



Advent Portfolio Exchange® (APX) on VMware® vSphere™ 4 and VMware® vSphere™ 5

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DEPLOYMENT AND TECHNICAL CONSIDERATIONS GUIDE

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Introduction

This document provides direction to those interested in running Advent Portfolio Exchange® (APX), a portfolio management application, on VMware® vSphere™ 4 and VMware® vSphere™ 5. It provides basic guidance on the architecture of the APX application, as well as the value of utilizing the VMware platform. The results of recent testing done jointly by VMware and Advent are covered, where the performance and functionality of APX on VMware virtual infrastructure are characterized. Finally, some best practices for utilizing the two product sets together in your datacenter are outlined.

VMware and APX Overview

Advent Portfolio Exchange® (APX) Overview

Advent Portfolio Exchange® (APX) is an industry leading portfolio management solution, integrating all phases of investment management process- portfolio management, performance analytics, accounting and reporting, client relationship management, and prospect marketing. It offers a wide range of functionality that helps Advent's clients deliver superior service to their clients with optimal efficiency.

APX services various types of users with different requirements from front office to back office. Key features of the application are represented in the testing that has been performed in the virtualized environment, which includes

- Portfolio reporting using the APX proprietary Rep infrastructure
- Requests to the accounting engine to update portfolio transaction and time-weighted performance history data
- Portfolio reporting using standard Advent SSRS reports
- Web requests to query for portfolio, investment security and contact information
- Web requests to edit CRM and accounting data
- Batch jobs, which usually run overnight, for instance importing custodial position data using Dataport.

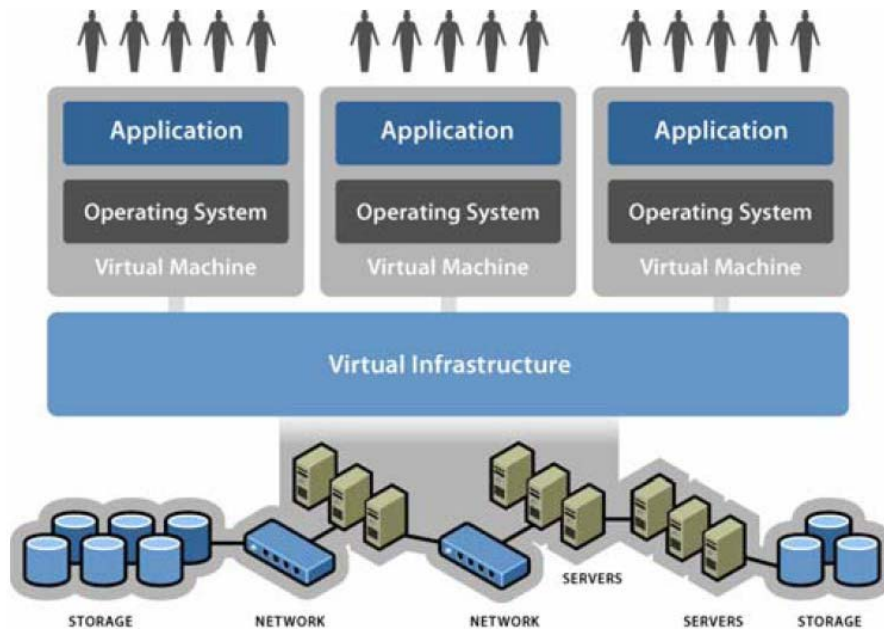
APX 4.0 was used for these performance tests, which supports up to 200 concurrent users.

VMware vSphere or VMware Virtual Infrastructure

VMware's leading virtualization solutions provide multiple benefits to IT administrators and users. VMware virtualization creates a layer of abstraction between the resources required by an application and operating system, and the underlying hardware that provides those resources. A summary of the value of this abstraction layer includes the following:

- **Consolidation:** VMware technology allows multiple application servers to be consolidated onto one physical server, with little or no decrease in overall performance.
- **Ease of Provisioning:** VMware virtualization encapsulates an application into an image that can be duplicated or moved, greatly reducing the cost of application provisioning and deployment.
- **Manageability:** Virtual machines may be moved from server to server with no downtime using VMware® VMotion™, which simplifies common operations like hardware maintenance and reduces planned downtime.
- **Availability:** Unplanned downtime can be reduced and higher service levels can be provided to an application. VMware® High Availability (HA) ensures that in the case of an unplanned hardware failure, any affected virtual machines are restarted on another host in a VMware cluster.

Figure 1: VMware vSphere Virtual Infrastructure



APX Architecture and Deployment Strategy

Advent Portfolio Exchange® offers you the flexibility to be installed in a variety of configurations depending on the firm's needs. Typically, APX is installed in a 2-server setup, one for the SQL-Server components and a second server for the application- and IIS web-server components. Beyond the basic configuration, you can add additional servers to optimize your processing environment. For example, it is common to have additional report servers to increase capacity for simultaneous report requests. Finally, depending on concurrent user-load and to allow for high availability, it is advisable to employ multiple load-balanced web and application servers and/or a database server cluster.

Advent publishes general guidelines for APX server sizing in a physical environment:
http://connection.advent.com/documentation/sys_req/APXSR40.pdf

The server sizing for a given implementation is dependent on the business requirements:

- The number of simultaneous report requests that may have to be served at peak levels determines how many total rep instances need to be configured. In a physical server environment, it is advisable for the number of configured rep instances to not exceed the number of logical cores on the app- and report servers. For virtual machines, this corresponds to the number of vCPU's of the virtual machine.
- If SSRS reporting is heavily used, enough resources should be available for the machine that hosts SQL Server Reporting Services.
- Depending on the concurrent user-load and intensity of users' activity, the SQL Server should be sized accordingly.

APX Test Environment Deployment

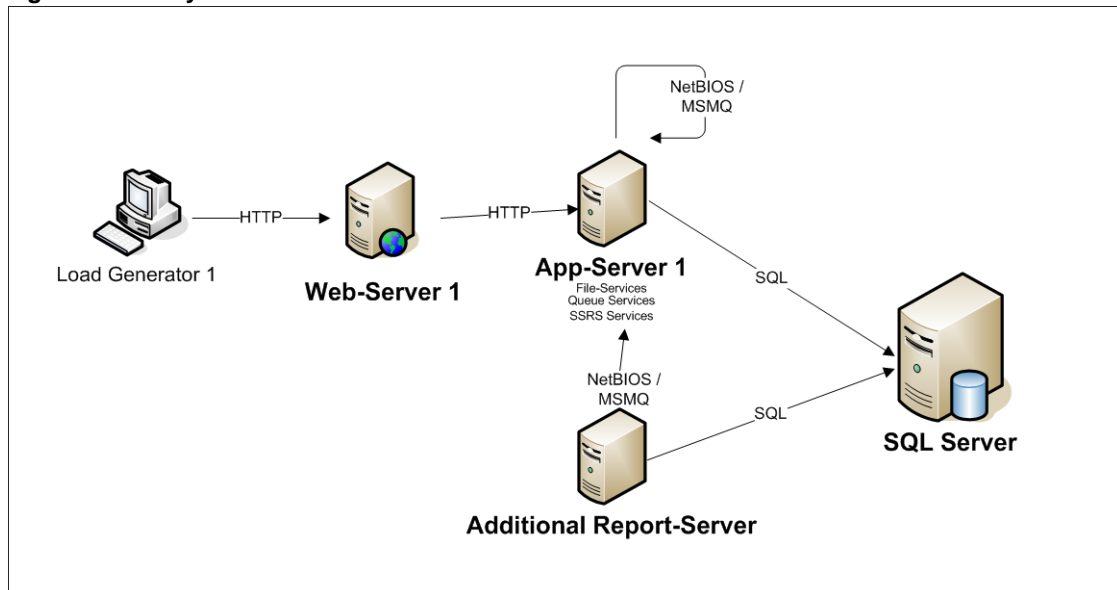
For purposes of the test performed in an entirely virtual environment, the following considerations were taken into account:

- Fast disk access to the storage is very important.
- The sizing of the virtual machines was adjusted in order to optimally service given work-loads (see details in section [Reference Architecture](#)).
- Under no circumstances were resources over-committed (that is, provisioning of CPU and memory in excess of what is physically available on the host).
- Clustering of the database server or application components were out of scope.

To accommodate work-loads up to 50 concurrent APX users, the test environment employed one application server and one web-server. The application server hosts APX File Services, Queue Services, and SSRS Services and is configured for 12 APX Rep instances. In a typical setup, the web-server is often combined with the application server. For testing purposes it was broken out to specifically measure the load on the IIS components. In order to service the amount of APX Rep reports requested by the load tests, an additional report server is configured with 12 Rep instances allowing for a total of 24 simultaneous Rep reports to be executed.

The Load Generator client simulates the user load by means of Microsoft Visual Studio 2010 Ultimate, a load generator tool which is used to drive user load, validate the application response and measure the response times for each test observation. Reported response times in this document are generally averages reported in seconds.

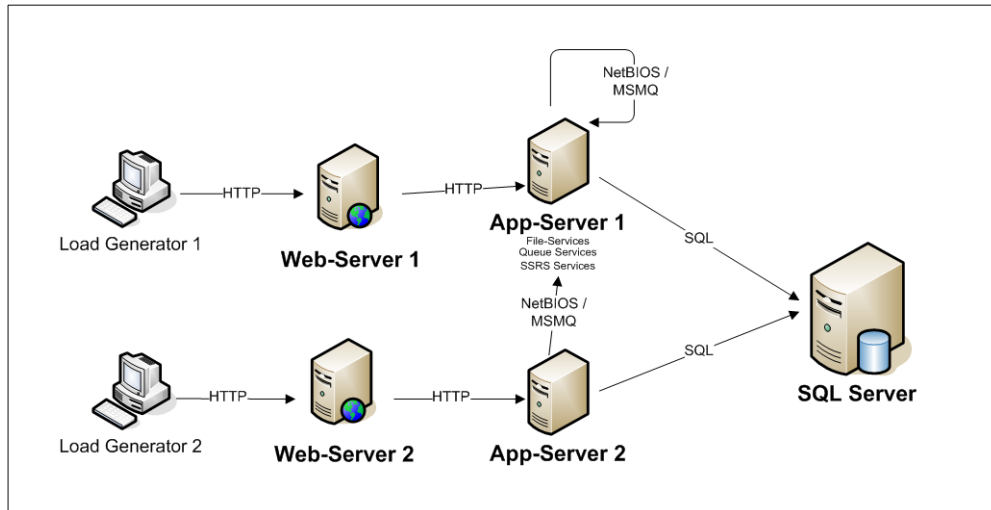
Figure 2: APX System Environment to service medium loads



In order to service concurrent user-loads of 100 users and beyond, a second web server and application server is employed. The workload is essentially split in half and distributed to the two web servers from two client load generators both running Microsoft Visual Studio 2010 Ultimate.

APX File- and Queue services as well as SSRS services are configured to run on App Server 1.

Figure 3: APX System Environment to service high loads



APX Test Environment Data Profile

Table 1:

Data type	Count
Portfolios	12,593
Portfolios with transactions	11,380
Average transactions per portfolio	1,189
Contacts	22,095
Securities	57,267
User Logins	443
User Groups	247
Used Database Size, excluding log	78 GB

Testing Process and Results

To characterize the performance of APX on VMware, Infrastructure performance tests were carried out jointly by VMware and Advent. The configuration tested and the results are summarized below.

The goal was to measure the following:

- APX application response time for different operations in a fully virtualized environment.
- The optimal virtual machine resource configuration to achieve the best possible response time.

The application response time in a fully virtualized environment is well within the acceptable limits. Test cases such as “Find Portfolio”, “Find Contact”, “Add/Delete Group”, Dashboard Viewing, Navigation etc. took less than one second on average (< 1 sec.) and different Rep report runs such as Appraisals, Realized Gain/Loss, Assets Under Management etc. took below 3 seconds (< 3 sec.) for normal workload condition of the environment (200 users with 60 sec. think time) and around 4 – 5 sec for stressed condition (200 users with 20 sec. think time).

It's been observed that the database virtual machine needs to provide 8 vCPU to support 200 user load tests with 20 second think times. Since this is the maximum vCPU configuration for vSphere 4.1, we could not scale up further. However, vSphere 5.0, which supports up to 32 virtual CPU's per virtual machine allows for even higher workloads, which was taken advantage of in the testing on vSphere 5.0.

As expected, the utilization of the application server configured to host SQL Server Reporting Services (SSRS) and APX Queue services is higher than the second report- or application server.

For detailed results, please refer the “[Results Observed](#)” section below.

Testing Methodology and Overview

The primary objectives of testing were to determine APX application performance characteristics and show that APX can scale and be run resiliently on VMware virtual infrastructure.

A single ESX host is used to host all virtual machines.

The testing is first conducted on ESX classic 4.1 U2 and later the same ESX host is upgraded to ESXi 5.0. While upgrading the ESX host, the service console or other components migration option is not chosen and a fresh install option is used.

vCenter server is not upgraded in this testing and two separate instances (vCenter 4.1 and vCenter 5.0) are used to manage the ESX host. vCenter server component is installed and configured in virtual machine.

The virtual machines are created using .vmdk files only and stored on vmfs file system, a high performance cluster file system that allows virtualization to scale beyond the boundaries of a single system, which is designed, constructed, and optimized for the virtual server environment.

The file system, vmfs 3, is used for testing on ESX classic 4.1 U2 and vmfs 5 for ESXi 5.0. The vmfs3 file system is not upgraded and virtual machines under tests on ESX classic 4.1 U2 are migrated to newly created vmfs5 file systems when tested under ESXi 5.0.

Performance tests are run for 25, 50, 100, 150 and 200 concurrent user loads at two different stress levels: think times of 60 seconds and 20 seconds. Think times represent a pause in between each executed test step. A warm up run for 10 – 15 minutes was done before starting the data collection. This ensures representative run-times similar to a production system. Each user set is run for 2 hours. Virtual machine configurations were adjusted based on the analysis of resource utilization of the virtual machines as reported by ESXTOP. This tool measures the performance of the underlying hardware rather than collecting

performance counters within the virtual machines themselves. ESXTOP allows monitoring and collection of data for all system resources: CPU, memory, disk and network. When used interactively, this data can be viewed on different types of screens; one each for CPU statistics, memory statistics, network statistics and disk statistics. In batch mode, data can be redirected to a file for offline uses.

Additional testing was conducted on a two-installation test with 200 concurrent users each (20 second think times).

Hardware and Software Configuration

Following diagram provides an overview of how the APX Firm is deployed in the ESX host to conduct the testing. The SSRS report is configured only in App Server 1 for One APX Firm and SSRS configured for App Srv1 and App Srv3 for Two Firm.

Figure 4: Test Bed for One APX Firm on ESX Host



Figure 5: Test Bed for Two APX Firm on ESX Host



Hardware and System Host Configuration

The following table describes the configuration of ESX host servers and storage in the Advent test configurations.

Table 2: ESX Host Hardware

Name	Specification
Server make/model	HP DL 980 G7 series
Processors	Eight Intel Xeon® X7560 @ 2.27 GHz (64 CPU cores)
Hyperthreading	Enabled
Memory	512 GB

Table 3: Storage Hardware

Name	Specification
Make/model of SAN	HP P4500 G2 iSCSI SAN with 3 nodes
Number of Spindles	36
Speed of HDD	15k rpm
LUN RAID type	RAID 1 + 0
How many other systems are sharing these LUNs	None
Datastore connection protocol	Software iSCSI protocol

Table 4: VM Hypervisor

Name	Specification
Version & patch level	ESX Classic 4.1 U2 and ESXi 5.0
Virtual switch type	Standard Switch
Port speed	iSCSI are on 10 GB NIC and VM are on 1 Gb NIC
Storage Connectivity	2 nos. of 10 GB NICs using software iSCSI (Both vmkernel switches are configured as Active/Active.)

Installed Software

Table 5: Software Installed for APX Solution

Installed Software	
VMware	VMware vSphere 4.1 U2, VMware vSphere 5.0
Advent	Advent APX 4.0
Microsoft	Microsoft SQL Server 2008 R2
Microsoft	Microsoft Visual Studio 2010 Ultimate (for load testing purposes only)

For details on APX 4.0 prerequisite and installation, please refer the following link :

http://connection.advent.com/documentation/sys_req/APXSR40.pdf

Virtual Machine Configuration

The following table describes the configuration of virtual machines running on ESX host servers in the APX test configurations.

Table 6: Virtual Machine Configuration

VIRTUAL MACHINE (CONFIGURATION FOR 200 USER STRESS TEST LOAD)	HARDWARE CONFIGURATION
Data Base Server (Windows Server 2008 R2 SP1)	<ul style="list-style-type: none"> • 8 vCPUs (for ESX 4.1 U2) / 12 vCPUs (for ESXi 5.0) • 16 GB memory • 1 Ethernet card (vmxnet 3) <p>Disk:</p> <ul style="list-style-type: none"> • OS/Page/PerfLogs/SQL Binaries (C:\) → 50 GB (vmdk only) • SystemDB Data/SystemDB Logs/User DBLogs/TempDB Logs/SQL trace & Logs (F:\) → 80 GB (vmdk only) • User data files (G:\) → 100 GB (vmdk only) • LSI Logic SAS SCSI controller
Application Server (Windows Server 2008 R2 SP1)	<ul style="list-style-type: none"> • 4 vCPU • 16 GB memory (App Server 1)/ 12 GB memory (App Server 2) • 1 Ethernet card (vmxnet 3) • 40 GB storage (1 x 40 GB) (vmdk only) • LSI Logic SAS SCSI controller
Web Server (Windows Server 2008 R2 SP1)	<ul style="list-style-type: none"> • 2 vCPU • 4 GB memory • 1 Ethernet card (vmxnet 3) • 40 GB storage (1 x 40 GB) (vmdk only) • LSI Logic SAS SCSI controller
vCenter Server (Windows Server 2008 R2 SP1)	<ul style="list-style-type: none"> • 4 vCPU • 4 GB RAM • 1 Ethernet card (e1000) • 40 GB storage (1 x 40 GB) (vmdk only) • LSI Logic SAS SCSI controller
Active Directory/DNS server (Windows Enterprise Server 2003 SP2)	<ul style="list-style-type: none"> • 1 vCPU • 1 GB RAM • 1 Ethernet card (e1000) • 15 GB storage (1 x 15 GB) (vmdk only) • LSI Logic Parallel

Load Generator (Windows Server 2008 R2 SP1)	<ul style="list-style-type: none"> • 4 vCPU • 8 GB RAM • 1 Ethernet card (vmxnet 3) • 40 GB storage (1 x 40 GB) (vmdk only) • LSI Logic SAS SCSI controller
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Workload Used

The workload in this performance validation includes both interactive and batch workflows.

Interactive activities include:

- Web UI navigation: Navigating through Portfolio, Contact or Security list and detail pages.
- Object creation: Performing creation and deletion of Portfolios, Groups, Contacts, Securities etc.
- Loading dashboards with content items. For example, graphs, charts, tables.
- Reporting: Running APX standard RepLang and SSRS reports.

Batch activities include:

- Posting transactions using trade blotter.
- Translating transaction, price, and position data using Advent Dataport.

Results Observed

In this validation, testing is categorized in two types:

- High-intensity load test with shorter think times of 20 seconds.
- Regular load tests with longer think times of 60 seconds.

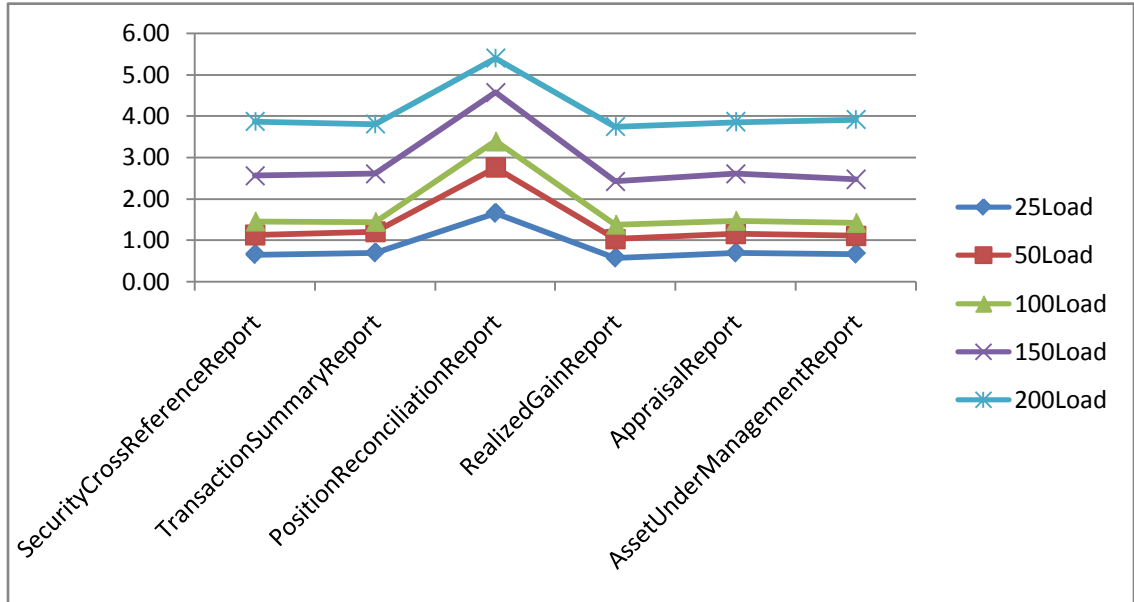
The performance tests are executed for both test types for ESX 4.1 U2. Since the results were well within acceptable limits for ESX 4.1 U2, only higher level stress tests are conducted for ESXi 5.0.

The tables and graphs discussed below are mostly for 200 users with 20 second think times since it is the highest user load.

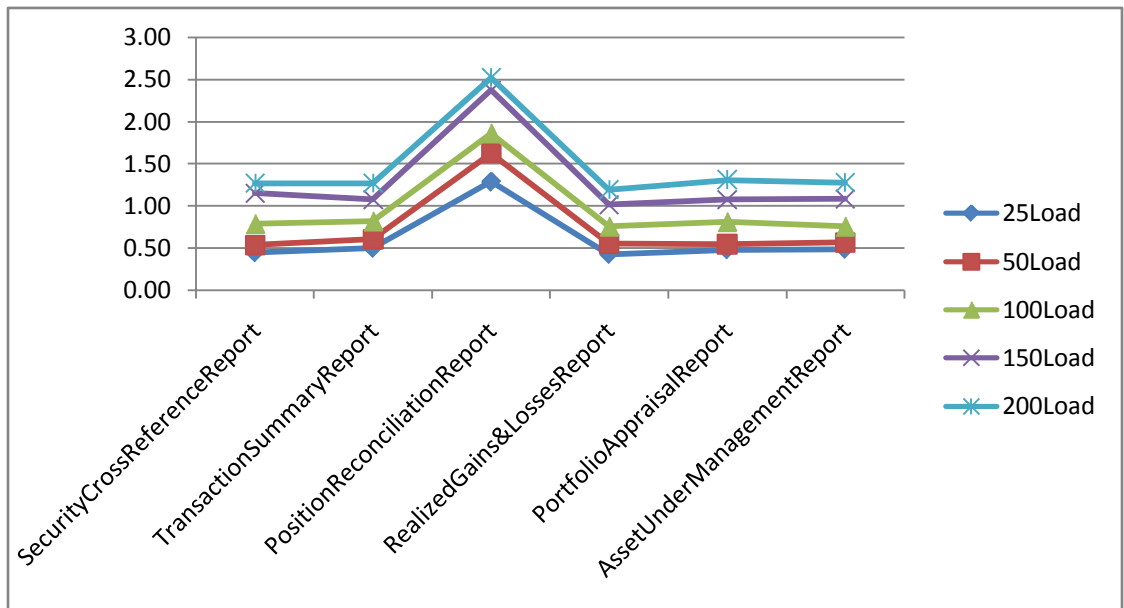
Furthermore, two APX installations are set up on the single ESX host to validate that multiple instances of APX can run in VMware vSphere.

Following graphs show the interactive rep report response for stress and normal user workload:

Graph 1: Interactive Rep Report for 20 seconds think time



Graph 2: Interactive Rep Report for 60 seconds think time



The following table discusses the report value comparison numbers between ESX 4.1 U2 and ESXi 5.0 for 200 users 20 sec. think time. The response time value for the reports improved in ESXi 5.0 when the database virtual machine vCPU count increased from 8 to 12.

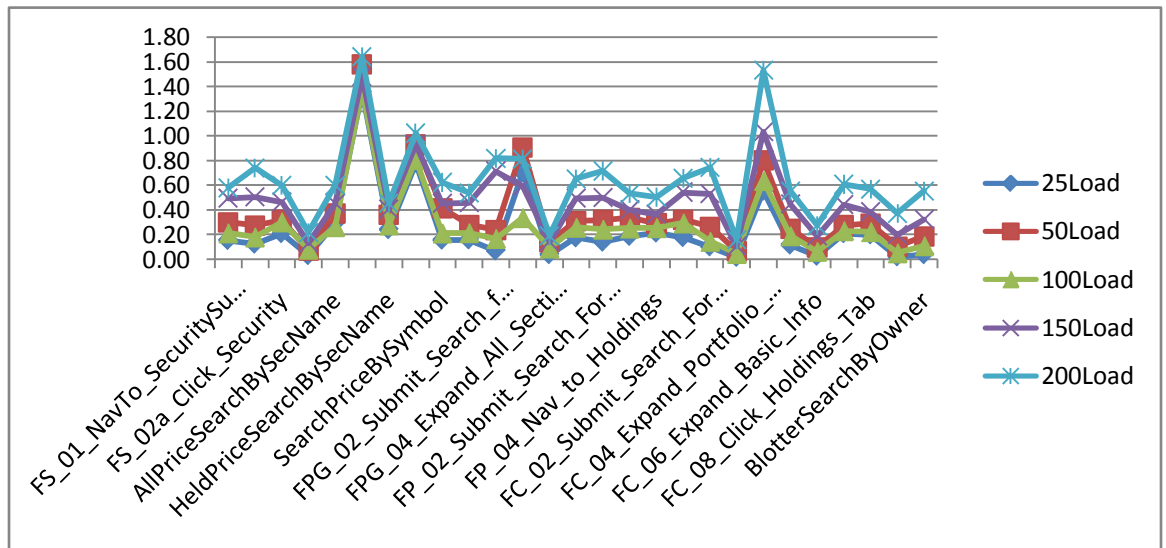


Table 7: Interactive Rep Report Comparative Results for 20 sec, think time

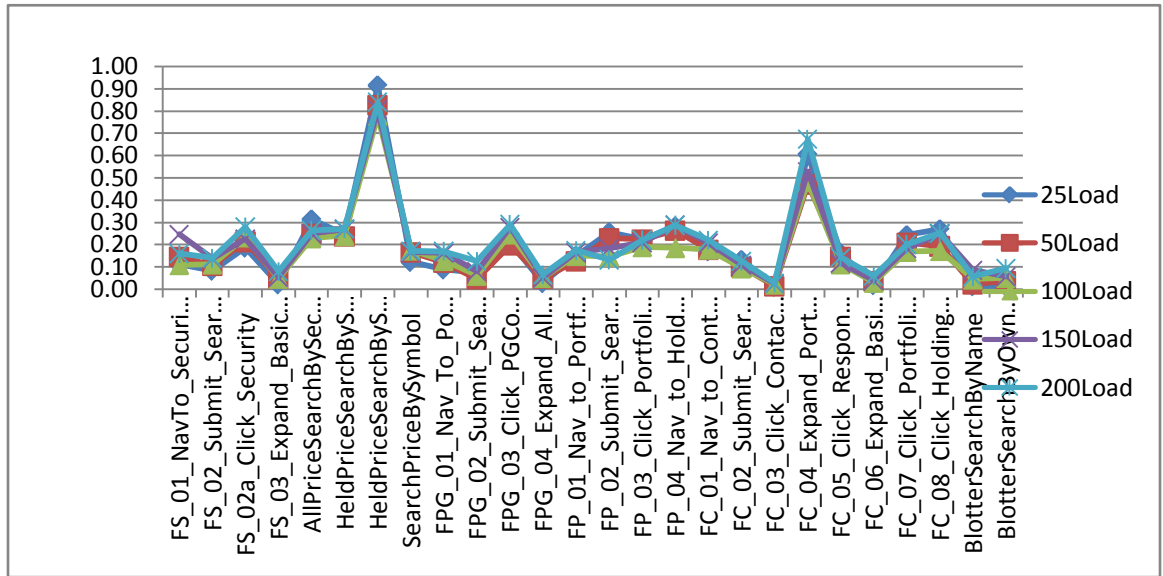
Test Name	Response Time in ESX 5.0 (in sec)	Response Time in ESX 4.1 U2 (in sec)
Security Cross Reference Report	3.66	3.86
Transaction Summary Report	3.58	3.8
Position Reconciliation Report	4.96	5.39
Realized Gains & Losses Report	3.57	3.75
Portfolio Appraisal Report	3.69	3.86
Asset Under Management Report	3.67	3.91

Following are graphical representation of navigation and search tests for APX application:

Graph 3: Navigation and search results for 20 sec. think time



Graph 4: Navigation and search results for 60 sec. think time



Following are the results of batch job testing:

Dataport

Two simultaneous translations for transaction, position, and price files:

Dataport	Number of Records	Execution Time	Translated/sec
Transaction	11,820	14 sec	844.28
	13,483	18 sec	749.05
Position	88,292	79 sec	1117.62
	88,665	60 sec	1477.75
Price	21,303	77 sec	276.66
	21,302	56 sec	380.39

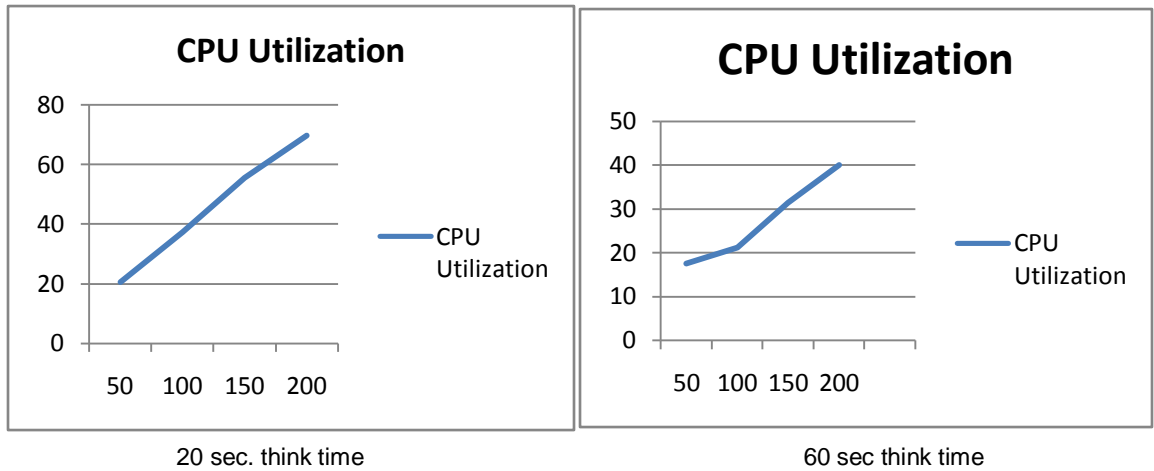
Blotter Posting

Two simultaneous blotter posting:

Load	Number of records	Execution Time
No additional load	10,107 lines 907 portfolios	4 min 17 sec
	11,012 lines process 1195 ports	2 min 48 sec
100 user load	10,194 lines 907 ports	5 min 17 sec
	11,049 lines 1,197 ports	6 min 2 sec

Below charts describes the CPU and Disk utilization for the Data Base (DB) server. Since the performance of Database is key to the response time, it is required to configure it correctly to get the optimal results.

Graph 5: Avg. CPU Utilization of DB server for 200 users test



Graph 6: Avg. Disk IO of DB server for 200 users test

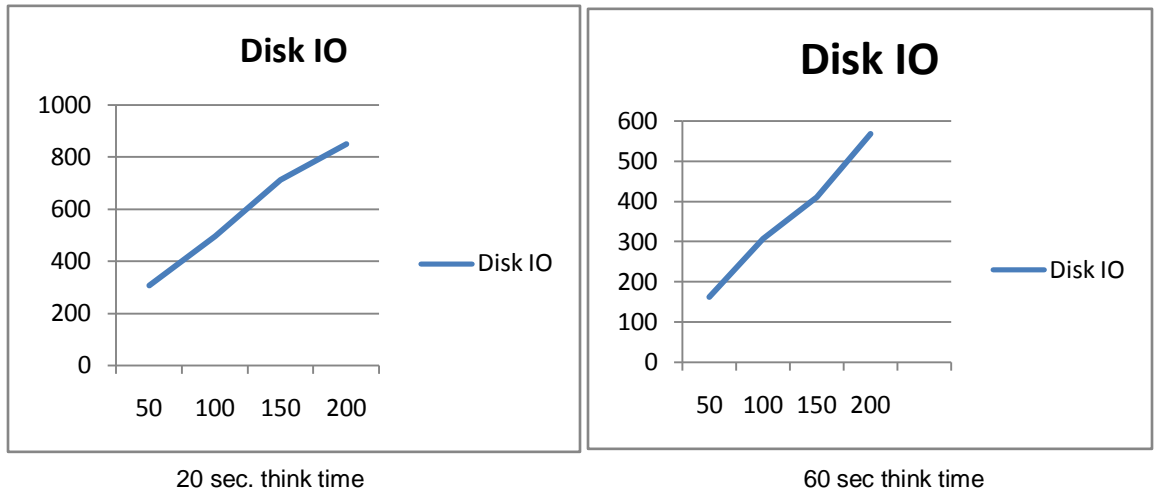


Table 8: Avg/Max Disk Throughput for DB server (in MBytes/sec):

	20 sec. think time				60 sec think time				
Users →	50	100	150	200	Users →	50	100	150	200
Throughput (Avg)	16.45	26.02	38	47.43	Throughput (Avg)	8.36	16.25	21.72	30.48
Throughput (Max)	40.82	70.93	65.29	118.32	Throughput (Max)	49.99	68.24	66.34	91.12

Graph 7: Disk throughput for DB server

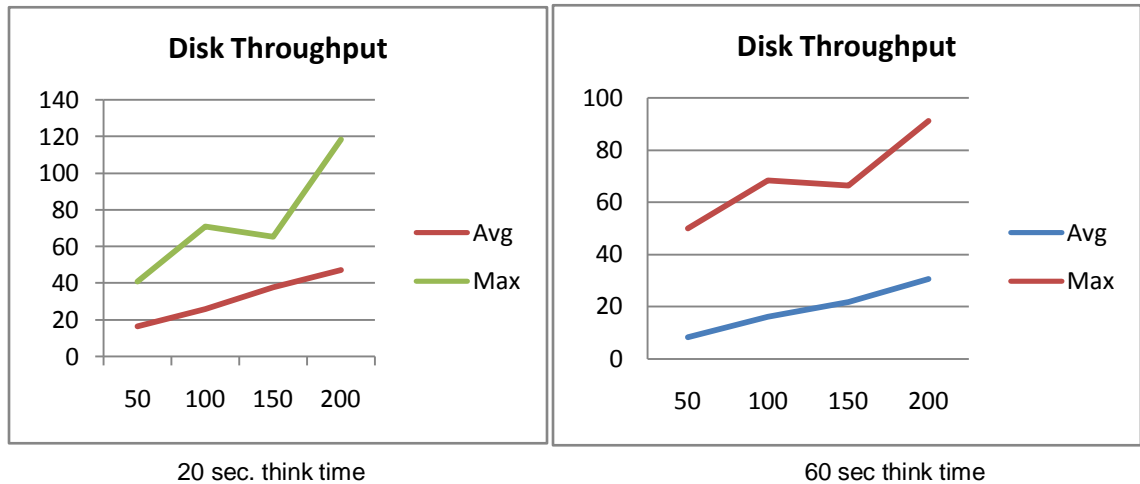


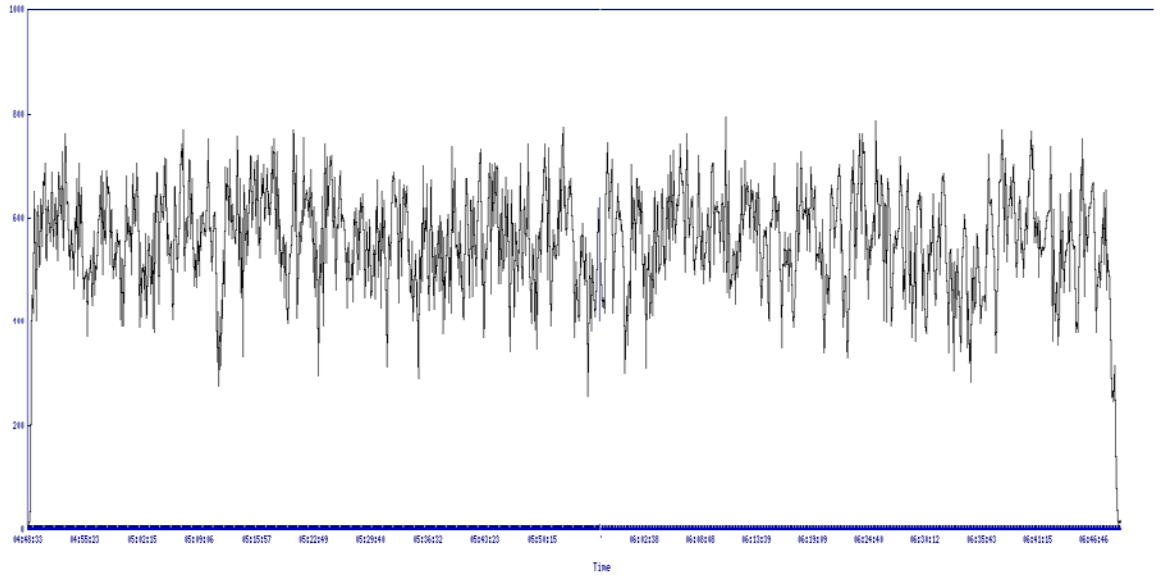
Table 9: Resource Utilization for 200 users, 20 sec think time on ESX 4.1 U2

VM	CPU		Memory		Network		Disk	
	(%)		(MB)		Packets/sec		I/O sec	
	Avg	Max	Avg	Max	Recd (Avg)	Txmitted (Avg)	Avg	Max
Advent-DB	69.79	96.52	3859.34	5079.04	3946.72	2683.05	851.94	1740.21
App Server1	51.13	93.64	6467.36	8192	4731.81	2486.26	33.34	71.32
App Server2	24.09	58.2	4393.81	5529.6	2598.9	1531.36	26.7	59.62
Web Server1	14.79	39.90	1679.08	2170.88	617.2	253.57	4.97	73.55
Web Server2	15.03	55.06	1584.18	2007.04	652.7	252.78	1.08	11.89

Table 10: Resource Utilization for 200 users, 60 sec think time on ESX 4.1 U2

VM	CPU		Memory		Network		Disk	
	(%)		(MB)		Packets/sec		I/O sec	
	Avg	Max	Avg	Max	Recd (Avg)	Txmitted (Avg)	Avg	Max
Advent-DB	39.98	68.41	3178.04	4423.68	2113.59	1351.1	568.53	3351.32
App Server1	39.11	83.68	5507.75	6881.28	3493.44	1817.94	21.04	36.83
App Server2	3.46	15.72	591.19	1105.92	397.32	297.02	2.07	14.14
Web Server1	8.79	26.66	1382.51	1679.36	394.66	149.46	1.16	64.31
Web Server2	9.11	29.27	1274.2	1679.36	383.09	148.85	1.21	64.99

Graph 8: CPU Utilization for 200 user 20 sec think time



Graph 9: Disk IO Utilization for 200 user 20 sec think time

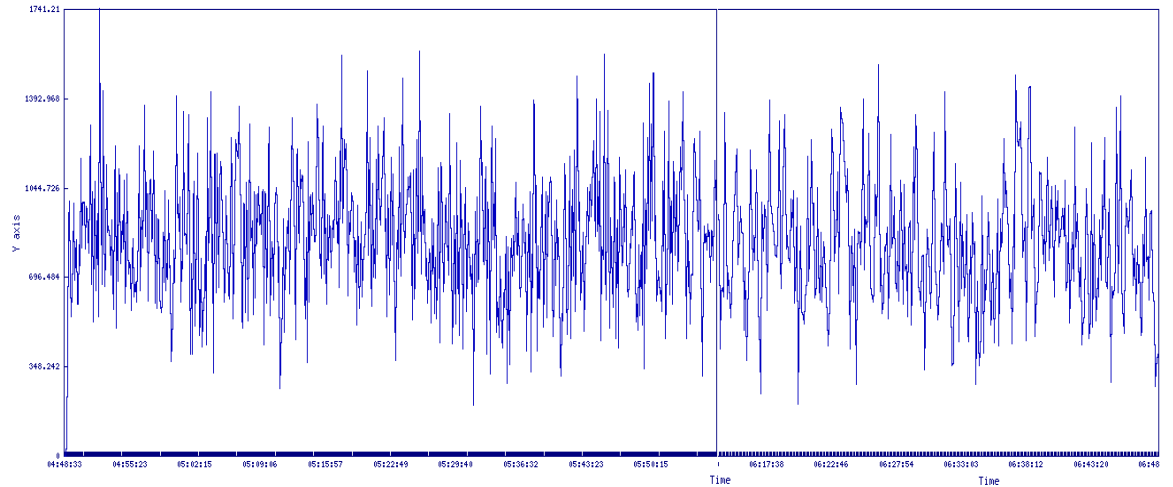


Table 11: Resource utilization for two APX installations on ESXi 5.0

VM	CPU		Memory		Network	
	(%)		(MB)		Packets/sec	
	Avg	Max	Avg	Max	Recd	Txmitted
Firm1 DB Server	55.71	81.43	3905.08	5406.72	3459.72	2408.56
Firm1 App Server1	53.88	82.90	6629.83	8192	4130.47	2105.42
Firm1 App Server2	32.02	64.24	4951.04	6758.4	2647.67	1471.14
Firm1 Web Server1	16.98	41.17	1940.71	2457.6	606.46	235.01
Firm1 Web Server2	16.06	45.48	2003.68	2375.68	579.99	232.62
Firm2 DB Server	55.95	75.57	3595.83	4915.2	3358.54	2318.7
Firm2 App Server1	52.47	78.26	5612.2	7208.96	4104.97	2029.07
Firm2 App Server2	36.36	64.88	4640.31	6062.08	3331.92	1873.52
Firm2 Web Server1	15.58	33.88	1800.65	2293.76	552.85	232.23
Firm2 Web Server2	16.53	42.19	1893.94	2375.68	605.46	236.91

Table 12: DB server avg. IO for two APX installations:

VM	Disk IO (Avg)
Firm1 DB Server	947.32
Firm2 DB Server	972.33

Deployment Best Practices

The following best practices were implemented during the testing and are recommended when deploying APX on the VMware vSphere platform:

- Configure the environment using ESX performance best practices for all infrastructure components as well as for BIOS.
- Create the vmdk disk file as “eagerzeroedthick” for virtual machines.
- It is recommended to perform partition alignment for the disk to get increased throughput and reduced latency. We did not need to do it as the testing is conducted on Windows 2008 R2 SP1 which is already partition aligned. For other OS, it needs to be configured.
- Apply the SQL server best practices for Database VM.
- Multiple volumes/LUNs are created for placing the database server VM disk files. Each disk file of database server VM is placed in one volume. This is done to achieve maximum disk throughput value. This is specific to the above storage and may vary for other storage. Please refer to your storage vendor documentation for best possible performance.
- Create a different virtual switch for VM and iSCSI traffic. It is recommended to provide at least two NIC cards for iSCSI traffic and configure it as “Active/Active” path.
- When using 10 Gb NIC card for iSCSI traffic, set the MTU size of network card to 9000. This helps avoiding network latency for packet transfer.
- Use “vmxnet3” network adapter for all VM's.
- Remove all devices which are not in use such as Floppy, CD/DVD and USB. If needed, they can be added to a VM.
- It is not required to assign the highest possible resource allocation for the VM during initial deployment. Use the hot add/remove feature of VMware vSphere for increasing the number of vCPU and memory of the virtual machines when user load is increased. Turn on the “hot swapping” feature for each VM from the vSphere client.
- Do not saturate/over-commit the systems and storage for best performance.
- Configure the Active Directory and DNS server correctly so that APX can access DNS server all the time.

Reference Architecture

The below tables describes the different configuration of CPU and Memory been used for different user load.

ESX 4.1 U2 (Single APX Firm)

Table 13: vCPU and Memory (in GB) distribution for stress tests having think time of 20 seconds

Load Size	DB Server		AppServer1		AppServer2		WebServer1		WebServer2	
	vCPUs	Memory	vCPUs	Memory	vCPUs	Memory	vCPUs	Memory	vCPUs	Memory
25	4	16	4	8	4	8	1	4	1	4
50	4	16	4	8	4	8	1	4	1	4
100	8	16	4	16	4	12	2	4	2	4
150	8	16	4	16	4	12	2	4	2	4
200	8	16	4	16	4	12	2	4	2	4

Table 14: VCPU and Memory (in GB) distribution for load tests having think time of 60 seconds

Load Size	DB Server		AppServer1		AppServer2		WebServer1		WebServer2	
	vCPUs	Memory	vCPUs	Memory	vCPUs	Memory	vCPUs	Memory	vCPUs	Memory
25	4	16	4	8	4	8	1	4	1	4
50	4	16	4	8	4	8	1	4	1	4
100	8	16	4	16	4	12	2	4	2	4
150	8	16	4	16	4	12	2	4	2	4
200	8	16	4	16	4	12	2	4	2	4

ESXi 5.0 (Single APX Firm)

Table 15: VCPU and Memory (in GB) distribution for stress tests having think time of 20 seconds

Load Size	DB Server		AppServer1		AppServer2		WebServer1		WebServer2	
	vCPUs	Memory	vCPUs	Memory	vCPUs	Memory	vCPUs	Memory	vCPUs	Memory
200	12	16	4	16	4	12	2	4	2	4

ESX 5.0 (Two APX Firm)

Table 16: VCPU and Memory (in GB) distribution for stress tests having think time of 20 seconds

	Load Size	DB Server		AppServer1		AppServer2		WebServer1		WebServer2	
		vCPUs	Memory	vCPUs	Memory	vCPUs	Memory	vCPUs	Memory	vCPUs	Memory
Firm1	200	12	16	4	16	4	12	2	4	2	4
Firm2	200	12	16	4	16	4	12	2	4	2	4

Licensing

There is no special licensing need to support the application in VMware virtualized environment. The APX application licensing as applicable to physical environment holds true for VMware virtual environment as well. To support VMware features such as vMotion, HA, DRS, DPM and so on, appropriate licensing has to be considered.

Technical Support

Advent Technical Support is available online at http://connection.advent.com/support/online_support.asp

Conclusions

Overall, testing results show that running APX on VMware Infrastructure performs well. Furthermore, it has potential to reduce cost, increase service levels and simplify the manageability of the application.

Application response times for all APX test cases are excellent, even at high-intensity load levels given the tested workloads and allocated hardware. The testing validates that all of the APX application components including the database server can be virtualized with ease in the VMware vSphere platform without compromising on application response time. If necessary, the VM configuration for CPU and memory can be changed at run time using the VMware “hot add” feature.

Although VMware vMotion, HA, and DRS features were not in scope for the described testing, these options may offer further virtualization benefits to this solution.

Finally, this document concludes that APX is ready to be deployed in production environment on VMware vSphere.

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- Biswapati Bhattacharjee, ISV Validation Engineer, VMware
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Resources

Customers can find more information about VMware and Advent products using the links listed below:

VMware Resources

- VMware official website:
<http://www.vmware.com/>
- VMware vSphere product Web site:
http://www.vmware.com/products/data_center.html
- VMware download Web site:
<https://www.vmware.com/download/>
- VMware support Web site:
<http://www.vmware.com/vmtn/>
- VMware Performance Tuning Paper:
http://www.vmware.com/pdf/vi_performance_tuning.pdf
- VMware vSphere performance best practices:
http://www.vmware.com/pdf/Perf_Best_Practices_vSphere5.0.pdf
- SQL server on VMware best practices:
http://www.vmware.com/files/pdf/sql_server_best_practices_guide.pdf
- iSCSI/SAN configuration guide:
http://www.vmware.com/pdf/vsphere4/r41/vsp_41_iscsi_san_cfg.pdf
- VMware compatibility guide for storage, I/O, systems, OS:
<http://www.vmware.com/resources/compatibility/search.php>

Advent Resources

- Advent Web site:
<http://www.advent.com>
- Advent Client-Only web site:
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