System Performance Monitoring 2000

By Van S. Husson, Allied Signal Technical Services Corporation, NASA SLR

Abstract: There is now a wealth of information available from the global analyst centers, via the internet, to assist stations in evaluating their own performance. This information coupled with proper onsite performance monitoring should enable stations to quickly identify problems at the sub-system level. The goal in system performance monitoring should be to determine the cause of suspected problem data as soon as possible to prevent more problem data from being taken. Also, this will greatly assist the analysts, because they can concentrate their efforts on doing science versus figuring out how to deal with the problem data. In the rest of this paper, we will discuss what station performance parameters should be routinely monitored, where to find station evaluation information (e.g. range and time bias information), and how to narrow the search of the cause of a data problem.

1. What should be routinely monitored?

Many system performance parameters (i.e. satellite RMS, calibration RMS, system delay, barometric pressure, station clock offsets, return rates, percentage of rejections after data fitting, etc.) should be available in near real time at the station or it's operations center (wherever the normal points are produced). This should be the first line of defense in station quality control. The second line of defense in station quality control is the ILRS analysis and associate analysis centers. Some analysis centers provide routine time and range bias information using simultaneous, short, and long arc analysis.

The secret in system performance monitoring is to aggregate the evaluation parameters versus time (i.e. graph all performance statistics vs time in a scatter chart). Some parameters can be displayed on the same chart (e.g. satellite RMS and calibration RMS should be displayed on the same chart). Another aggregation technique that has proven useful is to produce running averages of each performance parameter. After you have generated these charts identify any obvious outliers first and investigate the reason and eliminate the cause if possible, because this problem will probably occur again. Next examine any trends you see in the data and try to determine the cause. If the performance appears stable, establish control limits so that in the future you can automatically flag potential problem data without any manual intervention.

Accurate record keeping is also a pre-requisite for monitoring your performance. (e.g. Configuration changes; equipment repair/tweaking; sub-system calibration results; data processing algorithms/constants changes need to be well documented.) Below in Figure 1 is a scatter chart showing a system's long term trend analysis of satellite and calibration RMS's along with a footnote when a configuration change was made to the system.

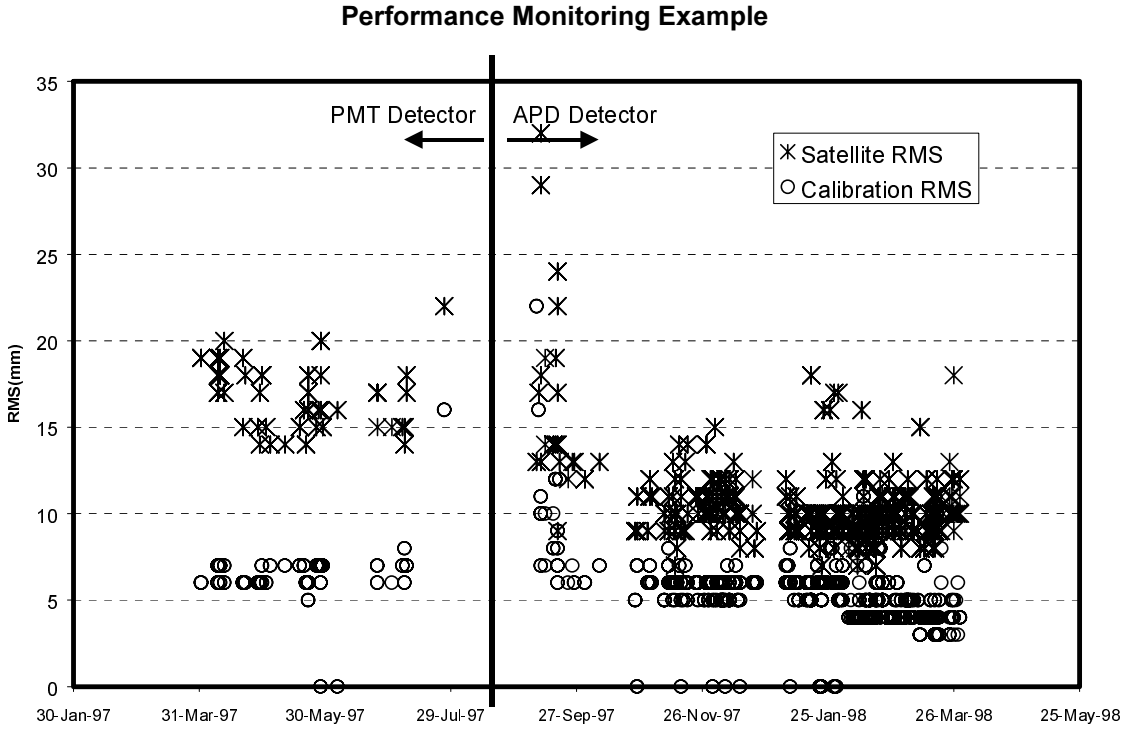

Figure 1 - Long term trend analysis

2. Where to find performance analysis information?

Currently, four analysis centers (Herstmonceux SLR Group, Center for Space Research, University of Delft, and the Moscow Control Center) provide weekly or daily LAGEOS quality control, with their results distributed via email or the World Wide Web (WWW). In addition, the Center of Orbit Determination in Europe provides daily GPS range and time bias information from SLR passes via email and the WWW. Three other analyst centers, Communications Research Laboratory (CRL), NASA/GSFC and OCA-CERGA Topex/Poseidon Precision Orbit Determination, provide monthly or ten day arc analysis results via the WWW. CRL provide monthly range and time bias information on LAGEOS and Ajisai. The Global Performance Report Card is produced once per quarter by NASA/ATSC is also is available via the Web. The URL for these performance results are all hyperlinked from the ILRS Analysis Reports Web Page at **Fehler! Textmarke nicht definiert.**. As more analysis centers put their results on-line, their hyperlinks will be added to the ILRS Analysis Reports Web Page.

3. How to narrow the search of a bias problem?

The analysis centers listed above report on pass-by-pass and/or aggregate range and time biases. Range and time biases are induced by one of different 3 ways. Either there is:

1) an error in the analysis (e.g. the wrong station position is used, the wrong wavelength is applied, the wrong retro-reflector array correction is applied, etc.)

2) an error in your supporting information or normal point processing (e.g. the eccentricities are wrong, the calibration distance is in error, the data processing algorithms have failed, the data processing constant(s) used have a clerical error, etc.)

3) an error in your system calibration; malfunctioning equipment; or improper equipment settings (e.g. an uncalibrated barometer, an operator error, clock frequency on internal, loose or broken connectors, calibration and satellite data taken with different parameters, etc.)

Below are simplified manifestations of the potential errors listed above: (Obviously if there is more than one error source, determining the root cause of the problem becomes much more difficult.)

1) Fixed range bias – The most likely potential causes are an error in station height by the analyst center(s), a clerical error in the data processing algorithms, a survey error to the calibration target, satellite data and calibration data taken consistently at different equipment settings, or a barometric error.

2) Variable range bias – The most likely causes are calibration procedures that are not consistent from pass-to-pass, frequent configuration changes, malfunctioning equipment, or an error in station position by the analyst centers.

3) Satellite dependent range bias – The most likely causes are the frequency used in the time-of-flight device is internal frequency; an error in the retro-reflector array correction; or different analysis centers are using different wavelength information or different station positions.

4) Fixed time bias – The most likely causes are an unmodeled clock error in the data processing or a clerical error in the data processing.

5) Variable time bias – The most likely cause is an unmodeled drifting station clock. If the time bias is satellite dependent see the next item.

6) Satellite dependent time bias – The most likely cause is an error in the station position used by the analyst center(s).

4. Conclusions

Hopefully, this paper has provided some insight into what is required to improve station quality control with the ultimate goal of expediting the resolution of range and time

biases. This paper will be used as a starting point in the development of an analysis knowledge base that will be placed on the ILRS Web Site.