VLB ARRAY MEMO No. 51

NATIONAL RADIO ASTRONOMY OBSERVATORY
Charlottesville, Virginia

January 12, 1982

MEMORANDUM

TO: R. Burns
B. Clark
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K. Sowinski
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FROM: S. Weinreb

SUBJECT: VLBA Proposal - Monitor and Control Chapter

A draft of the Monitor and Control chapter for the VLBA proposal is attached.

Our costs are 2 or 3 times the CalTech estimate for this portion of the system. Let's have another look at our numbers and discuss this with C.I.T. people.

I believe the 350k$ for redundant site computers should be lumped into a total spares inventory. There are other portions of the system which are probably less reliable than the computer (servo, hydrogen maser focus and polarization) that will not have an on-site backup. I doubt we would lose more than a few days per year per antenna due to CPU failures. Can we arrange it so that the system will run on one disk drive if the second one fails? (Two are included in the system; two more in the redundant system.)

Attachment

DRAFT

VLBA Proposal

January 1, 1982

Control and Monitor System

The overall concept of the Control and Monitor System is a central control center linked by telephone lines to control and monitor each antenna. Typical categories of information required or supplied by an antenna along with typical data rates are given in Table I. The data rates are comfortably low, of the order of 100 bps; an antenna could be controlled and monitored with a 2400 bps dial-up telephone line with large margin for future growth and error correction. The low data rate also allows low cost buffering of data in a memory for operation during a communication failure. In addition, data processing at the antenna will further reduce data rate requirements. For example, instead of sending an antenna position every 10 seconds, a position and duration of observation can be sent to a local computer which then updates the antenna at the required rate.

The distribution of computing power between central control and antenna is an interesting but not particularly crucial question. It would be possible to give the central computer direct control and monitor capability of every bit at the antenna with minimal data processing at the antenna. This minimal data processing would include error checking, immediate action for some severe out-of-limits conditions, equatorial to azimuth-elevation coordinate conversion, and memory-buffering of the data link in the event of a communications failure. However, the system which is favored is one with a small computer at each antenna linked through commercial computer-network software to the central computer. The

local computer program would be loaded via the phone link from the central control computer. This system has the advantage of great flexibility and the use of proven computer-network software.

A block diagram of a proposed remote system is shown in Figure 1. The data-sets are general purpose analog and digital input and output units which link to the local computer via a single serial-transmission twisted-pair cable. Each data-set is located close to the equipment it commands and monitors to minimize wiring. Units similar to those used on the VLA or a CAMAC adaptation will be used. The data verification buffer is a 2M bit RAM memory which is loaded with L.F. data while observing a high-flux unresolved source; the memory is then unloaded through the telephone link (taking 7 minutes at 4800 bits/sec) and correlated with similar data from another antenna to verify system coherence.

The antenna computer will be a 16-bit processor with 128k byte memory, CRT display, slow printer, keyboard, and two 10M byte disks. The communications modem will be of a advanced type which allows error checking and automatic switch-over to a dial-up line in the event of failure of the dedicated line.

A dedicated 4-wire communications line with 9600 bps capability in each direction is proposed. As many as three antennas may share one leg of the link so three 2400 bps data channels and a voice link may be simultaneously used. The line cost for such a link is $156k per year in 1982; approximately 1/2 the cost is for the Alaska and Hawaii links. A dial-up line to each site for 2.8 hours per day would cost the same amount and would not have the reliability or capacity of the 4-wire line.

The central control computer must perform the functions of communications to all antennas, presentation of CRT displays, monitoring of data, and correlation of fringe verification data. The latter inlcudes model-calculation, fringe rotation,

and delay. The proposed computer includes 512k byte memory, two 122M byte disks, two 1600/6250 bpi tape drives, tele-typewriter, printer, card reader, 2 graphics and 8 text CRT's and commercial software for operating system, communications, and FORTRAN. A telescope control computer is also included at the central operations center to facilitate software development. The programming labor for control and monitor software is estimated to be 16 man-years.

TABLE I - Typical Control and Monitor Data Rates

Control

Function	Bits	Update Period	Bit Rate (bps)
Antenna Pointing	48	10 s	4.8
Local Oscillators	48	10 s	4.8
Receiver Control	24	1 s	24
Tape Control	12	10 s	1.2
Total Control Bit Rate			34.8 bps

Monitor

Function	Bits	Update Period	Bit Rate (bps)
Servo Error	16	1 s	16
Receiver Total Power - 4 channels	64	1 s	64
Monitor Data	512	100 s	5
Fringe Verification	10^6	10^4 s	100
Total Monitor Bit Rate			185 bps

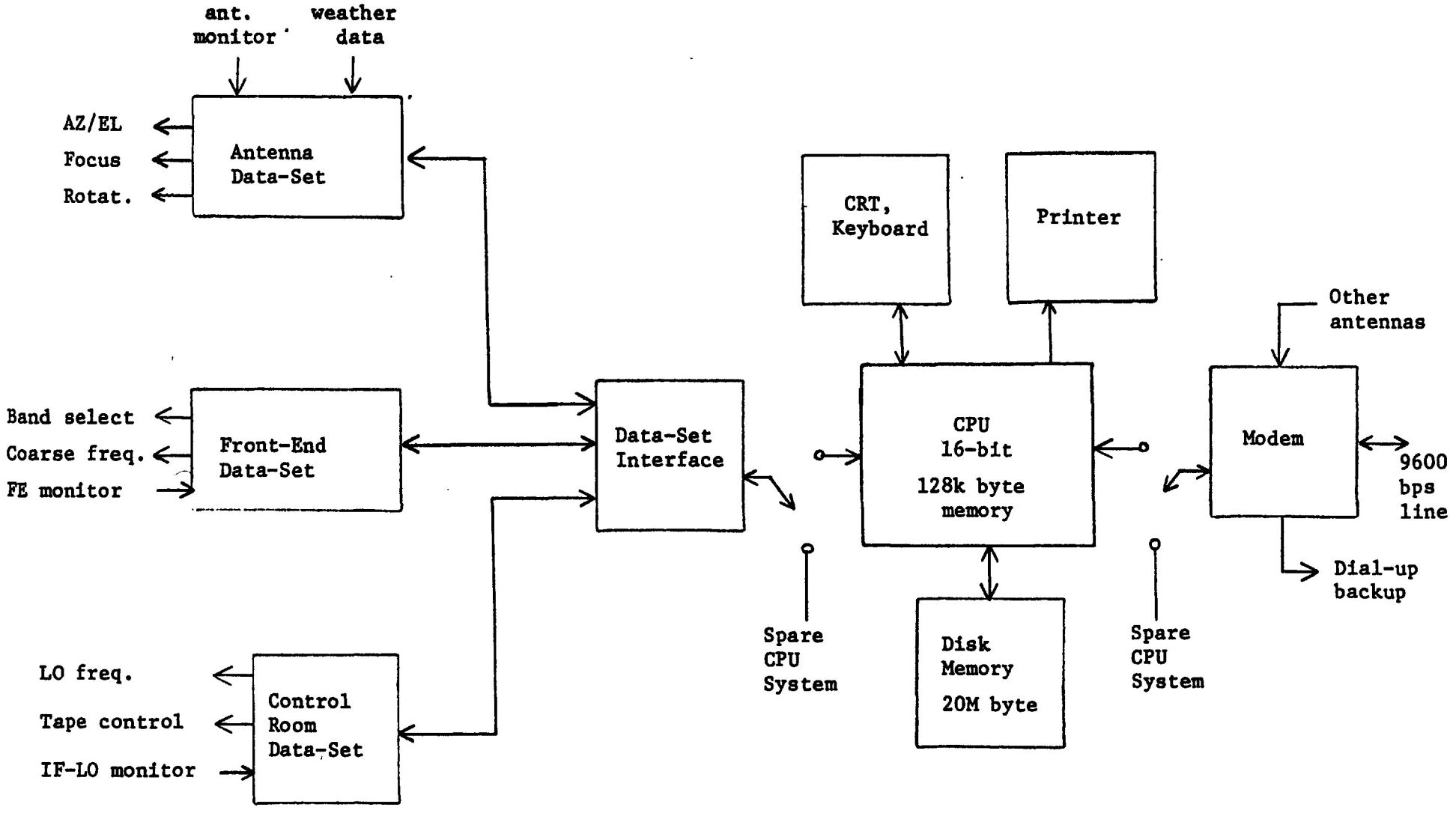

Fig. 1. Antenna Control and Monitor System

(For Cost Chapter)

Control and Monitor System Cost - Per Antenna

Telescope Control Computer (Includes 128k byte memory, two 10M byte disks, tele-typewriter, CRT, and manufacturer's operating system and communications software)	$35,000
Interface Equipment to Antenna and Receiver (Three data-sets and serial interface to computer)	5,000
Fringe Verification Buffer (256k byte memory)	3,000
Communication Equipment - Modems	5,400
Spare Computer	35,000
Installation Cabling ($1,000) and 1/2 man-year check-out labor	16,000
Total per Antenna	$99,400

Control and Monitor System Cost - Central Control

Array Control Computer	$ 204,000
(Includes 512k byte memory, two 1600/6250 bpi tape drives, two 122M byte disks, tele-typewriter, printer, card reader, 2 graphics and 8 text CRT's, and manufacturer's software for operating system, communications, and FORTRAN)	
Communication Equipment - Modems	15,000
Telescope Control Computer	35,000
(For software development)	
Software (16 man-years)	512,000
	$ 766,000
Total Control and Monitor System - Central Control	$ 766,000
Antenna Equipment ($99,400 x 10)	994,000
	$1,760,000