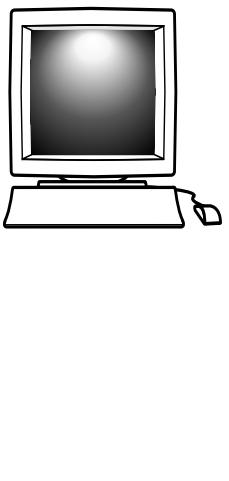
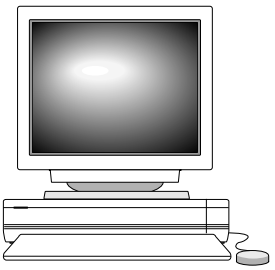
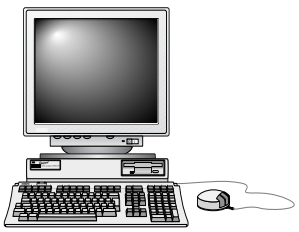
Alpha AXP Workstation Family
Performance Brief - DEC OSF/1 AXP



DEC 3000 Model 500X AXP Workstation
DEC 3000 Model 500 AXP Workstation



DEC 3000 Model 400 AXP Workstation



DEC 3000 Model 300 AXP Workstation
DEC 3000 Model 300L AXP Workstation

Digital Equipment Corporation
April 1993
Second Edition
EB-N0103-51

INSIDE

Benchmark results for:

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- LINPACK
- Dhrystone
- DN&R Labs CPU2
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- Rhealstone
- SLALOM
- AIM Suite III
- Livermore Loops
- CERN
- X11perf

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Introducing Digital's Alpha AXP Workstation Family

This document presents Digital's newest Alpha AXP™ , 64-bit, RISC workstations: the DEC™ 3000 Model 300L AXP™, the DEC 3000 Model 300 AXP, and the DEC 3000 Model 500X AXP. Industry-standard benchmarks for the entire Alpha AXP workstation family running the DEC OSF/1 ™ AXP™ operating system environment are presented on the following pages.

DEC 3000 Model 300L and Model 300 AXP Workstations

Digital's lowest-cost workstation, the DEC 3000 Model 300L AXP, features HX graphics and runs at a CPU clock speed of 100 MHz. The DEC 3000 Model 300 AXP workstation also features HX graphics and has two TURBOchannel slots and two storage bays. This workstation runs at a clock speed of 150 MHz. Both workstations are ideal for 2D graphics applications, commercial and technical applications, and software development environments. Additionally, the Model 300 is well-suited for new and emerging technologies such as multimedia.

DEC 3000 Model 400 AXP Workstation

The DEC 3000 Model 400 AXP workstation is Digital's mid-level, desktop workstation, and it runs at a CPU clock speed of 133 MHz. This workstation allows for expansion of memory, storage, I/O, and graphics. The DEC 3000 Model 400 AXP workstation satisfies the performance needs of technical users developing or deploying software and of commercial users doing financial analysis, network management, publishing, and database services.

DEC 3000 Model 500 and Model 500X AXP Workstations

The DEC 3000 Model 500 AXP workstation runs at a CPU clock speed of 150 MHz. It uses advanced CPU, TURBOchannel, and graphics technologies. This workstation is available in a deskside or rackmountable configuration and is the system of choice for such high-performance technical and commercial applications as mechanical CAD, scientific analysis, medical imaging, animation and visualization, financial analysis, and insurance processing.

The DEC 3000 Model 500X AXP, *the fastest uniprocessor workstation in the industry*, features a 200-MHz CPU and offers all the same features and functionality as the Model 500. The DEC 3000 Model 500X AXP is the system of choice for running applications such as financial modeling, structural analysis, and electrical simulation.

Alpha AXP Workstation Family Performance Brief - DEC OSF/1 AXP

Digital's Alpha AXP Workstation Family Performance

The performance of the Alpha AXP workstation family was evaluated using industry-standard benchmarks. These benchmarks allow comparison across vendors. Performance characterization is one "data point" to be used in conjunction with other purchase criteria such as features, service, and price.

***Notes**: The performance information in this report is for guidance only. System performance is highly dependent upon application characteristics. Individual work environments must be carefully evaluated and understood before making estimates of expected performance. This report simply presents the data, based on specified benchmarks. Competitive information is based on the most current published data for those particular systems and has not been independently verified.*

We chose the competitive systems (shown with the Alpha AXP workstations in the following charts and tables) based on comparable or close CPU performance, coupled with comparable expandability capacity (primarily memory and disk). Although we do not present price comparisons in this report, system price was a secondary factor in our competitive choices.

The Alpha AXP performance information presented in this brief is the latest measured results as of the date published. Digital has an ongoing program of performance engineering across all products. As system tuning and software optimizations continue, Digital expects the performance of its workstations to increase. As more benchmark results become available, Digital will publish reports containing the new and updated benchmark data.

For more information on Digital's Alpha AXP workstation family, please contact your local Digital sales representative.

Please send your questions and comments about the information in this report to: decwrl::"csgperf@msbcs.enet.dec.com"

Alpha AXP Workstation Family Performance Brief - DEC OSF/1 AXP

Table 1 Digital's Alpha AXP Workstation Family Benchmark Results

Benchmark	DEC 3000 Model 300L AXP	DEC 3000 Model 300 AXP	DEC 3000 Model 400 AXP	DEC 3000 Model 500 AXP	DEC 3000 Model 500X AXP
SPECint92	45.9	66.2	74.7	84.4	110.9
SPECfp92	63.6	91.5	112.5	127.7	164.1
SPECrate_int92	1,081	1,535	1,763	1,997	2,611
SPECrate_fp92	1,480	2,137	2,662	3,023	3,910
SPEC SFS Release 1.0	tbd	tbd	537	601	tbd
SPECnfs_A93 (ops/sec)	tbd	tbd	26.0	21.6	tbd
Average Response Time (millisec.)	tbd	tbd	54	60	tbd
SPECnfs_A93 Users					
LINPACK 64-bit Double-Precision					
100X100 (MFLOPS)	12.3	24.5	26.0	29.6	39.8
1000x1000 (MFLOPS)	52.8	72.3	91.7	103.5	133.2
Dhrystone					
V1.1 (instructions/second)	176,161	266,224	235,939	266,487	349,785
V2.1 (instructions/second)	151,515	238,095	238,095	263,157	333,333
X11perf (2D Kvectors/second)	512	517	579	662	670
X11perf (2D Mpixels/second)	30.5	30.8	27.2	31.0	31.0
DN&R Labs CPU2 (MVUPs)	134.4	207.4	185.0	209.1	284.7
AIM III Benchmark Suite					
Performance Rating	42	58.7	70.3	82.9	110.4
Maximum User Load	225	216	485	649	805
Maximum Throughput	411.7	575.5	688.7	812.9	1,082.4
Livermore Loops (geometric mean)	11.5	18.1	17.4	19.5	26.3
CERN	tbd	tbd	18.8	21.3	28.9
SLALOM (patches)	4,488	5,844	5,776	6,084	7,134

tbd = to be determined

SPEC Benchmark Suites

SPEC™ (Standard Performance Evaluation Corporation) was formed to identify and create objective sets of applications-oriented tests, which can serve as common reference points and be used to evaluate performance across multiple vendors' platforms.

SPEC CINT92 and CFP92

In January 1992, SPEC announced the availability of the CINT92 and CFP92 benchmark suites. CINT92, the integer suite, contains six real-world application benchmarks written in C. The geometric mean of the suite's six SPECratios is the SPECint92™ figure. CFP92 consists of fourteen real-world applications; two are written in C and twelve in FORTRAN. Five of the fourteen programs are single precision, and the rest are double precision. SPECfp92™ equals the geometric mean of this suite's fourteen SPECratios.

CINT92 and CFP92 have different workload characteristics. Each suite provides performance indicators for different market segments. SPECint92 is a good base indicator of CPU performance in a commercial environment. SPECfp92 may be used to compare floating-point intensive environments, typically engineering and scientific applications.

Alpha AXP Workstation Family
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Figure 1 SPEC CINT92 Results

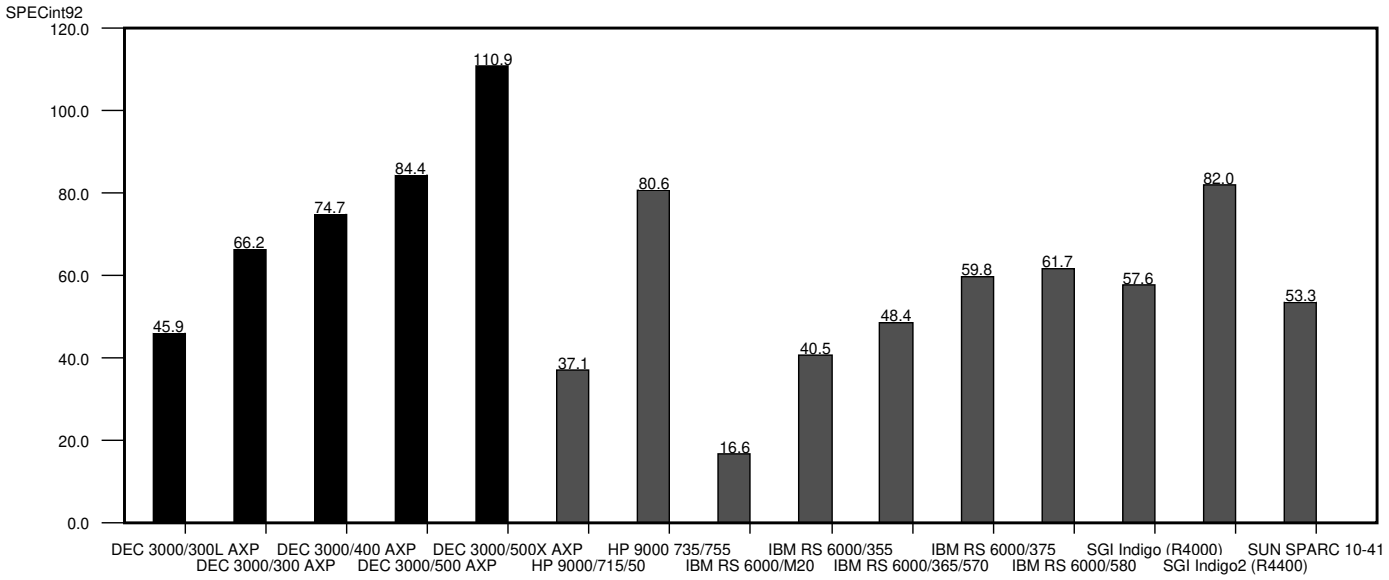
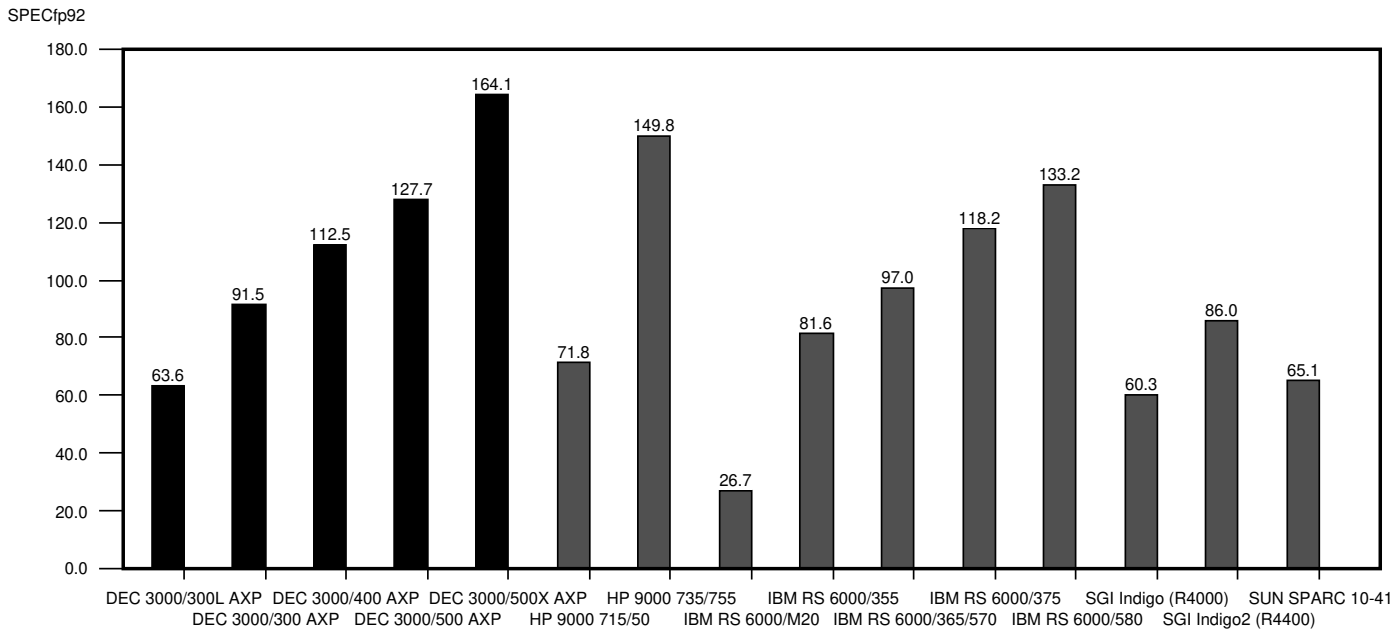


Figure 2 SPEC CFP92 Results



SPEC Homogeneous Capacity Method based on SPEC CINT92 and CFP92

SPEC Homogeneous Capacity Method benchmarks test multiprocessor efficiency. According to SPEC, "The SPEC Homogeneous Capacity Method provides a fair measure for the processing capacity of a system — how much work can it perform in a given amount of time. The "SPECrate" is the resulting new metric, the rate at which a system can complete the defined tasks....The SPECrate is a capacity measure. It is not a measure of how fast a system can perform any task; rather it is a measure of how many of those tasks that system completes within an arbitrary time interval (*SPEC Newsletter,* June 1992)." The SPECrate is intended to be a valid and fair comparative metric to use across systems of any number of processors.

The following formula is used compute the SPECrate:

SPECrate = #CopiesRun * ReferenceFactor * UnitTime / ElapsedExecutionTime

SPECrate_int92™ equals the geometric mean of the SPECrates for the six benchmarks in CINT92. SPECrate_fp92™ is the geometric mean of the SPECrates of the fourteen benchmarks in CFP92.

Figure 3 SPECrate_int92 Benchmark Results

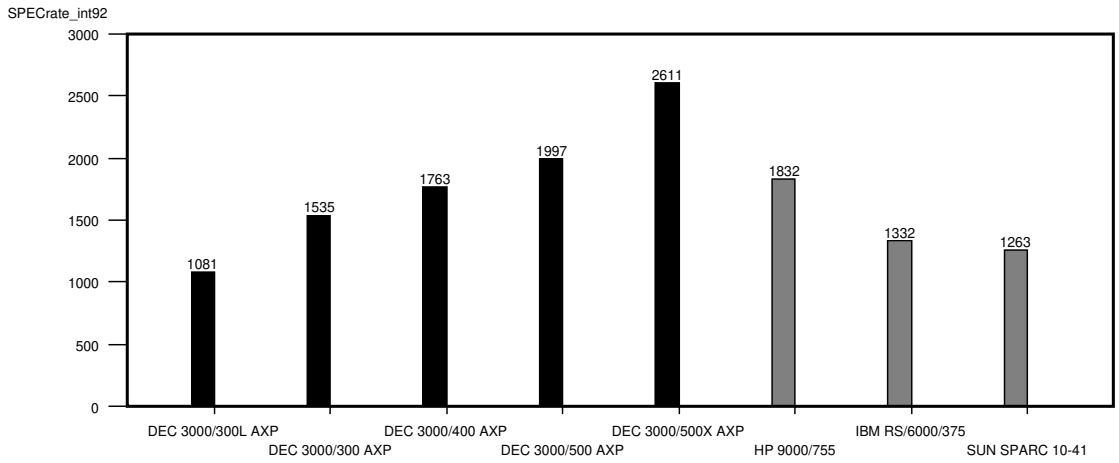


Figure 4 SPECrate_fp92 Benchmark Results

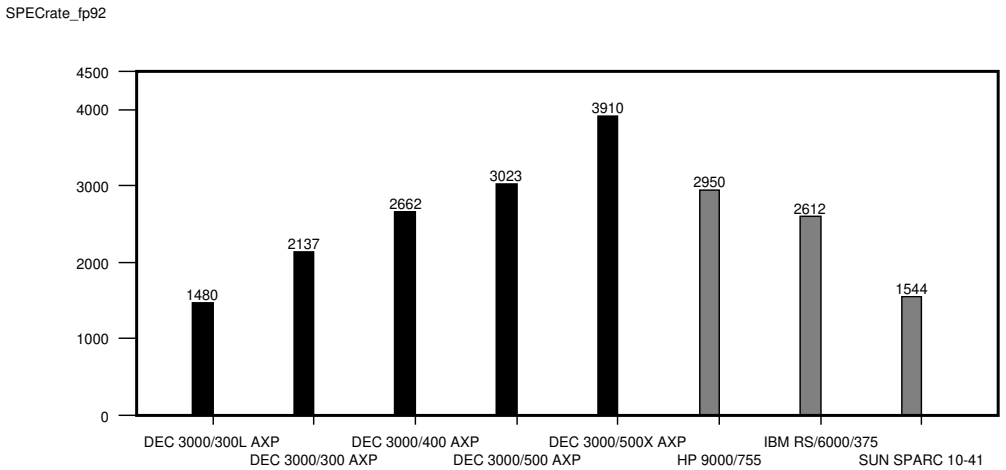


Figure 5 SPEC SFS Release 1.0

In March 1993, SPEC announced its SFS (System-level File Server) Release 1.0 Benchmark Suite. This suite is the first, industry-wide, standard method for measuring and reporting NFS™ file server performance.

SFS Release 1.0 contains the 097.LADDIS File Server Benchmark, which supersedes the nhfsstone benchmark. 097.LADDIS emulates an intense software development environment where system components important to file serving (i.e., network, file system, disk I/O, and CPU) are heavily exercised. This benchmark shows a server's ability to handle NFS throughput and the speed with which the throughput is processed.

SPEC's metrics for 097.LADDIS are:

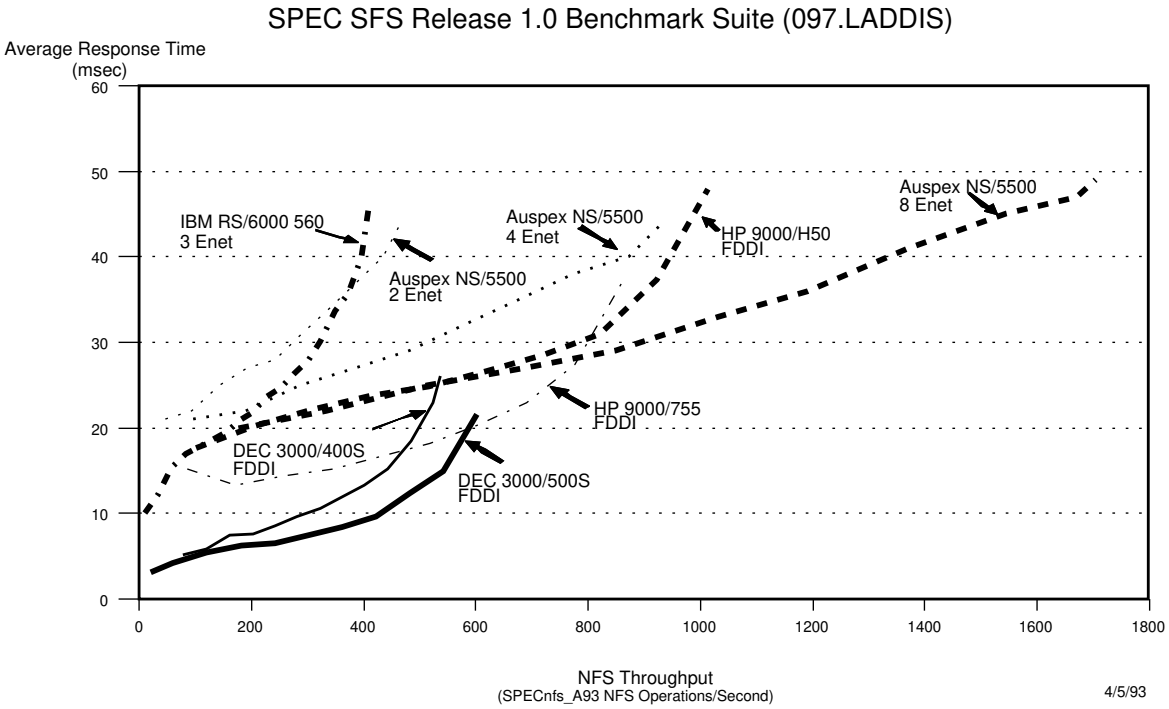
- SPECnfs_A93 operations/second, which is peak NFS throughput.
- Average Response Time associated with the peak NFS throughput level, measured in milliseconds.
- SPECnfs_A93 Users, an arbitrary, conservative, derived number of users supported at the reported peak NFS throughput level (SPECnfs_A93 operations/second) at an associated response time of less than or equal to 50 milliseconds.

Table 2 shows SPEC SFS Release 1.0 results for both Alpha AXP and competitive systems. Figure 6 shows their NFS server response time versus throughput results at various loads.

Table 2 SPEC SFS Release 1.0 Benchmark Suite Results

System (Network)	Memory (MB)	Disk Controllers	Number of Disks	SPECnfs_A93 (ops/sec)	Average Response Time (msec)	SPECnfs_A93 Users	Number of File Systems
DEC 3000/500S AXP (1 FDDI)	256	4 SCSI-2	10	601	21.6	60	8
DEC 3000/400S AXP (1 FDDI)	128	4 SCSI-2	9	537	26.0	54	8
Auspex NS/5500 (8 Enet)	256	3 SP-III	55	1,703	49.4	170	18
Auspex NS/5500 (4 Enet)	224	2 SP-III	37	933	43.9	93	12
Auspex NS/5500 (2 Enet)	208	1 SP-III	19	466	43.6	47	6
HP 9000/H50 (1 FDDI)	576	3 SCSI-2	22	1,014	47.9	101	19
HP 9000/755 (1 FDDI)	640	2 SCSI-2	13	859	36.9	86	2
IBM RS 6000/560 (3 Enet)	128	2 SCSI	12	410	45.8	41	10

Figure 6 SPEC SFS Release 1.0 NFS Throughput vs. Average Response Time



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LINPACK 100x100 and 1000x1000 Benchmarks

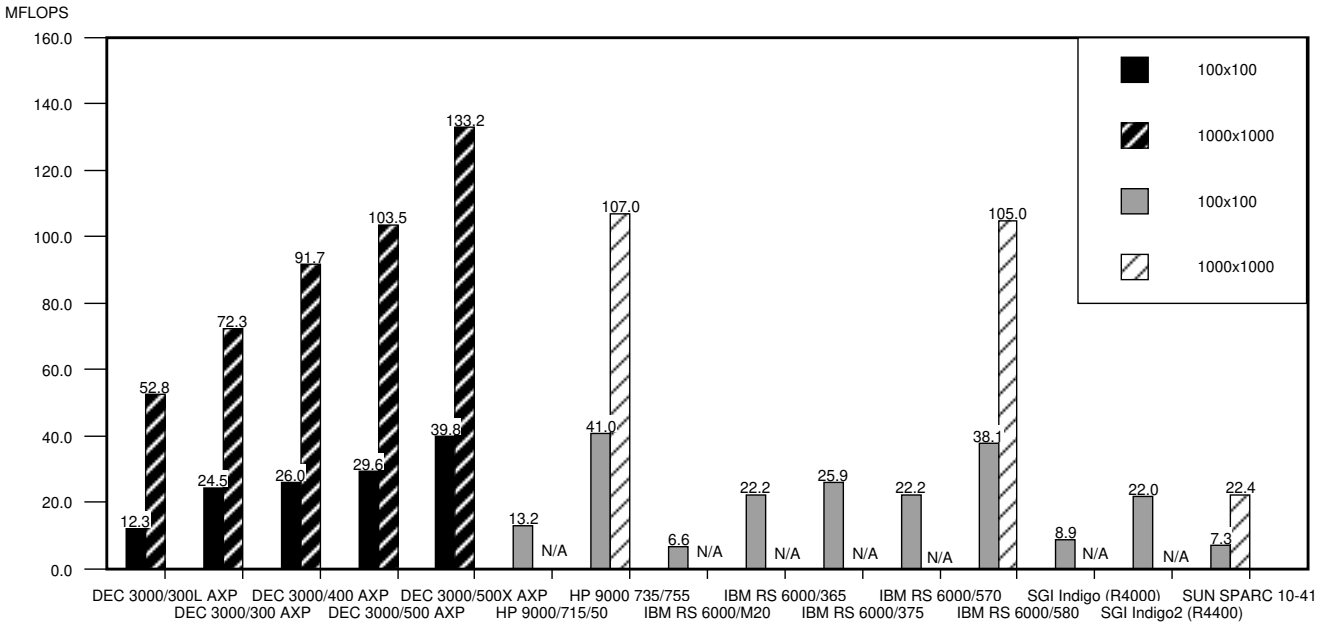
LINPACK is a linear equation solver written in FORTRAN. LINPACK programs consist of floating-point additions and multiplications of matrices. The LINPACK benchmark suite consists of two benchmarks.

1. 100x100 LINPACK solves a 100x100 matrix of simultaneous linear equations. Source code changes are not allowed so that the results may be used to evaluate the compiler's ability to optimize for the target system.

2. 1000x1000 LINPACK solves a 1000x1000 matrix of simultaneous linear equations. Vendor optimized algorithms are allowed.

The LINPACK benchmarks measure the execution rate in MFLOPS (millions of floating-point operations per second). When running, the benchmark depends on memory-bandwidth and gives little weight to I/O. Therefore, when LINPACK data fit into system cache, performance may be higher.

Figure 7 LINPACK 100x100 and 1000x1000 Double-Precision Results

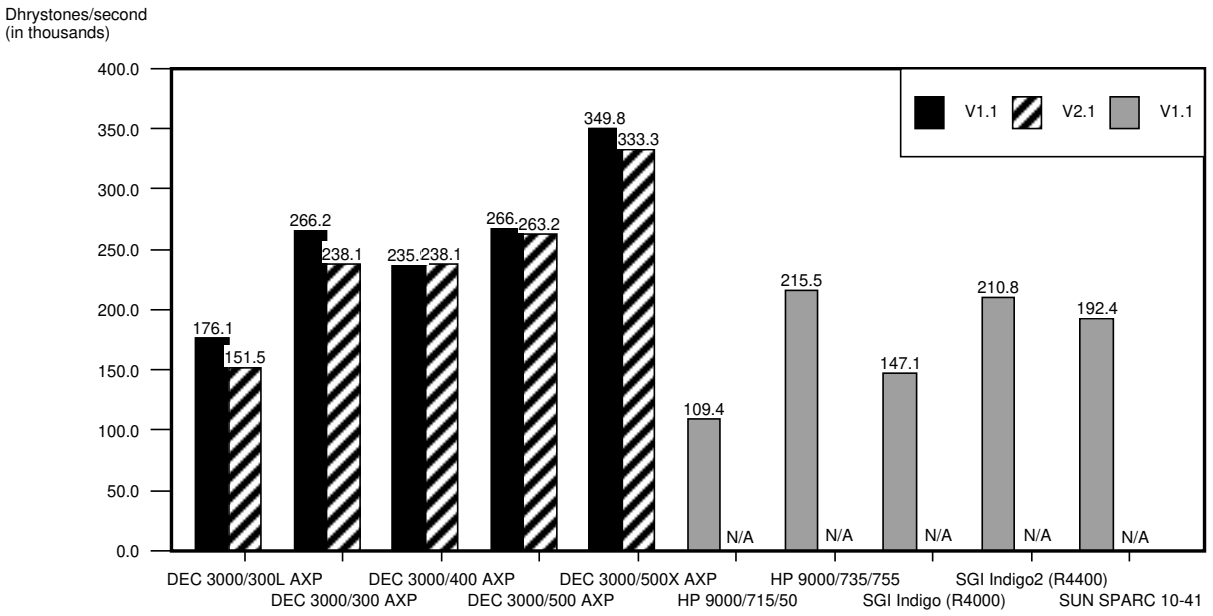


Dhrystone Benchmarks

Developed as an Ada program in 1984 by Dr. Reinhold Weicker, the Dhrystone benchmark was rewritten in C in 1986 by Rick Richardson. It measures processor and compiler efficiency and is representative of systems programming environments. Dhrystones are most commonly expressed in Dhrystone instructions per second.

Dhrystone V1 and V2 vary considerably. Version 1.1 contains sequences of code segments that calculate results never used later in the program. These code segments are known as "dead code." Compilers able to identify the dead code can eliminate these instruction sequences from the program. These compilers allow a system to complete the program in less time and result in a higher Dhrystones rating. Dhrystones V2 was modified to execute all instructions.

Figure 8 Dhrystone Results



***Note**: Hewlett-Packard has reported Dhrystone V2.0 results, but not V2.1. The other vendors have not reported Dhrystone V2.0 or V2.1 results.*

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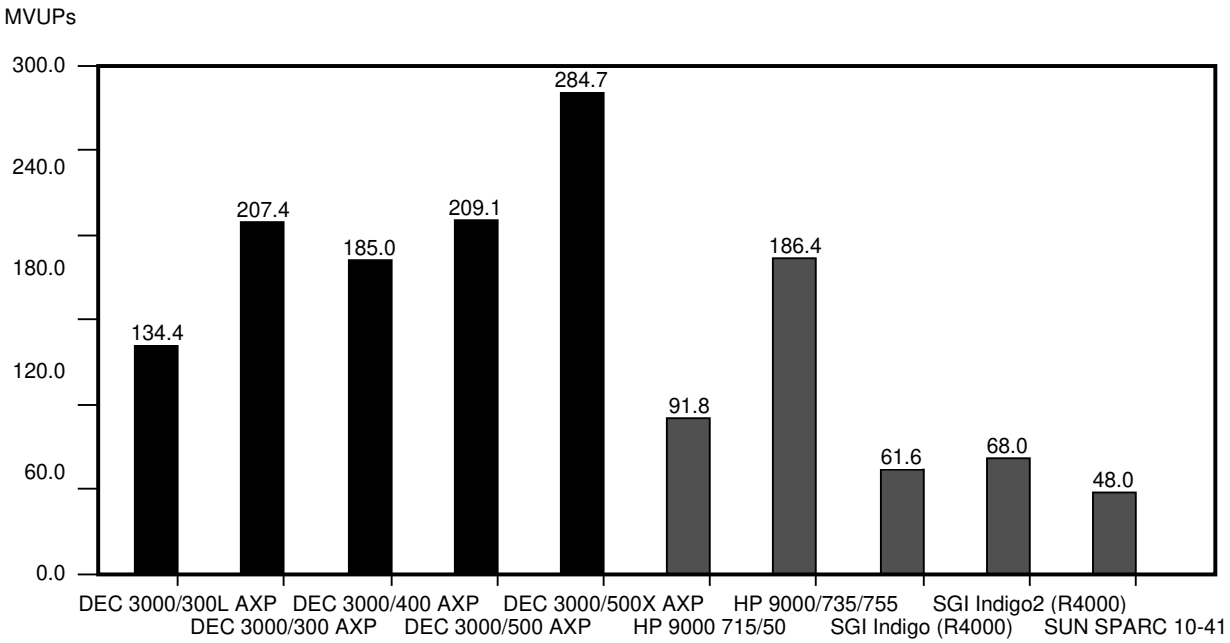
DN&R Labs CPU2 Benchmark

DN&R Labs CPU2, a benchmark from *Digital Review & News* magazine, is a floating-point intensive series of FORTRAN programs and consists of thirty-four separate tests. The benchmark is most relevant in predicting the performance of engineering and scientific applications. Performance is expressed as a multiple of MicroVAX II Units of Performance (MVUPs).

Figure 9 DN&R Labs CPU2 Results



Basic Real-Time Primitives

Measuring basic real-time primitives such as process dispatch latency and interrupt response latency enhances our understanding of the responsiveness of the DEC OSF/1 AXP Real-Time kernel.

Process Dispatch Latency is the time it takes the system to recognize an external event and switch control of the system from a running, lower-priority process to a higher-priority process that is blocked waiting for notification of the external event.

Interrupt Response Latency (ISR latency) is defined as the amount of elapsed time from when the kernel receives an interrupt until execution of the first instruction of the interrupt service routine.

The DEC 3000 Model 500 AXP's Basic Real-Time Primitives results appear in the following table.

Table 3 Basic Real-Time Primitives Results

Metric	Minimum (µsec)	Maximum (µsec)	Mean (µsec)
Process Dispatch Latency	62.5	187.7	68.9
Interrupt Response Latency	7.0	50.4	8.4

Test configuration: DEC 3000 Model 500 AXP, 256 MB memory, DEC OSF/1 AXP RT operating system, Ver 1.2.
Test conditions: Single user mode, no network.

Shown next are histograms of the process dispatch latency times and the interrupt response latency times of a DEC 3000 Model 500 AXP system running in the DEC OSF/1 AXP Real-Time operating system environment.

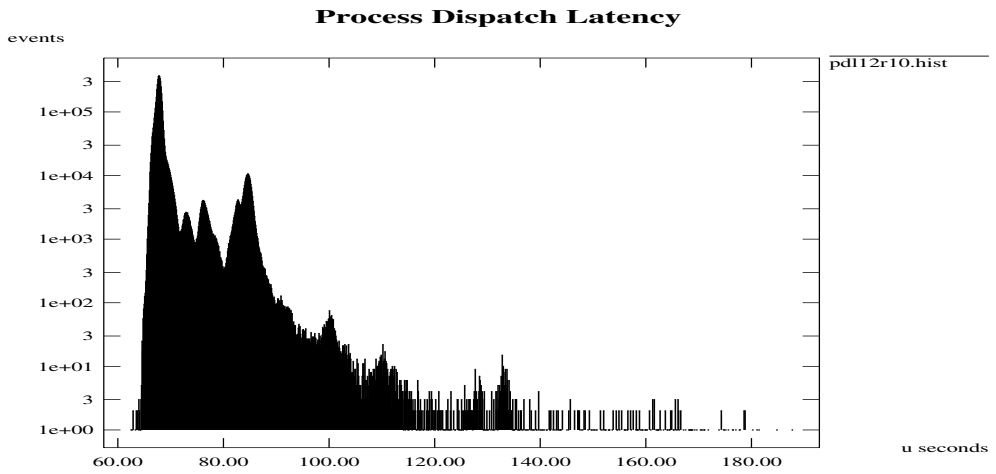


Figure 10 Basic Real-Time Primitives Process Dispatch Latency Results

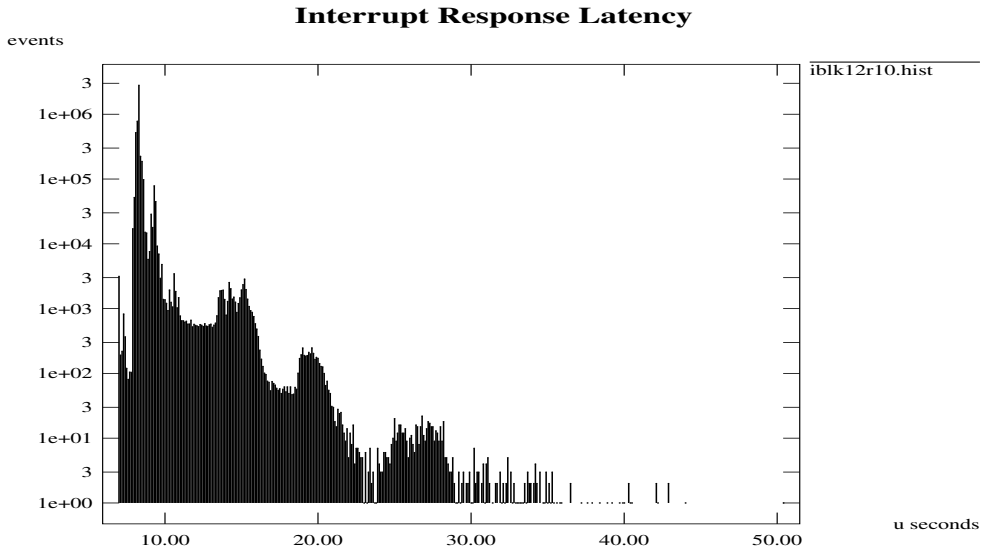


Figure 11 Basic Real-Time Primitives Interrupt Response Latency Results

Rhealstone Benchmark

The Rhealstone Real-time Benchmark is a definition for a synthetic test that measures the real-time performance of multitasking systems. It is unique in that "the verbal and graphical specifications, not the C programs, are the essential core of the benchmark" (Kar 1990). We implemented the following components of the Rhealstone Benchmark, which measure the critical features of a real-time system:

1. Task switch time—the average time to switch between two active tasks of equal priority.
2. Preemption time—the average time for a high-priority task to preempt a running low-priority task.
3. Interrupt latency time—the average delay between the CPU's receipt of an interrupt request and the execution of the first instruction in an interrupt service routine.

   Semaphore shuffle time—the delay within the kernel between a task's request and its receipt of a semaphore, which is held by another task (excluding the runtime of the holding task before it relinquishes the semaphore).

   ***Note**: We report the delays associated with* `sem_wait` *as well as* `sem_post` *plus the two corresponding context switches.*
4. Intertask message latency —the delay within the kernel when a non-zero-length data message is sent from one task to another.

Deadlock-break time is not applicable to DEC OSF/1 AXP Real-Time.

The following figures show the four components of the Rhealstone benchmark we implemented.

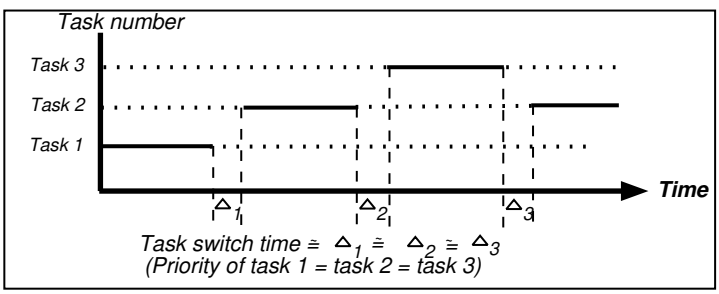


Figure 12 Rhealstone Component–Task-switch Time

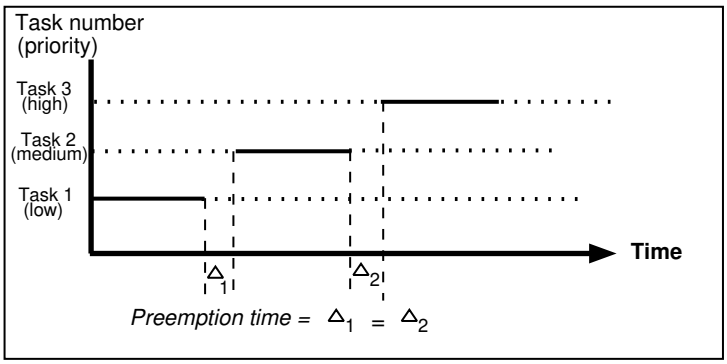


Figure 13 Rhealstone Component–Preemption Time

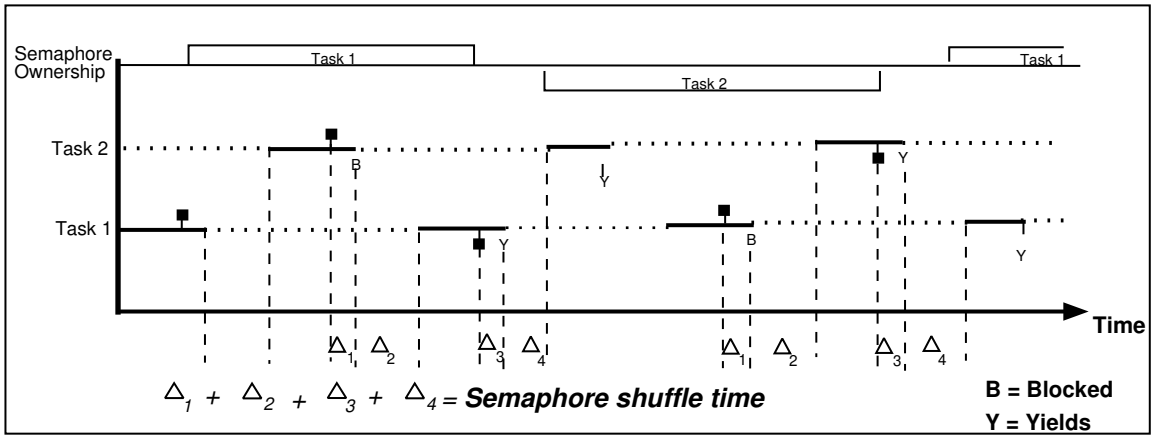


Figure 14 Rhealstone Component–Semaphore-shuffle Time

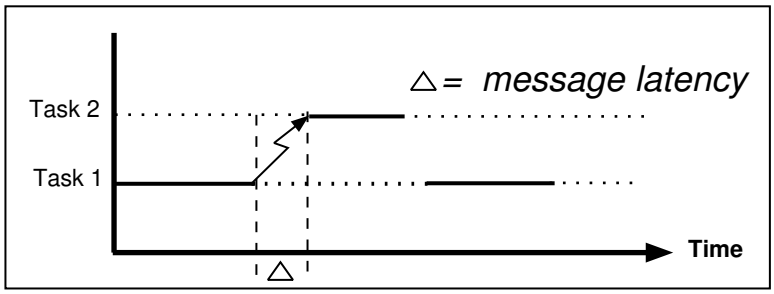


Figure 15 Rhealstone Component–Intertask Message Latency

Source: Figures 9, 10, and 12 largely taken from Kar, Rabindra, P., "Implementing the Rhealstone Real-Time Benchmark" *(Dr. Dobb's Journal*, April 1990).

Rhealstone results measured on a DEC 3000 Model 500 AXP are shown in the following table.

Table 4 Rhealstone Benchmark Results

Metric	Mean (µsec)
Task Switch Time	18.1
Preemption Time	33.1
Interrupt Latency Time	8.4 (Range: 7.0–50.4)
Intertask Message Time	92.8
Semaphore Shuffle Time	152.2

Test configuration: DEC 3000 Model 500 AXP, 256 MB memory, DEC OSF/1 AXP RT operating system, Ver 1.2.
Test conditions: Single user mode, no network.

SLALOM Benchmark

Developed at Ames Laboratory, U.S. Department of Energy, the SLALOM (Scalable Language-independent Ames Laboratory One-minute Measurement) benchmark solves a complete, real problem (optical radiosity on the interior of a box). SLALOM is based on fixed time rather than fixed problem comparison. It measures input, problem setup, solution, and output, not just the time to calculate the solution.

SLALOM is very scalable and can be used to compare computers as slow as 104 floating-point operations per second to computers running a trillion times faster. You can use the scalability to compare single processors to massively parallel collections of processors, and you can study the space of problem size versus ensemble size in fine detail.

The SLALOM benchmark is CPU-intensive and measures, in units called patches, the size of a complex problem solved by the computer in one minute.

Table 5 SLALOM Results

System	Patches
DEC 3000 Model 500X AXP	7,134
DEC 3000 Model 500 AXP	6,084
DEC 3000 Model 400 AXP	5,776
DEC 3000 Model 300 AXP	5,844
DEC 3000 Model 300L AXP	4,488

AIM Suite III Multiuser Benchmark Suite

Developed by AIM Technology, the AIM Suite III Benchmark Suite was designed to measure, evaluate, and predict UNIX multiuser system performance of multiple systems. It uses 33 functional tests, and these tests can be grouped to reflect the computing activities of various types of applications.

AIM Suite III is designed to stress schedulers and I/O subsystems and includes code that will exercise TTYs, tape subsystems, printers, and virtual memory management. The benchmark will run until it reaches either the user-specified maximum number of simulated users or system capacity.

The 33 subsystem tests, each of which exercises one or more basic functions of the UNIX system under test, are divided into six categories based on the type of operation involved. The categories are as follows:

- RAM
- Floating Point
- Pipe
- Logic
- Disk
- Math

Within each of these six categories, the relative frequencies of the subsystem tests are evenly divided (with the exception of small biases for add-short, add-float, disk reads, and disk writes).

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 time-sharing environment. The mix of subsystem tests can be varied to simulate environments with differing resource requirements. AIM provides a default model as a representative workload for UNIX multiuser systems and the competitive data that AIM Technology publishes is derived from this mix of subsystem tests.

The AIM Performance Rating identifies the maximum performance of the system under

optimum usage of CPU, floating point, and disk caching. At a system's peak performance, an increase in the workload will cause a deterioration in performance. AIM Maximum User Load Rating identifies system capacity under heavy multitasking loads, where disk performance also becomes a significant factor. Throughput is the total amount of work the system processes, measured in jobs/minute. Maximum throughput is the point at which the system is able to process the most jobs per minute. AIM verifies the results of the Suite III run by licensed vendors and uses the source data for their AIM Performance Report service.

Digital's Alpha AXP family's AIM Suite III benchmark results are shown in the following table:

Table 6 AIM Suite III Benchmark Suite Results

System	Performance Rating	Maximum User Loads	Maximum Throughput (jobs/minute)
DEC 3000/500X AXP (256 MB memory, 3 disks)	110.4	805	1082.4
DEC 3000/500S AXP (192 MB memory, 8 disks)	82.9	649	812.9
DEC 3000/400S AXP (128 MB memory, 3 disks)	70.3	485	688.7
DEC 3000/300 AXP (64 MB memory, 2 disks)	58.7	216	575.5
DEC 3000/300L AXP (64 MB memory, 1 disk)	42	225	411.7

Shown below are Digital Alpha AXP systems' competitors' AIM results.

Table 7 AIM Suite III Benchmark Suite Results for Competitive Systems

System	Performance Rating	Maximum User Loads	Maximum Throughput (jobs/minute)
HP 9000/755 (64 MB memory, 2 disks)	71.7	580	703.1.0
HP 9000/735 (32 MB memory, 2 disks)	71.7	422	703.1
HP 9000/750 (64 MB memory, 2 disks)	46.7	388	457.6
HP 9000/725/50 (32 MB memory, 1 disk)	34.2	246	335.4
HP 9000/715/50 (32 MB memory,2 disks)	33.7	252	330.0
IBM RS/6000 580 (128 MB memory, 4 disks)	62.1	518	609
IBM RS/6000 375 (128 MB memory, 3 disks)	60.9	490	597.1
IBM RS/6000 365 (128 MB memory, 3 disks)	47.7	428	467.5
SUN SPARC 10 Model 41 (64 MB memory, 3 disks)	44.3	203	433.8
SGI Indigo (R4000) (32 MB memory, 1 disk)	71	289	696.0

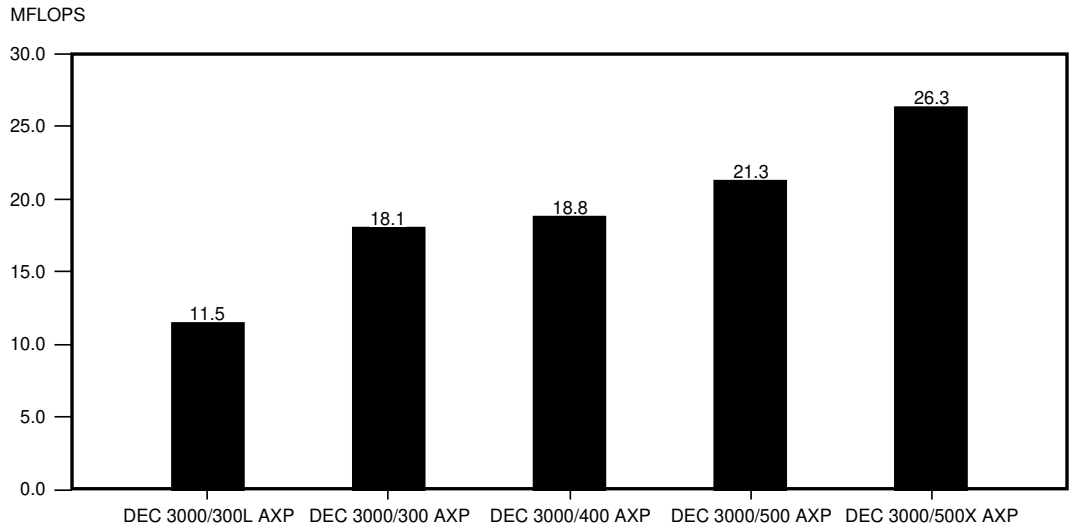
Livermore Loops

This benchmark, also known as Livermore FORTRAN Kernels, was developed by the Lawrence National Laboratory in Livermore, CA. The laboratory developed this benchmark to evaluate large supercomputer systems. Computational routines were extracted, 24 sections of code in all, from programs used at the laboratory in the early 1980's to test scalar and vector floating performance.

The routines (kernels) are written in FORTRAN and draw from a wide variety of scientific applications including I/O, graphics, and memory management tasks. These routines also inhabit a large benchmark driver that runs the routines several times, using different input data each time. The driver checks on the accuracy and timing of the results.

The results of the 24 routines, one for each kernel, are reported in millions of floating-point operations per second (MFLOPS). Shown in this report are the calculated geometric means.

Figure 16 Livermore Loops Results



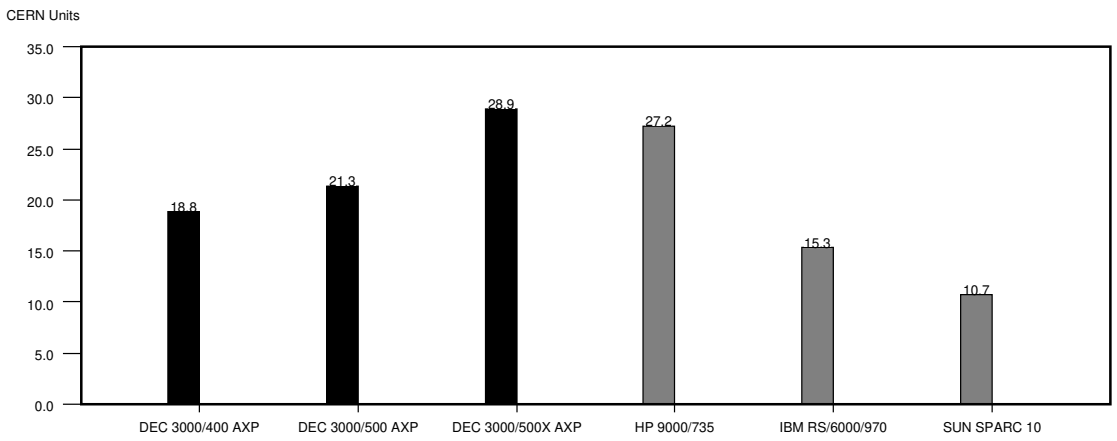
CERN Benchmark Suite

In the late 1970's, the User Support Group at CERN (the European Laboratory for Particle Physics) collected from different experimental groups a set of typical programs for event simulation and reconstruction and created the CERN Benchmark Suite. In 1985, Eric McIntosh, system analyst, redefined the tests in order to make them more portable and more representative of the then current workload and FORTRAN 77.

Presently, the CERN Benchmark Suite contains four production tests: two event generators (CRN3 and CRN4) and two event processors (CRN5 and CRN12). These applications are basically scalar and are not significantly vectorizable nor numerically intensive. Additionally, several "kernel" type applications were added to supplement the production tests to get a feel for compilation times (CRN4C), vectorization (CRN7 and CRN11), and character manipulation (CRN6).

The CERN Benchmark Suite metric is CPU time. Results are normalized to a DEC VAX 8600, and the geometric mean of the four production tests' ratios yields the number of CERN units. CERN units increase with increasing performance.

Figure 17 CERN Benchmark Results



X11perf Benchmark

X11perf tests various aspects of X server performance including simple 2D graphics, window management functions, and X-specific operations. Other non-traditional graphics include CopyPlane and various stipples and tiles.

X11perf employs an accurate client-server synchronization technique to measure graphics operations' completion times. X11perf tests both graphics primitive drawing speeds and window environment manipulation.

Table 8 contains the two most commonly requested performance metrics from X11perf tests for 2D graphics systems: X11perf *10-pixel line* tests and X11perf *Copy 500x500 from pixmap to window* tests. The *10-pixel line* results are shown in units of 2D Kvectors/second drawing rate, and the *Copy 500x500 from pixmap to window* are shown in units of 2D Mpixels/second fill rate (1 Mpixel equals 1,048,576 pixels).

Table 8 X11perf Benchmark Results

Workstation	2D Kvectors/second	2D Mpixels/second
DEC 3000 Model 500X AXP	670	31.0
DEC 3000 Model 500 AXP	662	31.0
DEC 3000 Model 400 AXP	579	27.2
DEC 3000 Model 300 AXP	517	30.8
DEC 3000 Model 300L AXP	512	30.5

References

System and Vendor	Sources
DEC 3000 Model 300L AXP Workstation	All benchmarking performed by Digital Equipment Corporation.
DEC 3000 Model 300 AXP Workstation	All benchmarking performed by Digital Equipment Corporation.
DEC 3000 Model 400 AXP Workstation	All benchmarking performed by Digital Equipment Corporation.
DEC 3000 Model 500 AXP Workstation	All benchmarking performed by Digital Equipment Corporation.
DEC 3000 Model 500X AXP Workstation	All benchmarking performed by Digital Equipment Corporation.
HP 9000 Models 715/50, 735, and 755	SPEC, LINPACK, Dhrystone, and X11perf benchmark results reported in Hewlett-Packard's "HP Apollo 9000 Series 700 Workstation Systems Performance Brief" (11/92). 735/755 LINPACK 1000x1000 reported by Dongarra, J., "Performance of Various Computers Using Standard Linear Equations Software" (3/6/93). DN&R Labs CPU2 and Khornerstone results reported by Workstation Laboratories, Inc., Volume 19, Chapters 20 and 21 (1/93) AIM III results reported by AIM Technology, Inc. (3/93). CERN results reported in "CERN Report" (11/23/92). SPECrate_int92 and SPECrate_fp92 results for HP 9000/755 reported in *SPEC Newsletter* (3/93).
IBM RS 6000 Models M20, 355, 365, 375, 570, and 580	SPEC and LINPACK 100x100 results reported by IBM (2/2/93). LINPACK 1000x1000 results reported by Dongarra, J., "Performance of Various Computers Using Standard Linear Equations Software" (3/6/93). AIM III results reported by AIM Technology, Inc. (3/93). CERN results reported in "CERN Report" (11/23/92). SPECrate_int92 and SPECrate_fp92 results for IBM RS 6000/375 reported in *SPEC Newsletter* (3/93).
SGI Crimson Elan (R4000)	X11perf benchmark results reported in Workstation Laboratories Inc., Volume 17, Chapter 21 (5/1/92).
SGI Indigo (R4000)	SPEC benchmark results reported in *SPEC Newsletter* (9/92). Linpack, Dhrystone, X11perf, DN&R Labs CPU, and Khornerstone results from Workstation Laboratories, Inc., Volume 19, Chapter 1 (1/93).
SGI Indigo2 (R4400)	SPEC and LINPACK 100x100 results from D.H. Brown Associates (1/27/93). Dhrystone results from IDC FAX Flash (1/93).
SGI Indigo2 (R4000)	X11perf and DN&R Labs CPU2 results reported by Workstation Laboratories, Inc., Volume 20, Chapter 1.

SUN SPARC 10 Model 41

SPEC benchmark results reported in *SPEC Newsletter* (9/92).
LINPACK 1000x1000 and Dhrystone benchmark results reported by SUN (11/10/92).
LINPACK 100x100 X11perf, DN&R Labs CPU2, and Khornerstone results reported by Workstation Laboratories, Inc., Volume 19, Chapter 19.
CERN results reported in "CERN Report" (11/23/92).

Articles

Kar, Rabindra P., "Implementing the Rhealstone Real-Time Benchmark" (*Dr. Dobb's Journal*, April 1990).