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# *Linaro Speeds Development in TI Linux™ SDKs*

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## **Overview**

Since Linaro™ ([www.linaro.org](http://www.linaro.org)) was formed in 2010, Texas Instruments (TI) has been a charter member of this non-profit engineering organization dedicated to optimizing open-source software for ARM® processors. Linaro's software is not a Linux distribution; in fact, it is distribution neutral. The focus of the organization's 120 engineers is on optimizing base-level open-source software in areas that interact directly with the silicon such as multimedia, graphics, power management, the Linux kernel and booting processes. To ensure the best possible development experience, Linaro is constantly improving and optimizing for ARM processors the GNU Compiler Collection (GCC) tool chain. The organization also improves the quality of ARM runtime code by promulgating a stringent set of testing and validation procedures. To make it even easier, Linaro's software is truly open source. It is available to anyone – members and nonmembers – without royalties.

Linaro software is targeted at ARM's advanced Cortex™-A processors, specifically the A5, A7, A8, A9 and A15.

## **Strength in numbers**

Linaro is an effective means for its member companies to affect improvements in base-level software for the ARM open-source community. This, of course, increases the performance and capabilities of the technologies available in the marketplace. By pooling their resources in support of Linaro, member companies are able to more favorably influence the scope, scale and nature of open-source software and make advanced capabilities available sooner for integration into ARM-based development programs. Pooling their resources for base-level software also allows member companies to focus more of their time on their differentiating software and provide those features to their customers sooner.

In fact, Linaro is able to provide ARM-focused advanced capabilities sooner than the maintainers of the GCC tool chain and compilers, and, at the same time, push these new features upstream for inclusion in GCC releases maintained by the Free Software Foundation (FSF). As a result, ARM developers can obtain the advanced features of Linaro releases up to one year before these same features are included in GCC. This can improve significantly a development organization's time-to-market, since advanced features often accelerate design cycles.

In addition, Linaro's robust testing procedures minimize the destabilizing effects that new tool chain features or compiler improvements sometimes provoke. Thorough initial testing is conducted prior to Linaro releases and also on a continuing basis following every release. These ongoing testing practices lead to patches and fixes that appear in Linaro's subsequent monthly releases of new capabilities, ensuring that Linaro-developed features are fully tested by the time they are included in the FSF's yearly GCC release.

Linaro's ongoing release process gives developers options to complement their design strategies. For example, if a design team is most concerned with rapid development through early access to advanced tool chain features, it could adopt the Linaro compiler's development version and take advantage of new features every month. Another team might place greater emphasis on the stability of the tools. This team might adopt Linaro's monthly

maintenance version which would include fixes and patches to the previous GCC, but no new features, since these might destabilize the code generated.

Linaro's engineers are also responsible for optimizing for the ARM community certain features and capabilities that have been included in the standard GCC tool chain. An example of this is the ARM-specific improvements Linaro has made to GCC's AddressSanitizer (ASAN), a fast memory error detector.

The Linaro tool chain is being integrated with open-source file systems and distributions such as Open Embedded and Yocto Project™. As this work progresses, developers will ultimately have access to a seamless development environment that works with a variety of Linux distributions from which developers can choose, each with their own strengths and capabilities.

Linaro releases are available for downloading from <http://releases.linaro.org>. Specific tool chain releases are available at <http://releases.linaro.org/YY.MM/components/toolchain>. "YY.MM" indicates the year and month of the particular release. Prebuilt binaries are available at <http://releases.linaro.org/YY.MM/components/toolchain/binaries>.

### ***The best of both worlds***

Because of the support it receives from across the industry, Linaro is uniquely empowered to offer engineers the best of both worlds: the open-source community and commercially available software. The fulltime on-staff developers of Linaro draw on the creativity and vibrancy of the open-source community for their inspiration. At the same time, their work conforms to a set of stringent quality standards. The result is an organization that is responsive to the needs of the ARM-based open-source community and which supports its work to the highest standards. This is evidenced by the regularity and frequency of its releases and its ability to keep pace with advancements in the ARM roadmap and issue code fixes and patches.

Much of the research and development conducted by Linaro's engineering staff is intended to improve the code generated by its compilers. For example, auto-vectorization when using Neon intrinsics to take advantage of the power of single instruction/multiple data (SIMD) capabilities is one area of particular attention. Another area of continuing investigation involves how to improve low-level code sequences. These efforts might examine how the compiler chooses which registers to use and whether the registers that are chosen do indeed optimize code execution. Selecting some registers for certain code sequences might require excessive storing and transferring of intermediate values which would slow code execution.

Besides its ongoing development programs, Linaro's engineers also respond to specific issues that are raised from within the community or by its members. An example of this might involve a designer at a member company who is developing a new algorithm. Unfortunately, the code output by the compiler for the new algorithm is not optimized, resulting in poor performance. Linaro's staff engineers can examine the compiler's processes and develop improvements to its output.

## **Empowering TI developers**

By integrating Linaro software, tools and testing procedures into its software development kits (SDKs), TI has improved the speed and performance of its ARM Cortex-based systems and accelerated user software development.

Linaro software is targeted at ARM's advanced Cortex-A processors, specially the A5, A7, A8, A9 and A15. Linaro's libraries have been optimized accordingly, recognizing and taking into account all of the various aspects of the ARM architecture, the function call procedures, compatible code structures and processing methods to ensure improved performance and system throughput. TI engineers are able to leverage these capabilities in enhancing their offerings for end equipment developers. For example, TI was able to improve floating-point processing performance on ARM processors recently by migrating from a software-based methodology to a hardware-based application programming interface for floating-point processing. In other words, the performance benefits and capabilities initially enabled by Linaro software are compounded with the improvements and additional features that TI engineers are able to provide.

Currently, Linaro tools, software and testing procedures are available in TI SDKs that support a range of TI's processors, including TI's **Sitara™ processors**, **OMAP™ processors** and **digital signal processors (DSPs)**:

- **Linux EZ Software Development Kit (EZSDK)** for Sitara processors
  - LinuxEZSDK-AM335x
  - LinuxEZSDK-AM35x
  - LinuxEZSDK-AM37x
  - LinuxEZSDK-BBXM
  - LinuxEZSDK-BONE
  
- SYS/BIOS™ and Linux KeyStone™ Multicore Software Development Kit (MCSDK) for multicore DSPs (**BIOSLINUXMCSDK-K2**)
  
- Linux Yocto Evaluation Software for OMAP5432 processor-based EVM (**LINUX-YOCTO-EVALUATION-SW-OMAP5432-EVM**)

As a result of this broad support, developers must only climb the Linaro learning curve once for one processor family, after which they can quickly transfer their newly acquired skills and expertise to other development programs based on another processor family.

**Conclusions**

Linaro support is just one of the many examples of TI's longstanding commitment to the open-source community. Linaro's tools, software components and testing procedures are important components of TI's Linux SDKs which provide developers with a highly efficient environment for creating optimized ARM Cortex-A-based solutions.

For more information about Linaro, go to [www.linaro.org](http://www.linaro.org).

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Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
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Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
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