

# LynuxWorks Solutions for FPGA Processing Systems

LynuxWorks offers open-source and open-standard RTOS support for Xilinx Platform FPGA-based processing.

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Much of the attention that Linux receives is focused on its growing use in servers. However, Linux scales down just as well as it scales up – as a result, Linux is an ideal operating system for a wide variety of systems. Nowhere is this more evident than in the world of embedded computing.

Recently, Xilinx and LynuxWorks announced an alliance that allows embedded engineers to develop systems rapidly with standards-based open-source embedded Linux and real-time operating systems (RTOS), along with flexible Xilinx® FPGA platform architectures.

LynuxWorks offers support for different application needs: LynxOS for hard real-time applications, Bluecat for embedded Linux applications, and now  $\mu$ Clinux for memory management unit (MMU)-less embedded systems. LynuxWorks products are based on open standards and utilize open-source components.

Xilinx offers a range of FPGA products from the Spartan™ family to the Virtex™ family as well as embedded processors, including the 8-bit PicoBlaze™ soft processor, the 32-bit MicroBlaze™ RISC soft processor running at 210 MHz on Virtex-4 FPGAs, and the industry-standard PowerPC™ 32-bit RISC hard processor running at 450 MHz on Virtex-4 FPGAs. The PowerPC is available in single- and multi-core formats on a single FPGA.

Xilinx also offers extensive IP blocks: UARTs and Ethernet MAC peripheral IP blocks and complex custom IP blocks such as the Reed-Solomon encoder/decoder. With the combination of FPGA fabric, processors, peripheral IP, custom logic IP, and DSP, you can define a truly flexible and cost-optimized hardware platform.

### Open-Standard Embedded Operating Systems

LynxWorks provides embedded operating systems to help you optimize designs, reduce development time and costs, and get critical products to market before the competition. This unique value proposition provides support for a family of operating systems, with the ability to migrate between operating systems with ease and a single development environment set to support them all.

### LynxOS RTOS

LynxOS is a hard RTOS for original equipment manufacturers (OEMs) and telecommunications equipment manufacturers (TEMs) that want to construct sophisticated real-time systems. LynxOS combines hard real-time embedded technology with broad conformance to open and de facto standards like Linux, POSIX, and UNIX.

Figure 1 shows the embedded network stacks that are an integral part of the RTOS. LynxOS is a superior foundation for sophisticated real-time systems that must:

- Perform a complex series of tasks within set periods of time
- Support multiple applications with multiple interrupting devices
- Take full advantage of today's powerful high-end microprocessors

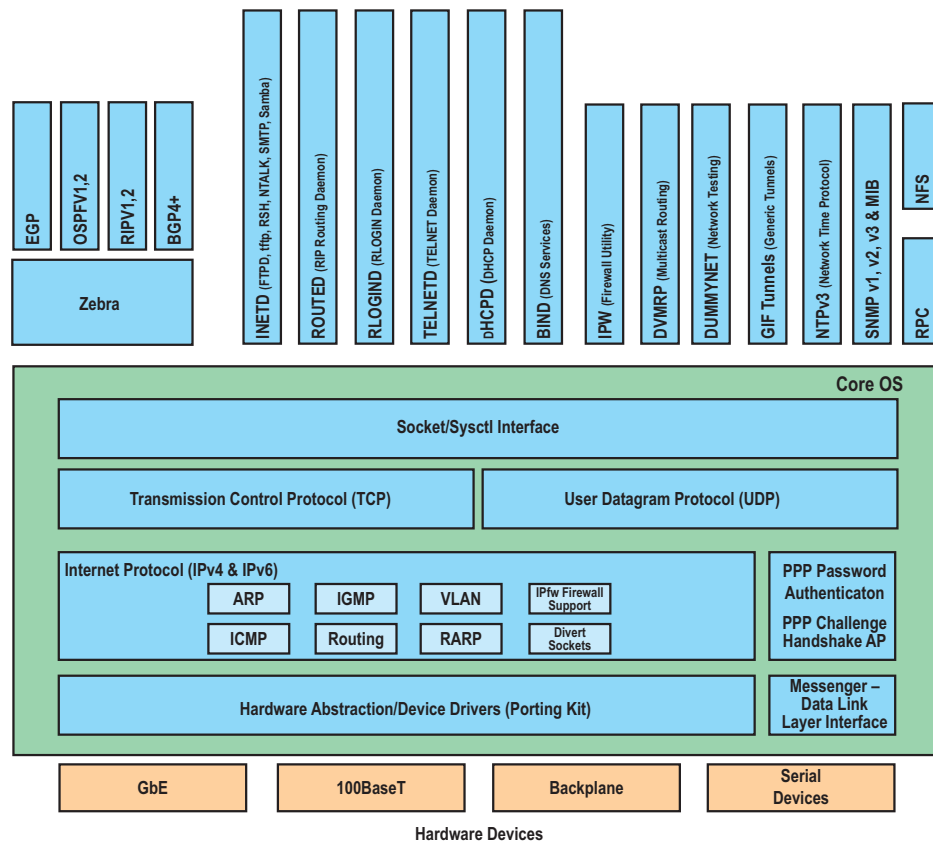


Figure 1 – LynxOS RTOS 4.0 architecture

- Leverage existing Linux, Unix, and POSIX programming talent for embedded real-time projects (open API customers)
  - Take advantage of existing POSIX-compliant applications including open-source Linux and Solaris
- LynxOS features include:
- POSIX real-time timer and clock support
  - MMAP support for regular files and shared memory
  - Four scheduling policies (FIFO, priority quantum, round-robin, non-preemptive)
  - Full state-of-the-art TCP/IP stack derived from FreeBSD 4.2 and enhanced for reentrancy, determinism, and performance
  - Application binary interface (ABI), allowing developers to leverage existing

Linux applications in a real-time OS environment without having to port or recompile the application

LynxWorks is currently developing LynxOS RTOS support for Virtex-4 FPGAs.

### Bluecat Linux OS

Bluecat Linux from LynxWorks, based on the 2.6 kernel, is an implementation of the Linux model enhanced for use in embedded systems ranging from small consumer-type devices to large-scale multi-CPU systems. Bluecat Linux delivers the flexibility and cost benefits of open-source software. It is uniquely constructed to be a stable commercial-grade embedded operating system.

Bluecat Linux features include:

- A preemptive kernel – preemption points in the kernel allow you to suspend an executing process so that you can launch another, higher priority process

## The alliance between LynuxWorks and Xilinx will enable embedded systems developers to leverage standards-based, embedded operating systems, which include embedded Linux, $\mu$ Clinux, and real-time operating systems along with flexible FPGA platforms from Xilinx...

- A low-latency scheduler ensures that processes are executed when they are ready to run, which improves overall system performance
- POSIX threading support – an open-standards ideology provides compatibility between applications over different architectures
- POSIX timers – time and alarm management for real-time applications requiring high throughput or fast response time
- Multithreaded debugger
- Kernel debugging capabilities

LynuxWorks offers target support for Virtex-4 devices utilizing the ML403 reference design. It is a truly cost-effective and open platform offering the flexibility of additional IP blocks on the FPGA based on customer needs and an open-source, open-standard operating system.

### $\mu$ Clinux OS

An open-source OS based on the Linux 2.6 kernel,  $\mu$ Clinux is an implementation for non-MMU-based processors offering a compact footprint.  $\mu$ Clinux will be supported by LynuxWorks for the Xilinx MicroBlaze soft processor. The  $\mu$ Clinux embedded OS is appropriate for many smaller, less complex embedded applications and is very popular because of its zero-royalty model. The board support package includes a collection of user applications, libraries, and software drivers to jump-start development.

### Development Environment

In the embedded software world, code reuse and migration are closely tied to software development tools. Migration has often required changing development tools, hampering productivity. Finding a

consistent development environment over different RTOSs and programming languages has been difficult. Chip companies have highly optimized tools for their architectures and RTOS companies have tools that include a detailed awareness of their operating systems, all with their own proprietary integrated development environment (IDE).

A major change sweeping across embedded tool vendors marries open-source and commercial tools, offering a consistent user interface for embedded developers regardless of chip, RTOS, or programming language: it is called Eclipse. Eclipse provides a universal design framework that has become an industry standard for software application development. By providing a common look and feel in all Eclipse-based tools, learning curves are much shorter and productivity improves.

For embedded software development, LynuxWorks provides the Luminosity IDE and tool suite, based on Eclipse, supporting all LynuxWorks operating system offerings. Luminosity provides a fast and easy way to create, edit, compile, manage, and debug C/C++ embedded and real-time applications. These tools allow software engineers to efficiently manage their project environments, including options to build individual files or the entire project. Environment options allow you to set the compiler and linker options as well as the target environment you are building.

To enable you to create a platform FPGA processing platform solution that is flexible and unique to your own specific application, Xilinx developed an IDE called Platform Studio. The Xilinx Platform Studio (XPS) IDE and tool suite are included in the Embedded Development Kit (EDK) bundle and are also based on the Eclipse framework.

XPS offers truly flexible tools that allow you to customize solutions in both the software and hardware layers of the system. XPS comprises a rapid IP block generation tool called Base System Builder (BSB), software development tools based on GNU/GCC, a processor debugging engine called XMD, an Eclipse-based software development kit called SDK, an extensive library of processing IP peripheral blocks, and the MicroBlaze 32-bit RISC core.

The C/C++ development tooling (CDT) project in Eclipse provides a modern but standard GUI for debuggers and comes preconfigured to work with the GNU Project Debugger engine. Many RTOS vendors have chosen to use the CDT debugger and added functionality specific to their RTOS, allowing you to migrate across different operating systems without having to make dramatic changes to the tools you use. The Luminosity IDE/debugger from LynuxWorks is based on the CDT project. As an engineer, you will benefit from both Xilinx and LynuxWorks utilizing Eclipse for common-looking design environments.

### Conclusion

The alliance between LynuxWorks and Xilinx will enable embedded systems developers to leverage standards-based, embedded operating systems, which include embedded Linux,  $\mu$ Clinux, and real-time operating systems along with flexible FPGA platforms from Xilinx, with a range of embedded hard and soft IP-based processors and a multitude of peripheral options. This approach truly enables a cost-optimized solution. For more information on LynuxWorks support for Xilinx processing solutions, visit [www.lynuxworks.com/corporate/press/2006/xilinx-partnership.php](http://www.lynuxworks.com/corporate/press/2006/xilinx-partnership.php). 