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IBM

Record–Breaking
Enterprise Scalability with
Clarify® FrontOffice™

ORACLE

HEWLETT
PACKARD

Clarify

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Executive Summary

Delivering successfully Front Office solutions (Sales & Marketing, Customer Service, Field Service, etc.) requires applications that can ensure timely response even during peak usage and throughout high growth. To support these business goals applications need to provide high performance and extensive scalability.

This paper describes a benchmark of the Clarify FrontOffice application suite conducted in December 1998 at the Hewlett-Packard High Performance Center located in Cupertino, CA and audited by Cambridge Technology Partners. The benchmark demonstrates that Clarify's n-tier FrontOffice solution meets today's performance and scalability goals by providing the highest performance for the largest number of concurrent users ever benchmarked for a front office application.

The Clarify FrontOffice suite supported 30,000 concurrent users while processing 405,000 business transactions per hour, with a 95th percentile subsecond response time. Even with such high throughput, the Clarify FrontOffice suite was well within the limits of acceptable system resource utilization to allow for future growth, as demonstrated by the average CPU utilization of the database server at 33 percent and the average CPU utilization of the application server at 36 percent.

The benchmark network environment was the product of a strategic partnership between Clarify, BEA Systems, Hewlett-Packard, Oracle, and Rational using the most advanced technology available from each vendor. Clarify ensured that this environment is a genuine indicator of real-world performance, and not simply a theoretical laboratory test, by creating real-world customer support scenarios using authentic workflows and a standard network configuration. This realistic scenario allows benchmark results to be replicated in a production environment.

The performance and scalability demonstrated in this benchmark ensure that Clarify's n-tier Front Office solution can be deployed with full confidence in a high-growth environment.

IN A BENCHMARK CONDUCTED WITH STRATEGIC PARTNERS BEA, HP, ORACLE AND RATIONAL, THE CLARIFY FRONTOFFICE APPLICATION SUITE SCALED TO 30,000 CONCURRENT USERS WITH SUBSECOND RESPONSE TIME IN A REAL-WORLD, REPEATABLE BUSINESS SCENARIO

Benchmark Methodology

Realistic environment ensures repeatable results

All aspects of the benchmark methodology create a real-world scenario that demonstrates how businesses actually use Clarify's FrontOffice today. These elements include the work-flow, network environment, and database. Response times are measured from the client perspective using the Rational PerformanceStudio reporting tool. To ensure replicable results, all response times are measured when the system is in a steady state. Internal system parameters are measured to ensure that resource requirements such as CPU time are valid for real-world situations. Individual end user operations, as defined by a single item click, are also measured.

Realistic workflow simulates production environment

This benchmark models a real-world, two-tier support system front office environment with attributes that conform to actual customer business processes. The first tier support person answers all phone calls, does minimum research on some cases, and closes cases whenever possible based on that limited amount of research. Cases that cannot be closed within the designated time period are passed to a second tier support specialist. This specialist performs in-depth research, works with the customer to resolve the case, and then closes the case. The following diagrams depict this workflow and detail the user distribution and transaction rates.

Scalability and Performance

Tier1
Support Specialist

Find Caller
by Serial No.

Enter Basic
Case Info &
Save Case

5% of Users
Take Dispatch
Route

Close Case

Dispatch Case
to Queue

Queues

Tier2
Support Specialist

Lookup Case in
Queue using
Open Case Report

Select Case

Open Case
for Review

Accept Case

Call Customer
& Log
Phone Notes

Hangup

Close Case2
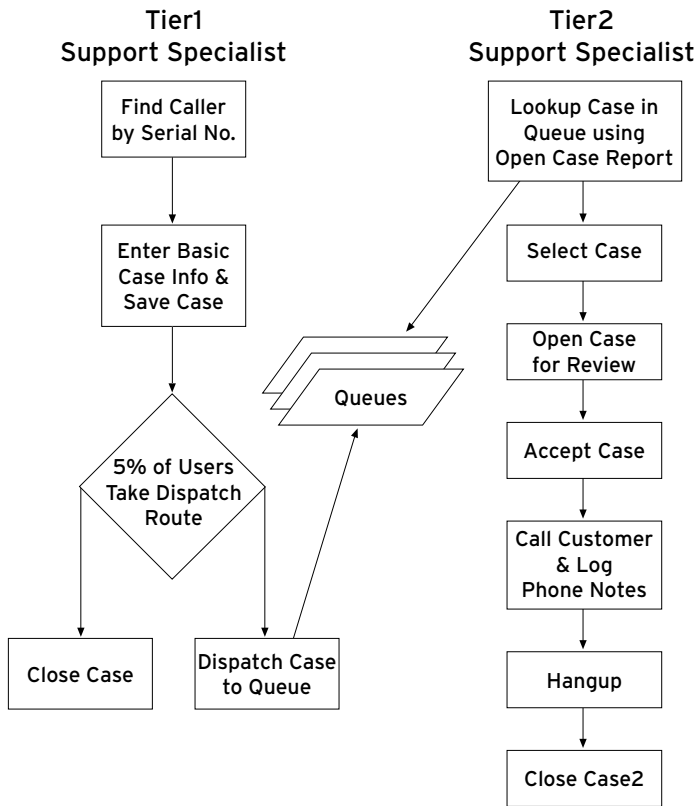
Figure 1

User Distribution and Transaction Rate

User Type	# Users	Transaction Rate
Tier 1C	16,500	4 Cases/Hr.
Tier 1D	1,500	6 Cases/Hr.
Tier 2	12,000	1 Case/Hr.

Table 1

Measurement strategy addresses all network elements

System Versus Application Measurement

System measurement monitors the overall computer system components such as CPU, Memory and Disk IO utilization. These measurements, taken using high-level tools such as HP OpenView's PerfView and GlancePlus, are critical for the system-wide tuning and understanding of application resource requirements needed for capacity planning.

Application measurement addresses end-user response time. The response time and its components are depicted in the following diagram, which shows how system components, combined with concurrent transaction activity, flow through the system. Note that with time represented on the vertical axis, the slope of its line measures a component's responsiveness, and will increase as the system is loaded. The goal is to monitor and minimize each component's contribution to system response time. The labeled vertical lines indicate the points where response times were measured during this benchmark.
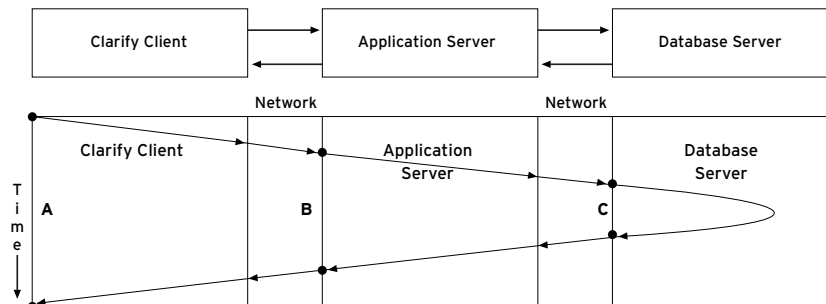

Figure 2

Measured Response Time Components

A: This segment represents end-user response time. These response times, captured and reported by PerformanceStudio, are captured for individual application service calls and also rolled up into transaction response times; these are reported in the Results/Findings section below. The transaction response times do not include client paint time. Client think and entry times are not included in the diagram, but were simulated by PerformanceStudio.

B: This segment represents the response time for individual application service routines from the application server. These are collected using the Tuxedo trace facility. This information is useful in debugging high latency calls and configuring the application server.

C: This segment represents the time a transaction spends in the database server. Response times for individual SQL statements are collected using Oracle's Enterprise Manager. This information is useful for tracking down and tuning problem SQL statements.

Benchmark Architecture

The following major technologies were employed for this benchmark. As of the time this benchmark was implemented, these products represented the most advanced technology available from each partner.

Clarify Front Office Software

Overview: Clarify FrontOffice 98 is a complete suite of customer interaction software for creating and automating all areas of contact with prospects and installed base customers, including the call center, sales and marketing, customer service and quality assurance, field service and logistics, and Help Desk. The ClearSupport call-handling module of the Clarify FrontOffice 98 suite allows call centers to manage information flow within a service organization so that customer service needs can be addressed quickly and efficiently.

For this benchmark: Clarify FrontOffice 98 Service Release 3 was used with one minor modification; a new algorithm to streamline the login process (available in the current software release) was developed and tested during the benchmark.

In the Clarify n-tier client/server core technology, the client, application server, and database server may reside on one, two, or more physical machines. For large-scale implementations, the application server will reside on one or more dedicated systems. For this study, Clarify's n-tier solution based on BEA Tuxedo middleware was used. In this configuration, the client makes processing and data requests directly to the Tuxedo application server, without direct connection to the database (see diagram X).
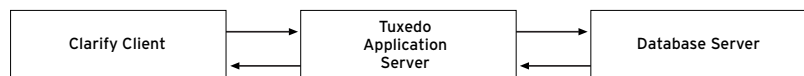

Figure 3

Each Clarify client creates a single network connection to the application server.

HP-UX Operating System And Servers

Overview: HP-UX is a 64-bit operating environment that delivers extensive scalability and performance for a broad range of business IT environments and hardware platforms. The reliability of HP-UX has historically ranked highest in the industry, and HP offers a long list of products and services to reduce planned and unplanned downtime. The HP 9000 V-Class server combines the strengths of a compute-intensive architecture and the industry's broadest suite of optimized, parallelized applications for OLTP, decision-support, ERP, and other distributed enterprise applications. HP 9000 K-Class Enterprise Servers are high-performance, highly expandable systems with robust SMP and 64-bit PA-RISC processors.

For this benchmark: The following Hewlett Packard enterprise-class hardware was used. All systems utilized HP-UX 64 bit 11.0:

- Database Server: HP 9000 V2250, 16 CPUs and 16 GB memory.

- Application Server: 3-HP9000 K580, 6 CPUs and 4 GB memory each.

- Network: 100 Mb/s switched fast Ethernet using stackable backbone switch HP ProCurve models 1600M and 8000M. Database server was configured with HP's port aggregation technology.

Oracle Database

Overview: The Oracle8 high availability architecture provides sophisticated features for minimizing the length and disruptiveness of unplanned database outages. By using these features, customers can greatly improve the total availability of their business systems. As a result of customer feedback, Oracle has continually refined its high-availability architecture to decrease down time and reduce disruptive outages.

For this benchmark: The Oracle 8.0.5 64 bit VLM option was used. VLM-SGA cache was not needed. The database resided on an EMC 3430 disk array connected via Fibre Channel. A baseline database of 120 Gigabytes was created to model a business that has been using the Clarify Application for 5+ years with the following table cardinalities:

Table Name	Number Records
table_case	5,500,000
table_act_entry	23,000,000
table_close_case	5,000,000
table_contact	1,000,000
table_condition	5,500,000
table_users	60,000
table_queue	2017

Table 2

BEA TUXEDO Application Server

Overview: BEA TUXEDO® enables developers to create applications that span multiple hardware platforms, databases, and operating systems with the freedom to mix and match those platforms to best fit the application environment. BEA TUXEDO is well-known for its wide array of message-based communication paradigms, distributed transaction processing capabilities, and robust runtime environment. BEA TUXEDO features compliance with The Open Group's X/Open standards, TCP/IP interoperability, and ports to more than 70 hardware platforms and operating systems including UNIX, Windows NT and AS/400. BEA TUXEDO's modular architecture is centered on its high-level API, ATMI (Application-to-Transaction Manager Interface). Comprised of 30 simple calls, ATMI has been adopted by The Open Group as a standard X/Open API.

For this benchmark: BEA Tuxedo System 6.4 was used.

Rational Performance and Load Testing Tool

Overview: Next-generation performance test tools must be highly automated, easy to use, scalable and produce accurate production environment workloads. PerformanceStudio meets these requirements with the introduction of Smart Load Testing, providing four Smart innovations: DataSmart Recording automates the use of multiple transactions from a single test script, LoadSmart Scheduling automates the creation of workloads for more than 10,000 users, ClientSmart Pacing automates the insertion of production level timing characteristics, and ServerSmart Playback ensures the integrity of the results produced. These innovations of PerformanceStudio are equally suited to address the needs of legacy systems such as two and n-tier client server architectures, ERP, as well as e-commerce environments.

For this benchmark: Rational PerformanceStudio 7.0 Network Simulation Software was used to develop the benchmark user scripts, manage user simulations and provide response time reporting. PerformanceStudio 7.0 is Rational's latest release of their System Performance and Load Testing tool. It automates the creation of scripts that simulate client application functionality. These scripts provide the basis of the simulated client process known as a Virtual User. An NT-based computer called the *master* is used to control and manage the benchmark. Virtual users (one software process for each simulated client) are initiated on computers called *agents*.
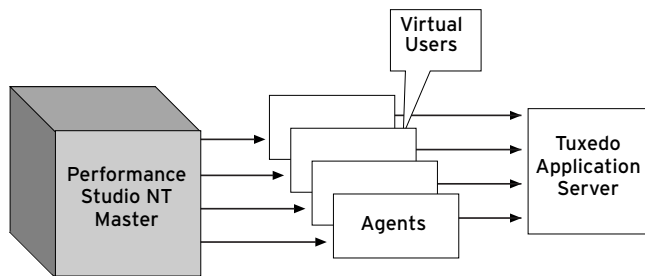
Figure 4

System Support

- Disk monitoring: EMC's EMS

- Backup: HP's OmniBack II 3.0

- Network Monitoring: HP's NNM 6.0

- Performance Monitoring: HP's Perfview and Glance +

Benchmark Configuration

Overview

The diagram below describes the physical architecture of the benchmark, using a simplified network representation. The actual network consisted of multiple 100BT networks configured to meet performance needs and resemble a production LAN configuration.

Performance
Studio Agents

7,000 Client
Connections

Tuxedo
Application Servers

HP K580

Performance
Studio Master
#1

HP V2250

HP K580

7,000 Client
Connections

HP V2250

Database
Server

100 Base-T

HP V2250

Performance
Studio Master
#2

HP K580

10,000 Client
Connections to
each Application
Server

3x21 (63) Total
connections from
Application
Servers

HP K580

4,000 Client
connections from
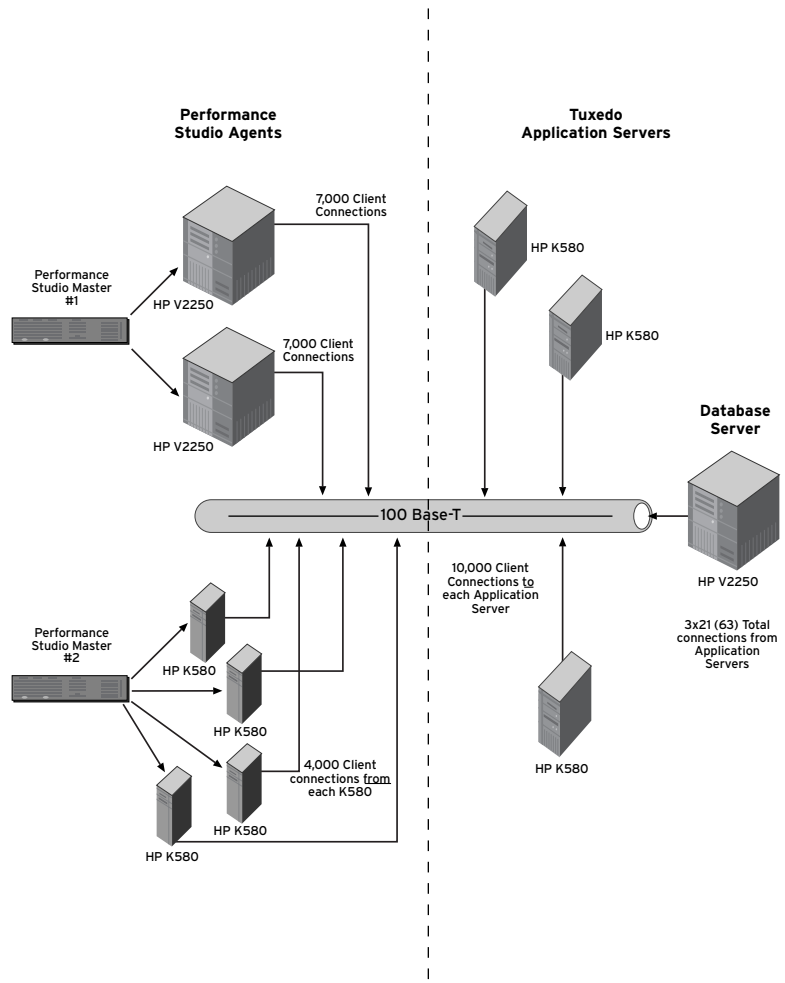each K580

HP K580

HP K580

HP K580

Figure 5

Hardware

PerformanceStudio Masters
2–Hewlett–Packard NetServer

- Dual Pentium Pro 200MHz

- 512KB L–2 Cache

- 1 GB RAM

- RAID Array disk configuration

Tuxedo Application Servers
3–Hewlett–Packard K580, each with

- 6 x 240MHz PA–8200 RISC Processors

- 4 GB Main Memory (RAM)

- Local Fast Wide SCSI Disk Drives

Database Server
1 Hewlett–Packard V2250

- 16 x 240MHz PA–8200 RISC Processors

- 16 GB Main Memory (RAM)

- EMC 3430 Disk Subsystem with 4 GB cache, 96 x 18GB Disk Drives,
  Database striped

- 4 Fibre Channel Ports configured for host redundancy

- HP OmniBack used for Database backup to DLT tape library.

PerformanceStudio Agents

- 2-Hewlett–Packard V2250: 7,000 virtual users each
- 16 x 240MHz PA-8200 RISC Processors
- 16 GB RAM
- 4-Hewlett–Packard K580: 4,000 virtual users each
- 6 x 240MHz PA-8200 RISC Processors
- 4 GB RAM
- Each system: 4 GB file system striped with HP LVM for collecting virtual user log files.

Network

- All machines on 100 Mb/s switched Fast Ethernet
- Database and Application Servers connected to three HP ProCurve Switch1600M and one HP ProCurve Switch 8000M.
- Work area PerformanceStudio master and agents connected to 5 HP AdvancedStack Switch 800T
- Database Server used new HP Auto Port aggregation technology, also known as Cisco's Fast EtherChannel(r). This technology permits one IP address to use multiple full duplex physical links, thereby allowing higher bandwidth than a single 100 Mbps port.

Benchmark Results

The following benchmark results demonstrate that the Clarify FrontOffice application suite and supporting technology can support up to 30,000 concurrent users with sub-second response time—the best performance to date in the industry.

1. 405,000 business transactions per hour (a business transaction represents a single button click)

2. 95th percentile sub-second response time

3. Database server average CPU utilization: 33 percent

4. Application server average CPU utilization: 36 percent each

The low overall resource utilization (CPU, memory, network and disk) indicate that similar results can be achieved with a smaller server. In addition, this low resource utilization presents evidence that more than 30,000 users could be supported with the current benchmark configuration. The following results detail measured end-user response time and actual utilization and resource requirements for the various systems.

End User Performance

The table and bar chart below represents the user response times. Each transaction represents an actual button click.

| Transaction	Mean	Min	80th	90th	95th
ClkAcpt	0.30	0.16	0.33	0.45	0.61
ClkClos	0.32	0.15	0.37	0.51	0.72
ClkPhn	0.07	0.04	0.07	0.10	0.18
ClosCas	0.16	0.09	0.18	0.23	0.31
Disp1	0.15	0.07	0.16	0.22	0.32
Disp2	0.22	0.12	0.26	0.35	0.50
FndCall	0.20	0.10	0.21	0.27	0.39
HngUp	0.36	0.18	0.40	0.54	0.83
NewCall	0.01	0.00	0.00	0.01	0.03
OpnCse	0.20	0.12	0.21	0.26	0.34
ShOpCas	0.03	0.01	0.04	0.06	0.10
SavCas	0.17	0.08	0.18	0.24	0.37
SelCase	0.07	0.03	0.07	0.10	0.15
ClkCls2	0.08	0.05	0.09	0.11	0.13
ClsCse2	0.27	0.14	0.33	0.43	0.60

Table 3

30K Run Response Times
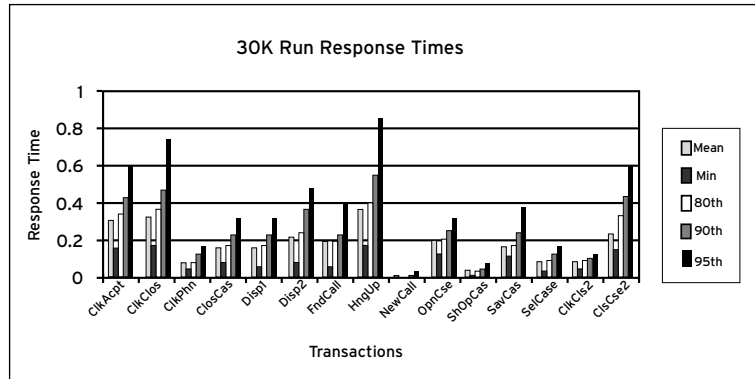
Figure 6

Database Server Performance

CPU

Average CPU utilization was a low and stable 33percent throughout the 90–minute duration of the benchmark:

System	User	Idle
10.5%	22.5%	67%

Table 4

Memory

The database server, configured with 16 gigabytes of main memory, utilized only 23 percent or 3.68 GB according to HP's GlancePlus monitoring tool. Of this amount, 21 percent was attributed to the Unix kernel, 58percent to user and the rest to the Unix block buffer cache. The primary memory consumer is the Oracle system with the following utilization:

SGA	Block Buffers	200MB
	Shared Pool	200MB
Database Connections: 5 MB each	63 Connections	315MB
Total		715MB

Table 5

Disk I/O

The database server's disk I/O system provided exceptional performance during the benchmark. Disk contention, measured by disk queue length and utilization percentage of 25percent was well within acceptable boundaries. The Oracle database 400 MB SGA cache configuration coupled with substantial EMC disk subsystem cache effectively removed physical write activity from client response times.

Network I/O

The following table shows average network utilization.

	Packets In	Packets Out	Mb/s
Database Server	2900	2500	58
Application Server	1134	1334	26.5

Table 6

Tuxedo Server Performance

Since client workload was evenly distributed to the Tuxedo application servers, resource utilization on all three application servers was effectively identical. Overall resource utilization was quite low, attesting to Clarify's lean middle tier (which is critical in providing this level of scalability).

CPU

CPU average utilization 36 percent with very little deviation throughout the benchmark.

Memory

Average memory utilization was 30 percent with no deviation. There was no UNIX paging or swapping. The primary consumer of memory was the Clarify server process *cleard* with an approximate virtual memory footprint of 25MB and active resident memory size of 5MB. Each application server was configured with 21 *cleard* server processes.

Disk I/O

The application server functionality does not require a significant amount of disk I/O, therefore disk IO was minimal and was easily accommodated by a single disk drive.

Performance and Load Testing Resource Requirements

PerformanceStudio NT Master

The PerformanceStudio master machine hosted the benchmark control environment. It maintains multiple network connections with each agent machine to coordinate the activities of each simulated client. After the benchmark, log files and response time data are downloaded to the master machine.

PerformanceStudio Agent Machines

The primary resource constraint and consequent configuration determinant for a PerformanceStudio agent system is the active memory footprint of the Virtual User process (one per simulated client). This amount was approximately 850 KB. When determining the number of clients that can be supported on a given agent machine, it is critical to maintain sufficient memory to prevent any memory paging since this can quickly lead to CPU-bound exercises which could create an undue influence on client response times. Keeping the CPU utilization under 70 percent on the master and agent machines is a good guideline to follow.

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