



Certifiable RTOS for  
safety-critical computing

## The world's most powerful, open-standards real-time OS

LynxOS® 7.0 is a deterministic, hard, real-time operating system that provides POSIX-conformant APIs in a small footprint embedded kernel. LynxOS provides symmetric multi-processing support to take full advantage of multi-threaded applications running on multi-core processors. Included are advanced tool chains, debuggers, and cross-development host support. LynxOS provides open APIs, robust support for the latest networking and I/O technologies, and state-of-the-art security features.

LynxOS is already installed on millions of devices worldwide. With the introduction of new and easy to implement security functionality, both existing and new customers can effectively secure their next generation of devices. LynxOS 7 implements a layered approach to security that allows customers

to develop highly secure devices for the Internet of Things, maximizing their availability and uptime and resistance to potential cyber threats. Advanced embedded development tools enable fast and efficient deployment of these technologies.

LynxOS supports the most popular reference targets within the Intel and PowerPC architectures including the new 4th generation Intel® Core™ i7 and Core™ i5, in addition to the Freescale QorIQ 'P' and 'T' series processors.

All embedded market segments, including military, aerospace, industrial, medical, automotive, and office automation benefit from these security and networking improvements realized in this next generation of LynxOS architecture.

### Real-Time Determinism

All RTOS components within LynxOS are designed for absolute determinism and performance. As a foundational feature of LynxOS, applications have relied on its stable, reliable, and proven real-time capability for over 25 years. Predictable response is ensured even in the presence of heavy I/O as a result of the kernel's unique and highly optimized threading model. Interrupt latency and context switch time is measurably the lowest in the industry.



- Mission-critical performance and reliability—absolute determinism and linear performance scalability
- Industry-leading openness—Full POSIX conformance
- Latest technologies for Internet communications—advanced networking feature sets for rapid development of differentiated products

### LynxOS Ensures:

- Guaranteed minimum interrupt latency and context switch times
- Reliable and steady when performing complex tasks under high interrupt loads
- Full MMU-backed POSIX process-thread execution model that guarantees the most robust application protection in the industry

### True Linear Scalability

LynxOS was designed for true linear scalability and remains unwavering as the number and complex tasks it performs scales upwards. Features of its advanced and efficient network I/O stacks are a reflection of the determinism and performance extended to connected applications that rely on true responsiveness, even in the face of the most complex I/O demands.

## Enhanced Features

- POSIX 1003.1-2003 PSE 53/54
- Security Capabilities: ACL, Audit, Quotas, OpenPAM, Roles/Capabilities and Residual Information Protection
- Symmetric Multi-Processing (SMP)
- Asymmetric Multi-Processing/thread affinity (AMP)
- GNU Toolchain, Debugger and Profiler
- Eclipse-based Luminosity tool suite
- ELF file format
- RAM Support up to 4GB

## Open APIs

LynxOS is the most solid, real-time operating system available today. The native interface of this RTOS are compatible with Linux®, UNIX® and Solaris™.

LynxOS is designed from the ground up to conform with open system interfaces. OEMs are now able to leverage existing Linux, UNIX and POSIX programming for embedded real-time projects. Development schedules are reduced while programmers are able to be more productive using familiar methodologies as opposed to learning proprietary programming methods.

## Full POSIX conformance

OEMs can leverage LynxOS' POSIX conformance to take advantage of existing POSIX-compliant applications—including those written for open-source Linux and Solaris™—to speed time-to-market.

Some real-time operating systems only comply with a subset of the POSIX specification, but LynxOS fully conforms with POSIX interfaces for core services, real-time extensions, and thread extensions—POSIX 1003.1-2003 PSE 53. Additionally, LynxOS provides most of the PSE 54 APIs (Multi-purpose) including file system functionality, Flash, RAM, wide chars, and user groups. A complete list of supported APIs are available for customers to perform their own comparisons.

## Advanced Tools

LynxOS developers achieve a head start with the most comprehensive suite of open development tools in the embedded-system industry that include:

- Luminosity IDE—A single cohesive environment to create, edit, build, manage, and debug LynxOS kernels, device drivers, and applications.
- Complete target management that includes full console support and file system access.
- Real-time target status monitoring including RAM and CPU utilization statistics, process text, data and stack allocation, along with system overhead.
- SpyKer™, our dynamically instrumented kernel analyzer—the first dynamically instrumented system trace tool ideal for viewing program execution and timing of events, identifying elusive application bugs, and fine-tuning system performance.

## Latest Technologies for Interconnecting Devices

LynxOS gives developers access to state-of-the-art networking technology. Its networking capabilities make it the most advanced of all the commercial RTOS offerings that include features such as IPSec, IPv6, an

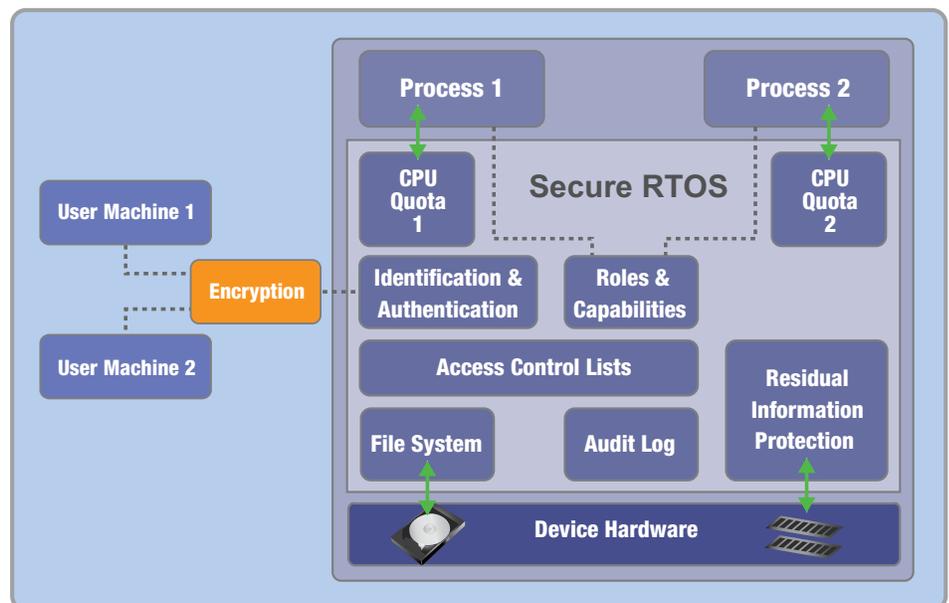
integrated firewall, and Quality of Service (QoS). Industry standard utilities are included which provide network configuration, diagnostics, and management. The latest protocols and capabilities for networking are included for Gigabit Ethernet, SNMP v1, SNMPv2, and SNMPv3, and routing algorithms. As a result, OEMs can now rapidly implement advanced features and functions to differentiate their products from the competition.

## Fast Request-Response

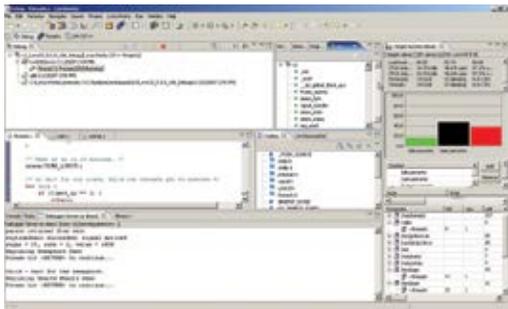
The TCP/IP stack has been enhanced for re-entrancy, determinism, and performance. In tests measuring TCP and UDP streaming for request-response bandwidth, LynxOS was measured to outperform Linux—which is considered the de facto industry standard for networking excellence.

## Strict Application Protection

LynxOS couples its hard real-time performance with strict system reliability to meet the needs of applications that must perform flawlessly in a range of demanding environments.

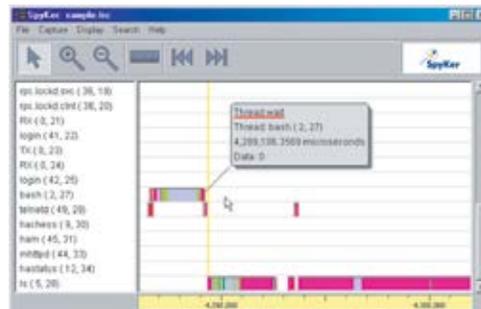


## Choice of popular Development Environments



### Luminosity Eclipse-based IDE

Create, edit, compile, manage, and debug C and C++ embedded and real-time applications with this full-featured Java™-based IDE for all LynuxWorks cross-development platforms.



### SpyKer™ Pro

The first dynamically instrumented system trace tool, ideal for visualizing program execution and timing of events, identifying elusive application bugs, and fine-tuning system performance.

A key component of LynxOS reliability is measured using its unique Memory Management Unit (MMU) support that resides at the lowest level of the LynxOS kernel. Full MMU support, included in the kernel since 1989 provides a reliable advantage for protected memory and virtual addresses.

While other real-time operating systems rely on unprotected tasks that run in a single flat address space, LynxOS executes each task or process in a protected virtual address space for uncompromising reliability.

### ISO 9001:2008 Certified Software

Lynx Software Technology is one of the few embedded software companies that support the ISO 9001:2000-certified software development process. Lynx backs-up LynxOS with a comprehensive range of professional services and support programs to reflect our unparalleled expertise in an embedded product development environment.

### Examples Include:

- Porting and compatibility verification services.

- Full LynxOS consulting and training services conducted on a global basis
- Long-term support options for development and deployment demonstrated over an unprecedented 15 years.

The bottom line is that Lynx Software Technologies customers not only come to market quickly with high-quality real-time solutions, but are able to more effectively provide value to their own customers over the long term.

### Kernel features

- Hard real-time determinism
- Multitasking and multithreaded RTOS
- Unlimited number of tasks
- Extensive support for multi-threaded applications
- Complete MMU based protected address spaces for tasks
- Page level memory mapping for efficient memory management
- 256 priority levels
- Priority inheritance semaphore support
- Kernel threads and priority tracking support (LynuxWorks patented)
- Four scheduling policies (FIFO, Priority Quantum, Round-Robin, Non-preemptive)
- Deterministic context switching through real-time scheduling
- Low interrupt & task response times through efficient interrupt handling
- Demand paged virtual memory support
- Comprehensive inter-task communication facilities
- Message queues, semaphores, shared memory, sockets, signals, pipes, mutexes, condition variables (POSIX)
- Comprehensive POSIX API conformance: POSIX 1003.1-2003 PSE 53
- Subset of POSIX 1003.1-2003 PSE 54
- MMAP support for regular files & shared memory
- Extremely fast boot times
- Configurable tick timer resolution
- Configurable time quantum for priority levels
- Dynamic loading of device driver modules
- MIB style visibility into kernel variables
- Efficient floating point context management
- Support for static and dynamically linked libraries
- ELF file format
- SVR4-style ELF shared library support
- Modular design for flexible footprint management
- Kernel downloadable image (KDI) for diskless environments (LynuxWorks patented)
- POSIX real-time timer and clock support
- Kernel crash analysis
- Kernel level event logging of system events
- Up to 4GB of system-managed RAM
- Debug version of kernel for profiling and watchpoint support
- Dynamic device drivers

### Networking Support

- Full state-of-the-art TCP/IP stack derived from FreeBSD 8.x enhanced for re-entrancy, determinism and performance
- IPv4 and IPv6 support
- IPsec/IKE/VPN
- Quality of Service (QoS)
- Protocols: TCP, UDP, ICMP, ARP, RARP, DHCP, NAT, RPC, NTPv4
- Divert Sockets, PF Packet, Raw Ethernet support

### Routing Protocols

- RIP, RIPv2

### Network Booting

- PXE Netboot, TFTP boot

### Network Security

- Secure DNS dynamic update
- IPSEC AH, IPSEC ESP
- PPP Password Authentication, PPP Challenge Handshake AP
- Firewall support: ipfw, ip6fw

### Network Management

- SNMP v1, v2 and v3
- BIND: dns services, named

### Network Device Support

- Gigabit Ethernet
- 100baseT interfaces

### Network Daemons

- IPv4: inetd, routed, rlogind, telnetd, dhcpcd, tftpd, etc.
- IPv6

### Linux application support

- Source compatible with most Linux applications

### File system support

- Lynx Fast File system
- Network File System (NFS)
- RAM disk file system

### IO device support

- IDE and EIDE with DMA support
- Flash support: M-systems TrueFFS, Flash interface chips
- PCMCIA support
- UART, PTY (pseudo TTY support)
- DRM device abstraction layer for portability of drivers
- USB 2.0
- Serial ATA

### Libraries and utilities

- Over 100 libraries and over 2500 utility routines

### Development environment

- Eclipse-based Luminosity IDE
- SpyKer system event trace and debug
- Multiple shell options: bash, csh,
- Cross Development: Windows 7, Redhat Enterprise Linux 6
- GNU tool chain: GCC, G++ 4.6.3, GDB 7.4.1, GPROF
- Ada support (available from 3rd party Connected Lynx partners)
- Full support for multithreaded ANSI C development
- Full support for multithreaded C++ development
- Static, Dynamic, Multithreaded versions of system libraries
- ELF Dynamic linking loader
- Watchpoint support for application & kernel debuggers
- Configurable core file support
- Selective core file contents - Stack plus data, BSS, heap, and/or shared memory
- Post-mortem debug
- XFree86, LessTif

### Architecture Support

- Freescale QorIQ PPC
- Freescale Power Architecture
- Intel 64-bit Core i3/i5/i7
- Intel 32-bit Atom

### Custom Board Support

- Modular architecture for rapid OS porting
- Improved Porting Guide documentation
- Pre-configured "Demo" KDIs (Kernel Downloadable Image)
- Reference library of device drivers for porting ease

### Security

- OpenSSL Cryptography
- Access Control Lists (ACL)
- Audit logs and monitoring
- Quotas - Disk, Memory and CPU
- Trusted path login
- User account management
- Pluggable Authentication Modules (OpenPAM)



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