

National Radio Astronomy Observatory

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To: VLBA Data Acquisition Group

From: Clinton Janes and Robert Treacy

Subject: **Proposal for bypassing barrel roll and system track substitution when using the VLBA formatter Data Buffer Module**

Introduction:

The Data Buffer Module in the VLBA Formatter permits capturing up to 4 mbits of formatter data. Capture occurs at the point where the data are exiting the formatter on their way to the tape recorder. With the intention that no data will be lost as a result of the capture, the data are routed to tape recorder and Data Buffer Module simultaneously. Data from up to 4 tracks may be captured; the captured data may be used for verifying correct formatter operation or for performing a fringe check.

Interpreting the captured data is confused, however, if the formatter has implemented the barrel roll and/or track substitution functions. Barrel roll rotates the tape recorder track assignments for the data channels once a frame starting from an initial configuration at the beginning of a 1PPS epoch. The purpose of the roll is to insure that a percentage of data is collected from all data channels in the presence of one or more bad recorder tracks.

Where a recorder track is known to be bad, the data channel that would normally use that track can be routed by the formatter to a system track; i.e., the system track substitutes for the bad track. System tracks are not included in the barrel roll.

Another problem with the use of the Data Buffer Module is the time it takes to transfer 4 mbits of data from the module RAM to the Station Computer. Currently, the transfer takes 20 - 30 minutes depending on MCB usage. The minimum transfer time conceivable with current MCB hardware is 8 minutes.

Track Substitution Solution

The hardware for substituting system tracks for data tracks exists in the tape recorder. The station computer software may be modified to use the tape recorder instead of the formatter for track substitution.

Barrel Roll Interim Solution

The immediate solution to the barrel roll problem is to turn off the barrel roll during a fringe check. At this writing, turning the barrel roll on and off requires that the formatter be reconfigured, a process that blocks data collection for several seconds. Peck and Clark have proposed a change to the firmware which will turn the roll off for 1 or more 2 second intervals beginning at an even second, and without blocking data collection.

The change requires that the firmware command the roll configuration every 2 seconds, so that all barrel roll modes begin a cycle at the even second epoch. A two second period was selected over 1 second because one of the barrel roll modes takes 2 seconds to complete a cycle.

Advantages: The proposal requires only firmware changes to the formatter. The formatter will not need to reconfigure so that data are not blocked from the recorder. The barrel roll need be turned off for only 2 seconds for a fringe check, since the 4 Mbit RAM on the Data Buffer Module will fill up during that time.

Disadvantages: Since there currently is no information in the data frames on whether or not the barrel roll is on, fringe checks will have to be recorded in the log, and the location of the fringe checks reconstructed from the log during correlation to take the 2 second barrel roll interruption into account. There are 2 digits available that can be used in the VLBA format to indicate the state of the barrel roll.

This solution does not speed up the data transfer rate from Data Buffer Module to the Station Computer.

Proposed Solution for Barrel Roll and Data Transfer Rate Problems.

Design and construct a module that performs the current functions of the Data Buffer Module, but extracts the data prior to the formatter. RAM data would be passed directly to the Station Computer via a high speed fiber optic serial data link. Control could be via the link or an MCB connection. The module would be located in the D-Rack in the space next to the existing Output Rate Synthesizer; there is no room for additional triple-high modules in the formatter. Data would pass from the Samplers to the new module, and then on to the formatter. RAM write timing would be derived from the Station 1PPS.

Advantages: The proposal kills two birds with one stone -- increases the transfer rate of data to station computer from the current 30 minutes to 1 minute or less and permits the fringe check independent of the formatter. No changes to formatter hardware and firmware are required. There is no need to keep track of sample rate since the data has not yet been framed. The current diagnostic capabilities of the Data Buffer module would

remain unchanged. In the event of failure, the new module could be bypassed by reconnecting the sampler directly to the formatter.

Disadvantages: The module would require design and construction at a materials cost of \$2500. It uses up precious space in the D-Rack, and adds a cabling complication. The design requires procurement of a serial port for the Station Computer end at a cost of \$1000. It is a change that non-NRAO formatter users may wish not to emulate, resulting in non-standard formatter applications.

Other Solutions:

The following proposals eliminate barrel roll from Data Buffer module data, but do not address the problem with the data transfer rate, and for that reason are not recommended.

1. Move barrel roll to the Tape Transport.

Advantages: No changes required to formatter.

Disadvantages: Since there is no room on the VME Write Module in the tape recorder, a new VME module would have to be designed, built and added. Currently, an ID stamp before and after the formatter barrel roll provides a means of identifying channels and tracks; this capability would be lost if the barrel roll were moved to the transport. Data transfer rate problems are not addressed. The cost of a new module would be about \$2500.

2. De-roll the data tracks to the Data Buffer Module.

De-roll could be added to the Data Buffer Module by bringing the barrel roll control signals from the Timing and Control Module to the Data Buffer Module and using the control signals to reverse the roll switching. To do this, all 32 data tracks would have to be brought to the Data Buffer Module from the Transport Driver Module to have room for the circuitry involved. Selection of tracks for the fringe check would be done on the Data Buffer Module instead of the Transport Driver Board. Note: de-roll cannot be done in Station Computer software because only 4 tracks or less are available at any one time to the Data Buffer RAM.

Advantages: Barrel roll would be completely transparent to the Station Computer. The materials cost would be under \$1000.

Disadvantages: Three formatter modules, the formatter back plane, and the formatter firmware would require modification. Data transfer rate problems are not addressed. It is a change that non-NRAO formatter users may wish not to emulate, resulting in non-standard formatter applications.

3. Extract data from formatter prior to barrel roll. There are two different places the data could be extracted:

a. On the Header Control module after the data frame is formed so that the timing design of the existing Data Buffer module would be preserved. The barrel roll, CRCC insertion, and parity insertion would be eliminated from the data received by the Data Buffer Module.

b. On the Digital Switch module before the data frame is formed. The timing design of the Data Buffer module would have to be redesigned to provide RAM write timing derived directly from the Station 1PPS.

Advantages: The materials cost would be under \$1000.

Disadvantages: To keep from losing the diagnostic property of SPAN to check full formatter operation, the change would require a multiplexer on the Data Buffer module to select between fringe test data and formatter test data. The fringe test data would be extracted from the data stream in front of the barrel roll while the formatter test data would be extracted from the Transport Driver module. Three formatter modules, the formatter backplane, and formatter firmware would all require revision. Data rate transfer problems are not addressed.

Conclusion:

Use of the interim solution for a year or two will help better define the problem and possibly lead to solutions less messy than those proposed. There does not appear to be any "quick fix."