Study of spacecraft onboard software verification environment —Part 2—

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As the performance of micro-processing units (MPUs) is advanced, onboard software (OBS) of spacecraft, such as for guidance, navigation and control, has been growing larger in scale and more complex. At the same time, the improvement in spacecraft reliability as well as cost reduction and shortening of the development period are being demanded. The process to supply fully tested software system which incorporates real-time operating system(RTOS), I/O drivers and applications has been important. It would therefore be very useful to prepare an integrated verification environment for OBS that is commonly utilized for software development process of various spacecrafts.

A few methods are used to verify OBS. Full-software simulation(FSS) on general-purpose PCs is for logic tests for application software. Processor-in-the-loop simulation(PILS) in which OBS is executed on an onboard processor is able to verify RTOS, device drivers, as well as major logics of application. Using a software emulator of MPU called instruction set simulator instead of the processor is an effective way to check all the exceptions including the behavior during hardware malfunctions, and to monitor them in detail. For all the methods, a spacecraft simulator with an interface is necessary to supply input data for OBS and to receive output data from it. The simulator consists of component models that depend on each spacecraft, and a common framework that controls execution of the simulation and connection of the models.

The aim of our study is to design a common framework and interfaces capable of absorbing the dependencies on the methods for the verification environment and OBS of various spacecrafts.

We have constructed a tentative OBS verification environment employing some commercial off-the-shelf(COTS) tools widely used in the embedded software domain. There is no need to modify OBS for the integrated verification. Stereotype communication interfaces between OBS and the spacecraft simulator can commonly be used for PILS and simulation with the software emulator. The simulation framework that maintains high compatibility between any methods and any spacecraft models are also being developed. The environment will be applied to development process of a small satellite plan in JAXA.