CALIFORNIA INSTITUTE OF TECHNOLOGY
VLBA Correlator Memorandum

To: VLBA Correlator Group

From: M. Ewing

Subject: **The Global Bus:** A signal distribution scheme

How are the the Correlator Input Channels (CICs) to be distributed; how much does a CIC cost? These questions must be answered before we can decide whether is practical to give full bandwidth in 14- or 19-antenna modes. There is a large number of possible signal distribution schemes, but I would like to work out one in order to have at least an upper bound on cost.

The basic principle is the similar to that described in VLBA Studies, Vol. III. Signals from each Data Playback System (or DPS Selector) are grouped together on a "Global Bus" and sent to "all corners of the correlator." Each Cross-correlator Module (CCM) has access to any channel of any antenna. This may seem an extreme requirement, but there are several reasons for it:

- Supporting 10-, 14-, and 19-antenna modes requires each CCM to have access to at least 6 antennas' signals. The 6 needed by each CCM do not follow a very regular pattern, and it is likely that an awkward "pseudorandom" interconnect scheme would be required if a more general scheme is not implemented.

- We want to use the 16 independent delay settings in the DPS to achieve wide delay coverage for spectral line correlation. If this is done, it will be necessary to have correlator inputs that "cross" in channel connections, adding yet another irregularity to a specialized interconnection scheme.

- A regular connection scheme makes it easy to switch out failed CCMs, to implement self-testing schemes, and to extend the correlator in the future.

- Pairs of independent experiments can be processed easily, up to the limits of the number of DPS units and the width of the Bus.

- It is straightforward to analyze.

Figure 1 illustrates the method. All 22 DPS outputs are transmitted together on a long linear Global Bus. It is not completely necessary, but each DPS output (16 channels) should probably be multiplexed onto as few wires as possible. Transmission rates over 100 Mb/s are not especially difficult to realize.

Signal Distribution Modules (SDMs) are tapped onto the global bus. Each SDM contains the input selectors for a convenient number of CCMs, possibly 64. Physically, this might mean one SDM for each rack. SDM to CCM connections should be short enough that cheap twisted pair backplane connections can be used that will not need expensive connectors. One additional SDM (or possibly a subset of an SDM) can be used for a rack of Auto-Correlation Modules.

Figure 2 suggests the circuitry inside an SDM. First the 22 multiplexed signal streams go to a 22-pole one-of-22 selector. (High clock rates pay off here in reduced multiplexor chips.) Each CCM requires 4 input streams, an R and an L channel for the direct and delayed correlator inputs. The streams for each CCM go into serial-to-parallel converters in which the 16 CIC channels are regenerated. Then a one-of-16 selector extracts the channel to be correlated.

SIGNAL DISTRIBUTION MODULE

The signals from each DPS/Selector will be carried on 4 coax cables at 128 Mb/s for the purpose of this analysis. This number of cables may be halved if a signalling rate of 256 Mb/s is achieved.

	Qty	Item	Unit Cost	Total
1.	176	coax connectors (BNC)	$2.40	$422
2.	88	line receivers/receivers (ECL)	4	352
3.	88	19:1 demultiplexors	8	704
4.	256	serial-to-parallel cvtrs	8	2,048
5.	256	16:1 demultiplexors	5	1,280
6.	6	PCB	100	600
7.	-	Backplane	-	200
8.	-	Power Supply/rack space	-	400

		TOTAL		$6,006

OVERALL

	Qty	Item	Unit Cost	Total
1.	22	DPS Multiplexors (Parallel-Serial CVT)	$200	$4,400
2.	4,400	RG-58A/U (feet)	0.16	704
3.	12	Signal Distribution Modules	6,006	72,072
4.	286	Cable connectors (BNC)	2.40	686

		TOTAL		$77,862

Comments.

About 60% of the cost is in the ECL demultiplexors. Pursuing 256 MHz cable transmission would save some fraction (up to 50%) of this, but would be more than compensated by increased wire and connector costs. (Twinax hardware is 3-4 times the cost of standard BNC.) It is not clear, however, if 128 MHz transmission on unbalanced coax is adequately reliable in a large, noisy system. Some hardware experimentation is needed. Optical fiber technology needs evaluation, but it appears to be expensive also.

Transmitting all 22 DPS outputs through the Global Bus makes the problem of substituting spares for failed DPS units and of efficiently buffering tape changes very simple. More DPS units can be accomodated with a modest (and linearly increasing) cost.

Interesting "multi-group" modes are straightforward, for instance two 10-station experiments could be processed simultaneously with full bandwidth but 1/4 frequency channels. In fact, a 10- and a 12-station experiment could be handled if no "extra" DPS units were required for tape changing.

The approach I use here does not really give us the cost of a Correlator Input Channel in a direct way. What can be said is that the saving that could be realized by restricting bandwidth (number of channels) in 14- or 19-antenna modes is no greater than some reasonable fraction of the total estimate derived above. It would be surprising if more than $20,000 could be saved.

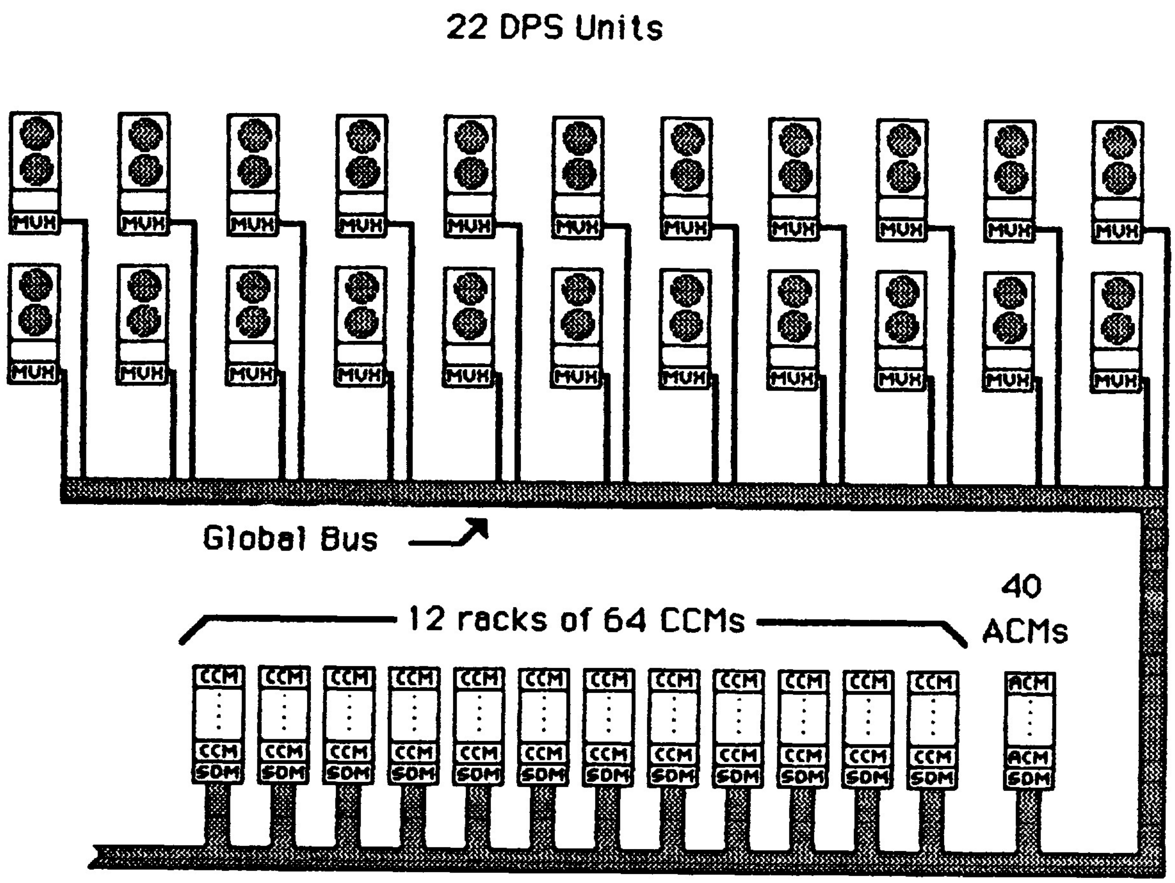

Figure 1. VLBA Correlator Configuration with Global Bus

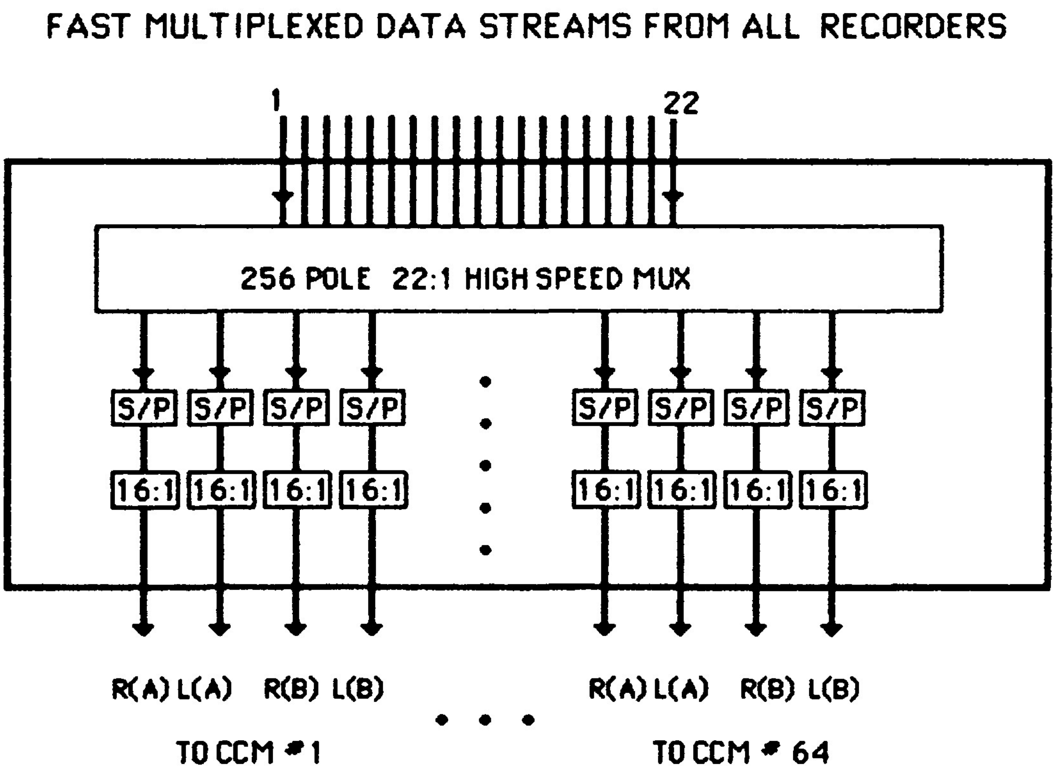

Figure 2. Signal Distribution Module