Performance Measurement

1. Don't trust computer, software, people
   (test both wall clock and CPU time)

2. Run on non-zero data
   (hardware sometimes detects special cases)

3. Output a result that depends on measurement
   (compilers eliminate "dead" code)

4. Break optimization that you do not want
   (call a function that cannot be inlined, etc.)

5. Try for one user on CPU timing
   (watch out for OS, network, I/O devices !)

6. Use double difference, check count, for features
   (be paranoid, benchmarks can fool you)

7. Note discontinuities, algorithm complexity, $n \log n$
   (exceed L1 cache, exceed L2 cache,
   exceed RAM virtual memory,
   exceed disk file cache in RAM, etc. etc. etc.)

\[
\text{TIME} = \sum_{i=1}^{\# \text{INSTRUCTION TYPES}} \left( \text{CPI}_i \times \text{COUNT}_i \right) \times \frac{\text{SECONDS}}{\text{CLOCK CYCLE}}
\]

\[
\text{PERFORMANCE IMPROVEMENT} = \frac{\text{PERFORMANCE FASTER}}{\text{PERFORMANCE SLOWER}} = \frac{\text{EXECUTION TIME SLOWER}}{\text{EXECUTION TIME FASTER}}
\]
Points | P1-166 | P2-266 | n Log n | FFT's on non zero data |
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<td>16</td>
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<td>2048</td>
<td>0.00824</td>
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<tr>
<td>4096</td>
<td>0.0177</td>
<td>0.00451</td>
<td>0.004915</td>
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</table>

Speedup Ratios P266/P166
1024 3.976744
2048 3.980676
4096 3.924612

Measured data:
P1-166 Micron Pentium I, 166MHz
P2-266 Dell Pentium II, 266MHz

32 bit floating point
same executable on both machines
Data fit in L2 cache on both machines

Note that a speedup of less than 2 was expected but actual speedup was about 4 due to architecture change
What can affect benchmarks?

1. Computer Architecture
2. Clock speed
3. Number and depth of pipeline
4. Cache size
5. Memory bandwidth
6. Which compiler
7. Which compiler settings
8. Choice of Operating System
9. Operating system settings, quanta
10. Environment, other processes

<table>
<thead>
<tr>
<th></th>
<th>2.4GHz P4</th>
<th>1.4GHz Athlon</th>
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<tr>
<td>Windows XP</td>
<td>940</td>
<td>1410</td>
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<tr>
<td>Suse Linux</td>
<td>200</td>
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All times in microseconds, smaller is better
4096 point complex FFT time from benchmark
fft_time.c source code available on WEB.
The same Microsoft C binary executable was used on both Windows computers, the same gcc binary was used on both Linux computers. Expect results to vary with different benchmarks.
not changed all that much from previous models. The real story is inside the case.

The most important aspect of the system hardware continues to be the Alpha processor. The AS500 now is available in four 64-bit CPU configurations: 200MHz, 333MHz, 400MHz, and 500MHz. Although the primary focus of our review is the 333MHz model, we also ran tests on a 400MHz system and discuss test results filed with SPEC for the new 500MHz model. All lab testing was performed using Digital UNIX 4.0.

The AS500 also introduces new graphics features. Although earlier AlphaStation models used the PCI bus common in PCs, DEC's new PCI-based PowerStorm graphics adapters were introduced concurrently with the AS500 and its little brother, the Model 255. These boards include the value-priced PowerStorm 3D10 (standard in the entry-level AlphaStation 200) for 2-D and lower-end 3-D: the 3D30 for fast 2-D graphics for MDA, GKS, and EDI applications; the 4D20 for fast 3-D wireframe and true-color 2-D and 3-D; and the high-end 4D60T board for high-end 3-D graphics with shading and texturing. The design and the resulting price structure are the most significant aspects of these boards. The 3-D capable 3D10 lists for $839, the 3D30 lists for $879, and the 4D20 lists for $82495. The 4D60T board, priced at $11,995, is intended to compete with the major players in the graphics market—the (N)Hrmpact and Maximum Impact board sets from Silicon Graphics Inc. (SGI) and the Visualize-48 board set from Hewlett-Packard. The 4D60T is a two-board assembly (consumming two slots), whereas the high-end solutions from IIP and SGI are three-board sets, leaving only one or two slots for other forms of expansion. DEC's graphics strategy with the AlphaStation line is to leverage the power of the Alpha processor by doing some of the calculations for graphics primitives on the CPU, providing for a less expensive design on the graphics boards.

On the software side of the system. Digital UNIX 4.0 includes new features and enhancements over previous versions. Noteworthy improvements in 4.0 include the Common Desktop Environment (CDE) as the default user interface; improved system management, with a new and easier interface; and enhanced security features.

**Operation**

Putting an AS500 into operation is a simple matter. Hardware installation follows industry norms, and all connectors on the rear panel of the system are well labeled. A spiral-bound User Information manual accompanies the system, providing additional details about system setup, along with the usual information about installing optional hardware components and performing system upgrades.

The only problem we encountered was configuring the Ethernet connection. The system includes connectors for both thimnet (10Base2) and twisted pair (10Base-T). The system defaults to the thimnet port, which is not mentioned in the AS500 User Information manual. Recalling a similar situation with the AlphaStation 250 4/266, we checked the console monitor commands in the User Information manual, found nothing, and resorted to an older AlphaStation manual for the information we needed. Executing the command

```
set env twisted
```

at the monitor prompt (the hardware-level prompt available prior to booting the operating system) allowed us to use twisted pair.
The Sun Ultra 2 Series 2200 workstation shows scores of 11.7 for SPECint95 and 7.81 for SPECfp95 for its 200MHz Ultra- 
SPARC CPU. Thus, the 333MHz model of the AS500 scores somewhat lower than the fastest Sun 
Ultra on floating-point calculations, somewhat higher than the 
Ultra on integer tests, and lower 
than the fastest HP PA-RISC 8100 
machine in both categories. The 
400MHz version of the AS500 
is only slightly lower than the 
fastest Ultra on floating-point 
tests but substantially higher 
on integer calculations. The HP 
C180 also is higher on floating-point 
tests than the 400MHz 
AS500 but somewhat lower than the 
DEC on integer tests. The 
scores for the 500MHz version 
on this benchmark, consider 
previous test scores of 14.93 
for the Sun Ultra 1 Creator 3D 
(167MHz UltraSPARC, see our 
review in the June 1996 issue, 
p. 33), 11.00 for the SGI Indigo 
Impact (see our review in the 
May 1996 issue, p. 49), and 
4.92 for the Network Computing 
Devices (NCD; Mountain View, 
CA) HMXpro21 high-end X 
terminal (see our review in the 
September 1995 issue, p. 57).

How It Rates

The basic design of the AS500 is 
good. The footprint of the system 
unit is small enough to let the 
keyboard be positioned in 
front of the unit on a standard-
sized desk with room to spare. 
Similarly, the height of the unit 
would make it the best in 
both categories. The AS500 also is impressive 
in basic graphics performance. 
Using the standard 3D30 2-D 
graphics adapter, we achieved 
an Xmark score of 30.17 for the 
333MHz model. For comparisons 
lets the monitor be set on top 
of it without placing the monitor 
uncomfortably high. We were 
not impressed by the swing-up 
door that hides the diskette 
and CD-ROM drives. Although 
stylish, the door obscures the activity 
light on the diskette drive.

Installation of the system is 
simple and straightforward. rating 
an excellent on our scale. 
Connectors on the rear panel of the system follow 
industry standards and are clearly 
labeled. making cable hook-
up intuitive for an experienced 
installer. Additionally, the Digital UNIX 
documentation provides 
throughout guidelines for installing 
and configuring the operating 
system.

Printed documentation accom-
pagnying the system is limited to 
the hardware-level User Infor-
mation manual described earlier 
and manuals for Digital UNIX - 
(Release Notes, Documentation 
Overview, Technical Overview, 
and Installation Guide). Online 
documentation includes traditional UNIX and xman manual pages, the 
standard CDE-based Help Manager, 
and an extensive set of HTML-
based, Digital-specific manuals. 
The HTML manuals, accessed 
through Netscape Navigator 1.21 
are thorough and well-written and 
include a comprehensive table of 
contents. We were particularly 
impressed by the concise yet 
easy-to-understand description 
of enhanced security features in 
Digital UNIX. Yet we were dis-
appointed that no search engine is 
provided for the HTML manuals 
to find specific topics within that 
documentation set.

Expandability of the AS500 is 
excellent for a small desktop work-
station. The chassis provides space 
for three hard disks in addition 
to the standard 3½-inch diskette 
drive and the CD-ROM drive. RAM 
can be expanded to 512MB, com-
mon for a workstation of this size 
but potentially limiting for some 
high-end engineering and scientific 
applications. The external SCSI 
port supports Fast-Wide SCSI-2