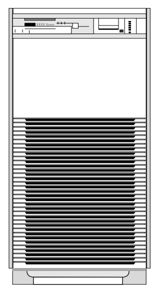
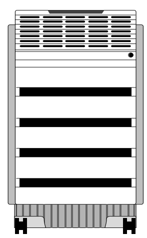
Alpha AXP Server Family
Performance Brief - OpenVMS

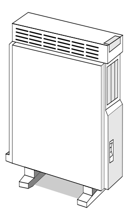
DEC 10000 Model 610 AXP Server



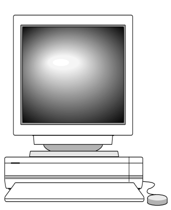
DEC 7000 Model 610 AXP Server



DEC 4000 Model 610 AXP Server



DEC 3000 Model 500S AXP Server



DEC 3000 Model 400S AXP Server

INSIDE

Benchmark results:

- SPEC
- Perfect
- LINPACK
- Dhrystone
- CERN
- ANSYS
- X-PLOR
- CHARMm
- DN&R Labs CPU2
- SLALOM

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Alpha AXP Server Family
Performance Brief - OpenVMS

Introducing Digital's Alpha AXP Server Family

This document presents the results of industry-standard benchmarks on Digital's Alpha AXPTM servers in the DEC OpenVMS™ AXPTM operating system environment. Alpha AXP servers are based on Digital's breakthrough 64-bit RISC architecture.

DEC 3000 AXP Servers

The DEC 3000 Model 400S AXP desktop is an entry-level server or multiuser system that provides affordable power for small workgroup computing and distributed applications. The DEC 3000 Model 500S AXP server is a deskside system that provides a blend of performance and expansion to meet the challenges of the most demanding workgroup computing. The DEC 3000 Model 400S AXP server runs at a CPU clock speed of 133 MHz, and the DEC 3000 Model 500S AXP server at 150 MHz.

DEC 4000 AXP Servers

DEC 4000 AXP servers deliver superior computing power in office-sized or rackmountable packages. Designed for symmetric multiprocessing, multiuser and technical server applications, DEC 4000 AXP servers meet the needs of technical and scientific markets. Optimized for speed and availability, DEC 4000 AXP servers will satisfy the commercial segment as well. The DEC 4000 AXP server runs at a CPU clock speed of 160 MHz and can be configured with one or two CPU boards.

DEC 7000 AXP Servers

DEC 7000 AXP servers deliver unsurpassed data center performance and price/performance. DEC 7000 AXP servers offer single or multiprocessing capability for such commercial and technical applications as transaction processing, general ledger, securities trading, signal processing, molecular modeling, and imaging. The DEC 7000 AXP server runs at a CPU clock speed of 182 MHz and can be configured with up to six processors.

DEC 10000 AXP Servers

DEC 10000 AXP servers are Digital's highest performance Alpha AXP systems. Designed to meet rigorous demands of compute-intensive, large enterprise applications, DEC 10000 AXP servers can be configured with up to six processors. The DEC 10000 AXP server provides the fastest enterprise server performance in the industry—at a fraction of the price of a traditional mainframe or supercomputer. The DEC 10000 AXP server runs at a CPU clock speed of 200 MHz.

Table 1 Digital's Alpha AXP Server Family Benchmark Results

Benchmark	DEC 3000 Model 400S AXP	DEC 3000 Model 500S AXP	DEC 4000 Model 610 AXP	DEC 7000 Model 610 AXP	DEC 10000 Model 610 AXP
SPECmark89	108.1	121.5	136.2	167.4	184.1
SPECthruput89 - 1 cpu	na	na	131.2	161.4	tbd
- 2 cpu	na	na	248.8	308.7	tbd
- 3 cpu	na	na	na	454.4	tbd
- 4 cpu	na	na	na	604.4	654.6
SPECint92	65.3	74.3	83.5	96.6	106.5
SPECfp92	112.2	126.0	143.1	182.1	200.4
SPECrate_int92 - 1 cpu	1549.3	1762.1	1985.8	2188.6	tbd
- 2 cpu	na	na	3816.1	4291.4	tbd
- 3 cpu	na	na	na	6306.5	tbd
- 4 cpu	na	na	na	8366.8	9107.9
SPECrate_fp92 - 1 cpu	2631.6	2967.4	3317.1	4126.0	tbd
- 2 cpu	na	na	6214.5	8135.1	tbd
- 3 cpu	na	na	na	11859.8	tbd
- 4 cpu	na	na	na	15739.4	17187.2
Dhrystone[a]					
V1.1 (instructions/sec)	228,310.0	257,731.0	279,329.0	311,526.0	342,465.0
V2.1 (instructions/sec)	249,625.6	281,214.8	303,951.4	343,642.6	377,358.5
LINPACK 64-bit Double-precision					
100x100 (MFLOPS)	26.4	30.2	36.3	38.6	42.5
1000x1000 (MFLOPS)	70.8	79.9	86.4	102.1	111.6
CERN Benchmark Suite	16.9	19.0	21.0	23.6	26.0
Perfect Benchmarks Suite (MFLOPS) (geometric mean)	18.1	20.4	22.9	26.0	28.6
DN&R Labs CPU2 (MVUPs)	179.4	197.5	216.5	247.5	272.7
SLALOM (patches)	3750	3934	4072	4432	4608

[a] Dhrystone scales linearly
na = not applicable
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 Release 1

In October 1989, SPEC introduced SPEC Release 1, a benchmark suite that measures CPU-intensive, single stream performance of uniprocessor systems. SPEC Release 1 consists of ten portable programs similar to those found in technical environments. Four programs are written in C and primarily test integer performance. The remaining six programs are written in FORTRAN and measure floating-point performance. SPECmark89™ is the metric for this suite.

SPECmark89 represents the geometric mean of the ten benchmark SPECratios™. The SPECratio for a benchmark is the quotient derived from dividing the SPEC Reference Time by a particular machine's corresponding run time. The SPEC Reference Time is the time that it takes a DEC VAX 11/780 to run each benchmark (in seconds).

Alpha AXP Server Family Performance Brief - OpenVMS

Figure 1 SPECmark89 Benchmark Results for Alpha AXP Servers

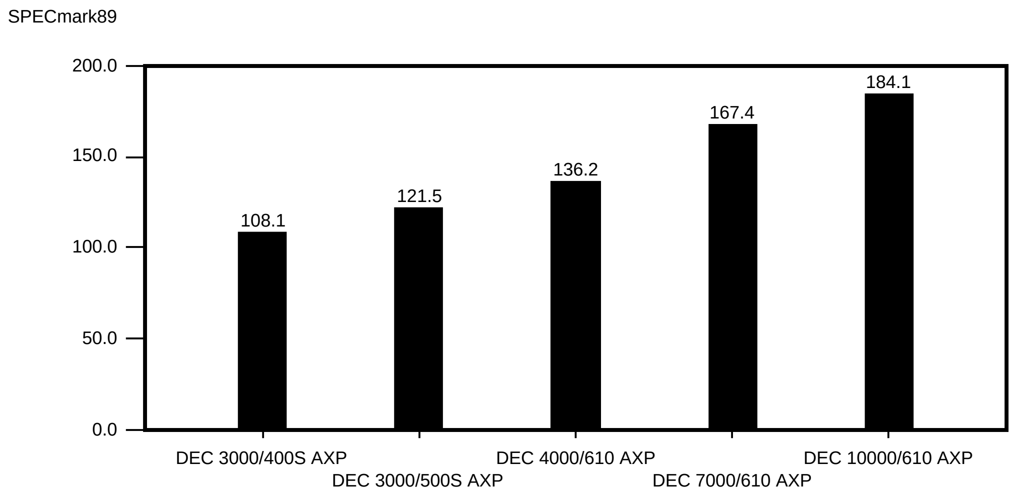
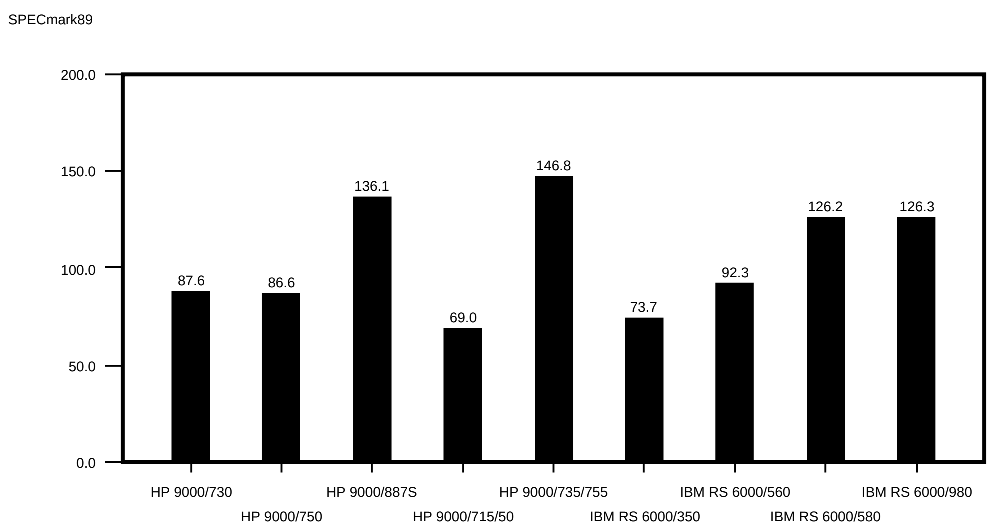


Figure 2 SPECmark89 Benchmark Results for Competitive Systems



SPECthruput89

SPEC devised the SPECthruput89 benchmark to measure the performance of multiprocessor systems. SPEC defines the SPECthruput89 benchmark as a measure of the amount of work, given a particular workload, that a system can perform compared to a reference system. In this case, the time posted by a VAX 11/780 concurrently running two copies of each SPEC Release 1 benchmark is the reference time. SPECthruput89 is the metric for this benchmark.

SPECthruput89 is calculated as follows. The system under test concurrently runs two copies of the same SPEC Release 1 benchmark per processor. Individual "thruput" ratios are calculated by comparing these run times with the reference system's run times for the same benchmark. SPECthruput89 is the geometric mean of all the individual thruput ratios multiplied by the number of processors in the system under test.

Figure 3 SPECthruput89 Benchmark Results for Alpha AXP Servers

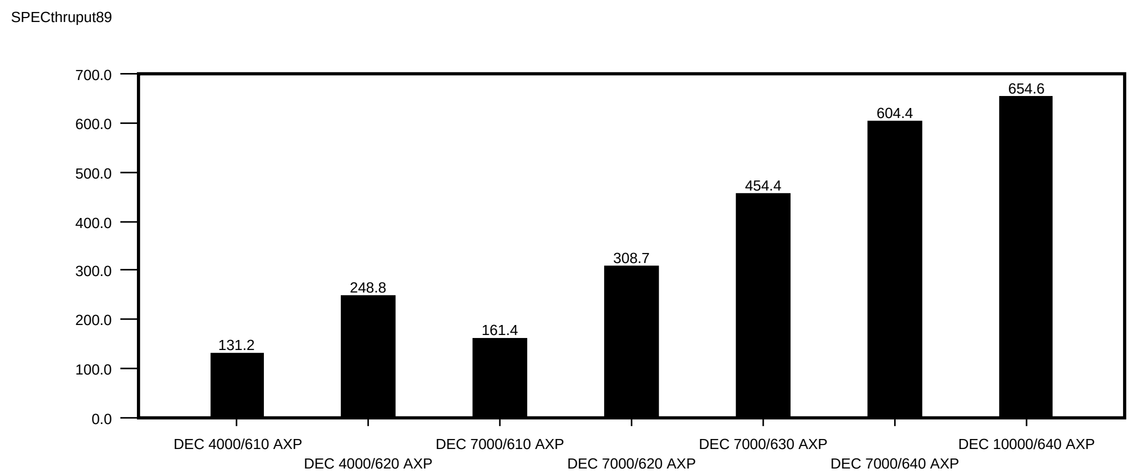
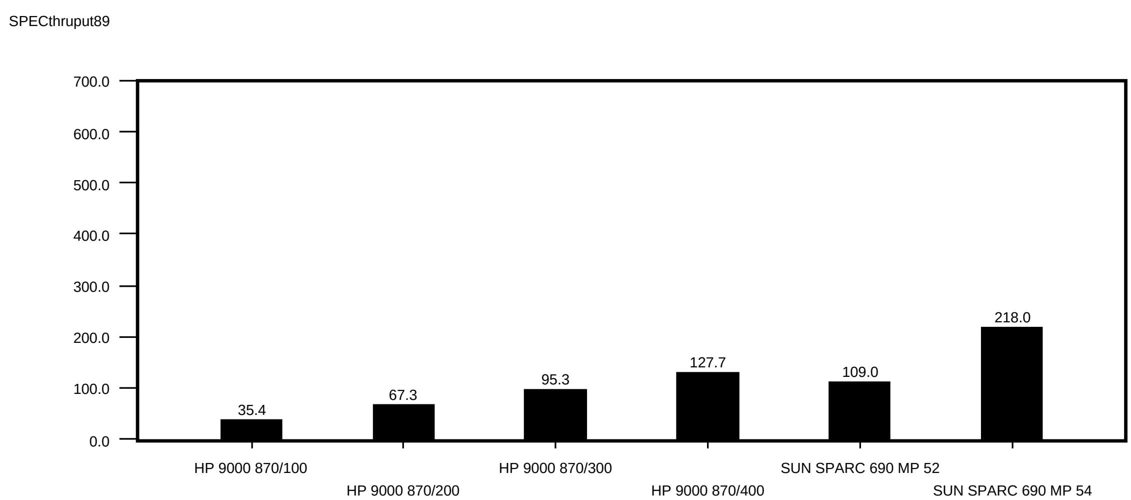


Figure 4 SPECthruput89 Benchmark Results for Competitive Systems



Alpha AXP Server Family Performance Brief - OpenVMS

SPEC CINT92 and CFP92

In January 1992, SPEC announced the availability of two new benchmark suites, CINT92 and CFP92. Each suite provides performance indicators for different market segments because each has different workload characteristics. SPEC CINT92 is a good base indicator of CPU performance in a commercial environment. SPEC CFP92 may be used to compare floating-point intensive environments, typically engineering and scientific applications.

SPEC CINT92

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. CINT92 suite includes the following application classes:

- 008.espresso–Circuit theory
- 022.li–LISP Interpreter
- 023.eqntott–Logic design
- 026.compress–Data compression
- 072.sc–UNIX™ spreadsheet
- 085.gcc–GNU C compiler

Figure 5 SPEC CINT92 Benchmark Results for Alpha AXP Servers

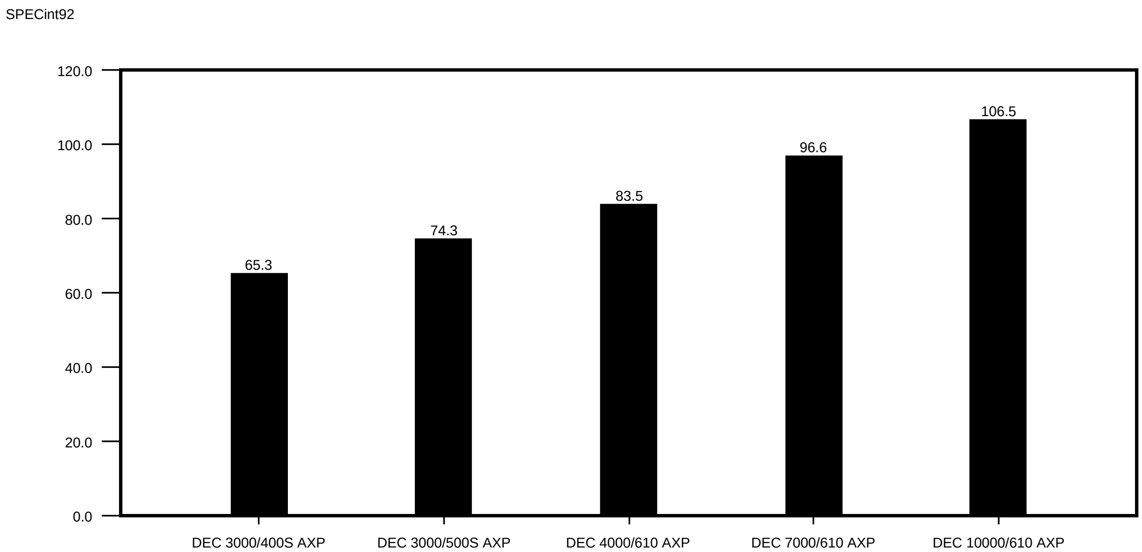
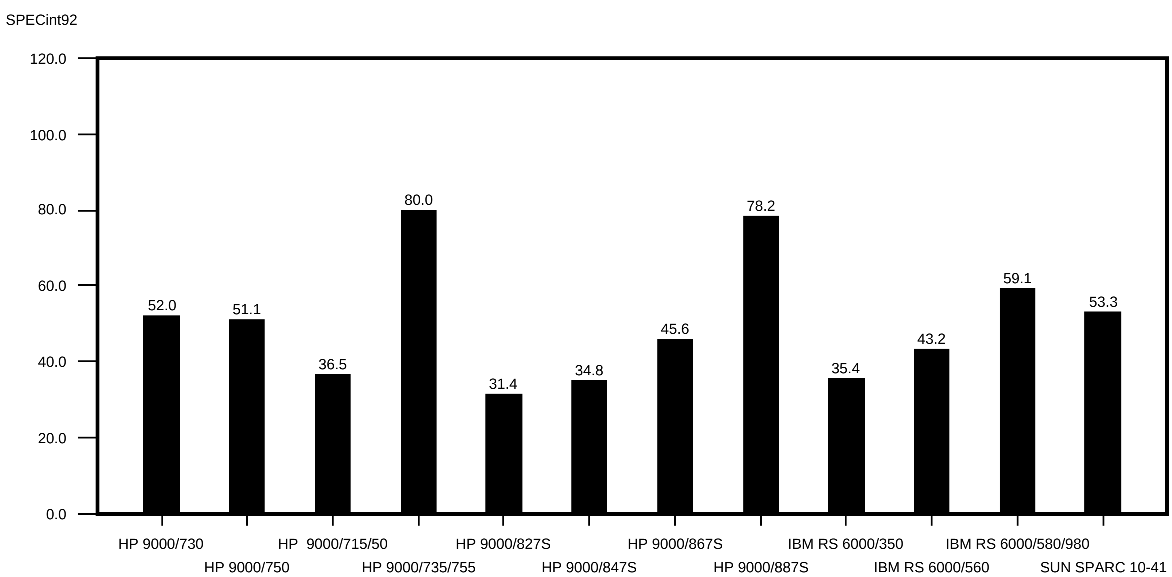


Figure 6 SPEC CINT92 Benchmark Results for Competitive Systems



SPEC CFP92

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. This suite contains the following application classes:

- 013.spice2g6–Circuit design
- 015.doduc–Monte Carlo simulation
- 034.mdljdp2–Quantum chemistry
- 039.wave5–Maxwell equations
- 047.tomcatv–Coordinate translation
- 048.ora–Optics ray tracing
- 052.alvinn–Robotics; neural nets
- 056.ear–Human ear modeling
- 077.mdljsp2–Single precision version of 034.mdljdp2
- 078.swm256–Shallow water model
- 089.su2cor–Quantum physics
- 090.hydro2d–Astro physics
- 093.nasa7–NASA math kernels
- 094.fppp–Quantum chemistry

Figure 7   SPEC CFP92 Benchmark Results for Alpha AXP Servers

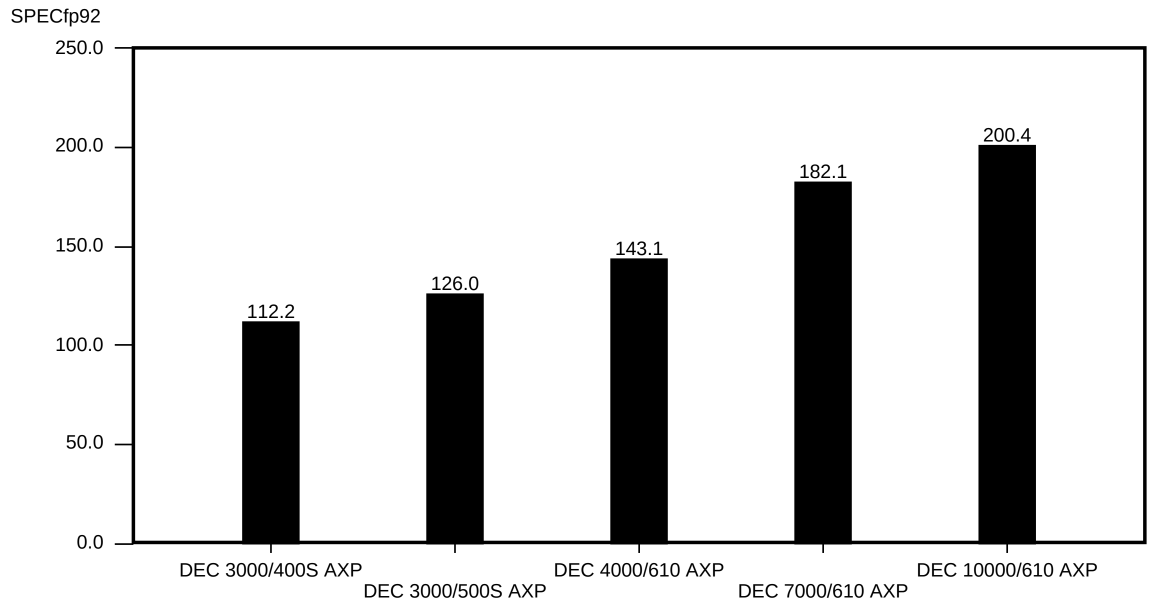
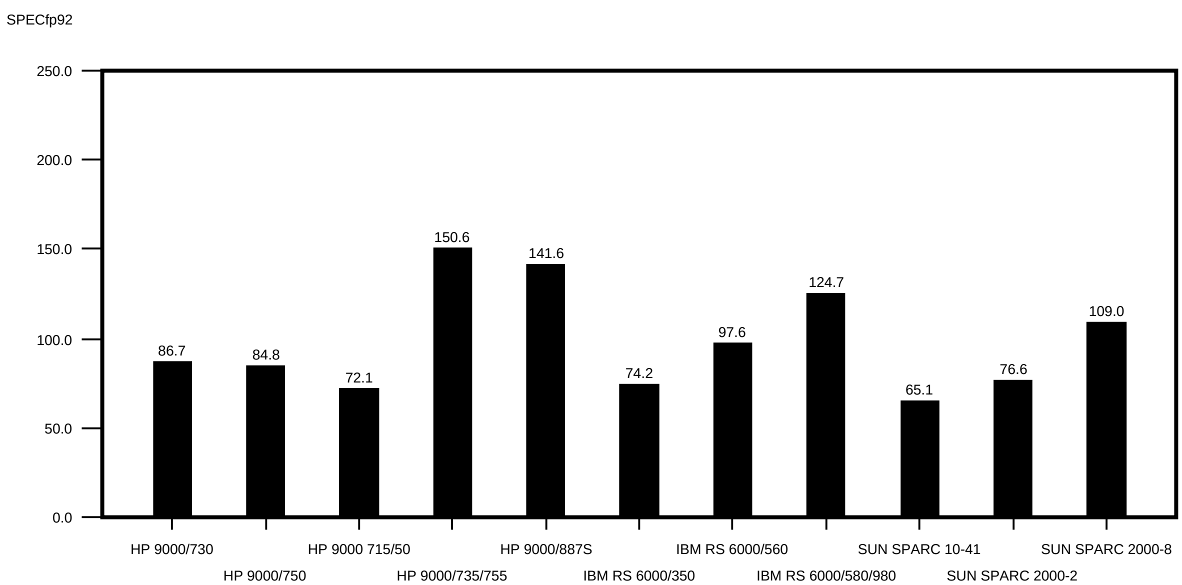


Figure 8   SPEC CFP92 Benchmark Results for Competitive Systems



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.

Alpha AXP Server Family Performance Brief - OpenVMS

Figure 9   SPECrate_int92 Results for Alpha AXP Servers

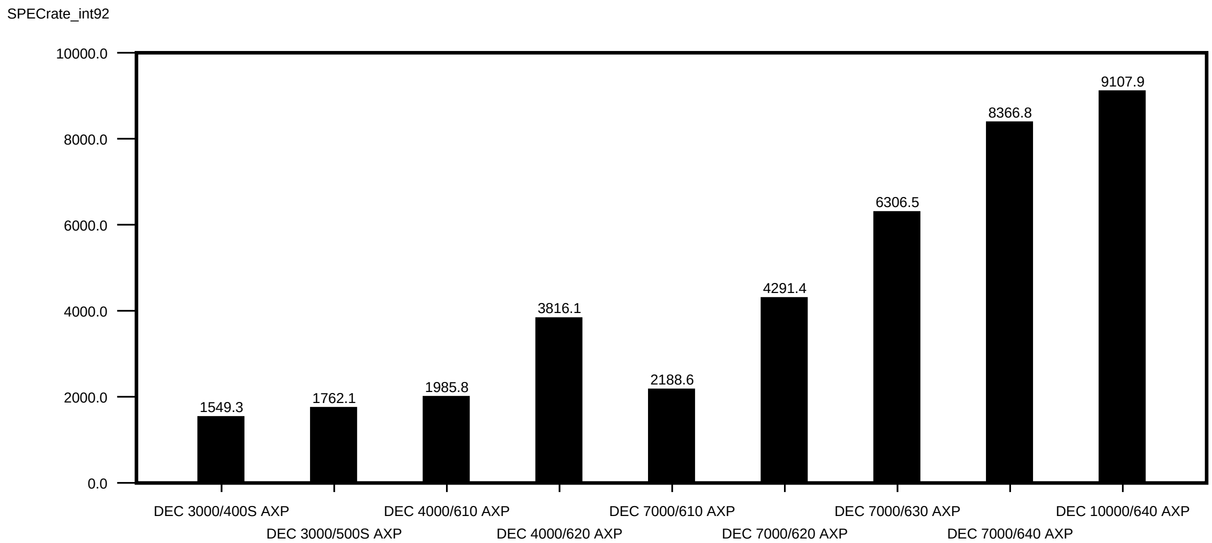
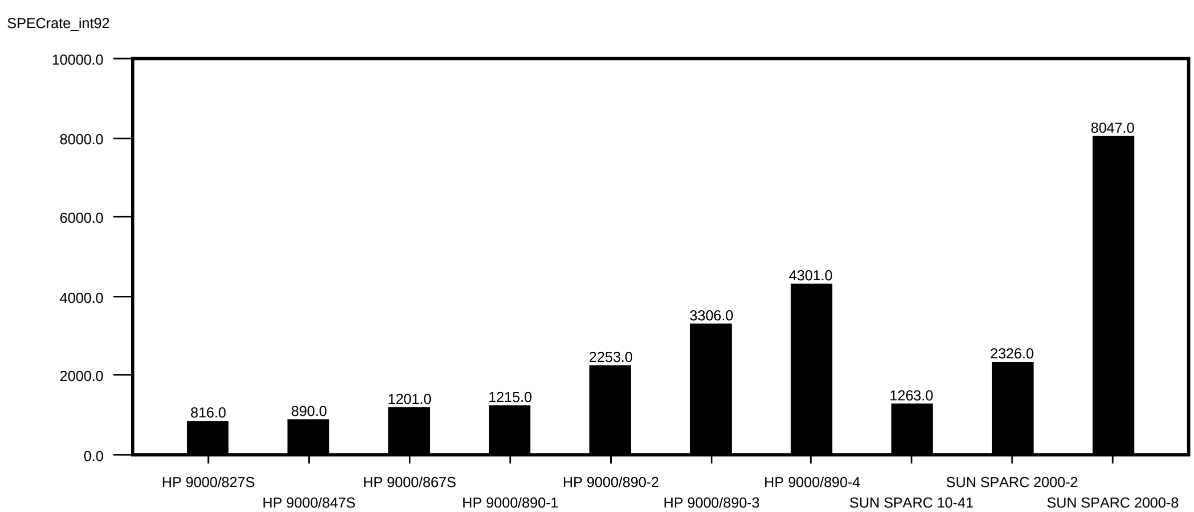


Figure 10   SPECrate_int92 Results for Competitive Systems



Alpha AXP Server Family
Performance Brief - OpenVMS

Figure 11   SPECrate_fp92 Benchmark Results for Alpha AXP Servers

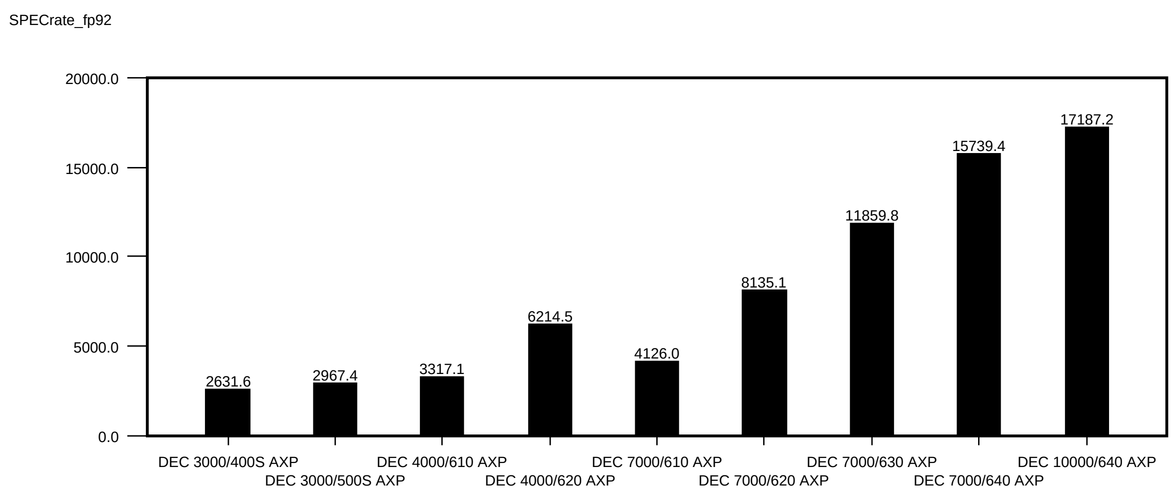
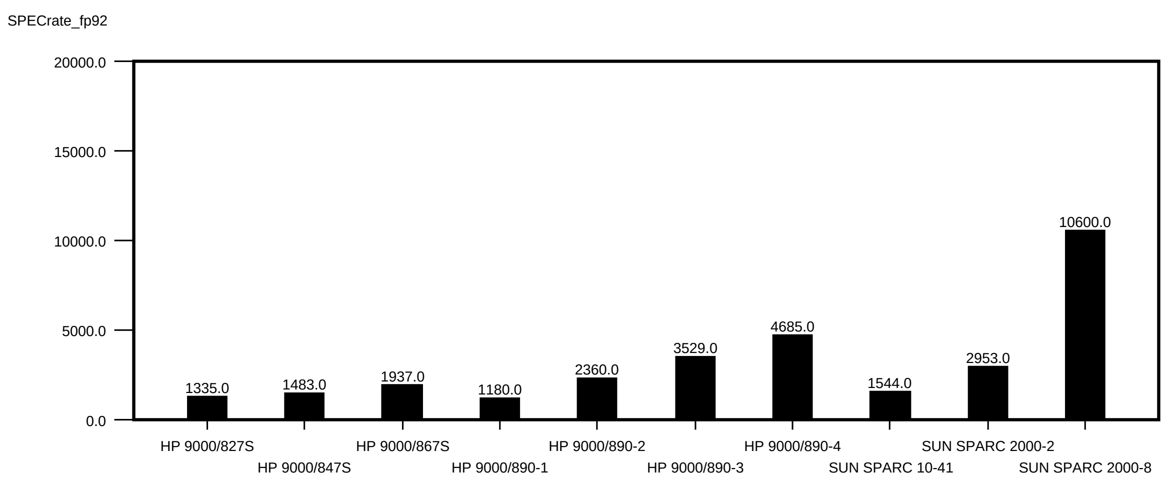


Figure 12   SPECrate_fp92 Benchmark Results for Competitive Systems



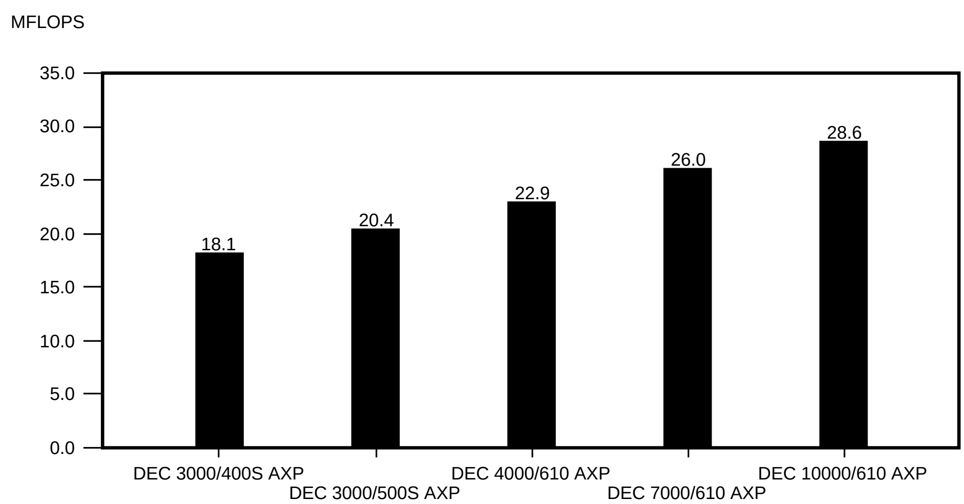
Perfect Benchmarks Suite

The Perfect (Performance Evaluation for Cost-effective Transformations) Benchmarks™ Suite represents an ongoing effort among several universities, research centers, and supercomputing firms to produce a benchmark package oriented to supercomputers and parallel processing. Currently, 13 FORTRAN programs totaling over 50,000 lines of code make up the Perfect Benchmark Suite. These programs include scientific and engineering applications representing four types of real applications areas: fluid flow, chemical and physical, engineering design, and signal processing.

Perfect Benchmark Suite's results are measured in millions of floating-point operations per second (MFLOPS). Figure 13 shows the geometric mean of the suite's results in MFLOPS.

Note: Comparable results from other vendors were not available.

Figure 13 PERFECT Benchmark Results for Alpha AXP Servers



LINPACK 100x100 and 1000x1000

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.

Alpha AXP Server Family
Performance Brief - OpenVMS

Figure 14 LINPACK Double-Precision Benchmark Results for Alpha AXP Servers

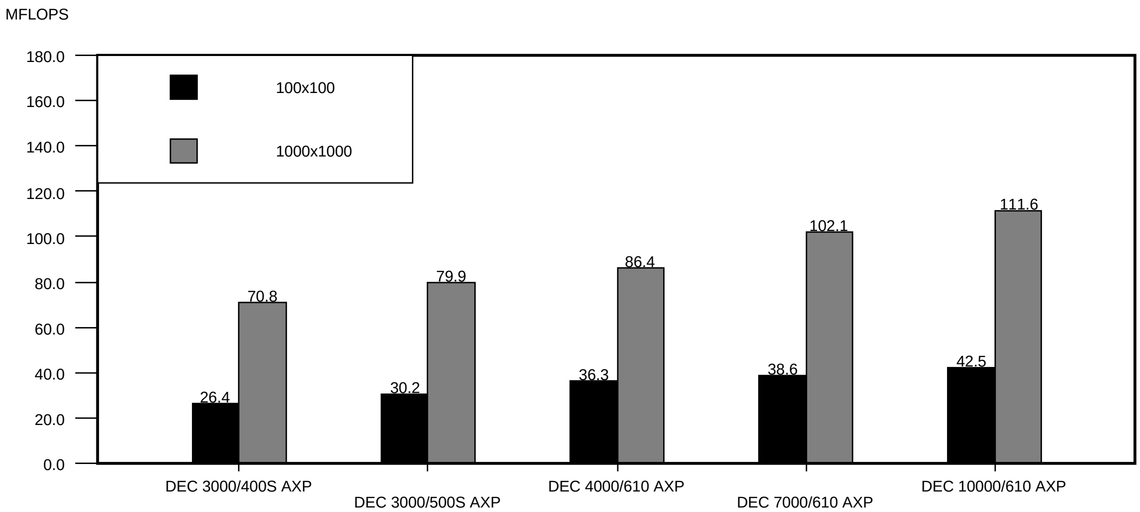
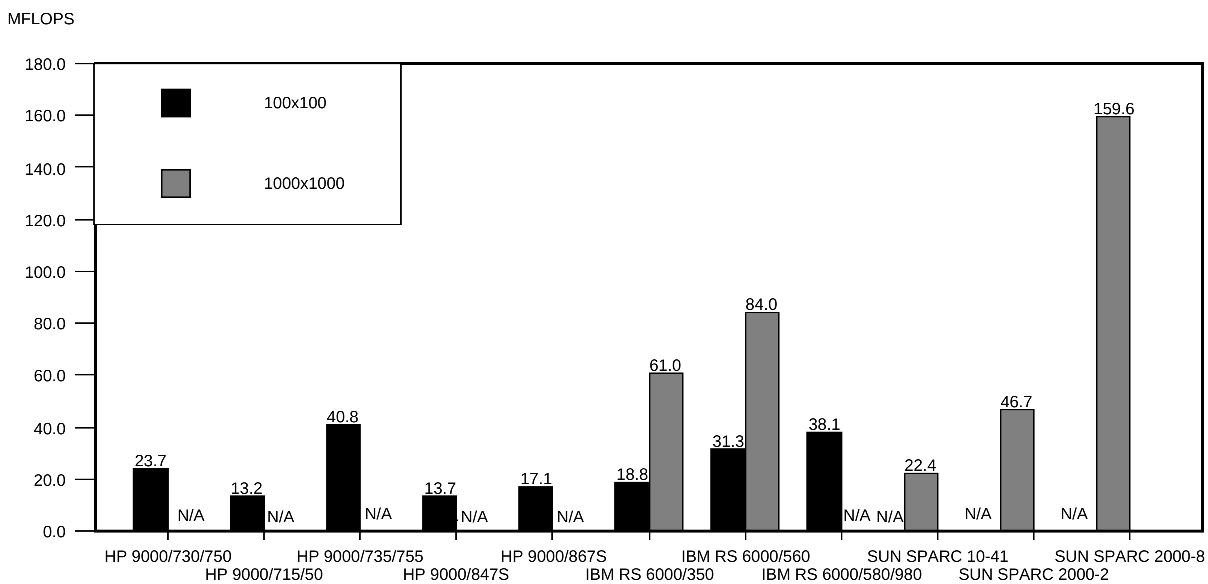


Figure 15 LINPACK Double-Precision Benchmark Results for Competitive Systems



Dhrystone

Developed as an Ada program in 1984, the Dhrystone benchmark was rewritten in C in 1986. Dhrystone measures processor and compiler efficiency and is representative of systems programming environments. Dhrystones are most commonly expressed in Dhrystone instructions per second or in integer MIPS (millions of instructions per second). For V1.1, one Dhrystone MIP equals the number of Dhrystone instructions per second performed by a DEC VAX 11/780 (1757 Dhrystone instructions/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.

Note: The Dhrystone benchmark is small and fits completely in most system caches. Level of compiler optimization, as well as the particular hardware architecture, can affect results. Additionally, Dhrystone scales linearly. For example, use 311,526x2 for DEC 7000 AXP server with 2 CPUs, use 311,526x3 for DEC 7000 AXP server with 3 CPUs, etc.

Alpha AXP Server Family
Performance Brief - OpenVMS

Figure 16 Dhrystone V1.1 Benchmark Results for Alpha AXP Servers

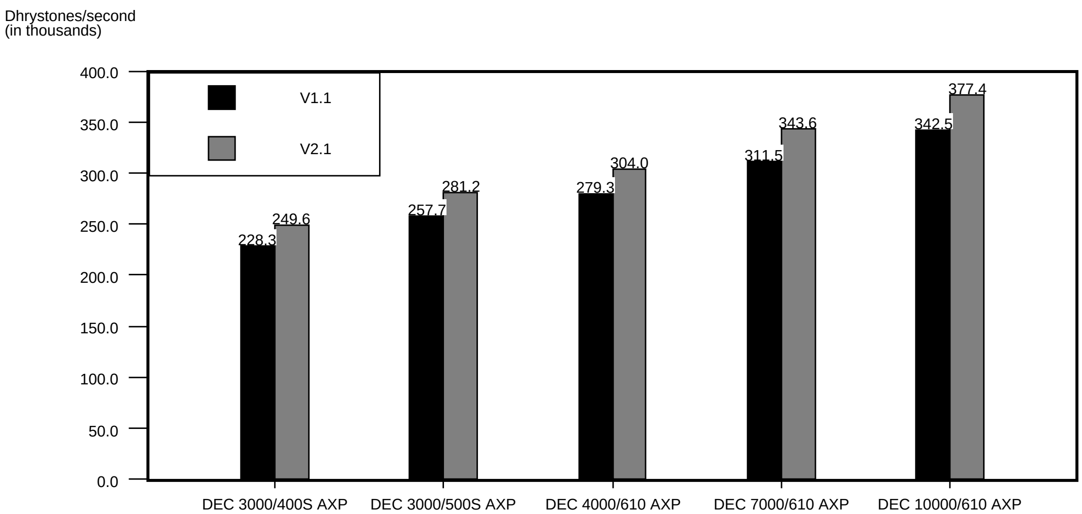
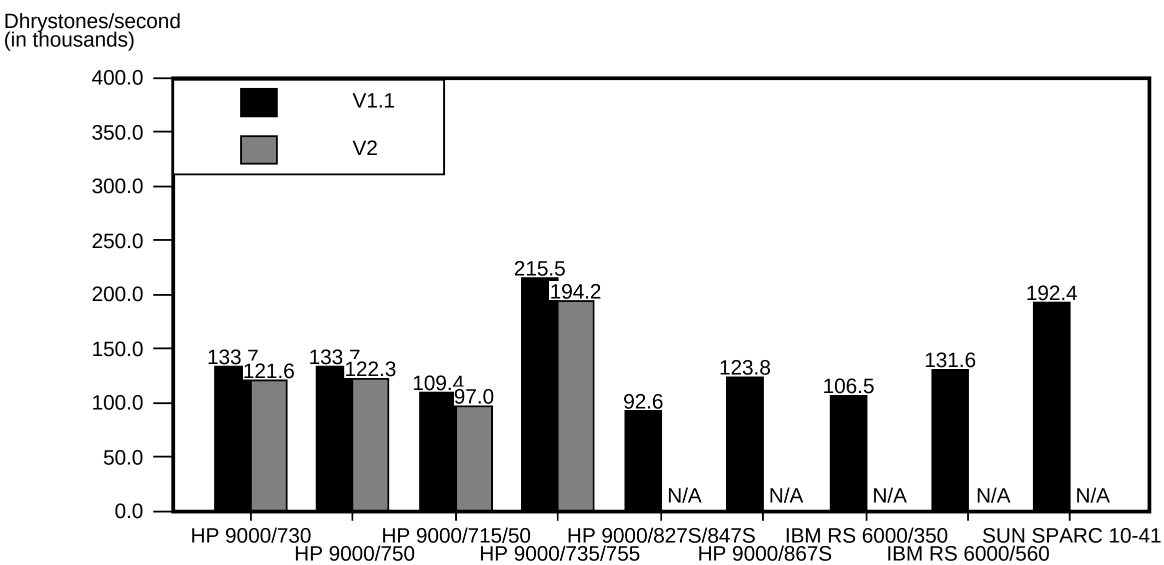


Figure 17 Dhrystone V1.1 Benchmark Results for Competitive Systems



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.

Note: Alpha AXP numbers shown in Figure 18 are not official CERN statistics.

Figure 18 CERN Benchmark Results for Alpha AXP Servers

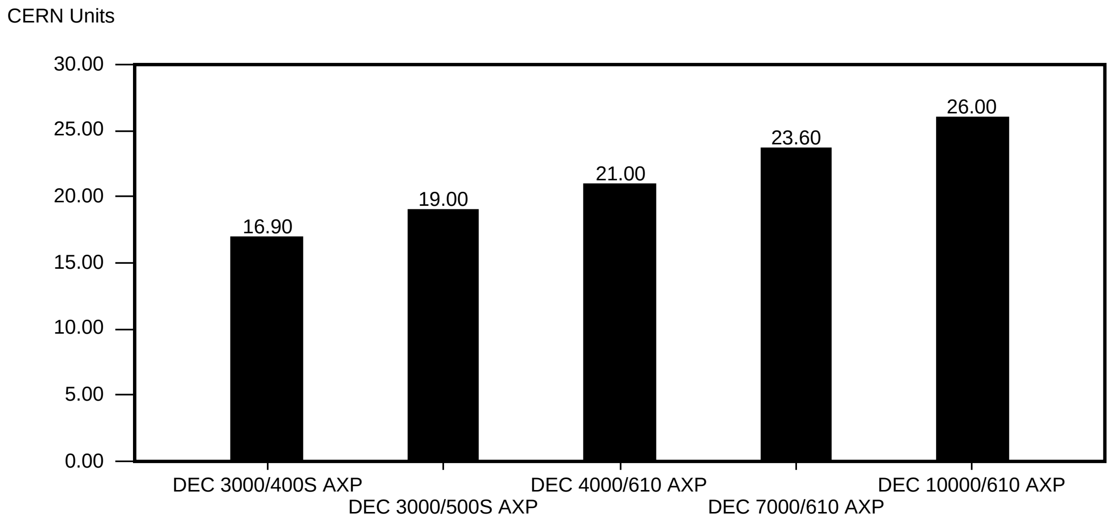
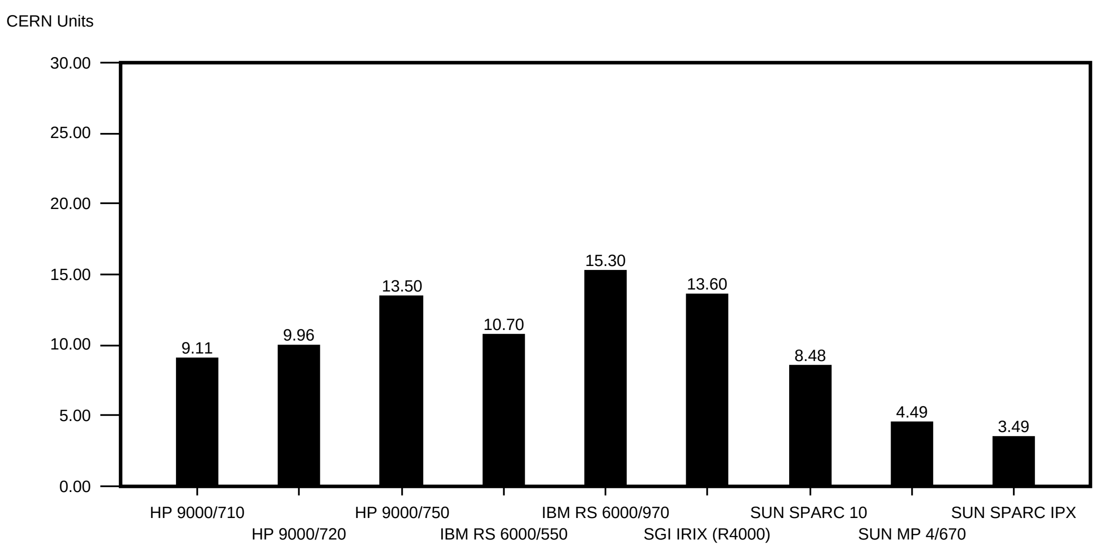


Figure 19 CERN Benchmark Results for Competitive Systems



Source: "CERN Report" (11/92).

ANSYS BENCHMARKS

Principal applications used for mechanical engineering range from drafting and detailing for the design of products, to NC machining for producing parts, to finite element analysis to understand the behavior of the product as it is intended to be used. These applications require a wide range of processing capabilities, including high speed computation and graphics. Digital chose the ANSYS™ software to demonstrate the superiority of the Alpha AXP servers because ANSYS is representative of the requirements of applications in the mechanical engineering environment.

SASI's (Swanson Analysis Systems Inc.) ANSYS software is a leadership finite element pre/post processing and analysis application used extensively by the aerospace, automotive, and other industries. SASI provides a set of benchmarks to system vendors, and measurements are typically made by the system vendors and validated by SASI.

Digital ran the ANSYS benchmark tests described below:

- SP1 - Modal analysis of a flat plate.
- SP2 - Static analysis of a weight dropped from 40 feet.
- SP3 - Static analysis of a pressure vessel.
- SP4 - Thermal and stress analysis of a curved plate.

ANSYS benchmark results are reported in CPU time and elapsed time required to complete each analysis. The timings are reported from an internal mechanism in the ANSYS software which keeps track of this data. Smaller numbers represent better performance.

Table 2 ANSYS Benchmark Results for Alpha AXP Servers (in seconds)

	SP1		SP2		SP3		SP4	
	CPU	elapsed	CPU	elapsed	CPU	elapsed	CPU	elapsed
DEC 10000 Model 610 AXP	4	6	15	18	20	23	7	9
DEC 7000 Model 610 AXP	4	6	17	19	22	26	8	10
DEC 4000 Model 610 AXP	5	7	24	26	27	29	10	11
DEC 3000 Model 500S AXP	6	8	24	26	30	32	10	12

Benchmarks ran on Alpha AXP servers running DEC OpenVMS AXP version FT4. Results obtained using a preliminary copy of the ANSYS V4.4A software product built with DEC FORTRAN for Alpha AXP version BL24. All results for Alpha AXP servers obtained using DECRAM, a layered product which uses the Alpha AXP memory subsystem for file I/O.

Table 3 ANSYS Benchmark Results for Competitive Systems (in seconds)

	SP1		SP2		SP3		SP4	
	CPU	elapsed	CPU	elapsed	CPU	elapsed	CPU	elapsed
HP 9000 Model 750	8	9	22	23	42	43	12	14
IBM RS 6000 Model 580	9	9	24	24	41	41	15	15
SUN SPARC 10 Model 30	20	22	48	65	111	114	27	30

IBM and HP benchmark results obtained from "ANSYS Benchmark Timing Results" report (7/15/92). SUN SPARC 10 Model 30 results obtained in Digital Equipment Corporation’s labs, due to no currently reported data from SASI.

X-PLOR AND CHARMm BENCHMARKS

X-PLOR

X-PLOR™ is a widely used program that helps automate a critical portion of the task of structural refinement of molecules. This task arises in structure determination work, including both X-ray crystallography and Nuclear Magnetic Resonance solution structure studies. The goal is to make an approximate or trial structure fit the experimental data as well as possible.

X-PLOR builds a trial structure by taking a model of the energy of the structure and adds to it a pseudo energy representing the difference between the real data and what the data would be for the current structure. X-PLOR pours in a lot of energy, heating up the molecule to a high temperature (like 1000 centigrade degrees) which is physically impossible, but quite useful for a simulated study. X-PLOR runs molecular dynamics for a short time at this high temperature, which lets the molecule try out and explore many alternate structures. Sample structures are saved and later "cooled" back to normal temperature. The set of final structures are analyzed to see whether there is a consensus structure, distinct families of structures, or something else. This structure refinement step has been greatly improved and automated by X-PLOR.

Task 1 of the benchmark is the molecular dynamics study, which is the fundamental operation to "explore" possible structural alternatives. It might be done several times for one problem and, of course, will be repeated for each new problem. Tasks 2, 3, and 4 need to be completed to look at and analyze the final results.

The four tasks used in the benchmark are:

- Task 1: 0.5 picosecond Molecular Dynamics simulation on a DNA-undodecamer.
- Task 2: Electron density calculation at 2.8 A for 3086 atoms.
- Task 3: 3-D real Fast Fourier Transformation on a 180x96x96 grid.
- Task 4: Application of four symmetry operators in reciprocal space to 8783 reflections.

Test 1 consists of Task 1, and Test 2 is the cumulative time spent in Tasks 2, 3, and 4.

Table 4 X-PLOR V3.0 Benchmark Results for Alpha AXP Servers (in seconds)

	Test 1		Test 2	
	CPU	elapsed	CPU	elapsed
DEC 10000 Model 610 AXP	89.6	92	22.0	24
DEC 7000 Model 610 AXP	94.3	95	24.1	26
DEC 4000 Model 610 AXP	109.8	111	31.3	33
DEC 3000 Model 500S AXP	119.4	121	32.6	34

CHARMm

CHARMm™ is one of a group of programs that scientists use to study matter at an atomic level of description. These programs calculate the energy of a molecule or a group of molecules from the positions of all the atoms. CHARMm benchmarks represent one common use of CHARMm called molecular dynamics. This is the calculation of the time evolution of the system to see how it vibrates and jiggles about due to its thermal energy.

The CHARMm benchmarks consist of two tests. In "dtest" a fragment of an immune-system protein is simulated, while in "ptest" it's a piece of a polystyrene chain. Each molecule contains roughly 1,000 atoms. This simulation runs for 1,000 steps, which amounts to one picosecond—that's one millionth of a microsecond or one thousandth of a nanosecond. In an actual calculation, the simulation would typically be run from 30 picoseconds to a nanosecond or more. Therefore, these benchmarks represent short versions of real jobs on real, typical molecules.

Both benchmarks are straightforward molecular dynamics. For each one, there's a "fast" and a "standard" version; this refers to internal approximations that may take advantage of hardware on some machines. Times are CPU usage measured in minutes.

Table 5 CHARMm 21.3 Benchmark Results for Alpha AXP Servers (in minutes)

	ptest				**dtest**			
	Test1-STD		**Test1-Fast**		**Test1-STD**		**Test1-Fast**	
	CPU	**elapsed**	**CPU**	**elapsed**	**CPU**	**elapsed**	**CPU**	**elapsed**
DEC 4000 Model 610 AXP	2.5	2.5	1.5	1.5	2.8	2.9	1.8	1.9
DEC 3000 Model 500S AXP	2.7	2.8	1.6	1.6	3.1	3.2	2.0	2.0

Table 6 lists other manufacturers' CHARMm results normalized to the DEC 3000 Model 500S AXP and DEC 4000 Model 610 AXP servers. The range indicates the performance variation between the slowest and fastest performance numbers obtained from all tests executed on each platform. A range gives an accurate representation of the performance since a user is likely to alternate between the two modes while working on different problems or phases of problems.

Table 6 CHARMm Benchmark Results Normalized to DEC 3000 Model 500S AXP and DEC 4000 Model 610 AXP Servers

	Normalized to			
	DEC 3000 Model 500S AXP		DEC 4000 Model 610 AXP	
Manufacturer and Model	**Standard**	**Fast**	**Standard**	**Fast**
DEC 3000 Model 500S AXP	1.00	1.00		
DEC 4000 Model 610 AXP			1.00	1.00
HP 9000 Model 720	.60 to .61	.47 to .56	.55 to .56	.43 to .50
IBM RS 6000 Model 320	.30 to .31	.23 to .26	.27 to .28	.21 to .23
IBM RS 6000 Model 530	.37 to .39	.29 to .33	.34 to .35	.27 to .30
IBM ES/9000 (AIX/370)	.38 to .39	.37 to .40	.35 to .36	.33 to .36
IBM ES/9000 (VM/CMS)	.38 to .39	.36 to .40	.35 to .36	.33 to .36
IBM ES/9000 (MVS/ESA)	.38 to .39	.35 to .40	.35 to .35	.33 to .36
SGI Indigo (33 MHz R3000)	.18 to .21	.14 to .15	.17 to .19	.13 to .14
SGI Crimson (50 MHz, R4000)	.42 to .44	.32 to .36	.39 to .40	.30 to .33
SGI Indigo (50 MHz, R4000)	.42 to .43	.32 to .36	.38 to .39	.29 to .32
Stardent Titan	.12 to .13	.15 to .15	.11 to .12	.14 to .14

Audited by Bruce Gelin of Custom Research and Consulting, Cambridge, MA, USA (11/4/92)

DN&R Labs CPU2

DN&R Labs CPU2, a benchmark from *Digital News & Review* 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 20 DN&R Labs CPU2 Benchmark Results for Alpha AXP Servers

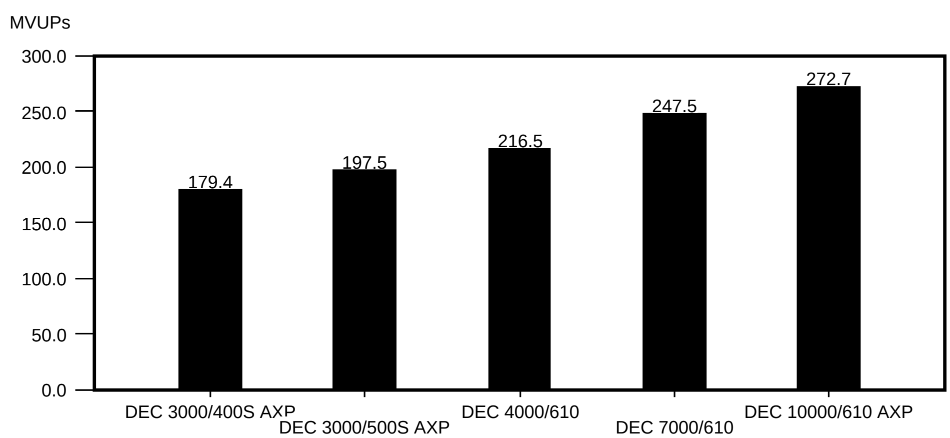
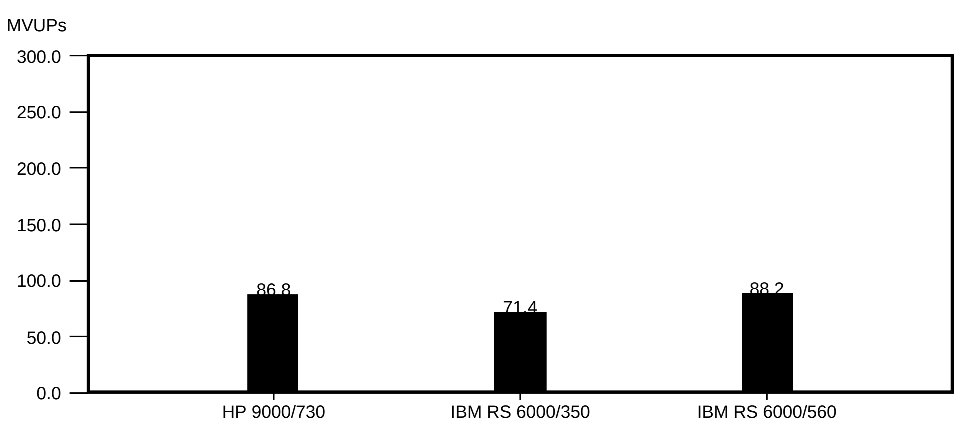


Figure 21 DN&R Labs CPU2 Benchmark Results for Competitive Systems



SLALOM

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 7 SLALOM Benchmark Results

System	Patches
DEC 10000 Model 610 AXP Server	4608
DEC 7000 Model 710 AXP Server	4432
DEC 4000 Model 610 AXP Server	4072
DEC 3000 Model 500S AXP Server	3934
DEC 3000 Model 400S AXP Server	3750

Alpha AXP Server Family
Performance Brief - OpenVMS

Information about Performance

The performance of the Alpha AXP server family was evaluated using industry-standard benchmarks. These benchmarks allow comparisons across vendors' systems.

Performance characterization is one "data point" to be used in conjunction with other purchase criteria such as features, service, and price. For the Alpha AXP server family, features may include resource sharing with VMSclusters, database systems, multi-vendor integration with Network Application Support (NAS), and network management with DECmcc.

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

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 (except as noted). 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 servers 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 server family, please contact your local Digital sales representative.

Alpha AXP Server Family Performance Brief - OpenVMS

References

System and Vendor	Sources
DEC 3000 Model 400S and 500S AXP Servers	All benchmarking performed by Digital Equipment Corporation.
DEC 4000 Models 610 and 620 AXP Servers	All benchmarking performed by Digital Equipment Corporation.
DEC 7000 Models 610, 620, 630, and 640 AXP Servers	All benchmarking performed by Digital Equipment Corporation.
DEC 10000 Models 610 and 640 AXP Server	All benchmarking performed by Digital Equipment Corporation.
HP 9000 Models 715/50, 735, and 755	SPEC, LINPACK, and Dhrystone benchmark results reported in "HP Apollo 9000 Series 700 Workstation Systems" (11/92).
HP 9000 Model 730	SPEC benchmark results reported by HP (11/10/92). Dhrystone and LINPACK 100x100 benchmark results reported in "HP Apollo 9000 Series 700 Performance Brief" (1/92). LINPACK 1000x1000 benchmark results reported in Dongarra, J., "Performance of Various Computers Using Standard Linear Equations Software" (9/28/92). DN&R Labs CPU2 results reported in Workstation Laboratories, Inc., Volume 16, Chapter 12 (3/1/92).
HP 9000 Model 750	SPEC benchmark results reported by HP (11/10/92). Dhrystone and LINPACK benchmark results reported in "HP Apollo 9000 Series 700 Performance Brief" (1/92).
HP 9000 Models 827S, 847S, and 867S	SPEC benchmark results reported in *SPEC Newsletter* (3/92). Dhrystone and LINPACK benchmark results reported in"HP 9000 Series 800 Business Server System Performance" (1992).
HP 9000 Models 870/100, /200, /300, and /400	SPEC benchmark results reported in "HP Apollo 9000 Series 700 Performance Brief" (1/92).
HP 9000 Model 887S	SPEC benchmark results reported in *SPEC Newsletter* (9/92).
IBM RS 6000 Models 350 and 560	SPEC benchmark results reported by IBM (9/92). Dhrystone and DN&R Labs CPU2 benchmark results reported in Workstation Laboratories, Inc., Volume 16, Chapter 20 (3/1/92). LINPACK benchmark results reported by IBM (9/92) and Dongarra, J., "Performance of Various Computers Using Standard Linear Equations Software" (9/28/92).
IBM RS 6000 Models 580 and 980	SPEC benchmark results reported in *SPEC Newsletter* (9/92) and by IBM (9/92). LINPACK benchmark results reported by IBM (9/92) .
SUN SPARC 10 Model 41	SPEC benchmark results reported in *SPEC Newsletter* (9/92). LINPACK and Dhrystone benchmark results reported by SUN (11/10/92).
SUN SPARC 10 Model 52	SPEC benchmark results reported in SUN's Product Data sheet (5/92).
SUN SPARC 690 MP52 and MP54	SPEC benchmark results reported in SUN's Product Data sheet (5/92).
SUN SPARC 2000 (2-cpu and 8-cpu)	SPEC and LINPACK benchmark results reported by SUN (11/10/92).