Real Time Analytical Dynamic Orbit Determination of Geostationary Satellite for National Time Synchronization Service

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A real time analytical orbit determination method has been developed for precision national time synchronization. The one-way time transfer technique via a geostationary TV satellite standard time and frequency signal (STFS) dissemination system was considered. The differential method was also applied for mitigating errors in geostationary satellite STFS dissemination system. Analytical dynamic orbit determination with extended Kalman filter (EKF) was implemented to improve differential mode STFS (DSTFS) service accuracy by acquiring better accuracy of a geostationary satellite position. The perturbation force models applied for satellite dynamics include the geopotential perturbation up to fifth degree and order harmonics, luni-solar perturbations, and solar radiation pressure. All of the perturbation effects were analyzed by secular, short, and long period variations for equinoctial orbit elements such as semi-major axis, eccentricity vector, inclination vector, and mean right ascension of the geostationary satellite. The reference stations for orbit determination were composed of four calibrated stations. Simulations were performed to evaluate the performance of real time analytical orbit determination in Korea. The simulation results demonstrated that it is possible to determine real time position of geostationary satellite with the accuracy of 300 m root mean square (RMS). This performance implies that the time accuracy is better than 25 ns in all over Korean peninsula. The real time analytical orbit determination method developed in this research can provide a reliable, extremely high accurate time synchronization service through setting up domestic-only benchmarks.