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WIDE AREA REAL TIME KINEMATIC: A NEW AUGMENTATION CONCEPT TOWARDS THE DEFINITION OF A HIGH ACCURACY AND INTEGRITY SERVICE

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Summary: A High Precision Positioning Service based in the Wide Area RTK is presented in this work. The integrity and the benefits of the multiconstellation system are also discussed.

1 INTRODUCTION

The Wide Area Real Time Kinematic (WARTK) is a new concept of Augmentation System that is being assessed to provide a High Accuracy and Integrity Service over continental areas, using basically, the infrastructure of a network of ground monitor stations (such as the EGNOS RIMS over Europe); allowing, in this way, to get a double benefit of a SBAS infrastructure. This application is being developed in the context of ESA GNSS Evolution by the research Group of Astronomy and Geomatics (gAGE) from the Technical University of Catalunya (UPC), under several ESA and GSA contracts.

The main characteristic of WARTK is that any user, working with 2 or 3 frequencies, can achieve precise positioning, in few minutes, even up to hundreds of kilometers away from any reference receiver. Indeed, in previous gAGE/UPC works, such as the ESA founded project FES-WARTK, it was shown that a position error at the level of 10-cm (RMS) over Europe can be achieved using the EGNOS reference stations (RIMS) network, thanks to the use of very accurate ionospheric corrections computed in real-time by a Central Processing Facility (CPF). Further studies on accuracy and, mainly, on integrity are being done in the Multiconstellation Regional System (MRS) project, towards to the definition of a High Accuracy Service for Galileo.

Similarly, to other high precision strategies, WARTK uses the carrier phase measurements as main observable (unlike the SBAS systems that uses the pseudorange measurements) which is much more precise than the pseudorange. But, the carrier phase ambiguities can not be solved in a single epoch mode, being necessary to combine several epochs in a navigation filter. This fact difficults the traceability of the integrity, due to the propagation of the error through the filter. Several alternatives can be taken in order to provide integrity to WARTK:

- To fix all the ambiguities externally to the navigation filter (i.e. to remove the carrier phase ambiguities as additional unknowns). This would allow the navigation in single epoch mode (like with the pseudorange). But, with this approach the integrity would be linked to the probability of a wrong ambiguity value (mainly for the short wavelength ambiguities). Because of the differential ionospheric and tropospheric effects, this probability increases with the distance between receivers, in such a way that the ambiguities can be solved with a certain confidence level only up to few tens of kilometers, although using accurate ionospheric corrections a very important extension of the baseline (up to few hundreds of kilometers) is obtained.
- To fix only the long wavelength ambiguities (wide lane and extra wide lane), and to use accurate ionospheric corrections to remove the ionospheric refraction. In this case, these ambiguities can be solved with a high confidence level, allowing the navigation in single epoch mode. The integrity in this strategy is mainly linked to the quality of the ionospheric corrections and their predicted error standard deviations (sigmas).
- To use the navigation filter to estimate both position and ambiguities, with the help of accurate ionospheric corrections and sigmas. In this case, the ambiguities can be constrained (instead of being fixed), diminishing the effect of a wrong fixed value. The problem with this approach is the already mentioned traceability of the integrity. In this way, additional inflating factors of the formal errors must be introduced in order to assure the integrity.

In this work, an assessment of the performance of these 3 approaches is done. This assessment evaluates the key parameters of this high accuracy positioning service, such as accuracy, protection level, converge time and availability, by using representative datasets of actual GPS and simulated Galileo GNSS signals in several experiments.

The benefits of using a multiconstellation system against to the single GPS constellation is also discussed, according to the preliminary results obtained in the above-mentioned MRS project.

Results based on actual GPS data show that user domain integrity can be provided for typical baselines up to 400 Km. The 95th percentiles for the position error are at the level of 20 and 30 cm, respectively, and at about 2-3 meters for the Protection Levels, depending on the strategy. The convergence time is around 5 minutes with actual GPS constellation data, and few seconds with a multiconstellation (simulated GPS+Galileo data).