Network Coordinator Report

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Abstract

This report summarizes the activities of the IVS Network Coordinator for 2001. It includes an assessment of the network performance in terms of the yield of usable data over a 12 month period. A discussion of a growing problem for geodesy, RFI, is presented. A brief report on the stability if the UTC measurement time-tags based on six months of data is presented.

1. Network Performance

The network coordinator maintains a "station performance database", which contains a wealth of information about station performance and problems. It includes all reports of problems from correlator pre-passes, correlation reports, analysts, and stations as well as a history of inquires made about resolving problems. It was started in May of 2001 and includes all reports since then. There are no analyst reports except for occasional e-mails about problems processing certain sessions.

It was decided to base assessment of station performance on the correlator reports, since they formed the most reliable, albeit not necessarily the most timely, reports of monitoring station performance. (Within the database, the issue of timely response is addressed by the station and correlator pre-pass reports.) The coverage of sessions in the correlator reports is somewhat spotty due to delays in processing sessions, the unevenness of the delays, and problems related to the start up of the Mark IV correlators. In order to provide a reliable annual period for year to year comparisons, yearly reports will be based on data from November through October. The rationale for this is that at the time of preparation of the Annual Report, the last month for which data have been fully processed is the preceding October. If in the future, processing time improves, the interval may be adjusted to run from December to November.

At the time of this writing, for data acquired during the November 2000 to October 2001 interval, correlator reports for 126 sessions had been received. This leaves six experiments, mostly from early in the year, that have not been processed. These totals exclude Syowa and domestic Japanese experiments, for which no correlator reports have been received to date. There are 757 station days (one day per station in each experiment), or about six stations per experiment on average.

Any assessment of station performance is somewhat arbitrary, but the following approach was used. For each station in each session an estimate is made of the fraction of data lost. Each station day was then assigned to one of the following categories: (A) No loss (0% lost), (B) Slight Loss (1-6% lost), (C) Moderate Loss (7-20% lost), Severe Loss (21-70% lost), and (F) Failed (71-100% lost). Again these categories are somewhat arbitrary. The divide between slight and moderate loss was set so that loss of one channel (7%) was considered moderate. Consequently, the slight category includes mostly some RFI, and short losses, up to a little less than 90 minutes. The divide between moderate and severe was set so that loss of three channels (21%) would be severe. This means that the loss of two channels or gaps of up to about 5 hours would be considered moderate. Severe loss includes loss of three channels or more, operation with a warm receiver, long gaps, and other severe problems. Failure includes any cases where the data from the station are not

Table 1. Loss Distribution

	2001	2000 (partial)
Station Days	**757**	**382**
Grade (Loss)	**Percentage**	**Percentage**
A - No Loss (0%)	41	51
B - Slight Loss (1-6%)	25	18
C - Moderate Loss (7-20%)	21	16
D - Severe Loss (21-70%)	6	8
F - Failure (71-100%)	6	7

useful for geodesy. The definitions of these categories will probably undergo some refinements in the future. The losses for 2001 and part of 2000 are given in Table 1.

For the 2001 period, the integrated data lost corresponds to 88.1 station days or about 11.6%. This compares to loss of about 11.8% for the 223 sessions contained in the entire database, which includes both the (partial) 2000 and 2001 year results and a few experiments from after October 2001. The results from 2001 do not seem out of line with the overall average. However, there was considerable variation from quarter to quarter. Please see Table 2 for a breakdown by quarters for 2001 and part of 2000. There is a hint of a trend that as the number of station days increased toward the end of 2001 there was also a higher rate of loss. This reflects some serious problems that occurred at the end of 2001.

The losses per station are given in Table 3 for stations that had more than six sessions in 2001. These results are probably reasonably accurate at the 5-10% level. The results are sorted by increasing percentage of lost data. Please note that Seshan did not have sufficient sessions in 2000 for the results to be considered meaningful. Please see Table 4 for results for stations that had too few sessions, six or less, for the results to be considered meaningful. This table is sorted first by decreasing number of station days and then by increasing percentage lost.

Table 2. Quarterly Data Lost

Quarter	Percentage lost	Station Days
Nov 99-Jan 00 (partial)	6.5	54
Feb 00-Apr 00 (partial)	8.0	61
May 00-Jul 00 (partial)	11.8	87
Aug 00-Oct 00	14.1	180
Nov 00-Jan 01	13.4	167
Feb 01-Apr 01	7.2	173
May 01-Jul 01	12.2	203
Aug 01-Oct 01	13.3	214

There were several problems that contributed to data being lost in 2001. The most significant of these are (not necessarily in order of significance): (1) RFI, (2) Gilcreek antenna and RX problems, (3) Matera azimuth motor, encoder and RX, (4) Hobart's headstack was decaying, (5) clock offsets, both jumps and incorrectly set time, and (6) Ny-Ålesund antenna and RX problems.

Table 3. 2001 Station Losses

Station	Sessions	Lost	Percent	2000	Problem in 2001
Kokee	87	1.7	1.9	6.0%	antenna, overwriting
Wettzell	100	3.8	3.8	3.6%	clock, antenna control, ops, RX
HartRAO	39	1.6	4.1	6.8%	pointing?
Westford	64	5.0	7.9	2.3%	maser, RFI, antenna
Tsukuba	24	2.0	8.2	2.3%	schedule error, typhoon
Foraleza	65	5.4	8.3	18.1%	ops, cryo, power, record quality, missed
Ny-Ålesund	68	6.0	8.9	5.9%	antenna, dewar, 5 MHz, overwriting
Medicina	27	2.7	10.2	12.8%	RFI
Gilcreek	90	14.2	15.8	13.5%	antenna, cryo
Seshan	14	2.2	15.8		X roll-off, BBC6, antenna
Onsala	26	4.1	15.9	3.2%	recorder, ops
Algonquin	57	10.1	17.8	9.6%	RFI, clock offsets, clock jumps, telescope
Hobart	11	3.1	28.3	19.2%	antenna, headstack
Matera	35	10.3	29.4	5.2%	antenna, RFI
Yellowknife	12	4.9	41.2	20.2%	lightening, clock offsets, antenna, recorder

Table 4. 2001 Station Data Loss - small n

Station	Sessions	Lost	Percent	Problem in 2001
Crimea	6	1.4	24.1	no fringes, bad track
Urumqi	6	2.6	44.1	record quality, pointing, missed
Yebes	6	4.2	70.1	formatter, record quality, RX, lightening
DSS65	5	0.3	6.0	focus, RFI
Noto	4	0.2	4.4	up-converter, formatter test
DSS15	3	0.9	28.6	misc, vacuum
TIGO	2	0.1	4.0	RX temp control
MV-3	2	0.1	6.1	record quality
DSS45	2	0.1	7.1	bad track, bad channel
Effelsburg	1	0.1	10.0	wind, formatter test
O'Higgins	1	0.8	79.2	technical problems

The station performance in terms of data lost are all referenced to the equivalent observing time lost at a station. However since a station appears in more than one baseline, this does not reflect the overall loss in data for the session. To estimate the overall fraction of data lost, consider that in an n station experiment, each baseline would, as an approximation, have equal numbers of measurements. If we consider the loss at a single station, the overall loss for an experiment would be the percentage loss at the station, p, times the number of baseline affected, $n-1$, divided by the number of total baselines $\frac{n(n-1)}{2}$ which gives $\frac{p(n-1)}{\frac{n(n-1)}{2}}$ which simplifies to

$$\frac{2p}{n}$$

If we assign the average overall loss of data to all stations in all experiments, and if we can assume that the average data losses at all the stations are approximately independent, this result is just multiplied by the number of stations n to give the average data yield or $2p$. This result is an approximation subject to the conditions given above: (1) the data distribution by baseline is roughly equal and (2) that the losses at different stations are independent. The latter assumption is most accurate when the losses are small. It tends to over-estimate the average loss as the losses become less independent, as they do when they are large. In any event for the overall average data lost per station we see 12%, thus the overall average data loss per session is about 24%. Statistics on this quantity will be kept by experiment in the future.

2. RFI

Radio frequency interference (RFI) is a significant and growing problem, particularly at S-band. Direct satellite broadcast of music radio started in North America. The DARS (Digital Audio Radio Service) band is 2320-2345 MHz. This is particularly a problem for Westford and Algonquin. There continue to be problems with point-to-point communication links in the S-band bandpass for Europe. This is particularly bad at Matera, but other European stations, particularly Medicina, are suffering from S-band RFI as well. A new international cellular telephone standard, IMT-2000, which occupies 2135-2150 MHz is now making an appearance in Japan and impacting Tsukuba and Kashima. At Tsukuba the problem is particularly severe because for some antenna orientations, the S-band front-end is saturating. Since IMT-2000 is an international standard this might also become a problem for other locations. For the stations that are impacted this is causing a 5-20% data loss. The RFI triggers correlator "G" codes which cause scans to be rejected because the fringe amplitudes vary too much between the channels. Ironically because of the way G codes are assigned, stronger scans tend to be deleted preferentially even though weaker scans may be as strongly affected. Unless the scan is strong, it is difficult to determine if a G code is warranted. Some consideration is being given to refining the definition of G codes to make them more useful and reduce the data loss. In any event, in the long run, we can expect the RFI situation to get worse.

3. Clock Offsets

One of the goals stated in the IVS Working Group 2 report is to measure UT1-UTC to an accuracy of about 2-3 μseconds. There is some question whether this is achievable with our current level of clock offset measurement. Any errors in the UTC time-tags of the observations are mapped directly into the estimate of UT1-UTC. The correlators construct the time tags by adding an offset to the measurements made at the stations of the differences between the formatter and the GPS system. The offset applied by the correlator corresponds roughly to the cable delay between the data recording system in the control room (the "back-end") and the receiver on the telescope (the "front-end"). One would expect that these offsets should be stable to much better than a microsecond, which corresponds to a cable length of about 300 meters. This is much larger than any expected cable variation at the station. After collecting the value of the offset from experiments over an approximately six month period, some problems have come to light at the few μsecond level: (1) different correlators use different offsets for a given station, (2) the offsets for a station at a correlator may vary significantly, sometime in a noise-like way and sometimes systematically, (3) the Washington correlator has artificially set the offset for Kokee to zero. The latter point is not so significant when examining the evaluation of UT1-UTC, but it may cause a few hundred nano-second error in the alignment of the reference frames. A plot of the correlator offsets or "adjustments" to the formatter-to-GPS differences for Algonquin are shown in Figure 1. The offsets for different correlators are shown with different symbols. Some of the previously mentioned problems are evident here. For the approximately six month period for which data is available: (1) the three correlators have used different offsets for data acquired at about the same time, (2) there is a 5 microsecond in 6 month trend and approximately 1 microsecond level of jitter in the values used by WACO, and (3) Haystack has been using an offset of zero. These problems will be investigated further in the coming months. Examination of the clock rate stability is also needed to evaluate the accuracy of LOD data.

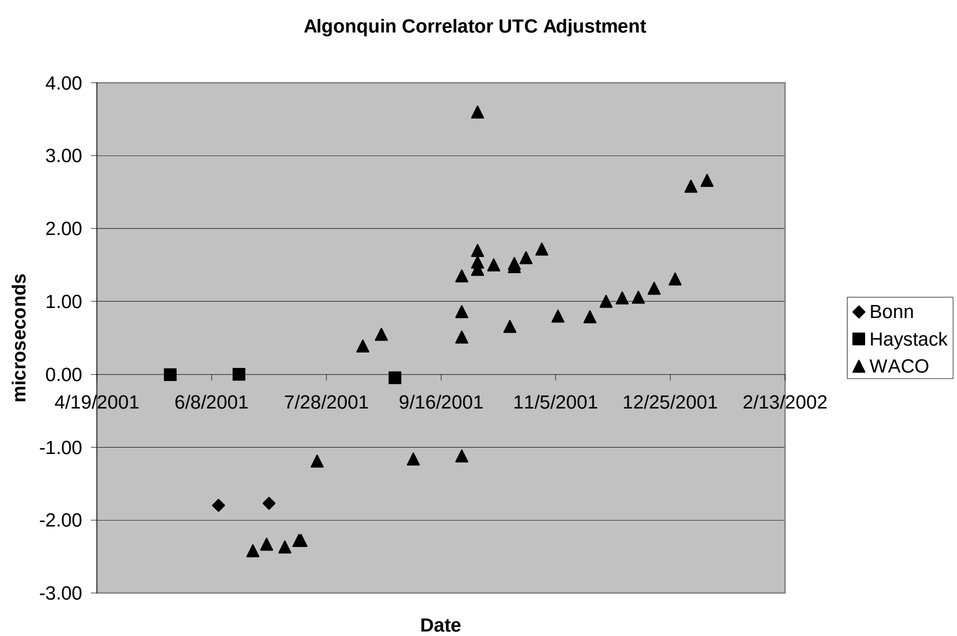

Figure 1. **Algonquin Correlator UTC Adjustment**