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Precise orbit determination of LEO satellites from onboard GPS tracking data

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Precise orbit determination is an essential part of precise gravity field missions such as CHAMP (CHAllenging Mini-satellite Payload) and GRACE (Gravity Recovery And Climate Experiment).

At National Institute of Information and Communications Technology (NICT; formerly known as Communications Research Laboratory) has developed its own analysis software package called 'concerto'. It was initially designed and used for the analysis of satellite laser ranging data, but it is extended to the analysis of GPS-LEO tracking data and accelerometer data both of which are obtained by the on-board instruments.

Given 4 or more GPS observation per epoch, the satellite position can be geometrically estimated at every epoch (kinematic method). Alternatively, like the traditional way of orbit determination, one set of six orbital elements (or more acceleration parameters) can be estimated from a certain time span (dynamic method). Acknowledging the advantage and disadvantage of the two method, we implemented these estimation sequences in the software 'concerto' and compared the solution each other and with the other institutes'.

From the analysis of the CHAMP satellite, we got the post-fit scatter of ionosphere-free carrier phase L3 data at 2 to 5 cm. The kinematic solutions occasionally show a huge deviation when the GPS geometry condition is not well arranged, whereas the dynamic solutions are smoother. The agreement with the orbits of other institutes is in the order of a few tens of centimeters.