Introduction to the TOPPERS Project
– Open Source RTOS for Embedded Systems –

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Abstract
The TOPPERS Project is to develop a series of open source real-time operating systems (RTOS) for embedded systems. The TOPPERS/JSP Kernel, which is the first product of the project, was released two years ago and is started to be used in industries. A technological basis of the TOPPERS Project is the ITRON Specification, which is a de-facto standard real-time kernel specification widely applied to consumer electronics, cellular phones, and other small-scale embedded systems in Japan.

1 ITRON Specifications
ITRON is a series of specifications for real-time operating systems (RTOS) and related standards for embedded systems [1, 2]. The standardization of the ITRON Specifications is being conducted as one of the sub-projects of the TRON Project and was started in 1984. The ITRON Specifications are open in that anyone can freely implement software based on the specifications.

Until now, four generations of the ITRON real-time kernel specifications have been developed and published. The latest version of the specifications is the \( \mu \)ITRON4.0 Specification, which was released in 1999 [3]. The letter “\( \mu \)” shows that its main target is small-scale embedded systems.

The ITRON Specifications have been implemented for a number of processors and widely applied to various kind of embedded systems, especially to small-scale embedded systems such as consumer electronics and cellular phones. According to a questionnaire-based survey conducted by the TRON Association, real-time kernels conforming to the ITRON Specifications are adopted in about one third of the embedded system designs recently developed in Japan [7].

Some other standards related to the kernel specification, such as the ITRON TCP/IP API Specification [4], the JTRON (Java on ITRON) Specification [5], and the ITRON Debugging Interface Specification [6], have been also developed.

Though the ITRON Specifications are successful as standard specifications, some problems caused by a lack of standard implementation are pointed out. For example, the detailed specifications and the inner structures of the real-time kernels based on the ITRON Specifications are different each other because of the implementation-dependent matters included in the standard specifications. This problem of excessive diversity makes the reuse of software components and development tools to other ITRON-specification kernels difficult.

2 TOPPERS Project
The TOPPERS Project is to develop a series of open source RTOS and related software based on the ITRON Specifications [8]. The project is initiated by us in 2000 and is now supported by several companies, research institutes, and individuals. We plan to incorporate the project in near future.

The aims of the TOPPERS Project is as follows. At first, the existence of an open source real-time kernel can ease the problem of excessive diversity and another ITRON’s problem of duplicated efforts that more than ten companies have developed and are maintaining ITRON-specification real-time kernels independently. Another aim is to develop the next generation RTOS technology. Again, open source software facilitates to bring development resources together both from industries and academia. The last (but not least) aim is to ease the training of embedded software engineers through providing good education materials.

The license condition of the products of the TOPPERS Project is called the TOPPERS license, which is similar to the BSD license condition and is much more unrestricted than the GNU General Public License (GPL). The basic concept of the TOPPERS license is to promote the wide use of the TOPPERS software while collecting information for claiming the contribution of the project. When an RTOS under the TOPPERS license is embedded in a device, for example, the developer has only to report the usage of the RTOS to the TOPPERS Project. We call this concept as reportware.

The TOPPERS/JSP Kernel, which is a real-time kernel conformant to the Standard Profile of the \( \mu \)ITRON4.0 Specification, is the first product of the TOPPERS Project. We have developed the JSP Kernel as the basis of our research and education. Based on the JSP Kernel, we are proceeding several research projects. The JSP Kernel is also used in the
industries for prototype development of embedded systems and also for final products.

We are also developing RTOS with extended functionalities. One of them is the IIMP Kernel, which is an extension of the JSP Kernel with the access protection function of kernel objects including memory objects. Another product is the IDL Kernel, an extension of the IIMP Kernel with dynamic object creation and deletion, on which dynamic loading function has been implemented.

Another development area of the TOPPERS Project is software components running on the ITRON-specification real-time kernels. One of them is a compact TCP/IP protocol stack conforming to the ITRON TCP/IP API Specification.

3 Concluding Remarks

This paper describes the overview of the TOPPERS Project which is based on the outcome of the ITRON Specifications. The project will proceed to develop next generation RTOS that meets the requirements of embedded systems.

References