CE Workgroup

Status of Embedded Linux
September 2013

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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 v3.6 – 30 Sep 2012 – 71 days
- Linux v3.7 – 10 Dec 2012 – 71 days
- Linux v3.8 – 18 Feb 2013 – 70 days
- Linux v3.9 – 28 Apr 2013 – 69 days
- Linux v3.10 – 30 June 2013 – 63 days
  - I predicted July 7, 2013 – (7 days off)
- Linux v3.11 – 2 Sep 2013 – 64 days
- Linux v3.11 (no –rc yet)
  - I predict 3.12 on …
Kernel Versions

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- Linux v3.7 – 10 Dec 2012 – 71 days
- Linux v3.8 – 18 Feb 2013 – 70 days
- Linux v3.9 – 28 Apr 2013 – 69 days
- Linux v3.10 – 30 June 2013 – 63 days
  - I predicted July 7, 2013 – (7 days off)
- Linux v3.11 – 2 Sep 2013 – 64 days
- Linux v3.11 (no –rc yet)
  - I predict 3.12 on … 8 Nov 2013 – 68 days
Linux v3.6

- Android RAM console functionality integrated into pstore
- CANFD support for CAN protocol
  - CAN with flexible data rate
- LED oneshot mode
  - Sysfs interface for certain one-time LED/gpio manipulations
- "Suspend to Both"
  - Create resume image both in RAM and on disk
  - If power dies during suspend, disk image can be used to resume
Linux v3.7

- ARM multi-platform support
  - See http://lwn.net/Articles/496400/
- ARM 64-bit support (Aarch64)
- Cryptographically signed kernel modules
  - See https://lwn.net/Articles/470906/
- Perf trace (alternative to strace)
  - Allows intermingling kernel trace events with syscall events
- Runtime power management for audio
- Kernelsdoc system can output in HTML5 format
Linux v3.8

- F2FS – flash-friendly file system
  - See https://lwn.net/Articles/518988/
- New thermal governor subsystem
- Memory control group support for accounting for kernel memory usage
  - Stack and slab accounting and limits
- Cpuidle support for big.LITTLE
Linux v3.9

- Ftrace snapshots
  - Grab a snapshot of a running trace without stopping
- KVM virtualization for Cortex A15 processors
- PowerPC support for transactional memory
- CONFIG_EXPERIMENTAL=y
  - And should be gone soon
- ‘make menuconfig’ now has "save" and "load" buttons
Linux v3.9 (cont.)

- Descriptor-based GPIO
  - Access GPIOs by descriptor (e.g. by name in addition to by number)
  - Allows for grouping GPIOs - for “atomic” operations
    - Possibly useful for handling realtime issues
  - See [http://lwn.net/Articles/533632/](http://lwn.net/Articles/533632/)
Linux v3.10

- Full tickless (more later)
- Single zImage for ARM
  - Lots more platforms support multi-platform kernels
  - Arnd Bergmann shooting for almost-complete coverage by v3.12
- Multi-cluster power management
  - Partial support for big.LITTLE PM
  - https://lwn.net/Articles/539082/
Linux v3.10 (cont.)

- Multiple ftrace buffers
- Memory pressure control group support
  - Allows for notification if memory gets low
  - [http://lwn.net/Articles/531077/](http://lwn.net/Articles/531077/)
Linux v3.10 (cont.)

- Full tickless (full dynamic tick)
  - Under some circumstance, some processors may run with no periodic ticks at all
  - Previous CONFIG_NO_HZ used dynamic tick, but only when CPU was idle
  - New option is tri-state: periodic, idle, full
  - Boot CPU cannot be ‘full’ tickless
  - CPU cannot be full tickless with more than one process
  - [https://lwn.net/Articles/549580/](https://lwn.net/Articles/549580/)
Linux v3.11

- Power-efficient workqueues
  - Allow work to be done on any CPU, to avoid waking sleeping CPUs
- LZ4 kernel image compression
- Checkpatch – fix
  - Attempt to fix some simple errors
- F2fs continues to mature
  - Lots of patches from Samsung
Linux v3.11 (cont.)

• Zswap
  • "Zswap is a lightweight, write-behind compressed cache for swap pages. It takes pages that are in the process of being swapped out and attempts to compress them into a dynamically allocated RAM-based memory pool. … This results in a significant I/O reduction and performance gains for systems that are swapping"

• See https://lwn.net/Articles/551401/
Linux 3.12 (probable)

• Full-system idle detection
  • Tricky rcu-based implementation to allow for fast indication of individual CPU idleness (using per-cpu variable), AND fast detection of global CPU idleness (single global variable)

• New cpu-idle driver that build on multi-cluster power management
  • Ie. Getting closer to support for “big.LITTLE” CPU scheduling

• Lots of device drivers converting over to device tree
  • More on this later
Things to watch

- Android features
  - Volatile ranges
  - ION memory allocator
- big.LITTLE MP scheduling
  - See [https://lwn.net/Articles/501501/](https://lwn.net/Articles/501501/)
  - See the In-Kernel-Switcher work
    - [https://lwn.net/Articles/549473/](https://lwn.net/Articles/549473/)
- Single zImage support on ARM
- Support for transactional memory instructions
  - Could be as big a deal (eventually) as locking primitives
Things to watch (longer-term)

- Non-volatile mass memory
  - Interesting remarks by Linus in LinuxCon 2012 keynote question and answer
  - Skeptical it will happen “this year” – it’s always within a few years of happening.
  - Won’t change a lot of kernel algorithms
  - Will mostly change filesystems
    - Byte-addressable storage has big implications for long-term storage
  - Applications will still segregate data between persistent and non-persistent groups
  - Things take longer to change than people think
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Bootup Time

- Not much new stuff this time
  - (Note: Watch out for device tree overhead…)
  - Sending device tree into random number pool
Graphics

• “Mir vs. Wayland” battles in Desktop realm
• Android using skia, OpenGL ES, surfaceflinger, etc.
• Other embedded still using X, fbdev, Qt, Gtk/Cairo
  • Qt now at Digia (sold by Nokia)
• Kernel Mode Setting (KMS) support
  • Control graphics modes in kernel
  • Prevent race conditions in user-space
  • Maybe switch HWComposer from fbdev to KMS
File Systems

• F2FS
• Flash Filesystem Tuning guide
• exFAT
F2FS

- Flash-friendly filesystem
- Mainlined in Linux version 3.8
- Log-structured, with lots of tweaks
  - E.g. hot vs. cold data separation
- Written by Samsung
  - They continue to enhance it
    - e.g. Support for security attributes in 3.12
- Not sure if it’s shipped in anything yet
Flash Filesystem tuning

• CE WG project to analyze filesystem performance on eMMC
• Goal: to test different block-based filesystems on flash media
  • Specifically, want to measure the effect of different kernel tuning options (IO scheduler, flash geometry vs. flash part attributes and workload characteristics)
• Result document is NOW available at:
exFAT

- Weird sequence of events
- Background: exFAT filesystem is covered by Microsoft patents
  - Used for sd cards – almost a requirement to support it
- exFAT code released by independent Russian developer
  - “Liberated” from Samsung
  - Not sure about license
    - But some code may have been derived from kernel
- Samsung released code a few weeks later
- I wouldn’t use this code
Memory Management

- ION memory allocator
Ion memory allocator

- Allows sharing of memory areas between kernel subsystems (and devices)
  - Which reduces copies
- Different devices have different memory constraints (cached, contiguous, etc.)
  - ION can select memory areas matching the least-common-denominator of the constraints
- ION can manage cache relationship to memory
- But, ION uses arm-specific page accessors, and allows hardware-specific optimizations, so it may have difficulty getting mainlined
Power Management

- Power-aware scheduling:
  - Small-task packing
    - Try to migrate tasks to allow more CPUs to go idle
  - Task placement on mixed cpu_power systems
    - Move large tasks to faster CPUs

- Resources:
  - [http://lwn.net/Articles/546664](http://lwn.net/Articles/546664) - overview
  - [http://lwn.net/Articles/552885](http://lwn.net/Articles/552885) - some resistance
    - Ingo Molnar wants to consolidate this power stuff in the scheduler – rather than spread out into power/cpufreq/cpuidle/scheduler systems
big.LITTLE scheduling

- Lots of work recently on big.LITTLE scheduling
  - Multi-cluster power scheduling
  - In-kernel-switcher work
  - See talk at LCJ by Nakagawa-san of Renesas
    - One User Space Approach to big.LITTLE MP System on Real Silicon

- Still waiting for real-product results ??
System Size

- Kernel size
- Library size
- Automated reduction research
Kernel size

- Cooperative memory relinquishment
  - Volatile Ranges
  - Lexmark work (membroker and ANR malloc)
    - See talk at ELC 2013 – "SystemWide Memory Management without Swap"
Library reduction

- olibc – bionic libc
  - Has good features from Android, and is smaller and more configurable than glibc
    
    glibc 2.11 : /lib/libc.so → 1,208,224 bytes
    uClibc 0.9.30 : /lib/libuClibc.so → 424,235 bytes
    bionic 2.1 : /system/lib/libc.so → 243,948 bytes

  - See ELC 2013 talk by Jim Huang

- Kconfig for eglibc
  - Ability to configure parts of libc to use
    
    libc-2.17.so reduced from 1.2M -> 830K
    ld-2.17.so reduced from 128K -> 120K
    libm-2.17.so reduced from 610K -> 580K

  - See ELC 2013 talk by Khem Raj
Advanced Size Optimization of the Linux Kernel

- “Auto-reduce” project
- Find automated ways to reduce the kernel
  - Link-time optimization
  - System call elimination
  - Kernel command-line argument elimination
  - Kernel constraint system
- Additional research
  - Link-time re-writing
  - Cold-code compression
- See Tim Bird’s presentation on advanced size optimization of the kernel
  - Notes and slides available at: http://elinux.org/System_Size_Auto-Reduction
Security

- SMACK
- SE-Linux
SMACK

- SMACK for Tizen
  - Simplified rule set (3 tiers, 40,000 rules)
  - See [http://lwn.net/Articles/55278](http://lwn.net/Articles/55278)
SE-Linux

- SE-Android
  - Implementation of SE-Linux for Android systems
- SE-Linux was previously too big for embedded
  - Early embedded SE-Linux required 2M
  - Desktop SE ruleset is 900,000 rules
- However, SE-Android only has 1658 rules and 263 types (71K policy size)
- [http://selinuxproject.org/page/SEAndroid](http://selinuxproject.org/page/SEAndroid)
  - Especially: [http://www.internetsociety.org/sites/default/files/Presentation02_4.pdf](http://www.internetsociety.org/sites/default/files/Presentation02_4.pdf)
Tracing

• **Ktap**
  - Dynamic tracing, without the overhead of compiling into a module
  - Adds an interpreter to the kernel
  - Single module, that leverages ftrace, kprobes, etc.
  - Prints results in ASCII
  - Good session in LinuxCon Japan by Jovi Zhang
Device Tree

- New requirements for implementing ARM board support and drivers
  - Separation of hardware description from code
  - Can use instead of “platform data”
- Has some problems
  - I have found it very complicated to use
  - Not mature yet
    - E.g. dma, pinctrl still being developed
  - Everyone defining their own bindings
  - Not enough documentation and examples
  - No type-checking or compile-time optimization
Device tree (cont.)

• Change in maintainership
  • Grant Likely transferred maintainership to others
  • Not enough review of bindings
• Discussion about having device tree be long-lived ABI to kernel
  • Should be usable by other operating systems
  • Maybe move out of kernel repository
• Lots of discussions planned at ARM mini-summit/Kernel Summit
  • Lots of presentations at ELC Europe
• See http://elinux.org/Device_Tree
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CEWG Contract Work 2013

- eMMC tuning guide completed
- Open Project Proposal period
eMMC tuning guide

• Description:
  • This project analysed EXT4, BTRFS and F2FS on a variety of block-based flash parts on a few different development boards
  • Output is a document describing best practices for tuning Linux block-based filesystems for block-based flash filesystems
  • Also, methods and scripts for filesystem testing
• Contractor: Cogent Embedded
• Status: Just completed
  • Document at: http://elinux.org/File_Systems#Comparison_of_flash_filesystems
Open Project Proposals

- Proposal period is now open
- Looking for ideas for projects to fund.
- Deadline is October 2
Other Projects

• Long Term Support Initiative (LTSI)
Long Term Support Kernel for Industry

- LTSI 3.4 is available now
- Held a workshop at LinuxCon Japan
  - Discussed testing phase of project
  - Discussed promotion of project
- Program for free hardware for LTSI kernel testing
- Linux 3.10 is next community Long Term Stable kernel
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- Tools
- Build Systems
- Events
- Miscellaneous
Tools

• Cortex
  • Coredump filter
  • Generates sparse coredump
  • See ELC 2013 presentation by Tristan Lelong
    • "Debugging for production systems"

• Debugging techniques
  • Good overview by Kevin Dankwardt at ELC 2013
    • "Survey of Linux Kernel Debugging Techniques"
Testing frameworks

- Autotest
  - Simple framework
  - Not cross-compiler aware?
- LAVA
  - Linaro test framework
- "Kernel Testing Tools and Techniques" BOF by Matt Porter at ELC 2013
- CE workgroup considering reviving test activity for 2013
  - Need input…
Build Systems

- Yocto project
  - Lots of talks at ELC (and previous ELCs)
    - Sean Hudson – good introduction tutorial
    - Saul Wold – current status
  - Tutorials now online
- Buildroot still hanging in there
Distributions

- Tizen – may be a serious competitor in embedded distros
  - Needs to open up a bit more (but it looks like it’s happening)
  - Replacing Bada at Samsung
  - Shipping in phones??
- Android use in non-CE embedded
  - Headless android
- Yocto Project = the new in-house distro
- Angstrom
  - Very common on development boards
Events

- **LinuxCon US**
  - September 2012 – New Orleans

- **Embedded Linux Conference Europe 2013**
  - October 21-23, 2013 – Edinburgh, Scotland

- **Embedded Linux Conference 2014**
  - April, 2013 – San Jose
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
- Working on wiki projects:
  - Video transcription project
Miscellaneous

- Kernel Community civility
  - Recent discussion about being nicer to people on LKML
    - Sarah Sharp complained about abusive language and attitude on LKML
    - Some say harshness is needed to maintain quality
    - Others say system works OK as is
    - Will be discussed at kernel summit

- Status of industry = Healthy
  - Over 1.5 billion devices shipped with embedded Linux
  - Still going strong
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- LWN.net
  - http://lwn.net/
  - If you are not subscribed, please do so
- Kernel Newbies
  - http://kernelnewbies.org/Linux_3.?
- eLinux wiki - http://elinux.org/
  - Especially http://elinux.org/Events for slides
- Celinux-dev mailing list
- LinuxCon Japan slides
  - http://events.linuxfoundation.org/events/linuxcon-japan/program/presentations
Survey for ELCE game

Please go to:

http://embeddedlinuxconference.com/

and take the survey!
Thanks!