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Modelling of GPS- and GLONASS satellite clocks

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The accurate and reliable prediction of satellite clocks and orbits is an indispensable condition of all GNSS based positioning applications in real time. While the orbits are output to an integration of the well-known force field the clock corrections to GPS Time have to be extrapolated by means of an experienced prediction model.

A new model for predicting GPS and GLONASS satellite clocks has been developed at the Institute of Geodesy and Geophysics at the TU Vienna. For the extrapolation of GPS satellite clocks we use the observed part of the IGS Ultra Rapid solutions, which are provided by the IGS (International GPS Service) since November 2000. A history of 48 hours is used as input data to a least squares adjustment to determine satellite specific coefficients of a polynomial of second order. Moreover, depending on the clock behaviour (caesium or rubidium), cyclic terms are added to predict the satellite clock values over the upcoming 12 up to 24 hours. A special problem to account for is the clock jump at the boundary of consecutive IGU solutions. This presentation will introduce the applied prediction models. Afterwards the predictions are compared to the IGS Rapid solutions. The quality of the clock predictions is usually at the sub-nanosecond level over the upcoming 6 hours and at the 3 ns level over a 12 hours period. Because of the availability of the IGS Ultra Rapid solutions 4 times a day (02:00, 08:00, 14:00, and 20:00 UT) a continuous coverage of high quality predictions is feasible. A second quality check was performed by utilizing the extrapolated clock correction as input data to Precise Point Positioning solving for the coordinates of various reference sites in kinematic mode.

Since the European GALILEO satellite system will use rubidium clocks of comparable type it would be possible to estimate GALILEO clock predictions with the same

prediction model as described above.

Finally, an attempt to extrapolate highly accurate clock correction of the GLONASS satellites was launched. Currently the IGS does not provide precise GLONASS clock and orbit information within the IGU product. This situation might change with February 2005. To apply a procedure similar to the GPS clock prediction the post-processed GLONASS clock solutions of ESA (European Space Agency) were used as input data. Again satellite specific model coefficients were calculated and the accuracy of the prediction was assessed against the ESA final solutions. The quality is slightly worse as for the GPS predictions. GLONASS clocks-offsets to GPS-Time can be extrapolated at the 10 ns level over interval of 6 hours. Over larger intervals the rms of the difference between prediction and observations increases with an approximately quadratic behaviour.