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# **Assessing a Performance Evaluation of SAP R/3 and Microsoft SQL Server in a Windows 2000 Environment**

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*A META Group White Paper*

**UNISYS**

*Commissioned by Unisys*



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## **Executive Summary**

This paper describes a proof of concept and performance evaluation that was run by Unisys and Accenture in Unisys' Mission Viejo, CA labs in late 2001. The primary objective of the test was several-fold:

- Evaluate the capabilities of an out-of-the-box solution based on the Wintel architecture.
- Perform the entire evaluation (installation, configuration, characterization, and testing) in only three weeks.
- Determine how well the system can scale without employing any attempts to optimize or tune the overall performance.
- Use real customer data from an actual ERP implementation (in this case, a large semiconductor manufacturer).
- Achieve performance loads of 3,000 concurrent users.

The evaluation used a Unisys ES7000 database server (32-way Intel server) and 8-way Pentium III application servers to run a Microsoft (Windows 2000, SQL Server) environment to support a large-scale ERP system (SAP R/3). The tests evaluated performance at varying levels of active user and batch process loads, using response time and system utilization as performance proxies. The tests employed GA (general availability) hardware, applications, and operating systems, and did not utilize non-standard tuning, optimization, or approaches.

From a scalability perspective, the solution achieved its objectives, however, the tests did not exhaustively test the availability requirements of the overall solution. In terms of database scalability, the system showed that it could support 3,000 concurrent users. Further testing will be required to prove that the solution can meet the overall availability requirements, and through optimization, overall performance (scalability and response times) can be improved further as well. The detailed results of the evaluation as well as suggestions for further work are presented in the paper.

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## **Introduction and Overview**

New and expanded classes of enterprise applications (e.g., Enterprise Resource Planning, Customer Relationship Management, Supply Chain Management) have created a crisis within organizations in terms of database infrastructure. As data volumes have grown, and as new users accessing this data have increased, organizations are faced with scaling their current infrastructure to respond to the growing pressures. As these user loads have increased, the available window to submit and provide resources for batch jobs has dropped significantly. This data proliferation phenomenon has been exacerbated by the advent of Internet-based business initiatives.

New approaches are constantly being sought to address these challenges. Distributed data marts and operational data stores are one such approach. Another approach, the use of Microsoft SQL Server running on up to 8 processor SMP (symmetric multiprocessing) IA (Intel architecture) servers, is taking the route of “provide the lowest TCO” (total cost of ownership). In doing so, however, issues often associated with this class of solutions like scalability and availability will need to be solved.

Unisys and Accenture have strived to address these challenges by testing out-of-the-box Wintel solutions with real customer data from one of Accenture’s large semiconductor manufacturing clients. They sought to determine how the solution would perform without tuning or modifying the hardware or software, or by employing anything “non-standard”. The tests leveraged data from a real customer ERP implementation, and determined whether or not SQL Server database scalability to a concurrent user load of 3,000 users could be achieved.

This white paper presents the results of the proof-of-concept evaluation. The test was run on Unisys’ 32-way IA server, the ES7000. The evaluation tested SAP R/3 performance on a distributed application architecture using single instance of Microsoft SQL server running on Window 2000 Datacenter Server edition as the database. The database was installed on the Unisys ES7000, while SAP R/3 was distributed among 14 8-way IA servers. The results indicate that while further improvements are warranted (and are underway), such a solution can perform in practical situations where the requirements include 3,000 concurrent user sessions and 40 batch processes.

## **Summary of Results**

The results of this evaluation illustrated the following: a single instance of a database comprised of Windows 2000 Datacenter Server edition, running SQL Server on a 32-way ES7000 can successfully support a distributed ERP application (in this case SAP R/3) for

loads up to 3,000 concurrent (active) users. While the evaluation was successful for a 2 hour run, further pilots are necessary before deploying this as a production application. Future pilots should include aggressive tests of all solution elements including the H/W, database, OS (operating system), and applications to fully characterize the specific performance of the solution with respect to availability.

Test results also indicate that with tuning and optimization applied to the database H/W and S/W, further improvements in response time and more efficient system utilization are quite possible. Such improvements and further testing will provide for the distinct possibility of scaling the overall application well upwards of 3,000 users.

### **Adaptive Infrastructure and Scalability**

Adaptive infrastructure is a concept developed by META Group that signifies infrastructure assets (hardware, networks, middleware, processes, people) that have been designed, implemented, and managed with an end-to-end perspective to maximize business evolvability. META Group contends that IT organizational agility has become increasingly important for business survival and success, and a means of addressing this is to embrace the concept of adaptive infrastructure. A critical component of adaptive infrastructure is the ability to leverage technology standards. For example, standards that enable interoperability, commodity technologies with open API's, standard design tools and languages, and mainstream operating systems.

Another crucial element of defining an adaptive infrastructure is defining an architecture that can scale (e.g., users, processes, memory, I/O, application loads). As such, the infrastructure can effectively respond to the increasing business needs. The data proliferation phenomenon described earlier in this paper is a perfect example of how and why adaptive infrastructure can be leveraged to address scalability requirements. In terms of overall application architectures, scalability and availability should be approached from two unique dimensions – scale-up and scale-out (see META Group Server Infrastructure Strategies Deltas 858 and 859, September 5, 2000).

While the utilization of data marts and/or operational data stores (scale-out) can provide an answer to scalability challenges, these solutions today present other challenges such as data management/administration, and major data integration with other applications.

For these reasons, enterprise data warehouses (EDWs) often present a sound solution, provided the scalability issues of a single EDW can be addressed. Therefore META Group recommends a “scale-up” approach be taken for the back-end EDW OLTP (online transaction processing) servers, where a single instance database of record must be maintained. A “scale-out” approach is recommended as being more practical for middle-tier application and Web servers.

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For the past several years, Microsoft and Intel have been furthering the development of their respective product lines (.NET Server and Itanium respectively) to address both “scale-up” and “scale-out” requirements. Widely accepted as entry-level solutions, the investments made by these vendors are geared to enable them to compete more effectively as enterprise-class solutions.

Microsoft has added significant functionality to Windows NT, resulting in what is now branded Windows 2000 Datacenter Server edition. While such improvements have addressed previous shortcomings including scalability, availability, and clustering, Window 2000 is still struggling to gain high-end acceptance in the user community as a viable alternative to UNIX-based architectures for mission critical application, but adoption is occurring.

Microsoft also continues to enhance SQL Server to compete as a viable mission-critical DBMS (database management system). While initially relegated to a role of low-end database, functionality is now part of SQL Server that is making organizations more comfortable in piloting the database for larger scale, mission critical applications.

*META Group believes that SQL Server will increase its share of the Windows DBMS market to 50% by 2005. Reliability perceptions will improve as more ITOs (Information Technology Organizations) adopt Windows as a mission-critical platform and enforce best-practice change management and support practices associated with current high-end Unix and mainframe platforms. In terms of scalability, SQL Server will still need to add features, such as partitioning, to address support for a scale-out approach, but its ability to scale up is no longer an issue.*

*META Group Server Infrastructure Strategies Delta 930, September 27, 2001.*

These technologies from Intel (microprocessors) and Microsoft (operating systems, database management systems) will further the cause of adaptive infrastructure. They represent a key set of component-based, standardized, technologies that when ready, will be poised to help organizations implement adaptive, scalable solutions.

### **Methodology**

This section describes the methodology of the overall evaluation, including the configuration of the solution, and the business process used for the test scripts.

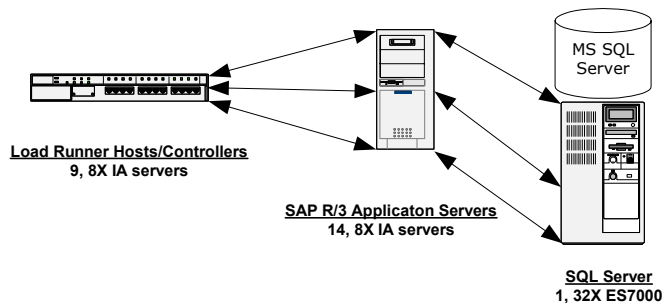
### **Configuration**

The simplified configuration of the performance evaluation is shown below. Client loads were simulated and controlled across 9, 8-way IA servers, while SAP R/3 was distributed

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across 14, 8-way IA servers. Finally, Microsoft SQL Server was deployed on a 32-way Unisys ES7000. Detailed information regarding each system and the associated software is contained in the next section.



### System Configuration

#### **Business process**

The simulation replicated the business processes captured from one of Accenture's large semiconductor manufacturing clients running SAP R/3. Actual customer data was used to replicate a fully featured factory operation process consisting of a mix of purchasing, financial, and inventory business processes.

The transaction mix covered the following: creation of invoice documents; entering general ledger (GL) account lines; providing cost line items by individual cost centers; generating inventory documents; creation and verification of invoices; posting invoices; creation of purchasing documents; processing sales orders; producing delivery documents; generating change shipments, creating and changing purchase orders; receiving purchase orders; creating purchase requisitions; providing inventory transactions; allowing material change requests; generating inventory position reports, and processing change orders.

Thus, the resulting workload data and transactions represented a large real world SAP environment for a major semiconductor manufacturer and provided reproducible results that were tied to real business environments, and didn't simply represent fictitious transactions for the sake of the performance evaluation.

### Test Environment

The detailed environment used for the evaluation is described in this section. Included are the system configurations for both the database and application server. Also included is revision data for each application.

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### **Database server**

|                       |                   |  |
|-----------------------|-------------------|--|
| Model                 |                   | Unisys ES7000  |
| Processors            | Number            | 32   |
|                       | Type              | Intel Pentium III Xeon                                       |
|                       | Speed             | 900 MHz  |
|                       | L2 Cache          | 2 MB   |
| Sub-PODs              |                   | 8  |
| Operating System      | Vendor            | Microsoft Windows 2000 Datacenter Server                     |
|                       | Version           | Service Pack 2   |
| Power Domains         |                   | 1  |
| Partitions            |                   | 1  |
| Memory                |                   | 32 GB  |
| Memory Storage Units  |                   | 4  |
| PCI slots             | Number            | 20 Used, 96 Available  |
|                       | Type              | 1 Boot, 1 GigaBit, 4 GigaNet, 14 Emulex LP8000 Fibre Channel |
| Internal Disk Storage | Number            | 4  |
|                       | Type              | 8 GB   |
|                       | Total Capacity    |  |
|                       | Type              | 32 GB  |
|                       | I/O               | SCSI   |
| External Disk Storage | Number            | 125  |
|                       | Capacity          | 35.8 GB (4 TB total)   |
|                       | Type              | EMC Symmetrics Disk Array                                    |
|                       | RAID Level        | Raid 1 + 0   |
| Internal Peripherals  | CDROM             |  |
|                       | Micro Floppy      |  |
|                       | Internal AIT tape |  |

### **Database software**

The database S/W used for the test was Microsoft SQL Server 2000 Enterprise Edition, Version 8.00384, Service Pack 1 (SP1).

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### **Application server(s)**

|                       |                       |   |
|-----------------------|-----------------------|---|
|                       | Number of App servers | 14  |
| Processors            | Number                | 8   |
|                       | Type                  | Intel Pentium III Xeon                    |
|                       | Speed                 | 700 MHz                                   |
|                       | L2 Cache              | 2 MB                                      |
| Operating System      | Vendor                | Microsoft Windows 2000<br>Advanced Server |
|                       | Version               | 5.0.2195; Service Pack 2                  |
| Memory                |                       | 4 GB                                      |
| PCI slots             | Number                | 2   |
|                       | Type                  | 1 GigaBit, 1 GigaNet                      |
| Internal Disk Storage | Number                | 2   |
|                       | Type                  | 18 GB                                     |
|                       | Total Capacity        | 36 GB                                     |
|                       | Drive Speed           | 10,000 RPM                                |
|                       | I/O                   | SCSI                                      |
| Internal Peripherals  |                       | CDROM                                     |
|                       |                       | Micro Floppy                              |
|                       |                       | Internal AIT tape                         |
|                       |                       | DLT Tape                                  |

### **Application software**

The application software used in this evaluation was SAP R/3 version 4.0B.

### **Client load device**

The client loads were created using LoadRunner from Mercury Interactive, which simulated active users. It submitted the login requests, and then ramped the active users and batch processes at a pre-determined rate.

### **Load simulation**

The load simulation approach taken for the test was to ramp up simulated users with LoadRunner, and to activate and sustain the number of users and batch process loads for a period of one hour. During the 3,000 user test, 4,200 simulated users were initially logged into SAP R/3. After initiating the login for all users, the first 500 users were ramped up in the SAP system, using test scripts to simulate concurrent users loads.

Once the active user level of 500 was reached, the level was maintained for 5 minutes. After 5 minutes of performance with 500 active users, another 500 active users were

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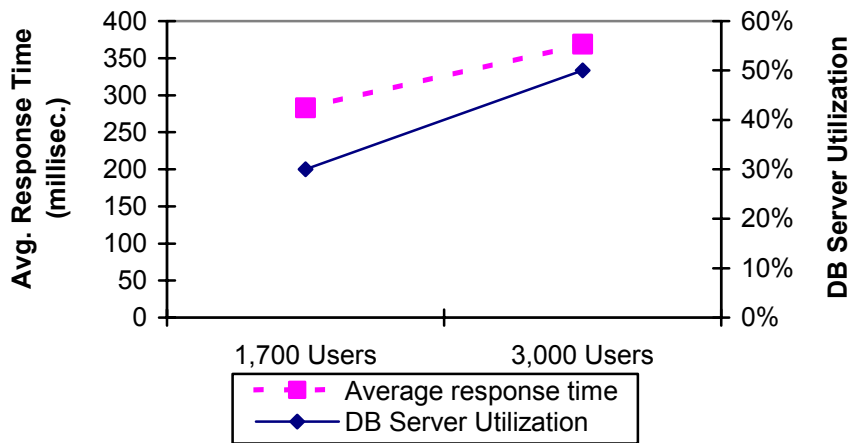
ramped into the system at an approximate rate of 40 users/minute. The system was then maintained at a level of 1,000 active users for 5 minutes. Another 200 active users were then added, bringing the grand total of concurrent users to 1,200. Upon maintaining a level of 1,200 active users for several minutes, 5 batch processes were added to the system. From that point forward, active users were added at a rate of 40 users/minutes, and batch jobs were added at a rate of 2 per 100 users. The system was then held for 5 minutes at 1,500, 2,000, and 2,500 active users. Statistics were collected once 3,000 active users and 40 batches were maintained for several minutes, and then the run was held for one hour.

### **Performance**

This section details the performance results achieved during the test, commenting on several performance attributes including response times and system utilization.

#### **Results**

The following test results were realized from the evaluation. Both performance data for 1,700 and 3,000 active user tests is shown.



The detailed performance data is presented in the table below.

| Statistics |                        |            |             |
|------------|------------------------|------------|-------------|
|            | Activity               |            |             |
|            | Logged in Users        | 2,100      | 3,600       |
|            | Peak Active Users      | 1,720      | 3,080       |
|            | Total Dialogs per hour | 419,446    | 759,231     |
|            | Database Requests      | 77,394,091 | 135,578,381 |

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|  |                               |            |            |
|--|-------------------------------|------------|------------|
|  | Database calls                | 20,572,447 | 35,558,972 |
|  | Performance                   |            |            |
|  | Average Response time (total) | 283 ms     | 369 ms     |
|  | Utilization                   |            |            |
|  | Database Server               | 30%        | 49.54%     |
|  | Application Servers           | 23%        | 30%        |

### **Response times**

Response times for the most aggressive test (3,600 logged-in users, 3,080 active users) were, on average, 369 milliseconds. This (< 1,000 milliseconds) represents a respectable application response time.

### **System utilization**

According to the performance logs, system utilization of the database server was still below 50%. This signifies the opportunity for further optimization to improve both the scalability and the response time of the overall test.

## **Future Improvements**

Unisys and Accenture achieved the results of this performance evaluation in three weeks, with an out-of-the-box solution. Given more time, there was a great deal of tuning and optimization that they would have liked to employ, and will undertake for future tests. Specifically, there are several areas that Unisys can explore to further improve the overall performance of this solution from a response time, user session, and CPU utilization perspective.

1. Contained within Microsoft SQL Server 2000 Service Pack 2 (SP2) there exist new tools for collecting data related to performance monitoring that can provide insight into CPU usage. Future tests using SP2 will enable further performance improvements.
2. The standard default SQL Server memory configuration was used for this evaluation, but by increasing the memory size significantly (as high as 2.5 times the default setting), performance will be optimized.
3. Disk I/O can have a significant impact on CPU usage. Optimizing the disk I/O in a way that balances the I/O load can improve performance. This evaluation was run with SQL Server distributed among 28 CPUs of the ES7000, while SQL I/O processing was bound to 2 CPUs (the final 2 CPUs of the 32-way server were used for SAP\_CI). This load balance is unlikely to be optimized for performance. In

fact, constraining the I/O to only 2 CPUs is likely to cause very inefficient CPU usage, with I/O requests using resources across all the CPUs. The net result is that such a configuration is bad for cache coherency, context switching, and certainly for overall performance.

Exploring these options will provide Unisys with alternatives to scale the system performance yet higher, and remove or increase the required resources that were creating the performance bottleneck.

## **Conclusions and Recommendations**

Further work to prove out this solution is warranted, because the results contained herein show that tuning and optimization, bottleneck analysis, and overall business continuity planning can further improve the capability of this solution. Furthermore, more aggressive testing must be run (for a longer period) during a production pilot to fine tune the system for production deployment.

## **Bottom Line**

This practical evaluation, while far from a robust, lengthy, production pilot, serves to illustrate that current available technologies which embody the “Wintel” standard are capable of delivering highly scalable, enterprise class Windows 2000 Datacenter solutions like those required for global, large scale ERP implementations.

## **About the Authors and Methodology**

For this white paper, META Group drew extensively from research from META Group’s Server Infrastructure Strategies and Application Delivery Strategies services, which are based upon daily, intimate interactions with and feedback from other large enterprises. The analysts and consultants involved in the creation of this document have had extensive experience providing strategic research and advice to global enterprises in their application benchmarking and implementation.

META Group helps companies make better information technology decisions by providing research and unlimited analyst consultation relevant to their specific business needs. Offering advisory services, strategic consulting, and interactive/research reports, META Group differentiates itself through a commitment to highly personal service (enabling “analysis in context”), bottom-line answers, and objectivity.