California Institute of Technology
VLBA Correlator Memorandum

To: VLBA Correlator Group — 7 June 1985
From: Martin Ewing
Subject: Correlator Option List

This memo describes options available to modify the correlator design described in the report "Architectural Design for the VLBA Correlator" (VC041). Options have been analyzed that would materially impact the specifications and/or cost of the correlator. Options, their cost, and the last phase at which they may be exercised are listed below. (Note that the costs are rather roughly estimated from the component costs of the VC041 correlator.)

Positive Options (features which may be added)

+1. Double number of channels

Description: Build 32 channels which can process up to 32 x 8 = 256 MHz RF bandwidth (512 MHz with Option +5) in 20 station mode or 512/1024 MHz in 10 station mode. Also doubles available frequency resolution for spectroscopy.

Cost: $ 1.7 million

Decision Before: Except for impact on input crossbar switch, this option may be exercised at any time. If two 16-channel crossbars are used, there is little penalty for selecting this option at any time.

+2. Add computer peripherals / CPU power

Description: Add TOP output tape, Control Computer disk, or upgrade CC CPU. These options add power for more rapid data output, greater calibration capability, etc.

Cost: Tape drives @$40K; disk @$25K/400 MB; CPU upgrade @$100 K.

Decision Before: No deadline, but selection may impact software design

+3. More Stations

Description: Expand to 12 / 17 / 24 stations

Cost: $ 650K

Decision Before: Detailed design of Correlator Electronics.

+4. High Speed Dump

Description: Dump RAM accumulators to very high speed mag tape similar to DAS/DPS (Honeywell 96), with minimal field-of-view limit. Allows archiving and reprocessing with minimal loss of data.

Cost: $ 300-400 K (very uncertain)

Decision Before: Detailed design of Accumulator, digital filter, and TOP subsystems.

+5. Double clock rate

Description: Exploit 2μ CMOS VLSI to run at 32 MHz clock rate. Provide correlation of 32 Msamples/sec per channel.

Cost: $150 K with some technical "risk"

Decision Before: detailed design of station electronics or correlator electronics.

+6. Oversampling in correlator

Description: Add extra delay stages to correlator VLSI chip. Provides slight sensitivity increase in certain observing modes.

Cost: $150K with some technical "risk"

Decision Before: detailed VLSI design

+7. Double Lags

Description: Use 32 lags (complex stages) per "Elementary Correlator". Doubles frequency resolution for spectroscopy. Requires more correlator boards and doubles TOP requirement.

Cost: $1.1 million

Decision Before: Detailed correlator electronics design and possibly before detailed VLSI design.

+8. Quadruple phase calibrator detection

Description: Use 1 phase calibration detector per channel instead of 1 for every 4 channels.

Cost: $ 75K

Decision Before: detailed station electronics design

Negative Options (features which may be deleted)

-1. Eliminate digital filter subsystem

Description: Eliminate board which performs efficient sample rate reduction algorithm. Multiplies output data by factor of 2 or 4 for a given fringe rate window. E.g., may limit maximum field-of-view to 1" radius for 1 cm H_2O masers.

Saving: $ 325K

Decision Before: No limit; board has been designed as separate plug-in module.

-2. Eliminate phase calibrator detector

Description: Eliminate all phase cal. capability, except using lobe rotators in dummy correlation.

Saving: $ 100K (?)

Decision Before: detailed design of station electronics

-3. Fewer channels

Description: Implement only 8 (or 4) channels, restricting bandwidth for continuum and frequency resolution for spectroscopy.

Saving: $900K (8 channels); $1300K (4 channels). Possible added saving from using smaller control computer.

Decision Before: construction of station electronics or correlator electronics.

-4. Fewer Stations

Description: Build only a 5 / 7 / 10 station system, not directly upgradeable to 10 / 14 / 20.

Saving: $1.0 million

Decision Before: detailed design of station or correlator electronics.

Discussion

Option +1 (doubling channels) is nearly the same as doubling the whole correlator. In fact, building a second correlator might be preferable on operational grounds.

Option +5 (double clock rate) appears particularly attractive. A 32 MHz sample rate, however, would have considerable impact on the Acquisition / Recording / Playback systems. A decision would have to be made early on whether to make such a change in the first generation of that equipment. The correlator could be built for 32 Ms/s, even if the acquisition system ran at 16 Ms/s; this would allow for a later upgrade.

The 32 MHz option carries a somewhat higher risk/difficulty factor in the VLSI design. It would be beneficial to wait for a while before committing to a specific technology, but we feel that this rate may be achievable now with the 2µ CMOS from LSI Logic. Greater pipelining and more gates would be required compared with the 16 MHz design. Discussions with Austek have indicated that their chips can be run up to about 50 MHz with suitable precautions; this provides independent support for the 32 MHz option.

Option +5 could be combined with option -3 (8 channels) to process the same total bandwidth at a lower overall cost. However, there would be problems with frequency resolution (cut in half) and in geodetic / astrometric compatibility, for which at least 14 channels are desired.

Option +4 (high speed dump) is not well understood. Is such a capability useful if the correlator is normally fully-scheduled? Can we afford to routinely archive data at this point? Is the cost accurate?

Option -4 (fewer stations) could also be approached as a board-level compatible subset of the "baseline" (VC041) configuration. That is, the boards from the 5/7/10 system could later be used in a full 10/14/20 system. This would probably reduce the cost saving for this option.

Some options (e.g., -3 and -4) may be combined to increase savings. However the savings will generally be less than the sum of the individual options.