CE Workgroup

Status of Embedded Linux
February 2012

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LF CE Workgroup
Outline

Kernel Versions
Technology Areas
CE Workgroup Projects
Other Stuff
Resources
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- Kernel Versions
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Kernel Versions

- Linux v2.6.37 – 4 Jan 2011
- Linux v2.6.38 – 14 Mar 2011 – 69 days
- Linux v2.6.39 – 19 May 2011 – 66 days
- Linux v3.0 – 21 July 2011 – 63 days
- Linux v3.1 – 24 Oct 2011 – 95 days
- Linux v3.2 – 4 Jan 2012 – 72 days
- Linux v3.3-rc2 - (as of 6 Feb)
• Perf symbols abstraction
  • Added 'symfs' option for off-box analysis of perf.data
  • Should be good for embedded
Linux v2.6.39

- **Pstore**
  - Store information from dying kernel into some persistent storage
  - Similar to mtndoops or ramoops
  - See [http://lwn.net/Articles/434821/](http://lwn.net/Articles/434821/)

- Device power domains for runtime PM
- ARM arch tree changes (just starting)
Linux v3.0

- Fast symbol resolution for module loading
  - Binary search instead of linear lookup for module linking
- POSIX alarm timers
  - Similar to Android Alarm Timers
  - See http://lwn.net/Articles/429935/
- BKL function calls are now gone
- More ARM arch tree changes
Linux v3.1

- Watchdog timer core
- New framework for handling power management domains was added
  - See driver/base/power/domain.c
- Multiple ARM SoCs now have device tree support
Linux v3.2

- New pin control subsystem
  - Allows control of multiple pins as named groups, with multiplexing
  - See Documentation/pinctrl.t.xt
- `devfreq` – DVFS for non-cpu devices
- PM QOS now supports per-device constraints
  - See Documentation/power/pm_qos_interface.txt
  - See http://lwn.net/Articles/466230
Linux v3.3 (probable)

- ARM large physical address extensions
  - See Catalin Marinas talk at ELC Europe
- ALSA support for compressed audio
- New “charger manager” subsystem
  - Can partially resume to poll battery and re-suspend
- Android patches in staging
Things to watch

- ARM arch sub-tree refactoring
  - [http://lwn.net/Articles/443510/](http://lwn.net/Articles/443510/)
- Device trees
- More runtime PM improvements
- Android features
  - Especially after October kernel summit
- Boot timing patches
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Bootup Time

- Readahead getting lots of attention
  - Ureadahead in Ubuntu
  - See my presentation at ABS 2011 about readahead with Android

- Snapshot boot
  - Old topic, but still very popular
  - Requires work both inside and outside kernel
    - Not much mainlined
  - See ELC 2011 presentation by Kang Dongwook

- Filesystem speedups
  - CELF funding work in this area (more later)
Bootup Time (cont.)

• XIP (Execute-In-Place)
  • Almost removed from kernel
    • Version in kernel was broken
    • Use of XIP on only out-of-tree platforms is a problem

• Bootloader improvements
  • Coreboot on x86
    • See “Really fast x86 boot” presentation at FOSDEM 2011
  • U-Boot ARM caching enhancements

• See presentation by Andrew Murray at ELC Europe 2010
  • Very good philosophy of boot time reduction
    • Bootup time work = re-specialization of software
Graphics

- 3D
  - OpenGL ES is de-facto standard everywhere
- 2D
  - Android had Skia, but is moving to...?
  - Meego used Clutter, Qt, and X
  - Framebuffer is going away, with acceleration required for larger screens
- Lots of work around memory management between kernel, user-space and GPU
• /dev/ion -- a unified approach to buffer management and sharing between display, GPU, camera, codecs, etc, new in Ice Cream Sandwich

• Accelerated rendering is a big topic
  • Google introduced renderscript
    • Uses LLVM to do runtime retargeting of script to whatever capabilities device has

• Ability to support GPU in SOC is very important
Graphics Drivers

- PowerVR graphics driver
  - PowerVR is being used lots of places
    - Intel adopted for Cedarview and it's already in Sodaville
    - Is in very many ARM SOCs
  - PowerVR driver is closed-source
  - Alan Cox submitted some driver pieces in February 2011
    - Omitted anything relating to out-of-tree binary driver
  - See http://thread.gmane.org/gmane.linux.kernel/1103793
Multimedia

- Gstreamer
  - Is still being used in TVs
    - Ex: Google TV uses it
- Android media layer
  - Stagefright – new media layer
    - Replaces OpenCore?
- Codec wars
  - WebM/VP8
    - Free codec by Google
    - Integrated into HTML5
File Systems

- UBIFS
  - Replacing JFFS2 as default raw flash FS of choice
  - Still needs some boot time improvements
- YAFFS2 is not in mainline yet
  - Despite CELF funding
- LogFS
  - Appears to be abandoned
- AXFS
  - Advanced XIP File system – developed by Intel/Numonyx but never mainlined
File Systems (cont.)

- Google moving to Ext4 for future Android devices
  - Already using eMMC instead of raw flash
  - Sad to see proprietary algorithms in black boxes responsible for storage performance
    - Lots of MMC optimized for serial workloads and FAT filesystems
- Want to optimize Linux block filesystem layers for flash
  - See Arnd Bergmann's talk at ELCE on filesystem performance on cheap flash media
Power Management

- Runtime Power Management
  - Relatively new ability to suspend and resume individual system components
  - See http://lwn.net/Articles/347573/
- See Magnus Damm’s slides at: http://elinux.org/ELC_2011_Presentations
- Device power domains
  - Set of devices sharing power resources (clocks, power planes, etc.)
  - See Rafael Wysocki’s talks at LinuxCon Japan 2011 and ELC Europe 2011
System Size

- CE WG has revived the Linux-tiny project
- Bloatwatch still running – but who looks at it?
  - http://www.selenic.com/bloatwatch
  - Big increases in some kernel versions
- Good talks recently:
  - Xi Wang at ELC 2011 about optimizing memory usage throughout the system
  - Darren Hart at ELCE 2011
- User space is memory problem area now
  - OOM killer or OOM avoidance is big issue
    - Cgroup memory notifications
    - Android has its own thing
      - Application lifecycle is key feature
Observations

- Rate of “general features for embedded” contributions to kernel seems low
  - Not a lot of progress recently on bootup time reduction, size reduction, security in embedded
    - Some problems and solutions shifted to user space
  - Hot areas in kernel:
    - Power management, ARM board support refactoring, GPU management (memory sharing, driver support)
- Still seeking ways to facilitate participation of embedded developers in community
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CEWG Contract Work 2010

- Bootchart and smemcap in busybox
- Function-sections
- YAFFS2 mainline effort
- SquashFS enhancements
- U-Boot ARM enhancements
- Trace format standard
- Kexecboot enhancements
- Flash filesystem testing
CEWG Contract Work 2010

- Bootchart and smemcap in busybox
- Function-sections
- YAFFS2 mainline effort
- SquashFS enhancements
- U-Boot ARM enhancements
- Trace format standard
- Kexecboot enhancements
- Flash filesystem testing
Mainline YAFFS2 effort

- YAFFS2 is a popular NAND flash filesystem
  - Was used by Android in many devices
- 3 mainline attempts made, but hit some barriers
  - Currently stuck on some locking issues
- Outlook for mainline acceptance is uncertain
- Was a classic case of developer wanting to retain multi-platform support
  - This approach is rejected by community
Trace Format Standard

- Create a singled trace format standard for the embedded industry (CTF – Common Trace Format)
  - See http://www.efficios.com/ctf
  - Allows reuse of tools with data from different tracing systems
- BabelTrace trace conversion library
  - Converts trace formats into CTF (and back?)
  - Proof of concept conversion implementation
    - Can convert kernel messages with timestamps to CTF and back to text
CEWG Contract Work 2011

- Mainline fast symbol resolution
- Mainline Device Firmware Upgrade (DFU) code in U-Boot
- Work on Linux tiny patches
- Improve UBIFS mount time
- Flash filesystem testing
Contract Work 2011 (cont.)

- Mainline the watchdog framework
- Extend bluetooth stack with Remote SIM Access protocol
- Kernel trace and debug documentation (on eLinux wiki)
- Mainline Android kernel features
Contract Work Details

- **Mainline fast symbol resolution**
  - Change symbol lookup to use binary search instead of linear scan to speed up module loading
  - Already mainlined (Linux v3.0)

- **Mainline DFU code in U-Boot**
  - Device Firmware Upgrade (DFU) is an industry standard for upgrading and manipulating firmware in embedded devices

- **Work on Linux tiny patches**
  - Revive Linux-tiny patch set
  - Forward-port patches to latest kernel
  - Add more patches to improve kernel configurability
Contract Work Details (2)

- Improve UBIFS mount time
  - Add logging or checkpointing to UBI to avoid bad-block scan of whole device on UBI attach
- Flash filesystem testing
  - Publish performance results for each new kernel version
  - Lots of great data – charts and graphs!
  - Check out: http://elinux.org/Flash_Filesystem_Benchmarks
Mainline the watchdog framework
- Provides a generalized watchdog mechanism
  - Should provide easier method to add watchdogging to drivers and the kernel going forward
- Original framework was written by Alan Cox and others

Extend bluetooth stack with Remote SIM Access protocol
- Allows for Linux bluetooth and telephony stack to utilize SIM in external device for operation
- Primary use is for Linux-based in-car system to utilize SIM in mobile device for telephony
Mainline Android kernel features
- Goal is to incrementally reduce diff between Android and mainline kernels

Interesting discussion at kernel summit
- Would be nice to support Android with mainline kernel
  - Linus – we’ve taken wrong stuff before

Multi-party effort to mainline patches
- Greg KH put some files into drivers/staging
- Good discussion last week at Linaro Connect
Busybox replacement proposal

• Proposal by me to replace busybox to avoid infringing the license
  • Is not a (yet) a real project - in particular it is:
    • NOT A SONY PROJECT!!
• http://elinux.org/Busybox_replacement_project
• Currently considering using toybox, by Rob Landley (former busybox maintainer)
• Some community discussion:
  • http://lwn.net/Articles/478308/ - A tempest in a toybox
  • http://lwn.net/Articles/478249/
Long Term Support Kernel for Industry

- CE Workgroup is initiating a new project for companies to collaborate on maintaining a kernel version for embedded products
  - Similar to long-term kernel maintained in enterprise space
  - Based on community long-term tree
- See presentation by Tsugikazu Shibata
LSTI reasons

- Various effects contribute to low contribution rate from consumer electronics product teams
  - Version gap, product schedule impedance mismatch with mainline releases, focus on short-term rather than long-term solutions
- Want to create an area for collaboration between companies, as well as a staging ground for moving code to mainline
LTSI project overview

- Project consists of three parts

Kernel Mainline

Kernel.org (Greg K-H)

CE WG

Industry

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LSTI details

- The plan (subject to change):
  - 2-year overlapping releases
  - Bugfixes from community longterm tree and product trees
  - Backport of some features from mainline
  - Integration of some (a very small set) of out-of-mainline patches (e.g. LTTng, RT-preempt, Linux-tiny)
- Should have first release in early 2012
Other Stuff

- Tools
- Build Systems
- Distributions
- Android
- Industry Organizations
- Events
- Miscellaneous
Tools

• QEMU
  • QEMU is being used everywhere, for device emulation (Android, Yocto)
  • Javascript QEMU implementation (!!)
• Eclipse
  • Is now de-facto “umbrella” tool for development
  • Need to pry seasoned developers away from command line
• Tracing
  • Perf, ftrace and LTTng 2.0
  • Common Trace Format standard
Build Systems

• Yocto project
  • Umbrella project – has builder, eclipse tools, other things
  • OpenEmbedded and Yocto are getting integrated
  • Many talks at ELC and ELCE 2011
• Still lots of custom build systems out there
Embedded Distributions

- Tizen = MeeGo + Limo + (WAC technologies)
  - Was announced a few months ago
  - Nokia switching to Windows Mobile
  - Focus = HTML5 applications
  - http://www.tizen.org/

- WebOS
  - Open source announced
  - For sale?

- Legacy custom embedded
  - Still no “standard” embedded distribution
Android

- Android 4.0 SDK (Ice Cream Sandwich) released October 2011
  - Source released this week!
- Ice Cream Sandwich unifies mobile, tablet and TV platforms in one codebase
- Phone activations at 550,000 per day
- Dalvik ported to non-Android
  - Myriad Alien Dalvik for Meego
  - IcedRobot for native Linux
  - OpenMobile’s ACL (Application Compatibility Layer)
Distributions


- Embedix
- Hardhat
- MontaVista
- Denx ELDK
- TimeSys Linux RT
- LynuxWorks
- Wind River Linux
- Ångström
- Poky
- Maemo
- Moblin
- Meego
- Tizen
- Embedded Debian
- Ubuntu (embedded)
- Android
- Fire?
Industry organizations

- Linux Foundation
  - Has lots of embedded-related projects
    - Yocto, Meego, CE Workgroup
- CE Workgroup
  - Now utilizing LF infrastructure
    - Should mean it’s easier for public to participate in CE WG initiatives
      - Was out of commission in fall
- Linaro
  - Doing lots of great stuff
  - See David Rusling’s ELC 2011 talk
Events

• Android Builders Summit
  • Just finished yesterday
  • Content will be online
• Embedded Linux Conference Europe 2012
  • November 7-9, 2012
  • Barcelona, Spain
Unlockable bootloaders
- Announced by Motorola, Sony/Ericsson
- Can unlock bootloader to install custom firmware
- Wipes the phone to remove DRM-protected content
- Motorola says you can re-lock by reinstalling vendor image

Increased use of Stack Overflow
- Great site for answering detailed development questions
- See www.youtube.com/watch?v=NWHfY_lvKlQ
- Google developers answer questions here
eLinux wiki

- http://elinux.org
  - Web site dedicated to information for embedded Linux developers
    - The wikipedia of embedded linux!
  - Hundreds of page covering numerous topic areas: bootup time, realtime, security, power management, flash filesystem, toolchain, editors
    - Some areas have lots of content – some need work
• LWN.net
  • http://lwn.net/
  • If you are not subscribed, please do so
• Kernel Newbies
  • http://kernelnewbies.org/Linux_2_6_??
• eLinux wiki - http://elinux.org/
  • Especially http://elinux.org/Events for slides
• Linux-embedded mailing list
  • http://vger.kernel.org/vger-lists.html#linux-embedded
Thanks!