Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES
Näher dran.

Theoretical Investigations and Practical Studies using of High Rate Satellite Orbit & Clocks Estimation by Bernese Software for Real-time PPP Applications

Introduction

The OPPP techniques used in the navigation field require the use of precise orbit files in SP3 format in order to perform the coordinate computation. As a result, the Internet connection becomes a restriction, since the software is downloading real-time precise orbit data to compute the coordinates. The accuracy of the computation depends on the positioning mode (PPP-Static or PPP-Kinematic) and in the IGS SP3 product used for the computation. In this thesis, the influence of the SP3 interval (precise orbit recomputation) has been evaluated.

As a second step, in order to avoid the necessity of being permanently online, the orbit prediction (Clock parameters and ERP parameters) becomes another matter to analyze in this thesis (PPP). Therefore, it was also necessary to evaluate the accuracy of the different predicted orbits in order to find the best configuration for every navigation situation.

To perform the orbit & clock parameter estimation, *Bernese GNSS Software v.5.2* was used (more specifically ORBGEN program). Then, to analyze the accuracy of the SP3 files obtained in the PPP-Static and PPP-Kinematic modes, RTKLIB open source software package was used.

Orbit recomputation

The goal of this section was to be able to determine an arc of orbit with the best accuracy possible, in order to be able to export high-rate Orbit & Clock parameters with only one second of interval. Applying this new high-rate SP3 files in PPP-Static and PPP-Kinematic the accuracy of the system increases considerably (e.g. in GPS Satellite 1: Real-time orbit files differ from Final orbits an average of 0,014m while the predicted from Ultra-rapid orbits differ an average of 0,069 m, and the clock parameters differ an average of 14µm in the case of Real-time and 4µm in the case of predicted orbits from Ultra-rapid products).

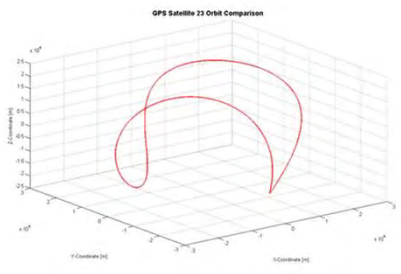

Figure 1. *GPS Satellite 23 Orbit*

Orbit Prediction

Since the Internet connection is an important restriction in autonomous car navigation situations, it is very important to be able to extrapolate an arc of orbit with some time in advance (and Earth Rotation Parameters). This time depends on the latencies of the different IGS products available. In this case Predicted orbits were obtained out of Ultra-rapid and Rapid products.

Hochschule Karlsruhe – Technik und Wirtschaft
Fakultät IMM • Studiengang Geomatics
http://www.hs-karlsruhe.de
Bearbeiter: Nicolas Garcia Fernandez
E-Mail Adresse: nicomtb@hotmail.com
Betreuer: Prof. Dr.-Ing Reiner Jäger
M. Sc. Hoscislawski

Orbit & Clock parameter comparison

The importance of comparing the results obtained with a reference (Final product used as "true" position of the satellites) is very important in order to know which orbit to use in each situation (e.g. the predicted orbit coordinates differ an average of around 7 cm while Real-time orbits only differ an average of 1,8 cm, and regarding Clock parameters, the predicted orbits differ from the Final orbits around 10µm while Real-time around 15µm).

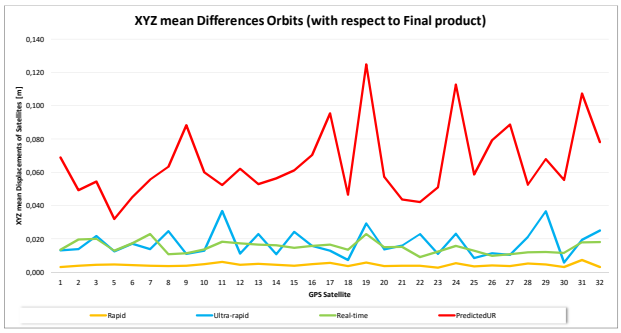

Figure 2. *Differences of obtained Orbit coordinates with respect to Final*

PPP Computation: Results

For autonomous car navigation, the most important results to analyze are the ones obtained out of PPP-Kinematic mode computation with predicted orbits out of Ultra-rapid products (short prediction).

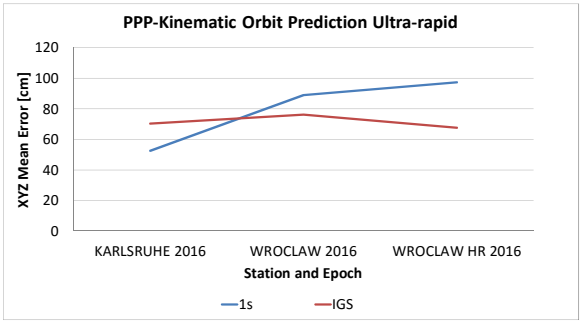

Figure 3. *XYZ mean Error. Predicted Ultra-rapid orbit VS IGS rapid product*

Conclusions

- In the navigation situation, in which it is not possible to connect with a WLAN network, it will be necessary to predict an orbit out of Ultra-rapid products.
- In the case of being able to connect to the internet, Real-time SP3 files are more accurate than any predicted orbits.
- In the case of post processing, the Final SP3 files are the best results for the coordinate computation (non-recomputed).
- The recomputation of the precise orbit files (precise orbit file generation with short interval) has a positive effect in the PPP-Kinematic computation. Therefore, physical reestimation becomes a new step in the methodology in order to get the best accuracy in autonomous car navigation.