Status of Embedded Linux

June 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

- 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
  - Larger due to kernel.org breakin
- Linux v3.2 – 4 Jan 2012 – 72 days
- Linux v3.3 – 18 Mar 2012 – 74 days
- Linux v3.4 – 20 May 2012 – 63 days
- Linux v3.5-rc2 – 9 June 2012 …
  - (Maybe 3.5 at start of August)
Linux v2.6.39

- Pstore
  - Store information from dying kernel into some persistent storage
  - Similar to mtdoops 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
New pin control subsystem
- Allows control of multiple pins as named groups, with multiplexing
- See Documentation/pinctrl.txt
- See ELC 2012 talk by Linus Walleij

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

- ARM large physical address extensions
  - See Catalin Marinas talk at ELC Europe 2011
- ALSA support for compressed audio
- New “charger manager” subsystem
  - Can partially resume to poll battery and re-suspend
- Android patches in staging
  - This is really cool
  - Please don’t use any interfaces from code in staging!!
Universal Flash Storage host controller drivers
- See Documentation/scsi/ufs.txt

Common clock framework
- Unifies handling of subsystem clocks
- See Documentation/clk.txt

HSI (High-speed synchronous serial interface) framework
- Used for communication between CPU and cellular modem engines
Linux v3.4 (continued)

- DMA buffer sharing API
- Remoteproc subsystem
  - Allows for control of other CPUs through shared memory
  - Rpmsg is a new mechanism for communicating with other CPUs (running non-Linux)
  - See Documentation/remoteproc.txt and rpmsg.txt
Linux v3.5 (probable)

• Kernel log rework
  • Structured printk (new format), with tags
  • http://lwn.net/Articles/492125/
• Support for writing NFC drivers
• Integration of ramoops and pstore
  • Part of work to support Android ram_console
Things to watch

- Device trees
- Android features
- Big/Little
- Single kernel image for ARM
  - Result of lots of device tree and ARM refactoring work
  - See LinuxCon Japan talk by Deepak Saxena
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Bootup Time

- Not so much a kernel problem any more
  - Lots of previous talks and presentations
  - Good kernel techniques on eLinux wiki
    - http://elinux.org/Boot_Time

- User-space is big problem area now
  - Kernel should provide features for overall performance

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

- Bootloader improvements
  - U-Boot ARM caching enhancements
- 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
Graphics

- **3D**
  - OpenGL ES is de-facto standard everywhere

- **2D**
  - Android had Skia, but is moving to HWUI
  - Other platforms can use 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
• Android has /dev/ion
  • A unified approach to buffer management and sharing between display, GPU, camera, codecs, etc, new in Ice Cream Sandwich
  • Replacement for pmem
• Mainline has Contiguous Memory Allocator (CMA) and dma-buf
  • http://lwn.net/Articles/468044/ - CMA
  • http://lwn.net/Articles/470339/ - dma-buf
Accelerated rendering

- 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
- No clear way to pressure ImageTech or write community driver
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
  - Sony uses this
Google using Ext4 on eMMC on current Android devices
  • No more raw NAND flash

Want to optimize Linux block filesystem layers for flash
  • See Arnd Bergmann's talk at ELC Europe 2011 on filesystem performance on cheap flash media
  • See Ken Tough’s ELC 2012 talk
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
Power Management

- New attempt at wakelock-compatible solution by Rafael Wysocki
  - “Autosleep and wakelocks”
  - http://lwn.net/Articles/479841/
  - Rafael: “This series tests the theory that the easiest way to sell a once rejected feature is to advertise it under a different name”
  - Appears to be generating less heated discussion
System Size

- Good talks recently:
  - Xi Wang at ELC 2011 about optimizing memory usage throughout the system
  - Darren Hart at ELCE 2011 – poky-tiny
- User space is memory problem area now
  - OOM killer or OOM avoidance is big issue
    - Cgroup memory notifications
    - Android has it's own low memory killer
      - Application lifecycle is key feature
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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
- Mainline the watchdog framework
- Extend bluetooth stack
- Kernel trace and debug documentation
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
- Mostly mainlined in u-boot and kernel

Work on Linux tiny patches
- Revive Linux-tiny patch set
- Forward-port patches to latest kernel
- Add more patches to improve kernel configurability
- Last work was with function-sections for kernel
• Improve UBIFS mount time
  • Add logging or checkpointing to UBI to avoid bad-block scan of whole device on UBI attach
  • Series fo “fastmap” patches submitted over last few months

• 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
- Mainlined in 3.1

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
- Mainlined in upstream bluez and kernel
Long-term Projects

- Android mainline project
- Long Term Support Initiative (LTSI)
Android Mainline Project

• 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 sub-optimal stuff before
• Multi-party effort to mainline patches
  • CE WG, Linaro, and others
    • Greg KH put some files into drivers/staging
• Good meeting at Linaro Connect in February
Android mainline status

- 3.3 kernel (with 12 lines of patches) boots AOSP
  - Some pieces missing: wakelocks, network security, Android USB gadget
- Work is needed to move items from staging to fully mainlined
- Some work recently on
  - Logger
  - Ram console
  - Led timers
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 Hisao Munakata at LinuxCon Japan
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

- LTSI project consists of three parts
- **Kernel Mainline**
- **Kernel.org (Greg K-H)**
- **CE WG**
- **Industry**

**Upstream support**

- **long-term stable tree**
  - Bug fixes
  - Feature back-porting

- **LTS Industry tree**
  - LTSI Staging tree
  - Industry staging tree
  - Features
  - Bug Fixes

- **Products**
  - Features
  - Bug Fixes

(LinkedIn-Next)
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 June or July 2012
Open Project Proposals

- Was announced on celinux-dev mailing list
- Architecture Group voted on projects in early June
  - Need to get BOD approval, then we’ll announce the projects for 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
  • Sony is adopting Yocto
• 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/](http://www.tizen.org/)

- **WebOS**
  - Open source announced, HP dropping project

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

- Android 4.0 SDK (Ice Cream Sandwhich) released October 2011
- Ice Cream Sandwich unifies mobile, tablet and TV platforms in one codebase
- Phone activations at 900,000 per day
- Dalvik ported to non-Android
- Ubuntu for Android
  - Very interesting – use Android device as PC, when connected to dock (large screen and keyboard)
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, Tizen, LTSI
  - CE Workgroup
    - Now utilizing LF infrastructure

- Linaro
  - Doing lots of great stuff
  - See David Rusling’s ELC 2011 talk
Events

- Embedded Linux Conference – February 2012
- Android Builders Summit – February 2012
- LinuxCon Japan – June 2012
  - Lots of great presentation – almost all online
- Japan Jamborees
  - Next = June 21, Nakano Sun Plaza, Tokyo
  - http://elinux.org/Japan_Technical_Jamboree_41
- Embedded Linux Conference Europe 2012
  - November 7-9, 2012
  - Barcelona, Spain
Miscellaneous

- 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
  - Search: “site:stackoverflow.com <question>”

- Raspberry Pi
  - Extremely low-cost development board - $25
  - Targeted at students and hobbyists
eLinux wiki

- [http://elinux.org](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
Resources

• 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!