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A METHOD FOR CALCULATING THE PROBABILITY DISTRIBUTION OF INTERFERENCE INVOLVING MEGA-CONSTELLATIONS

Abstract

In recent years, the mega-constellation programs represented by StarLink have been proposed successively. Mega-constellations compose of far more satellites than traditional constellations, which makes the problem of co-frequency interference between satellite constellations more prominent. The probability distribution of interference is used as a common evaluation indicator to describe inter-constellation interference, which can be usually obtained by extrapolating the satellite orbit position and calculating the occurrence time proportion of different interference values. Mega-constellations are large in scale and complicated in configuration. Therefore, the computation amount of extrapolation in the mega-constellation scenario will increase substantially, and common PC may not be able to handle the interference simulations. In addition, the extrapolation requires a long simulation period to obtain the occurrence probability of maximum interference value. To address these challenges, we propose a new method for calculating the probability distribution of interference between mega-constellations. For the satellite communication system whose operating mode and communication parameters have been determined, the interference value is only related to the position distribution of satellites in different constellations relative to the earth station. Hence, the probability distribution of inter-constellation interference value can be solved by deriving the probability of different constellations' satellites position relative to the earth station. On basis of this, we establish a system model of co-frequency interference between a traditional non-geostationary orbit (NGSO) constellation and a NGSO mega-constellation in the downlink case. In this scenario, we calculate the occurrence probability of different constellations in the visual field of earth station and the interference value between snapshots of different constellations in turn. Furthermore, we can use the joint probability of constellations' satellite distribution to evaluate the probability distribution of interference between mega-constellations. We consider two different types of constellations in the simulation, the former is the fixed beam with ground-oriented antenna and the latter is the dynamic spot beam with staring antenna. Simulation results demonstrate that the proposed method achieves the same accuracy as the traditional method with higher computation efficiency, and the occurrence probability of maximum interference value can be obtained deterministically, which is suitable for the interference evaluation involving mega-constellations.