



## **T-Engine 2011**

by

**Ken SAKAMURA**

Professor, The University of Tokyo  
Interfaculty Initiative in Information Studies  
Graduate School of The University of Tokyo  
Chair, T-Engine Forum / uID Center  
Chairman, YRP Ubiquitous Networking Laboratory  
IEEE Fellow

**Contact**

**T-Engine Forum**

The 28th KOWA Bldg. 2-20-1, Nishi Gotanda,  
Shinagawa, Tokyo 141-0031 Japan  
TEL: +81-3-5437-0572 / FAX: +81-3-5437-2399  
E-mail: [office@t-engine.org](mailto:office@t-engine.org)



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# T2

## —T-Engine Project on to the Second Stage

### 1 Evolving TRON

The TRON Project, launched in 1984, is a development project for new computer systems covering areas from hardware, mostly microprocessors, to applications with real-time processing at its core.

In 1987, the TRON Project released its ITRON specification for real-time operating systems. At the time, hardware resources were extremely limited and system optimization that touches operating systems was essential. Therefore, for ITRON, only specification was released so that anyone could implement it freely thereby permitting customization in accordance with hardware. As a result, the ITRON specification operating systems running on many types of processors were created, and it became the de facto standard of real-time operating systems for embedded devices.

However, in the 10 years or so since the release of the ITRON specification, requests for ITRON-based applications became diversified with the improvement of hardware performance. Application of ITRON

specification OS requiring peripheral functions such as file management and device management increased, and companies began to enhance ITRON with their own middleware. As a result, new problems such as the decreased compatibility and reusability of middleware due to incompatible unique extensions arose.

T-Engine and T-Kernel were developed in this background.

While we attempted to unify the development environment including hardware with T-Engine, we aimed to standardize the middleware development environment by making T-Kernel extensible utilizing the high performance real-time functions of ITRON specification. In addition, we have released not only the T-Kernel specification but also the source code free of charge in order to enhance the portability and reusability of software. Furthermore, the specification and source code of basic middleware, T-Kernel Standard Extension, have been released so that typical functions of general information processing operating systems could be added easily to T-Kernel. Using this system design approach, a real-time operating system

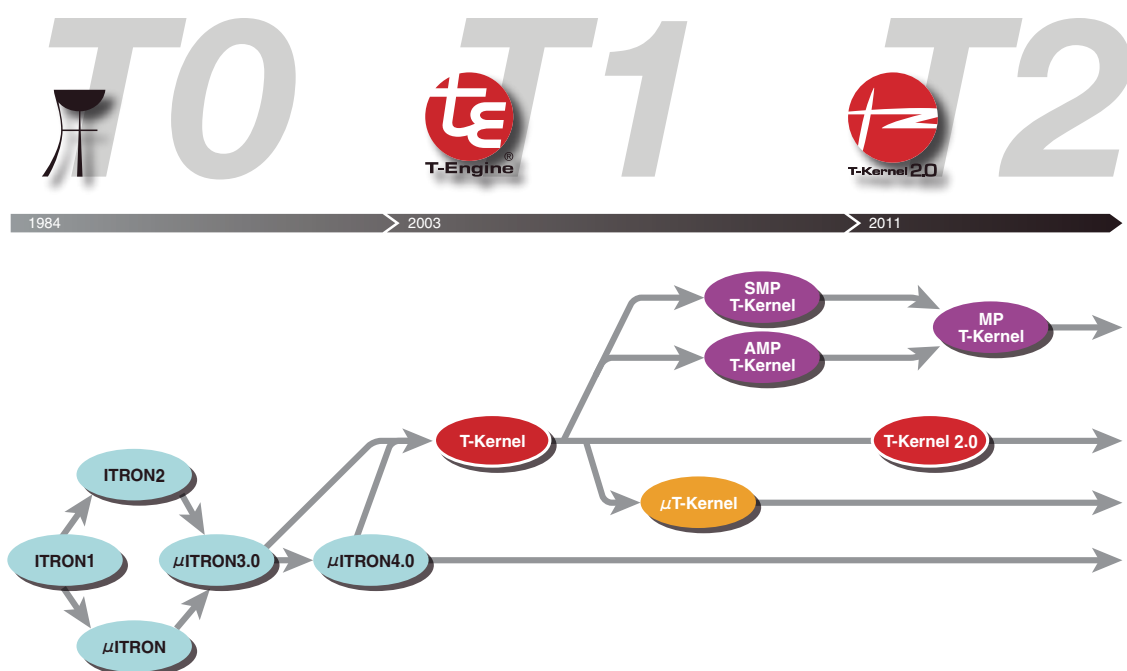


Figure 1. Milestones of TRON/T-Kernel

supporting embedded devices that require both high-level function and high performance can be provided.

In fact, the adoption of T-Kernel in high-end embedded devices such as car navigation systems, advanced printers, and handy terminals for business use has been steadily increasing.

In addition, to meet market needs, we have released  $\mu$ T-Kernel tuned to support small embedded devices easily along with AMP T-Kernel and SMP T-Kernel that support multiprocessors and multi-core processors.

### 1.1 $\mu$ T-Kernel



$\mu$ T-Kernel is a version of T-Kernel for small embedded systems. It is designed so that performance can be maximized even in environments with few resources, such as 16-bit single chip microcomputers.

$\mu$ T-Kernel has realized the fine balance of the rich API compatible with T-Kernel and the sufficiently small size of required ROM and RAM. In particular,  $\mu$ T-Kernel features small RAM size that results in energy-saving. At the same time, advanced real-time performance is realized by a fast context switch and scheduling based on priority as in T-Kernel.

It is important for small-scale systems to perform optimization or adaption depending on products. For this reason, reference  $\mu$ T-Kernel source code has been released with more relaxed terms of use ( $\mu$ T-License) than the regular license for T-Kernel. Redistribution of  $\mu$ T-Kernel is permitted after porting it to their systems by manufacturers and vendors. Since T-Kernel and  $\mu$ T-Kernel are highly compatible, porting of applications to either OSs only involves recompiling the source code if only functions common to both OSs are used.

### 1.2 MP T-Kernel



MP T-Kernel is real-time OS very suited to the embedded system with multi-core processors.

Since MP T-Kernel has a good compatibility with T-Kernel, most of the real-time functions of T-Kernel can be used on multiprocessors. Moreover, as MP T-Kernel supports the Standard Extension to extend the function of T-Kernel, process management and file

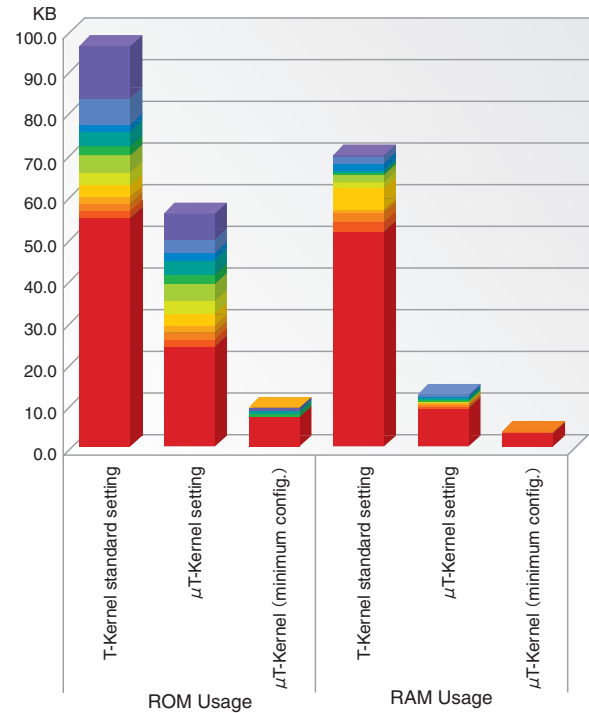


Figure 2. ROM/RAM Usage by  $\mu$ T-Kernel

Source: T.Nguyen, B. Anh, S. Tan: "REAL-TIME OPERATING SYSTEMS FOR SMALL MICROCONTROLLERS," IEEE MICRO Sept./Oct 2009 pp.30-45

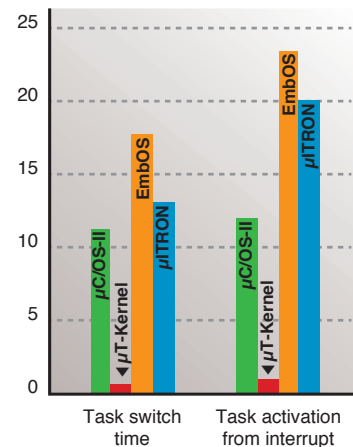


Figure 3. Execution time benchmark for four RTOSs

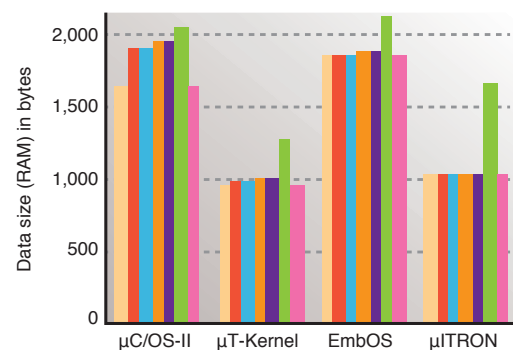


Figure 4. Benchmarking results for the four RTOSs: comparisons of data size

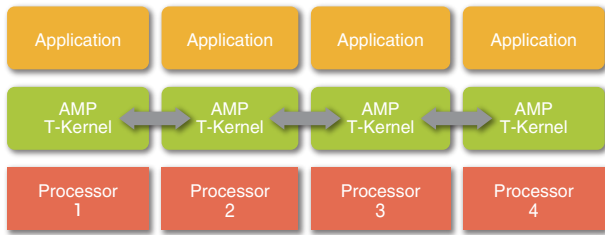


Figure 5. AMP T-Kernel

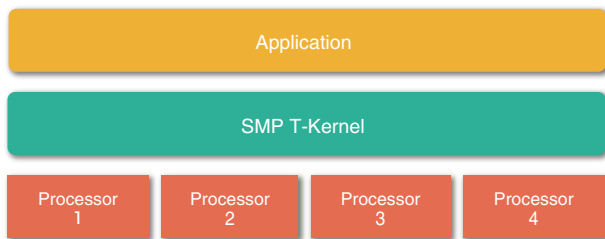


Figure 6. SMP T-Kernel

system are available.

Multiprocessor systems can be classified into two types: AMP (Asymmetric Multiple Processor) and SMP (Symmetric Multiple Processor). AMP assigns specific functions to each processor and implements programs on each CPU accordingly. Its merit is the ease of utilizing the software resources and know-how of existing single processor. SMP dynamically assigns functions to each processor, achieving good utilization of processor resources. Process allocation is conducted by OS so that application program does not need to be aware of the number of processors.

As the embedded systems are diversified, AMP or SMP is selected based on the respective system requirements.

Both AMP T-Kernel (Fig. 5) and SMP T-Kernel (Fig. 6) are provided by MP T-Kernel to support various systems.

## 2 From T-Kernel 1.0 to T-Kernel 2.0

After the debut of T-Kernel, the performance of the processors of embedded devices has progressed significantly in comparison to the performance of then available CPUs when T-Kernel was designed. In addition, since the development of products using T-Kernel got popular, we received many feature requests for T-Kernel. From this background, the previous T-Kernel (T-Kernel 1.0) has been upgraded to T-Kernel 2.0 in line with the new era as well as to support future progress adequately while maintaining the basic design concept of T-Kernel.

### 2.1 Significant Enhancement of Time Control Functions

A time control function and physical timer control function using microsecond unit have been added to T-Kernel 2.0.

In T-Kernel 1.0, the time of day can be specified in one millisecond while in T-Kernel 2.0 an API which enables the time of day to be specified in one microsecond has been newly added. For example, the use of a cyclic handler that starts at 250 microsecond intervals, and specifying 15 microseconds for the semaphore timeout are now possible.

Internally, the system timer interrupt interval that conducts cyclic handler startup and wait release on timeout can now be specified in microseconds. It is natural that overhead will increase accordingly if the system timer interrupt interval becomes shorter; however, a more precise time specification is essential for certain the applications. T-Kernel 2.0 can support these systems without having to go over the limit of specification in non-standard manner.



Figure 7. Features of T-Kernel 2.0

In addition, SoC (System on Chip) has become popular with recent microcomputers and many peripheral functions are available on-chip today. Among them, a large number of timers that operate independently are often found. Since embedded devices need to operate in real time, many applications utilizing such timers are developed; however, until now they have mostly been handled outside the operating system management. In T-Kernel 2.0, we aim to improve the development efficiency and portability of programs handling physical timers by standardizing the APIs handling these physical timers.

If you use the physical timers, systems with very high real-time characteristics can be built while minimizing overhead due to the use of system timers.

## 2.2 Large Capacity Device Support

In recent years, the capacity of peripheral storage devices has been increasing while the price has been steadily dropping. Today, it is not unusual to find embedded devices with terabyte hard disks. Support for large capacity devices is inevitable even in embedded devices.

APIs for device control in T-Kernel 1.0 use 32-bit signed integers. Assuming that there is a 512-byte per block device, one terabyte is the maximum size that can be accessed.

Therefore, in T-Kernel 2.0, APIs using 64-bit signed

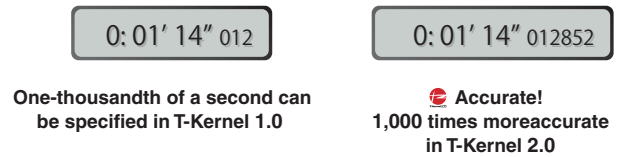


Figure 8. Time specification in microseconds

integers have been added to support larger capacity devices. Theoretically, if each block is 512 bytes, T-Kernel 2.0 can support devices up to a capacity of one zettabyte (10 to the 21st power).

## 2.3 Enhancement of System Management Functions and Utility Functions

APIs to control the following functions have been also added to T-Kernel 2.0.

- Cache control
- Setting access rights with MMU
- Address space information acquisition
- Fast lock

These functions could be used as implementation-dependent functions and libraries in T-Kernel 1.0 as well; however, incorporating these functions into the specification of the operating system itself in T-Kernel 2.0 has expanded the scope of standardization. By doing so, the development efficiency and usability, and

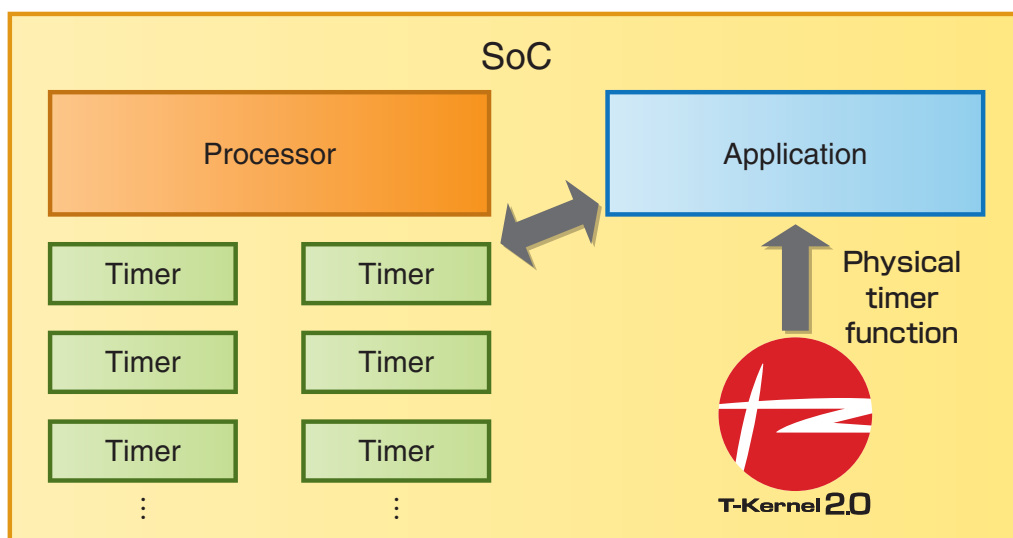


Figure 9. Physical timer APIs standardized in T-Kernel 2.0



Approximately 90 hours can be recorded in 1TB  
 In the distant future, approximately 42 million years can be  
 recorded in 1 ZB  
 (When recording BS Digital broadcasting in DR mode)

Figure 10. Large capacity HDD support

portability of software will improve.

## 2.4 Upward Compatibility of T-Kernel 1.0

The T-Kernel 2.0 specification is upward compatible with the T-Kernel 1.0 specification.

Since new functions have been added to the APIs of T-Kernel 1.0, binary compatibility is maintained. In other words, even if the T-Kernel 1.0 operating system of running systems is changed to T-Kernel 2.0, applications and device drivers can be used as they are.

Thus, T-Kernel 2.0 offers extended functions to support new hardware while maintaining the small memory footprint of T-Kernel 1.0.

## 3 One Stop Service

In T2, not only T-Kernel 2.0 but the development environment has gone through a major evolution. The scope of items released as open source is expanded, and all of them are provided in one package.

Specifically, various device drivers such as T-Monitor and LAN drivers which are indispensable for the use of T-Kernel will be released together with the debut of T-Kernel 2.0. Thus far, only the specifications have been released since device drivers are highly hardware-dependent and generalization is difficult; however, the T-Engine Reference Board with published technical information will be prepared and various device drivers will be released as self-contained source for this board.

Requirements of the T-Engine Reference Board are as follows.

- T-Kernel 2.0 runs on it.
- Device drivers for T-Kernel 2.0 are available.
- Technical information related to T-Kernel 2.0 is obtainable.

On the other hand, the board size, connector positions, etc. are not stipulated unlike T-Engine specification.

To start with, T-Engine Forum will prepare one T-Engine Reference Board model, and the release of reference boards for many CPUs is scheduled in the future.

## 4 Electronic Document of the T-Kernel 2.0 Specification

The specification of T-Kernel has been revised very much to produce T-Kernel 2.0. In particular, parts of T-Kernel/SM have major additions so that users of T-Kernel can easily understand the specification.

Paper-based usage of the specification was assumed when the T-Kernel 1.0 specification was prepared, but the T-Kernel 2.0 specification assumes electronic usage, and reusability of the specification itself has been improved. The original specifications have been re-written in XML format now, and not only will the PDF format be released as in the past, but HTML format and the UNIX man command format will also be produced and used easily.

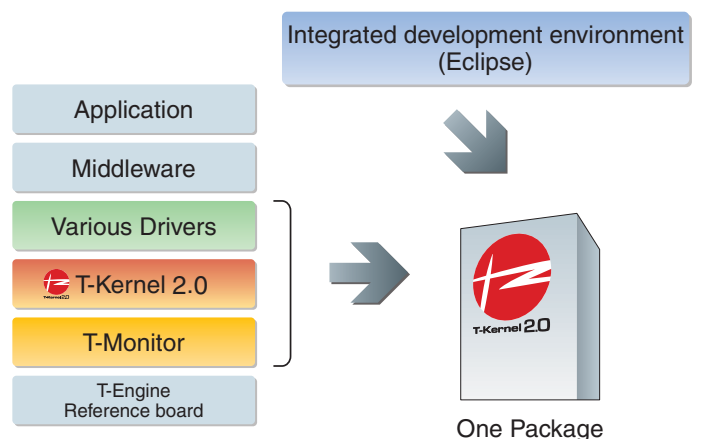


Figure 11. One Stop Service





Photo 1. T-Engine Reference Board

## 5 T2

Nearly 25 years have passed since the ITRON OS specification was released to the public by TRON Project. T-Kernel has also undergone some major changes, and entered the next stage of "T2" as T-Kernel 2.0. In "T2," the ease of use of T-Kernel has been

improved.

For "T2," the release will begin with T-Kernel 2.0 and one stop service. Later release plan includes the release of the following (but not limited to them only): enhancements of T-Kernel Standard Extension, namely, the standard support of network functions and GUI functions, generalization improvement of the file system, functional enhancement of the power-saving features, etc. Regarding the power-saving, methods to realize an efficient power-saving function are being studied: such methods coordinate middleware such as T-Kernel 2.0 and T-Kernel Standard Extension and applications in a comprehensible manner.

The new evolution of TRON is about to begin under the flag of "T2."



Photo 2. T-Kernel 2.0 specification in electronic form

# T-License 2.0

T-Engine Forum has released the source codes of T-Kernel Standard Extension and MP T-Kernel as well as T-Kernel source code under the license agreement called T-License. T-License has the following features appropriate for development of embedded systems.

- 1) The source codes can be freely modified or reproduced.
- 2) No license fee. No fee is required for commercial use as well as research use.
- 3) Unlike GPL, it does not require users to release the source code of developed software.
- 4) Display of use of T-Kernel is obligated.
- 5) The source code files supporting the hardware-dependent part and compiler-dependent part of T-Kernel source code can be released so that the latest CPUs and development environments in the market can be supported.

Based on the policy of “single one source” (meaning a single source from one master repository) in order to promote distribution of middleware, T-Engine Forum previously required users to download T-Kernel source code from the official T-Engine Forum website. With the launch of the revised T-License 2.0, T-Engine Forum has decided to make the big transition of not only releasing the T-Kernel source code from T-Engine Forum, but also allowing the source code to be freely re-distributed by anyone who accepts the terms and conditions of the T-License 2.0.

T-Engine Forum allocates unique codes called ucodes through its subsidiary, Ubiquitous ID Center. “Traceability” using this ucode, in other words, the mechanism for managing historical or tracking information, is applied to the T-Kernel source code. Specifically, the scheme affects the users who have used T-Kernel source code to develop a modified version of the T-Kernel by porting it for a specific machine or by enhancing T-Kernel functions. After receiving a ucode issued by the T-Kernel Traceability Service which is

prepared by Ubiquitous ID Center, the users are obligated to register the modified version of the T-Kernel they have developed, as well as the version information of T-Kernel which was the basis of their development.

The figure on the next page shows the mechanism for knowing the genealogy of operating systems by traceability. When the OS ver 2.00.00 on the left top side, which has been released by T-Engine Forum, goes through upgrades, a ucode is allocated to each of these versions. A ucode is also applied for and assigned to each modified version developed by ABC Company and its upgraded versions.

This mechanism allows users who acquire the modified version of T-Kernel to know the OS that is the origin of the modified version. Therefore, the users will be able to know what areas need careful attention when porting the middleware, for example. Making re-distribution easy is planned by allowing users to distribute the modified version with T-License 2.0 attached to it, and simply asking the recipient to accept terms and conditions of T-License 2.0.

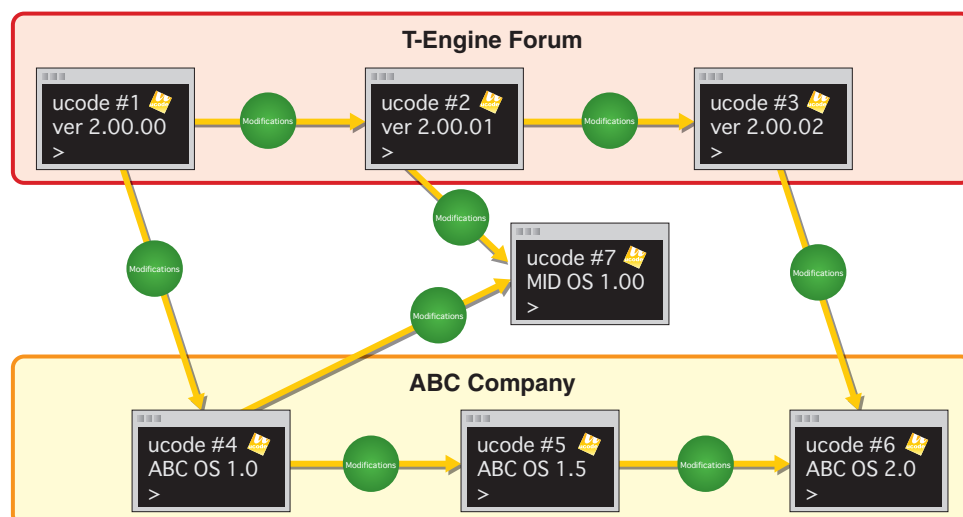
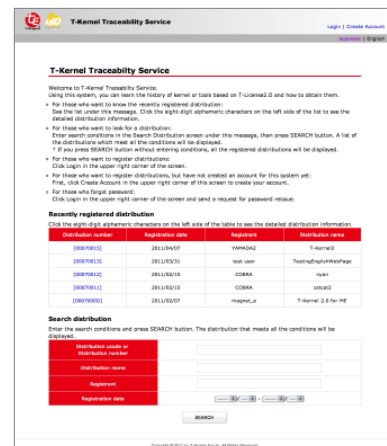
# T-Kernel Traceability Service

The T-Kernel Traceability Service is a system for clarifying the relationship between different versions of T-Kernel 2.0 source codes by assigning numbers with guaranteed uniqueness called ucodes to source code revisions.

Unlike T-Kernel, T-Kernel 2.0 is not a single source from one master repository only. The newly developed source code for the improved version of T-Kernel can also be distributed. In this framework, the T-Kernel Traceability Service provides the function of tracing the origin of the improved source code.

The original of T-Kernel 2.0 source code is the T-Kernel 2.0 source code released by T-Engine Forum. Users that have registered an account with the T-Kernel Traceability Service can release a source code improved by themselves after the ucode is assigned to their source code. When you register the source code, you will register history information including where the source code has been provided from and which version of source code was used to create your source code in the traceability system. It is also possible to release information on what part of each source code was modified in addition to the history information. For the released T-Kernel source code, ucode is assigned to each package unit (in other words, downloadable unit). The history of source codes registered in this way can be outlined in a graphical form shown in the following figure.

Users who access the T-Kernel Traceability Service can browse the source code history information as well as the date of release, the source of acquisition, and the provider using the ucode. For example, the figure shows that the source code developed by ABC Company to which ucode#7 is assigned is based on T-Kernel version 2.00.02 (ucode#3 is assigned to this) released by T-Engine Forum and the source code which was previously released by ABC Company to which ucode#6 was assigned. Furthermore, it is also easy to trace, on the web, the genealogy of the source code to which ucode#6 is assigned. The modifications are also viewable if the registrant has released that information. A new management method of the open system is realized by commonalizing the management of T-Kernel version which has been respectively conducted by each company.



# The TRON Engineer Certification Examination

<http://www.t-engine.org/exam/>

Embedded systems are part of the foundation of the Japanese electronics industry, but there is a shortage of software development engineers. According to "2008 Report on the Actual Status of Embedded Software Industry" published by the Ministry of Economy, Trade and Industry in 2008, the number of engineers engaged in the embedded software development throughout Japan is estimated to be 242,000. However, it is estimated that approximately 88,000 engineers are still in short supply. In order to compensate for this shortage of engineers, the companies developing the embedded software are forced to outsource the development to various sub-contractors. We often hear of trouble that the delivered software does not meet the expected quality due to the inadequate technical skill of the engineers at sub-contractors. We often hear that those troubles occur especially when development is outsourced to overseas companies.

For developing embedded software, developers need to have a high-level knowledge, technical skill, and rich experience because it is necessary to have the knowledge of both hardware and software and to implement real-timeliness, high-reliability, energy-saving function, etc. within the limited resources. However, there are no methods and standards at the moment to measure the knowledge, the technical skill, and the experience of embedded software engineers.

Those who outsource the work do not have the objective criteria to judge the technical skill of their counterparts.

Therefore, T-Engine Forum has started to conduct the TRON Engineer Certification Examination to gauge the knowledge and technical skill of engineers for embedded systems based on TRON architecture with the focus on T-Kernel and ITRON specification OS.

Today, people from human resources departments of companies, and temporary staffing firms are interested in the TRON Engineer Certification Examination as an exam to check the practical skill of engineers who develop embedded systems.

We plan to extend the TRON Engineer Certification Examination to the world in the future so that it can be held in many countries.

The members of T-Engine Forum can take the exam at a discount price.




**トロン技術者認定試験**

トロン技術者認定試験とは？

受験の流れ

受験申し込み

受験対策

FAQ

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ETEC

**トピックス**

2011.2.4 受験対策に第11回トロン技術者認定試験の募集と正解を掲載しました。

2011.1.17 1月17日より第12回トロン技術者認定試験(2011年3月5日開催)の受付を開始しました。

2010.10.23 受験対策に第10回トロン技術者認定試験の募集と正解を掲載しました。

2010.9.6 9月6日より第11回トロン技術者認定試験(2011年1月15日開催)の受付を開始しました。

2010.6.18 受験対策に第9回トロン技術者認定試験の募集と正解を掲載しました。

2010.6.7 6月7日より第10回トロン技術者認定試験(2010年8月15日開催)の受付を開始しました。

2010.4.5 4月5日より第10回トロン技術者認定試験(2010年6月15日開催)の受付を開始しました。

2010.4.5 2010年度試験スケジュールを掲載しました。

2010.3.19 受験対策に第8回トロン技術者認定試験の募集と正解を掲載しました。

2010.1.29 受験対策に第7回トロン技術者認定試験の募集と正解を掲載しました。

2010.1.18 1月18日より第9回トロン技術者認定試験(2010年3月5日開催)の受付を開始しました。

2009.10.9 受験対策に過去問と正解を掲載しました。

2009.10.5 TRONWARE(トロンウェア)VOL.118にトロン技術者認定試験の紹介掲載されました。

2009.9.7 TRONWARE(トロンウェア)VOL.118に全過去問集が掲載されました。

2009.9.7 9月7日より第7回トロン技術者認定試験(2010年1月15日開催)の受付を開始しました。

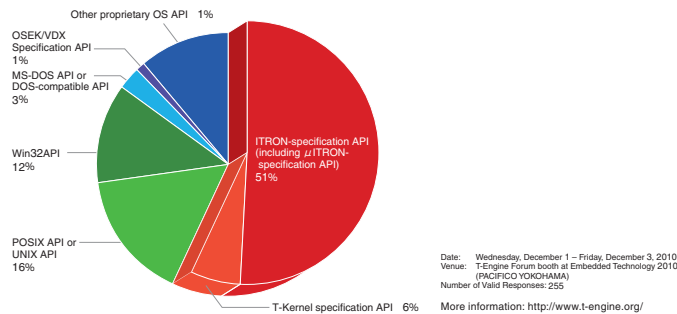
2009.6.8 6月8日より第8回トロン技術者認定試験(2009年8月15日開催)の受付を開始しました。

2009.5.13 受験対策の参考資料に参考文庫を追加しました。

2009.4.7 4月7日より第5回トロン技術者認定試験(2009年6月15日開催)の受付を開始しました。

# Questionnaire Survey on Embedded Real-time OS Usage Trend

**No.1** share for 12 consecutive years\*



\*No. 1 "API of embedded operating systems" since the start of survey in 1999

The following are some adoption and application examples.

For publication of your products in this section, please contact the T-Engine Forum Secretariat at [office@t-engine.org](mailto:office@t-engine.org).

## Adoption example / Application example

### ● Products with T-Kernel μITRON specification OS (including JTRON)

#### ■ eT-Kernel Multi-Core Edition

eSOL Co., Ltd.



#### ■ DVD 800 Navi

Robert Bosch GmbH

Navigation headunit with T-Kernel



#### ■ Multi Photo Colorio

SEIKO EPSON CORPORATION

Color Printer with T-Kernel



EP-901F



EP-901A



EP-801A

#### ■ DIGITAL MULTITRACKER

FOSTEX (COMPANY)

Digital Multi Track Recorder use with T-Kernel



LR16



MR-8HD CD



MR-8HD



## ■ UC (Ubiquitous Communicator)

PDA with T-Kernel

Personal Media Corporation



UC-Phone



Ubiquitous Communicator for business use



UC  
(Ubiquitous Communicator)

## ■ T-CORE SS/IS

Entering and Leaving Control System with T-Kernel

CORE CORPORATION



## ■ PerfectSystem CT8

(Ball rental machine with a counter for pachinko (Japanese pinball) machine)

SILVER DENKEN CO., LTD.



## ■ General-purpose Seismometer SDP-1000

Kinkei System Corporation



## ■ STAGE PIANO CP1

YAMAHA CORPORATION



## ■ DIGITAL MIXING CONSOLE M7CL-48ES

YAMAHA CORPORATION



## ■ GELJET Printer IPSiO GX e3300

Ricoh Company, Ltd.



■ Drive Recorder CPiReDR-2

TOSHIN ELECTRIC CO., LTD.



■ Drive Recorder (YAZAC-eye3)

YAZAKI Corporation



■ Digital Tachograph (DTG4)

YAZAKI Corporation



■ Taxi Meters (LT24TZ)

YAZAKI Corporation



■ EXILIM PRO EX-F1

CASIO COMPUTER CO., LTD.

High-Speed Capture Digital Camera with  $\mu$ ITRON4.0 specification OS



■ EXILIM ZOOM

CASIO COMPUTER CO., LTD.

Digital Camera with  $\mu$ ITRON4.0 specification OS



EX-Z300



EX-Z250



EX-Z85

■ Kodak EasyShare Z1275

KODAK JAPAN LTD.

HD-capable Digital Camera with  $\mu$ ITRON4.0 specification OS



■ **Kodak EasyShare V570**

KODAK JAPAN LTD.

DUAL LENS DIGITAL CAMERA with  $\mu$ ITRON4.0 specification OS



■ **NV-GS150**

Panasonic Corporation

Digital Camcorder with  $\mu$ ITRON3.0 specification OS



■ **HDC-HS9**

Panasonic Corporation

HD-capable Digital Camcorder with  $\mu$ ITRON specification OS



■ **Landcruiser PRADO**

TOYOTA MOTOR CORPORATION

$\mu$ ITRON specification OS was adopted for engine control



in 2005

■ **CROWN**

TOYOTA MOTOR CORPORATION

$\mu$ ITRON specification OS was adopted for engine control



in 2005



in 2005

■ **G-BOOK-capable DVD Voice Navigation**

TOYOTA MOTOR CORPORATION

Car Navigation System with  $\mu$ ITRON specification OS

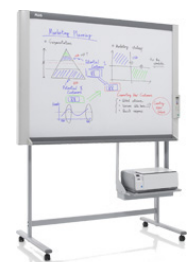


in 2004

■ **M-12 Series**

PLUS Corporation

COPYBOARD with  $\mu$ ITRON specification OS





## ■ MD DISCAM

MiniDisc Camcorder with JTRON

Sony Corporation



※ End of Sale

## ■ VAIO [type X]

AV Recording Server with  $\mu$ ITRON specification OS ※

Sony Corporation



※  $\mu$ ITRON (Sub-OS)  
※ End of Sale

## ■ X Video Station

VCR Server with  $\mu$ ITRON4.0 specification OS

Sony Corporation



※ End of Sale

## ■ IPSiO G7570

GELGET Printer with  $\mu$ ITRON3.0 specification OS

Ricoh Company, Ltd.



## ■ imagio Neo 1050

Multifunction B & W with  $\mu$ ITRON specification OS

Ricoh Company, Ltd.

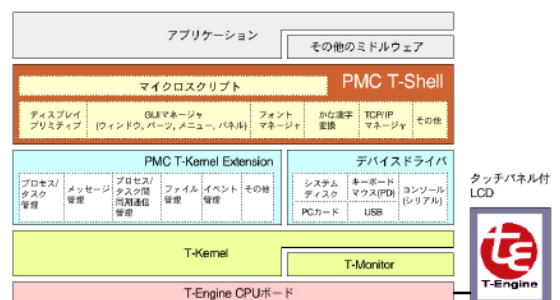


# ● T-Kernel, $\mu$ T-Kernel specification OS and Development Environment

## ■ PMC T-Kernel

T-Kernel specification OS

Personal Media Corporation



## ■ eT-Kernel

eSOL Co.,Ltd.

T-Kernel specification OS



eBinder  
T-Kernel/μITRON-based  
system development suite

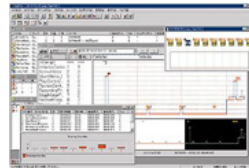


Embedded software platform  
with T-Kernel/μITRON

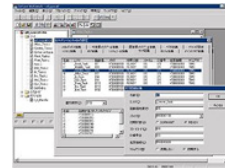
## ■ SOFTUNE μT-REALOS/FR

FUJITSU MICROELECTRONICS LIMITED

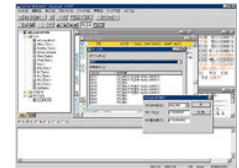
μT-Kernel  
specification OS



REALOS ANALYZER



REALOS CONFIGURATOR

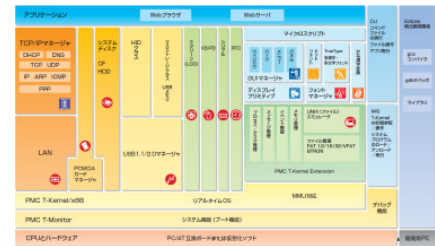


Multi-task DEBUGGER

## ■ T-Kernel/x86 Evaluation Kit

Personal Media Corporation

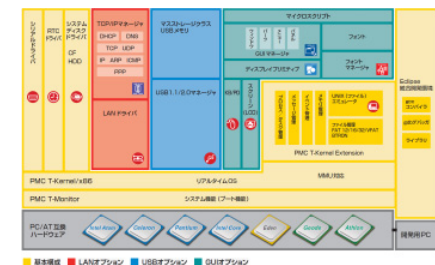
T-Kernel specification OS



## ■ T-Kernel/x86 Production Copy

Personal Media Corporation

T-Kernel Specification OS



## ■ Real-Time OS Education & Training Package

Personal Media Corporation



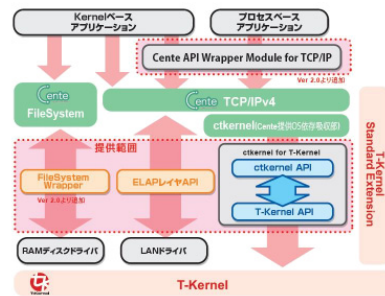
## ■ T-Kernel 2.0 Reference Kit

Personal Media Corporation



## ● Middleware and Development Kit with T-Kernel

### ■ Middleware with T-Kernel



T-Kernel Wrapper for Cente2.0  
T-Kernel-compliant middleware library  
CORE CORPORATION



EMPRESS ULTRA EMBEDDED  
Embedded Database  
EMPRESS SOFTWARE INC.  
Planners Land Co., Ltd



EGI (Embedded General Index)  
API library for Building Index  
Outstanding Technology Co., Ltd.  
Planners Land Co., Ltd.

### ■ T-Engine/μT-Engine



Standard T-Engine board  
Yokogawa Digital Computer  
Corporation



μT-Engine board  
Yokogawa Digital Computer  
Corporation



T-Engine/SH7727  
Development Kit  
Personal Media Corporation



T-Engine/SH7760  
Development Kit  
Personal Media Corporation



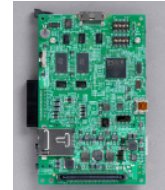
T-Engine/VR5701  
Development Kit  
Personal Media Corporation



T-Engine/TX4956  
Development Kit  
Personal Media Corporation



T-Engine/ARM926-MB8  
Development Kit  
Personal Media Corporation



T-Engine/ARM926-MX21  
Development Kit  
Personal Media Corporation



T-Engine/ARM920-MX1  
Development Kit  
Personal Media Corporation



T-Engine/PPC-V4FX  
Development Kit  
Personal Media Corporation



μT-Engine/V850E-MA3  
Development Kit  
Personal Media Corporation

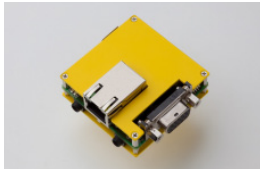


μT-Engine/VR4131  
Development Kit  
Personal Media Corporation



SH7780 T-Engine  
Development Kit  
Renesas Electronics Corporation

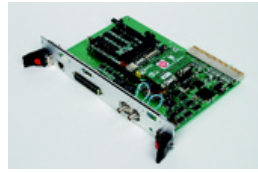
## T-Engine Appliance



Teamacaron  
Personal Media Corporation



Teacube/VR5701 Evaluation Kit  
Personal Media Corporation



MIL-STD-1553B Specification-  
compliant CPU board  
NEC TOSHIBA  
Space Systems, Ltd.



T-CORE H8SX for mobile  
CORE CORPORATION



@Face Development Kit  
Unit board  
T.D.I. Co., Ltd.



Teatouch  
Personal Media Corporation



MP T-Kernel/NE1  
Evaluation Board  
Personal Media Corporation



μTeaboard/ARM7-AT91  
Personal Media Corporation



μTeaboard2/ARM920-MX1  
Personal Media Corporation



CRAFTSYSTEM  
Multi Protocol Analyzer  
NEC TOSHIBA  
Space Systems, Ltd.



T-CORE SH7619 Unit  
CORE CORPORATION



LXR Controller  
Matsutame CO., LTD



MP T-Kernel/NE1  
Evaluation Board  
Personal Media Corporation



Algo Smart Panel  
ALGO SYSTEM



SH7723 Reference Platform  
(T-Kernel Appliance)  
Renesas Electronics Corporation

## T-Kernel SDK / μT-Kernel SDK



T-Kernel SDK for SH7785  
CORE CORPORATION



T-Kernel SDK for T-CORE  
SH7619  
CORE CORPORATION



T-Kernel SDK for NALTEC  
SH7619  
CORE CORPORATION



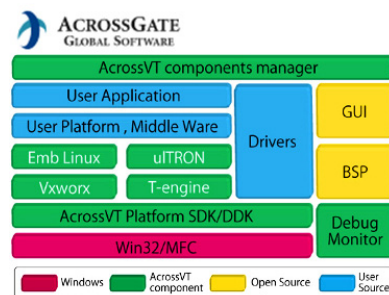
T-Kernel SDK for ARM9 (MP201)  
CORE CORPORATION



μT-Kernel SDK for T-CORE  
H8SX/1653F  
CORE CORPORATION



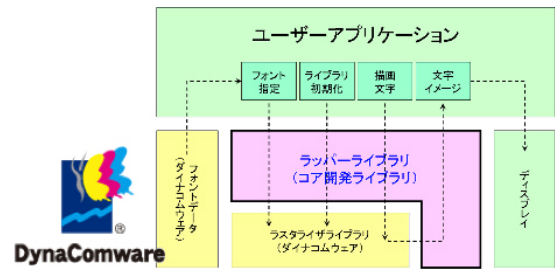
**ASURA**  
μT-Kernel SDK for ASURA  
CORE CORPORATION



Development Environment Simulator  
AcrossVT for Developer  
CORE CORPORATION



■ Other



Font System for multiple languages with T-Kernel  
CORE CORPORATION

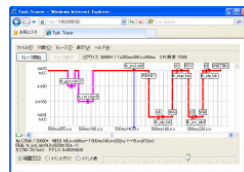
● T-Engine Related Software

■ T-Engine Related Software

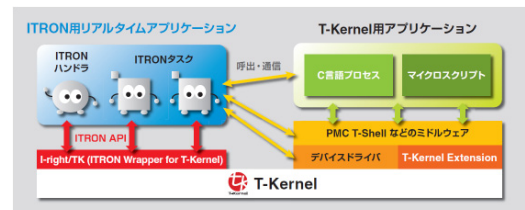
Personal Media Corporation



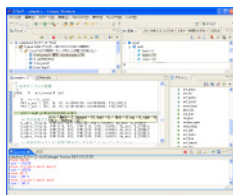
PMC T-Kernel



Task Tracer for T-Kernel



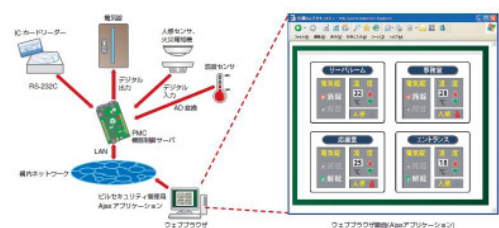
I-right/TK



Eclipse for PMC T-Kernel



PMC T-Shell



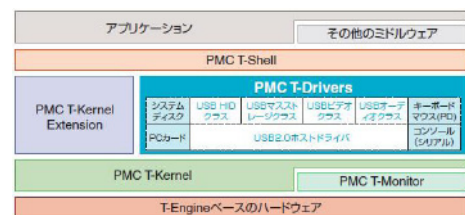
PMC Equipment Control Server



PMC T-Drivers



Multi-RFID Driver for T-Kernel



PMC T-Drivers USB2.0 Development Kit

● T-Kernel Related Products

■ T-Kernel Related Products

Personal Media Corporation



Disk Shredder 4 Light



Disk Shredder 4 Standard



Disk Shredder 4 Super

## ● $\mu$ ITRON specification OS and Development Tools

### ■ PrKERNELv4

$\mu$ ITRON4.0 specification OS

eSOL Co., Ltd.

PrKERNELv4<sup>®</sup>



eBinder  
T-Kernel/ $\mu$ ITRON-based  
system development suite



Embedded software platform  
with T-Kernel/ $\mu$ ITRON

### ■ Development tool that supports $\mu$ ITRON specification OS

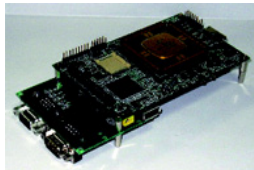


advicePRO microVIEW-PLUS  
Yokogawa Digital Computer  
Corporation



TRQer  
Measuring Instruments for  
quality and performance  
Yokogawa Digital Computer  
Corporation

### ■ Embedded System Unit / Evaluation Board with $\mu$ ITRON specification OS



HR5000 Evaluation Kit  
NEC TOSHIBA  
Space Systems, Ltd.



NVP-Ax135P  
Image Processing Unit  
Renesas Northern Japan  
Semiconductor, Inc.



FD2/HL  
High-speed Controller Unit  
Japan Minicomputer  
Systems Co., Ltd.



SVP-330  
Image Processing Unit  
Renesas Northern Japan  
Semiconductor, Inc.

### ■ Embedded system unit with $\mu$ ITRON specification OS



IPsec encryption adapter  
"IP-Chipher"  
ZUKEN ELMIC, Inc.



In-vehicle System  
FUJITSU LIMITED



RFID Tag-capable  
Handheld Terminal  
FUJITSU LIMITED



YZ-320 Series  
Centralized Monitoring System  
YAZAKI CORPORATION



DTG2  
Digital Tachograph  
YAZAKI CORPORATION



BTA-3005A  
IT Adaptor for Internet Appliance  
TOSHIBA CONSUMER  
MARKETING CORPORATION



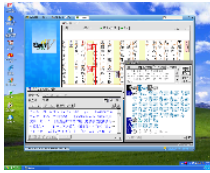
FD2/DX  
FA Process Controller  
Japan Minicomputer  
Systems Co., Ltd.



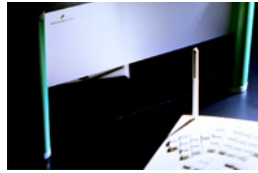
TB-100  
FA Computer  
Japan Minicomputer  
Systems Co., Ltd.

## ● BTRON, etc.

### ■ BTRON-specification OS



B-right/V  
Personal Media Corporation



MCUBE / BTRON3  
Work Station  
Personal Media Corporation

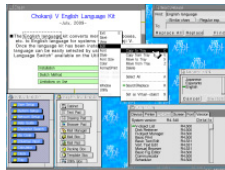


1B/desktop  
Personal Media Corporation

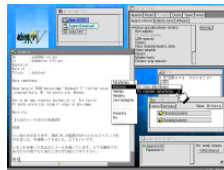


1B/V1  
Personal Media Corporation

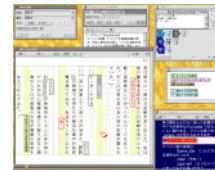
### ■ BTRON Related Products



Chokanji V  
English Language Kit  
Personal Media Corporation



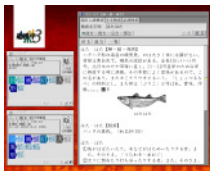
Chokanji V  
Esperanto Language Kit  
Personal Media Corporation



Chokanji  
Document Processor 2  
Personal Media Corporation



Chokanji Integrated Dictionary  
Personal Media Corporation



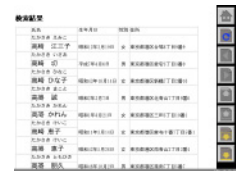
Chokanji Kojien  
Personal Media Corporation



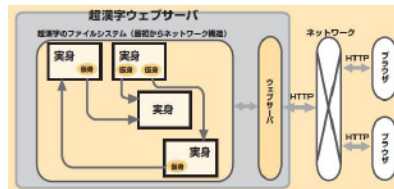
Chokanji  
Iwanami Shin Kango jiten  
Personal Media Corporation



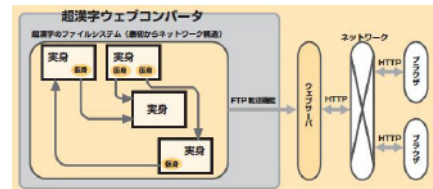
Chokanji Kouki Jiten  
Personal Media Corporation



Chokanji Solution  
for Oracle  
Personal Media Corporation



Chokanji Web Server  
Personal Media Corporation



Chokanji Web Converter  
Personal Media Corporation

### ■ Ergonomics Keyboard

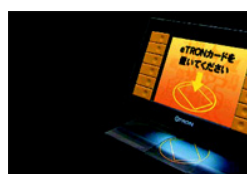


μTRON Keyboard  
Personal Media Corporation



TK1  
TRON Specification-compliant  
Keyboard  
Personal Media Corporation

### ■ Security Tool with eTRON



PSE-3000  
Personal Media Corporation



File Locker  
Personal Media Corporation

# T-Engine Forum Admission Guide

## Who is T-Engine Forum?

T-Engine Forum is an NPO with the activity of international scope to promote the standards to improve the efficiency of real-time embedded systems development and to develop the infrastructure to implement ubiquitous computing environment.

- T-Engine Forum conducts the followings: creation of the specification of real-time OS based on open architecture, "T-Kernel," distribution of its open source code, promotion of the distribution of middleware implemented on T-Kernel, and specification creation and publication, promotion of standard development environment T-Engine.
- T-Engine Forum designs and maintains ITRON specification.
- T-Engine Forum writes the specification of ucode, which is the universal number to identify "objects" and "places" as well as conducts the specification creation, utilization, and promotion of ubiquitous ID architecture, which is an application of ucode.
  - Operates Ubiquitous ID Center, which is in charge of issuing/managing ucode.
  - Conducts standardization activities toward achieving ubiquitous computing environment, and plays a coordinating role among governmental/international organizations.

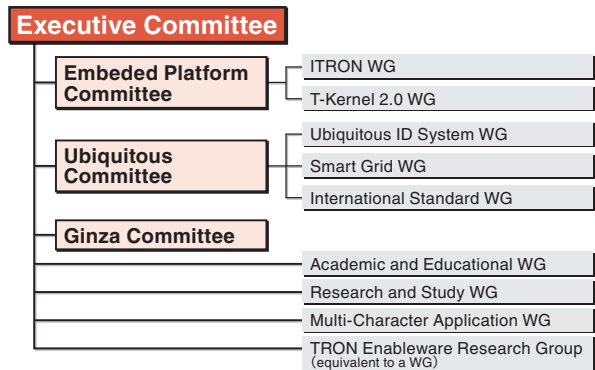
## Policy

- The specifications created through the forum activities will be released to the public worldwide in an easy-to-access manner to anyone after review by members. For example, the source code of real-time OS, "T-Kernel" has been downloadable for free since January 2004.
- The forum does not create just technical specifications but performs the study of intellectual property rights (IPR) system appropriate for the embedded industry. For example, the studies are reflected in

the license system such as "T-License" established in consideration of how open and free OS specifications can be utilized in business scene or how the rights of users (companies) can be protected without causing any problems after the use of specifications, etc.

## Various Meetings

- **Executive Committee**  
[Only Executive Committee members can attend.]
  - Decision-making body of T-Engine Forum consisting of Executive Committee members
- **Committee**  
[A- and Executive Committee members can attend.]
  - T-Engine Platform Committee, Ubiquitous Committee and Ginza Committee are held. This is where the WG activities are reported.
- **Working Group**  
[A- and Executive Committee members can attend.]
  - Studying particular topics



## Activities

### [General Meeting]

- The general meeting is held four times a year to report the forum activities to members, introduce the products of members, and promote exchanges of information among members. Members can attend a speech by Professor Ken Sakamura, Chair of T-Engine Forum.



[General meetings for A- and B-members and for A- and e-members are respectively held, which those having respective memberships can attend.]



## [Participation in Seminars]

- Seminars related to T-Engine, T-Kernel, ubiquitous ID technology are held.

[available to each membership type]

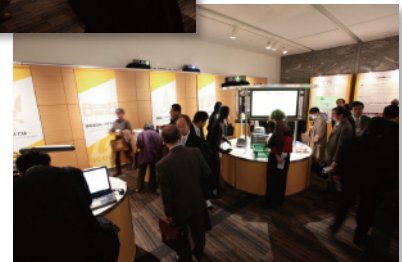


## [Obtaining Information]

- Members will obtain information on T-Engine, T-Kernel, ubiquitous ID technology through websites and e-mail magazines.
- Members will obtain the following information at the members-only webpage: (However, available information is different depending on membership types. Separate contracts or applications may be required for some types of information.)
  - The latest and updated information of T-Kernel,  $\mu$ T-Kernel, T-Kernel Standard Extension, MP T-Kernel, selectable adaptation patch, and tool, etc. prior to the public release.
  - Activity reports of general meetings, committees, and selectable WGs
  - Seminar texts or sample codes, etc.
  - Members can widely disseminate information on their own products related to T-Engine and/or T-Kernel to the public.

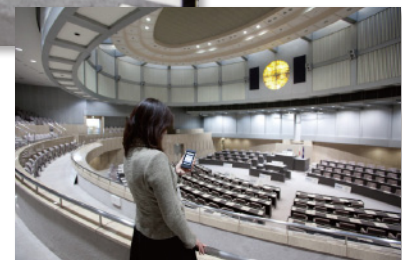
## [Exhibit]

- The forum introduces T-Engine, T-Kernel and ubiquitous ID technologies to the public, hosting TRONSHOW, an annual technology exhibition where the results of TRON Project and related projects are shown, and making presentations at various exhibits.



## [Cooperation for Various Feasibility Study Experiments]

- T-Engine Forum has participated in the activities of “Free Mobility Assistance Project” across Japan, including “Tokyo Ubiquitous Technology Project.” It has conducted a variety of preparations and coordination and has worked together to improve the experiment environments.



#### [Information for the Media]

- The forum disseminates information on T-Engine, T-Kernel, and ubiquitous ID technology to the press and cooperates with the media for news gathering activities.



#### The TRON Engineer Certification Examination

- Many problems occur due to the lack of criteria to measure technical skills objectively when development work is outsourced. Such outsourcing happens often due to the scarcity of embedded engineers. To resolve them, T-Engine Forum conducts the "TRON Engineer Certification Examination." The purposes of the examination are to objectively measure the technical skills of engineers who use embedded real-time OS such as T-Kernel and ITRON specification OS, etc., in order to improve the status of engineers with high technological skills and to stimulate the entire embedded systems industry.
- The examination is for embedded real-time systems development engineers in companies that utilize or consider utilizing TRON specification OS such as T-Kernel and ITRON specification OS, etc.
- The examination time is 90 minutes.
- The perfect score is 100 points, and a pass/fail judgment is not made.
- T-Engine Forum members can take the examination at a discount.

#### Ubiquitous ID Center

- T-Engine Forum operates Ubiquitous ID Center that issues and manages ucodes.
- Developing and certifying the following core technology for ucodes:

- Data carrier devices to store ucodes (RFIDs, smart cards, active chips, etc.)
- Devices that communicate with data carrier devices (Ubiquitous Communicators)
- Communication infrastructure that can retrieve information associated with ucodes
- Secure wide-area distributed systems for ucodes and information associated with the ucodes
- Supporting overseas branches of Ubiquitous ID Center, which issue and manage ucodes abroad
- Collecting and providing information toward the realization of ubiquitous computing environments
- Conducting standardization activities and coordinating with government agencies or international organizations toward the realization of ubiquitous computing environments

#### T-Engine Forum membership types

##### • Executive Committee member

- Executive Committee members can
  - participate in the decision-making processes for policies and strategies of T-Engine Forum.
  - participate in the Executive Committee meetings, Committee meetings, working groups, general meetings, and seminars.
  - have all the privileges that A-, B-, and e-members have and can browse all of the members-only websites.

##### • A-member

- Companies that manufacture hardware, develop various middleware, or provide its development environment in the embedded systems industry can participate in T-Engine Forum. Companies that provide products related to ucode tag such as RFID tags or QR codes, etc. and their reader devices related to Ubiquitous ID technology or web services using ucodes can also participate in the forum.
- Those that develop products using T-Engine and/or T-Kernel and would like to be deeply involved in the specification creation and development of T-Engine and/or T-Kernel find A-member type suitable for their needs.

- Those that develop ubiquitous-related technologies and/or products and would like to be deeply involved in the specification creation and development of Ubiquitous ID technology, etc. and provider services find A-member type suitable for their needs.
- A-members can
  - access information of T-Engine, T-Kernel, and Ubiquitous ID technology, etc. prior to the releases to B- and e-members.
  - participate in committees, working groups, general meetings, and seminars.
  - demonstrate their own products or services related to T-Engine, T-Kernel, and Ubiquitous ID technology to other members by showcasing at general meetings.
  - enjoy the privileges that B- and e-members have and browse all of the members-only websites.

#### • B-member

---

- Companies that manufacture hardware, develop various middleware, or provide its development environment in the embedded systems industry can participate in T-Engine Forum.
- Those that consider developing products using T-Engine and/or T-Kernel find B-member type suitable for their needs.
- B-members can
  - access information of T-Engine and T-Kernel, etc. prior to the releases to the public.
  - participate in general meeting for B-members and seminars.
  - browse the B-members-only website.

#### • e-member

---

- Companies that provide products related to ucode tag such as RFID tags or QR codes, etc. and their reader devices related to ubiquitous ID technology or web services using ucodes can participate in the forum. Furthermore, the users of such products in all industries and public sectors such as food, retail, distribution, construction, and contents industries, local governments, and government agencies, etc. can participate.
- Those that use Ubiquitous ID technology and eTRON

find e-member type suitable for their needs.

- e-members can
  - access information of Ubiquitous ID technology prior to the release to the public.
  - conduct various feasibility study experiments using the Experimental Activity Procedure (EAP).
  - participate in general meeting for e-members and seminars.
  - browse the e-members-only website.

#### • Academic member

---

- Academic parties that use T-Engine, T-Kernel, ubiquitous ID technology, and eTRON can participate in the forum.
- Academic members can
  - participate in unit as university, faculty, department, or individual laboratory.
  - receive 48-bit ucode allocation.
  - participate in seminars.
  - browse the academic members-only website.

#### • Liaison member

---

- Organizations that conduct the research and development of open architecture which they can promote with T-Engine Forum.
- Liaison members can
  - participate in some types of meetings if the participation is approved by the Executive Committee.
  - browse the liaison members-only website.

#### • Supporting member

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- For those that provide financial support for the activities of T-Engine Forum.
- Supporting members are not involved in the formulation or approval of forum standards.
- Supporting members can
  - receive 48-bit ucode allocation.
  - participate in general meeting and seminars.
  - browse the supporting members-only website.

Membership Type/ Activity content	Executive Committee members	A- members	B- members	e- members	Academic members	Liaison members	Supporting members
Participation in Executive Committee meeting	○	×	×	×	×	×	×
Participation in General meeting	○	○	○	○	×	△ <sup>*1</sup>	○
Participation in Committee meeting	○	○	×	×	×	△ <sup>*1</sup>	×
Participation in WGs	○	○	×	×	×	△ <sup>*1</sup>	×
Participation in Seminars	○	○	○	○	○	△ <sup>*1</sup>	○
A-members- only website	○	○	×	×	×	×	×
B-members- only website	○	○	○	×	×	×	×
e-members- only website	○	○	×	○	×	×	×
Academic members- only website	○	×	×	×	○	×	×
Liaison members- only website	○	×	×	×	×	○	×
Supporting members- only website	○	×	×	×	×	×	○
ucode Allocation (General)	○	○	×	○	○	×	○
ucode Allocation (Provider)	○	○	×	○ <sup>*2</sup>	×	×	○
Monthly e-mail magazine distribution	○	○	○	○	○	○	○

\*1: Can participate if approved by the Executive Committee \*2: If pay three shares or more

E-mail: [office@t-engine.org](mailto:office@t-engine.org)

URL: <http://www.t-engine.org/index.html>

## 【T-Engine Forum Annual Fee and Validity Period of Membership】

T-Engine Forum's activities are held on an annual basis from April 1 to March 31. Irrespective of the timing of participation, the membership is valid only for the applicable year. Only a legally incorporated organization can join in T-Engine Forum.

- Executive Committee members:  
A-members that pay 3,000,000 yen or more
- A-members: one share 1,000,000 yen/year  
(please pay one or more shares)
- B-members: one share 100,000 yen/year  
(please pay one or more shares)
- e-members: one share 100,000 yen/year  
(please pay one or more shares)
- Academic members: Free/year
- Liaison members: Free/year
- Supporting members: one share 1,000,000 yen/  
year (please pay three or more shares)

## Application for participation or inquiries

For inquiries, please contact T-Engine Forum Secretariat.

In YRP Ubiquitous Networking Laboratory  
The 28th Kowa Building, 2-20-1,  
Nishi-Gotanda, Shinagawa, Tokyo  
141-0031, Japan  
Tel: +81-3-5437-0572  
Fax: +81-3-5437-2399

# Member Organization List

(January 31, 2011: 295 members)

## Executive Committee members 17

Aplix Corporation  
DAI NIPPON PRINTING CO., LTD.  
DENSO CORPORATION  
eSOL Co., Ltd.  
FUJITSU LIMITED  
Fujitsu Semiconductor Limited  
Hitachi, Ltd.  
Hitachi ULSI Systems Co., Ltd.  
NEC Corporation  
Nihon Unisys, Ltd.  
NTT DoCoMo, Inc.  
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 Department of Civil Engineering, HanYang University (Korea)  
 Department of Computer Science, University of Yamanashi  
 Department of Control and Computer Engineering, Numazu College of Technology  
 Department of Electrical and Electronics Engineering, Kokushikan University  
 Department of Electrical and Electronic Engineering, School of Electrical and Computer Engineering, National Defense Academy of Japan  
 Department of Information Science, Osaka Institute of Technology  
 EHIME ELECTRONIC BUSINESS COLLEGE  
 Electronics Design Lab., Hanoi University of Technology (Vietnam)  
 Employment and Human Resources Development Organization of Japan Tochigi  
 Environmental Design and Information Technology Laboratory, Division of Sustainable Energy and Environmental Engineering, Graduate School of Engineering, Osaka University  
 Faculty of Information Technology, Ho Chi Minh City University of Technology (Vietnam)  
 Farm Management, Division of Natural Resource Economics, Graduate School of Agriculture, Kyoto University  
 Field Monitoring Research Team, National Agricultural Research Center, National Agriculture and Food Research Organization  
 Fu Jen Catholic University (Taiwan)  
 Fukuda Laboratory, Department of Micro-Nano Systems Engineering, Nagoya University  
 Fukuyama University  
 Furukawa Laboratory, GRADUATE SCHOOL OF MEDIA DESIGN, KEIO UNIVERSITY  
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 Hongo Laboratory, Department of Frontier Information Engineering, Faculty of Advanced Engineering, Hokkaido Institute of Technology  
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 Iijima Laboratory, Faculty of Science and Technology, Keio University  
 Inaba-Inamura laboratory, Dept. of Mechano-Informatics, Faculty of Engineering, Univ. of Tokyo  
 Industrial Technology Research Institute/Identification and Security Technology Center(ISTC)(Taiwan)

Information-technology Promotion Agency, Japan  
 Inha University (Korea)  
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 Integrated System Design Lab. (IMAI Lab.), Osaka University  
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## **T-Engine 2011**

### **T-Engine Forum**

The 28th KOWA Bldg. 2-20-1, Nishi Gotanda, Shinagawa, Tokyo 141-0031 Japan

TEL: +81-3-5437-0572 / FAX: +81-3-5437-2399

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