

# SELECTING AN EMBEDDED RTOS



## FEATURED INTERVIEW:

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## OK LABS: VIRTUALIZATION FOR EMBEDDED &amp; REAL-TIME SYSTEMS

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**Q. First of all, tell us a little bit about yourself and your responsibilities at OK Labs.**

A. I have worked with embedded systems for over 20 years, including time spent as a developer. For the last 10 years I have worked in product management, where it is my responsibility to translate customer and market needs into product requirements.

Currently I am focused on Open Kernel Labs embedded hypervisor, *OKL4*.

**Q. Before we get too deep, give us a quick overview of “virtualization.” What is it? How does it work at the interface between software (OS) and hardware (microprocessor(s))?**

A. In general virtualization is the abstraction of computing resources and typically results in a more efficient use of resources. In embedded systems like mobile devices, virtualization allows a single processor to support multiple operating systems. The software that provides virtualization is called a hypervisor. The hypervisor is responsible for managing the sharing of resources by multiple operating systems. In a system using virtualization, operating systems are referred to as guests. This terminology reflects the fact that the hypervisor manages the underlying hardware to provide each guest OS with access to the resources it requires.

**Q. What sorts of common applications can benefit from virtualization? We’ve heard, for example, of the cell phone that needs to run both a general purpose OS (a.k.a. Linux) and a hard RTOS to get the benefits of both. What other sorts of app’s benefit from virtualization?**

A. *OKL4* enables virtualization and componentization for mobile devices and other embedded systems. *OKL4*’s support for both virtualization and componentization results in more applications than if it offered virtualization alone. There are many ways in which

the use of *OKL4* results in lower development cost, shorter time to market, reduced BOM cost, higher reliability, and better security so I could easily provide pages of information here. Let me summarize the ways in which *OKL4* helps embedded developers and some of the most common examples:

*OKL4* helps maximize the return on the investment in software development by reducing development cost and protecting the value of the resulting software. It protects the investment in legacy code by making it easier to reuse in new handsets. *OKL4* also makes it easier to integrate software from different sources. Additionally *OKL4* makes it easier to meet the real-time requirements of functions like audio processing in designs using high-level operating systems with little or no real-time capability. Finally, the functionality provided by *OKL4* allows for the logical separation of software used under different license terms.

*OKL4* makes it easier to address security requirements, whether those requirements are high, medium or low by providing a separate, trusted, software environment for data or functionality requiring a higher level of security.

*OKL4* can enable lower bill of materials costs by consolidating the functions of multiple processors onto a single processor, while maintaining isolation between those functions. An example of this is running a Linux application environment and a mobile phone communication stack with real-time requirements on a single ARM processor.

*OKL4* increases Hardware Platform Independence. It provides an abstraction of the underlying hardware, reducing the coupling between specific hardware and device software, which improves portability across different handsets.

*OKL4* increases Application Environment Independence by offering a direct execution environment for services that need to be used in a variety of products incorporating different operating systems. Implementing such a service as an *OKL4* hypercell utilizing our *OKL4 Secure HyperCell™* Technology reduces the coupling between a specific operating system and that service.

*OKL4* can enable new mobile device capability by providing multiple use contexts on a single device. For example a mobile worker context supported by a corporate IT department and a personal use context that is more open and less restricted. *OKL4* can also increase the reliability of the system through improved fault isolation and recovery.

- Q. In October, you announced OKL4 3.0 and OKL4 Nano. Would you tell us a little bit about this announcement, especially what is “new?”**
- A. Our latest release of *OKL4*, along with *OKL4 Nano*, provide the ability to reduce cost and time to market by increasing uniformity of the software architecture across a range of devices, allowing increased software re-use. *OKL4 Nano*, a streamlined configuration, targets highly resource constrained devices, which do not require virtualization, but do require the kind of high performance, highly efficient microkernel provided by *OKL4*. With *OKL4* and *OKL4 Nano*, developers have an upward compatible API allowing increased software portability. Software developed for *OKL4 Nano* is reusable on the full *OKL4* in other devices.

**Q. How does OKL4's Secure HyperCell Technology impact virtualization? And how is this different than other virtualization implementations?**

- A. Secure HyperCell Technology provides fundamental benefits for security. *OKL4's* unique Secure Hypercell System builds in security at the system level and enables flexible system partitioning in accordance with security requirements.

Hypercells can contain anything between a full Virtual Machine (VM) and an individual device driver. Hypercells can also be isolated, communicate using IPC, or communicate through shared memory. One of the benefits of hypercells is that access to resources by software in a hypercell is controlled by design.

Many virtualization technologies for the embedded market only offer virtualization and not the additional benefits of componentization. Using *OKL4* allows the system designer to incorporate BOTH virtualization AND componentization into their system architecture. By componentization I mean creating an architecture in which a number of simpler software components are combined in well-defined and well-managed ways. The opposite of componentization is monolithic software architecture where well-defined separation and interfaces are few and far between.

Security is also enhanced through implementation of *OKL4's* embedded hypervisor. It ensures that minimal code runs at the highest privilege level. This leads to trustworthy management of resources and the isolation of cells per chosen design. We have an Open Kernel Labs T-Shirt with the headline "I operate in privileged mode," reinforcing our belief that a smaller trusted computing base is optimal for subsystems or services with higher security requirements.

**Q. Your website has this handy little white paper that claims one can have "security" and "performance." How does virtualization help this trade-off? What is unique about the OK Labs approach to get there?**

- A. When we talk about the mobile/wireless sector, including handset OEMs and mobile chipset providers, embedded virtualization supports security in the same way that using multiple processors supports security — by allowing a trusted application to be isolated from less trusted software. Embedded virtualization provides the same isolation without the expense associated with using multiple physical processors.

*OKL4's* implementation provides additional security benefits with minimal impact on performance. *OKL4* allows more fine-grained partitioning of a complex system into a number of hypercells. By using *OKL4*-provided mechanisms for address space isolation, inter-cell communication, and information flow control, developers can designate the level of isolation between specific hypercells.

Often, increased context switching and inter process communication associated with virtualization can cause concern over performance. However, *OKL4's Secure HyperCell Technology* includes performance optimized, lightweight IPC between hypercells to minimize the impact of added security on performance. *OKL4* context switches have also been highly optimized.

- Q. There are more and more companies getting involved in virtualization from companies like Wind River or QNX (RTOS companies) to direct competitors of yours like VirtualLogix to even other approaches involving multicore. Where does OK Labs stand in the landscape? How is your approach different from that of others offering “virtualization?”**

With deployment in over 250 million wireless devices, *OKL4* has been proven ready for commercial deployment, which sets us apart from our competitors.

*OKL4* also offers a more flexible and fine-grained capability to divide complex software into a number of separate hypercells using its *Secure HyperCell Technology*. In *OKL4*-based systems, a hypercell can contain anything from a full virtual machine to an individual device driver. In addition, *OKL4*-provided mechanisms give the developer more precise control over the level of isolation between hypercells.

Additionally, *OKL4* is the only embedded hypervisor available under both an open source license and a commercial license. The availability of *OKL4* under an open source license makes the source code available for inspection by anyone, allowing technology evaluation independent of OK Labs, and facilitates the broadest possible use of *OKL4* in academic and research activities around the world.

- Q. Once we move to a virtualization architecture, doesn't that create new problems and opportunities for the application software? Does it require engineers to rewrite their legacy applications to actually benefit from virtualization? Is there any assistance from companies like OK Labs for this legacy application software that was written for a single OS / single chip architecture environment?**

- A. Virtualization requires no modification to any software outside the kernel of the guest operating system. OK Labs engineers make those guest OS kernel modifications, making the migration of legacy application software to an *OKL4* virtual machine is very straightforward.

Of course creating a system that takes full advantage of the architectural capabilities offered by *OKL4* involves the same kind of system design and implementation activities as any embedded system development project. Where detailed expertise specific to *OKL4* is required, Open Kernel Labs Field Applications Engineering and Professional Services capabilities are available to assist.

- Q. OK Labs is obviously not an operating system (OS) company. Tell us a little bit about your products and technology and what they do for engineers who want to deploy virtualization in their applications.**

- A. *OKL4* is an embedded hypervisor, providing a unique combination of virtualization and general-purpose microkernel capability in an implementation optimized for the embedded systems environment.

I think I've covered the benefits of using *OKL4* for virtualization in previous questions.

In addition to the previously mentioned benefits, *OKLA's Secure HyperCell Technology* compliments the operating system by; providing a more trustworthy parallel environment for securing data and services, improving reliability through better fault isolation, increasing hardware and OS independence for middleware, and making legacy software re-use easier.

These technical benefits result in lower Bill of Materials cost, reduced development expense, shorter time to market, and more compelling end products.

**Q. You seem to target the “mobile phone” space. Is that the best space for your technology? What other sorts of verticals and applications do you think will most benefit from OK Labs products?**

A. While *OKLA* is the established leader in the mobile device sector, *OKLA* technology addresses market needs found in almost all embedded systems applications. In the near term we are focused specifically on continued success in the mobile device, set-top box, and point-of-sale space.

**Q. Thank you for this interview.**