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The impact of precise inter-satellite ranges on relative precise orbit determination in a smart CubeSats constellation

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The use of CubeSats is expanding in space and earth science applications due to the low costs of building and the possibility of launching them in a large low-earth orbits (LEO) constellation. Such constellation can serve as an augmentation system for positioning, navigation and timing. However, real-time precise orbit determination (POD) is still one of the challenges for this application. Real-time reduced-dynamic POD requires more processing capability than what is available in current CubeSats, and the kinematic POD highly depends on the number and the quality of the signals from Global Navigation Satellite Systems (GNSS). In this study, an approach is proposed to increase the orbital accuracy by implementing the precise inter-satellite ranges in the Kinematic POD. The precise orbits of a set of CubeSats from the Spire Global constellation that are determined using the reduced-dynamic POD is to be used to generate the precise inter-satellite ranges. These ranges vary from hundreds to thousands of kilometres and are constrained in the relative kinematic POD between the tested CubeSats. The results, which depend on the length of the inter-satellite ranges, show the improvement of the orbital accuracy in all directions. An initial architecture for implementing such a method in a smart CubeSats constellation is proposed and the limitations and remedies are discussed.