Objective

Very Long Baseline Interferometry (VLBI) is one of the most relevant geodetic space techniques for determining station positions in the terrestrial reference system and Earth orientation parameters (EOP). Furthermore, it is the only technique capable of estimating the positions of extra-terrestrial objects in the celestial reference system. VLBI is based on radio telescopes measuring micro-waves emitted from quasi-stellar radio sources (quasars), whose distances from the Earth amount to billions of light-years. When two telescopes are observing the same quasar simultaneously, it is possible to estimate the length of the baseline between the two devices by measuring the difference of the signal’s arriving times (Figure 1).

The corresponding mathematical model is based on both simple geometry and rather sophisticated geophysical and even relativistic effects (see Sovers et al. [1998]). The model parameters are either fixed to a-priori values or estimated by the well-known Gauss-Markov least-squares adjustment approach (see, e.g., Koch [2004]). In the latter case, it is possible to derive a multitude of useful parameter information from VLBI experiments. A reliable estimation of these parameters is only possible if many radio telescopes are involved, and if these telescopes are distributed homogeneously around the Earth. Unfortunately, there are rather few such telescopes, and their locations are concentrated in the northern hemisphere (Figure 2). Furthermore, during a so-called VLBI “single session”, only a subset of devices is observing the quasars simultaneously, hence the distribution of telescopes is not optimal. An approach to improve this situation is to combine several single sessions in the parameter estimation process. This combination will be called a VLBI “multi session”, and the project at hand will study its potential for geodetic applications, especially the realization of reference systems and EOP.
VLBI Sessions
The layout and scheduling of (single) VLBI sessions is maintained by the International VLBI Service for Geodesy and Astrometry (IVS). In each session, certain VLBI stations (i.e. telescopes) are asked to observe a set of radio sources in a fixed order. The most prominent sessions are the “rapid turnaround” ones: IVS-R1 and IVS-R4 are supposed to provide fast EOP results and station coordinates twice a week. Here, a well-distributed set of telescopes is used, but there are also sessions with rather restricted networks of VLBI stations, like the “intensive” sessions (IVS-INT1 etc.), which consist of a single baseline (i.e. two stations) only.

We plan to identify those single sessions that are not yet usable for geodetic applications but can potentially contribute to the latter when being combined with other sessions. For this purpose, various combination strategies will be analyzed.

Tools and Focus
The DGFI-TUM has developed a proprietary software (“DOGS-RI”) for processing VLBI observations. It will be used and extended for conducting the research on multi sessions. As the station and source networks might differ significantly between the corresponding single sessions, the main focus will be on the estimation of EOP, which are relevant for all experiments. The latter are necessary for transferring coordinates from terrestrial to celestial reference systems and form a crucial part of the functional models of the other geodetic space techniques.

References