Desktop-Quality 3D Graphics on Mobile Linux* Devices

Create 3D visual experiences on mobile devices similar to those on a desktop or console. New mobile usages are possible in fields such as life sciences, energy, and computer-aided engineering.

The number and variety of Linux*-based mobile devices in our lives continues to grow, as do the purposes we put them to work for. The breadth of app offerings for mobile devices alone is staggering, from games and entertainment to productivity and specialized usages for fields such as medicine and energy.

At the same time, however, the level of mobile graphics support provided by the industry has been limited to 2D and fairly rudimentary 3D implementations. A wide range of usages can benefit from extending mobile Linux graphics capabilities, as well as more sophisticated UI functionality.

A key gating factor in this regard has been that advanced 3D graphics have generally been confined to relatively large-footprint systems such as PCs and game consoles. To help advance the state of mobile graphics experiences, Intel's Open Source Technology Center recently released a new version of the driver for Intel Gen graphics offered under the MIT license.

The Intel open-source driver was certified by the Khronos Group industry consortium for compliance to the OpenGL* ES (OpenGL for Embedded Systems) 3.0 specification on the first day such submissions were granted. It was one of only a handful of such certifications awarded in that time frame. The significance of this work includes the following:

• **Dazzling 3D graphical effects** similar to those traditionally limited to devices such as PCs and consoles, now supported on mobile Linux.

• **Optimization for Intel® architecture**, including support for developing on today's Intel® Core™ processors for mobile Intel® platforms coming in 2014.

• **Confirmation of time-to-market support**, part of Intel's ongoing effort to provide early access to emerging technologies using Intel® Gen Graphics.

Intel's commitment to advancing and complying with open standards helps advance complementary innovation across the ecosystem. Since the Open GL ES 3.0 specification was announced publicly in August 2012, the Intel open source team has been submitting patches and helping refine the conformance test suite. Intel's OpenGL ES 3.0 3D driver is available today, both as a binary and as source code (which can be modified and enhanced by anyone) under the MIT license.
Develop in 3D Now for the Next Gen of Mobile Graphics

The new capabilities enabled by this technology represent significant opportunity for those organizations that plan to target mobile devices that are based on Gen graphics found in the 3rd and 4th generation Intel® Core™ processors as well as the upcoming Intel® Atom™ processor code-named Bay Trail. These devices will be running Chrome*, Tizen*, and other Linux-based mobile OSs.

OpenGL ES has become the leading 3D rendering API for mobile and embedded devices, and it has been adopted by every major handset OS.1 As shown in Figure 1, OpenGL ES is expected to remain the dominant 3D API in mobile devices over the next several years.2 Note that while Microsoft DirectX* is expected to grow to some extent in the coming years, its prevalence on the PC is not expected to extend to mobile devices. As the chart also points out, OpenGL ES is used in nearly every mobile and embedded OS, helping to ensure continuing viability of the technology in addition to supporting code portability across platforms.

OpenGL ES 3.0 offers a high level of abstraction that frees application developers to a great extent from concerns with underlying platform details. That characteristic enables them to focus more sharply on features and capabilities that add greater value to their product offerings. Moreover, the well-established development community and industry support behind the OpenGL ES specifications helps to ensure that ongoing innovation will continue at a rapid pace.

![Use of 3D APIs in Mobile Devices](image)

OpenGL* ES is the 3D API used in almost every mobile and embedded OS, other than Microsoft Windows*.

Source: Jon Peddie Research

Figure 1. Use of 3D APIs in mobile devices.2
The New Specification to Enable Accelerated, Open 3D Graphics

OpenGL ES is a lightweight API (a subset of the OpenGL desktop API, optimized for mobile and handheld devices). It is used in the majority of smartphones and tablets for authoring and acceleration of graphics processing. The OpenGL ES 3.0 specification is royalty-free and backward-compatible with OpenGL ES 2.0, allowing transparent migration of those existing applications to the new standard.

It was developed with exceptionally broad industry support and is highly portable. The Khronos announcement of the OpenGL ES 3.0 specification identified the following new set of functionality:

- **Multiple enhancements to the rendering pipeline** to enable acceleration of advanced visual effects, including occlusion queries, transform feedback, instanced rendering, and support for four or more rendering targets.
- **High-quality ETC2/EAC texture compression** as a standard feature, eliminating the need for a different set of textures for each platform.
- **A new version of the GLSL ES shading language**, with full support for integer and 32-bit floating-point operations.
- **Greatly enhanced texturing functionality**, including guaranteed support for floating-point textures, 3D textures, depth textures, vertex textures, NPOT textures, R/G textures, immutable textures, 2D array textures, swizzles, LOD and MIP level clamps, seamless cube maps, and sampler objects.
- **An extensive set of required, explicitly sized texture and render-buffer formats**, reducing implementation variability and making it much easier to write portable applications.

The open-source graphics driver from Intel is both optimized for 3rd gen Intel Core processors and certified to comply with the OpenGL ES 3.0 certification. That combination gives Linux mobile-solution providers the ability and confidence to develop and test their applications on a 3rd gen Intel Core processor-based PC today in advance of the availability of upcoming mobile platforms that will use the same driver.

Part of Intel’s Broader Open-Source Graphics Enablement

Development of Intel’s OpenGL ES 3.0-compliant open-source driver illustrates how the work done by the Open Source Technology Center complements Intel® products and technologies as a whole. Intel’s open source graphics driver stack has one of the largest rates of deployment on Linux PC clients, with support for all major PC Linux distributions and optimization for several generations of Intel Gen graphics.

Cutting-edge, open-source driver support for next-generation devices and graphics hardware enables the ecosystem to deliver enhanced user experiences at an accelerated pace. Providers of devices, applications, and OSs benefit from early access to hardware, drivers, and documentation, long before Intel platforms are introduced to the public. The Open Source Technology Center acts, in part, as an incubator to create freely distributed and modifiable code to support that early access.


People think of Intel as a hardware company, and of course, that’s true; but we are also consistently one of the top two contributors to Linux® and one of the top employers of software engineers in the world.

The Open Source Technology Center is the heart of Intel’s open-source work, which complements closed-source solutions, for an ecosystem that shapes the future of user experiences.

Learn more at 01.org

Intel Senior Software Engineer Eric Anholt elaborates on the value of control over open-source code to ecosystem partners: “Availability (of the driver source code) is important—almost more important to them than performance—because in the world of embedded products, they need to audit and edit code, and our open-source stuff allows them to do that. When Intel releases code like this in advance, it allows others to see how good our hardware really is.”

The Intel open-source driver certified for the OpenGL ES 3.0 specification is available through the Mesa project 9.1 release or later, making access simple and open to anyone who wants it, in the best tradition of open source. Additionally, it is available as the built-in driver for Ubuntu® 13.04, and in an update package for Fedora® 18. It is also available using a binary installer at 01.org/linuxgraphics/.


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Conclusion

With the development of an open-source driver for 3D mobile graphics that is certified for the OpenGL ES 3.0 specification and optimized for Intel Gen graphics, Intel is helping enable a new era of graphical user experiences. Immersive mobile games and entertainment, as well as sophisticated mobile UIs for applications in fields such as energy, medicine, and design, are now poised to become mainstream.

Application developers and software-vendor decision makers can immediately begin porting their existing applications and developing new ones using the advanced features of the OpenGL ES 3.0 specification on 3rd gen Intel Core processor-based PCs. They and their code will be ready for future devices, including devices that are based on the upcoming Intel Atom processor code-named "Bay Trail" containing Intel's Gen 7 graphics. Driver developers are invited to participate in the ongoing evolution of this driver by submitting patches containing new features and enhancements.

Participate in the community.

Develop applications for future devices, today.

www.01.org/mobilegraphics