NATIONAL RADIO ASTRONOMY OBSERVATORY
VERY LARGE ARRAY PROGRAM
SOCORRO, NM 87801

VLA COMPUTER MEMORANDUM NO. 163

SELF-MAINTENANCE FOR VLA COMPUTERS

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INTRODUCTION:

This report summarizes an investigation into possible self-maintenance for the VLA asynchronous computer equipment. It is rather more detailed than the brief report I prepared last November and has involved help from Digital Equipment Corporation (DEC) representatives.

The investigation involved two main assumptions: (1) that we would want to maintain the computer equipment at the same level as is presently done by Digital under our maintenance agreement with them; and (2) that, for estimation purposes, the equipment to be maintained by VLA staff is only that now covered by the agreement (that is, no allowance has been made for future purchases). Extrapolation for the future is fairly simple.

The maintenance situation is rather complex and no simple solutions exist outside of continuing to pay Digital to maintain our machines. To perform self-maintenance at the required level will involve a number of very serious problems for us with the only advantage being, perhaps, a few per cent saving in our annual maintenance budget. Hence, this report is mainly a summary of the problems we could face, ending with a strong recommendation that we continue as at present.

THE PRESENT CONTRACT:

We presently have a maintenance agreement with DEC for all of the DEC computer equipment on the VLA site, even that DEC equipment which was purchased from third parties. The contract provides for routine preventive maintenance, installation of all Field Engineering Change Orders (FCO's), remedial service response on a best-effort basis and remote diagnostics for eligible equipment. In practice, this means that we get a Digital technician on-site during the contract window period (8 am to 5 pm weekdays); he looks after all the DEC equipment with support from the Albuquerque DEC office. DEC is responsible for maintaining stocks of spares, providing service if the assigned technician is on holiday or otherwise not available, helping diagnose problems with the remote diagnostic facility and generally keeping the equipment running and up to current FCO's. DEC also provides support in the form of maintenance materials, drawings, diagnostics software and tools and test equipment. DEC, of course, is also responsible for all the administration and bookeeping required.

The service we get from DEC is presently very good, although we have no right to demand, for example, that DEC keep a field engineer on site. Outside of the call window (eg. at night or on weekends), DEC will provide best-response service at additional cost (per-call maintenance at $95 per hour). DEC maintains a very good stock of spares at the VLA site, particularly for the VAX's.

The whole contract for this service costs us about $137,000. per year (1982 contract). A summary of costs is shown in the Appendix.

REQUIREMENTS FOR SELF-MAINTENANCE:

To switch from DEC maintenance to self-maintenance, we would need the following:

1. Spare parts inventory;
2. A mechanism for getting parts repaired;
3. Diagnostic software;
4. Maintenance aids, tools and documentation;
5. At least one full-time engineer (highly trained);
6. An efficient maintenance administration system.

Some of these are discussed separately below and the Appendix shows estimates of costs for items 1 through 5. Item 6 is a major problem since it would add significantly to the work of present staff (management, purchasing etc.) and I have not attempted to do a cost analysis for this aspect - basically, we would be trying to duplicate the administration that DEC now does, but on a much smaller scale and therefore with much higher costs.

SPARE PARTS INVENTORY:

For all of our systems, except the DEC-10, DEC can provide spare parts kits. Each kit is designed to support up to 10 units of a given module at the 90 per cent service level. For most of our systems, this would provide satisfactory spares inventory (it is about what DEC keeps on-site now). The spares kits are also the most convenient way to obtain spares - they are easy to order and keep re-supplied and are cheaper than buying individual modules.

The investment in spare parts kits for VLA computers is very expensive, mainly because of the diversity of computer types. Each spares kit is designed to support up to 10 units but we have, with few exceptions like disk and tape drives, only two of any given type. The costs for kits would be reduced substantially if all, or most, of our computers were the same.

For the DEC-10, modules would have to be spared individually rather than in packaged kits. This is not a real problem as DEC has nicely provided a complete list of all recommended spares for our system (as

well as for all the PDP-11's and VAX's). DEC-10 spares, however, differ from those for other systems in that the required lead time is often much longer; i.e. we would have to order some modules at least 9 months or one year ahead of the date at which we would need them.

As mentioned above, DEC has worked out a list of all recommended spares, diagnostic aids, tools and documentation that we would need. I have these lists and we would simply have to place one (or more) orders for the spares to begin self-maintenance. Because of the sometimes long lead time required, I do not believe that we could begin self-maintenance on any system for at least six months after the decision to proceed was taken (allowing some time for engineer hiring and training) and we could not take over self-maintenance on all systems for about 2 1/2 to 3 years.

The costs for spares, tools and documentation listed in the Appendix allow for discounts of 20 percent (the discount for large orders, over $200,000. in value). The costs for diagnostic software have had no discounts applied.

The inventory of spares would be a major investment for NRAO: the Appendix shows that the total investment would approach $400,000 We would have to save significantly on annual maintenance costs, over the expected lifetime of our computer systems, in order to make this large investment attractive.

PARTS REPAIR:

For repair of parts or modules which fail, we would have a number of choices; I assume that we would not want to do our own repairs at the chip level but rather would send modules to DEC for repair and return. The choices are not fixed; that is, we could choose which repair scheme to use on a module-by-module basis as failures occurred. Some parts, of course, would not be repairable and we would have to buy new ones.

The choices are: (1) Loose Piece Repair: DEC would repair the module and return the same module to us. This option is the cheapest but turn-around time could be up to several weeks. The returned module would be guaranteed for 60 days and would be brought up to the latest FCO's (it might be incompatible with other modules which had not been so updated). (2) Module Mailer: Provided we agreed to purchase at least $2000. worth of repairs per year, some modules (excluding many that we have, and all the DEC-10 modules) could be repaired under the DEC Module Mailer program. This is slightly more expensive than the Loose Piece Repair - typically 15 per cent more - but has a 5-day maximum turn around at DEC. Other conditions are the same. (3) Module Swap: This is the fastest and most expensive option. The turnaround at DEC is 48 hours but the price is 60 per cent of the new part price (maximum of $750 except for memories and power supplies). However, we would get a guarantee of 90 days.

We also have the option of emergency ordering parts, at a premium of $100. per part with a maximum of 2 parts per order and 2 orders per month (DEC imposed condition). The requested parts would be sent to us as fast as possible, usually air express. This is equivalent to the "Priority 1" service that the DEC field engineer can now request in an emergency.

The figures in the Appendix for replacement spares are projected annual costs, based on our past experience with the VLA DEC computer systems. They have been estimated from current DEC price lists assuming that the cost for repair of parts or buying new parts would average about 80 per cent of new parts prices (no discounts have been applied). The figures are likely to be accurate only to about 15 or 20 per cent.

To ensure that the latest FCO's were included in our operational equipment and spares inventory, we would likely use either the Loose Piece or Module Mailer program to cycle our modules to DEC for modification as required. Thus, we would incur repair expense even in the case of no failures.

DIAGNOSTIC SOFTWARE:

DEC currently owns the diagnostic software as well as the Remote Diagnostic hardware (enabling the field engineer to get remote help to find faults). We would lose both if we went to self-maintenance but presumably we would buy our own copies of the diagnostic software. It is expensive: for example, it costs about $45,000. for the DEC-10 and about $12,000. for the VAX (one copy needed). The Remote Diagnostic facility would not be available to us but this might not be very important; as far as I know, DEC has only used this facility once.

ENGINEER(S) AND TRAINING:

To go to self-maintenance, we would, of course, have to hire the technical skill required to work on the computers. We do not now employ anyone with sufficient knowledge and training to take over from the DEC-supplied field engineer. At least one full-time position would be required. A backup, for times when the primary engineer was ill, on vacation etc. would be necessary; this could be provided by part time help, after training, from one or more of our current staff, or by hiring TWO full-time engineers (!), or by relying on DEC for per-call maintenance to help out as needed. This last option is not likely to prove satisfactory because of the anticipated response time from DEC (perhaps several days). In the cost estimate in the Appendix, I have assumed that we would hire one full time engineer and provide backup service with existing staff. If we hired two engineers, then we would have full backup for the DEC equipment plus extra help for computer maintenance in general, but the initial and continuing costs would rise proportionately.

From the training point of view, it would be impossible to get training on all VLA systems simultaneously and it would be desirable to introduce self-maintenance in several stages, eg. first the PDP-11's, then the VAX's, then the DEC-10. Progress with, and requirements for, training would depend critically on the quality of the engineer(s) we

hired to do our maintenance. Obviously, the best solution would be to hire an engineer who already had extensive training but this is certain to be extremely difficult.

DEC regularly runs hardware maintenance training courses for VAX's and PDP-11 series computers as well as for the various peripheral devices. The courses are offerred at DEC offices in either Boston or San Francisco; however, a number of courses are offerred only in Boston (eg. RP06 disk maintenance courses). The costs range between about $600. and $5,000. per student for courses of one to five weeks duration. Courses begin often enough that we could choose a convenient schedule.

DEC very rarely (once every couple of years) offers maintenance courses for the DEC-10 system (CPU, memory, RH20) because of low demand. The course lasts seven weeks, excluding training for peripherals, and costs about $1100. per week per student. The DEC-10 course was offered in January 1982 and will not likely be offered again for at least a year.

On-site courses, where DEC sends instructors to the customer's site, are available for all DEC equipment at a cost of roughly $7,000. to $10,000. per week for up to ten students. These courses must be scheduled 3 to 6 months in advance.

EXTENDED DEC MAINTENANCE COVERAGE:

The imminent appearance of the "pipeline" system and the possibility of going to self-maintenance on only some of our DEC computers brings up the question of extended DEC service (i.e. after hours and on weekends). Under a new policy, recently announced by DEC, we can not obtain extended service for any equipment without changing from our present Basic Monthly Service to DECSERVICE. This would increase our present cost by 25 per cent (to go to DECSERVICE) plus up to 43 per cent of the new cost (to go to 24 hour, 7 day coverage). At this price, we would have to incur more than several failures per month to make DECSERVICE more cost-effective than paying for off-hours calls.

REVERSION TO DEC MAINTENANCE:

If we decided that we couldn't handle self-maintenance and wanted to go back to DEC maintenance, then DEC would require some time (perhaps two to three months) to re-stock inventory, relocate an engineer etc. In addition, DEC would require complete inspection of all proposed maintenance equipment to make sure that hardware had been properly maintained and that FCO's had been implemented. Installation of the Remote Diagnostic hardware would also be required. The inspection and any necessary changes would be at our expense (regular per-call charges of $95. per hour).

A further problem would be disposing of a large stock of spares, diagnostics etc. DEC would NOT buy them back from us and we could not recoup any money for them.

THIRD PARTY MAINTENANCE:

One possibility for maintenance is for us to hire a third party to look after all our maintenance - there are firms that specialize in maintaining computer equipment though they are either not manufacturers themselves or manufacture other computer equipment (eg. Control Data Corporation could maintain our DEC equipment). The price is likely to be about 10 per cent lower than DEC's price but there would probably be problems for the third party in obtaining parts from DEC, especially for a competitor like CDC.

Third party maintenance would provide a complete service: spares, PM, diagnostics (but not remote diagnostics), administration and everything else that DEC does now. This option would be the equivalent of continuing with DEC except for the price, the parts obtainability and, perhaps, the response time for calls - we probably could not be so lucky as to find anyone with a technician in Socorro!

EXPERIENCE OF OTHER INSTALLATIONS:

I have spoken to representatives or a number of other installations which operate DEC computer equipment about self-maintenance and maintenance in general. The overwhelming reaction is that it is just not worth the trouble to self-maintain large DEC systems. No one I spoke to (including the DEC maintenance representative) knew of any installation that performed its own maintenance on a DEC-10 system. In fact, DEC seems to assume that customers would not want to maintain DEC-10's themselves since there are no packaged spares kits and any maintenance plans would have to be custom designed by the customer and DEC.

Other DEC equipment users have tried third-party maintenance with some success but ran into problems of parts supply from DEC. Obviously, DEC can get parts quicker and more reliably than can third parties.

One option to reduce costs, used by several sites, is to split the DEC maintenance contract into two sorts of equipment - critical and non-critical. The critical equipment would then be covered by a full DECSERVICE maintenance agreement (or Basic Monthly agreement) and the non-critical equipment would be serviced on a per-call basis. This option, however, requires that it be acceptable for the non-critical equipment to be out of service for up to several days, or that back-up systems, with minimum configuration, be available.

CONCLUSIONS AND RECOMMENDATIONS:

From the discussions above and the figures in the Appendix, it is clear that NRAO could not replace the DEC maintenance contract for VLA computer systems without making: (1) a major investment in hardware (spares), software and maintenance aids; (2) a substantial investment in technical manpower and training; and (3) a major effort in an administration system. The expected savings from these investments would not be sufficient to justify attempting to perform our own maintenance.

I therefore recommend that NRAO should:

1. Continue with the present system for the next few years, at least until we begin implementing a long-term plan for development of the VLA computer systems;
2. Investigate the requirements for maintenance and service on the pipeline system with a view to modifying our present DEC contract to allow for greater, or different, needs for service to keep the system operational. This plan should be complete at least three months before the need for continuous operation of the pipeline arises.
3. Investigate the possibility of removing some equipment (eg. terminals, memory) from the DEC contract, relying instead on per-call maintenance if problems arise. This could be done fairly soon, once a review of the maintenance performance for asynchronous computers over the past six months is completed (it is now underway).
4. Begin negotiations with DEC in the early autumn 1982 to see whether it is possible to reduce the overall cost of our maintenance contract (i.e. would DEC be willing to give us a discount simply because of our contract size? Would DEC be willing to reduce the price if we threatened to remove substantial parts of the systems from the contract?).

APPENDIX 1. ESTIMATED SELF-MAINTENANCE COSTS

	DEC-10	VAX's	PDP 11's		
1. INITIAL INVENTORY:					
Spares kits	176,200.	92,000.	98,000.		
Tools, aids	27,700.		900.		
Documentation	1,400.	1,800.	2,100.		
Diag. Software	45,000.	12,000.	10,000.		
	250,300.	105,800.	111,000.	$467,100.	
less 20 per cent discount on parts				-$ 80,000.	
				$387,100.	
Engineer hire				$4,500.	
Initial training	7,700.	9,400.	9,000.		
Travel	2,500.	3,200.	3,000.		
	10,200.	12,600.	12,000.	$34,800.	
				$39,300.	
					$426,400.
2. CONTINUING ANNUAL:					
Spares repl. & mod.	34,800.	12,700.	5,600.		
Add'l. spares	4,500.	3,000.	1,900.		
Docu. update	2,000.	2,100.	1,700.		
Misc.	2,500.	2,000.	1,000.		
	43,800.	19,800.	10,200.	$73,800.	
Engineer salary				$35,000.	
Benefits (23 per cent)				$ 8,000.	
Add'l Training	2,000.	1,500.	1,500.		
Travel	1,000.	700.	700.		
	3,000.	2,200.	2,200.	$7,400.	
				$50,400.	
					$124,200. *
3. CURRENT DEC CONTRACT:	70,100.	34,500.	32,200.		
					$136,800.

* Does not include costs for extra duties of present staff