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MAINTAINABILITY OF VLA EXPANSION CORRELATOR

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The Correlator System Observer's Manual[1] gives an estimated MTBF for the current VLA correlator as 5 to 10 days. After continuous productive operation of nearly a quarter century this turns out to be a bit optimistic. Currently the MTBF is around 3 to 4 days. This is largely due to a rather high failure rate for one of the two custom integrated circuit types in the system. Even with this rather high failure rate the overall system availability remains very good.

This good availability is due to the fact that the correlator system has very effective real time diagnostics built in. VLA operators are trained to recognize common failure modes and effect simple repairs. The time from identifying a failure until proper operation is restored is usually only a few minutes.

This memo addresses some of these operational and maintenance issues for the VLA expansion correlator from the point of view of the people who will be maintaining it.

The correlator of a synthesis array is a single point of failure for the system. When the correlator is down due to a failure or maintenance activity the entire array is out of operation. In order to achieve good overall system availability a number of system level characteristics must be achieved. As with any kind of features and functions, the earlier in the development these are addressed the easier and cheaper it will be.

First of all the system mean time between failure (MTBF) must be as long as possible. The current state of the art for electronics in this regard is, indeed, very good. In large, complex, one of a kind systems this can be hard to accomplish due to the high expense of design and prototype and inability to amortize these costs over large production numbers. If one gets lucky and gets it right the first time all is well. If not, it is just too expensive to go back and fix the problem. It is then prudent to include design features which make it possible to minimize down times when failures do occur.

To this end I recommend:

- Include real time diagnostics to the greatest extent possible to minimize the time from the occurence of a failure to its detection. When a failure is detected all data from that point in time back to the previous time when the failure could have been detected is suspect. In the case of the VLBA correlator it is possible to go back and recorrelate a project that might have been effected in this way. In a real time system like the VLA the data, and observing time, is lost forever.

- Include design features to allow hot swapping of functional modules and power supplies. It is possible to take one antenna of the VLA down for maintenance and still have the remainder of the array productive. In the same way it is very desirable to be able to exchange parts of the correlator without taking the whole system out of production. In the present correlator it is possible to hot swap nearly all of the circuit cards in the system. If hot swapping of modules is too expensive or difficult to implement without effecting system performance, complex and time consuming shutdown and startup procedures should be avoided. In this regard n+1 redundant power supply architectures would be highly desirable. This would allow replacement of a failed power supply without stopping the system.

- The real time diagnostics should identify the failure to the replaceable module level and module replacement should be simple enough for the array operators to perform. Array operators are on site and can effect a repair within a few minutes. The travel time from Socorro is at least an hour. If a call-out can be avoided at least an hour of down time can be avoided.

- Test fixtures or other means of trouble shooting failed modules outside of the system should be provided. This would allow for first level checkout during construction and ongoing operational maintenance. With sufficient processing at the module level this might be built into the module firmware or down loadable from a maintenance workstation.

The VLA is a heavily subscribed instrument. Down time is expensive from a maintenance point of view and irreplaceable from a user's point of view. It is crucial to reduce future down time wherever possible in the design stage. In a real time synthesis array the correlator is an unavoidable single point of failure every effort applied to avoid and minimize down time will pay off in the future. From an architecture and scientific point of view these considerations are rather mundane, lost telescope time is not.

References

[1] VLA Technical Report No. 39, Correlator System Observer's Manual, R.P. Escoffier, December 1979.