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REPORT

GRANT NSG 7024

DEVELOPMENT INTERDATA 8/32 COMPUTER SYSTEM

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March 1983

PRESENT SYSTEM HARDWARE

The INTERDATA 8/32 is a 32-bit word length mini-computer manufactured by the Perkin-Elmer (PE) Corporation. This computer though, in widespread operation in the U. S., including a number of research organizations, does not have the recognition of the VAX series, with which it is comparable, insofar as both are 32-bit minis. With the 32-bit word length (and double precision capability), large mainframe addressing is possible. The mainframe memory contains 1024 Kbytes supplemented by a special on-line microprocessor for special functions. The disc drives comprise two 80-Mbyte (CDC 9762) units. User languages include FORTRAN VII and BASIC. The present software operating system (INTERDATA OS/3), though not the most current version, has been extensively adapted for auto-priority and accounting purposes. Presently, there are 28 utility (physical) and/or terminal (logical) ports. Twenty-two are terminal ports and six are utility ports. In addition, we have a Houston plotter, Tektronix graphics terminal, Chromatics color graphics terminal, 2000-, 1200-, and 300/1200-baud auto answer modems, as well as 7- and 9-track tape drives, a 300-line/minute printer, and QUME high-speed text printer. A block diagram of the present system is shown in Figure 1. It is possible to operate from home through the communciation system during off hours as the computer is on continuously. The computer is operated on an "open shop" basis; this decreases the cost substantially and speeds up processing measurably. It also has the effect of bringing the computational process close to the investigator.

Some idea of the throughput speed of our 8/32 can be seen from the benchmark test tabulated in Table I. The WCS (word control store) is a special small memory programmed in assembler code with specific routines, in our case standard vector operations. Inspection of the table discloses that the 8/32, as we have it configured and with our software modifications, is comparable to the VAX 11/780 and even exceeds the latter by about 30% for the vector test. The modifications proposed herein will increase the machine speed, especially for I/O-laden jobs by a substantial margin, keeping the computer current with needs.

The computer is currently housed in an air-conditioned room adjacent to a large working area containing most of the I/O devices (see Figure 2). The modems are used extensively for communication between the 8/32 and investigator homes for after-hour work including job submission and monitoring (batch mode processing), editing (word processing), and some actual system control from one link. Off campus, the principal PI (Sonettt) uses an Otrona "Attache" on a Vadic 1200-baud dedicated line, a 300/1200 baud line is used by Hubbard and Jokipii with APPLE II's, a fourth user (D. E. Gault, Murphys, CA) with a TRS terminal, while various other users employ a TI SILENT 700 terminal, a Radio Shack VIDEOTEX terminal, an Ohio Scientific micro, and a Netronics ELF (used for remote system control). Other light-to-heavy usage includes links to TYMESHARE (Pioneer Venus/Hunten) and to USGS (Flagstaff/B. Smith) also on an as-needed basis. Further use of this type of communication is anticipated.

CURRENT INTERDATA 8/32 SYSTEM CONFIGURATION

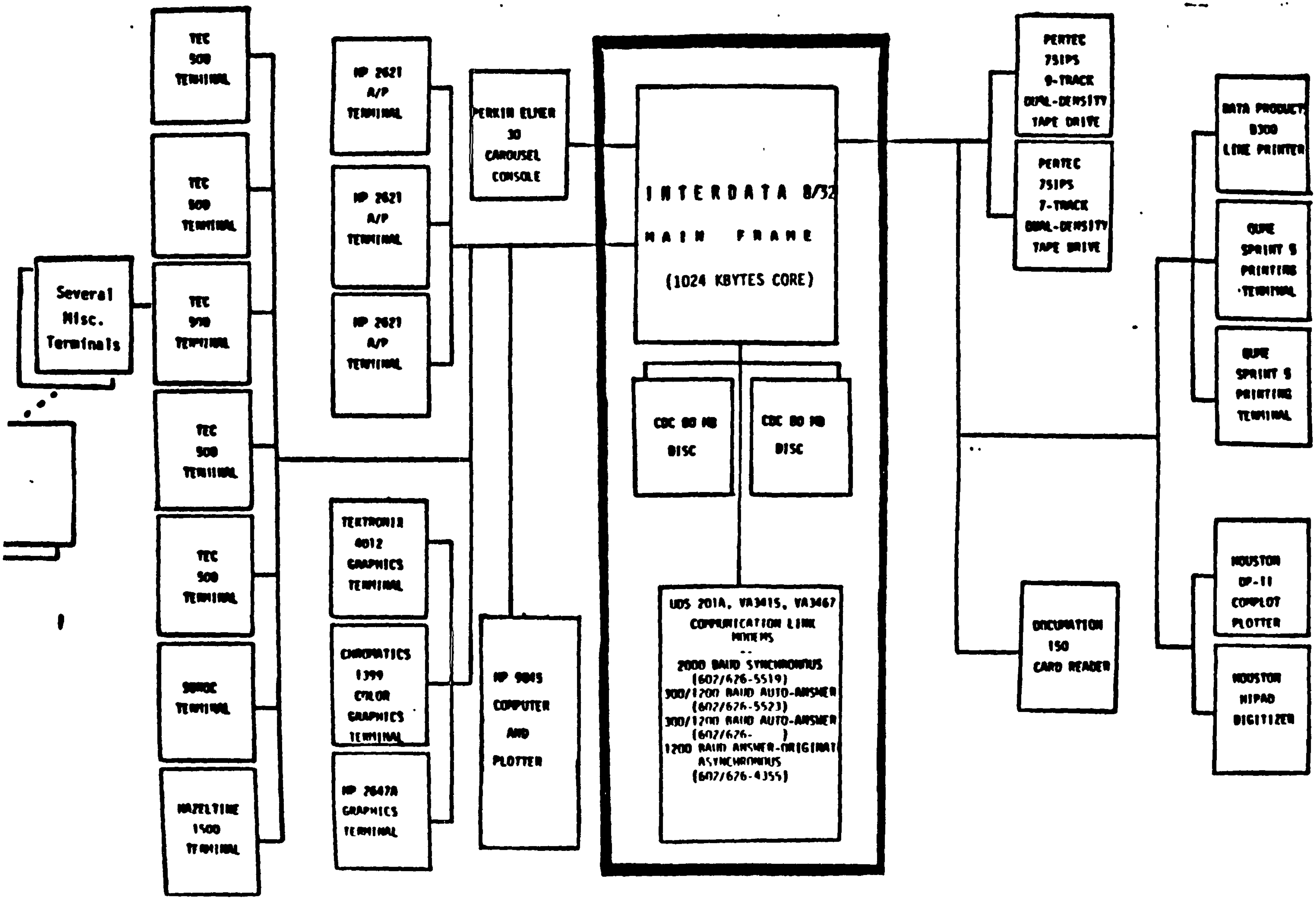

TABLE I

COMPUTER

	8/32	3240	VAX 11-780	3230
TRIG TEST	106 sec	78	86	-
VECTOR TEST	172 sec	117	130	249
VECTOR TEST with/WCS*	106 sec	-	-	-

*(90% of 3240) (82% of VAX)

CURRENT SYSTEM SOFTWARE

It is now widely recognized that the software complement of a computer system is a major factor in effective utilization. The manufacturer-supplied operating system for the 8/32 has been extensively modified so that some characteristics are essentially unreognizable from the original. We have found that a priority allocation system was an essential feature for effective operation. This current system for allocation of time is shown in Table II.

Data processing

Large scale processing of data tapes from spacecraft, complemented by various geophysical data sets, is implemented by fast access via magnetic tape drives at 800 and 1600 BPI rates. Codes are available for reading most tape formats; direct access makes rapid plotting of a variety of outputs onto either screen (black/white or color) or hardcopy possible. Data reduction usually takes place on a batch basis, plotting via special plot routines called from console. Current data reduction is somewhat limited in scope due to disc load limits so that very long data files must be handled as separate jobs, or reduced in length by filtering and decimation. Much data analysis involves coordinate rotations, decimation, computation of auto- and cross-power spectral densities, and auto- and cross-correlation functions. Current work also includes large programs for formal solution to geophysical inversions.

Batch mode

For large scale computations, subission is generally in batch mode, which is active concurrently with interactive operations such as compiling, word processing, and small computations. Job submission, breaks, and tracking of jobs can all be done either from LPL or from remote terminals, e.g., home installations. The status of all jobs can be monitored from any terminal in the system.

TABLE II

PRIORITY ALLOCATION SYSTEM

Priority	*Job Execution Time (sec) Sonett/Hunten	Other Users	System Functions
126	--	--	MTM (Operating System)
127	--	--	Houston plotting WCS Loader (Writable Control Store) CPS EDIT
128	--	--	CONTROL EDIT SPL (Spooler)
129	1000	1000	Compile TET (Task build) Tektronix plotting Word Processing BACKUP File copy BASIC
130	100	50	--
131	600	300	--
132	1800	900	--
133	10800	7200	--
134	>10800	>7200	--

*FORTRAN entry priority is 130; if job size >250 Kbytes, priority goes to 134 immediately

Compiling

Compilation can be done via several system routines. The nominal procedure is to call "FOR filename." This requires of order 35 Kbytes of core. For faster compiling (if core is available) using "QFOR filationname" can result in a faster compilation, but uses some 100 Kbytes. A FORTRAN optimizer, also available, is restricted to very large codes which are intended for long runs as its use involves very large core dedication.

Word processing

Word processing is an outgrowth of the original editing software, supplied primarily as an adjunct to program editing. However, the requirements for widespread document editing and processing, together with department library multi-card production and accession listing required extensive modification to the original editor. The current system is not optimum for a word processor, but has been modified insofar as feasible in view of the widespread types of terminals in LPL. The modifications to the manufacturer-supplied system have all been made without availability of a source code. Modifications to the system software are based on the QUME printer requirements. They include essentially all standard word processing calls such as uper/lower case, underline, backup, centering, sub- and superscript, lines advance, page advance, page numbering options, font selection, line numbering option, margin adjustments, etc.

Accounting

Although the operation of the computer is maintained as an open shop facility, we have found that an accounting system is a vital factor in effective usage for several reasons. It is designed to provide a minimum of information compatible with orderly operation, allocation of priorities, improvement of the operating system, and planning for system growth, without administrative software overloading. Accounting readout is made once per week. The cumulative log is kept on a permanent disc file which can be made into hardcopy at any time. An example of the weekly log output is shown in Table III. Usage of the computer is given in condensed form in the next section.

Priority allocation

Auto allocation of the CPU is done on a time/job size basis, with the longest running jobs progressively retreating on the priority scale, eventually ending in background. Editing has the highest priority (128), with other interactive jobs such as word processing one down (129) and FORTRAN entry at 130. The general order of priority allocation is shown in Table IV.

Library routines

In addition to the operating system, we maintain a large library of special programs for computation purposes. In the interest of economy these are not listed in the proposal.

TABLE III

TYPICAL WEEKLY USER SUMMARY

(Week of 2/22/82)

ACT NO.	NAME	NO. JOBS	CORE (KB)	SECTORS VOL1	VOL2	TOTAL	CORE HOURS	CPU TIME (MIN)
1	HOOD	0	0	6017	6210	12227	0	0.
2	OFFICE1	4	12	3894	3406	7300	0	0.
3	OFFICE2	0	0	1402	11	1413	0	0.
4	DDS	0	0	387	438	825	0	0.
5	STEIN	208	32	5507	797	6304	32	30.98
6	WEEKS	252	27	826	0	826	3	4.97
10	GROUP10	0	0	1285	0	1285	0	0.
11	SONETT	76	16	5033	10931	15964	4	14.78
12	HERBERT	60	24	12290	16159	28449	49	32.38
13	SMITH2	530	42	11107	22169	33276	188	139.08
14	JAKOPIN	27	27	4154	4576	8730	7	8.90
15	SONETT2	0	0	7007	355	7362	0	0.
16	CANTRELL	733	32	6583	14361	20944	12	21.97
17	SMITH	59	28	10584	346	10930	1	2.55
19	TREBISKY	157	40	5472	1277	6749	19	14.00
20	GROUP20	0	0	1	0	1	0	0.
21	HUNTEN	0	0	0	0	0	0	0.
22	HUNTEN2	531	48	14190	6607	20797	1351	415.97
23	SOWELL	65	33	1472	171	1643	2	3.95
24	ADAMS	24	22	10084	0	10084	0	1.92
25	MASSIE	143	42	7524	7858	15382	187	122.62
26	DEPATER	0	0	6574	21545	28119	0	0.
27	PARIDOT	0	0	0	0	0	0	0.
30	GROUP30	0	0	279	0	279	0	0.
31	JOKIPII	10	15	2203	3145	5348	0	0.02
32	MASTALER	378	35	9848	14210	24058	1710	644.97
33	JOKIPII2	0	0	15	0	15	0	0.
34	KOTA	247	32	13917	12201	26118	14828	2948.97
35	BOYER	17	46	2442	1370	3812	3	2.17
40	GROUP40	0	0	0	0	0	0	0.
43	BSMITH	1	10	3811	0	3811	0	0.02
50	GROUP50	0	0	1	0	1	0	0.
51	MACFARLAND	449	36	3648	5499	9147	2202	608.97
52	MOORE	0	0	754	0	754	0	0.
53	OSBURN	0	0	0	0	0	0	0.
54	WILLIAMS	0	0	13	0	13	0	0.
55	MAIN OFFICE	0	0	2468	0	2468	0	0.
56	LIBRARY	0	0	3263	4620	7883	0	0.
57	STROM	0	0	5467	0	5467	0	0.
58	HUBBARD	82	39	2660	6052	8712	453	156.53
59	HOREDT	98	30	16	2400	2416	71	44.40
**	SYSTEM	0	0	65438	7760	73198	0	0.

GROUP SUMMARY

GROUP	NO. JOBS	AVE. CORE	SECTORS	CORE HOURS	CPU MIN	PCT SEC	PCT CHR	PCT CPU
SONETT	2106	33	162584	314	270	39	1	5
HUNTEN	763	45	76026	1539	545	18	7	10
JOKIPII	652	34	59630	16541	3596	14	78	69
SMITH	1	10	3811	0	0	1	0	0
LPL	629	35	36861	2725	810	9	13	16
TOTALS	4151		412110	21119	5221			
UNUSED VOL1						8		
UNUSED VOL2						32		

(NOTE: CORE HOURS (CHR) = SUM OF EACH USERS KBYTES*CPHRS)

TABLE IV

TYPICAL CURRENT TRAFFIC LEVELS

TASK ID	ACT	SIZE (KBYTES)	PRIORITY	STATUS	SYSTEM SPACE	CPUSEC
TMP	26	227	134	ROLLED	24	18331
L	13	154	131	ROLLED	8	222
DM	13	1	129	IN	1	0
TFD3D	51	227	132	ROLLED	7	377
BCON	26	1	129	IN	2	0
AER	25	110	131	IN	5	150
DATA	2	10	128	IN	4	7
SCOTTIE	16	10	128	IN	4	0
FAYE	11	52	129	IN	4	8
FLOYDOOS	12	113	135	IN	4	30202
BVEC	32	131	131	IN	7	339
FLOYDAPX	12	268	132	ROLLED	11	293

CURRENT COMPUTER USAGE

The computer is currently utilized for a large variety of jobs, ranging from interactive data reduction and interpretation through computational batch mode extensively for manuscript preparation via word processing, and for a number of office routines involving bibliographic search and retrieval and business problems such as budget accounting and completion of standard forms required for travel, purchasing, etc. Indication of typical state of current traffic levels is given by Table III as noted earlier, showing jobs at one time by name, account number, core size, priority, status, and core seconds run to the time of tabulation.

Research

A summary of the research programs now carried out on the INTERDATA computer is given by the following descriptions of the activities of the primary user groups as follows:

Prof. C. P. Sonett for reduction and interpretation of solar wind data from various NASA spacecraft aimed at understanding of the hydromagnetic structure of the solar wind including the kinetmatic properties of the small scale wave structure; analysis of various geophysical record compilations such as ^{14}C containing a record of solar-terrestrial processes; simulation of large bolide impacts into the Earth's oceans leading to information on megaocean waves in the fossil record; a study of the possible role of magnetic fields in the early solar system from the avaialable record in meteorites supplemented by conceptual models; electromagentic induction and the physical structure of the Moon's interior; and thermal energy sources in the early solar system, especially those based upon electromagnetic interaction of the nebula and the protoplanets. Associated research (L. L. Hood) is on the permanent magnetic field of the Moon, the interaction of the magnetospheric plasma of the giant planets and their satellites, and (F. Herbert) on the interaction of the solar wind and comets, electromagnetic sounding on the Moon, and the physical structure of the Moon according to models of the physio-chemical differentiation of the lunar interior.

(b) Prof. W. B. Hubbard for computing interior models of the Jovian planets with allowance for interior differential rotation; the planetary structure is calculated via a self-consistent field approach involving evaluation of the equation of state, iterative solution of the equation of hydrostatic equilibrium, and propagation of the solution into higher spatial harmonics; in addition, it has been used with a scheme to numerically solve the Thomas-Fermi-Dirac equation in three dimensions which is to be used to generate more accurate results for the problem of phase separation of liquids and solids at high pressure in addressing the problem of hydrogen-helium separation, separation of hydrogen and high-Z materials, and separation of different kinds of high/Z material; finally, soon it will be used for reducing astronomical data from observational projects.

(c) Prof. D. M. Hunten for research on planetary atmospheres and problems of the Jovian magnetosphere; specifically, during the first two years of the Pioneer Venus mission, it was used to access the unifited data base (UADS) maintained by TYMESHARE for Ames Research Center while, in a similar effort, it has been used to process Voyager tapes from the infrared spectrometer (IRIS); other studies include those in theoretical aeronomy (S. Massie) for solutions to large systems of coupled low-order differential equations to get the distribution of various compounds and radicals, a study of eddy diffusion of the Earth's stratosphere, and a study of ortho-para H_2 conversion in the Jovian planets; a visitor (J. P. Parisot) pursued studies of the chemistry of the Venus mesosphere; I. De Pater (a planetary radio astronomer interested in both atmospheres and magnetosphere of Jovian planets) works on problems ranging from analysis of data from the Very Large Array to synthesis of synchrotron emission from electrons in the Jovian magnetosphere.

(d) Prof. J. R. Jokipii for modelling studies of the propagation of cosmic rays in the inteplanetary medium; his group has developed a set of codes which have permitted the most comprehensive modelling of the solar modulation of cosmic rays yet attempted. The codes make possible full three-dimensional simulations in a frame co-rotating with the sun, and incorporate all known propagation effects. In addition, detailed studies of the transport of fast charged particles in various magnetic field configurations have been carried out (with E. H. Levy), shedding light on the basic transport and scattering mechanisms for cosmic rays.

(e) Prof. E. H. Levy for a research program that involves the construction of computational models to explore the character of magnetic fields in natural objects, including planets, the sun, stars, etc., generated under a variety of circumstances, leading to conclusions, for example, about dynamical influences of the field stresses on the behavior of evolving objects; current projects include calculations aimed at understanding the possible generation of dynamo magnetic field in the protoplanetary nebula from which the solar system formed, calculations aimed at determining the influence on the solar magnetic cycle of a possible fossil magnetic field frozen into the sun from the time of its formation, and a program of research (with J. R. Jokipii) aimed at the physics of the interplanetay medium and cosmic-ray transport theory, concentrating on elucidating the role of particle drifts on the modulation of galactic cosmic rays in the heliosphere though construction of detailed computer solutions of the cosmic-ray transport equations incorporating the drift terms.

Additional use is made of the communcations and word processing by other faculty and staff, and also the department office and library.

Accounting

The accounting record is dumped weekly for planning purposes and for tracking of the priority optimizer sub-routine of the operating system. The accounting stores weekly average of usage by major groups. This permanent record is available on demand in tabular or graphical form. The items stored by major group are disc sector totals, CPU utilization in units of CPUmin, and core (memory) in units of Kbyte hrs. The disc total is for the previous week; the other two parameters are instantaneous readouts. The maximum computer totals are (a) 134 Mbytes (523 Ksectors) of utilizable disc, and (b) 1024 Kbytes of core of which about 225 Kbytes is devoted to the full operating system. (Note that for dedicated single-user computation, it is posible to disable a major fraction of the operating system yielding about 900 Kbytes of usable core.)

Disc

Figure 3 provides the accounting summary for the past year, (February 1981-February 1982) for the three major user groups. The total generally hovers at about 400 Ksectors vs. the available total of 523 Ksectors. The major characteristics are the near saturation condition most of the time, and the intrinsic partitioning between heavy data processing (Sonett) and theoretical modelling (Jokipii and Hunten).

Core

Core utilization, given in Figure 5, is more irregular, showing many heavy traffic periods during the year. The major user is Jokipii; this is expected because of the computational emphasis of his work. Of the three major areas whose traffic is defined by the accounting, core utilization is perhaps the least well defined. At the same time, it is the least critical of the hardware areas requiring attention.

Usage vs. original system design goals

These graphs provide compelling evidence that our original philosophy with respect to computer requirements and implementation has been successful, thus providing a strong basis for confidence that the projections of this proposal are soundly based. That philosophy was based upon four principal axioms: (a) the need for a hands-on (open shop) computer for data analysis with large core and disc capability, but used intermittently, (b) the expected requirements of the NASA data network, (c) the need for intermittent large core capacity for theoretical modelling, and (d) the ability to access data rapidly either directly from tape or from core onto "hard" copy. Item (c) has turned out to generally exceed the possibilities afforded by use of the University computer, which has restricted core access.

Finally, Figure 6 gives the time distribution of jobs over the year by weekly sums. This graph gives an approximation to computer usage since it indicates jobs only by SIGNON time together with execution of at least one operation. Recognizing this restriction on accuracy, note that the number ranges from a yearly low of about 1000/week upwards to a peak of nearly 5000/week in the spring.

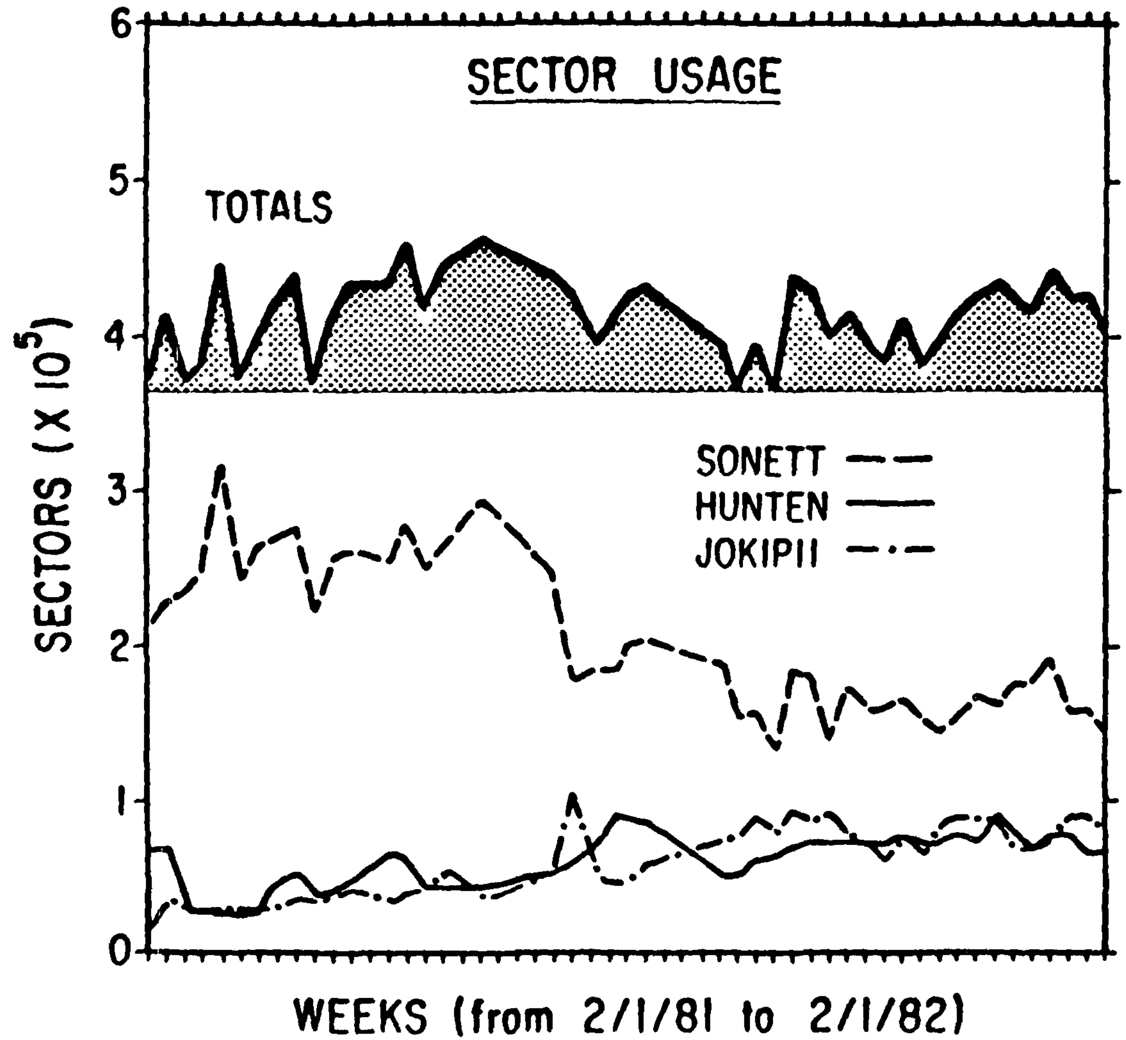
SECTOR USAGE
TOTALS
SONETT
HUNTEN
JOKIPII
SECTORS (X 10^5)
WEEKS (from 2/1/81 to 2/1/82)
0
1
2
3
4
5
6

FIGURE 3

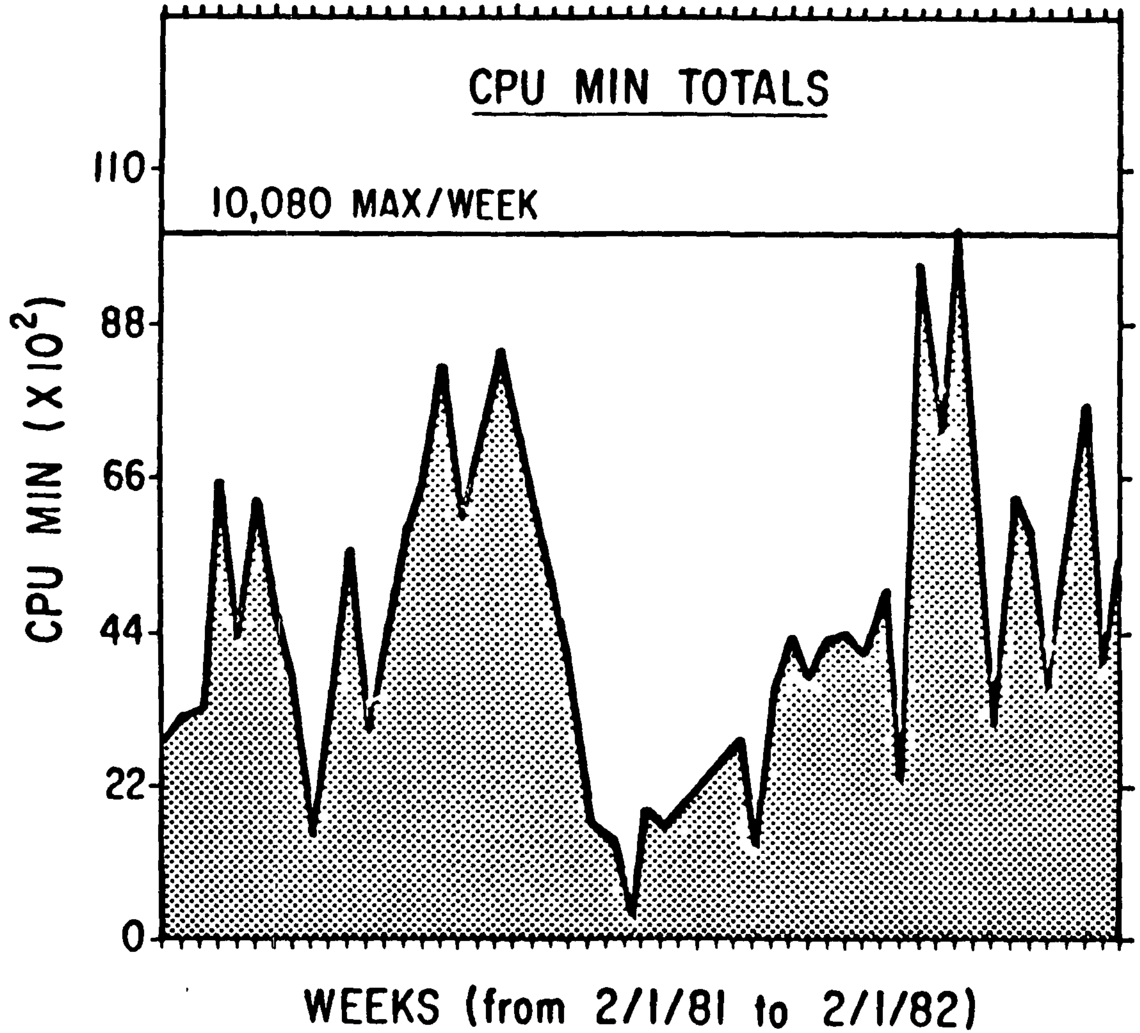
CPU MIN TOTALS
10,080 MAX/WEEK
CPU MIN (X 10²)
110
88
66
44
22
0
WEEKS (from 2/1/81 to 2/1/82)

FIGURE 4

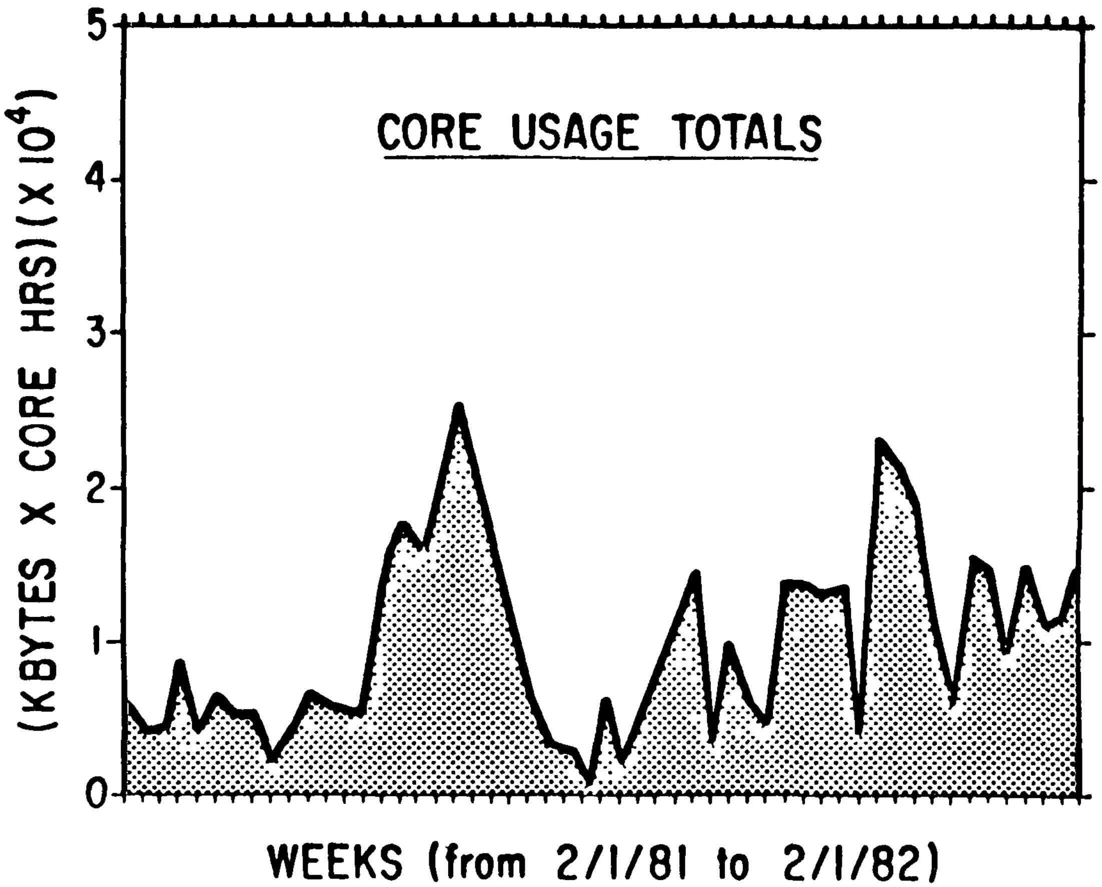
CORE USAGE TOTALS
(KBYTES X CORE HRS)(X 10^4)
0
1
2
3
4
5
WEEKS (from 2/1/81 to 2/1/82)

FIGURE 5

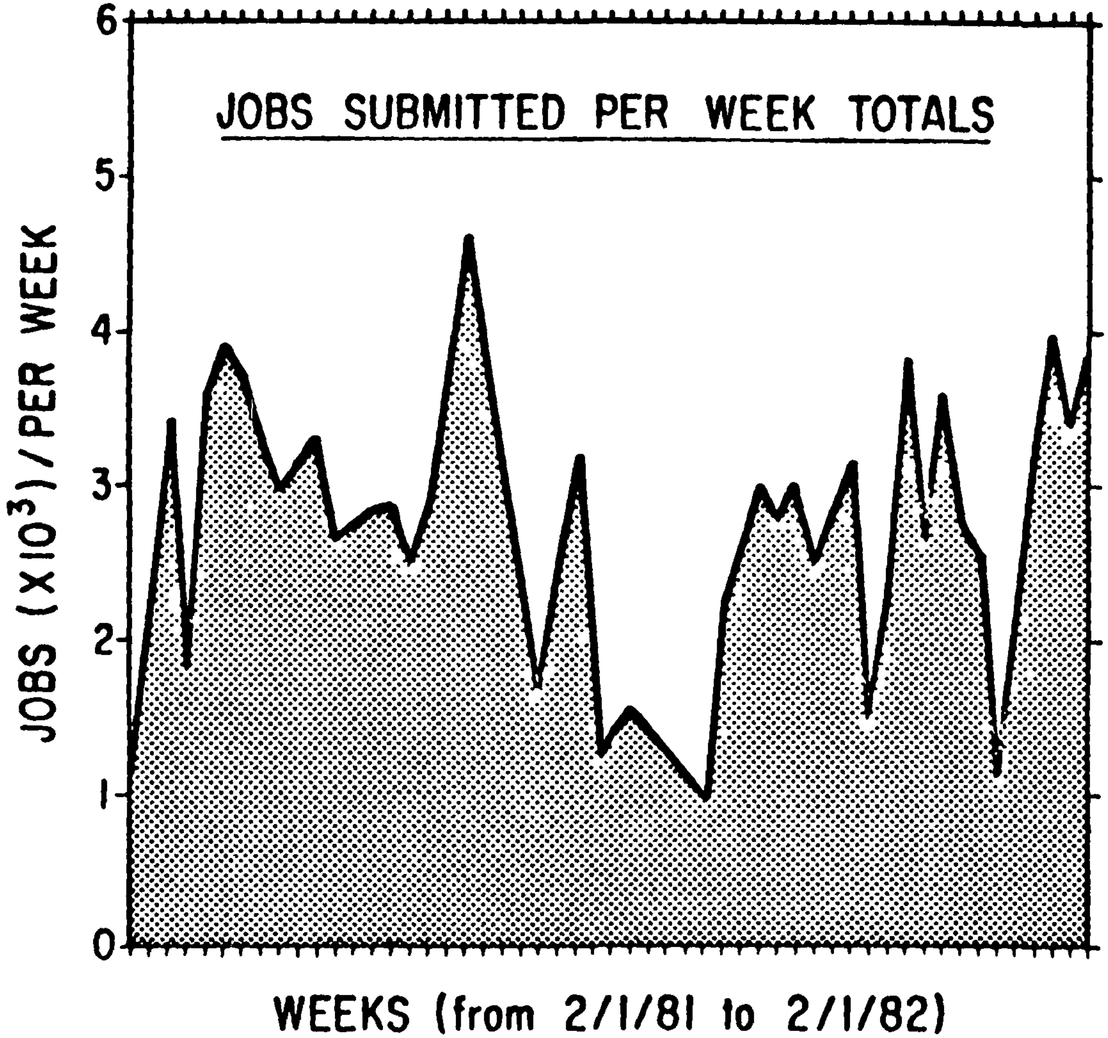
JOBS SUBMITTED PER WEEK TOTALS
JOBS (X10³)/PER WEEK
0
1
2
3
4
5
6
WEEKS (from 2/1/81 to 2/1/82)

FIGURE 6