Green Hills Software
Device Software Optimization Q & A

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1. Background

1.1 What is *device software optimization*?

Device software optimization (DSO) is fundamental to the success of a manufacturer of intelligent devices. In order to succeed in today's highly competitive, global and fast-paced electronics markets, a device manufacturer must be able to:

- Produce better devices—that run faster, have higher reliability, higher security, and are less expensive to manufacture
- Develop device software more quickly, at a lower cost and with less risk.

Device software optimization is the fulfillment of these goals.

1.2 How does a manufacturer implement device software optimization?

Device software optimization requires that a manufacturer deploy an optimized development methodology that enables its developers to more efficiently produce better software. To be effective, both the methodology and the results must be optimized. For example, if a manufacturer can produce a high performance, high quality device but takes so long developing it that competitors are able to get to market much earlier and at a much lower cost, then that product will not be successful. Similarly, if a manufacturer can quickly and inexpensively get to market but the resulting device is slow and unreliable, then that product will not be successful. Effective device software optimization must improve both the quality of the software that goes into the device and the efficiency with which it is developed.

1.3 Is *device software optimization* different from *embedded software*?

From a technology perspective, *device software optimization* incorporates the development tools and embedded real-time operating systems (RTOS) that have been categorized under the "embedded software" umbrella. *Device software optimization* goes beyond the traditional use of "embedded software" by also encapsulating the benefits of a strategic approach to optimizing device software and its development. In particular:

- Device software optimization recognizes that the goal of an embedded software development solution is to optimize the quality of a device, the time and cost required to develop it, and the cost of manufacturing it. The tools and RTOS used to develop a device directly impact its ultimate profitability.

- Device software optimization encompasses the methodology that a manufacturer uses to optimize its device software development across projects, products and product lines (see question 1.6 for how).

1.4 For how long has Green Hills Software provided device software optimization solutions?

Device software optimization was the purpose for which Green Hills Software was founded in 1982 and has been the company's focus ever since. Green Hills Software's first product, the Green Hills Optimizing Compiler, brought the benefits of optimized high-level language development to embedded software developers—enabling them to more quickly develop higher performance, more reliable applications. Today, Green Hills Optimizing Compilers are still proving that they generate the industry's most optimized code (see question 2.1).

1.5 Why does Green Hills Software embrace *device software optimization*?

Green Hills Software embraces *device software optimization* for two reasons:

- *Device software optimization* is an excellent description of the benefits of Green Hills Software's solutions
- By using the same terminology as other DSO vendors, Green Hills Software is eliminating any market confusion that may result from different suppliers using different lingo. We believe that the DSO/embedded software market is better served by discussions of technology and solutions than by debates about market definition.

1.6 What makes Green Hills Software the leader in device software optimization?

Green Hills Software is the leader in device software optimization because our software and services solutions enable manufacturers to develop devices that have:

- The highest performance
- The highest reliability
- The highest security
- The fastest time-to-market
- The lowest manufacturing cost
- *All at the same time, with no tradeoffs*

In addition, Green Hills Software enables manufacturers to significantly reduce the time, cost and risk of device software development by standardizing their development methodology and environment across product lines and projects. This allows developer expertise, application code and software licenses to be shared across an organization.

To make enterprise-wide standardization possible, Green Hills Software addresses the diversity of hardware and software that organizations employ in their device development by providing:

- The broadest processor support
- The broadest operating system support
- The broadest Eclipse support
- The broadest tools support
- The most broadly available operating system technology
- The most complete standards support

2. Optimizing a device's software

2.1 What is an example of how Green Hills Software delivers the highest performance?

Green Hills Software has never seen an application that it could not make at least 20% faster than when that application was developed using a non-Green Hills Software solution.

Green Hills Software's industry-leading performance is demonstrated by the fact that, in 2004, microprocessor vendors—including Analog Devices, Freescale, IBM and NEC—selected Green Hills Optimizing Compilers more than three times as often as all other compilers combined in order to achieve the highest possible performance on benchmarks that were certified and published by the Embedded Microprocessor Benchmark Consortium (EEMBC). Since EEMBC began certifying benchmark results in 2000, microprocessor vendors selected Green Hills Optimizing Compilers nearly twice as often as the next three most popular compilers combined (GNU, Microsoft and Wind River).

EEMBC is an independent, vendor-neutral organization whose membership consists of microprocessor vendors and device software suppliers, including Green Hills Software and Wind River Systems. EEMBC-certified benchmarks are the principal means that microprocessor vendors use to validate the performance of their processors.

2.2 What is an example of how Green Hills Software delivers the highest reliability?

With the INTEGRITY operating system, Green Hills Software is the first and only independent software vendor that has designed, developed and certified a securely partitioned operating system to the Federal Aviation Administration's (FAA) most stringent standard for flight-critical avionics systems (RTCA/DO-178B Level A).

2.3 Don't other vendors also claim FAA certifiability?

Other DSO vendors that hype FAA safety certification have never received the highest-level FAA certification that Green Hills Software received in 2002. For example, while Wind River Systems markets its Platform for Safety Critical ARINC 653 (based on VxWorks® 653) as DO-178B Level A certifiable, it has never been used in an application certified to Level A. Until an operating system has been used in a certified application, one can never know how long or how expensive the certification process will be.

2.4 What is an example of how Green Hills Software delivers the highest security?

Since 1996, INTEGRITY has been the only commercial device operating system to support the Multiple Independent Levels of Security (MILS) architecture. INTEGRITY has been deployed in security-critical applications such as nuclear weapons systems for years and is now undergoing the most stringent security evaluation ever undertaken by any commercial operating system, to Common Criteria Evaluation Assurance Level 6+ (EAL6+). On the seven-level EAL scale, no operating system has previously been certified beyond EAL5.

2.5 Don't other vendors also claim to have secure operating systems?

Other DSO vendors that hype security are still trying to develop their secure operating systems.

2.6 What is an example of how Green Hills Software delivers the fastest time-to-market?

Only Green Hills Software's TimeMachine debugger and SuperTrace probe, released in 2003, give software developers an "instant replay" capability, enabling them to debug by running and stepping forward and backward in time using a real-time recording of a device's behavior. This allows our customers to find even the most elusive, irreproducible bugs in just minutes and can shave months off the time required to debug software using other solutions.

2.7 What are examples of how Green Hills Software reduces production cost?

Green Hills Software's INTEGRITY and *velOSity* operating systems have always been royalty-free since their introduction in 1996, eliminating the per-copy license fees that manufacturers have traditionally been forced to pay for their device operating systems. INTEGRITY and *velOSity* also minimize memory and processor costs with higher performance and a smaller footprint, as low as 3 KB of RAM.

2.8 Don't other vendors claim royalty-free business models?

The other major DSO vendors depend on per-copy production royalties for their profits. Even if they offer a royalty-free option, a significant premium is charged for it, negating its benefit. For example, Wind River Systems, which promotes a royalty-free option, generates 30% of its revenue from production royalties.

3. Optimizing device software development across an organization

3.1 How broad is Green Hills Software's processor support?

Green Hills Software's MULTI development environment supports 25 different 32- and 64-bit processor families—including PowerPC, ARM, Pentium, MIPS, Blackfin, ColdFire, V800 and 18 others. (For a complete list, see www.ghs.com/products/MULTI_IDE.html.) Other DSO vendors only support a handful of processors.

3.2 How broad is Green Hills Software's operating system support?

With MULTI, Green Hills Software supports the most popular device operating systems. MULTI was the first device software optimization environment to support Linux and Wind River Systems' VxWorks together with customers' in-house operating systems. MULTI support includes:

- Green Hills Software's INTEGRITY and *velOSity*
- Express Logic's ThreadX—which is available from and supported by Green Hills Software
- Linux
- VxWorks
- Enea's OSE
- Windows
- Solaris
- In-house operating systems
- Devices that do not use an operating system

Other DSO vendors support just a few device operating systems.

3.3 How broad is Green Hills Software's Eclipse support?

The MULTI development environment and Green Hills compilers can be used within any Eclipse implementation.

Other DSO vendors require that customers use a custom version of Eclipse that must be licensed from them, resulting in a Balkanization of Eclipse and vendor lock-in that subverts the benefit of an open environment. For example, Wind River Systems' Workbench development environment can only be used with its own version of Eclipse. Users cannot plug Wind River's tools into their own Eclipse environment (or any that they get from other suppliers)—meaning that they cannot deploy a single Eclipse environment across an organization for use by both IT and device software developers.

3.4 How broad is Green Hills Software's tools support?

MULTI is integrated with about 100 different tools from Green Hills Software and its partners to support the entire device software lifecycle across an entire enterprise—including design, development, simulation, integration with new hardware, debugging, testing, performance optimization, resource optimization and configuration management. Other DSO vendors have very few of their own tools and work with just a few third-party tools.

3.5 How broadly applicable is Green Hills Software's operating system technology?

Green Hills Software's INTEGRITY operating system can scale from the smallest, most resource constrained devices up to large distributed systems with the highest reliability, security and safety requirements—including security-critical enterprise applications. The use of a single operating system technology maximizes the ability of organizations to re-use expertise and code across products and liberates manufacturers from the past quagmire of having to use different, incompatible operating systems to satisfy diverse device requirements.

Other DSO vendors promote the use of different, incompatible operating systems for different types of devices. This vastly increases the complexity of systems, slowing development and introducing myriad bugs and security holes.

3.6 How complete is Green Hills Software's standards support?

INTEGRITY is the first and only operating system to be certified under the "POSIX®: Certified by IEEE and The Open Group" program to the 1003.1™-2003 System Interfaces Product Standard and is listed on the certification register at http://get.posixcertified.ieee.org/register.html. While other DSO vendors promote open standards such as POSIX to customers that do not want to be locked into a proprietary operating system, they are not actually certified to the latest POSIX standards—or in many cases to any POSIX standard.