Android on a Highly Reliable Real-Time OS

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eSOL for Android extends Android applications to a wider marketplace of embedded devices that require high performance and reliability, such as car infotainment systems, multimedia devices, office automation equipment, and more.

Android™ from The Open Handset Alliance was originally designed to be used in mobile computing applications, from handsets to tablets to e-books. But developers are also looking to employ Android in a variety of other embedded systems that have traditionally relied on the benefits of true real-time operating systems: performance, boot-up time, real-time response, reliability, and no hidden maintenance costs.

To literally “embed” these elements in Android-based system development, eSOL has developed eSOL for Android™. eSOL has more than 30 years’ experience in operating system technologies and applied its accumulated expertise to develop this comprehensive solution. The core component is eT-Kernel Adaptor for Android, which replaces Linux with eSOL’s eT-Kernel real-time OS, thus ensuring faster real-time response and higher reliability in an Android-based system. eT-Kernel Adaptor for Android brings Android into the wider embedded systems marketplace — including consumer electronics that increasingly utilize cloud computing technology, in-vehicle multimedia systems, multifunction printers, and many other embedded applications that require high performance and reliability.

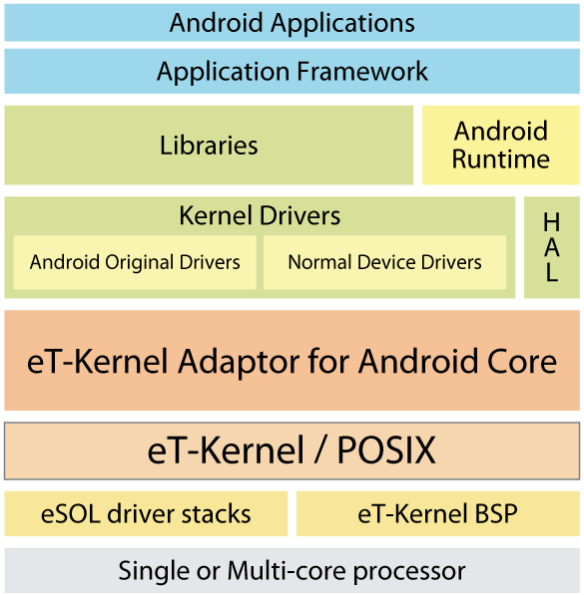
This article describes the eSOL for Android architecture and the advantages of its eT-Kernel Adaptor for Android, and shows how the deployment of eT-Kernel in future Android-based systems will offer more than higher performance and reliability. The article also explores the details of eT-Kernel, which provides full-scale POSIX services, eSOL’s unique Blended Scheduling® feature, and system protection for multicore systems.

eSOL for Android

eSOL for Android consists of eSOL Adaptor for Android — adaptation software that replaces Linux with true embedded operating systems — and eSOL Professional Services for Android — engineering services tailor-made for Android system development. eSOL Adaptor for Android works on both ARM single core and multicore processors, such as ARM Cortex-A9/ARM11 MPCore and ARM11 based single cores.

eT-Kernel Adaptor for Android — Combining the Advantages of Android and the Highly Reliable eT-Kernel Real-Time OS

eSOL's eT-Kernel is the first RTOS to replace the Linux OS in the eSOL Adaptor for Android product line. eT-Kernel Adaptor for Android acts as the core component, enabling Android's standard libraries, runtime environment, application framework, and application software to run on the highly reliable eT-Kernel RTOS. As a result, eT-Kernel Adaptor for Android combines the advantages of middleware- and application-rich Android systems with those of eT-Kernel.



Here are some of the main advantages of eT-Kernel Adaptor for Android:

- Provides fast real-time response and boot time
- Provides high system reliability with eSOL's proven eT-Kernel RTOS
- Provides highest level of reliability for embedded multicore systems
- Enables coexistence of Android, POSIX, and real-time applications
- Ensures full compatibility with Android application programs and the Android SDK
- Enables reuse of Linux software and engineering resources

This next section describes three eT-Kernel product lines and how they support the development of Android applications. These three lines include:

- eT-Kernel/POSIX, a POSIX-compliant profile of the multiprofiled eT-Kernel
- eT-Kernel Multi-Core Edition, a version of eT-Kernel for multicore processors
- eT-Kernel Multi-Core Edition Memory Partitioning, a system protection add-on for the eT-Kernel Multi-Core Edition that provides extra reliability for multicore systems

eT-Kernel — Ensuring Fast Real-Time Response and High Reliability for Android

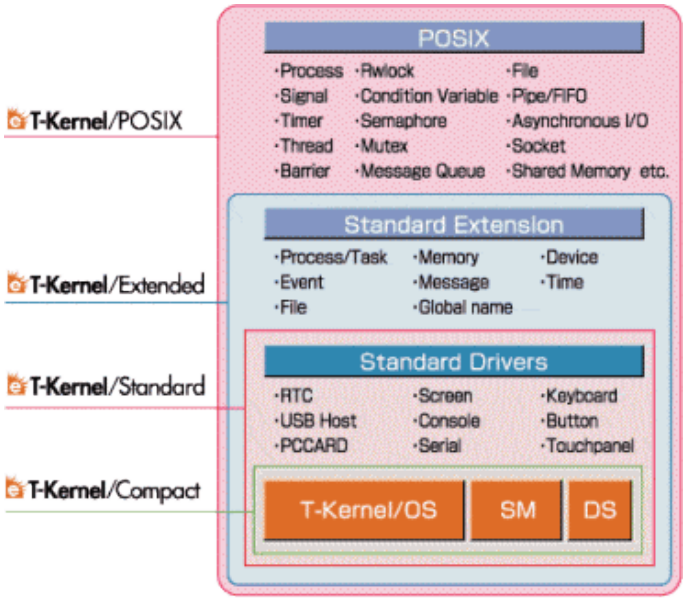
The eT-Kernel RTOS provides fast real-time response and boot-up time to Android-based systems that Linux cannot match. With its memory protection function and eSOL's unique system protection features for multicore systems, eT-Kernel also provides higher-quality reliability for Android. eT-Kernel has proved its value in a wide range of embedded systems such as car navigation systems, aerospace, and consumer electronics. eT-Kernel also supports ARM core-based single-core and multicore processors, including ARM Cortex-A9 MPCore, Cortex-A8, ARM11, and MPCore.

Although open-source code like Linux is popular, it requires individual development teams to take responsibility for their own OS maintenance, optimization, system integration, and custom BSP development. eSOL, on the other hand, can provide all those services through its professional services team. And while eT-Kernel source code is open to its licensees, an individual customer's code need

not be open to anyone if it is linked to the kernel. What's more, developers can use eSOL's flagship eBinder® integrated development environment — which is bundled with ARM's RealView® Compilation Tools — to create eT-Kernel applications. In addition, eT-Kernel allows reuse of Linux software and engineering resources.

The scalable eT-Kernel has four profiles to fit different memory sizes and purposes.

eT-Kernel/POSIX	Real-time OS compliant with POSIX specifications
eT-Kernel/Extended	Real-time OS with memory protection and a process model for large systems
eT-Kernel/Standard	Real-time OS including eT-Kernel/Compact with standard device drivers
eT-Kernel/Compact	Compact real-time OS with high real-time performance



OS:Operating System, SM:System Manager, DS:Debugger Support

Since each profile has a common kernel at its core, kernel-level software such as device drivers and middleware are easy to reuse on every other profile. This enables developers to not only streamline series product development, but also easily incorporate variant eT-Kernel profiles into new products.

For multicore systems, eSOL provides the eT-Kernel Multi-Core Edition. A system add-on, eT-Kernel Multi-Core Edition Memory Partitioning, provides the maximum level of reliability possible.

eT-Kernel/POSIX — Enabling Reuse of Linux Software

eT-Kernel/POSIX is a POSIX-compliant real-time OS that facilitates UNIX-based software reuse. Since Linux is a UNIX-based OS, eT-Kernel/POSIX is highly compatible with Linux-based Android. Linux users can still utilize familiar UNIX-based software and engineering resources while adding the advantages of eT-Kernel to their systems.

eT-Kernel/POSIX complies with the IEEE Std 1003.1, 2004 Edition, The Open Group Technical Standard Base Specifications, Issue 6, and supports

most prescribed POSIX APIs. It supports pthread as a thread-managing function both in and between processes, interprocess communication (IPC), and programming with signals that are often used in UNIX systems. The basic services of eT-Kernel/POSIX are listed below:

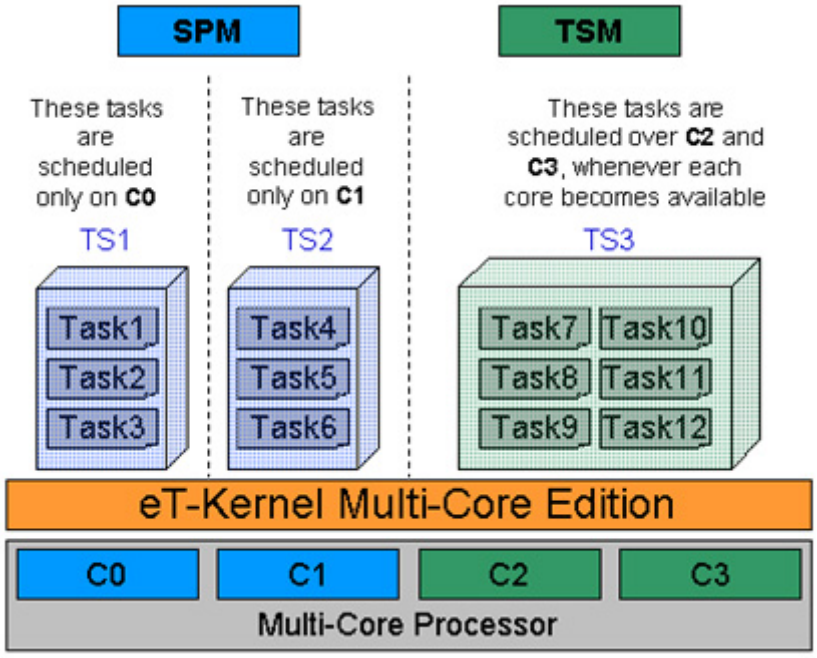
Process	Barrier	Mutex	Asynchronous I/O
Signal	Rwlock	Message Queue	Socket
Timer	Condition Variable	File	Shared Memory
Thread	Semaphore	Pipe/FIFO	

On eT-Kernel/POSIX, POSIX-based applications and µITRON/T-Kernel-based real-time applications can coexist in one system. By deploying eT-Kernel Adaptor for Android, Java-based Android applications can also coexist. Generally there are different types of applications in just one system, varying greatly with types of developer, software reusability, and reliability: for example, GUI-rich user applications, real-time applications, and kernel applications that require high reliability. By appropriately selecting and blending features of both eT-Kernel/POSIX and Android, all required applications can be safely implemented in terms of both quality and cost.

eT-Kernel Multi-Core Edition — Enabling SMP and AMP Software to Coexist in a Single System

Feature-rich, high-performance Android systems require high-end CPU power and so, in many cases, need to be implemented on multicore processors. The eT-Kernel Multi-Core Edition permits flexible software design that enables developers to optimize multicore processor performance.

The eT-Kernel Multi-Core Edition features Blended Scheduling, which enables the coexistence of both symmetrical (SMP) and asymmetrical (AMP) multicore processing in a single system. There are two scheduling modes: single processor mode (SPM) and true SMP mode (TSM). To take advantage of both SMP and AMP programs, developers can select an appropriate mode for each program, and achieve high throughput, real-time performance, and software reuse, all in one system. Because one OS controls programs on all CPU cores, no additional, often slow inter-OS communication layer is required for intercore communication and synchronization.



eT-Kernel Multi-Core Edition Memory Partitioning — Achieving Maximum Reliability in a System Where Android, POSIX, and Real-time Applications Coexist

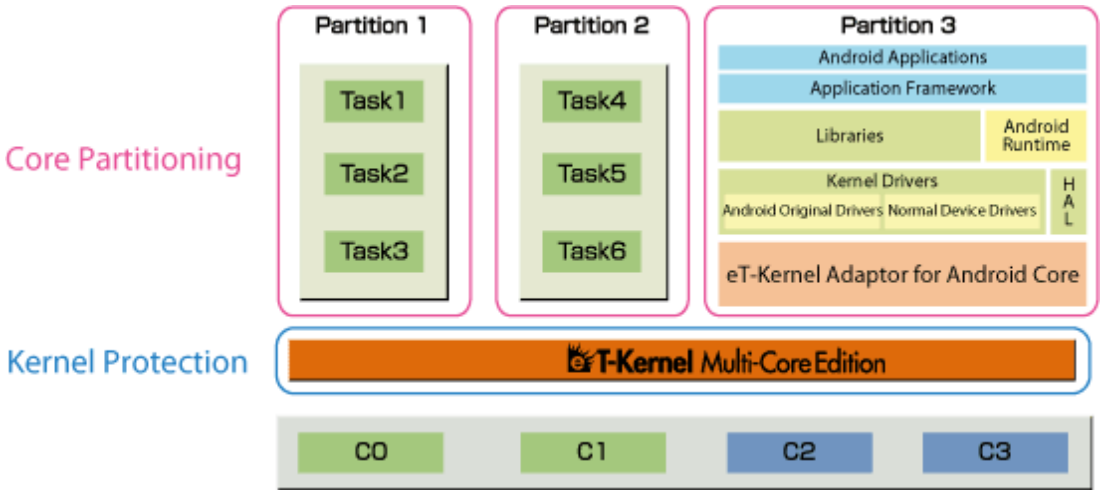
eT-Kernel Multi-Core Edition Memory Partitioning offers the highest level of reliability — the kind of reliability that prevents memory interference between any application and kernel on any given core(s).

The following diagram shows how. POSIX/µITRON/T-Kernel real-time applications are assigned to Core 0 and Core 1, while the Android system and its applications are assigned to Core 2 and Core 3. Memory Partitioning protects individual partition memories from interfering with each other, and even with kernel-level drivers. What's more, eT-Kernel Multi-Core Edition Memory Partitioning has the unique ability to permit these partitions to communicate to each other via basic OS services like messaging and semaphore, thus creating an integrated system that contains separate yet blended components.

Conclusion

eSOL for Android, with its core component, eT-Kernel Adaptor for Android, can be used to develop Android-based systems, especially on ARM cores. eSOL supports a wide range of ARM cores and is a member of the ARM Solution Center for Android as well as the ARM Connected Community. eSOL also offers optimized engineering services for ARM-based Android systems.

In summary, replacing Linux with the eT-Kernel real-time OS expands the market for Android applications and adds real-time capability and higher reliability.



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