MODELLING OF THE INTEROPERABILITY BETWEEN ON-BOARD COMPUTER AND PAYLOADS OF THE NANOSATC-BR2 WITH SUPPORT OF THE UPPAAL TOOL

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Almeida, D. P., Mattiello-Francisco, F.

Instituto Nacional de Pesquisas Espaciais – INPE São José dos Campos, Brazil

Abstract

This paper presents an experience in using a Model Driven Engineering (MDE) approach in the context of nanosatellite requirements verification. In the last ten years MDE approaches have been extensively used for the analysis of extra-functional properties of complex systems, like safety, dependability, security, predictability, quality of service. The NanosatC-Br2 is a 2U Cubesat under development at INPE. Expected to launch later this year, the nanosat will carry three physical payloads and a couple of software experiments, all of which are being developed in different regions of Brazil, by teams of partner universities, as well as INPE itself. The on-board software (OBSw) is being entirely developed by the team in INPE and its local partners, and this work is included in the development process. Each physical payload has an individual microcontroller, which are all connected as Slaves on the I2C bus of the nanosat platform, and the onboard computer (OBC) acts as the Master in the Master-Slave serial communication protocol. Besides interfacing with the payloads, the on-board software (OBSw) is in charge of routine onboard data handling functionalities such as housekeeping, satellite command and control, data handling (telemetry). Moreover, two software-intensive payloads run in the OBC, being subsystems of the OBSw.

In order to anticipate the verification of the OBSw requirements in the NanosatC-Br2 development cycle, MDE approach was used.

Models of the interoperability between the on-board computer and payloads were developed using *timed automata* theory with the support of UPPAAL, a tool environment for modeling, simulation and verification of real-time systems. The models were created based on meetings with the payload development teams and requirement baseline documents of the payloads' operations, as well as system and interface requirements. The models were discussed in the System Requirement Review (SRR) and new requirements were raised and therefore some of the models were redesigned and some are still in the process. The models have helped in the development of the OBSw and will provide possibilities of further development in testing and verification & validation with more exploration of the UPPAAL tool and its functionalities, such as the verification tool and automatic C code generation.

Keywords: Cubesat, NanosatC-Br2, Model-Driven Engineering, Timed Automata, UPPAAL