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Is the cloud the right place for IBM Informix?

A TPC-C based stress test of Informix 12.10

Prepared by: Oninit Consulting Ltd

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Acknowledgments

About the Author

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Special Acknowledgments

We would like to thank the following individuals without whom this project would not have been possible:

Jon "JJ" Ritson
We would like to give a special note of thanks to JJ for his significant contribution to this and many other projects. The original test environment, used as the basis for this and many other projects, was architected by JJ whilst on secondment to Oninit Consulting Ltd. JJ is currently working for IBM UK in a support role focussed on Big Insights.

Eric Vercelletto
Eric adapted the original benchmark software for use with Informix and released his own benchmark results in 2012. With Eric's kind permission, this software was used as the basis for our tests. We'd like to thank Eric for his ongoing contribution to the Informix community.

Introduction

Objectives

We get asked a lot of questions about Informix, but over the last 2-3 years we've been asked this question more than any other:

"Should we move our Informix database applications into the cloud?"

Not the easiest question to answer, but it deserves something more than "Well, that depends!".

Cloud computing represents a fundamental change to the IT landscape and pretty much every customer we engage with is considering cloud at some level. We felt it was becoming increasingly important for us to more formally measure how Informix performs in a cloud environment and share that with our Informix customers and the Informix community.

The last Informix benchmark that we are aware of, was performed and published by Eric Vercelletto in 2012. It sought to demonstrate how cost-effective Informix database technology is - by putting the free version of Informix (Innovator-C) on a small, low-cost system and running a standard benchmark test against it to see how it would cope with the load.

Objective 1
With Eric's kind permission, we have recreated the tests he performed in 2012 and performed the same tests in a cloud environment. The cloud environment we selected aimed to reproduce the exact computing capacity of the system used by Eric in 2012. The benchmark workload was identical to the test in 2012. In our tests we used Informix 12.10 and Amazon Web Services as our cloud environment for the stress tests.

Objective 2
We've extended the tests to understand the difference between Innovator-C and Informix Workgroup Edition from a scalability and performance perspective. This helps to understand how far we can push the free version of the product today and stays true to the purpose of the original tests.

About the Test

The TPC-C Benchmark we are using was originally developed by students from the Universidad de Valladolid, managed by Professor Diego Llanos. This was adapted for use with Informix in 2012 by Eric Vercelletto. As Eric pointed out in his original white paper, this is not the TPC Council official source code, but it is compliant with TPC Council requirements. So this represents a STRESS TEST rather than an official benchmark.

The stress test measures the response times on 5 different OLTP transactions each comprising a set of SQL SELECT and DML statements. If more than 10% of each transaction type has a response time below the acceptable limit, the test fails. The limit for each transaction is hard-coded into the benchmark application.

The test will be given an overall result expressed in tpmC-uva, meaning number of valid transactions executed per minute. For each of those transactions, the stress test also reports the minimum, maximum, average and 90th percentile response times.

Resources and Recommended Reading

Eric Vercelletto's 2012 benchmark report.
http://en.vercelletto.com/2012/03/21/informix-innovator-c-edition-pushed-to-limits/

Feature comparison of all of the Informix database editions at V12.10.
http://www.ibm.com/developerworks/data/library/techarticle/dm-0801doe/

IBM software licensing metrics for IBM Softlayer and Amazon EC2.
http://www-01.ibm.com/software/passportadvantage/eligible_public_cloud_BYOSL_policy.html

For access to Informix software, presentations and technical material from the IIUG website.
http://www.iiug.org/index.php

To learn more about what Informix database technology is all about and what you can do with it.
http://www-01.ibm.com/software/data/informix/

Summary

Informix Innovator-C 12.10 Test Results

We've been using Amazon Web Services for several years now. We've even launched our own Informix database services on AWS and we run a number of our own core systems on AWS. Even taking into account our previously positive experiences with AWS as a platform, AWS has produced some impressive results in this test and produced some outstanding price/performance results.

"We saw an increase in computed throughput of 42%"

In Eric's test in 2012, performance started to degrade beyond 55 warehouses (550 connections). The maximum computed throughput in Eric's test was **610 tpmC-uva**. In our testing, 12.10 Innovator-C performance started to degrade beyond 70 warehouses (700 connections). The maximum computed throughput was **867 tpmC-uva**.

This means we saw an increase in computed throughput of 42% when compared to the 2012 test. We saw very similar results when testing Informix Innovator-C 11.70 in the same environment.

Figure 1: tpmC-uva for 12.10 Innovator-C

Interpreting the Informix 12.10 Innovator-C Test Results

The performance and throughput results outlined above would be impressive in themselves, but when we looked at the resource utilisation on the cloud platform we saw that the combined Informix database and application workload was consuming a mere 10% of the available computing capacity with I/O wait representing around 3%. This is significant, as in Eric's 2012 test, I/O contention was generating significant processing overhead - as much as 50% CPU utilisation associated with I/O wait. This contention was the ultimate cause of failure of the 2012 benchmark test when higher workloads were being tested.

This says something very important about the cloud infrastructure we used in this test. The quality and performance of the I/O subsystem has had a significant bearing on our test results and this quality and performance is something that is difficult to attain with low-cost commodity server hardware.

“The total daily cost was less than the price of 2 cups of coffee”

The total daily cost of the cloud environment was £4.34 – less than the price of 2 cups of coffee. We completed our testing over a two-week period at which point we closed our test. The total cost of the test environment was £60.76. And we'd done a lot of testing over that period!

Comparing Scalability of Informix 12.10 Innovator-C and Workgroup

To make this comparison meaningful, we configured Innovator-C and Workgroup to use their respective maximum CPU allocation. Otherwise, we retained the same configuration for Informix Workgroup as we used for Innovator-C. We didn't, for example, increase the memory allocation for Workgroup beyond the 2GB limit for Innovator-C. We also adhered to the 8GB storage limit in Innovator-C 12.10.

"Informix 12.10 Workgroup scaled linearly"

In short, Informix Workgroup scaled better than Innovator-C. This was unsurprising. If we have a look at the summary benchmark results graphically, we can see this demonstrated perfectly.

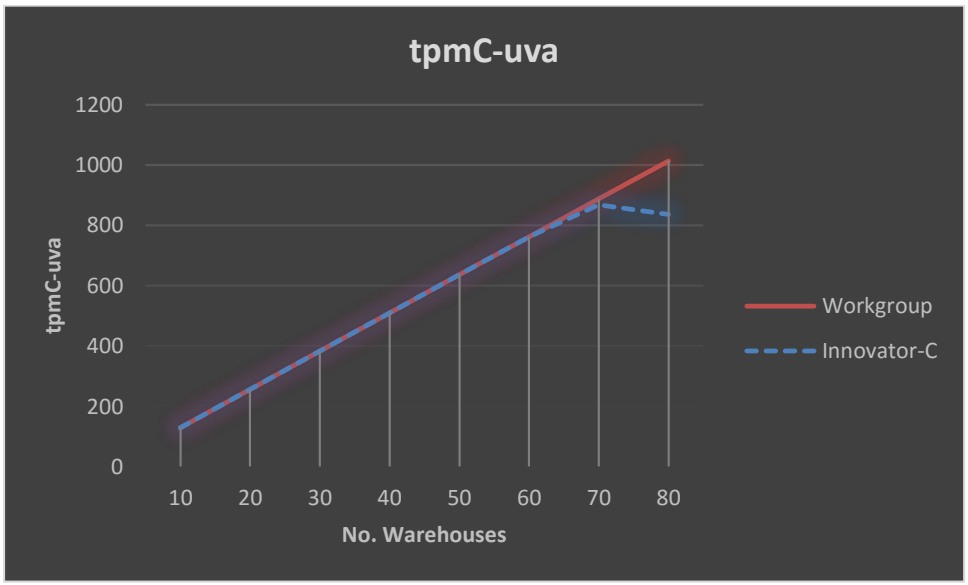

Figure 2: tpmC-uva comparing Innovator-C and Workgroup

As mentioned above, Informix 12.10 Innovator-C performance started to degrade severely beyond 70 warehouses (700 connections). The maximum computed throughput was 867 tpmC-uva. In terms of tpmC-uva, Informix 12.10 Workgroup scaled linearly even beyond 80 warehouses. At 80 warehouses (800 connections), the computed throughput was 1,013 tpmC-uva. At this level of processing, the system was still only consuming less than 13% of the available computing capacity.

Interpreting the Informix Workgroup 12.10 Scalability Test Results

In the knowledge that Informix Workgroup was clearly outperforming Innovator-C, we saw little value in increasing the data size (i.e. the number of warehouses). Instead, we elected to stress the Informix system by adding more connections (i.e. increasing the number of "terminals"). This had the benefit of significantly increasing the load but allowing us to recycle the tests more quickly.

We increased the number of terminals from 10 to 20. This meant a total of 1,600 database connections. In this case, we achieved a computed throughput of 1,964 tpmC-uva. The system was consuming less than 24% of the available computing capacity.

With Informix 12.10 Workgroup, we had to increase the load to 2,400 connections before the TPC-C stress test would fail.

This emphasises the importance to scalability of the CPU allocation. In Informix Workgroup 12.10 the CPU allocation actually exceeds the limit of the environment on which we have installed the test, so it scales practically linearly until we hit the I/O limit of the environment.

Comparing Performance of Informix 12.10 Innovator-C and Workgroup

The tpmC-uva measure does not accurately report performance. It is more a measure of transaction capacity.

In order for us to assess the relative performance of the Innovator-C and Workgroup products we needed to analyse the transaction response times during the measurement period and establish whether there was any performance difference.

"For very small workloads Innovator-C performed well"

Because each of the transaction types is different and may represent a slightly different proportion of the overall workload during any single benchmark run, we couldn't simply compare the average response times for each transaction type because this doesn't give us any sense of how each transaction is "weighted". Instead, we calculated the total transaction response times across all transaction types. When viewing this graphically, we see that there is a clear distinction between the two products.

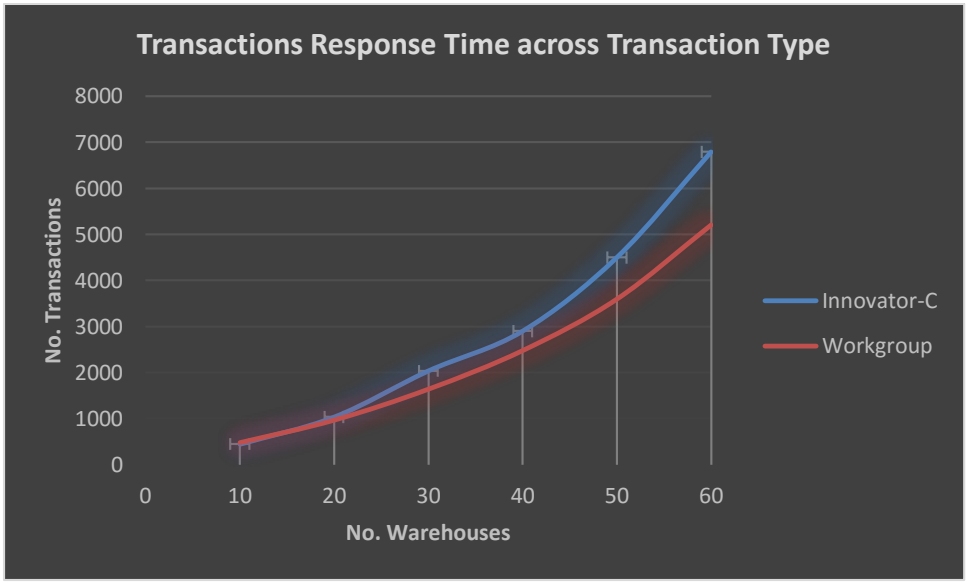

Figure 3: Transactions Response Time vs Transaction Type (1)

Interpreting the Informix Workgroup 12.10 Performance Test Results

From a performance perspective, Informix Workgroup performed better than Innovator-C in every test except the smallest of the benchmark tests.

In fact, we noticed that for very small workloads Innovator-C performed well. In some cases, as well or even slightly better than Workgroup.

The reason for this, we believe, is that CPU efficiencies kick-in at higher workloads. In our tests we have configured Innovator-C to operate in "single processor mode". This means that for tests that involve smaller workloads, smaller data sets and fewer connections, Innovator-C is potentially better optimised.

As we increase the workload the performance difference becomes very pronounced.

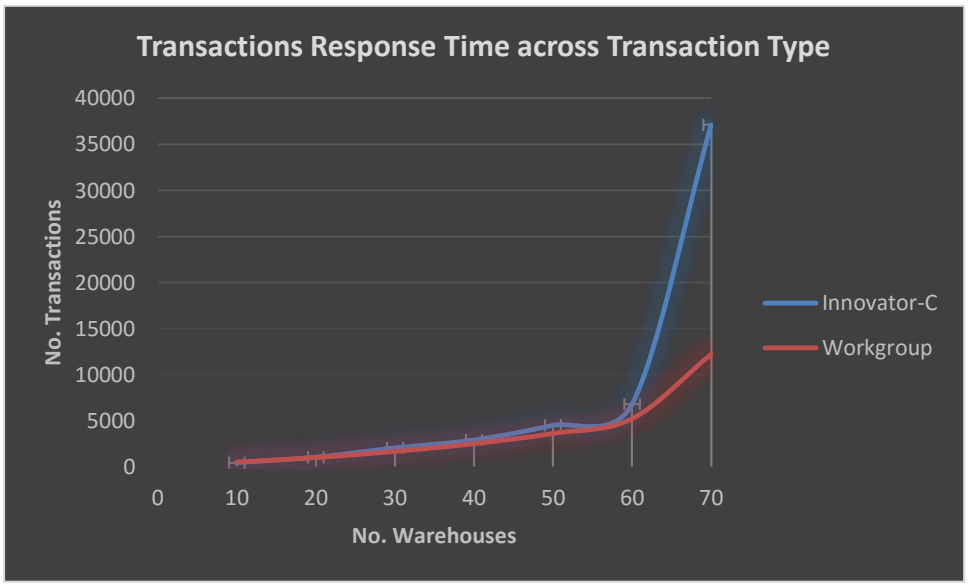

Figure 4: Transactions Response Time vs Transaction Type (2)

Pushing Informix Workgroup 12.10 to its limit

Up until this point all the testing was performed in a cloud environment that was using magnetic storage - i.e. HDD. This was done to have some basis for comparing our results with the tests performed in 2012.

As a bit of fun, we decided to run some higher volume tests on the same cloud environment using SSD. The highest volume test we performed that passed was 100 warehouses with 80 terminals (8,000 database connections). In this case, we achieved a computed throughput of 8,279 tpmC-uva.

What's changed from the 2012 test?

We're using Informix 12.10 instead of Informix 11.70. This seems an obvious statement, but it's worth emphasising that IBM continues to enhance and improve the Informix database technology with every new version. That said, Informix 12.10 Innovator-C has more usage restrictions than the very early 11.70 versions of the product.

We're running in a virtualised cloud environment. Again, this is obvious but worth stating.

We're using a different Linux distribution. Amazon Linux (based on RHEL).

In order to extend the benchmark tests to support higher volume workloads we've had to improve the stability of the benchmark program. Specifically, we've applied some code-fixes to its memory management, IPC, signal handling and error handling. There are no application changes. It generates exactly the same workload.

We've applied our own Informix configuration.

We've optimised the storage layout to accommodate a larger test. This is only required to stay within the 8GB storage limit applied to Informix 12.10 Innovator-C. However, we have applied exactly the same storage layout approach in the various Informix Workgroup tests.

Appendix A: System Configuration + I/O Performance

AWS Instance Configuration:

```
Name:                       M4 Extra Large
API Name:                   m4.xlarge
Memory:                     16.0 GB
Compute Units:              13 units (ECU)
Cores:                      4 (based on Intel 2.4 GHz Xeon E5-2676)
Storage:                    EBS only
Architecture:               64-bit
Network Performance:        High
EBS Optimised:              Max Bandwidth 93.75 MB/s
VPC Only:                   Yes
Operating System:           Amazon Linux (RHEL)
Storage:                    1x 64GB EBS general performance (SSD)
                            4x 16GB EBS magnetic (HDD)
```

The following is set of 'dd' results testing the write speed and latency of a traditional 7200rpm SATA II disk drive (3 Gb/s) and the AWS magnetic disks.

SATA II 7200rpm Disk

Write Speed

```
dd if=/dev/zero of=/backups/tmp/test1.img bs=1G count=1
oflag=dsync
1+0 records in
1+0 records out
1073741824 bytes (1.1 GB) copied, 11.306 s, 95.0 MB/s
```

Latency

```
dd if=/dev/zero of=/backups/tmp/test2.img bs=512
count=1000 oflag=dsync
1000+0 records in
1000+0 records out
512000 bytes (512 kB) copied, 9.59676 s, 53.4 kB/s
```

AWS Magnetic Disk

Write Speed

```
dd if=/dev/zero of=/idxdbs_01/tmp/test1.img bs=1G count=1
oflag=dsync
1+0 records in
1+0 records out
1073741824 bytes (1.1 GB) copied, 47.195 s, 22.8 MB/s
```

Latency

```
dd if=/dev/zero of=/idxdbs_01/tmp/test2.img bs=512
count=1000 oflag=dsync
1000+0 records in
1000+0 records out
512000 bytes (512 kB) copied, 2.27794 s, 225 kB/s
```

Appendix B: TPC-C Results (Informix Innovator-C)

```
Test results accounting performed on 2016-04-03 at 10:12:43 using 70
warehouses, 10 terminals.

Start of measurement interval: 15.029183 m
End of measurement interval: 60.029183 m

COMPUTED THROUGHPUT: 867.022 tpmC-uva using 70 warehouses.

 89495 Transactions commited.

NEW-ORDER TRANSACTIONS:
  39016 Transactions within measurement time (49774 Total).
  Percentage: 43.596%
  Percentage of "well done" transactions: 98.834%
  Response time (min/med/max/90th): 0.007 / 0.547 / 10.193 / 1.400
  Think time (min/avg/max): 0.000 / 12.020 / 120.000

PAYMENT TRANSACTIONS:
  38788 Transactions within measurement time (49794 Total).
  Percentage: 43.341%
  Percentage of "well done" transactions: 99.755%
  Response time (min/med/max/90th): 0.001 / 0.157 / 14.084 / 0.200
  Think time (min/avg/max): 0.000 / 11.993 / 120.000

ORDER-STATUS TRANSACTIONS:
  3914 Transactions within measurement time (5121 Total).
  Percentage: 4.373%
  Percentage of "well done" transactions: 99.285%
  Response time (min/med/max/90th): 0.001 / 0.287 / 10.843 / 0.560
  Think time (min/avg/max): 0.000 / 9.912 / 85.000

DELIVERY TRANSACTIONS:
  3885 Transactions within measurement time (5098 Total).
  Percentage: 4.341%
  Percentage of "well done" transactions: 98.533%
  Response time (min/med/max/90th): 0.023 / 0.495 / 8.781 / 1.200
  Think time (min/avg/max): 0.000 / 4.984 / 42.000

STOCK-LEVEL TRANSACTIONS:
  3892 Transactions within measurement time (5098 Total).
  Percentage: 4.349%
  Percentage of "well done" transactions: 99.974%
  Response time (min/med/max/90th): 0.002 / 1.703 / 21.398 / 5.120
  Think time (min/avg/max): 0.000 / 4.978 / 42.000


>> TEST PASSED
```

The following is a sample of the TPC-C style output reports. The reports for all of these tests can be made available on request.

TPC Clause 5.6.1: Innovator-C (70 Warehouses)

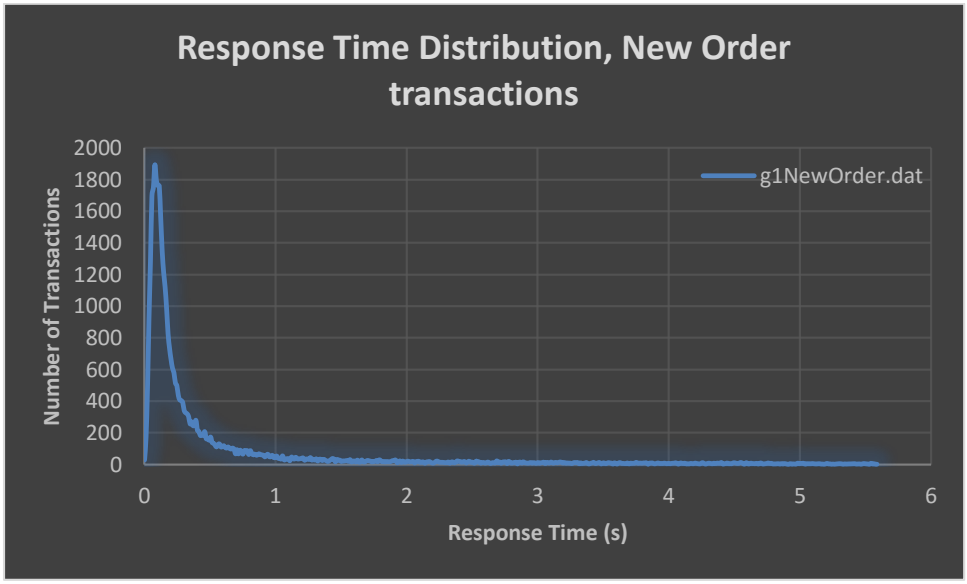

Figure 5: Response Time Distributions for New Order transactions [Innovator-C at 70 warehouses]

TPC Clause 5.6.4: Innovator-C (70 Warehouses)

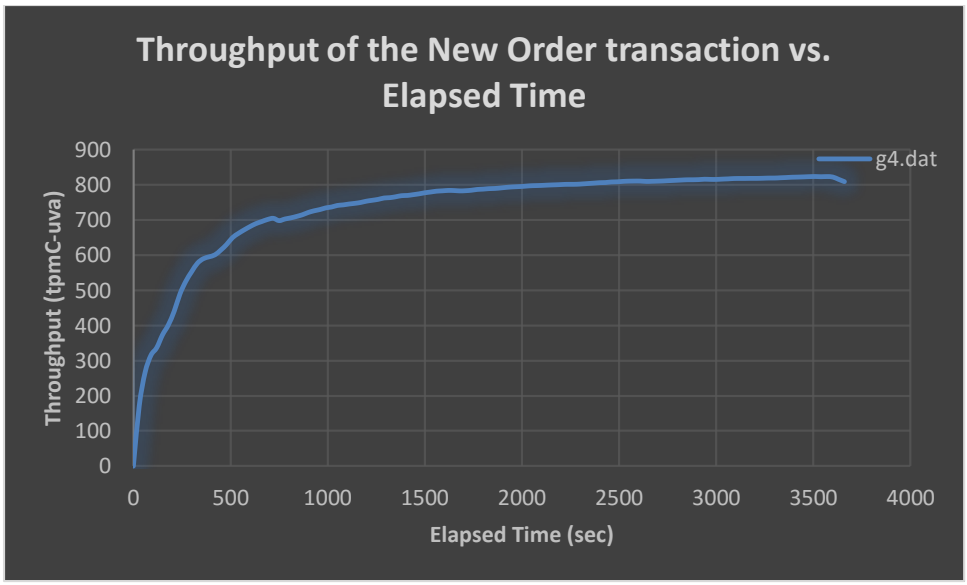

Figure 6: Throughput over time for New Order transactions [Innovator-C at 70 warehouses]

Appendix C: TPC-C Results (Informix Workgroup)

```
Test results accounting performed on 2016-04-06 at 09:25:44 using 80
warehouses, 10 terminals.

Start of measurement interval: 15.035600 m
End of measurement interval: 60.035600 m

COMPUTED THROUGHPUT: 1013.578 tpmC-uva using 80 warehouses.

 104511 Transactions commited.

NEW-ORDER TRANSACTIONS:
  45611 Transactions within measurement time (54808 Total).
  Percentage: 43.642%
  Percentage of "well done" transactions: 99.634%
  Response time (min/med/max/90th): 0.005 / 0.211 / 16.180 / 0.280
  Think time (min/avg/max): 0.000 / 12.046 / 120.000

PAYMENT TRANSACTIONS:
  45319 Transactions within measurement time (54324 Total).
  Percentage: 43.363%
  Percentage of "well done" transactions: 99.835%
  Response time (min/med/max/90th): 0.001 / 0.039 / 13.299 / 0.000
  Think time (min/avg/max): 0.000 / 12.043 / 120.000

ORDER-STATUS TRANSACTIONS:
  4522 Transactions within measurement time (5707 Total).
  Percentage: 4.327%
  Percentage of "well done" transactions: 100.000%
  Response time (min/med/max/90th): 0.000 / 0.063 / 2.553 / 0.080
  Think time (min/avg/max): 0.000 / 9.880 / 85.000

DELIVERY TRANSACTIONS:
  4520 Transactions within measurement time (5657 Total).
  Percentage: 4.325%
  Percentage of "well done" transactions: 99.668%
  Response time (min/med/max/90th): 0.013 / 0.186 / 13.927 / 0.240
  Think time (min/avg/max): 0.000 / 4.953 / 42.000

STOCK-LEVEL TRANSACTIONS:
  4539 Transactions within measurement time (5614 Total).
  Percentage: 4.343%
  Percentage of "well done" transactions: 100.000%
  Response time (min/med/max/90th): 0.001 / 0.035 / 6.104 / 0.000
  Think time (min/avg/max): 0.000 / 4.945 / 42.000


>> TEST PASSED
```

The following is a sample of the TPC-C style output reports. The reports for all of these tests can be made available on request.

TPC Clause 5.6.1: Workgroup (80 Warehouses)

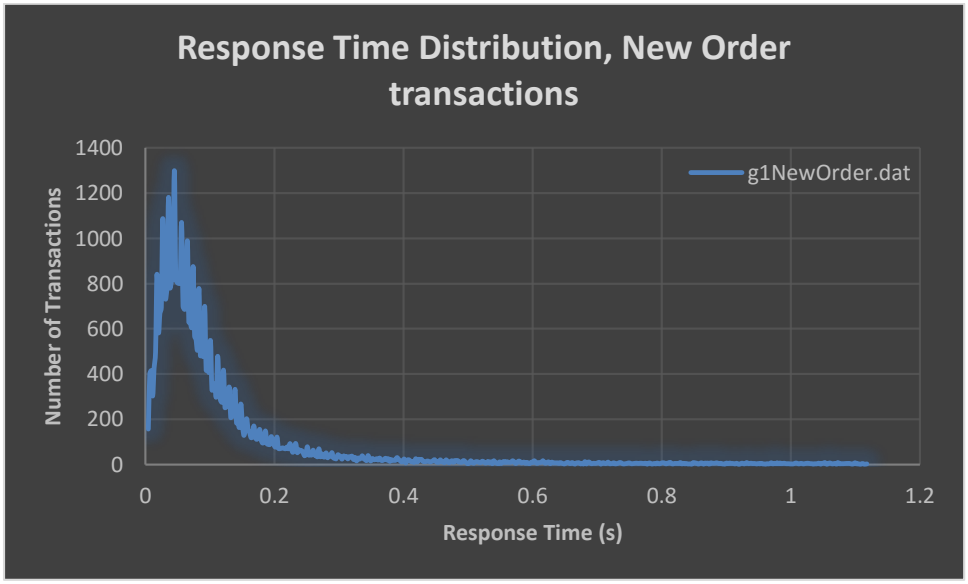

Figure 7: Response Time Distributions for New Order transactions [Workgroup at 80 warehouses]

TPC Clause 5.6.4: Workgroup (80 Warehouses)

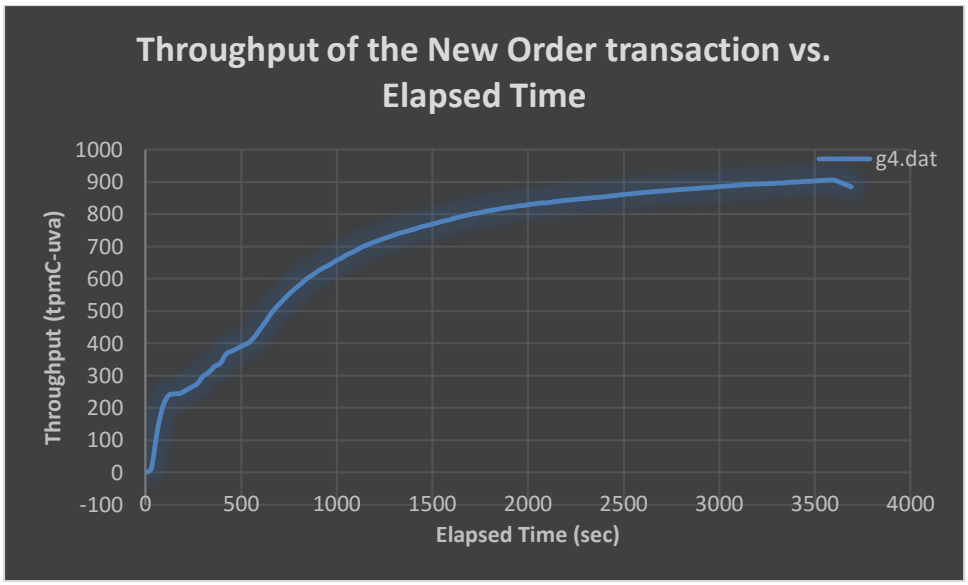

Figure 8: Throughput over time for New Order transactions [Workgroup at 80 warehouses]

Appendix D: CPU Utilisation Summary

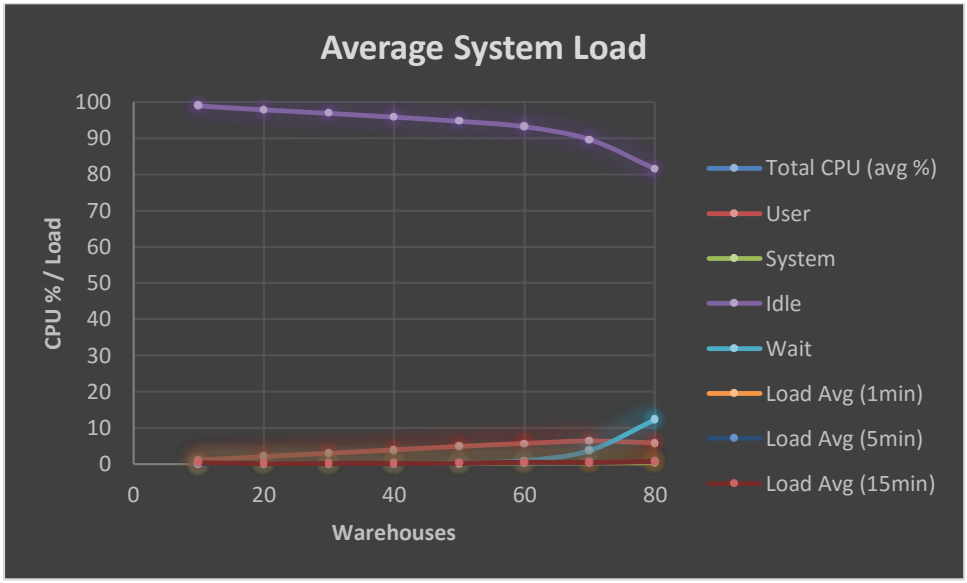

Figure 9: Average System CPU Load, by warehouse [Innovator-C]

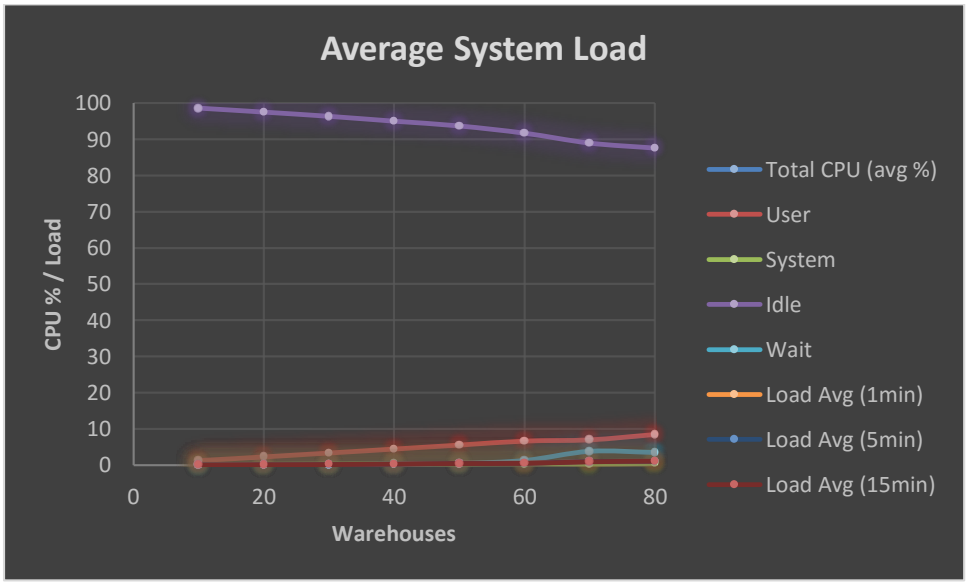

Figure 10: Average System CPU Load, by warehouse [Workgroup]

Appendix E: About Oninit Consulting Ltd

Oninit Consulting Ltd is a specialised IBM Premier Business Partner and one of the leading consulting firms in the UK in the field of IBM database technology. We provide expertise on high-performance, high-availability and high-volume database systems and we provide a dedicated UK-based technical support function.

Since 2005, we have delivered software and service solutions to more than 150 customers in the UK. Many of these companies are household names in the retail, media and finance sectors.

We are a partner-centric organisation and have links to many of the leading development and system integration companies in the UK, US and Germany.

As an organization, we support the work of the International Informix User Group and we promote the IIUG in the UK.

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