CE Workgroup

Status of Embedded Linux
April 2015

Tim Bird

Architecture Group Chair

LF CE Workgroup

Outline

Kernel Versions
Technology Areas
CE Workgroup Projects
Other Stuff
Resources

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Kernel Versions

Technology Areas

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Other Stuff

Resources

Kernel Versions

- Linux v3.14 – 30 Mar 2014 – 70 days
- Linux v3.15 – 8 Jun 2014 – 70 days
- Linux v3.16 – 3 Aug 2014 – 57 days
- Linux v3.17 – 5 Oct 2014 – 63 days
- Linux v3.18 – 7 Dec 2014 – 63 days
- Linux v3.19 – 8 Feb 2015 – 63 day
- Linux v4.0-rc7 – (60 days so far)
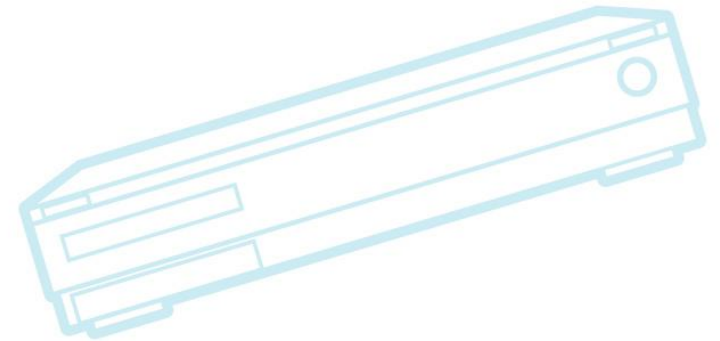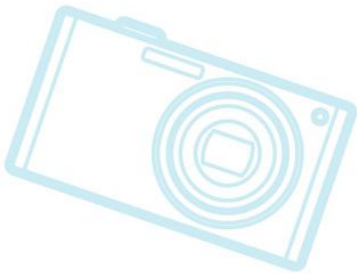 - Linus said probably this weekend or next

Linux v3.14

- Last long-term stable (LTS) kernel
  - LTS is at 3.14.37 (as of March 2015)
  - Will be supported until August of 2016
- Current LTSI is based on 3.14.28

Linux v3.16

- Power-aware scheduling
- decode_stacktrace.sh
  - Converts offsets in a stack trace to filenames and line numbers
- F2FS large volume support

Linux v3.17

- Lots of ARM hardware support
  - Newly enabled ARM hardware
    - Rockchip RK3288 SoC
    - Allwinner A23 SoC
    - Allwinner A31 Hummingbird
    - Tegra30 Apalis board support
    - Gumstix Pepper AM335x
    - AM437x TI evaluation board
  - Other ARM boards with existing support also saw improvements with Linux 3.17
- Rework of "config-bisect" mode in ktest

Linux v3.18

- OverlayFS introduced
- Size reduction patch:
  - madvise and fadvise syscalls can be configured out
- More LLVM support
- New SOC support:
  - Hisilicon HiP04
  - Amlogic Meson6 (8726MX)
  - Renesas R-Car E2 (R8A77940)
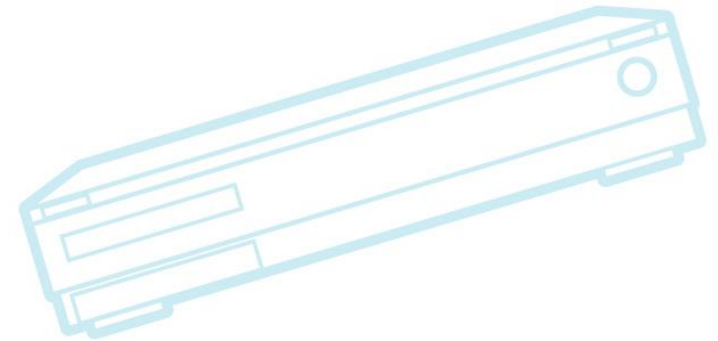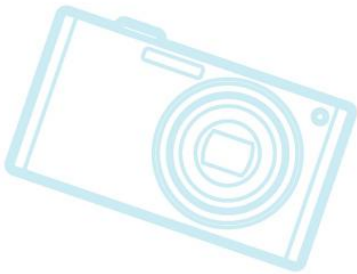 - Broadcom BCM63xx DSL
  - Atmel SAMA5D4

Linux v3.19

- F2FS now has a "fastboot" option
- Device tree overlay support
- Squashfs supports LZ4 compression
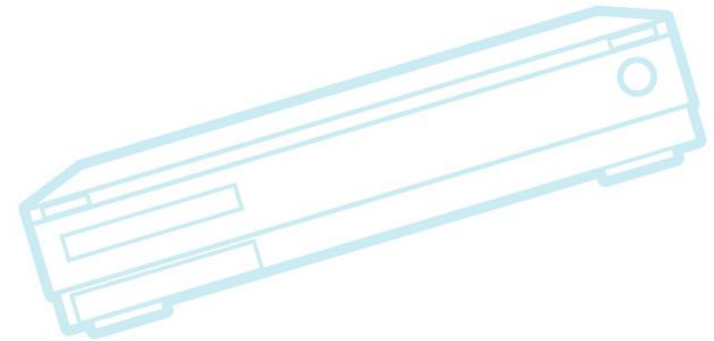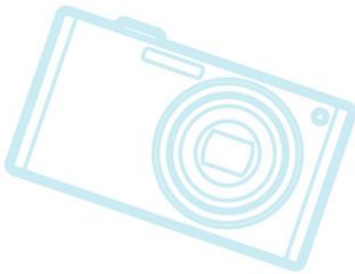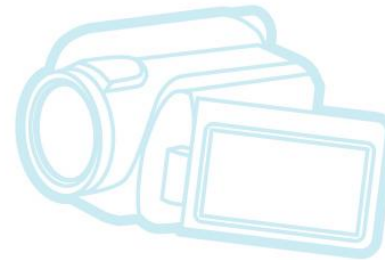- Android "binder" code has been moved from the staging tree

Linux v4.0
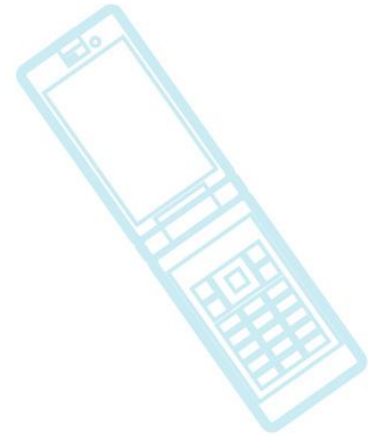
- This version is not v3.20
  - Linus conducted a survey on Google+
    - 56% of respondents preferred 4.0
  - The name of this kernel is "hurr durr I'ma sheep"
- Android binder has security hooks
  - Can use SELinux security with it
- Non-volatile memory support patches
  - Can use filesystem in persistent memory
  - http://lwn.net/Articles/610174/
- UBIFS performance improvements

Things to watch

- Kdbus
- Kernel tinification!
- Systemd in embedded
- RT-preempt (again…)

Kernel contribution notes

- ## Contributions by different companies

Author email domain	commits	Commiters (since 3.4)
Sony[me] *(sonymobile)*	53	14
Lge.com	565	11
Huawei	1220	71
Qualcomm|Codeaurora	1349	46
Moto	1035	15
Free-electrons	2333	9
Samsung	7031	160
Intel	17374	469

Results from: git log v3.4.. –author=<expr> --format=%ae | sort | uniq | wc -l

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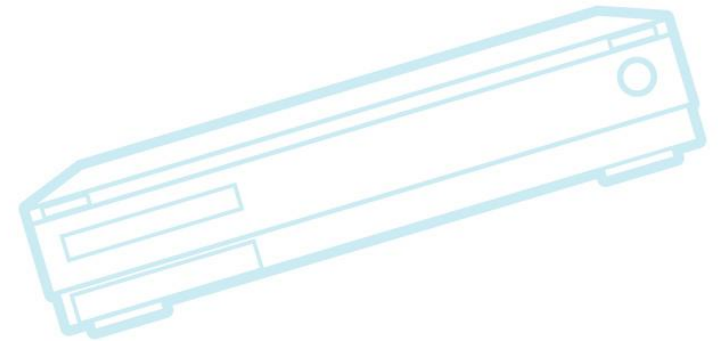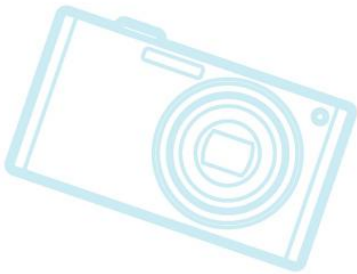
Resources

Bootup Time

- F2FS filesystem has a new "fastboot" option
  - Skips some boot-time checks to reduce mount time
  - Sacrifices a little bit of normal performance
    - Due to more synching during normal filesystem operation

15

Device Tree

- Device Tree is causing delays getting stuff upstream
  - DT maintainers are overloaded
  - Backwards compatibility is a problem
  - See "The Device Tree as a Stable ABI: A Fairy Tale?" – Thomas Petazzoni
- Device Tree Overlays
  - Useful for boards that have daughterboards (e.g. capes or shields) that need DTS changes at boot time.
  - "Transactional Device Tree & Overlays: Making Reconfigurable Hardware Work" - Pantelis Antoniou
  - Also see: http://lwn.net/Articles/616859/

Graphics

- Freedreno graphics driver
  - GPL driver for Adreno GPU on Qualcomm chips
  - 3xx supports OpenGL ES 3.0
  - 4xx supports OpenGL ES 3.1
  - There are still some pieces that need work
    - Bug reports are appreciated
  - Some interesting reverse-engineering tools developed for the project
    - https://github.com/freedreno/freedreno/wiki/Reverse-engineering-tools
  - http://lwn.net/Articles/638908/

File Systems

- SquashFS supports LZ4 compression
- OverlayFS
  - Support for read/write filesystem over the top of a read-only filesystem
  - Most common use-case is live CDs, but it can be useful for some embedded scenarios
- Proposals for UBIFS handling of MLC NAND
  - Lots of complexity due to MLC characteristics
  - See "NAND Support: (New?) Challenges for the MTD/NAND Subsystem" – Boris Brezillon

File Systems (cont.)

- ELC talks:
  - "Filesystem Considerations for Embedded Devices" – Tristan Lelong
    - Great talk with performance and robustness results for different file systems
    - Ext4, BTRFS, F2FS, XFS, NILFS2
    - Summary: F2FS is faster in many cases, EXT4 is mature

Power Management

- At ELCE
  - Power management measurement devices
- At Plumbers
  - Energy management vs. power management
    - Performance vs. battery life
    - Want performance hinting from apps
- At ELC
  - PM domains
    - See "Last One Out, Turn Off The Lights" - Geert Uytterhoeven
      - Good talk showing how to use this with device tree

20

Power Management (cont.)

- Energy-aware Scheduling
- Idle time prediction
  - Permits better choice of idle state
  - http://lwn.net/Articles/618074/
- CPUFREQ
  - Changing clock frequency according to demand
  - Continuing integration into scheduler
- PM domains
  - Sets of devices to be treated similarly with regard to power management

Real Time

- RT-preempt patch set got a sponsor
  - That's good!
- Still have Xenomai (using Cobalt RT core)
- Good overview of existing RT solutions, and a new alternative at ELCE:
  - "rtmux: A thin multiplexer to provide hard realtime applications for Linux"
    - By Jim Huang
- Lots of people using PRUs (programmable real-time units)
  - See http://lwn.net/Articles/639258/

System Size

- Size project keeps nibbling away at items
- Single-user patches
    - Gets rid of users and groups
    - Saves about 25K
    - http://lwn.net/Articles/631853/
- Removal of kernel command-line parsing
    - Ability to make any command-line option static
    - Example for initcall_debug = saves 385 bytes
        - A lot of the savings are due to GCC constant folding

System Size (cont.)

- Some ELC talks:
  - Optimize uClinux for ARM Cortex-M4 – Jim Huang
    - Target = STM32F4xx
  - Linux for Microcontrollers: From Marginal to Mainstream – Vitaly Wool
    - Target = STM32F2x
    - 840K .text, 132k .rodata, 86k .data (BT, no TCP/IP)
- Both have good descriptions of additional kernel areas that can be reduced

Toolchains

- LLVM being used for more and more
  - Including Linux kernel
    - ELCE talk by Behan Webster with latest update
  - More fixes for LLVM support in 3.18
  - Building Android with Clang (next slide)
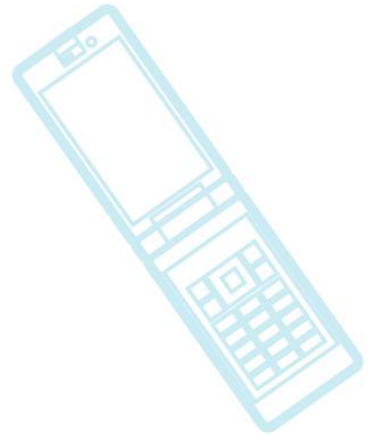
Building Android with Clang

- Nexus 7 and 10 are booting and can run many apps
- Nexus 4 and 5 still problematic
- 112 patches submitted
  - 74 accepted
  - 34 waiting
- GCC performance is slightly better
- Clang is finding real bugs

Testing

- Kselftest
- LTSI Test Project
- Kernelci.org
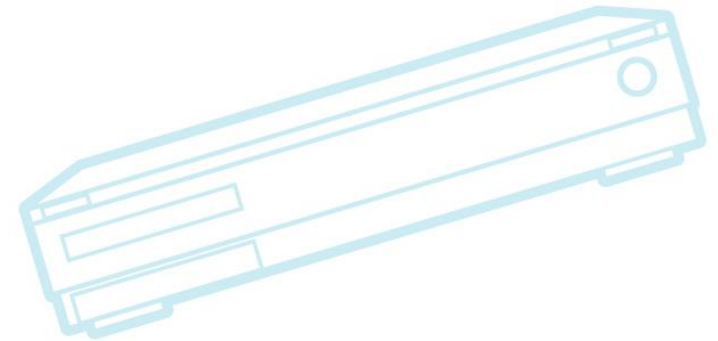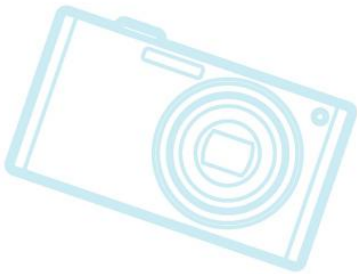
kselftest

- Inside kernel source tree
  - Makefile target: 'make kselftest'
- Currently supports host-mode selftest
  - Ability to install tests is in linux-next
  - Cross-build now being worked on
- New size test:
  - "make TARGETS=size kselftest"
    - Really needs cross-build and deploy-to-target support
- See http://lwn.net/Articles/608959/
- See "Linux Kernel Sefltest Framework BoFs – Quality Control for New Releases" – Shuah Khan

LTSI test project

- Jenkins-based Test Automation (JTA)
  - We need a new name!!
- Available now
- Fujitsu has tested the test framework, and contributed ethtool tests
- Officially would like to encourage:
  - Please use JTA
  - Please send feedback to LTSI mailing list
    - https://lists.linuxfoundation.org/mailman/listinfo/ltsi-dev
  - Or add to elinux wiki page

Kernelci.org

- Place to get free build/boot testing for your board
- Sony Mobile has a phone in this farm
- http://kernelci.org
- Don't know many details
  - But I can see kernel build/boot failures online for my platform
  - I missed this ELC session, but the site looks interesting

Outline

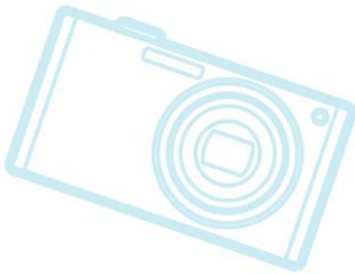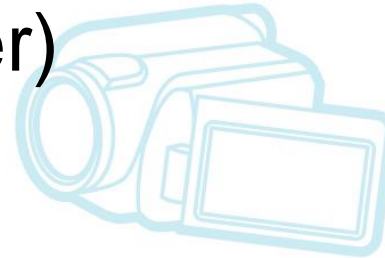Kernel Versions

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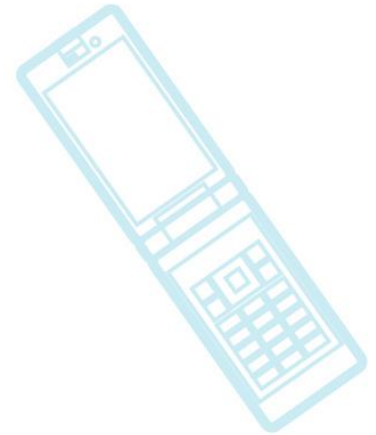Resources

CEWG Projects

- Contract work
- Projects and initiatives
- (conferences covered later)
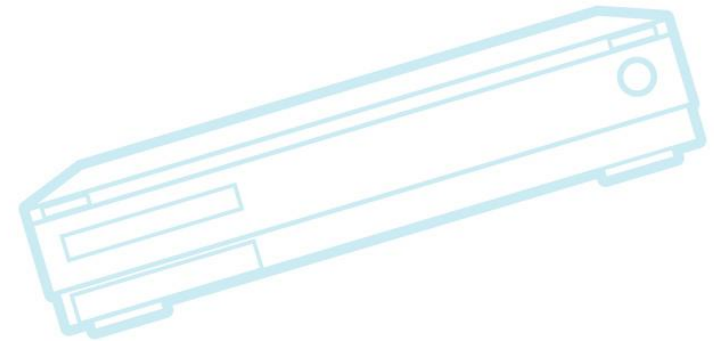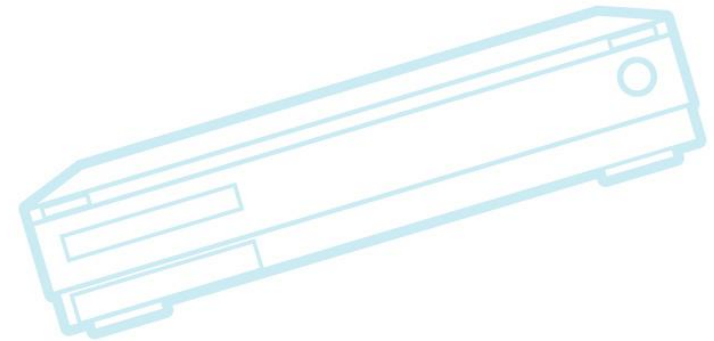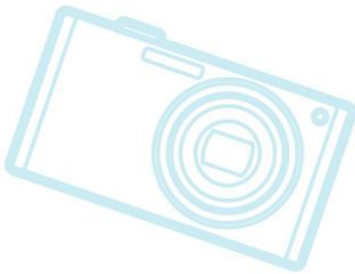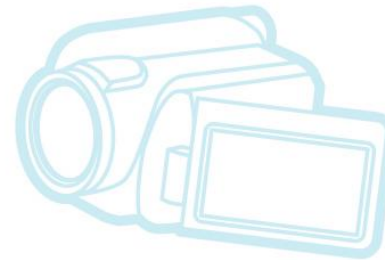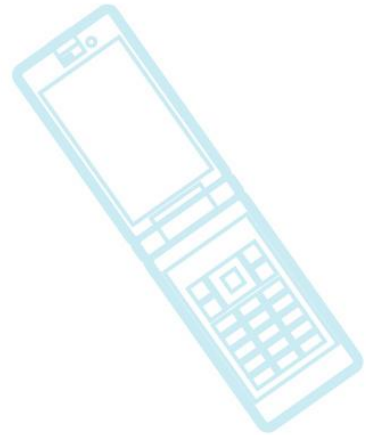
CEWG Contract Work

- Compressed printk
- Device tree documentation
- LTSI test framework
  - Funded by Renesas

Compressed printk

- Project completed
- Contractor: Wolfram Sang
- Results are on elinux wiki
  - http://elinux.org/Compressed_printk_messages_-_Results
- Wolfram delivered reports at LinuxCon North America and ELC Europe 2014
- Result of investigation: it's not worth doing
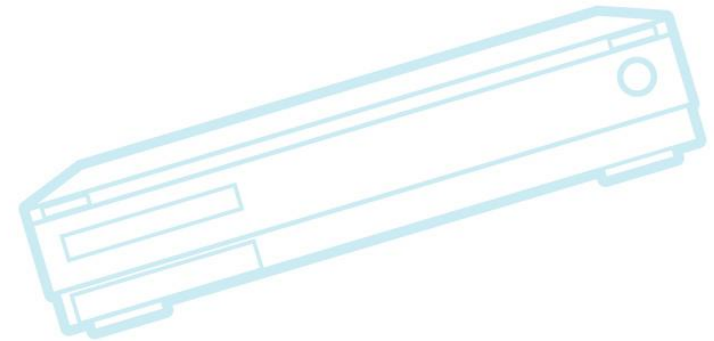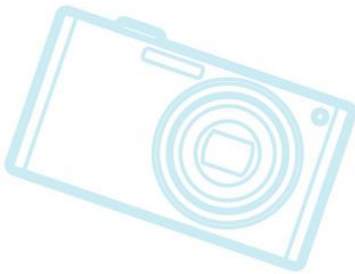 - But some interesting size optimizations were found

DT documentation
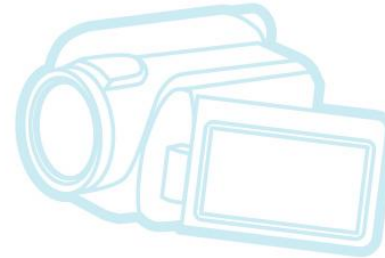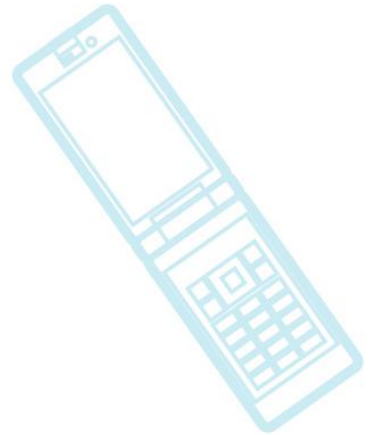
- Still want to proceed with documentation
- Frank Rowand has been collecting data and giving talks
  - LinuxCon North America and ELC Europe
- Not sure when this will be released
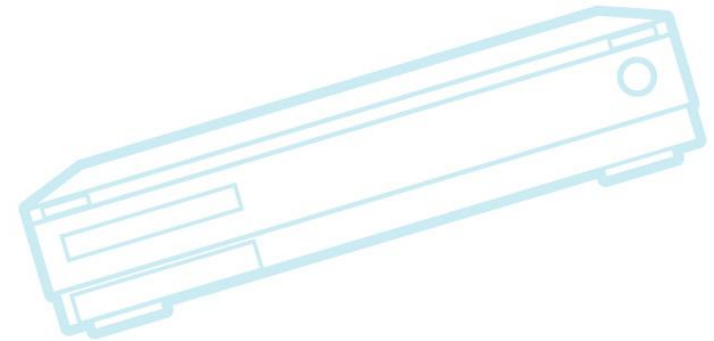
LTSI test framework

- (Discussed previously)

Projects and initiatives

- Social infrastructure
- Standard Embedded Distribution
- Device mainlining
- Possibly a "size" project
- LTSI
- eLinux wiki
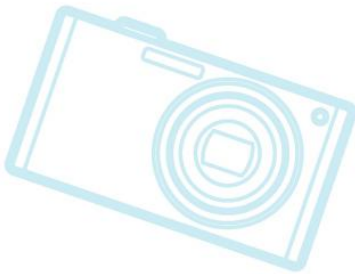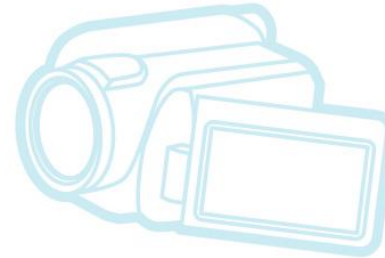
Social Infrastructure

- Goals
  - Solve problems with Linux for use in social infrastructure systems
- Status
  - Recent Activity
    - BOFS at ELCE 2014 and ELC2015
    - Private meetings to discuss goals with interested companies
  - Still working to define requirements in areas of functional safety and maintenance longevity
- Next steps:
  - Hold additional meetings to define requirements
  - Initiate project with goal of starting in Fall 2015

Embedded Distribution

- Goals
  - Create an industry-supported distribution of embedded Linux
- Status
  - Toshiba reported results of Poky-Debian project
  - Lots of results to be described in presentation later today
- Next steps
  - Write up more detail on project, to solicit Linux Foundation funding or involvement of more parties
  - Approach individual companies about collaborating on the project

Device Mainlining

- Goals
  - Study obstacles to mainlining, and work to reduce obstacles
- Status
  - Recent Activity
    - Survey in September 2014
    - Talk about overcoming obstacles at ELCE 2014 and ELC 2015
    - BOF in October 2014 in Dusseldorf
    - Mobile phone source code analysis
    - SIG meeting in March 2015 in San Jose

Device Mainlining (cont.)

- Review of source analysis
  - Phone kernels have between 1.1 and 3.1 million lines of code out-of-tree
  - Tried to identify problem areas
  - Next few slides show results of source analysis for 9 phones with 5 different processors
    - Based on 3.4 of 3.0 kernels
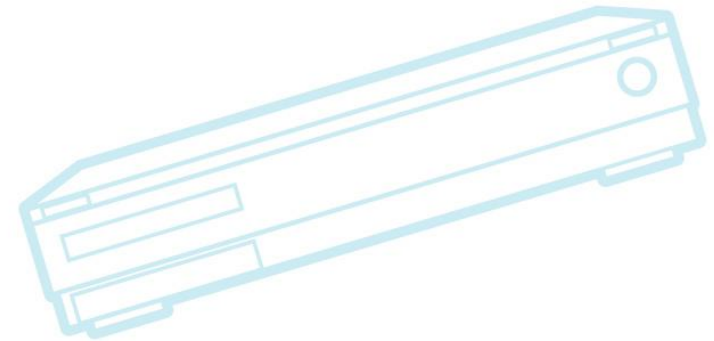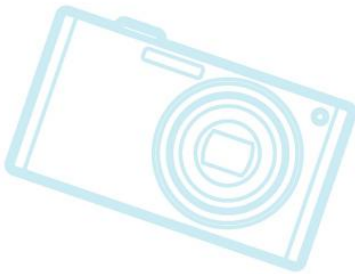
SOC overview

Company	SOC	Files	Insertions	Deletions
LG	Msm	5775	2.616M	40K
Motorola	Msm	4490	1.795M	40K
Samsung	Exynos	2877	1.100M	51K
Samsung	Msm	6096	3.105M	53K
Sony	Msm	4625	1.784M	41K
Sony	Mediatek	3689	1.935M	7K
Acer	Mediatek	3122	1.411M	6K
Asus	Atom	7351	2.163M	22K
Huawei	Hisilicon	5082	2.659M	43K

Big problem areas

Area	Insertions range
Mach-msm	347K – 417K
Media	120K – 360K
Video	37K – 346K
Wireless	80K – 250K
Sound	74K – 240K
Input	51K – 238K
Camera	50K – 210K
GPU	36K – 172K
Power	44K – 94K

SIG meeting notes

- Attendees included several maintainers and companies interested in mainlining patches
- Some obstacles mentioned:
  - Lack of business incentive for companies to mainline code
    - Obsolescence of SoC before code can be mainlined
  - Device tree bottleneck
  - Unresponsive maintainers
- Some ideas mentioned:
  - Assist maintainers with paid help
  - Educate companies on benefits
  - Create SoC staging area (particularly for unstable device-tree bindings)

Device mainlinig - Next steps

- Need to process input from SIG meeting
- Most promising ideas:
  - Fund projects (possibly with Linaro) in certain key kernel areas
    - Need to dig deeper to find common problem areas
  - Fund a developer to be co-maintainer for certain overloaded maintainers
    - Need method to find overloaded maintainers
- LF white paper on overcoming obstacles

Possible size project

- Separate people and companies are working on kernel size reduction patches
- Josh Triplett now manages a linux-tiny tree
- CEWG may contribute to that effort

Long Term Support Initiative

- LTSI 3.14 is latest kernel
- Many presentations available on status
  - Including this Jamboree
- Latest project push is testing facility
  - Test framework (JTA) is now available!!
- Currently considering multiple merge windows
- See the presentation later in this jamboree

eLinux wiki

- http://elinux.org
  - Web site dedicated to information for embedded Linux developers
    - The wikipedia of embedded linux!
- Hundreds of pages covering numerous topic areas: bootup time, realtime, security, power management, flash filesystem, toolchain, editors
- Working on new wiki projects:
  - Video transcription project

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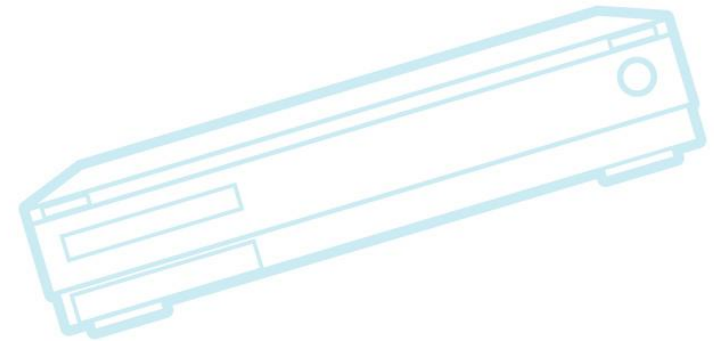
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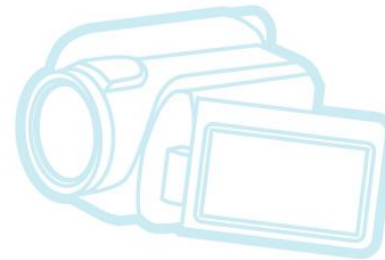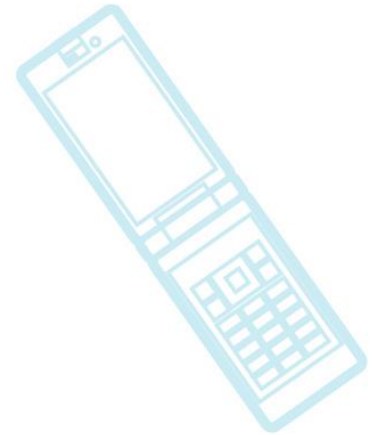
Resources

Other Stuff

- Projects and Consortia
- Distros and Build Systems
  - Android
  - Tizen
  - Poky-Debian
  - Yocto Project
  - Buildroot
- Events

Projects and Consortia

- Allseen Alliance – Peer-to-peer ad-hoc networking
  - http://allseenalliance.org
  - AllJoyn is the name of the implementation
- PRPL Foundation – Multi-company MIPS non-profit
  - Projects: PRPL OpenWRT, MIPS QEMU
- DroneCode – Open source UAV software group
  - http://www.dronecode.org/
  - First Linux Drone summit at ELC
  - Andrew Tridgell on ELC program committee

Distros - Android

- Lollipop now shipping
- Lots of changes in upper portions of stack
- Some kernel level changes
  - Android no longer uses logger kernel driver
- Toybox now included in AOSP!!
 - Should be in default builds for the "M" release

Distros - Tizen

- Doing lots of security work with SMACK
  - Have new access-control broker: Cynara
    - See https://lwn.net/Articles/602060/
- Have proposed security modules for use with Yocto Project
  - "Ready made Recipes to add Security and Data Protection to a Yocto based Project reusing Tizen-Meta" – Dominiq Ar Fol

Distros – Poky Debian

- (See Kobayashi-san's presentation later today)
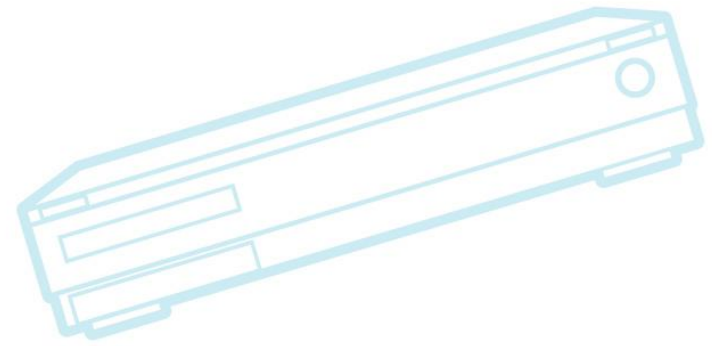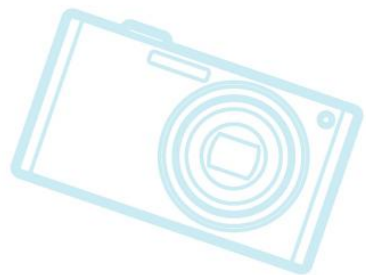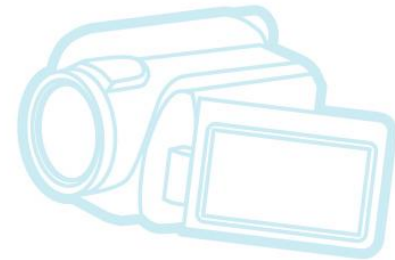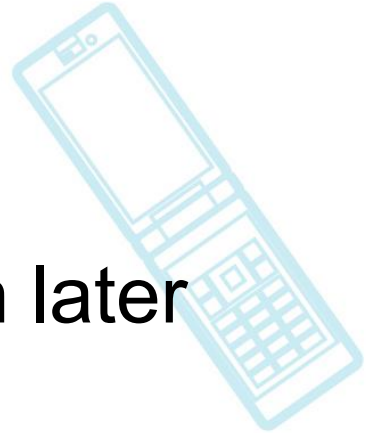
Build System – Yocto Project

- Promoting "Toaster" - web interface to the Yocto Project
- New Features in 1.8:
  - Import and build your own custom layers
  - Set configuration variables (in toaster)
  - Add packages to core images
  - Select target and build them
  - Download artifacts
- Lots of projects making meta-layers for YP
- Need to get slides for YP sessions at ELC from presenters

Build System - Buildroot

- Is continuing, as the simpler alternative to Yocto Project/OpenEmbedded
- 600+ packages
- New features:
  - Allow defconfigs and recipes from external tree
  - Check integrity of downloaded archives
  - Better report licensing information
- See "Buildroot: Embedded Linux for Small Devices and Makefile Enthusiasts" - Stephanie Lockwood-Childs

Events

- Embedded Linux Conference 2015
    - March 23-25, 2015 – San Jose
    - Many presentations online at:
        - http://elinux.org/ELC_2015_Presentations
- LinuxCon Japan
    - June 3-5, 2015 – Tokyo, Japan
- Embedded Linux Conference Europe 2015
    - October 5-7, 2015 - Dublin, Ireland
- Embedded Linux Conference 2016
    - April 4-6, 2016 - San Diego

ELC overall impressions

- Was our biggest ELC yet
  - Over 600 attendees
- Theme: Drones, Things and Automobiles
- Drones = exciting area (one vertical)
  - They need RT-preempt – it's good someone picked it up
  - Otherwise, they are using standard Linux features – just need board support and drivers for hardware
  - Lots of interesting technology and features in their space (see Andrew Tridgell's slides)
- Automotive = seems to be going along
  - I worry about whether we're getting sufficient traction – but I'm not in that space

ELC impressions (cont.)

- IOT – Internet of Things
  - Linux has "won" the cloud and the gateway
  - It will only "win" (some) sensors if it is smaller
    - Renewed interest in size reductions is welcome
  - Other areas that could be improved:
    - Security improvements
    - In-field upgrades (this is not a Linux problem, per se, but some Linux features can help with this)
  - Other problems are infrastructure, social, etc.
  - We have plenty of IOT stacks
    - Including mature but newly released OpenDOF from Panasonic

Final Thoughts

- We can still improve, especially in mainlining

- But overall, Embedded Linux is doing very well!!

Outline

Kernel Versions
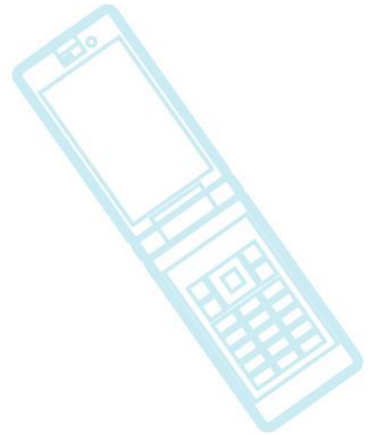Technology Areas
CE Workgroup Projects
Other Stuff
Resources

Resources
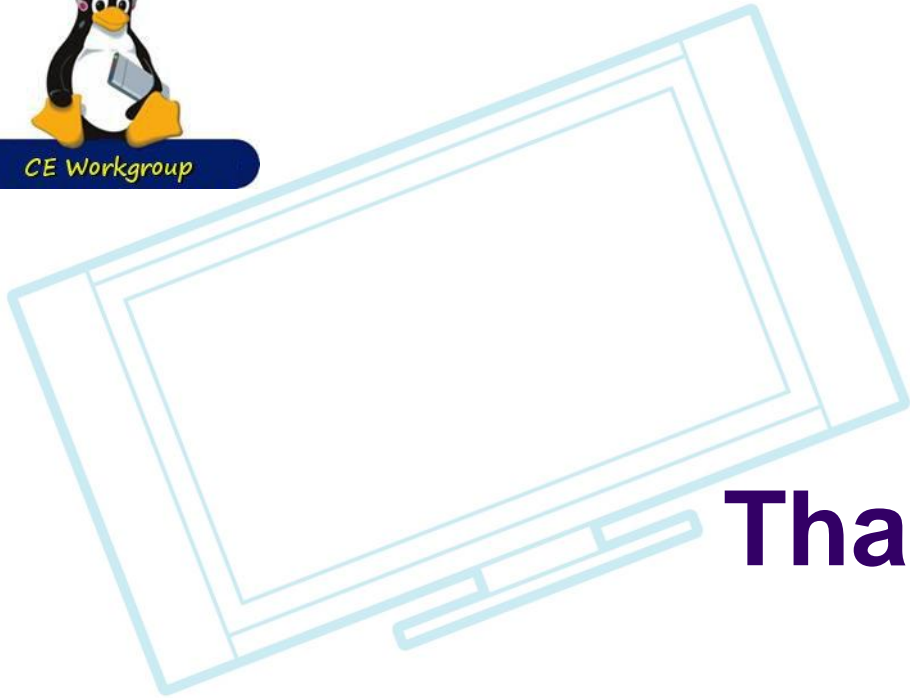
- LWN.net
  - http://lwn.net/
  - If you are not subscribed, please do so
- Kernel Newbies
  - http://kernelnewbies.org/Linux_3.?
- eLinux wiki - http://elinux.org/
  - Especially http://elinux.org/Events for slides
- Celinux-dev mailing list

Thanks!