wasabi

Embedding the NetBSD Operating System

– A Guide for FAEs –

OS Selection Factors

NetBSD is an embeddable BSD Unix operating system with more than 25 years of development and real world deployment

What differentiates NetBSD from other embedded OS choices?

Technical Features

1. Leading networking functionality with best-of-breed TCP/IP stack
2. Full-featured Unix OS with stable code base and robust feature set
3. Wide platform support
4. Advanced file system support
5. Development tools
6. Secure, protected memory design
7. Scalability and predictability for embedded applications

Commercial Features

1. Real speed to market with unique Modular Portability Layer
2. Business friendly license, free of Linux's GPL
3. Lower cost than VxWorks or Windows
4. Support from Wasabi Systems, stable company with NetBSD leadership

Technical Selection Factors

1. Networking Functionality

NetBSD is the gold standard in TCP/IP, with the best networking functionality of any embedded OS.

- Stack has been fully maintained for over 25 years
- Selected by DARPA; reference implementation for Unix.
- Comprehensive Networking stack including IPv6 & IPv4
- Complete firewall, proxy, and NAT (masquerade) tools in the base system
- Zero copy TCP and UDP transmission
- High security with IPSec (IPv4&IPv6), VPN Tunnels, Kerberos 5, AES encryption, OpenSSH and OpenSSL support
- Support for Gigabit Ethernet, 802.11b, VLANs and bridging

TCP/IP Development by Year	
Year	Lines changed
1993-94	12,780
1994-95	11,877
1996-97	9,241
1997-98	18,040
1999-2000	29,687
2000-01	14,671
2001-02	26,028

Many RTOS kernels use BSD networking code, but often an old version, from 4.4BSD or earlier. As shown above, however, the code base has changed greatly in the last decade.

Technical Selection Factors

2. Full-featured Unix OS

Unlike many embedded operating systems, NetBSD includes all the features of Unix.

- Twenty-five year code heritage
- Solid and Fast Internet Protocols
- IPSec and IPv6
- Remote Maintenance
- Advanced Storage Protocols
- Comprehensive Device Driver Support
- POSIX-compliant APIs
- RAID 5, disk striping, and mirroring available
- 140 million lines of packaged third-party code
- 64 bit addressing capability
- Unique binary compatibility protects users' investment in existing applications by in-kernel support for non-native binaries (for the same processor) to run transparently.
- Hundreds of embeddable third-party applications including Apache, graphics libraries, Java VMs, multimedia applications, VMWare, SNMP, and web browsers

Technical Selection Factors

3. Wide Platform Support

NetBSD runs on over fifty distinct hardware architectures, on over fifteen processor families.

Popular platforms include:

- ARM, StrongARM, Intel XScale
- Hitachi/Super-H SH-3, SH-4, SH-5
- MIPS 32- and 64-bit systems
- Intel 80x86 (IA-32) based systems
- Motorola 680x0/683xx (68k) based systems
- PowerPC architectures from Motorola and IBM
- Sun SPARC and UltraSPARC systems in 32- and 64-bit modes

Supported evaluation boards include:

- ADI BRH (Intel 80200/Xilinx Virtex FPGA)
- AMD Alchemy Pb1000 (Alchemy Au1000)
- ARM Integrator (ARM 720T/920T)
- Broadcom 91250 (BCM1250)
- IBM Walnut (PPC 405GP)
- Intel XScale IQ80310, IQ80321 (IOP310, IOP321)
- MIPS Malta (MIPS 4Kc/5Kc)
- Motorola Sandpoint (PPC 8240/7400)
- Toshiba RBHMA4200 (Toshiba TMPR4927)
- Xilinx ML300 (PPC 405GP + Virtex-II Pro FPGA)

Technical Selection Factors

4. Advanced File System Support

While many embedded products ship with an old version of the BSD FFS, NetBSD has High Performance enhanced FFS.

- All major filesystems supported, including: NFS, DOS FAT, Linux ext2fs, ISO 9660, and NTFS 4.4BSD Log Structured File System (LFS)
- Wear-leveling Flash support works with all file systems
- Robust file system support and file system layer abstraction
- Support for large filesystems of up to 32 terabytes

Technical Selection Factors

5. Development Tools

NetBSD offers a suite of built-in development tools :

- Built-in kernel debugger
- Remote GDB connections, kernel core dumps
- Extensive cross-platform development capabilities
- Complete GNU toolchain on all platforms
- Single build mechanism for all of kernel and user code

Technical Selection Factors

6. Secure, Protected Memory Design

Advanced, object-oriented virtual memory with unified buffer cache and advanced sharing semantics

All the standard Unix features -- Memory protection, copy on write, sharable images – *plus:*

- Original Mach VM completely replaced with UVM
- Page loanout for zero-copy data movement
- Tunable page and file data cache
- Memory pool manager reduces TLB thrashing and object allocation overhead
- Tunable cache coloring

Technical Selection Factors

7. Scalability and Predictability for Embedded Applications

Memory storage footprint as small as 400kB

NetBSD can provide greater throughput than traditional "real time" systems in complex applications, without sacrificing networking and filesystem support.

- Preemptive scheduling, kernel threads, locks, and interrupt priority levels
- Line rate from Gigabit Ethernet cards if host system has memory bandwidth
- Highly flexible scheduling algorithms

Commercial Selection Factors

1. Speed to Market

Everyone talks about time to market, but Wasabi can offer a real difference:

NetBSD's Modular Portability Layer (MPL)

With the MPL, the driver is completely isolated from the hardware platform -- I/O instructions or no I/O instructions, interlocking, retry error recovery, bounce buffers, memory type boundaries, scatter/gather maps in host bridges, even peripherals which use pseudo-DMA to write a buffer RAM with host CPU copyin and copyout -- all are transparently handled beneath the driver layer.

Result:

NetBSD runs on over fifty hardware architectures, and consistently beats Linux, Windows, and VxWorks in the time needed to port to new ones. With the MPL, NetBSD's unified source tree for all architectures (kernel and user-level code), toolchain support, auto-configuration framework, and rich feature set, Wasabi's engineers can port NetBSD to new hardware faster than any other OS, **saving up to a year of product development time.**

Commercial Selection Factors

2. Open Source without the GPL

Linux's General Public License (GPL) requires that changes to the kernel be made open source.

While the GPL is is of minimal importance in desktop and server applications, it can be business critical in embedded, where changes to the kernel and other modules may represent confidential information and IP investment. As a result, complicated work-arounds are often developed to evade the requirements of the GPL. None of these workarounds has been tested in court, and embedded OEMs should proceed with extreme caution when using GPL'd software.

NetBSD offers **open source Unix WITHOUT THE GPL.** Customers may make code open source or keep it proprietary as they wish, with no risk of litigation or challenge.

Commercial Selection Factors

3. Lower Cost than VxWorks or Windows

Between licensing, royalty fees, and expensive development tools, VxWorks and Windows can cost hundreds of thousands of dollars per project.

Embedding NetBSD instead can eliminate these costs from development budgets.

Commercial Selection Factors

4. Reliable Support from Wasabi Systems

Company Profile

- Founded by leaders of the NetBSD project
- Engineering team includes port masters for all major embedded architecture families (XScale, MIPS, PowerPC, SuperH, ARM, etc.)
- Venture-backed, Intel Capital portfolio company
- Seasoned CEO, Frank Logan; years of embedded management experience
- Vertical market penetration: Remote storage, Internet infrastructure, set-top boxes
- Long-term development partnership with Intel, partnerships with AMD, MIPS, and others
- Line of NetBSD-enabled products and tools to be introduced in FY 2003
- Stable OS vendor provides industry-leading expertise and peace-of-mind throughout all stages of product development process

Commercial Selection Factors

Wasabi Systems Development Services

- Porting to new platforms
- Custom engineering
- Hardware selection consulting
- Driver development and optimization
- Lifetime product support, including ongoing maintenance and debugging
- Firmware development
- Toolchain development
- Custom images
- System tuning
- Performance analysis
- Application development
- iSCSI storage solutions

Full featured OS, top-tier networking, fast time to market, solid support infrastructure

NetBSD: The embedded OS for tomorrow's smart devices

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