

Automatic Generation of Qualification Documentation at the Example of RTEMS QDPs

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RTEMS is a real time operating system frequently used for space applications. End of 2021 ESA made Qualified Data Packages (QDPs) freely available for download (<https://rtems-qual.io.esa.int/>). These QDPs are officially pre-qualified by ESA according to the European Cooperation for Space Standardization (ECSS) standard, initially to Cat. C and now to Cat. B thanks to a followup Independent Software Verification and Validation (ISVV) activity. The QDPs contain a subset of Symmetric Multiprocessing (SMP) as well as single-core RTEMS which is deemed most space relevant and target Gaisler GR712RC (LEON3 dual core) and GR740 (LEON4 quad core) System on Chip (SoC) architectures.

The user can build a space application on top of the RTEMS contained in a QDP. This simplifies the qualification of the system as the user can present to ESA the qualification documentation and produce test results for RTEMS based on the material contained in the QDP. Hence the user will effectively only need to qualify the space application and not the operating system.

RTEMS is Free Open Source Software (FOSS) undergoing permanent development and bug fixing. The user as well as ESA prefers to use the newest release with current features and bug fixes, of course. However, each change of the code sources requires a new evaluation and re-qualification. For each change, the specifications, requirements, tests and documentations must be adapted or newly created. This process is so laborious that former qualified RTEMS releases have never been actualized and the user was forced to be contented with an outdated RTEMS.

With the pre-qualified RTEMS QDPs we decided for a novel approach. The RTEMS code and its properties are described in so called *specification items*. New tools create from these the specifications, requirements, user documentations and tests. The content of the documents to be presented to ESA for qualification will be automatically generated and checked as far as possible. For example, tests and performance benchmarks are not only automatically executed but also the resulting data and measurements are inserted into the relevant documents and examined whether the requirements for qualification are fulfilled. Likewise, the required metrics as well as the traceability matrices are automatically measured (where possible) and are stored in the corresponding documents.

Despite all automation, a certain amount of human work is still needed at each new round of qualification. Yet, the total efforts are significantly smaller compared to the situation without the automatic generation. This will provide us with the ability to update the RTEMS QDPs in more regular intervals aligned with the RTEMS community versions. Another advantage of the improved automation are lower costs to extend the function volume or to provide QDPs for other architectures.