memory, increasing scalability in memory constrained environments. Other architectural improvements include faster processor speeds up to 3.6GHz, support for DDR2 memory and increased front side bus speed. The following link provides more information on the Intel® EM64T processor: [http://www.intel.com/products/server/processors/server/pentium4/index.htm](http://www.intel.com/products/server/processors/server/pentium4/index.htm)

**RESULTS**

<table>
<thead>
<tr>
<th>Server</th>
<th>Dell PowerEdge 2850 3.0GHz Xeon EM64T</th>
<th>Dell PowerEdge 2650 3.0GHz Xeon</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Results(Simulated Users)</td>
<td>189 ± 1</td>
<td>164 ± 1</td>
<td>+15.2</td>
</tr>
</tbody>
</table>

The results of the Single Server Scalability test conclude that the user experience of the 3.0GHz Xeon EM64T on a Dell PowerEdge 2850 servicing 189 concurrent users is equivalent to the user experience of the 3.0GHz Xeon on a Dell PowerEdge 2650 servicing 164 concurrent users when running this specific test. Extending the number of concurrent users beyond this recommendation in this test environment would result in decreased performance and impact the end user experience on the Citrix MetaFrame Presentation Server. When sizing MetaFrame Presentation Servers the number of actual users per server varies based on the applications deployed.

Based on these results, the Xeon EM64T processor shows a performance increase of 15.2% when compared to the Xeon processor in a pure 32-bit environment. The overall CPU utilization for the Xeon EM64T is 5% lower throughout most of the test, which is illustrated in Figure 2. Also, it is important to note that the faster front side bus speed (800MHz vs. 533MHz) and the DDR2 memory in the Xeon EM64T server contributed to the overall increase in performance. All other areas including memory, disk and network utilization show like results for both systems, with no apparent bottlenecks.

**UNDERSTANDING THE TEST SCORE**

Viewing the score column in the test results is the easiest way to determine the server's degradation point. For the Single Server Scalability test a score of 80 has been determined as the optimal load for a server. This means that the server has enough additional CPU and memory resource to handle spikes in performance. When the test iteration score drops below 80, additional users added to the server consume more resources causing lower test scores and slower performance.
Dell PowerEdge 2850 3.0GHz Xeon EM64T vs. Dell PowerEdge 2650 3.0GHz Xeon

Figure 1: ICAMark Score Results

DELL POWEREDGE 2850 3.0GHz XEON EM64T RESULTS:

<table>
<thead>
<tr>
<th>Iterations</th>
<th>Time</th>
<th>Bytes Sent</th>
<th>KBps</th>
<th>ICAMark Score</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iteration Step 1</td>
<td>17:33</td>
<td>113643.2333</td>
<td>0.326472</td>
<td>101.982252</td>
<td>0</td>
</tr>
<tr>
<td>Iteration Step 2</td>
<td>17:35</td>
<td>89154.6833</td>
<td>0.255767</td>
<td>101.870167</td>
<td>0</td>
</tr>
<tr>
<td>Iteration Step 3</td>
<td>17:34</td>
<td>81691.4333</td>
<td>0.233884</td>
<td>101.912623</td>
<td>0</td>
</tr>
<tr>
<td>Iteration Step 4</td>
<td>17:34</td>
<td>76950.7667</td>
<td>0.220238</td>
<td>101.921681</td>
<td>0</td>
</tr>
<tr>
<td>Iteration Step 5</td>
<td>17:35</td>
<td>74167.6</td>
<td>0.212178</td>
<td>101.815689</td>
<td>0</td>
</tr>
<tr>
<td>Iteration Step 6</td>
<td>17:39</td>
<td>72578.71111</td>
<td>0.207273</td>
<td>101.650623</td>
<td>0</td>
</tr>
<tr>
<td>Iteration Step 7</td>
<td>17:44</td>
<td>71285.25714</td>
<td>0.202646</td>
<td>101.274975</td>
<td>0</td>
</tr>
<tr>
<td>Iteration Step 8</td>
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<td>71943.9875</td>
<td>0.204092</td>
<td>101.060369</td>
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</tr>
<tr>
<td>Iteration Step 9</td>
<td>18:04</td>
<td>70619.75465</td>
<td>0.198975</td>
<td>100.490011</td>
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</tr>
<tr>
<td>Iteration Step 10</td>
<td>18:21</td>
<td>70488.6867</td>
<td>0.196568</td>
<td>99.545747</td>
<td>0</td>
</tr>
<tr>
<td>Iteration Step 11</td>
<td>19:13</td>
<td>70661.80851</td>
<td>0.191348</td>
<td>96.900136</td>
<td>1</td>
</tr>
<tr>
<td>Iteration Step 12</td>
<td>20:03</td>
<td>70664.35655</td>
<td>0.187391</td>
<td>95.086999</td>
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<tr>
<td>Iteration Step 13</td>
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<tr>
<td>Iteration Step 14</td>
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<td>69537.24762</td>
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<tr>
<td>Iteration Step 15</td>
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<tr>
<td>Iteration Step 16</td>
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<tr>
<td>Iteration Step 17</td>
<td>23:27</td>
<td>67802.48814</td>
<td>0.158421</td>
<td>83.663681</td>
<td>4</td>
</tr>
</tbody>
</table>
### Dell PowerEdge 2650 3.0 GHz Xeon Results:

<table>
<thead>
<tr>
<th>Iterations</th>
<th>Time</th>
<th>Bytes Sent</th>
<th>KBps</th>
<th>ICAMark Score</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iteration Step 1</td>
<td>17:32</td>
<td>115386.8</td>
<td>0.331257</td>
<td>101.9805</td>
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<tr>
<td>Iteration Step 2</td>
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<td>91430.72</td>
<td>0.26197</td>
<td>102.0027</td>
<td>0</td>
</tr>
<tr>
<td>Iteration Step 3</td>
<td>17:34</td>
<td>82568.47</td>
<td>0.236386</td>
<td>101.8901</td>
<td>0</td>
</tr>
<tr>
<td>Iteration Step 4</td>
<td>17:34</td>
<td>77331.12</td>
<td>0.221557</td>
<td>101.9454</td>
<td>0</td>
</tr>
<tr>
<td>Iteration Step 5</td>
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<td>74704.1</td>
<td>0.213482</td>
<td>101.7378</td>
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<td>Iteration Step 6</td>
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<td>72607.42</td>
<td>0.206678</td>
<td>101.3989</td>
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<tr>
<td>Iteration Step 7</td>
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<td>72785.41</td>
<td>0.206127</td>
<td>101.0084</td>
<td>0</td>
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<tr>
<td>Iteration Step 8</td>
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<td>70948.61</td>
<td>0.198385</td>
<td>99.71373</td>
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<tr>
<td>Iteration Step 9</td>
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<td>71404.49</td>
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<td>98.02306</td>
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<tr>
<td>Iteration Step 10</td>
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<td>70955.42</td>
<td>0.191375</td>
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<tr>
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<td>0.18541</td>
<td>94.16642</td>
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<tr>
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<td>70088.38</td>
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<td>5</td>
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<td>70782.08</td>
<td>0.177199</td>
<td>89.68675</td>
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<td>Iteration Step 14</td>
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<td>69680.51</td>
<td>0.169543</td>
<td>87.45909</td>
<td>5</td>
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<td>Iteration Step 15</td>
<td>22:51</td>
<td>69534.63</td>
<td>0.162225</td>
<td>83.56976</td>
<td>10</td>
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<tr>
<td>Iteration Step 16</td>
<td>24:41</td>
<td>67698.03</td>
<td>0.152537</td>
<td>80.69577</td>
<td>1</td>
</tr>
<tr>
<td>Iteration Step 17</td>
<td>25:32</td>
<td>67173.56</td>
<td>0.148626</td>
<td>78.99491</td>
<td>9</td>
</tr>
</tbody>
</table>
PROCESSOR PERFORMANCE DATA

Figure 2: Comparison of the “Total Processor Utilization” between the Dell 2850 Xeon EM64T and the Dell 2650 Xeon

Figure 3: Comparison of the “Processor Queue Length” between the Dell 2850 Xeon EM64T and the Dell 2650 Xeon
Dell PowerEdge 2850 3.0GHz Xeon EM64T vs. Dell PowerEdge 2650 3.0GHz Xeon

Figure 4: Comparison of the “Context Switches” between the Dell 2850 Xeon EM64T and the Dell 2650 Xeon

MEMORY CONSUMPTION DATA

Figure 5: Comparison of the “Available Memory in MBytes” between the Dell 2850 Xeon EM64T and the Dell 2650 Xeon
**Disk Performance Data**

### Disk Utilization

![Disk Utilization Chart]

Figure 6: Comparison of the “Disk Utilization” between the Dell 2850 Xeon EM64T and the Dell 2650 Xeon

### Disk Queue Length

![Disk Queue Length Chart]

Figure 7: Comparison of the “Current Disk Queue Length” between the Dell 2850 Xeon EM64T and the Dell 2650 Xeon
**NETWORK PERFORMANCE DATA**

![Network Bytes/Sec Graph](image)

Figure 8: Comparison of the “Network Bytes per Second” between the Dell 2850 Xeon EM64T and the Dell 2650 Xeon

**SERVER HARDWARE CONFIGURATIONS**

**DELL POWEREDGE 2850**

- Dual Processor - 3.0 GHz Xeon EM64T with 1MB L2 Cache – 800MHz FSB
- 36 GB HDD U320 SCSI 15K RPM with Dell PERC 4e/Di Raid Controller – RAID 1
- 8 GB RAM - DDR2 400MHz
- 4 GB Page File

**DELL POWEREDGE 2650**

- Dual Processor - 3.0 GHz Xeon with 512Kb L2 Cache & 1MB L3 Cache – 533 MHz FSB
- 36 GB HDD U320 SCSI 15K RPM with Dell PERC 3/Di Raid Controller – RAID 1
- 8 GB RAM - DDR 266MHz
- 4 GB Page File

**TEST CONFIGURATION**

- Step Size: 10 users
- Iterations: 25 Iterations
Total Users in this test: 250 users
Script Version: 2.0

**CLIENT HARDWARE CONFIGURATION**

Pentium P3 1GHz w/256 kb Cache and 256 MB RAM

**CLIENT SOFTWARE CONFIGURATION**

Windows 2000 Server SP4, Citrix ICA Windows 32-bit Program Neighborhood Client Version 8.00.24737

**SERVER SOFTWARE CONFIGURATION**


**TEST METHODOLOGY - ICAMark**

A standard test begins by launching a set number of client sessions to the MetaFrame server being tested. Once all of the sessions have successfully connected, each of the sessions begins to run a set of scripts. Each script is staggered by one second so that the sessions are not running in parallel. The scripts are timed, the values are then compared to a calibration value, and the iteration’s score is computed. The process begins again, adding more sessions for each successful iteration. The calibration value was determined by running the scripts on a calibration machine. This machine is considered to perform at the level we expect an ICA Session to work. Each script was run locally, and the data recorded.

The Single Server Scalability tests are conducted using two internally developed tools – AutoSSS and ICAMark. AutoSSS is responsible for launching client sessions on the client machines and ensuring that all sessions are connected before launching the ICAMark scripts.

The ICAMark scripts simulate typical user actions performed using Microsoft Office XP PowerPoint, Excel, and Access. These scripts can have a tendency to fail during heavy load when a window does not appear within a specified amount of time. All the scripts have been modified to fail gracefully when they cannot find a window. If a script failure occurs, the script sets a registry key that identifies where it failed and the time of the failure. The AutoSSS console computes an estimated ICAMark score, by dividing the calibration score at this fail point by the script’s score at the recorded point. Delta time, delta bytes and KBps is disregarded for a failed script.

Four pieces of data are collected and stored by AutoSSS: Delta Time, Delta Bytes, KBps, and ICAMark Score. All values are recorded on an individual basis for each script, and for the iteration as a whole. The delta time is simply the running time of each script, and the delta bytes are the number of bytes sent over the wire to each session. The KBps is calculated by dividing the delta bytes by the delta time (in seconds). The ICAMark score is calculated by comparing a calibration value of the Delta Time, with the time gathered during this iteration.

AutoSSS has been configured to launch the Performance Data Log service in order to capture data from Microsoft Performance Monitor.
MEASUREMENTS AND CALCULATIONS

There are many calculations performed by ICAMark. Here is a summary of the more complex equations involved and measurements used in ICAMark.

Time
The time is taken using Ctime objects provided by MFC. A start and stop time are taken, and the difference is calculated using a CTimeSpan object.

Bytes
The byte count is measured by taking the output bytes from a WFAPI call and saving them as the start bytes. Then the script is run, and the stop bytes are taken. The difference is recorded.

KBps
This is taken by dividing the delta bytes by the time. The time is converted to seconds using the CtimeSpan.GetTotalSeconds() function.

AppScore
This is the score a script receives after it runs. The ICAMark client calculates it after a run of the script. Calibration time is the time recorded in the registry for each script. It was generated on the calibration machine. Delta time is the time recorded for the script just ran.

\[
AppScore = \frac{CalibrationTime}{DeltaTime} * 100
\]

FailScore
This is the recovery score that is recorded when a script fails. It is calculated by dividing the calibration fail score for the script by the fail score.

\[
FailScore = \frac{CalibrationFailTime}{ScriptFailTime} * 100
\]

IterationScore
This is the summary of the ICAMark score per iteration. It is the sum off all the app scores divided by the number of users. This score will be calculated at the end of the test. Data is recorded along the way to allow for this calculation.

\[
IterationScore = \sum_{u=1}^{Users} \left( AppScore_u + AppScore_{u+1} + \ldots + AppScore_n \right)
\]

\[
IterationScore_0 = \frac{\sum_{u=1}^{Users} (AppScore_0 + AppScore_{1} + \ldots + AppScore_n)}{Users * n}
\]

n = the number of apps being tested.
U = current user.
Users = the number of users involved in an iteration.
AppScore includes both FailScore and AppScore values listed above.
**Performance Data Log Counters**

The following provides summary information about the metrics, both objective and subjective, used to quantify performance during the scalability testing.

**Percent Processor Time**

Percent Processor Time is the percentage of time the processor is busy handling non-idle tasks. When observing processor utilization, quick and sudden spikes are not a huge concern. Simple tasks, such as logging in, will cause the processor utilization to spike. Administrators should look for an upward trend in the total utilization percentage. On an idle Terminal Server, typical processor utilization will hover around 0-10%. As more users connect to the server and begin to work, this percentage should slowly creep upwards on the performance monitor scale. Once the ‘Percent Processor Time’ reaches a sustained value between 70 and 80% or more, users might begin to notice performance degradation in the system.

**Processor Queue Length**

Processor Queue Length is the number of threads that are waiting to be processed by the processor. Processor queue lengths are minimal, typically less than two. If the queue length is consistently above two, the processor is typically considered to be overloaded.

**Available and Committed Memory**

Available memory indicates how much RAM is available for system processes, whereas committed memory is how much of the paging file has been reserved for future memory paging in case it is needed. By doing a proper benchmarking test of the system, one will get a better representation of how much memory, available and committed, is being used just by the operating system. By then monitoring the system with one user, and then subsequent numbers of users, an administrator should be better able to extrapolate how much memory a new user’s session will utilize. By having a good estimate of this, one would be better equipped to identify how much memory a Terminal server will require to serve a certain number of concurrent users.

**Percent Disk Time**

Percent Disk Time is the amount of time that the disk subsystem is busy trying to fulfill the requests to read or write data to or from the disks. This value is the sum of the percent disk time for all the disk drives in the system, and can therefore exceed 100%. For example: if there are 3 disks in the system and the utilization of each disk is 60%, 50% and 0%, the percent disk time would respond with 110%. However, the actual percent disk time is 110/3 or 37% busy.

**Current Disk Queue Length**

Current Disk Queue Length is the current number of disk requests to do read and write processes. Typically, one should not see any queue lengths when examining the disk subsystem. It is very likely one will see the queue length hit one or two. However, when a sustained value of greater than two is consistently observed, the disk subsystem is quite possibly the bottleneck.