12 METER MILLIMETER WAVE TELESCOPE

MEMO No. 102

National Radio Astronomy Observatory
Tucson, Arizona

November 19, 1981

Memorandum

To: H. Hvatum

From: M. A. Gordon

Subject: Changes in the Computer System for the 12-m Surface

Because this memorandum is intended for inclusion in the 12-m Telescope series, I've written a brief history of computing at the 36-ft (at least, since 1973).

1. Background

From 1973 to 1980, the computer system for the 36-ft telescope consisted of a DEC 11/40 and a single fixed-point arithmetic program written in FORTH. The same program controlled the telescope and hardware, acquired data, and permitted a limited amount of data manipulation and analysis.

Given the objectives in 1973, the program was a tour de force. The high cost of non-volatile core memory caused Chuck Moore to fit the entire program into the smallest unit of memory possible--the amount which came with basic machine. To do this, he had to intertwine different tasks like the pattern of an Oriental rug. There was not even room for software diagnostics such as recognition of parity checks! (Chuck had a lot of confidence in hardware reliability.) When all was said and done, Tucson Operations had one of the most advanced, cost-effective, and efficient telescope programs available.

The few shortcomings in Chuck's program were overcome in subsequent years by Mike Hollis. Hardened by the experience of using the program, Mike changed the program to include some software diagnostics, to be tolerant of mispunched keys, and to exclude the astronomer from the inner workings of the software. Mike transformed a good idea into an excellent, highly reliable program for the majority of observers.

By 1979, the pressures to expand the program had increased considerably. The astronomers wanted to be able to reduce all of their data at the telescope, a capability that even Green Bank's

systems provided (until 1977 Green Bank's computer capability had been among the most conservative of the US observatories.) In Tucson the need had arisen to have the computer control an increasing number of telescope and hardware tasks, such as focus control, thermal correction of pointing, reading the many Local Oscillators, etc. And, the prognosis was a demand for even more computer control.

In terms of progress, our computer system was dead in the water. There was no space available in the memory, and FORTH could not be expanded to gain access to additional memory planes. The Moore-Hollis system could not grow.

This problem was partially solved by adding an additional DEC 11/40 to the mountain system. By means of a data link, the astronomical data was transferred to this second computer. Betty Stobie adapted (by making fundamental changes) the Green Bank POPS system for analysis of spectral line data for the 36-ft telescope. Over the 1980-81 season, the spectroscopists gradually gained confidence in the new analysis system. At the November User's Meeting, there were many plaudits for the new system and tacit approval for removing much of the analysis system of FORTH.

In spite of this new potential for space in the control computer, the space available is inadequate for the new demands for hardware control. Part of the problem is the rigid architecture intrinsic to our vintage FORTH system, and part is the large amount of space required for the additional hardware control. In short, the transfer of the spectral and continuum analysis to the second DEC 11/40 computer gives only a temporary respite in the battle for space in the control computer.

2. What to do?

At my request, Betty Stobie and Bob Freund have taken a careful look at the situation. Here are the options.

a. Rewrite the System with a modern FORTH kernel. This is a modern, sensible approach which would allow FORTH access to additional memory core. But, the coding task is not an easy one. It involves creating a whole new system of task management. Kitt Peak has tried this, but with only limited success so far. In any case, we would again reach a memory limit in a year or so. Also, this solution forces all code to be written in FORTH--which is a little-known language and is unsuited for many applications.

b. Rewrite the control system in FORTRAN under the DEC operating program RSX-11M. This approach is a radical one. It means starting all over again. It also means using FORTRAN as a process-control language -- a role for which it is not ideally suited .

c. Run FORTH as a separate task under the DEC operating system RSX-11M. This has the most appeal for us. It uses FORTH where it is best, for process-control. And, it uses the well-developed and highly debugged operating system developed by DEC. RSX-11M contains all the task management, system-protection and growth possibilities we will need for some years to come. Its copy license fee of $3k is equivalent about 1 man-month of NRAO programmer time.

3. The Plan

Betty will soon begin to adapt the present FORTH program to running under RSK-11M. Al Braun will have to give us some of his time.

Some hardware will also have to be purchased. (Any of the options would also require additional hardware.) We plan to buy 2 used RL02 disks drives and one controller for the control computer, and 1 used RL02 disk drive with controller for the analysis computer. Together with the copy license fee, these should cost less than the $20k budgeted in OOE for Tucson computing.

4. What if the new system is not ready?

The encoder error tables will be required in any case. These will be developed first.

Betty will re-assess her progress in May or June of next year. If it looks as if she cannot meet the mid-November deadline, she will go to the backup plan.

The back-up (short-sighted) plan is to squeeze only the absolute essentials into the existing FORTH system -- the tables of encoder errors. This temporary maneuver will buy her a couple of months of time.

5. Conclusion:

We will meet the computer requirements for the new surface (pointing) by revising the control system program. The goal is to get FORTH to run under the DEC operating system RSX-11M. As a back-up (temporary solution only), the pointing tables could be squeezed into a stripped version of our present FORTH program.

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