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THE EFFECT ON THE ITERATIVE DESIGN APPROACH OF DIFFERENT STARLINK SATELLITE GENERATIONS AND VERSIONS AS SEEN BY THE APPARENT BRIGHTNESS CHARACTERISTICS

Abstract

SpaceX' Starlink is the largest constellation of spacecrafts currently in orbit. It consists of currently more than 4000 satellites and many thousands more are planned. These satellites, and also from other constellations, are interfering with astronomical observations. SpaceX addressed the reactions from the scienctific community and Centre for the Protection of Dark and Quiet Sky (International Astronomical Union) by including changes to their initial designs, orbital configuration and operations to minimize the disturbing effects. Until now, models of three generation 1 (v1 original, v1.2 visor v1.5 post-visor) and one generation 2 (v2 mini) versions were launched so far. These will be followed in the comming years by further models. All of these satellites are already and will be providing different apparent brightness characteristics that pose different ways to the scientific community how to operate in such an environment.

This paper emphasizes on the iterative design approach as seen from the visual brightness of all four models of the two Starlink generations so far. SpaceX efforts to work with the community to improve the situation by interfering with the astronmoical observations are shown with respect to modifications directly confirmed by SpaceX and those that are derived from the measurements. SpaceX acknowledged modification in the designs. The addition of visual blockers called visors reduced the brightness from magnitude 4 to 6. The paper shows further the effect on brightness due the addition of Laser Communication Terminals (LCTs) onboard when the brightness increased again to magnitude 5 levels. Besides design, the operation in orbits can be seen with dimming effects. The paper shows orbit configurations and the satellites' attitudes of their flying modes. An outlook is given for the the yet unnamed full generation 2 satellites, here refered to as "v2 big", with respect to their orbit selection and the brightness of their increased dimensions based on their "v2 mini" which started operation in February 2023. SpaceX continues to find comprimises between their business case and scientific needs.

This paper is based on own measurements as well on other measurements from the SatObs.org SeeSat-L community. The DGSN project was started within the SmallSat-Design-Studies at the Institute of Space Systems (IRS) at the University of Stuttgart. It was part of several annual Google and ESA Summer of Code campaigns. It is a PhD-research topic at the Institute for Photogrammetry (IFP) at the University of Stuttgart.