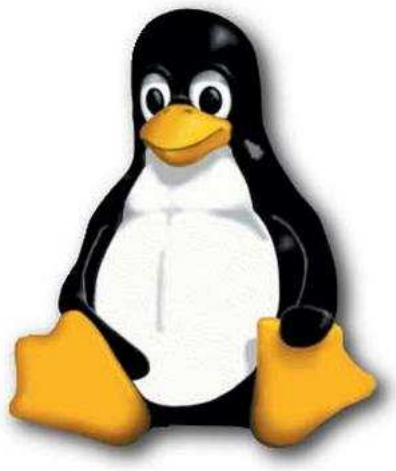
Embedded Linux



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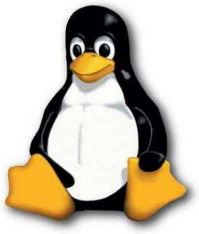
Topics

- What is Linux
- Why Use Linux?
- Linux Portability
- What is Embedded Linux?
- Generic Architecture of Linux
- What Is Real-Time Linux?
- Architecture of Real-Time Linux
- File Systems in Embedded Linux
- Who Provides Embedded Linux ?
- References

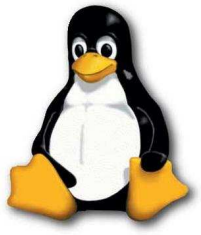


What is Linux

Linux is a free Unix-type operating system that is causing a revolution in the computer world.

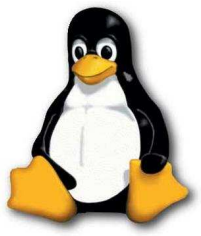
The kernel maintained by Linus Torvalds with the assistance of developers around the world, this operating system in only a few short years is beginning to dominate markets worldwide.

A key reason for this is its development under the GNU (GNU's Not Unix) General Public License, meaning that the source code for Linux is freely available to everyone for the asking.



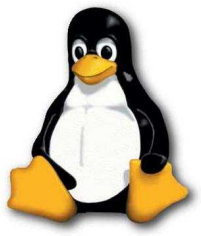
Why use Linux

- Open Source
- Reliability
- Scalability
- Secure
- Supports Virtually All Network Communication Protocols
- Large pool of skilled developers
- Free software and tools
- No runtime license

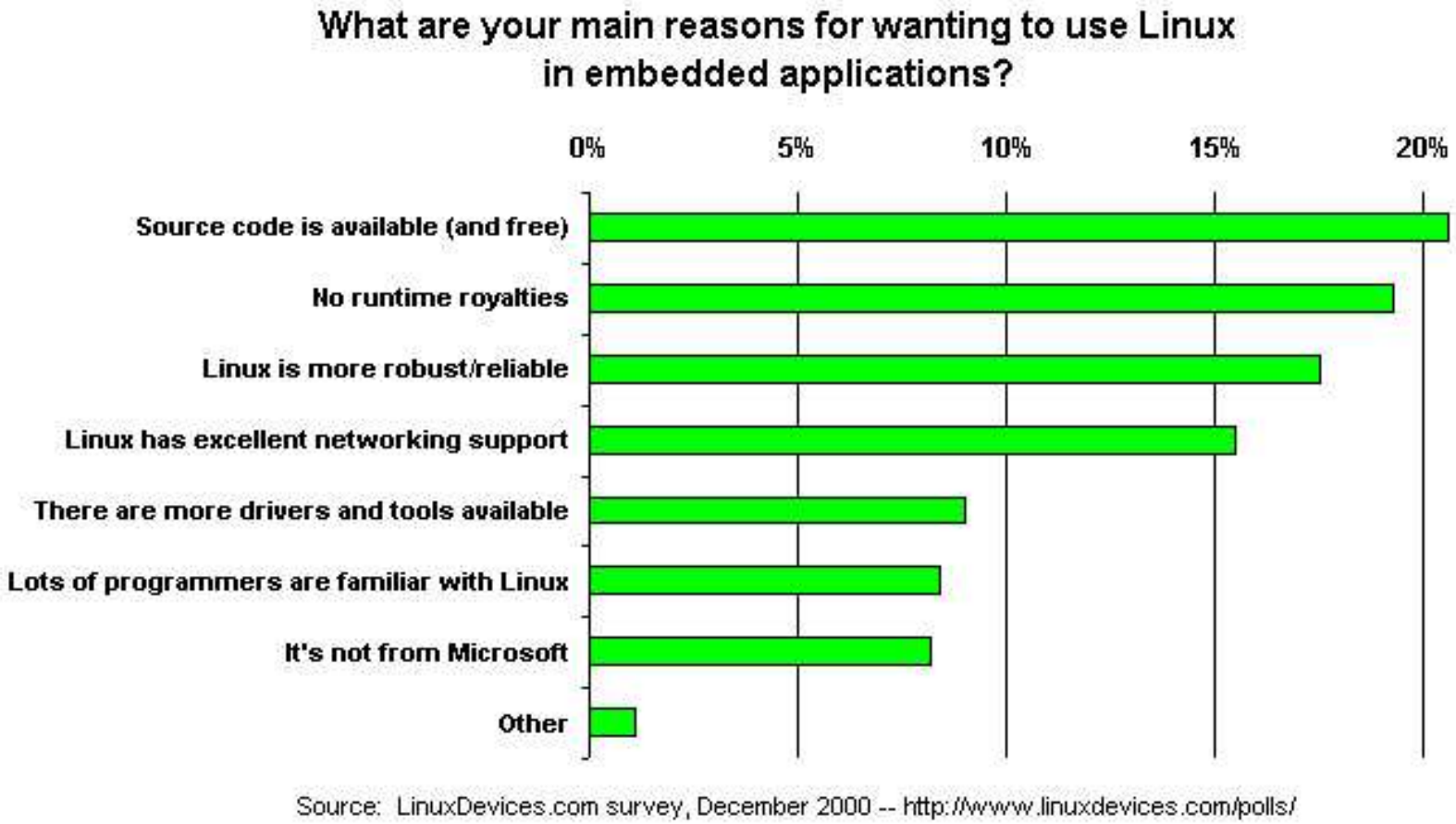


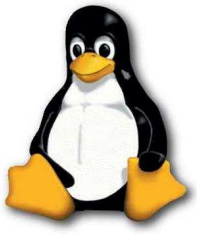
Linux Portability

- Linux provides great portability.
  - The same Application Source Code is Used For
    - A Large number of processors and architectures.
    - A Large number of Embedded Board Support Packages (BSP).
    - A Large number of interfaces with device drivers available.
- Linux is able to runs the same applications on everything from a Linux based PDA to your desktop systems to your enterprise servers.



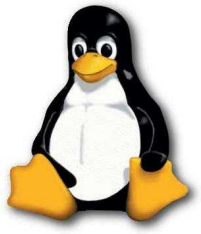
Why Linux for Embedded Systems?





What is Embedded Linux?

- The Linux OS ported to an embedded system.
  - Generally contain a smaller subset of functionality.
    - Less services provided.
    - Less memory required.
    - Boots from ROM.
    - No keyboard or mouse required.
    - Special software developed to control embedded peripherals. (flash disks, touch screens, tiny displays)



Implementation of Embedded Linux

- Initial Program Loader (IPL)

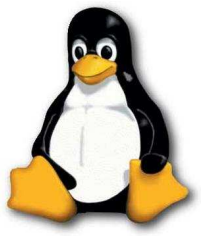
  Loads the kernel into memory

- The Kernel

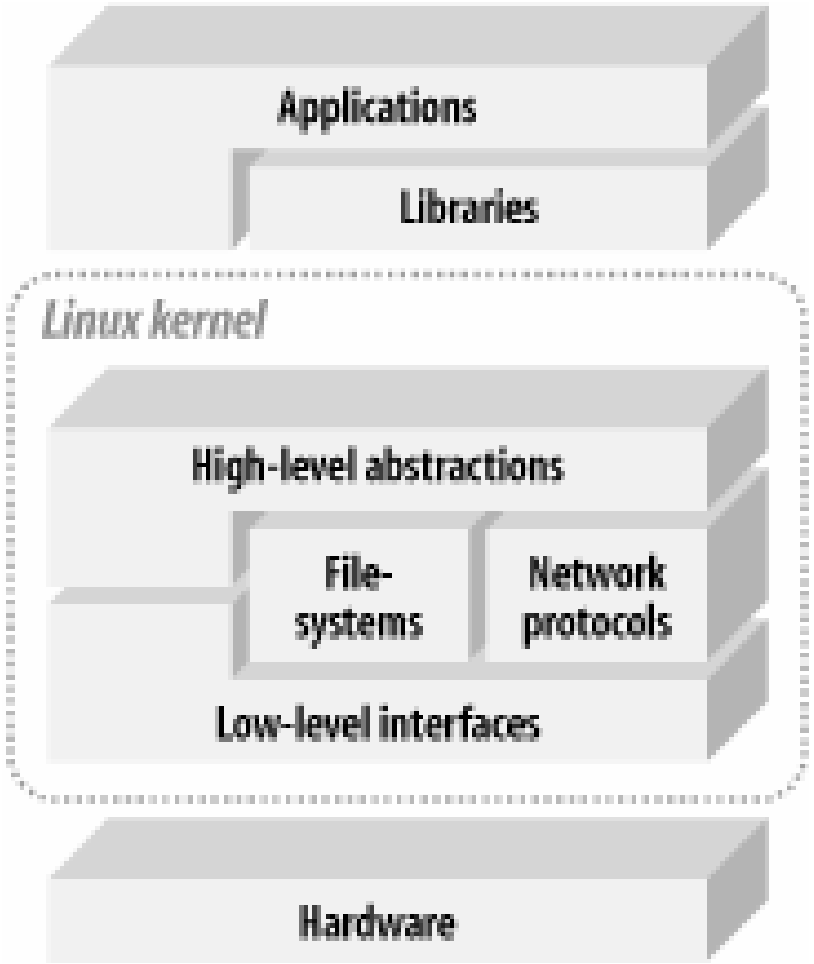
  This is the heart of Linux operating System. Linux has a monolithic kernel.

- File System

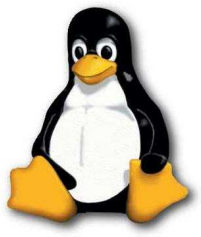
  The Linux kernel mounts a root file system when booted.



Generic Architecture of Linux



Ref: “Building Embedded Linux Systems” – Karim Yaghmour

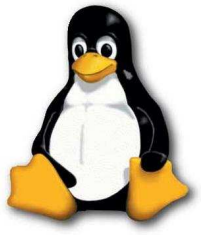


Linux and Real-Time

- Is Linux Real-Time?
  - NO, BUT…Why?

  - **Monolithic Kernel::** The Linux kernel allows a kernel task exclusive access to some data for long periods. This could delay the execution of any POSIX (Portable Operating System Interface for uniX) real-time task that needs access to that same data.

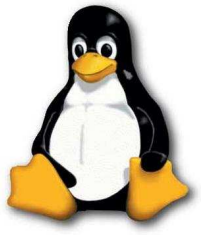
  - **Non Preemptable::** The Linux kernel does not preempt the execution of any task during system calls. If a low-priority process is in the middle of a system call and a message is received for a real-time process, the message will unfortunately be held in the queue until the system call completes, despite its low priority.



Linux and Real-Time

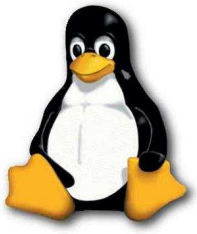
- **Resource Lock::** Linux makes high-priority tasks wait for low-priority tasks to release resources. For example, if any process allocates the last network buffer and a higher priority process needs a network buffer to send a message, the higher priority process must wait until some other process releases a network buffer before it can send its message.

- **Priority Scheduling::** The Linux scheduling algorithm will sometimes give the most unimportant and "nicest" process a time slice, even in circumstances when a higher priority process is ready to execute.



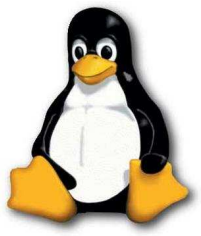
Real-Time Work on Linux

- Today Linux can provide Soft Real-Time
- Two Approaches to Real-Time Linux
  - Modify Linux to include a Real-Time scheduler.
    - Fixes the problems discussed previously.
  - Put Regular Linux on top of a Real-Time operating system (RTOS).

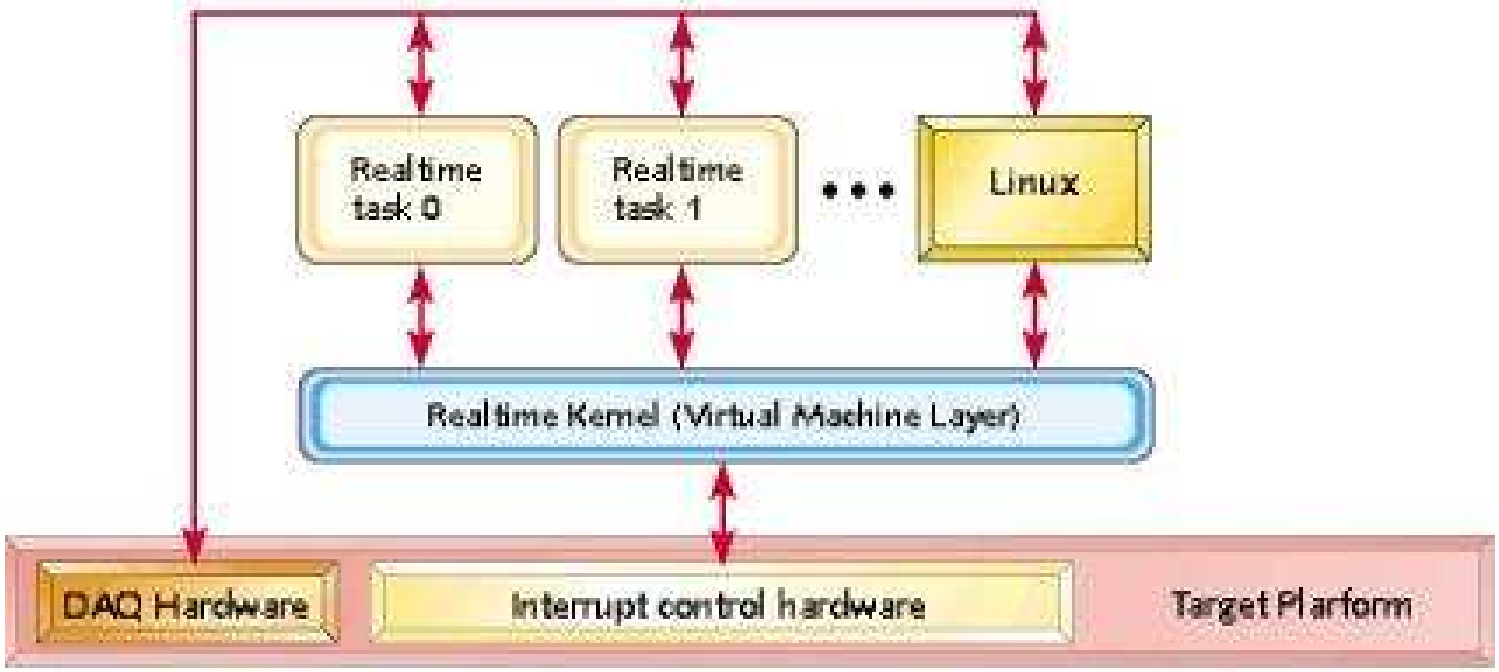


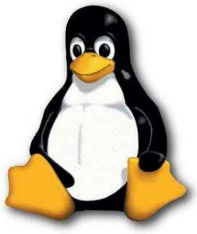
Real-Time Work on Linux

- Several Vendors are working on Real-Time solutions:
  - MontaVista has a Real-Time kernel that they are trying to get accepted by the Linux Community.
  - RTLinux provides a Real-Time kernel uses Linux a thread of the Real-Time OS.
  - Lineo has implemented the Real Time Application Interface (RTAI) for Linux.



Architecture of Real-Time Linux

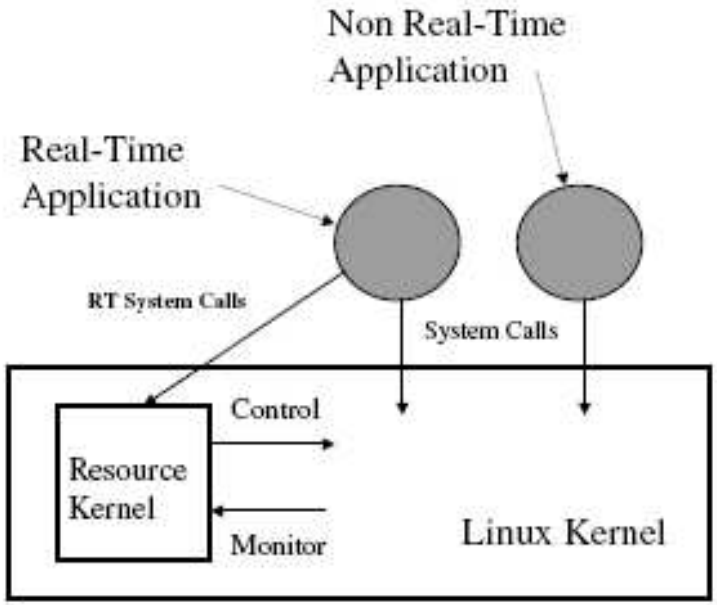


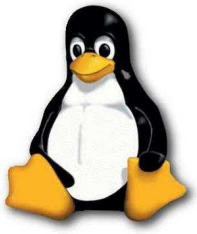


Ref: Circuit Cellar Article

Architecture of Real-Time Linux (contd.)

Resource Kernel



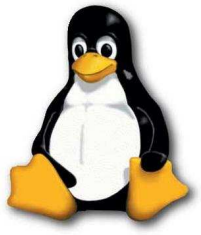


Ref: Issues for Making Linux Predictable by T. Nakajima, M. I. Asaki

File Systems in Embedded Linux

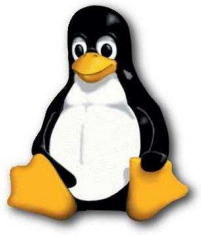
Supports a wide range of file systems:

- Log-based file systems (XFS, JFS, JFFS2, ReiserFS, ext3): favorites for servers.
- Traditional Unix file systems (minix, ext, ext2, UFS)
- Network file systems (NFS, Coda, AFS, DFS)
- DOS/Windows file systems (FAT16, FAT32, NTFS)



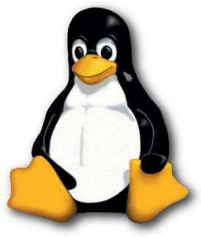
Distributions of Embedded Linux

- MontaVista Software
- LynuxWorks
- Lineo
- Interesting Alternative
  - OnCore Systems
- Others
  - RedHat

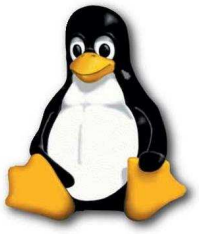


Types of Embedded Linux Systems

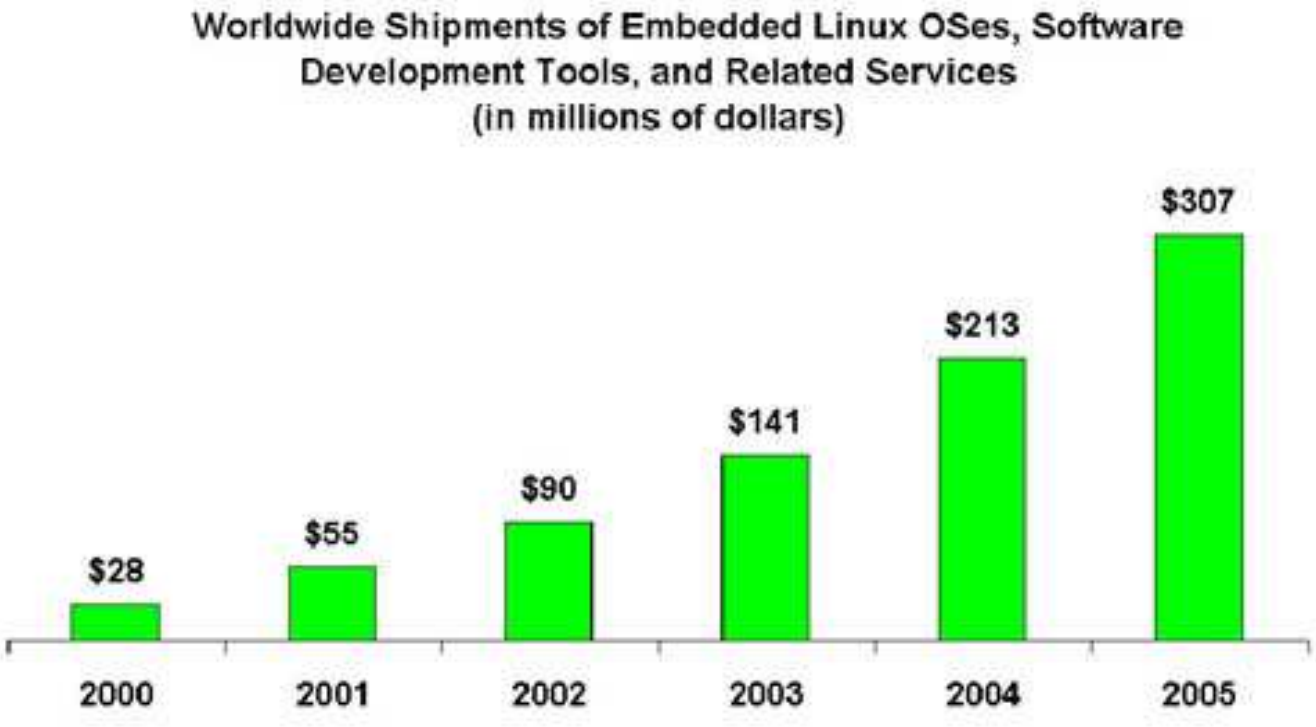
- ETLinux
- LEM
- LOAF
- uClinux
- uLinux
- ThinLinux



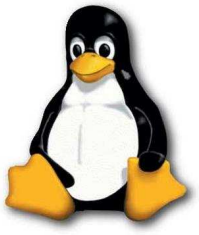
Flies in the Ointment



Growth of Embedded Linux



Source: Venture Development Corporation (VDC) 2000 Embedded Linux Market Study



Applications of Embedded Linux

PDA

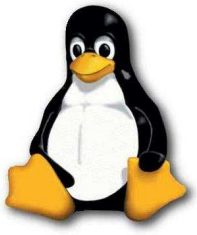
Entertainment devices

Embedded Single Board Computer

Robot

Smart Phone

Embedded Processor and System-on-Chip IC



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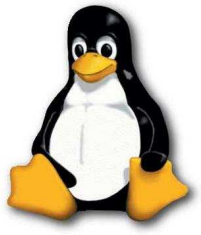


We suck more!
(c) Fidget 2001