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ASTRONOMICAL DATA REDUCTION AT THE UNIVERSIDAD CATOLICA DE CHILE

H. Quintana

Pontificia Universidad Católica de Chile

RESUMEN. Se describe brevemente el sistema computacional que se instala actualmente en la Universidad Católica. Las necesidades de reducción de datos son las típicas de un pequeño grupo de investigación y son satisfechas por una red de estaciones de trabajo, permitiendo reducciones con programas usuales y cálculos teóricos intensivos en uso numérico. La disponibilidad de la última tecnología en estaciones de trabajo, reflejada en unidades con velocidades de 100 MIPS y capacidad de cálculo numérico cercano a 15-20 Mflops, permite acceder a una fracción del poder de un supercomputador a un bajo costo. Los esfuerzos desplegados y resultados obtenidos para constituir el sistema de reducciones pueden ser útiles para otros grupos pequeños de la región.

ABSTRACT. The computational system presently being installed at U. Católica is briefly described. Needs for data reduction are typical to those for a small astrophysics research group and will be satisfied by a network of workstations, allowing reductions and numerically intensive theoretical calculations. The availability of the latest workstation technology, represented by machines with speeds of 100 Mips and numerical performances around 15-20 Mflops, makes fractions of supercomputer power accesible at very small costs. The efforts made and results obtained in establishing a reduction and computational system can be useful for other small groups in the region with very small budgets.

Key words: **DATA ANALYSIS**

The usage of digital detectors in nearly every astronomical instrument makes it imperative to be able to reduce and analize large quantities of data in digital form. Complete facilities for data reductions are particularly important in a small group such as ours, where the staff has fairly heavy teaching duties. This factor makes it difficult to program extended data reduction stays at the observatories in northern Chile, beyond the actual observing periods. Three years ago we started a drive in search of funds to acquire an up-to-date computational system capable of efficiently running standard astronomical packages, like IRAF and MIDAS. We submitted a number of research proposals and have been fortunate to receive grants from several national and international agencies and foundations.

The starting point was the acquisition of a MicroVAX II, thanks to a grant from the Volkswagen Stiftung. An FG-100 image display card from Imaging Technology Inc., ITI, and a Sony 19" color monitor was added soon after. This system has recently been upgraded to 13 Mb in RAM memory, 900 Mb in disk space and a 1600 bpi Cypher magnetic tape unit (due to arrive shortly). We have a DECnet link to the University Computer Center VAX 8600, where IRAF has been running for the last few years (alas, without an image display) up to now on 4800 bauds serial lines. The MIDAS package (Banse *et al*, 1988) was mounted on the MicroVAX and has been interfaced to the ITI image display (this interface software is available on request).

We are embarked in the process of installing several APOLLO and SUN workstations, which will considerably increase the power of the overall system. Three color Apollo workstations (DN10.000 and DN3.500's) at the Astrophysics Group are linked to another three Apollo stations at the Mathematics Department (DN3.500's and one DN3.000) by a high speed Apollo Token-Ring network (12 Mbits/s). One of our DN3.500 links the Token-Ring to an Ethernet that networks the Apollos to the MicroVAX, two SUN workstations (a 16" color SUN 3/60 with local disk and a monochrome 386i) and an AT 286. The Ethernet will soon be extended to the University Computing Center VAX 8600. Fig. 1 shows a schematic diagram of our current network and Table I shows the configurations of the present CPU's at the Astrophysics Group. Peripherals include an HP laser and three other

FIGURE 1

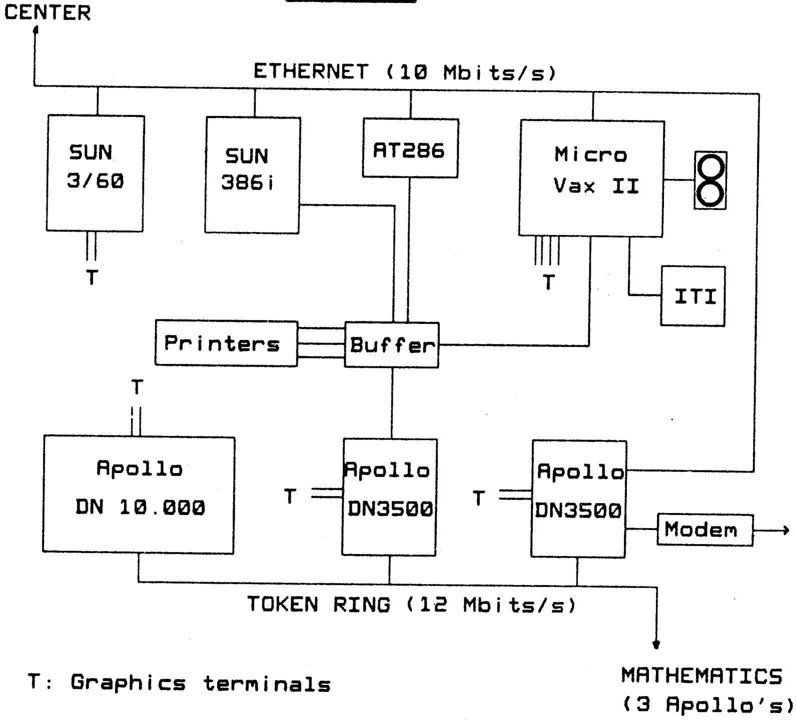

Table 1

Computers in U.C. Data Reduction System.

CPU	Processor	RAM Mb	Disk Mb	Display	Speed MIPS [1]	Computing Power Mflops [2]	
APOLLO 10.000	3 PRISM	32	760	19" color 1000x800	90	17.0	(3 processor)
						5.8	(1 processor)
APOLLO 3.500	68030/25	8	350	19" color 1280x1000	4	~0.15	(68882/no FPA)
APOLLO 3.500	68030/25	8	diskless	16" color 1000x800	4	~0.15	(68882/no FPA)
MicroVAX-FPA	DEC	13	900	19" color 1000x1000 ITI FG-100	1	0.11	(FPA)
SUN 3/60	68020/20	8	140	16" color 1150x900	3	0.11	(68881)
SUN 386i	80386/20	8	diskless	15" mono 1150x900	3	~0.10	(80387)
AT 286	80286	1	70	14" mono EGA			
PC's, Atari,etc.							

[1] MIPS: million instructions per second.

[2] Mflops: million floating-point operations per second, full precision FORTRAN.

printers, several smaller PC's and graphics terminals. Two of the PC's are attached to a microdensitometer and a x-y measuring table for coordinate determinations (± 5 arc sec) from the sky surveys: SRC/ESO J and R, partial ESO Quick B, Palomar, Infrared SRC and Palomar Milky Way Surveys. The J color copy of New Palomar II is on order.

The Apollo workstations are centered around an APOLLO DN10.000 supercomputer with 3 PRISM processors (Parallel Reduced Instruction Set Multiprocessor), 32 Mb in RAM, a large disk and 19" 8-plane color monitor, which has a speed of 50-90 MIPS and a number crunching LINPACK rating of 8.2 Mflops (million floating-point operations per second, Dongarra 1988), 5.8 Mflops in double precision per processor, which on parallel jobs gives a combined power of 24 Mflops and 17 Mflops, respectively. The total computational power of this unit exceeds that of a VAX 8600 (0.48 Mflops) by a factor of 30, that of a SUN 4 (1.2 Mflops) by a factor of 14 and is comparable to the speed of a CRAY 1S (12-27 Mflops) for secuential and slightly parallel computations, but is obviously much slower for vector processing than the CRAY. This opens up the possibility of carrying out, for instance, large scale n-body simulations with immediate image visualization of results. Moreover, the APOLLO NCS software (Network Computing System) allows distribution of a process calculations over the several CPU's of the network, increasing the overall power for computing. TCP/IP protocols and NFS software will permit transparent access among the UNIX CPU's or accross to the VMS systems. In this way, for instance, the big APOLLO DN10.000 or the MicroVAX II can be used as servers for the smaller APOLLO or SUN workstations. Input to the system can be gained via a variety of ways: 1600bpi magnetic tapes at the MicroVAX, standard 60mbytes cartridges at the SUN or APOLLO workstations, (shortly) via the Ethernet from the magnetic tape units at the Computing Center VAX 8600 (all of 1600bpi, as of this moment) or via 1.44mb or 1.2mb floppies (SUN 386i, APOLLO's with 286 coprocessor unit or AT computers).

Available software includes IRAF (Tody, 1986) at the SUN workstations and VAX 8600, soon to be running also in the three Apollos (as part of our purchase agreement with APOLLO Computer Inc. last October, the compamy agreed to donate a DN3.500 workstation to Kitt Peak for porting the IRAF package). MIDAS is running on the MicroVAX and we expect to install it on some of the workstations. We are also installing the R2D2 package from the University of Victoria, BC; GASP, SDAS, AIPS and some additional astronomical programs. By the end of 1989 we hope to have all these packages available with support from one or two programmers, on a total of five full color and two or three monochrome workstations. It is likely that in the meantime the use of the VAX 8600 for astronomical reductions will slowly be phased out due to new University computer usage policies, the load being taken out by the workstations.

A series of software tools have been included in the APOLLO network to help develop programs and applications. The standard graphics packages GKS, PHIGS and GMR3D are available, as well as software development tools like Open Dialogue and the Domain Software Engineering DSEE package. We plan to support a large number of mathematical routine packages, useful in a joint program with the Mathematics Department and also useful in astrophysical calculations. We hope to overcome some gaps remaining in the system hardware and software in the near future. With the increasing pace of developments in computing, one is forced to continously upgrade any system. We hope to keep increasing computational and graphics powers and to incorporate advances as they become available (optical disks, 8mm cartridge massive backup units, faster processors, memory increases, etc.).

We have a committment to carry out, jointly with the Mathematics Department, some non-astronomical projects on this system (a necessary condition to gather part of the hardware and supporting man-power) but we foresee that time will be available to other latin-american astronomers for collaborative programs or who have special reduction needs. The computing system in place at our Group shows that the use of the new generation of very fast workstations, like the APOLLO DN 10.000, Stellar or Ardent UNIX machines, permits a small Department to have a computing power comparable to a share of a supercomputer at a very small fraction of the cost (the APOLLO DN 10.000 configured as described in Table 1, costs US$150.000.-, list price). These small machines have some degree of parallelism (the APOLLO DN 10.000 can have up to 4 PRISM processors, each with 3 internal paths) and can compete at the lower scale with massive parallel machines (Jenkins 1989), some of which have specialized hardware for extremely fast floating-point operations.

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Hernán Quintana: Astrophysics Group, Pontificia Universidad Católica de Chile, Casilla 6014, Santiago de Chile.