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Performance of the Kalman Filter of the Global Positioning System Operational Control Segment During January - March 1997*

Marc Weiss, Audrey Zarr
National Institute of Standards and Technology
Time and Frequency Division
325 Broadway, Boulder, CO 80303

Abstract

We characterize the errors in the broadcast estimates of the Global Positioning System's satellite ephemeris and clock states made by the Operational Control Segment's (OCS) Kalman filter over the period when the system ephemeris Q's were changed. This change was called the Ephemeris Enhancement Endeavor (EEE). We report on the accuracy, stability, and periodic variations of the GPS Kalman filter's estimates of satellite clocks and ephemerides, particularly how they changed with EEE. Root-sum-squared (RSS) ephemeris error variations decreased by a factor of 1.7. The amplitude of the 2 cycle/d component decreased by a factor of 2.2. While the 2 cycle/d periodic effects dropped from 0.65 to 0.49 of the RSS ephemeris error, they still seem to be a major component. Radial ephemeris errors appear to be negatively biased by about 1 m. This bias is unchanged by EEE. Error deviations are generally no more than SV clock stabilities — the Kalman filter Q's are generally good. Clock estimate errors are worse than ephemeris errors — there may still be some room for improvement. Broadcast ephemeris errors add diurnal variations to the GPS time offset from the U. S. Naval Observatory Master Clock (USNO MC). GPS - USNO MC variations for averaging times near 1 d are consistent with White PM, averaging down to 1.5 ns at 1 d with 48 points/d. GPS - USNO MC appears to have periodic variations with periodicity spread approximately over periods from 16 to 24 d and a total amplitude of up to 4.5 ns.

INTRODUCTION

This report characterizes the performance of the ephemeris and clock parameters as broadcast from the Global Positioning System satellite vehicles (SVs) [1] during the first three months of 1997. During this period a change was made to refine the way these parameters are estimated by the Operational Control Segment's

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