Digital's DECsystem Family Performance Summary

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Part I

Executive Summary

1 Introduction

The *DECsystem Family Performance Summary* presents the results of system characterization tests performed on Digital's newest UNIX-based RISC server systems:

- DECsystem 5000 Model 25
- DECsystem 5000 Model 133

The DECsystem 5000 Model 25 is a desktop, TURBOchannel-based system that provides RISC power for PC database environments. The DECsystem 5000 Model 133 is Digital's newest low cost-of-entry server system. It has a 33MHz CPU. Like all members of the DECsystem family, the DECsystem 5000 Model 25 and Model 133 deliver optimum performance through balanced CPU, memory, and disk I/O.

Also included in this report are the performance results of the other current members of the DECsystem product set: DECsystem 5100, DECsystem 5000 Model 200, and DECsystem 5500.

The DECsystem 5100, DECsystem 5000 Models 133, and 200, and the DECsystem 5500 were specifically designed to meet such server requirements and activities as NFS file serving, database serving, and multiuser serving. All DECsystems provide excellent overall performance, particularly commercial performance, when compared to the competition.

AIM Performance Rating, AIM III Multiuser, AIM Milestone, nhfsstone, ULTRIX NFS Workload, SPEC SDM, and TPC-B benchmarks measure complete system performance, including processor, I/O, and memory subsystems. SPEC, MIPS, and MFLOPS are single-stream, compute-intensive benchmarks and basically measure just one component of system performance: the processor. DECsystems were designed to provide excellent balanced system performance, and the DECsystem family of computers has superior system price performance ratings.

The *DECsystem Family Performance Summary* is a technical reference document for Digital sales support personnel, customers, and other individuals who need to understand the performance characteristics of the DECsystem family. This document provides information about the server and system-level performance of the DECsystem family running standard industry benchmarks and workloads.

The benchmarks and workloads results appear in the following order:

- AIM Performance Ratings
- AIM Suite III
- AIM Milestone
- Nhfsstone NFS File Server Benchmark
- ULTRIX NFS Workload
- SPEC SDM Release 1.0 Benchmark
- SPEC Benchmarks
- TPC Benchmark B
- Dhrystone
- Linpack
- Whetstone
- DR Labs CPU2
- Khornerstones

The metrics for recording system performance vary according to the workload and focus on useful work done by the system.

The tests discussed in this document were run in October through December, 1991.

Subsequent sections briefly describe the workloads and graphically depict the results. Test configurations and references appear in the document's two appendices.

2 Methodology

Wherever possible, we executed the same benchmark code on all systems. However, due to equipment availability of competitive systems and time constraints, some information is based on the most current, previously published data for those particular systems and has not been independently verified. See Appendix A, titled *Test Configurations,* for hardware configuration, operating system and compiler versions, and source of each benchmark result.

3 Summary of Relative Performance and System Attributes

Table 3-1 and Table 3-2 show relative application performance positioning only. It is important to consider other factors when selecting a system to solve a specific problem. Other factors include operating environment, expandability (such as expanded memory and storage), and price. Using this data, the most appropriate system can be selected based on system attributes, as well as performance characterization.

Table 3-1: Digital DECsystems' and Competitive Systems' Benchmark Results I

Server	SPECmark	SPECint	SPECfp	Dhrystone MIPS	Dhrystone per second	Linpack Single MFLOPS	Linpack Double MFLOPS	Whetstone Single KWIPS	Whetstone Double KWIPS	DR Labs CPU2 MVUPs	Khorner stones
DS 5000/25[1]	19.1	15.7	21.7	26.70	46927	6.60	2.80	25860	20882	27.71	32822
DS 5100[1]	18.9	15.6	21.4	21.60	38060	5.38	3.01	20547	16700	22.74	29511
DS 5000/133[1]	25.5	20.9	29.1	34.42	60475	8.79	5.93	33292	26724	37.10	39606
DS 5000/200[1]	23.5	19.5	26.7	27.27	47920	6.81	3.73	25679	20899	28.61	27604
DS 5500[1]	27.3	22.7	30.9	32.51	57117	8.23	4.25	30864	25189	33.87	82650
IBM RS/6000 320H[2]	41.2	20.0	66.8	37.10	65185	11.70	6.91	n/a[3]	n/a	n/a	n/a
IBM RS/6000 520[2]	32.6	15.8	52.9	29.50	51832	9.20	8.50	n/a	n/a	27.86	n/a
IBM RS/6000 530H[2]	57.4	26.6	95.9	37.10	65185	20.00	n/a	n/a	n/a	n/a	n/a
IBM RS/6000 550[2]	72.2	33.9	119.7	56.00	98392	25.20	23.00	n/a	n/a	n/a	n/a
IBM RS/6000 930[2]	43.4	20.1	72.4	37.10	65185	15.20	13.70	25000	27778	35.75	n/a
IBM RS/6000 950[2]	72.2	33.8	119.7	56.00	98392	25.20	23.00	30303	33333	42.80	n/a
SPARCserver ELC[2]	20.3	18.0	22.0	23.07	40540	3.61	2.20	23148	14663	17.29	23909
SPARCserver IPX[2]	24.4	21.7	26.5	26.68	46875	4.34	2.65	27778	19120	20.80	29111
SPARCserver 2[2]	25.0	21.7	27.4	28.50	50075	6.10	4.20	19920	14641	21.16	27142
SPARCserver 600MP[2]	26.8	22.5	30.2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Refer to Appendix A for test configurations
Table current as of January 1992

[1] SPEC results recorded using Kuck and Associates' pre-compilers which will be available in Spring 1992
[2] SPEC results recorded using Kuck and Associates' pre-compilers
[3] n/a = not available

Table 3-2: Digital DECsystems' and Competitive Systems' Benchmark Results II

Server	AIM Perform-ance Rating	AIM Max. User Load	AIM Mile-stone MPH	TPC-B tpsB	TPC-B $/tpsB	SPEC SDM SDET SPEC SDM SDET Peak Throughput Scripts/Hour	SPEC SDM Concurrent Workloads at Peak Throughput	SPEC SDM KENBUS1 KENBUS1 Peak Throughput Scripts/Hour	Concurrent Workloads at Peak Throughput
DS 5000/25	15.3	136	33.4	n/a	n/a	n/a	n/a	474.9	48
DS 5100	17.5	153	37.4	28.2	2345	131.2	10	965.4	120
DS 5000/133	16.6	146	40.9	n/a	n/a	n/a	n/a	795.8	108
DS 5000/200	14.0	131	53.2	n/a	n/a	133.7	18	1055.4	144
DS 5500	25.9	229	58.4	40.6	3944	195.0	4	1261.1	160
IBM RS/6000 320H	20.7	193	30.6	41.4	2600	138.9	11	n/a	n/a
IBM RS/6000 520	16.9	156	24.7	n/a	n/a	n/a	n/a	n/a	n/a
IBM RS/6000 530H	27.9	244	34.2	n/a	n/a	183.4	6	n/a	n/a
IBM RS/6000 550	34.5	307	48.8	69.2	3005	234.6	11	n/a	n/a
IBM RS/6000 930	20.8	195	31.7	n/a	n/a	n/a	n/a	n/a	n/a
IBM RS/6000 950	34.6	310	52.0	74.2	4521	n/a	n/a	n/a	n/a
HP 9000/817S	30.1	226	n/a	64.8	1940	n/a	n/a	n/a	n/a
SPARCserver ELC	11.3	69	25.7	n/a	n/a	n/a	n/a	n/a	n/a
SPARCserver IPX	14.4	117	30.4	n/a	n/a	n/a	n/a	n/a	n/a
SPARCserver 2	15.4	142	31.2	39.7	2600	140.4	3	935.9	136
SPARCserver 630MP	n/a	n/a	n/a	121.4	2081	n/a	n/a	n/a	n/a
SPARCserver 670MP	n/a	n/a	n/a	121.4	2222	n/a	n/a	n/a	n/a

Part II

Benchmark Results

Results of individual benchmarks can be changed dramatically by the choice of operating system version, compiler version, level of optimization used, memory size, configuration, cache size, process scheduling, buffer management, and so on. Because some systems have more than one compiler available from the vendor, using different compilers can have a significant impact on benchmark performance. RISC architectures are very dependent on compiler technology to keep pipeline operating at peak performance.

When making comparisons between systems on the same benchmark, it is standard practice to normalize all results to that of a certain system. In this report, we have in some cases, normalized the results to the DECsystem 5000 Model 25. This system is then defined to represent 1.0 on the scale, and all other systems fall higher or lower than that system.

The following table explains the abbreviations used in the graphs and tables contained in this section.

Table 3-3: Key to Graphs

Abbreviation	Full Product Description
DS 5000/25	Digital DECsystem 5000 Model 25
DS 5100	Digital DECsystem 5100
DS 5000/133	Digital DECsystem 5000 Model 133
DS 5000/200	Digital DECsystem 5000 Model 200
DS 5500	Digital DECsystem 5500
IBM RS/6000 320H	IBM Risc System/6000 POWERserver 320H
IBM RS/6000 520	IBM Risc System/6000 POWERserver 520
IBM RS/6000 530H	IBM Risc System/6000 POWERserver 530H
IBM RS/6000 930	IBM Risc System 6000 POWERserver 930
IBM RS/6000 950	IBM Risc System 6000 POWERserver 950
HP 9000/817S	Hewlett-Packard 9000 Series 817S
SPARCserver ELC	Sun SPARCserver ELC
SPARCserver IPX	Sun SPARCserver IPX
SPARCserver 2	Sun SPARCserver 2
SPARCserver 600MP	Sun SPARCserver 600MP (single processor)
SPARCserver 630MP	Sun SPARCserver 630MP (multiprocessor)
SPARCserver 670MP	Sun SPARCserver 670MP (multiprocessor)

AIM Performance Rating

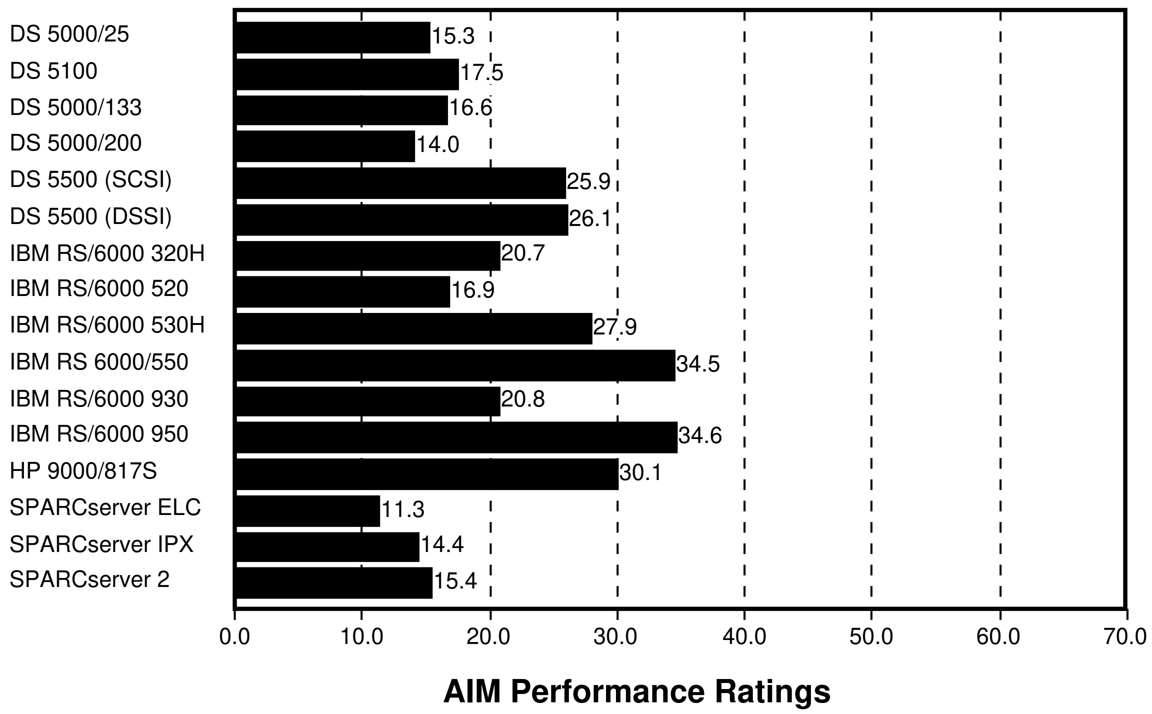
According to AIM Technology, Santa Clara, CA., "The AIM Performance Rating reflects the peak performance of the system measured in AIM Multiuser Performance Units. A VAX 11/780 typically rates 1 AIM. Performance Ratings of a wide range of UNIX systems can be compared using available AIM Performance Reports."

3.1 AIM Performance Ratings Results

The AIM Performance Ratings appear in the following chart.

Note: AIM Performance Ratings were not available for the SPARCserver 630MP and SPARCserver 670MP.

Figure 3-1: AIM Performance Rating Results



AIM Suite III Multiuser Benchmark

The AIM Suite III, a product of AIM Technology of Santa Clara, CA., is a synthetic, multiuser benchmark for UNIX systems. It measures multiuser system performance of multiple systems under a variety of application mixes and resource loads, and assesses the multiuser performance of a single system under varying use conditions. Thirty-three function tests are used to evaluate system performances under user-defined application mixes.

AIM Suite III contains no application level software. Each simulated user runs a combination of subsystem tests. The load that all simulated users put on the system is said to be characteristic of a UNIX timesharing environment.

AIM Technology uses "User Load Rating", the number of emulated users running when the throughput metric reaches 1.0 jobs/minute/user.

3.2 AIM III Suite Results

The AIM Multiuser Benchmark does not reflect NFS or X-Windows performance. DECsystem's outstanding X-Windows and NFS performance give DECsystems an advantage over comparable, competitive systems in networked and client/server multi-tasking environments.

Note: AIM Suite III results were not available for the Sun SPARCserver 630MP and SPARCserver 670MP.

Table 3-4: AIM Suite III Maximum User Load

System	Disk Controller	Prestoserve Enabled	User Rating	Relative to DECsystem 5000 Model 25
DECsystem 5000 Model 25	SCSI	N/A	136	1.00
DECsystem 5100	SCSI	No	153	1.13
DECsystem 5000 Model 133	SCSI	N/A	146	1.07
DECsystem 5000 Model 200	SCSI	N/A[1]	131	.96
DECsystem 5500	DSSI	Yes	235	1.73
DECsystem 5500	SCSI	Yes	229	1.68
IBM RS/6000 320H	SCSI	N/A	193	1.42
IBM RS/6000 520	SCSI	N/A	156	1.15
IBM RS/6000 530H	SCSI	N/A	244	1.79
IBM RS/6000 550	SCSI	N/A	307	2.26
IBM RS/6000 930	SCSI	N/A	195	1.43
IBM RS/6000 950	SCSI	N/A	310	2.28
HP 9000/817S	SCSI	N/A	226	1.66
SPARCserver ELC	SCSI	N/A	69	.51
SPARCserver IPX	SCSI	N/A	117	.86
SPARCserver 2	SCSI	N/A	142	1.04

[1] N/A = Not Applicable

AIM Milestone Benchmark

The AIM Milestone benchmark evaluates the performance of a system by simulating a pre-defined collection of user types. The seven user types are:

- Administrative Assistant
- Spreadsheet User
- Database User
- Manager
- Scientist
- Software Engineer
- Technical Writer

Equal weight is assigned to each of the user types. Because each user performs different tasks repetitively, excessive CPU instruction and data caching caused by locality of reference is avoided. Milestone was designed to functionally represent real user loads.

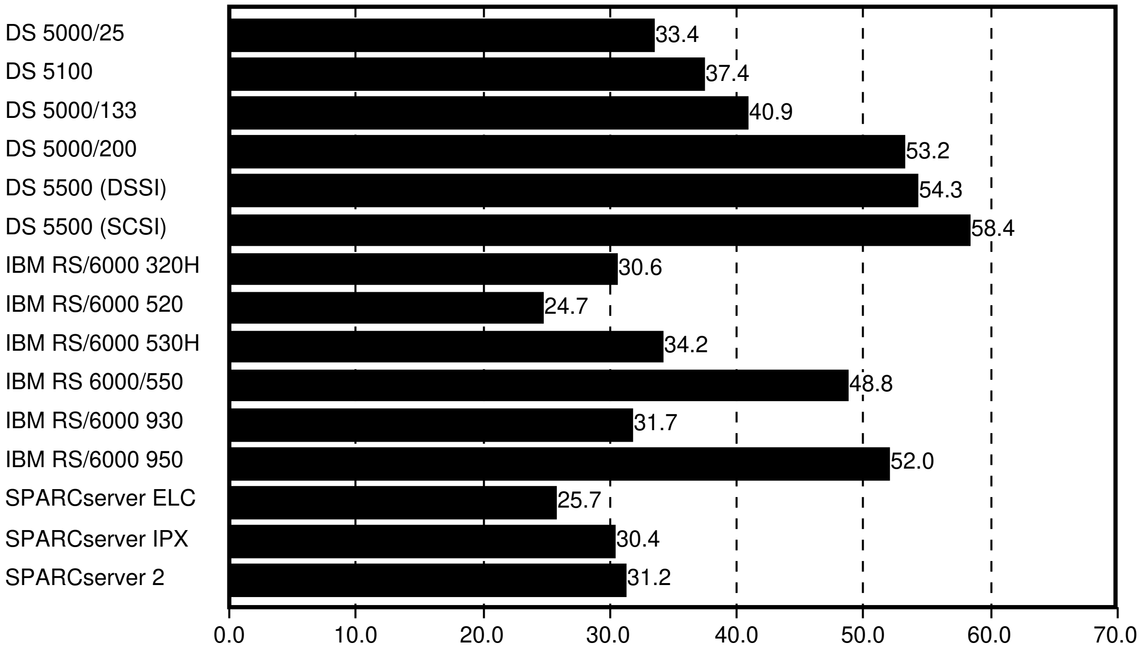
The results of running AIM Milestone Benchmark are rolled up into one number called MPH (Milestone user loads the system under test completes Per Hour). The MPH rating is intended to provide a relative measure of the speed of one vendor platform to another from the user's perspective.

3.3 AIM Milestone Results

The AIM Milestone MPH ratings for the DECsystem family of systems and competitive servers appear on the next page.

Note: AIM MPH ratings for the HP 9000/817S, the SPARCserver 630MP, and the SPARCserver 670MP were unavailable.

Figure 3-2: AIM Milestone MPH Performance Ratings



Nhfsstone NFS File Server Benchmark

The nhfsstone V1.22 workload, distributed by Legato Systems, Inc., facilitates the analysis of NFS server performance from the NFS client's perspective. It emulates traffic patterns of typical networked file system environments and represents the kind of loads seen during very heavy usage.

Nhfsstone executes on the NFS client. Nhfsstone creates subprocesses which generate file operations on the specified remotely-mounted file systems. The nhfsstone parent process waits for the subprocesses to finish and then reports the results.

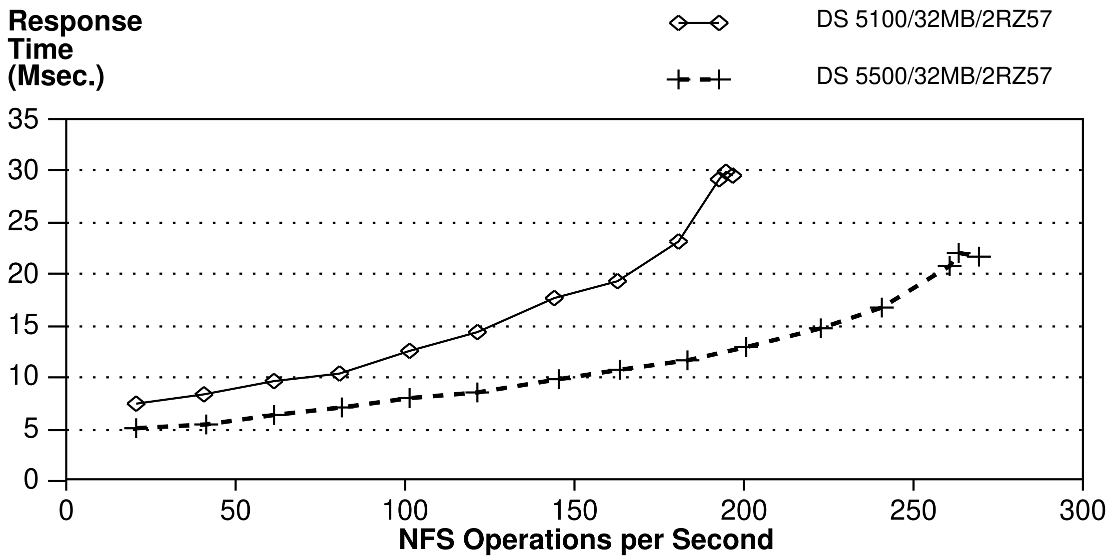
The metric used in nhfsstone is average response time (in milliseconds) for NFS transfers as the load on the server is increased.

3.4 Nhfsstone Results

Below are the results for the DECsystem 5100 and DECsystem 5500 running the nhfsstone utility. Each used a DECsystem 5500 configured with 16 MB of memory, 10% buffer cache, cache_bufcache=1, and 4 block I/O daemons (biods), as the client system.

The graph shows average server response time (in milliseconds) using the default nhfsstone mix over a range of applied load rates (in NFS operations/second). For each sample point, load was applied for 120 seconds.

Figure 3-3: Average Server Response Time Using nhfsstone



ULTRIX NFS Workload

Digital's ULTRIX NFS Workload emulates a UNIX software engineering environment in which one software engineer is assigned to one client workstation. Each workstation executes a different sequence of ULTRIX commands, with each command sequence being probabilistically generated from a single pool of the 30 ULTRIX commands that are most frequently used in a software engineering environment. The overall performance of the DECsystem configured as the NFS file server in this ULTRIX NFS environment is measured. The server is then characterized in terms of

- Client service time re-testing throughput trends as the load increases on the server
- Server resource consumption trends as the load increases on the server
- and resource consumption trends as the load increases on the server

The metric used in this report for the ULTRIX NFS Workload is optimum number of supported clients.

3.5 ULTRIX NFS Workload Results

Table 3-5 shows the recommended optimum number of clients for the DECsystem 5100, DECsystem 5000 Model 200, and DECsystem 5500 when configured as an ULTRIX NFS server. Each number is based on the throughput/response ratio when applying the ULTRIX NFS Workload to progressive numbers of diskless client workstations. A list of the benefits gained by enabling Prestoserve appears after the table.

Note: Different workloads and applications will most likely yield different results.

Table 3-5: ULTRIX NFS Workload Recommended Optimum Number of Clients

Configuration	Memory	Disks	Operating System & Version	Buffer Cache Percent of Total Physical Memory	Optimum Number of Clients Supported
DECsystem 5100[1]	48 MB	4 RZ57s	ULTRIX T4.1	4.8 MB or 10%	36
DECsystem 5100[2]	48 MB	4 RZ57s	ULTRIX T4.1	4.8 MB or 10%	36
DECsystem 5000/200	24 MB	6 RZ56s	ULTRIX T4.0	2.4 MB or 10%	36
DECsystem 5500[3]	128 MB	7 RZ57s	ULTRIX V4.1	12.8 MB or 10%	>70

[1] Prestoserve enabled
[2] Prestoserve disabled
[3] Prestoserve enabled

Prestoserve-related findings from the DECsystem 5100 ULTRIX NFS Workload characterization study were

- As a NFS server, the DECsystem 5100 with Prestoserve enabled, improved response time of the I/O intensive elements of the workload. While enhancing the client performance, the Prestoserve option does *not* negatively impact the server CPU utilization.
- The response/throughput peak value for DECsystem 5100 with Prestoserve enabled was greater than that for the DECsystem 5100 with Prestoserve disabled. The server performance for the 36 diskless clients on the DECsystem 5100 with Prestoserve enabled was better than the server performance for the 36 diskless clients on the same system with Prestoserve disabled.
- The DECsystem 5100, with Prestoserve enabled, has a high potential for network throughput.

SPEC SDM Release 1.0 Benchmark

In May 1991, Standard Performance Evaluation Corporation (SPEC) announced the availability of a new benchmark suite called SPEC System Development Multi-Tasking (SDM) Release 1.0. SDM measures overall system performance using two workloads derived from two different application environments. It is designed to measure the capacity of a system in a multi-tasking UNIX environment and consists of two multi-tasking system level benchmarks named SDET and KENBUS1. The SDET benchmark uses UNIX commands that are found in a C-based software development environment; KENBUS1 benchmark uses commands and procedures that are found in a UNIX/C research and development environment. Both benchmarks are designed to exercise a variety of system resources.

SDM measures performance by gradually increasing the workload on the system. The system throughput increases until a constraint is reached in some system component (e.g., CPU, memory, I/O). SDM Release 1.0 Benchmark is an accurate predictor for multi-tasking environments where multiple processes are running simultaneously, and increased amounts of operation system services are needed.

The throughput metric is defined as the total amount of work done in a given time. The metric for both SDET and KENBUS1 is called scripts/hour. A throughput curve is plotted as scripts/hour against number of scripts that generated the scripts/hour throughput. The highest scripts/hour measured is called the peak value and is reported as the peak system throughput.

Note: The SDET and KENBUS1 benchmarks are unrelated and results should not be compared.

3.6 SPEC SDM Release 1.0 Results

SPEC SDM Release 1.0 results, for the vendors who have submitted to SPEC, are shown in Table 3-6. A list of performance gains gotten by enabling Prestoserve on the DECsystem 5100 running SPEC SDM appear after the table.

Note: SPEC SDM SDET and KENBUS1 results were unavailable for the IBM RS/6000 950; the HP 9000/817S; and the SPARCserver Models ELC, IPX, 630MP, and 670MP. SPEC SDM SDET results were not available for DS 5000/25 and DS 5000/133. SPEC SDM KENBUS1 results were unavailable for the IBM RS/6000 Models 320H and 530H.

Table 3-6: SPEC SDM Release 1.0 Benchmark Results

System	SDET Peak Throughput Scripts/Hour	SDET Concurrent Workloads at Peak Throughput	KENBUS1 Peak Throughput Scripts/Hour	KENBUS1 Concurrent Workloads at Peak Throughput
DS 5000/25	n/a	n/a	474.9	48
DS 5100	131.2	10	965.4	120
DS 5000/133	n/a	n/a	795.8	108
DS 5000/200	133.7	18	1055.4	144
DS 5500[2]	195.0	4	1261.1	160
IBM RS/6000 320H	138.9	11	n/a	n/a
IBM RS/6000 530H	183.4	6	n/a	n/a
IBM RS/6000 550	234.6	11	n/a	n/a
SPARCserver 2	140.4	3	935.91	136

[1] Prestoserve enabled
[2] Prestoserve enabled

3.7 SPEC SDM V1.0 Release Test Results and Prestoserve

As stated earlier in this section, SPEC SDM Release 1.0 Benchmark measures overall system performance using two different multi-tasking workloads simulating two different software development computing environments. Basic software development activities apply to such user environments as software engineering, applications development done to support particular job functions, and to students learning programming. The DECsystem 5100 SPEC SDM characterizations were performed with and without the Prestoserve option enabled. Our analysis of the data produced the following Prestoserve-related findings:

- Examination of the results of the two SPEC SDM benchmarks performed on the DECsystem 5100 showed that the performance improvement achieved solely by enabling Prestoserve varied from 20% for KENBUS1 to 120% for SDET.
- Enabling Prestoserve on the DECsystem 5100 demonstrated that it increases system performance in a software development environment.

- For environments that are disk file manipulation intensive and have CPU processing available to increase disk I/O processing, enabling Prestoserve is recommended. Prestoserve uses CPU processing to improve disk I/O performance.
- In general, as the disk file manipulation load increases, the performance improvement realized by enabling Prestoserve will also increase.

SPEC Benchmark Suite

This section presents the results of the Standard Performance Evaluation Corporation (SPEC) Benchmark Suite. SPEC is a nonprofit organization formed to develop a standard suite of benchmark programs that characterize system performance. Digital is a member of SPEC and endorses its goals.

The release suite consists of ten codes/programs, four of which are written in C and considered to be compute intensive. The geometric mean of these make up the SPEC metric called SPECint and are classified as integer benchmarks. The remaining six programs are FORTRAN based and floating point intensive. They make up the SPECfp rating. The SPECmark is the geometric mean of the ten programs' elapsed times normalized to the VAX 11/780.

3.8 SPEC Results

The SPECmark recorded for the DECsystem 5000/25 was 19.1 and the DECsystem 5000 Model 133's rating was 25.5. Figure 3-4 compares these ratings with competitive systems.

Notes: DECsystems' SPEC results were recorded using Kuck and Associates' pre-compilers which will be available in Spring 1992. IBM, HP, and SPARCserver SPEC results were recorded using Kuck and Associates' pre-compilers.

Figure 3-4: SPECmark Ratings

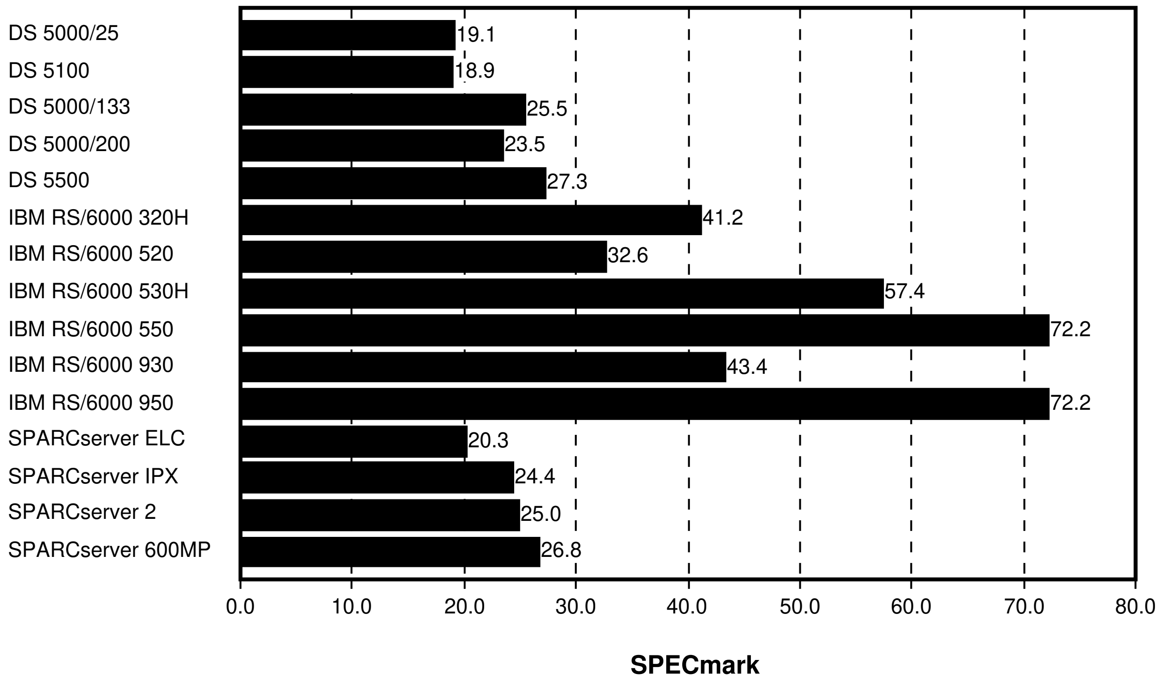


Figure 3-5: SPECint Ratings

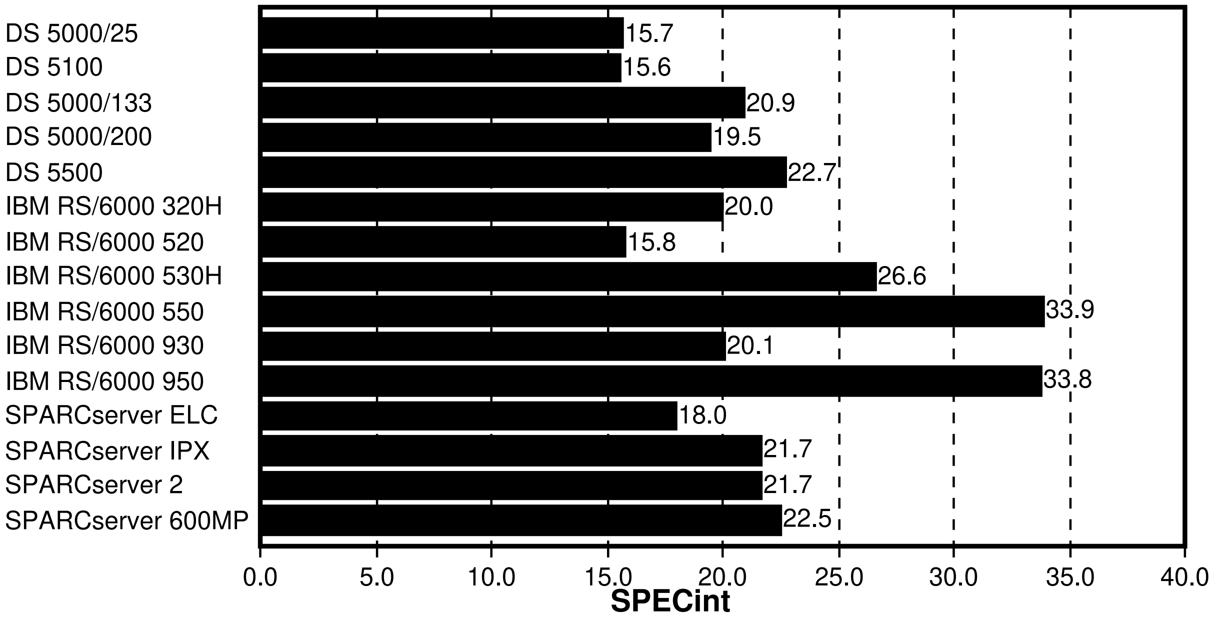
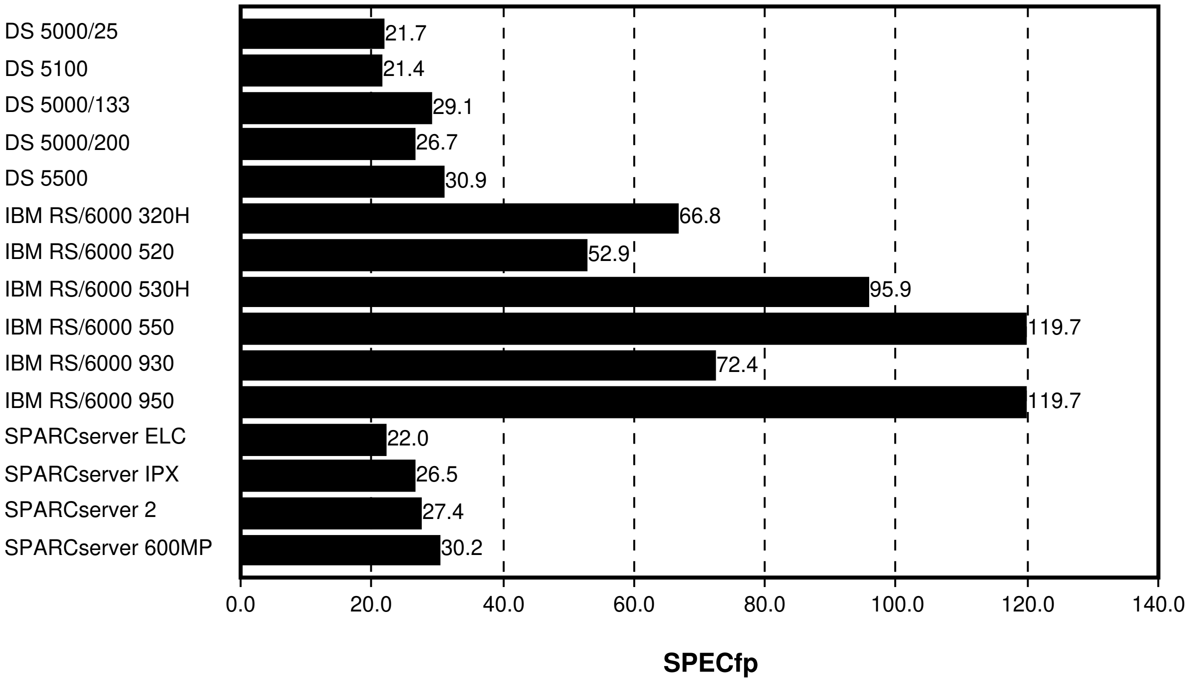


Figure 3-6: SPECfp Ratings



The SPECratio for a benchmark is the quotient derived from dividing the SPEC Reference Time by a particular machine's corresponding run time. For Release 1.2, the SPEC Reference Time is the time (in seconds) that it takes a VAX 11/780 machine to run each particular benchmark in the suite.

Note: DECsystem SPECratios were recorded using Kuck and Associates' pre-compilers which will be available in Spring 1992. Competitors' SPECratios were recorded using Kuck and Associates' pre-compilers.

Table 3-7: DECsystems' SPECratios (SPEC Reference Time/Elapsed Time)

Benchmark No. & Name	Type	DS 5000/ 25	DS 5100	DS 5000/ 133	DS 5000/ 200	DS 5500
001.gcc	Integer	12.2	14.9	16.8	18.1	21.0
008.espresso	Integer	17.4	14.7	22.7	18.3	22.0
013.spice 2g6	Floating point	11.4	11.5	14.8	14.3	17.0
015.doduc	Floating point	18.7	16.5	25.2	20.8	24.3
020.nasa7	Floating point	19.9	21.8	25.4	27.7	30.7
022.li	Integer	17.5	18.1	22.4	23.1	25.7
023.eqntott	Integer	16.5	15.1	22.3	18.7	22.5
030.matrix300	Floating point	57.4	53.9	82.7	66.5	78.4
042.fpppp	Floating point	22.1	20.1	28.4	25.1	29.3
047.tomcatv	Floating point	19.5	21.2	27.1	26.4	29.9

Table 3-8: Competitors' SPECratios (SPEC Reference Time/Elapsed Time)

Benchmark No. & Name	Type	IBM 6000 320H	IBM 6000 520	IBM 6000 530H	IBM 6000 550	IBM 6000 930	IBM 6000 950	SPARC server ELC	SPARC server IPX	SPARC server 2
001.gcc	Integer	16.9	13.3	22.1	28.9	17.0	28.6	16.6	19.9	20.0
008.espresso	Integer	19.9	15.8	26.9	33.8	20.2	33.9	18.0	21.7	21.7
013.spice 2g6	Floating point	26.0	20.5	37.5	47.2	28.8	47.2	13.4	16.1	16.5
015.doduc	Floating point	28.8	22.9	39.0	49.4	29.6	49.6	14.0	16.6	18.2
020.nasa7	Floating point	72.6	57.5	126.8	144.4	88.1	144.4	23.6	28.4	29.1
022.li	Integer	20.0	15.8	26.9	33.8	20.2	33.8	19.0	23.0	23.1
023.eqntott	Integer	23.6	18.7	31.4	39.9	23.4	40.0	18.4	22.2	22.3
030.matrix300	Floating point	404.0	320.9	572.8	729.8	435.1	729.8	67.7	81.5	82.6
042.fpppp	Floating point	53.0	41.7	66.6	86.8	53.3	86.6	19.1	23.0	23.8
047.tomcatv	Floating point	76.6	60.8	109.9	119.7	83.0	138.0	19.7	23.8	24.9

TPC Benchmark B

Formed in 1988, the Transaction Processing Performance Council (TPC) charter is to define standard benchmark specifications for commercial transaction processing systems. To date, the TPC has defined two different types of TPC benchmarks: TPC Benchmark A (TPC-A), established in 1989; and TPC Benchmark B (TPC-B), established in August 1990.

TPC-B environments are characterized by:

- Significant disk input/output
- Moderate system and application execution time
- Transaction integrity

This benchmark is not on-line transaction processing (OLTP) in that it does not require any terminals, networking, or think time. It is similar in many respects to a "batch" test focusing on the database throughput. TPC-B is most likely to be performed by database vendors.

The metrics used in TPC-B are throughput as measured in transactions per second (tpsB), subject to response time constraint, and the associated price-per-TPS ($/tpsB). The only benchmark results comparable to TPC-B are other TPC-B results. In spite of similarities to TPC-A, TPC-B contains substantial differences which make the TPC-B results not comparable to TPC-A. Also, as benchmark results are dependent upon workload, specific application requirements, and system design and implementation, comparative system performance will vary as a result. TPC-B should not be used as a substitute for specific and/or critical capacity customer application benchmarking.

The TPC Benchmark B Standard requires that test sponsors publish a full disclosure report of the implementation details along with the published test results.

3.9 TPC-B Results

TPC-B transactions per second (tpsB) and TPC-B price-per-TPS ($/tpsB) results appear in the following charts. All of the TPC-B tests used INFORMIX-OnLine database software except for the SPARCserver 630MP and 670MP which used Sysbase SQL Server. SPARCserver 2 TPC-B tests using Informix or Sybase are shown.

The DECsystem 5100 and DECsystem 5500 TPC-B tpsB and $/tpsB results are shown in the following charts.

Note: TPC-B results were unavailable for the DECsystem 5000 Models 25, 133, and 200; the IBM RS/6000 Models 520 and 530H; and the SPARCserver Models ELC and IPX.

Figure 3-7: TPC-B tpsB Benchmark Results

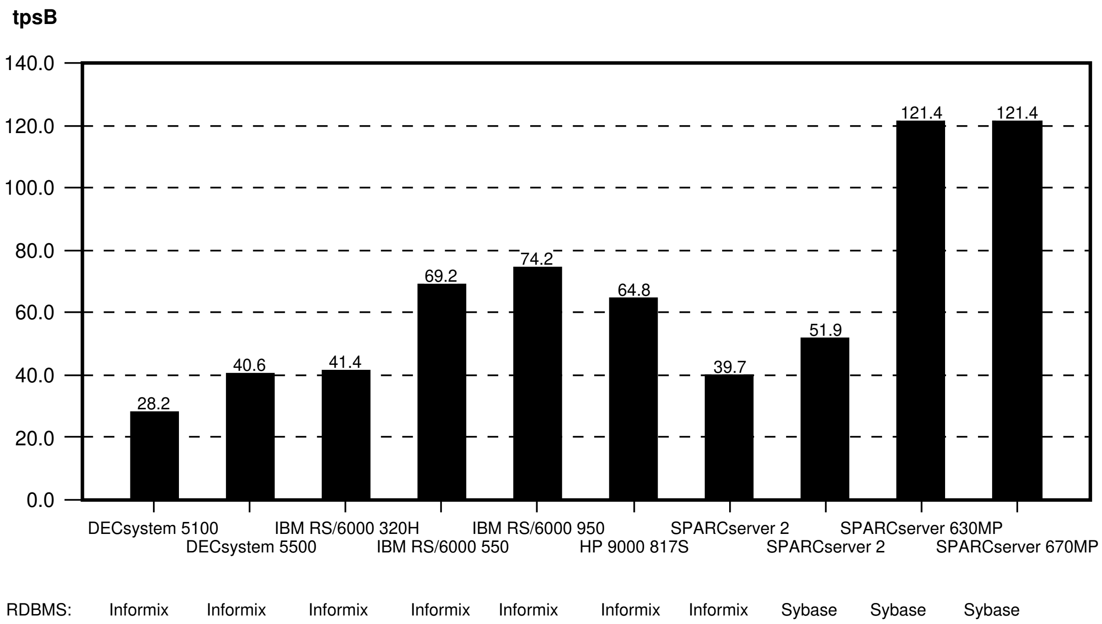
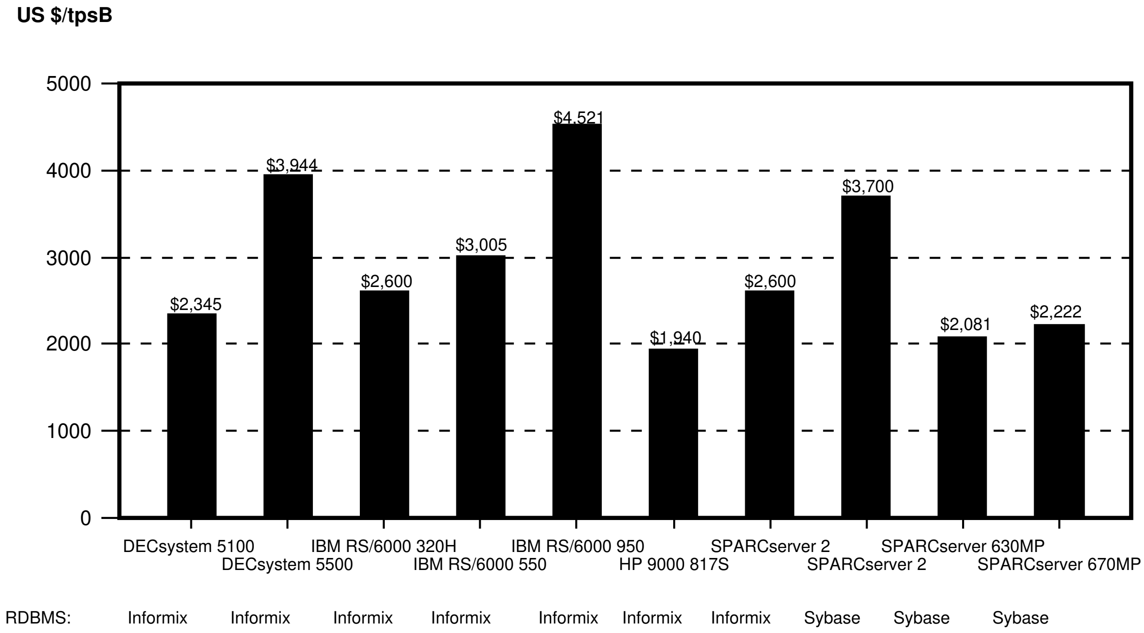


Figure 3-8: TPC-B Price-per-TPS ($/tpsB) Benchmark Results



Dhrystone Integer Benchmark

The Dhrystone benchmark was introduced in 1984 as an ADA program by Reinhold P. Weicker. It has since been translated into C and TURBO PASCAL.

This synthetic benchmark[1] measures processor and compiler efficiency. Its emphasis is on the type of data and operations encountered in a system rather than numerical programming. Dhrystones is CPU-intensive.

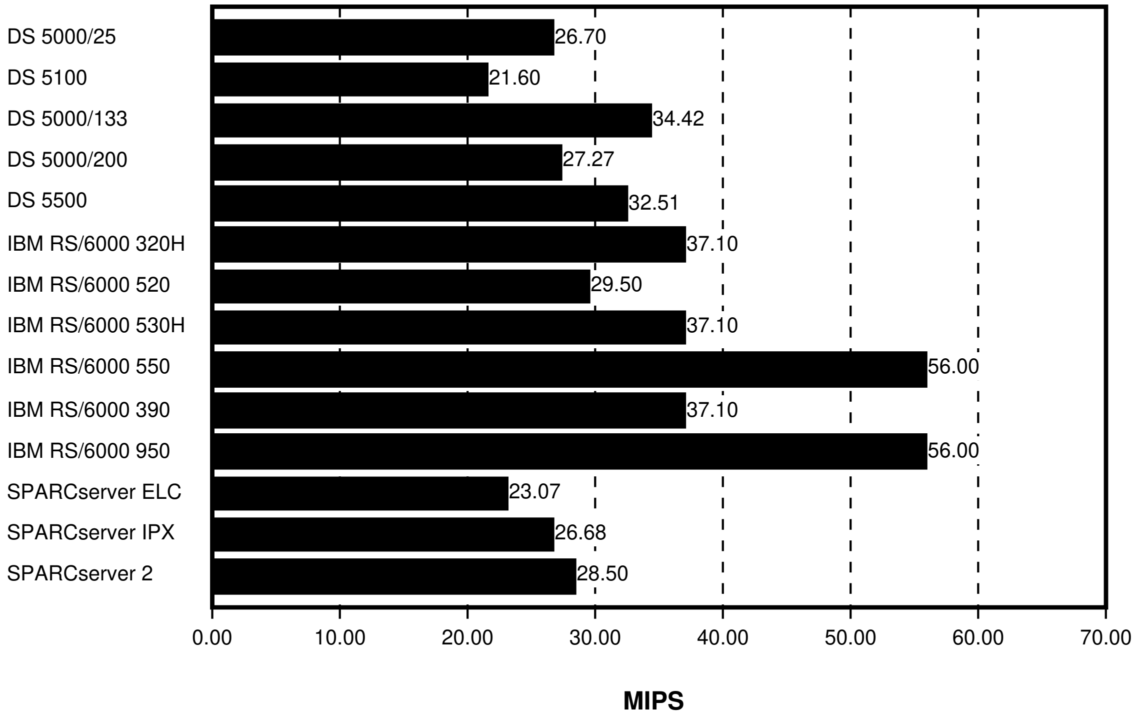
Dhrystones are most commonly expressed in Integer MIPS (Millions of Instructions Per Second) where 1 MIP is the number Dhrystones per second that can be performed by a VAX 11/780 (1757 Dhrystones/second).

3.10 Dhrystone Results

The following graph shows the MIPS ratings for the DECsystem family and competitive servers.

Notes: Dhrystone results were unavailable for the HP 9000/817S and the SPARCserver 600MP series.

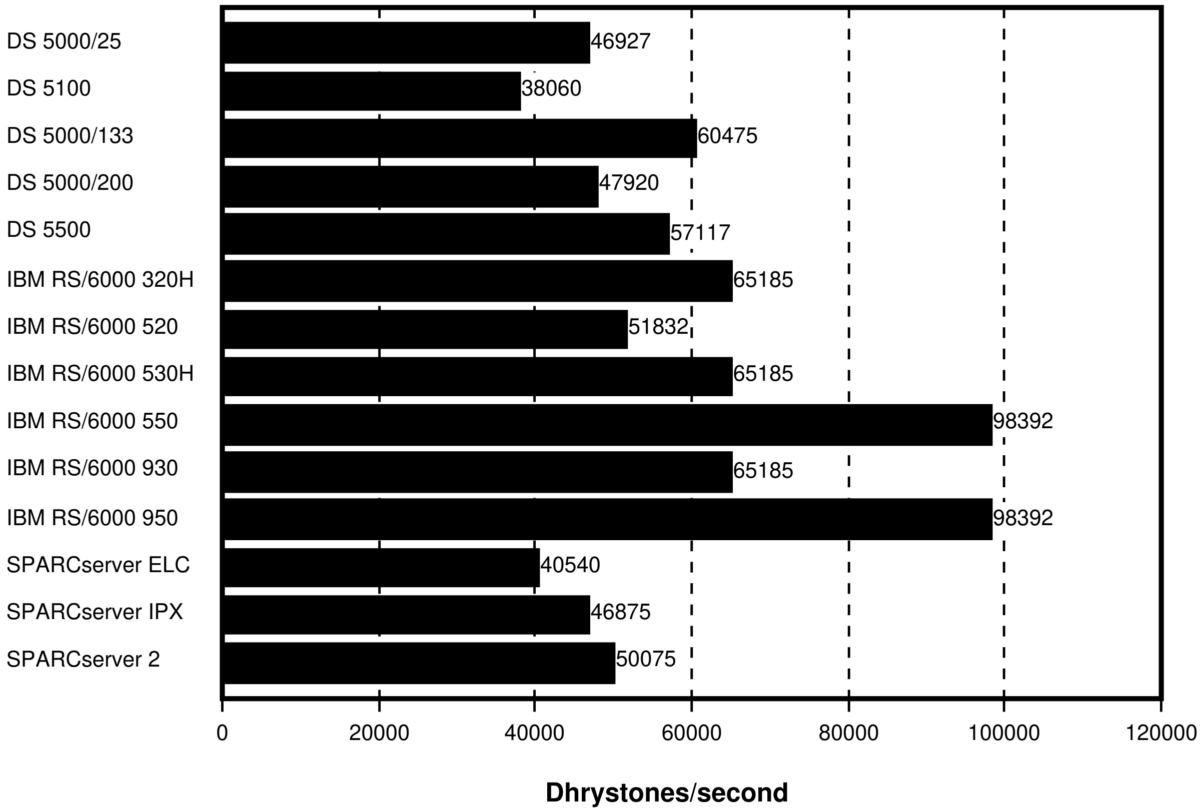
Figure 3-9: Dhrystone MIPS Ratings



[1] Synthetic benchmarks are mostly loops which time different system calls and are not based on actual applications.

Dhrystones per second are charted below.

Figure 3-10: Dhrystones/second Ratings



Linpack Benchmark

Developed at Argonne National Laboratories, Linpack is a FORTRAN benchmark that solves a 100x100 system of linear equations. The benchmark is used to compare the performance of mathematical and scientific applications where floating point computations are prevalent. When running, the benchmark gives little weight to I/O.

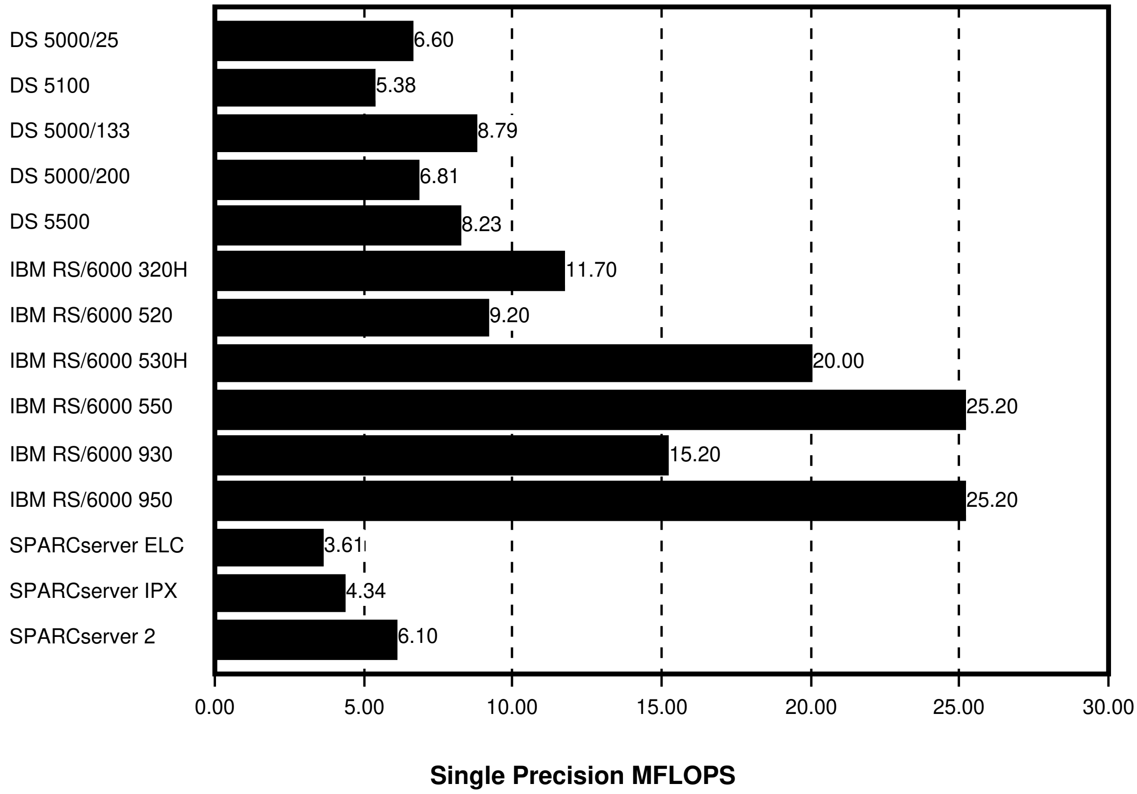
The results are measured in millions of floating point operations per second (MFLOPS). Both single and double precision operations are reported here.

3.11 Linpack Results

Single precision MFLOPS ratings are shown in the following graph.

Note: Single Precision MFLOPS ratings were unavailable for HP 9000 Model 817S and SPARCserver 600MP Series.

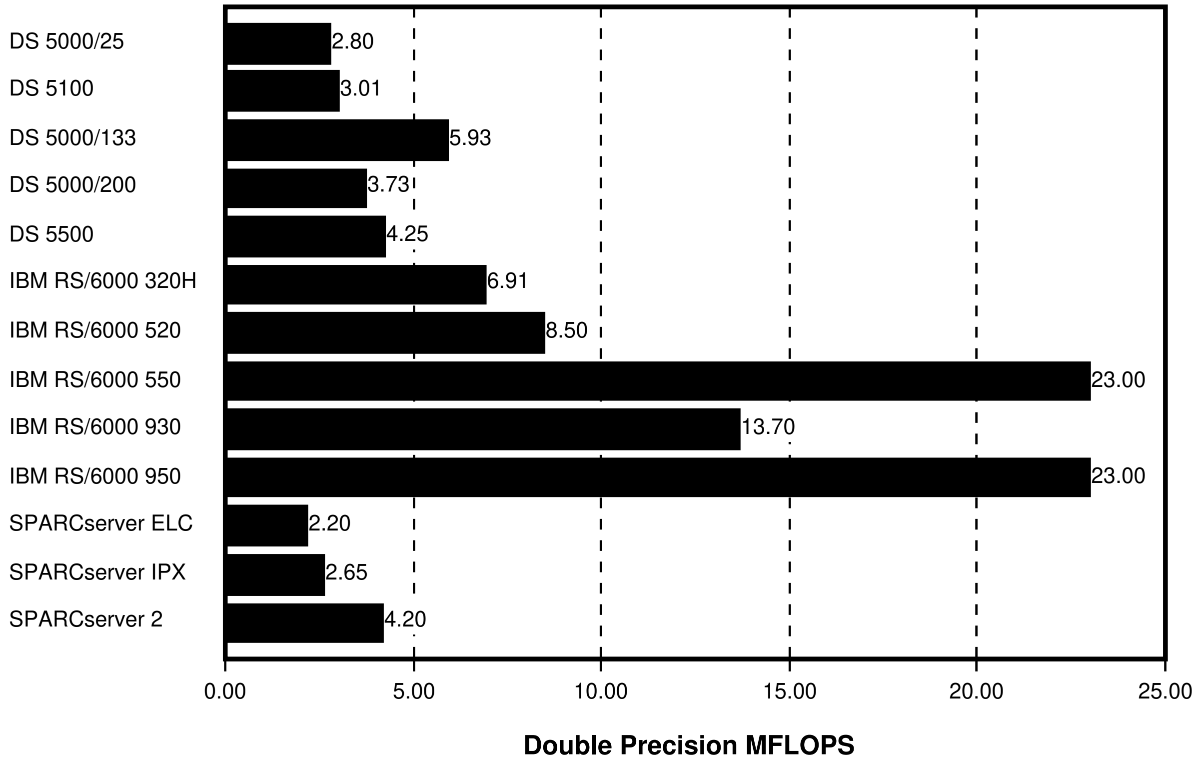
Figure 3-11: Linpack Single Precision MFLOPS Ratings



The following chart contains the double precision MFLOPS results.

Note: Double precision MFLOPS for the IBM RS/6000 530H, HP 9000/817S, and the SPARCserver 600MP Series were unavailable.

Figure 3-12: Linpack Double Precision MFLOPS Ratings



Whetstone Benchmark

The Whetstone benchmark was developed at Great Britain's National Physical Laboratory in Whetstone, England in 1970. It is a synthetic benchmark designed to represent small engineering/scientific programs.

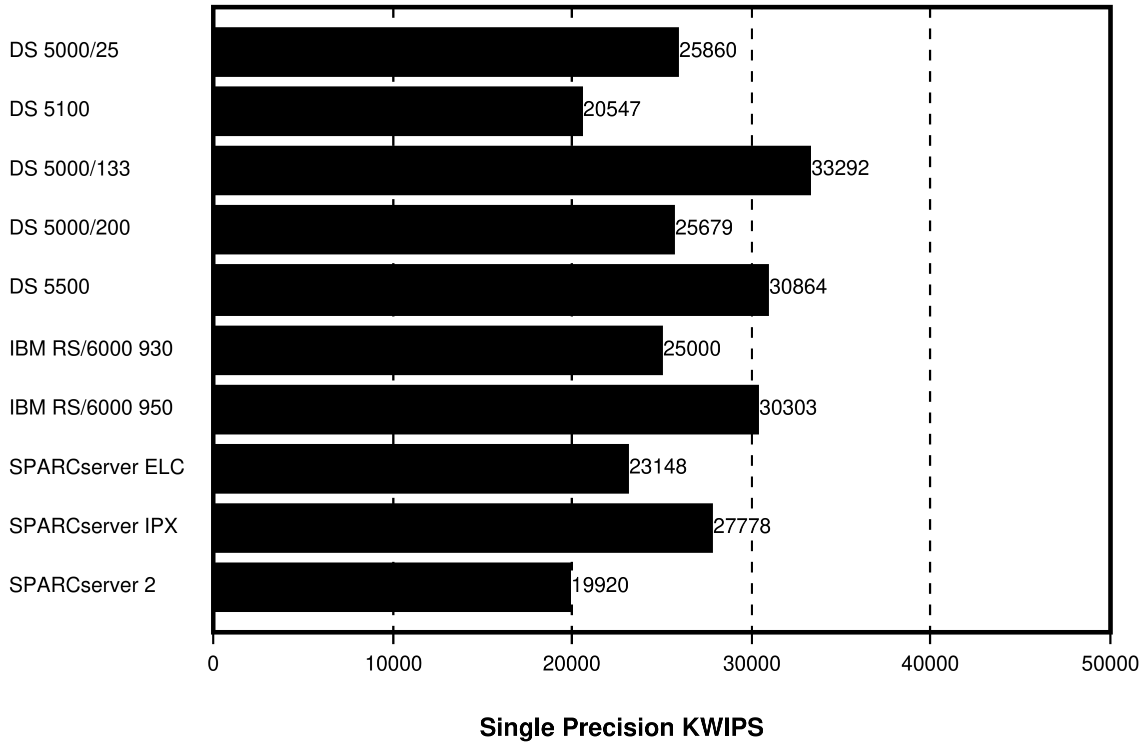
The Whetstone benchmark has been implemented in single precision and double precision FORTRAN programs, each arranged to defeat most compiler optimizations. The results are measured in KWIPS (thousands of Whetstone Instructions Per Second).

3.12 Whetstone Results

Charted below are the Whetstone single and double precision benchmark tests results.

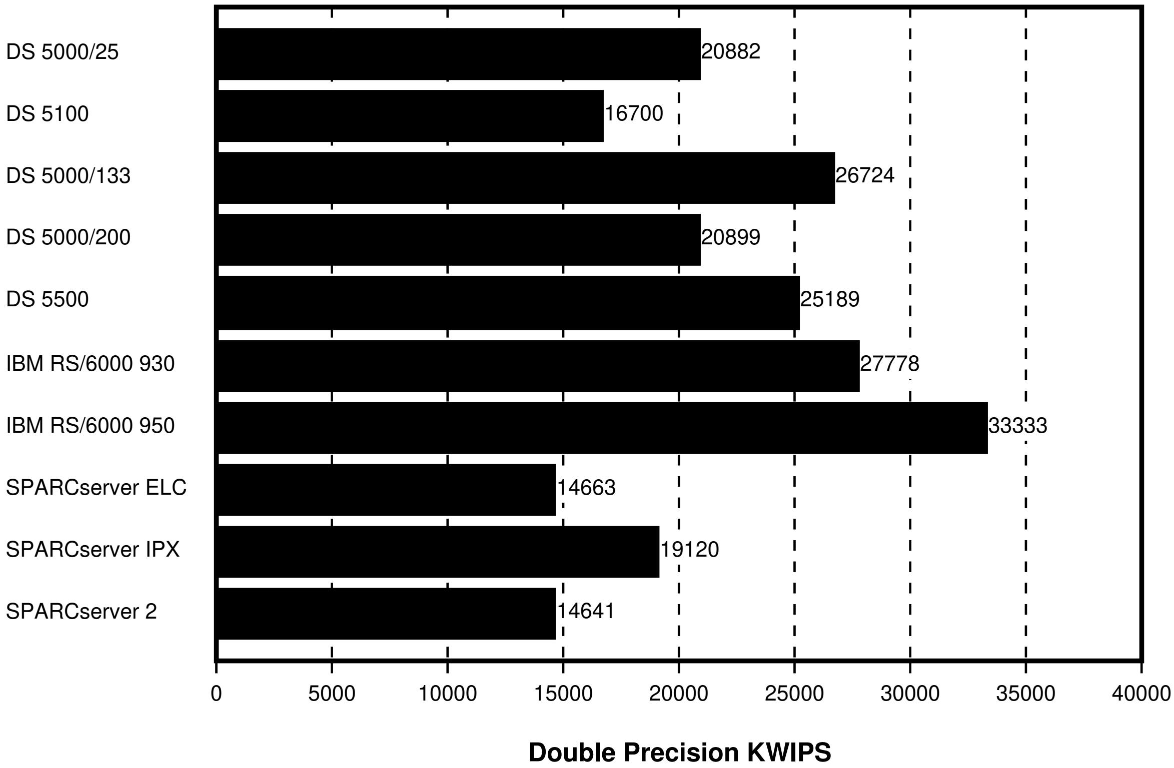
Note: Single and Double Precision KWIPS were unavailable for the IBM RS/6000 Models 320H, 520, 530H, and 550; the Hewlett-Packard 9000 Models 817S; and the SPARCserver 600MP Series.

Figure 3-13: Whetstone Single Precision KWIPS Ratings



Whetstone double precision KWIPS ratings appear in the following chart.

Figure 3-14: Whetstone Double Precision KWIPS Ratings



DR Labs CPU 2 Benchmark

The DR Labs CPU2 benchmark from *Digital Review Magazine* is a floating-point intensive series of FORTRAN programs that include thirty-four separate tests. The benchmark is most relevant in predicting the performance of engineering/scientific applications.

The geometric mean of the CPU times for the 34 kernels tested is compared. Performance is expressed as a multiple of MicroVAX II Units of Performance (MVUPs).

3.13 DR Labs CPU2 Results

The DR Labs CPU2 results appear in the following table. All values have also been normalized to the DECsystem 5000 Model 25.

Note: MVUPs for the IBM RS/6000 320H, IBM RS/6000 530H, IBM RS/6000 550, HP 9000/817S, and SPARCserver 600MP Series were unavailable.

Table 3-9: DR Labs CPU2 MVUPs Ratings

System	MVUPs Rating	Relative to DECsystem 5000 Model 25
DECsystem 5000 Model 25	27.71	1.00
DECsystem 5100	22.74	.82
DECsystem 5000 Model 133	37.10	1.34
DECsystem 5000 Model 200	28.61	1.03
DECsystem 5500	33.87	1.22
IBM RS/6000 520	27.86	1.01
IBM RS/6000 930	35.75	1.29
IBM RS/6000 950	42.80	1.54
SPARCserver ELC	17.29	.62
SPARCserver IPX	20.80	.75
SPARCserver 2	21.16	.76

Khornerstone Benchmarks

The Khornerstone and Khornerstone2 Benchmarks were developed by Workstation Laboratories, Irving, TX. Consisting of 21 separate tests, the benchmarks rate the overall performance of a system. The tests include both public domain (Whetstone, Dhrystone, Sieve, etc.) and proprietary routines. The purpose of these tests is to measure single-user loads on a system and to provide one number representing that load condition.

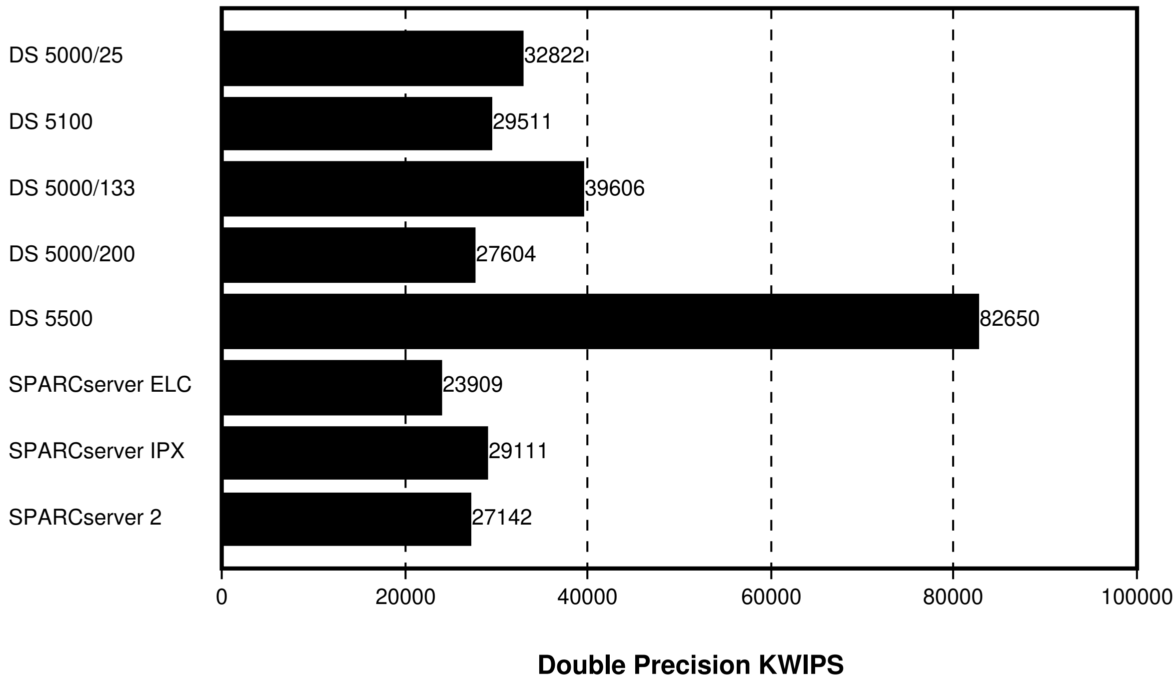
The Khornerstone and Khornerstone2 benchmarks differ in that the Khornerstone2 test runs 10 times as many repetitions of each test.

3.14 Khornerstone Results

Khornerstone and Khornerstone 2 results are shown in the following graph.

Note: Khornerstone results were unavailable for the IBM RS/6000 Models 320H, 520, 530H, 550, 930, and 950. HP 9000/817S and SPARCserver 600MP Series Khornerstone results were also unavailable.

Figure 3-15: Khornerstone Results



A

Test Configurations

Test Configurations

The benchmarks were run on systems with the following configurations:

Personal DECsystem 5000 Model 25 Server/Multiuser Computer:

CPU Chipset	R3000A
CPU MHz	25 MHz
FPU Chipset	R3010A
FPU MHz	25 MHz
Memory	16 MB
Disk	SCSI 1 426 MB RZ25, 1 665 MB RZ56
Cache Size	64KB data/64KB instruction
Network Interface	Ethernet
Operating System	ULTRIX X4.2A-4 (Rev. 20)
Compilers	DEC Fortran T3.1 (ft2), DEC C V1.0
File System	Berkeley FFS
Tuning Parameters	10% bufcache, cache_bufcache=1, delay_wbuffers=1

SPEC benchmarks were recorded using Kuck and Associates pre-compilers will be available in the Spring 1992.

SPEC KENBUS1 benchmark ran with 40 MB of memory; 3 426MB RZ25s; MIPS C V2.10; system state was multi-user; system tuning parameters were MAXUSER=1000, MAXUPRC=1000, BUFCACHE=50, cache_bufcache=1, delay_wbuffers=1; process tuning parameters none; and background load was standard multi-user.

Khornerstone2 tests were run with 10% buffer cache.

All tests were performed by Digital.

DECsystem 5100 Server/Multiuser Computer:

CPU Chipset	R3000
CPU MHz	20
FPU Chipset	R3010
FPU MHz	20
Memory	48 MB
Disk Controller	SCSI
Disk	1.0 GB RZ57
Cache Size	64 KB data/64 KB instruction
Network Interface	Ethernet
Operating System	ULTRIX T4.2 (Rev. 54)
Compilers	DEC FORTRAN EFT5, DEC C
File System	Berkeley FFS
Tuning Parameters	Unlimited Stack Size, cache_bufcache=1, delay_wbuffers=1
Background Load	None
System State	single user

The SPEC benchmarks were recorded using Kuck and Associates pre-compilers which will be available in Spring 1992.

Khornerstone 2 tests were run with 10% buffer cache.

Dhrystone V1.1 was compiled with -O3 optimization.

Linpack, Whetstones, Dhrystone and DR Labs CPU2 benchmarks were compiled with default -O optimization.

For nhfsstone test, system had 32 MB of memory, 2 1.0 Gbyte RZ57s, 16 nfs daemons, 25% buffer cache , and cache_bufcache=1.

The AIM benchmarks ran with 64 MB of memory, 1 SCSI controller with 3 RZ56s, ULTRIX V4.1, C V3.1, and 50% of memory was allocated as file buffer cache. All C source compilations were performed using level -O3 optimization.

TPC-B results from TPC-B Full Disclosure report submitted to TPC council 12/3/91. Configuration consisted of 32 MB of main memory, one embedded SCSI Controller supporting 2 RZ57 disk drives (1 Gbyte each) and 4 RZ25 disk drives (426 Mbytes each).

All tests were performed by Digital.

DECsystem 5000 Model 133 Server/Multiuser Computer:

CPU Chipset	R3000A
CPU MHz	33
FPU Chipset	R3010A
FPU MHz	33
Memory	64 MB
Disk	2 209 MB RZ24, 1 332 MB RZ55
Cache Size	128KB data/64KB instruction
Network Interface	Ethernet
Operating System	ULTRIX X4.2A-5
Compilers	DEC FORTRAN T3.1, DEC C V1.0
File System	Berkeley FFS
Tuning Parameters	10% bufcache, delay_wbuffers=1, cache_bufcache=1
Background Load	none
System State	single-user

SPEC benchmarks were recorded using Kuck and Associates pre-compilers which will be available in the Spring 1992.

Khornerstone2 benchmarks were run with 10% buffer cache.

All AIM benchmarks ran with 48 MB of memory, 2 426 MB RZ25s, ULTRIX 4.2a operating system, and MIPS C 2.1 compiler.

All tests were performed by Digital.

DECsystem 5000 Model 200 Server/Multiuser Computer:

CPU Chipset	R3000
CPU MHz	25
FPU Chipset	R3010
FPU MHz	25
Memory	16 MB
Disk Controller	SCSI
Disk	665 MB RZ56
Cache Size	64 KB data/64 KB instruction
Network Interface	Ethernet
Operating System	ULTRIX T4.2 (Rev. 54)
Compilers	DEC FORTRAN EFT5, DEC C
File System	Berkeley FFS
Tuning Parameters	Unlimited Stack Size, cache_bufcache=1, delay_wbuffers=1
Background Load	None
System State	single user

The AIM benchmarks used 64 MB of memory, 1 SCSI controller with 4 660 MB disks, ULTRIX V4.1-32, cc compiler, and 20% of memory was allocated as buffer cache.

The SPEC benchmarks were recorded using Kuck and Associates pre-compilers which will be available in Spring 1992.

Dhrystone V1.1 was compiled with -O3 optimization.

Linpack, Whetstones, Dhrystone and DR Labs CPU2 benchmarks were compiled with default -O optimization.

Khornerstone2 tests were run with 10% buffer cache.

All tests were performed by Digital.

Test Configurations

DECsystem 5500 Server/Multiuser Computer:

CPU Chipset	R3000A
CPU MHz	30
FPU Chipset	R3010A
FPU MHz	30
Memory	32 MB
Disk Controller	SCSI/DSSI/SDA
Disk	1.2 GB RA90
Cache Size	64 KB data/64 KB instruction
Network Interface	Ethernet
Operating System	ULTRIX T4.2 (Rev. 54)
Compilers	DEC FORTRAN EFT5, DEC C
File System	Berkeley FFS
Tuning Parameters	Unlimited Stack Size, cache_bufcache=1, delay_wbuffers=1
Background Load	None
System State	single user

The AIM benchmarks used 128 MB of memory, SCSI controller with 3 665 MB RZ56s, ULTRIX V4.1 Rev 52, cc V3.1, and 50% of memory was allocated as buffer cache.

The AIM benchmarks used 128 MB of memory, DSSI disk controller with 3 381MB RF31s, ULTRIX V4.1 Rev 52, cc v3.1, and 50% of memory was allocated as buffer cache.

The SPEC benchmarks were recorded using Kuck and Associates pre-compilers which will be available in Spring 1992.

Khornerstone tests were run with 10% buffer cache.

Dhrystone V1.1 was compiled with -O3 optimization.

For nhfsstone test, system had 32 MB of memory, 2 1.0 Gbyte RZ57s, 16 nfs daemons, 25% buffer cache , and cache_bufcache=1.

Linpack, Whetstones, and DR Labs CPU2 were compiled with default -O optimization.

TPC-B results from TPC-B Full Disclosure report submitted to TPC council 12/3/91. Configuration consisted of 32 MB of main memory, two embedded controllers; a DSSI controller supporting seven 381 MB RF31 disk drives and a SCSI controller supporting three 665 MB RZ56 disk drives and 2 1 Gbyte RZ57 disk drives.

All tests were performed by Digital.

Hewlett-Packard Apollo 9000 Series 817S System:

AIM results from Aim Technology. TPC-B results from TPC Council .

IBM Risc System/6000 POWERserver 320H Computer:

CPU	25 MHz IBM 2564
FPU	Integrated
Memory	16
Disk Controller	DBA/SCSI
Disk	320 MB
Cache Size	64 KB data/8 KB instruction
Network Interface	Ethernet
Operating System	AIX
Compilers	C, FORTRAN
File System	AIX

The SPEC results, recorded using Kuck and Associates' pre-compilers, and SPEC SDM results from *SPEC Newsletter,* Volume 3, Issue 3, September 1991.

Dhrystone, and Linpack ratings from IBM information dated March 1991.

The AIM benchmarks used 64MB of memory, IBM SCSI disk controller, 2 400 MB disks, AIX v3.1.5 operating system, x1c v3.1 compiler, and dynamic I/O buffers. CPU type was POWER 2532, ext. cpu cache was 32K data, 8K instruction.

IBM Risc System/6000 POWERserver 520 Computer:

CPU	20 MHZ
Memory	16 MB
Disk Controller	SCSI
Disk	355 MB
Cache Size	32 KB data/8 KB instruction
Network Interface	Ethernet
Operating System	AIX
Compilers	C, FORTRAN
File System	AIX

The SPEC results, recorded using Kuck and Associates' pre-compilers, Dhrystone, and Linpack ratings from IBM information dated March 1991.

The AIM benchmarks used 48 MB of memory, SCSI disk controller, 1 857 MB disk, AIX v3 was the operating system, compiler x1c, and dynamic I/O buffers. CPU type was IBM POWER 2032.

DR Labs CPU2 benchmark ran operating system AIX 3.0. Rating from *Digital Review,* October 15, 1990, page 24.

IBM Risc System/6000 POWERserver 530H Computer:

CPU	33 MHz POWER 3364
FPU	Integrated
Memory	32 MB
Disk Controller	SCSI
Disk	1-400 MB
Cache Size	64 KB Data/8KB Instruction
Operating System	AIX v3.1.5
Compilers	AIX XL C/6000 Version 1.1.5, AIX XL FORTRAN Version 2.2
File System	AIX
Tuning Parameters	None
Background Load	None
System State	Multiuser (single user login)

SPEC and SPEC SDM SDET results from *SPEC Newsletter,* Volume 3, Issue 4, December 1991. SPEC results recorded using Kuck and Associates' pre-compilers. SPEC SDM SDET results used 2 SCSI 400 MB disks (feature 2560) and 3 SCSI 320 MB disks (7204-320). System state was multiuser, MAXUPROC=2000. Tuning parameters were default.

AIM benchmark results from AIM Technology.

IBM Risc System/6000 POWERserver 550 Computer:

CPU	41.67 MHz IBM 4164
FPU	Integrated
Memory	64 MB
Disk Controller	SCSI
Disk	800 MB
Cache Size	64 KB data/8 KB instruction
Network Interface	Ethernet
Operating System	AIX
Compilers	C, FORTRAN
File System	AIX

SPEC results , recorded using Kuck and Associates' pre-compilers, from *SPEC Newsletter,* Volume 3, Issue 3, September 1991.

SPEC SDM results from *SPEC Newsletter,* Volume 3, Issue 2, Spring 1991.

The AIM benchmarks used 128 MB of memory, 2 IBM SCSI disk controllers, 2 400 MB disks, operating system AIX v3, compiler x1c, and dynamic I/O buffers

TPC-B results from Sun Microsystems Computer Corp., *Sun SPARCserver 600MP Performance Brief,* September 1991, pages 2-3.

IBM Risc System/6000 POWERserver 930 Computer:

CPU	25MHz POWER 2564
FPU	Floating Point
Memory	64 MB
Disk	SCSI 857 MB
Cache Size	64 KB data/8 KB instruction
Operating System	AIX v3.1
Compiler	xle v3.1
File System	AIX

SPEC results were recorded using Kuck and Associates' pre-compilers. Information from IBM dated 5/8/91.

AIM results from AIM Technology.

IBM Risc System/6000 POWERserver 950 Computer:

CPU	41.6 MHz
Memory	64 MB
Disk Controller	SCSI
Cache Size	64 KB data/8 KB instruction
Operating System	AIX
File System	

AIM results from AIM Technology.

TPC-B results from Sun Microsystems Computer Corp., *Sun SPARCserver 600MP Performance Brief,* September 1991, pages 2-3.

Sun SPARCstation ELC Computer:

Processor Type & Frequency	SPARC (LSI) - 33MHz
Floating Point Unix & Frequency	SPARC (Fujitsu) - 33 MHz
Cache Memory Size & Speed	64 Kilobytes
RAM Memory Size & Speed	8 Megabytes / 80 ns (except khorner1 @ 16Mb)
Hardfile Brands & Model Numbers	CDC (Imprimis) 94191
Hardfile Quantity/Interface	1 / SCSI
Hardfile Size(s) (Unformatted/for.)	760 / 680 MB
Operating System Name & Level	Sun OS 4.1.1
Fortran Supplier & Version	Sun Fortran 1.4
Fortran Compiler Switches Used	-O4
C supplier & Version	Sun C 1.1
Compiler Switches Used	-O4
Graphics Libraries Used	X11

SPEC benchmark numbers from *SPEC Newsletter,* Volume 3, Issue 3, September 1991, page 24. Memory configured 16MB, Disk subsystem 207 MB SCSI, other software KAP/SUN pre-processor. System state single user, no tuning parameters in use, and no background load.

Dhrystones, Whetstones, Khornerstone, Linpack, DR Labs CPU2, and X11perf benchmark numbers from *Workstation Laboratories*, 9/1/1991, Volume 15, Chapter 21.

Sun SPARCstation IPX Workstation:

Processor Type & Frequency	SPARC (LSI) - 40MHz
Floating Point Unix & Frequency	SPARC (Fujitsu) - 40MHz
Cache Memory Size & Speed	64 Kilobytes
RAM Memory Size & Speed	16 Megabytes / 80 ns
Hardfile Brands & Model Numbers	Maxtor 3.5" SCSI
Hardfile Quantity/Interface	1 SCSI
Hardfile Size(s) (Unformatted/for.)	? / 207 Mb
Operating System Name & Level	Sun OS 4.1.1
Fortran Supplier & Version	Sun Fortran 1.4
Fortran Compiler Switches Used	-O4

C Supplier & Version	Sun C 1.1
Compiler Switches Used	-O4
Graphics Libraries Used	X11

SPEC benchmark numbers from *SPEC Newsletter,* Volume 3, Issue 3, September 1991, page 22. Other software used was KAP/SUN pre-processor. Disk Subsystem was 424 MB SCSI. No tuning parameters in use, no background load and system state was single user.

Dhrystones, Whetstones, Khornerstone, Linpack, DR Labs CPU2, and X11perf benchmark numbers from *Workstation Laboratories*, 9/1/91, Volume 15, Chapter 22.

Sun SPARCserver 2 Computer:

CPU Processor	SPARC
CPU MHz	40 MHz
FPU	SPARC (TI)
FPU MHz	40 MHz
Memory	16 MB
Disk Controller	SCSI
Disk	207 MB
Cache Size	64 KB data/64 KB instruction
Network Interface	Ethernet
Operating System	SunOS 4.1.1
Compilers	Sun Fortran, Sun C
Compiler Switches	-O3

SPEC results from *SPEC Newsletter,* Volume 3, Issue 3, September 1991, page 24. Memory configuration 16MB, disk subsystem 207 MB SCSI, other software KUP/SUN pre-processor. System state single user, no tuning parameters in use, and no background load.

SPEC SDM results from *SPEC Newsletter,* Volume 3, Issue 2, pages 37-38. Configuration was 64 MB of memory, 2 SCSI controllers, 4 SCSI disks, and SBUS Prestoserve.,

DR Labs CPU2 rating from Digital Review, March 11, 1991, page 19. Configuration tested was running was Sun SPARCstation 2GX , SunOS 4.1.1-1/91. (From same article, "The SPARCstation 2 has a server counterpart, the SPARCserver, that is virtually identical to the SPARCstation 2 without the graphics option.")

Linpack and Dhrystone benchmark ratings from *SPARCstation 2 Performance Brief,* Sun Microsystems, Inc., November 1990. Tested configuration was SPARCstation 2 running SunOS 4.1.1beta, Sun FORTRAN 1.4beta and Sun C1.1beta.

Whetstones results from Workstation Laboratories, Inc., Volume 12, page V12-23-Config.

Sun SPARCserver 600MP Series Server Systems (per processor):

CPU	40 MHz
FPU	40 MHz
Memory	64 MB
Disk Subsystem:	SCSI
Operating System/compilers:	Sun OS 4.1.2 Alpha 2.2, NC400 driver 1.7, Prestoserve driver 2.3
Other Hardware:	Sun SBus Prestoserve NFS Accelerator Board 2 or 4 Sun Network CoProcessor Boards

SPEC results for Sun SPARCserver 600MP (single processor) from *Sun SPARCserver 600MP Performance Brief*, September 1991, pages 10-11.

TPC-B results for Sun SPARCserver 630MP and 670MP from *Sun SPARCserver 600MP Performance Brief*, September 1991, pages 2-3.

B

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