Status of Embedded Linux

Tim Bird - CELF AG Chair
Outline

• Kernel Versions
• Technology Areas
• CELF Contract Work
• Embedded Distributions
• Community
• Conferences
• Resources
Linux Kernel Versions
Kernel Versions

- Linux v2.6.26 – 13 July 2008
- Linux v2.6.27 – 9 Oct 2008
- Linux v2.6.28 – 24 Dec 2008
- Linux v2.6.29 – 23 Mar 2009
- Linux v2.6.30 – 10 June 2009
- Linux v2.6.31-rc3 – 14 July 2009
Linux v2.6.26

- KGDB
  - Finally, an in-kernel debugger gets mainlined
Linux v2.6.27

- Ftrace core
- UBIFS
- Bits of Linux-tiny
Linux v2.6.28

- Tracepoints
- Bits of Linux-tiny
Linux v2.6.29

- SquashFS
- BTRFS
- Kernel mode setting
  - Ability to set graphics mode in kernel
- Asynchronous Function Calls
Linux v2.6.30

- TOMOYO security module
- Integrity measurement
- Threaded interrupts
- NILFS
Linux v2.6.31-rc3

- Ftrace filters
- kmemleak
Technology Areas
Technology Areas

- File Systems
- System Size
- Tracing
- Real-time
- Security
- Power Management
- Bootup Time
File Systems

- SquashFS
  - Compressed, read-only FS
  - Mainlined in 2.6.29
    - Was out-of-tree for years
    - CELF contracted author to mainline it

- UBIFS
  - General purpose flash filesystem, built on wear-leveling layer above flash
  - Mainlined in 2.6.27
  - See http://lwn.net/Articles/276025

- BTRFS
  - Check-pointing log-structured file system
  - Mainlined in 2.6.29, BUT STILL EXPERIMENTAL
  - See http://www.linux-mag.com/id/7308
More File Systems

- **NILFS**
  - NILFS = New Implementation of a Log-Structured FS
  - Continuous checkpointing, ability to snapshot
  - Mainlined in 2.6.30

- **AXFS**
  - Advanced XIP File System
  - Still hanging around
  - Offered to Numonyx customers
  - Last mainline attempt was August 2008

- **LogFS**
  - Effort seems to have dropped off
File Systems Issues

- Patches of interest:
  - VFAT patent workaround
    - 2 attempts by Andrew Tridgell to work around Microsoft VFAT long-name patent
    - First attempt was controversial, because functionality was lost
      - New approach preserves functionality
    - [http://lwn.net/Articles/339641](http://lwn.net/Articles/339641)
  - VFS-based union mounts
  - Some log-structured file system is needed for fast mounting
    - Possibly NILFS or BRTFS will fill this role
System Size / Memory

- Linux-tiny
  - CELF contracted with Free-Electrons
  - 8 patches mainlined in Fall by Thomas Petazzoni
- -ffunction_sections
  - Put each function in its own linker section
  - Allows elimination of unused code
  - Patches sent last July, but I haven’t seen any update since then
- Compression
  - LZMA support
    - Support for LZMA kernel image compression (up to 30% better than gzip)
    - Still would like to see generic LZMA support in kernel (for e.g. SquashFS)
      - See http://www.squashfs-lzma.org/
- XIP
  - Not much new development (AXFS?)
Compressed swap

- Latest patch is “compcache”
- Uses LZO-compressed RAM based block device as swap disk
- NACKed because MM developer disliked the use of xvmalloc
Compcache results
smem

- **Description:**
  - New tool to provide information about system memory usage
  - Reports *Proportional Set Size* (PSS), which accounts better for shared pages, and doesn’t lie, like RSS
  - Supports visualization (charts)

- **Author:** Matt Mackall

- **Status:**
  - Presented at ELC 2009 – is in good shape
  - See [http://www.selenic.com/smem](http://www.selenic.com/smem)
Mem_notify patch

- Addition to cgroup system to support notification on low memory
- Patches not really noticed by community
- Some feedback was addressed, and patch was submitted again (last week)
- Work was funded by CELF
Bootup Time

- Bootup time is now a hot topic (due to netbooks)
- Intel 5-second boot on Moblin
  - See http://lwn.net/Articles/299483
- Asynchronous function calls
  - Mainlined in 2.6.29
  - See http://lwn.net/Articles/314808
- `scripts/bootgraph.pl` for visualization of initcalls
- New Readahead techniques
- Aggressive application optimizations (especially for X)
Bootup Time patches

- devtmpfs
  - A form of devfs again (oh no!)
  - 0.6 second faster boot-time
    - On desktops – who uses dynamic device nodes in embedded?
Tracing

- Ftrace
- LTTng
- SystemTap
- Perf Counters
FTrace

- Is a new system to provide kernel tracing
- Generic framework for adding tracing to the kernel
  - Provides multiple tracers, selectable at runtime
  - Infrastructure for tracepoint definition, data capture (ring buffer), tracer control and trace output
- Core mainlined in 2.6.27
  - More bits coming (generic filtering in 2.6.31)
- See
  http://people.redhat.com/srostedt/ftrace-world.odp
Real-time

- RT-preempt
  - Interrupt threads
    - Mainlined 2.6.30
  - Sleeping Spinlocks
    - Thomas Gleixner and Ingo Molnar got busy with other stuff
    - Maybe a push to mainline this Fall.

- Xenomai
  - Dual-kernel Real-time kernel
  - Successor to Adeos/I-Pipe
Power Management

- Wakelocks submitted by Google
  - Kernel PM developers rejected the approach
  - But this opened a discussion of the requirements
  - See http://lwn.net/Articles/318611

- I’m not sure what else is going on lately
Audio/Video/Graphics

- **GStreamer**
  - Is de-facto standard for video management for handhelds
- **DirectFB**
  - Continued uptake in TV domain
- **OpenGL ES**
  - De-facto standard for 3D API (/Gaming in embedded?)
- **Clutter (GTK UI Framework)**
Security

- Tomoyo
- SMACK
  - CELF project to analyze SMACK
- Embedded SELinux
  - I haven’t heard anything new
Security Modules

- Tomoyo Linux
  - Path-based security module
  - Mainlined in 2.6.30
    - Was a big deal to get a path-based LSM into the kernel
  - See [http://elinux.org/TomoyoLinux](http://elinux.org/TomoyoLinux)
    - Presentations on using Tomoyo with Android at Japan Technical Jamborees 27 and 28

- Smack
  - Mainlined in 2.6.25 kernel
  - Seems good for embedded (low overhead)
    - CELF started project to evaluate TV use case
  - See [http://lwn.net/Articles/292291](http://lwn.net/Articles/292291)

- Embedded SE Linux
  - Haven’t heard much lately
Security – other

- **Integrity Measurement**
  - Allows kernel to interact with TPM and ensure trusted operation
  - Mainlined in 2.6.30
  - See [http://lwn.net/Articles/137306](http://lwn.net/Articles/137306)
  - Search: “Integrity Measurement Architecture IBM”
Device Trees for ARM

- Device Trees is a mechanism to pass info from bootloader to kernel
  - Supported in X86 and PPC
  - If all platforms supported it, it could allow more uniform device drivers
  - Also, allows for a single binary to run on multiple platforms
- Is a new hot topic

DLNA summit 2 – November in the Netherlands

- CELF profided DLNA hardware and specs to OSS developers
Embedded Distributions
Embedded Distributions

- Moblin
  - Intel transferred control to Linux Foundation
- Android
  - Number of devices seem to be exploding
    - Waiting to see consumer uptake
- Maemo
  - Maemo to use Qt (not a big surprise)
    - http://lwn.net/Articles/341391 (subscriber only)
- OpenWRT
- Chrome
  - Don’t really know what’s in it yet
Contract Work
CELF Contract Work

- smem
- OOM notifications in cgroups
- SquashFS
- SMACK on TV analysis
- Flash filesystem testing and comparison
- DirectFB mainlining
- Matt Mackall – maintainer work
Contract Work Notes

• SMACK on TV analysis
  • White paper completed this week
  • Should show up on elinux wiki very soon

• Flash filesystem testing
  • Should be available on elinux wiki

• DirectFB mainlining
  • Adding support to Linux kernel for “fusion” extension
Matt Mackall

- Is now in MAINTAINERS file as an embedded Linux maintainer
  - Joining David Woodhouse and Paul Gortmaker
- CELF pays for Matt to do miscellaneous development and advocacy for embedded Linux kernel work
Community
Community

- Need to build embedded linux community
  - Please use linux-embedded list
- MELD embedded linux developer portal
  - Supported by Monta Vista
- eLinux wiki
eLinux Wiki

- Site for embedded Linux developers
- Very good for some technical areas
- Stagnant in some areas
- Promotion
  - Contests
  - Elinux.org working BOF at ELC
- Please use it and post stuff there
Conferences

• Past
  • ELC Europe 2008
  • ELC 2009
    • Videos should be available soon

• Future
  • ELC Europe 2009
  • Japan Linux Symposium
  • ELC 2010

• See http://www.embeddedlinuxconference.com/
ELC Europe 2009

- Grenoble, France
- October 15, 16
- Speakers notified – program looks good!
Japan Linux Symposium

- Tokyo, Japan
- October 21-23
- Linus Torvalds is speaking
- Kernel Summit scheduled for October 19-20
- Status:
  - Speakers notified – program shaping up
Current plan:
- April 12-14 in San Francisco, CA, USA
- Co-Located with Linux Foundation Collaboration Summit
- Call for presentations should go out shortly
Resources

- LWN.net
  - http://www.lwn.net/
  - If you are not a subscriber, please do so
  - This is an invaluable community resource that needs your support

- eLinux wiki
  - http://elinux.org/

- Linux-embedded mailing list
  - http://vger.kernel.org/vger-lists.html#linux-embedded
Discussion

- How to take control of kernel away from Enterprise and Desktop developers?
  - Classic community answer – donate more patches than them
  - Any other ideas?
    - Distractions, bribes…
Thanks!

- Keep up the good work!