VLB ARRAY MEMO No. 396

VLBA Maintenance Computer Needs

B.G. Clark

September, 1984

A good deal of the design of the real-time software for the VLBA is the design of the human interface for the people who have to maintain the instrument. The choices are mainly to be dictated by what the technicians want, with some constraints given by what is practical within the computer system. These last are not very ornerous at the moment, and we have essentially free control of what sort of human interface we wish to implement. However, once implementation begins, it will become increasingly difficult to add features that were not conceived of in the original design. It is therefore important to give some thought to what these human interfaces should look like, now, before it's too late.

1. General Considerations

We have already decided, more or less, on the hierarchy of computers and the sort of software capabilities of each.

The top of the heap is the Array Control Computer. This computer will run the management programs (for instance tape management, spares management, maintenance request management) that provide the logistical backup for the VLBA. It will also have historical data. The programs to plot, say, an oscillator power output for the past month will be run here. It will have semi-realtime data. One can plot antenna pointing error for the last three hours, or phaselock loop phase for the last three minutes, either on screen or on hard copy. Finally, it will have programs to provide access to the next level down the hierarchy. These will be the programs to send observing lists to the stations, and to tap into the real-time monitor data.

The station computer will be programmed in a high level language and drive user terminals. Among other facilities provided on these user terminals will be to connect to the array control computer and run its programs. There will be additional stand-alone capabilities that will be available if the central computer is down or uncommunicative. The trade-offs in deciding what capabilites to provide stand-alone are discussed below.

The station computer will probably provide all human interfaces at the station except for simple LED, LCD, or meter displays attached to particular devices. Though there will be many other microprocessors at the station, providing human interfaces will in general not be one of their functions. The possible exception, as discussed below, is whether, for major debugging, we need a portable "bus zot box", which would provide a limited human interface for experts.

2. Terminals

Terminals will be needed at several places through the system, serving a fairly large clientele and a wide variety of uses. They will be needed in the array operations center for array operators to control and monitor the array, and for experts in the various systems to diagnose problems. A terminal will be needed in the station control building for monitoring the local electronics, for local "housekeeping" functions (eg telling the computer that a given tape has been shipped), for local control (eg requesting a tape unload) and maintenance (eg set the switches so I can do a front end sweep) functions. It also appears advantageous that some general purpose access to the system data be provided in the antenna servo room, in the receiver room and at the prime focus.

For the array control center I advocate the use of VT100 or equivalent terminals. These terminals seem to be sufficiently standard that we should have no trouble replacing them as they age or prove inadequate. Color terminals are desired by the operators, for a quick indication of the most important things to look at. On the other hand, I think the standardization of color has not gone far enough that we would have a reasonable expectation of being able to replace terminals without software changes. To me this seems to outweigh the advantages of using color in an operator context.

An alternative would be to use PC type micros as terminals to the array control computer. The advantage is that their bit-mapped graphics and local display generation could present a very attractive screen to the operator, with lots of options for mice, trackballs, tablets, and other goodies. The disadvantages are that it would introduce another operating system to the programming environment and that the greater cost of the terminal would tend to limit their number.

There will need to be some sort of graphics terminal in the array control center as well, either the graphics extension to a VT100 or, more likely, a Tek 4010 type terminal. In view of the current lack of standardization I would initially try to keep down the number of programs (or, hopefully, subroutines) that drive such terminals. Alternately, we could assume that the GKS will be the future standard system for all graphics development, and find, purchase, or write a GKS implementation interfaced to the programming language we choose for the array control implementation.

The terminal in the station control building has very similar uses and considerations to those in the array control center. It seems to me that they should be the same, unless we end up buying the station control computer as a system which includes a built in terminal.

There are a number of interesting options for terminals, or terminal-like devices, in the various electronics areas. The options are: full screen CRT terminals permanently mounted in places where they can be seen from all around the room, a light (less than 10 lbs) terminal which could be moved to any of a number of places to plug in (and tie down) in the room, a portable device that could be hung on the belt and plugged into any of a number of jacks in the room, or limited special purpose displays analogous to the VLA datataps. The fixed terminals would be the same type found elsewhere, and would thus have access to all the programs and facilities available to anybody. The light terminal would probably be best implemented as one of the flat screen (EL or LCD) microcomputers, with the equivalent of cursor addressing and any other VT100 features we might want to support being provided by a program in the micro. Again, the system would have access to most, though perhaps not all, programs available to the control system in general. The portable device would again probably be a microcomputer with a LCD display, of reduced size to save weight. Because of the reduced screen size, its function would be more nearly that of a smart DVM with some control capabilities than that of the full diagnostic terminals mentioned above. It would be possible to have such a device interface either by way of the control/monitor bus or by a terminal line to the station control computer. The latter is far easier to implement, but the latter has the advantage that it could be designed to operate when the station control computer is down (though a great deal of work would have to be put into it such at it should decline to try to operate things when the station control computer is trying to observe). Special purpose displays, like the VLA datataps, could be implemented with LED or LCD displays, and, again could run as parasites on the control/monitor bus, or on terminal lines on the station control computer. With the level of inteligence we would think of putting into such a thing (unless it is profitable to make it into a microcomputer system as well) it is unlikely that it would function without the station control computer.

One of the commonest uses of the VLA datataps is as a stupid DVM, for making adjustments, etc. If these were their only use, we would certainly find it more profitable to use a real DVM and separate multiplexors. However, the datataps have more sophisticated capabilities which can be used as needed, as would the equivalent devices for the VLBA. Since this is a very common use, it should be an extremely convenient thing to do. Specifically, it should be possible to single out the number from any given monitor point, and and so emphasize it that it can easily be read from the vicinity of the device wherein it is located.

3. Maintenance Needs

It seems to me that the highest level programs should be based on the philosophy that we have developed at the VLA. The system is based on the updating screen, showing current values of a number of monitor points associated with a given device. Different screens are called up by very short commands (perhaps directly to the operating system or command parser of the computer). While the screen is up, the keyboard will have a number of one-letter commands that will operate the device in question (with a system of protection against inadvertant operation yet to be specified), some of which may cause the screen updating to pause for entry of a value. Lower level programs may have a simpler display. If this sort of display is used in the receiver and electronics rooms, it might be worthwhile to be able to select one (or two) of the monitor points for prominent display (for example as a bar graph on the otherwise blank bottom line of the display).

3.1. Logistical support programs

We need a tape inventory program, and a spares inventory program. We should first investigate what is available commercially before writing something. I suspect something adequate can be found to run either on a VAX or on an IBM PC, both of which should be acceptable.

We need a maintenance form processing program similar to the one for the VLA. It may well be that very simple modifications to that one will suffice for the VLBA. This has the distressing feature that it ties the VLBA to the DEC 10 computer. I doubt that anything very close to what we want is available commercially, but, on the other hand, it should not be too much trouble to program on a microcomputer spreadsheet. We should consider this in place of rewriting this program in the language of choice for the array control computer.

None of the above require anything special for their execution, unless you consider another PC or two something special.

3.2. Array control and monitor

I can picture only two screens needed for this purpose, of the type discussed above. One would control sending new observing programs to the various stations. The second would display status - whether communicatins are currently up or down, the antenna pointing (observed minus commanded and az el if there is room), and any serious problem indicators.

3.3. Graphic maintenance aids

As I mentioned in VLBA memo 278, it seems to me convenient to have two levels of monitor database for the VLBA. One would be rather complete and would hold the monitor data from only two or three days. This still might amount to 100MBytes of data. The other would be heavily pruned, and would be kept on disk for perhaps twenty or thirty days after the experiment tapes had been correlated. The two databases may not have the same organization. The size and I/O requirements of the voluminous database might be strongly cut by specifying that some points not be logged unless the change in value exceeds some prespecified threshold. On the other hand, the management of the long-term database is simplified if points are logged at equal intervals.

We need listing programs, graphic terminal programs, and hard copy programs to provide access to these databases.

3.4. Diagnostic programs for use by array control center experts.

This need is the forte of the updating screen-single key command program. I see the need for at least as many such programs as there are engineers, perhaps as many as there are devices.

It is not yet clear where these programs should run. We could have them run in the array control computer or in the station control computer.

The following advantages accrue to having them run in the station control computer. 1). They are available at the station if the array control computer or the communications are down. 2). It becomes somewhat easier to manage hardware changes; one merely must be careful to have the command program in the station computer that corresponds to the version of the device actually installed at that station. 3). It is easier (though not imperative) to provide command functions at this closer location to the hardware. 4). It is easier to write the security provisions that lock out the command program commands or the standard observing program commands as appropriate. 5). It is much easier to provide enhanced sampling rates for glitch catching. 6). The worst case data rates are smaller (in this case, the worst case is the usual, with program at the station and display screen at array control; in the other case the worst case is the unusual, with program at array control and the display screen at the station).

The following advantages accrue to having thse programs run in the array control computer. 1). The program updating process becomes simpler. Since the programs will be written in a high level language, and all sensitive functions will be done by subroutine calls, it would become relatively easy for people with little programming experience to put together special purpose screens, and to try them out in a non-priviledged mode. 2). Switching from one station to another while looking at the same device is almost trivial (a frequently used mode at the VLA). 3). Switching from the updating screen display to the graphic display of past history is much easier and more straight-forward.

3.5. Diagnostic programs for use by experts at the station.

The entire range of programs as discussed above should be available at the station. I suspect that an expert, having been driven to the extremity of acturally visiting a station, would be extremely unhappy to find that his usual diagnostic tools were unavailable or replaced with something different.

3.6. DVM programs

As mentioned above, it seems useful to provide such a facility, either as a subset of the diagnostic programs mentioned above, as separate programs, or as separate terminal types. For making the decisions, it seems to me important to know, as soon as possible, what sort of visibility is possible in the receiver room, and what display visibility is necessary for the care of the receivers.

3.7. Laboratory design and diagnostic tools

If the expert diagnostic programs run in the station control computer, a copy of that system for the laboratory repair facilities would probably suffice for most needs. Otherwise, we would have to decide whether to make them an additional parasite on the array control computer, or to make an entirely separate laboratory system what would run in a microcomputer of its own.

An especially urgent case arises during the design phase. It is clear that some sort of screen-to-device and device-to-screen facility is needed during the device breadboard stages. The alternatives are to provide a bus-to-text converter device (probably as an 8055 microprocessor in a small box) or simply a bus-to-RS232 box. In either case, the device would run into any of a number of microcomputers, and the device designer could write his own Basic (or whatever) program to communicate with the device, albeit probably at a much slower rate than the station control computer will eventually use. For the last stages of debugging, a station control computer could probably be brought to the laboratory for final testing, not only of the device but of its diagnostic and control screen.