LynxOS RTOS

The world's most powerful, open-standards real-time OS for the Internet of Things

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-core/multi-threaded processors. Luminosity, our Eclipse based cross-development environment includes advanced toolchains, debuggers, and profilers that support both kernel and application development while adhering to open APIs, offering robust support for the latest networking and I/O technologies, and state-of-the-art security features.

LynxOS is already relied on in millions of devices worldwide and with the introduction of new and easy to implement advance security functionality, both existing and new customers can effectively secure their next generation of devices on the Internet of Things. Advanced embedded development tools enable fast and efficient

Enhanced Features

- POSIX 1003.1-2003 PSE 53/54
- Security Capabilities: ACL, Audit, Quotas, OpenPAM
- 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

- 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

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, and the Freescale QorIQ processors.

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

Real-Time Determinism
All RTOS components within LynxOS are designed for absolute determinism ; i.e., hard real-time performance.

As a foundational feature of LynxOS, applications have relied on its stable, reliable, and trusted 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 the lowest in the industry.

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

True Linear Scalability
LynxOS was designed for true linear scalability and will remain unwaveringly deterministic - even as the number and complexity of the tasks it performs scales upwards. As a feature of its advanced and efficient network and I/O stacks, this determinism and performance extends to connected applications which can be relied upon to stay responsive even in the face of the most complex I/O demands.

Open APIs
LynxOS is the most open hard real-time operating system available today. The native interfaces of LynxOS are similar to those of Linux®, UNIX® and Solaris™.

Because LynxOS is designed from the ground up for conformance to open system interfaces. OEMs are able to leverage existing Linux, UNIX

and POSIX programming talent 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 is fully conformant with POSIX interfaces for core services, real-time extensions, and thread extensions—POSIX 1003.1-2003 PSE 53. A complete list of supported APIs is 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 Eclipse based Integrated Development Environment to create, edit, build, manage, and debug applications for LynxOS device drivers, kernels and applications.
- Complete target management tools that include full console support, file transfer, and file system access.
- Real-time target status monitoring including RAM and CPU utilization statistics, process text, data and stack allocation, and system overhead.
- SpyKer™, our dynamically instrumented kernel analyzer—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.

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 with 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.

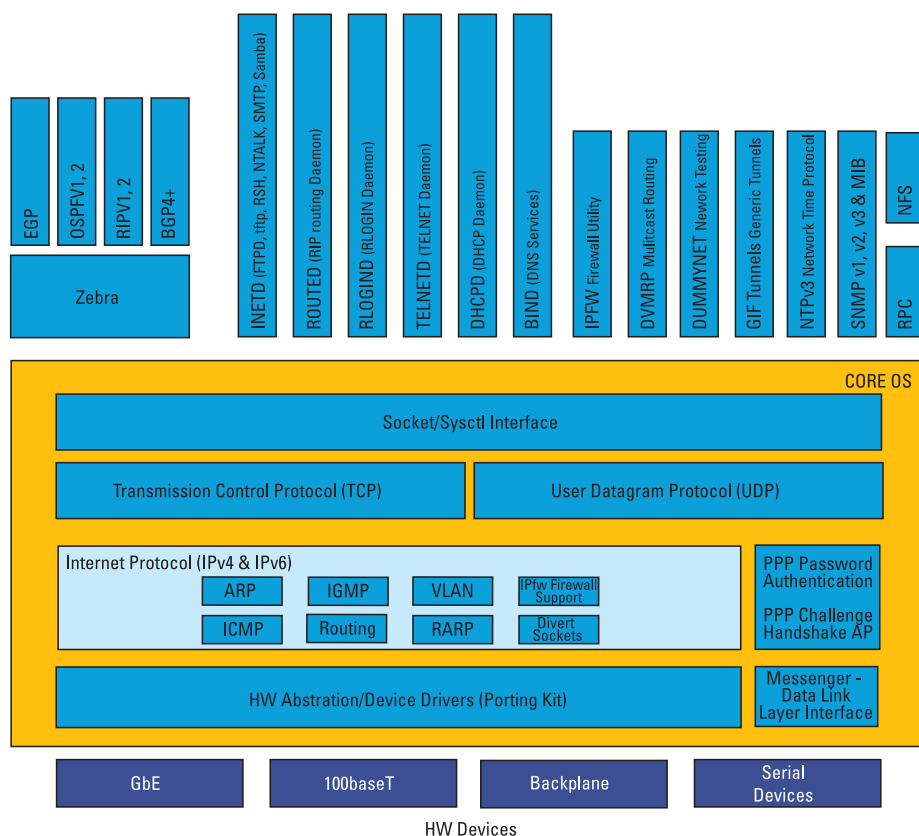The latest protocols and capabilities for networking are provided, including Gigabit Ethernet, SNMP v1, SNMPv2, and SNMPv3, routing algorithms such as RIPv2, OSPFv2, and BGP-4. As a result, OEMs can now rapidly implement advanced features and functions to differentiate their products from the competition.

Fast Request-Response

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

Strict Application Protection

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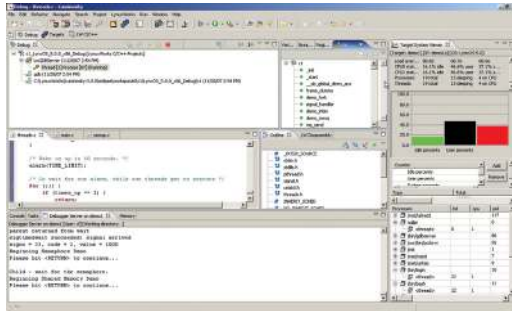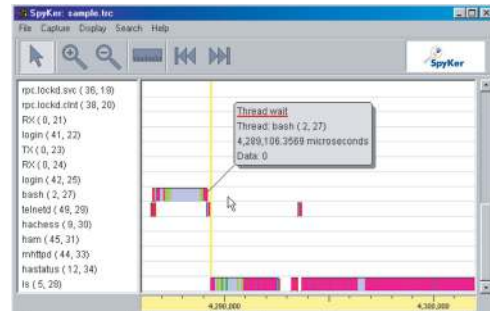
luminosity

Luminosity Eclipse-based IDE

*Create, edit, compile, manage, and debug
C and C++ embedded and real-time appli-
cations with this full-featured Java™-based
IDE for all Lynx Software Technologies
cross-development platforms.*

SpyKer

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 enabler of LynxOS reliability is its unique Memory Management Unit (MMU) support, residing at the lowest level of the LynxOS kernel.

Full MMU support, included in the kernel since 1989 provides the reliability advantages of protected memory and of virtual addresses.

While other real-time operating systems rely on unprotected tasks running in a single flat address space, LynxOS enables each task to run protected in its own space for uncompromising reliability.

ISO 9001:2008 Certified Software
One of the few embedded software companies with an ISO 9001:2000-certified software development process, Lynx Software Technologies backs-up LynxOS with a comprehensive range of professional services and support programs that reflect our unparalleled expertise in 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 de-

velopment and deployment support of a LynxOS release for an unprecedented 15 years.

The net result 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 (Lynx Software Technologies 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
- 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 (Lynx Software Technologies 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 8.3 enhanced for re-entrancy, determinism and performance
- IPv4 and IPv6 support
- IPSec/IKE/VPN
- Quality of Service (QoS)
- Protocols: TCP, UDP, ICMP, IGMP, ARP, RARP, DHCP, NAT, RPC, NTPv3
- 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, dhcpd, tftpd, etc.
- IPv6: faithd, pim6sd, pim6dd, rtsold, route6d, etc.

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

IO device support
- IDE and EIDE with DMA support
- SCSI support: Adaptec 19160, 29160, 29160N; Symbios 53c895/896
- 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, ash
- Cross Development: Windows 7 (64bit), Redhat Enterprise Linux 6.2 (64bit)
- GNU tool chain: GCC, G++ 4.6.3, GDB 7.4.1, GPROF
- 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
- PowerPC
- Freescale QorIQ
- Intel x86 Architecture Family
  - Intel 64-bit Core i5/i7
  - Intel 32-bit Atom
  - Intel 32-bit Quark

Custom Board Support
- Modular architecture for rapid OS porting
- Improved Porting Guide documentation
- Boot loader support for firmware-less configurations
- Pre-configured "Demo" KDIs (Kernel Downloadable Image)
- Reference library of device drivers for porting ease

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