Microsoft Dynamics® AX 2012 "Day in the life" benchmark summary

In August 2011, Microsoft conducted a "day in the life" benchmark of Microsoft Dynamics® AX 2012 to measure the application's performance and scalability characteristics.

The benchmark runs a variety of functional scenarios that use different client and integration technologies, thereby providing a view of ERP workload performance on Microsoft Dynamics AX 2012. This benchmark includes rich client simulations of core accounts receivable scenarios, from order entry through invoicing, quotation management, item arrivals, transfer orders, and payment processing. Enterprise Portal for Microsoft Dynamics AX is used to create timesheets and purchase requisitions. Purchase requisitions are converted into purchase orders through a workflow, and then posted to the general ledger. Services and Application Integration Framework (AIF) are used to generate sales orders. Batch processing with a Microsoft Dynamics AX 2012 asynchronous batch server is used to post general journals and invoice the sales orders that are received through services and AIF.

These scenarios generate load on an instance of Application Object Server (AOS). In this benchmark, some of the AOS instances are configured as multiple logical AOS instances in a cluster.

With this concurrent workload, a 48-core 256-gigabyte (GB) database server sustained 77-percent CPU utilization, while demonstrating the ability of Microsoft Dynamics AX 2012 to scale up and scale out on the AOS tier. User experience measures were below 2 to 3 seconds for intensive posting operations, and line save operations averaged sub-second response times. The benchmark simulated 5,135 concurrent users who were divided among three roles. The benchmark demonstrated a sustained rate of more than 1 million lines per hour for these concurrent scenarios.

The benchmark results demonstrate the ability of Microsoft Dynamics AX 2012 to handle various specialized loads concurrently, without compromising performance and scalability for critical business processes.

This document presents a summary of the benchmark results. For detailed results, see Microsoft Dynamics AX day in the life benchmark results, (http://go.microsoft.com/fwlink/?LinkID=230564).

RESULTS SUMMARY

The mixed workload scenario focuses on demonstrating the ability of Microsoft Dynamics AX 2012 to run mixed workloads without encountering scalability or response timeout issues. The mixed workload includes simulated rich clients performing online transactions, Enterprise Portal performing self-service transactions, services processing messages, and batch processing of postings.

The goal of the mixed workload scenario is to provide customers with a sizing data point for AOS and database servers, with representative functionality.

Throughput measurements

Transaction	Lines/hour	User concurrency
Invoiced – Sales order lines created through AIF	381,885	N/A
Posted – General ledger journal lines	250,000	N/A
Approved timesheet lines	56,418	1,095
Sales order lines	224,080	2,820
Sales quotation lines	29,770	210
Purchase requisition lines	11,265	95
Purchase order lines	9,640	95
Transfer order lines	47,765	410
Item arrival lines	42,420	410
Total	1,053,243	

Response time measurements

Transaction unit	Time (seconds)
Sales order header creation	0.40
Sales order line creation	0.45
Sales order picking list creation	1.32
Sales order packing slip creation	1.42
Sales order invoicing	1.84
Sales order line creation through AIF	1.92
Purchase requisition header creation	0.20
Purchase requisition line creation	0.59
Purchase requisition submission	0.88
Purchase order confirmation	1.26
Purchase order receipt list creation	0.57
Purchase order packing slip creation	2.60
Purchase order invoicing	3.83
Item arrival header creation	0.11

Transaction unit	Time (seconds)
Item arrival line creation	0.20
Item arrival posting	2.29
Item arrival end	1.85
Transfer order header creation	0.13
Transfer order line creation	0.24
Ship transfer order	1.70
Receive transfer order	0.20
Sales quotation header creation	0.66
Sales quotation line creation	0.59
Sales quotation confirmation	0.12
Sales quotation send	1.93
Enterprise Portal transactions	
Employee service page	0.44
Click new timesheet	0.51
Click new line	0.34
Line creation	0.41
Submission	1.00
Sign out	0.07

Utilization summary

Utilization measure	Result
Number of concurrent users	5,135
Number of AOS instances supporting rich clients	5
Utilization of rich client AOS instances	46.5%
Number of batch servers	3
Utilization of batch server for sales order invoicing (2 servers)	18.8%
Utilization of batch server for general ledger posting and workflows (1 server)	19.4%
Utilization of AOS instance dedicated to AIF and services	25.5%
Number of servers running Enterprise Portal	1
Utilization of Enterprise Portal server	58.5%
Utilization of AOS instance dedicated to Enterprise Portal	13.19%
Utilization of database server	77.0%

BENCHMARK TRANSACTION PROFILE

This benchmark consists of the following transactions.

Sales order processing

- Save the sales order header.
- Enter 5 line items.
- Simple trade agreements.
- 20% of the lines include discount calculation.
- Simple chart of accounts.
- 1 miscellaneous charge.
- No manufacturing or cost accounting.
- No administrative user usage.
- Invoice the sales order.
- Detailed tax and chart of accounts update [Ledger].
- Commission calculation.
- Credit limit checking at invoicing.

Sales order lines created through services/AIF

- Save the sales order header.
- Enter 15 line items.
- No tax needed.
- Simple chart of accounts. The intent is a financial and inventory update. No markup transactions.
- No manufacturing.
- No cost accounting.
- No standard cost.

Purchase requisitions

- Save the purchase requisition header.
- Enter 5 line items.
- Firm purchase requisitions to purchase orders by using auto-approve on the purchase orders.
- Half of the purchase requisitions are split into 2 purchase orders, based on the preferred vendors. Therefore, the number of lines on the purchase orders is between 3 and 5.

Purchase orders

- Purchase orders are created by firming purchase requisitions.
- Confirm the purchase order.
- Receive and pack.
- Invoice the purchase order.

Item arrivals

- Create an arrival journal, and select the purchase order.
- Create a quarantine order.
- Use quarantine management to end quarantine and move the inventory to the regular warehouse.

Transfer orders

- Create and save the header.
- Enter 5 lines.
- Warehouse-to-warehouse transfer.

Sales quotations

- Create the sales project quotation header.
- Enter 10 lines.
- Send the sales quotation.
- Confirm the sales quotation.

Time entry

- Create a timecard with 6 lines.
- Enter a project code, a category, and hours on each line.
- Save and submit the timecard.
- Approve the timecard by using workflow.

General ledger

- 10-line entry with a simple chart of accounts.
- Each journal consists of one voucher with 10 lines. 40% of the lines contain sales tax and are spread across ledger accounts, bank accounts, and vendor and customer accounts.

The following table shows the user breakdown, as well as the overall transaction rate breakdown.

Transaction	Con-currency	Transactions per hour per user	Lines per hour per user
Sales orders	2,820	16	90
Purchase requisitions	95	24	119
Purchase orders	95	25	101
Sales quotations	210	14	149
Item arrivals	410	21	121
Sales orders created through AIF	84	303	4,774
Expense timecard entry	1,095	9	56
Transfer orders	410	23	239
General ledger	N/A	25,000	N/A

BENCHMARK METHODOLOGY

Microsoft® Visual Studio® 2010 Ultimate was used as a load driver to simulate three types of loads:

- Concurrent users through .NET Business Connector for Microsoft Dynamics AX – A business transaction was simulated at an average rate of once every 6 minutes for each concurrent user.
- Enterprise Portal users through .NET Business Connector – A business transaction was simulated at an average rate of once every 6 minutes for each concurrent user.
- Service and AIF calls to create sales orders.

Measurements were recorded on the servers used for the benchmark and were measured when the concurrency reached a steady state. The steady state was maintained for a minimum of 60 minutes, with repeat runs that were within acceptable deviation for throughput and response times.
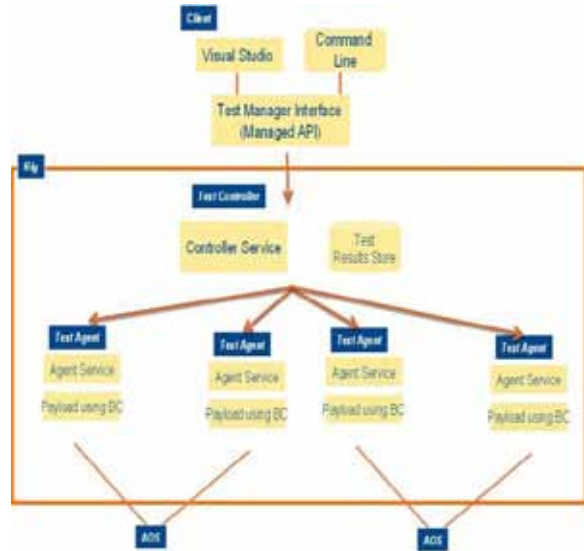
The following rules were followed for the benchmark:

- Benchmark runs had a minimum steady state of 1 hour.
- The ramp-up duration was approximately 30 minutes.

HARDWARE LAYOUT AND CONFIGURATION
None of the servers were hyper-threaded.

AOS server specification

- 10 AOS servers, 8–12 cores, 16 GB of RAM
- 64-bit version of Microsoft Windows Server® 2008 R2 Enterprise Edition – Or– 64-bit version of Windows Server 2008 Enterprise Edition with SP2

Enterprise Portal server specification

- 1 Internet Information Services (IIS) server, 8 cores, 16 GB of RAM
- 64-bit version of Windows Server 2008 R2 Enterprise Edition with SP2

Visual Studio Ultimate client specification

- 3 controllers, 14 agents
- 2–8 cores, 4–8 GB of RAM
- 64-bit version of Windows Server 2008 Enterprise Edition with SP2
- 64-bit version of Visual Studio 2010 Ultimate

Database server specification

- 4-processor 12 core (48 cores)
- 2.2-GHz AMD Opteron processor
- 256 GB of RAM
- 64-bit version of Windows Server 2008, Enterprise Edition
- 64-bit version of Microsoft SQL Server® 2008 R2 (Build 10.50.1797)

Database disk configuration

- HP logical volume SCSI disk drive
- Disk volumes are RAID 10

Data volume

- 40 physical disks, 15,000 revolutions per minute (RPM)
- 2.67-terabyte volume
- 1.90-terabyte data file

Log volume

- 4 physical disks, 15,000 RPM
- 273-GB volume
- 46.7-GB transaction log file

TempDB data and log volume

- 6 physical disks, 15,000 RPM
- 410-GB volume
- 48x2-GB data files
- 20-GB transaction log file

BENCHMARK DATA COMPOSITION

The benchmark was run on a 1.5-terabyte database that did not use page compression. The system was configured as follows:

- Multisite-enabled setup
- 17 companies, with 90 percent of the data in one company
- 50,000 customers across 100 customer groups
- 120,000 items across 100 item groups
- 50,000 vendors across 100 vendor groups
- History:

  Sales orders – 12 million invoiced sales orders, 87 million lines
  Purchase orders – 1.7 million invoiced purchase orders, 11 million lines
  General journal – 1.9 million posted journals

DISCLAIMER

These benchmark results were measured in a controlled lab environment, without other applications running. The response times reflect only server response time: they do not include the rendering time on the client. The benchmark was executed on optimized hardware, using the Microsoft Dynamics AX 2012 SYS layer without reporting activity during execution. Sample code included in this report is made available AS IS. Performance tests and ratings are measured using the computer systems and components specified in this report (e.g., non-customized version of Microsoft Dynamics AX 2012, transaction mix, data composition, and indexes) and reflect the approximate performance of Microsoft Dynamics AX 2012 as measured by those tests. Any difference in system hardware, software design or configuration, customizations, transaction mix, data composition, or indexes may affect actual performance. The transaction mix and data composition affect sizing and hardware requirements.

Inherently, Microsoft believes that the Microsoft Dynamics AX 2012 stack and application are built to scale, and changes to the code base must go through localized performance testing. Customers or partners should consult other sources of information to evaluate the performance of systems or components they are considering purchasing.

Comparison

	Ultimate Solid with the e-Trade BLS-configuration	Microsoft Dynamics® AX 2012
Concurrent users amount	**18,000**	**5,000**
Time spent to create a purchase order	**150** positions in **1.28** sec	**5** positions in **12.29** sec
Time spent to create a sales order	**5-8** positions in **0.9** sec	**5** positions in **9.15** sec
Application-server	**6** servers **2** Core CPU 2.2 GHz, **2** Gb RAM	**10** servers, **12** cores each, **16** Gb RAM
Database-server	Oracle Exadata Database Machine X2-2 48 Core CPU, **32** Gb RAM	4-processor 12 core (48 cores), 2.2 GHz AMD Opteron, **256** Gb RAM

LOAD TESTING RESULTS

proto$ gen VIII mod 4B91B2
(Ultima core)

In September, 2013 load testing of a new revised Ultima core was performed to assess efficiency, scaling and stability at high loads.

The test consisted of real user activity imitation, the profiles for which were taken from the data of a real operator proto$*, the leader of Russia's online trade market.

*— A much earlier prototype on the Londinium core, 2004.

Test architecture

The test included the main actions performed by users — order creation (including clear balance), processing, stock, shipment, resupply, transportation between warehouses to maintain assortment etc. While order creation a real profile was used, thus the test created a real distribution of goods into warehouses and product categories. Supplier orders for resupplying were created with regard to the current company sales turnover. Similarly, resupply orders in sales offices were calculated on the base of real office turnover and warehouse limitations (weight and dimensional, price, etc.).
The test was sequentially launched with an increasing load.
The maximum load with which the test was performed — **18,000** users.

Hardware parameters

The test was performed on 6 m-server and Oracle Exadata Database Machine X2-2 with RAC deployed from two 24-core virtual servers.

8 drives in RAID 10 and 2 SSD drives in RAID 0 were used as storage drives. The average application server overhead was 85% and the database server was 70%.

Hereinafter, only the data obtained from the test with **18,000** users will be described.

Test was performed on a server to exclude network influence and client application rendering losses.

Subjective impressions of human operators who participated in the test

In order to review real user experience, several operators performed test scenarios manually from the main client application to assess real delays.

With that the operators noted that saving client order required less than 1-2 seconds, creating reports took less than 2 seconds, displaying product list with current balance, reserve, prices and other analytic data – less than 1 second.

The test went on for 2 hours, but only the results of the last hour were considered for better data precision.

The test showed the ability to withstand high loads, great scaling from 1,500 to 18,000 simultaneously working users, high efficiency and usability in business-critical elements. This document describes obtained test results in detail.

Calculated results

The load test was preform to demonstrate application's ability to adapt to high loads without complications for casual users, to determine hardware efficiency and to provide clients with system possibilities for processing data and requests from real users, websites or other sources.

The following table demonstrates user role distribution (Table 1).

Role	Amount of simultaneous users
Purchase manager	90
Stock keeper, supply receiver	117
Warehouse resupply request creation	522
Stock keeper, interdepot transfer admission	1,521
Sales manager	4,626
Cashier	4,284
Stock keeper, warehouse orders	5,436
Stock keeper, interdepot transfer reception	1,494
Total:	**18,090**

The following table demonstrates the average completion time of scenario operations for roles (Table 2).

Role	Time, s
Purchase manager	1.28
Stock keeper, supply receiver	0.3
Warehouse resupply request creation	0.45
Stock keeper, interdepot transfer admission	0.55
Sales manager	0.9
Cashier	0.51
Stock keeper, warehouse orders	0.27
Stock keeper, interdepot transfer reception	0.4

Role scenarios

In order to complete the test, a role was chosen for each virtual user, a scenario which he performed in an endless cycle. User role distribution is shown in Table 1. After the scenario completion the user waited for a specific time, which was taken from real user profiles. The following scenarios were performed.

Purchase manager
Imitates the role of a purchase department manager. Sequentially performs the following operations:

- Make a report with a product list, which are to be bought and will be sufficient for 2 days of sales in all offices, keeping in mind products that were already ordered, reserved etc.

- Choose a supplier with least debts.

- Create an order for 20% of entries from the list (150 entries on average).

- Wait for 4 minutes.

Stock keeper, supply receiver
Imitates work of a stock keeper, responsible for receipt goods from suppliers.

- Open a random supply order and change the status to "receiving".

- Generate product barcodes and add them to the document.

- Save the order.

- Move it through mchain to accepted, and all equants will be automatically generated, based on stock, balance and other mfaces.

- Wait for 5 minutes.

Resupply request creation
Operations:

- Create a report with a list of products that are available in clear balance in the distribution warehouse, that need to be transferred to be sufficient for 2 sales days.

- Choose 20% of entries relevant to the profile (100 entries on average).

- Create a product interdepot transfer, which will reserve the product in the distribution warehouse.
- Wait for 2 minutes.

Stock keeper, interdepot transfer admission
Operations:

- Choose a random transfer request.
- Choose transfer bar codes for each product.
- Save the request.
- Change request status to "ready".
- Change request status to "shipped". That way the products and barcodes will be marked off the warehouse and loaded on the corresponding transport.
- Wait for 9 minutes.

Sales manager
Operations:

- Choose available products in one of the sales offices.
- Choose 5-8 random products with specified office and category sale distribution.
- Create an order; specified product will be reserved, client debts and other conditions are checked. If there is a shortage in clear balance, the unavailable product is marked with a special way.
- Wait for 6 minutes.

Cashier
Operations:

- Choose a random order.
- Create a receipt order in the register and change client request status to "paid". Then all equants are created, clients balance is changed, the balance of the "register" account is changed and all the necessary checks are made.
- Wait for 6 minutes.

Stock keeper, warehouse orders
Operations:

- Choose a random client order with the "paid" status.
- Choose barcodes in the warehouse and add them to the order.
- Change order status to "ready".
- Wait for 8 minutes.

Stock keeper, interdepot transfer dispatch and reception
Operations:

- Choose a random dispatched interdepot transfer.
- Create a interdepot transfer receipt and add barcodes from the original mpack.
- Save the created mpack and move to mstep "received".
- Wait for 8 minutes.

The following table shows the amount of corresponding mpacks, entries and lead that were created by each role:

Role	mpacks created or changed	Entries changed, deleted or created	equants
Purchase manager	1,351	199,948	199,948
Stock keeper, supply receiver	1,384	204,832	614,496
Warehouse resupply request creation	11,448	1,110,456	1,110,456
Stock keeper, interdepot transfer admission	11,878	1,164,044	3,492,132
Sales manager	38,853	252,544	252,544
Cashier	38,056	38,056	76,112
Stock keeper, warehouse orders	39,131	273,917	273,917
Stock keeper, interdepot transfer reception	11,372	1,091,712	2,183,424
Total:	**153,473**	**4,335,509**	**8,203,0297**

Methodology

To exclude network delay impact all roles were performed on a m-server, and the client application wasn't involved to eliminate rendering impact on the execution. An even proportional number of streams were launched on each server. For the test with 18 thousand users it amounted to 3,000, accordingly. A role was assigned to each stream and a random initial delay to terminate simultaneous access to the system by all users.

Test went on for 2 hours, but only the results of the second hour are used, to exclude the launch phase of the corresponding virtual users on the totals. Each stream performed a scheduled scenario and went to sleep in accordance with a real user profile, thus emulating real user activity.

While awake the stream remembered the scenario performance start time and calculated the total time of completion on completion. The data was transferred to a special service for accumulation and calculation. Since the time necessary to transfer data to the accumulating service was insignificant (less than 0.1 s), this time wasn't included as delay of the following active phase.

Hardware

m-server deployed on 6 virtual servers.

Specification

- 2 Core CPU 2.2Hz, 2Gb RAM, 100Gb disk drive
- 64-bit Windows Server 2012 .NET FrameWork 4.5
- Oracle 12c Managed ODP.NET

Database server

- Oracle Exadata Database Machine X2-2 48 Core CPU, 32Gb RAM, 8 HDD RAID 10 + 2 SSD RAID0
- 2-node RAC Oracle 11gR2

Test data scope

A database loaded with generated data in advance and a final volume of 900 GB was used for the final test. The database contained a virtual model of the company with the following parameters:

- 400,000 products in the item master data;
- 100 sales offices, with a warehouse for each office;
- 2 distribution centers;
- 1,000,000 (one million) customers, suppliers and other counteragents;
- there are 40,000 items in the warehouse simultaneously.

At the beginning of the test the database included:

- around a million of client orders (both shipped and unshipped);
- around 10,000 supplier orders (both received and not received);
- around 900,000 cash orders;
- around 40 million entries in stock balance;
- around 20 million entry sales;
- around 900,000 entries in register balance;
- around 10 million entries of client and supplier balances;
- total data volume of 900 GB.

Independent monitor

The largest developers of Oracle-based systems in East Europe

Press release about the test results