SGP MEMO NO. 31

What Does the Correlator Array Processor Really Do?

K. Sowinski

13 May 1983

As the filler of the pipeline, the correlator system and its AP determine the maximum visibility data throughput of the pipeline; I will estimate AP execution times for both line and continuum observing, and draw some obvious conclusions about minimum integration times. Cast in our usual units the AP is capable, if we let it, of producing about 200,000 channels per 10 seconds.

I have spent a recent morning trying to determine how busy the correlator system AP really is and this note is intended to record my conclusions. Various assumptions have been made about Array Processor IO rates and these were verified by measurements carried out with C. Broadwell. This table records our findings. Two words constitute one complex visibility measurement.

Integrator to AP	0.66 Mword/sec
AP to CORA/B	0.2 Mword/sec

LINE. Integrator data is read out in such a fashion that a total of 1024 lags and leads are read for each baseline regardless of the number of frequency channels to be synthesized, so we have 378 x 1024 / 0.66 = 0.6 seconds to read all integrator data. For 256 channels, we have 351 x 512 / 0.2 = 0.9 seconds to send all the data to CORA. Much time was expended adding up subroutine calls and AP machine cycles, if we assume 351 baselines and self-products for 27 antennae the following numbers, expressed in seconds, result. We assume that neither data selection nor Hanning smoothing is requested, since either will reduce both the computation and IO time. Note that the case of 1024 frequency channels is hypothetical since the correlator produces only 512 channels.

Number of Channels	256	512	1024
Constant overhead	0.6	0.6	0.6
Munging	0.26	0.52	1.04
Selfprod. Norm.	0.15	0.30	0.6
Bandpass Norm.	0.52	1.04	2.08
LSB Corrections	0.37	0.74	1.48
BWC = 8 Corrections	0.16	0.32	0.64
FFT	0.70	1.60	3.14
Worst Case Totals	2.61	4.82	8.98
Best Case Totals	1.71	3.02	5.38

Adding the IO times, not trying to overlap IO and computing and assuming that CORA is always ready to read, we can get worst case total AP run times:

Number of Channels	256	512	1024
Integrator to AP	0.6	0.6	1.2
Calculations	2.61	4.82	8.98
AP to CORA/B	0.9	1.8	3.6
Totals	4.1	7.2	13.8

If the AP main memory were to be replaced with "fast" memory, the time for "Calculations" could be reduced slightly, perhaps between ten and thirty percent.

CONTINUUM. We can perform the same exercise for continuum observations. In this case, integration to ten seconds is performed in the AP itself. The AP reads data from the integrator at 0.3125 second intervals, sums it and computes variances. Once per ten seconds (or per integration time), it will take the summed data, apply all necessary corrrections and write it to CORA. The worst case timing constraint here is that the sum of both these operations must be less than 312.5 milliseconds. Times in this table are expressed in milliseconds.

	Configuration	AC	AC + BD
Per dump-time (312.5 msec)	Integrator to AP	16	32
	Sum Data	34	68
Per integration (10 sec)	Compute 10sec stuff	27	54
	Output to CORA	42	84
	Totals	119	238

The comment made above about "fast" memory applies here as well. If more time should ever be needed, it is also possible to lengthen the basic dump time cycle from six to eight waveguide cycles; this should provide sufficient time for any future processing requirements.

For line work the AP could, in principle, provide five and ten second integration for 256 and 512 channels respectively. The current Modcomp system however would require twenty and forty seconds to be sure of archiving all the data. With fewer channels, proportionately shorter intgration times could be supported, with a fixed minimum of 1-2/3 seconds imposed by the order 32 Walsh function periodicity. In the case of continuum, the AP has no difficulty supporting 1-2/3 second integrations, however the Modcomp system requires about three seconds to carry out its archiving and data transfer functions. If the Walsh functions were not a concern, the AP could probably support 0.3125 second integration times. It should be pointed out though that no other part of the online system could do so.