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Author: Mr. Woo Seok Park
Bundeswehr Univeristy Munich, Germany, woo.park@unibw.de

Ms. Maren Hülsmann
Universität der Bundeswehr München, Germany, maren.huelsmann@unibw.de

Mr. Salman Ali Thepdawala
Universität der Bundeswehr München, Germany, thepdawala95@gmail.com

Prof. Roger Förstner
Bundeswehr Univeristy Munich, Germany, roger.foerstner@unibw.de

SAFETY GUIDED SYSTEM DESIGN FOR SATELLITE MEGA-CONSTELLATIONS

Abstract

With the trend towards satellite Mega-Constellation more and more satellites are being placed into the Low-Earth Orbit (LEO). Considering the number of satellites already in orbit, with and without inter-satellite communication, it is now necessary and feasible to take measures for safe operation and safe orbit maintenance. In terms of operating more than hundreds or thousands of satellites for a single mission, on-board autonomy based on artificial intelligence is coming into focus. The rapid growth of AI-based technology enables the autonomous control of specific sub-systems, formation management, monitoring of each satellite in a cluster, or on-board decision-making during operation.

This paper presents a preliminary system concept for a LEO mega-constellation mission with on-board autonomy based on safety-guided design principles. To take measures considering emergent properties created by the interaction between different subsystems in a satellite and satellites in a cluster, the system theory-based hazard analysis method ‘System Theoretic Process Analysis’ is applied. Based on this hazard analysis, a preliminary system architecture including the control structure in a multi satellite system is derived. This work is divided into several parts according to autonomous architecture concepts (centralized- and distributed coordination). Each part includes possible hazardous scenarios, associated causal factors, and derived safety requirements for safe autonomous operation in orbit.