VLBA Acquisition Memo # 012

DATA TRANSMISSION ERROR SPECIFICATION

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Introduction

VLBA data will usually be transmitted to the correlator by means of magnetic tape recordings. In some cases, it may also pass through a radio link or fiber optic cable. In the future, recorded data may use a medium other than tape. In all cases, a specification on the allowable errors in the transmission is needed. The recorder chapter of Volume III of the VLBA proposal, and the formal proposal from Haystack Observatory to NRAO on construction of the recording system, both give the following specifications:

Parity error rate	$< 10^{-4}$
Sync error rate	< 2 per minute.

Such specifications are meaningless except in the context of a particular parity checking scheme and a particular synchronization scheme. Since both of these may vary depending on the type of transmission system and its design (and since they are not yet chosen for either of the two possible tape systems), we require a specification which is better defined and more general.

Definitions

In general, the digitizers will provide sampled data for C signal channels. These will be transmitted using T transmission channels; the latter will be known as TRACKS, which is descriptive of tape transmission. C and T may or may not be equal.

Each track must include a means of maintaining time synchronization. The details of this will not be specified here, but we will assume that it includes inserting a SYNC WORD periodically; the data between sync words will be called a SYNC BLOCK.

The receiver of the transmission system (playback machine for tapes) must predict the expected time of each sync word, and must attempt to detect each sync word. If a sync word is detected at other than the expected time, then a SYNC ERROR is said to exist; the sync error is in effect from the time of the preceding correctly detected sync word. Complete failure to detect a sync word may also create a sync error; alternatively, if the receiver has sufficient buffering, it may defer this decision until the next predicted sync word.

The transmission system may include means of error detection and/or error correction, if these are necessary to ensure that the specifications are met. We assume that any error correction is internal to the transmission system, and the specifications apply after all available corrections have been made. If error detection is implemented, then detection of an error means that one or more bits of a group contains an uncorrectable error. We assume that error detection is possible only over groups of bits of a fixed length, and such a group will be called an ERROR BLOCK. In some implementations, it may be advantageous to distribute error blocks among tracks; this is not excluded.

We assume that the correlator will ignore (blank) all samples coming from sync blocks for which a sync error is in effect, and will also ignore all samples from error blocks for which an error has been detected. (Note that sync blocks and error blocks may contain non-contiguous samples from more than one signal channel.)

If an error is detected and the error block contains a sync word, then it is NOT true that a sync error is automatically generated. An attempt should nevertheless be made to detect the sync word, since it may contain sufficient redundancy to be detectable in the presence of errors.

Specifications

1.	Detected errors: fraction of error blocks	$< 2 \times 10^{-3}$
2.	Undetected errors: fraction of data bits	$< 1 \times 10^{-5}$
3.	Sync errors: fraction of sync blocks	$< 8 \times 10^{-3}$
4.	Sync failures: fraction of data bits for which no sync error exists, but which are not being received at the correct times	$< 1 \times 10^{-5}$
5.	Maximum size of an error block or a sync block divided by sampling rate	80 msec

Discussion

Specifications 1 and 3 determine how much of the data we are willing to discard, namely 1%. In order to be sure that we discard most of the bad data, we are willing to discard some good data too. Failures which discard good data are included in items 1 and 3.

An easy way to meet specification 1 is not to include any error detection. Normally, this will increase the rate of undetected errors, but that is acceptable if the error rate is sufficiently low to satisfy item 2.

The sync error rate is allowed to be fairly high in order to permit a conservative implementation which throws away data for which synchronization is in doubt.

Specifications 2 and 4 determine how much bad data we are willing to process. This is kept quite small, because it will cause an uncorrectable calibration error rather than just an increase in noise.

Specification 5 prevents discarding blocks so large that sampling in the spatial frequency plane is impaired.

When a sync error occurs, it always affects the immediately preceding sync block, but may also affect earlier sync blocks, depending on when the last correct sync word was detected. If a sync word is detected at the wrong time, it is in principle possible to re-synchronize the data bits immediately; if this is done, then the next sync word will occur at the correct time, in which case all bits of the last sync block will be assumed correct. However, immediate re-synchronization is not required; in that case, the next sync word will not be found at the correct time and the sync error will persist for more than one sync block. If the design allows for re-synchronization in the middle of a sync block, then the incorrectly synchronized bits in the first part of the sync block will contribute to the sync failure rate of specification 4.