CE Workgroup

Status of Embedded Linux

February 2012

Tim Bird

Architecture Group Chair
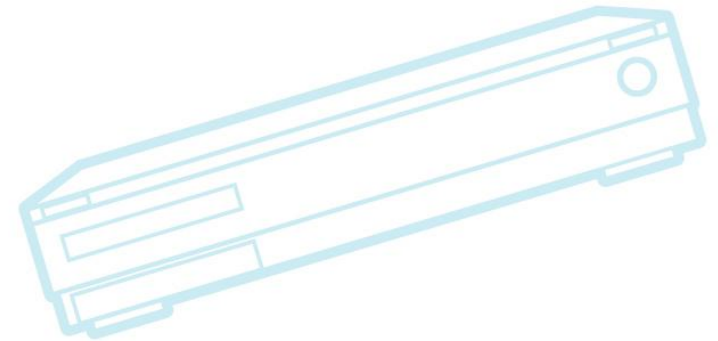
LF CE Workgroup

Outline

Kernel Versions
Technology Areas
CE Workgroup Projects
Other Stuff
Resources

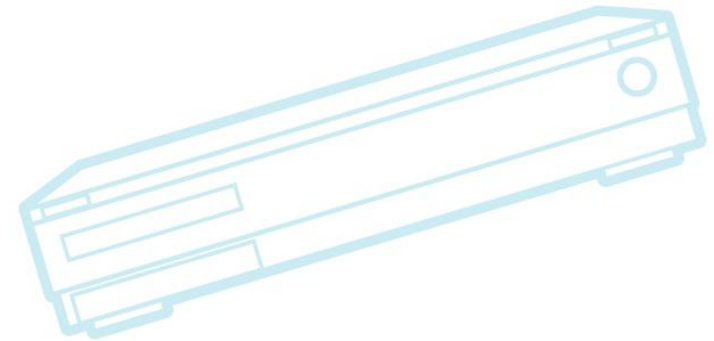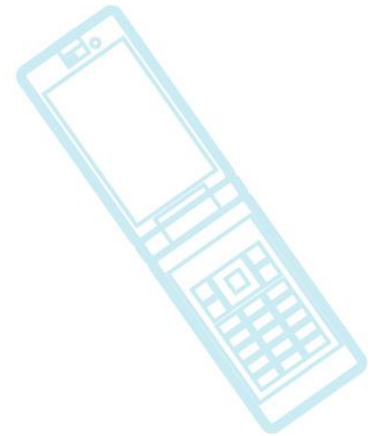# Kernel Versions

Technology Areas

CE Workgroup Projects
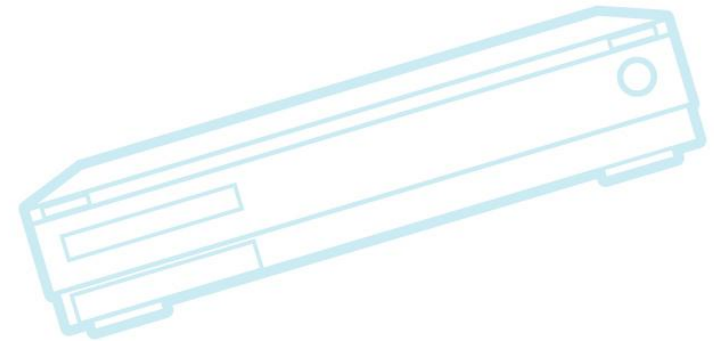
Other Stuff
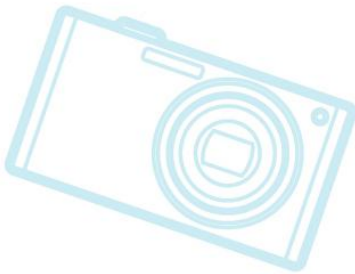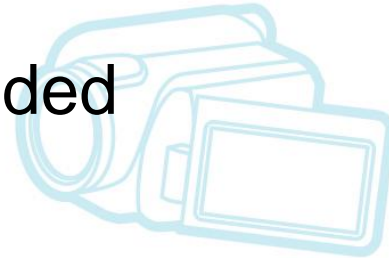
Resources

Kernel Versions

- 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-rc3 - (as of 15 Feb)

Linux v2.6.38

- Perf symbols abstraction
  - Added 'symfs' option for off-box analysis of perf.data
  - Should be good for embedded
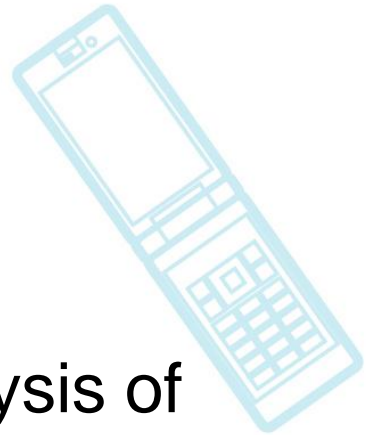
Linux v2.6.39

- Pstore
  - Store information from dying kernel into some persistent storage
  - Similar to mtdoops or ramoops
  - See 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/pinctrlt.xt
  - See ELC talk on Friday 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 (probable)

- ARM large physcial 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
  - This is really cool
  - Please don't use any interfaces from code in staging!!

Things to watch

- ARM arch sub-tree refactoring
  - http://lwn.net/Articles/443510/
  - See Arnd Bergmann talk on Thursday
- Device trees
  - See Thomas Abraham talk today
- More runtime PM improvements
- Android features
  - Especially after October kernel summit
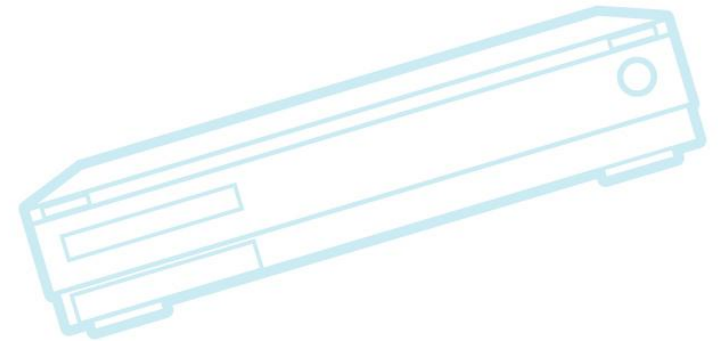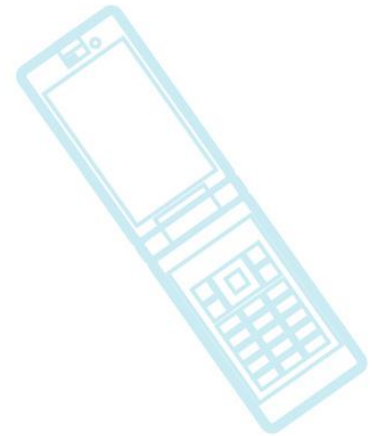- Boot timing patches
  - See http://lkml.org/lkml/2011/9/23/348

Outline

Kernel Versions

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Resources

Bootup Time

- Not so much a kernel problem any more
  - Lots of talks and presentations
  - Good kernel techniques on eLinux wiki
    - http://elinux.org/Boot_Time
- User-space is big problem area now
  - 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
  - Coreboot on x86
  - See "Really fast x86 boot" presentation at FOSDEM 2011
  - 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
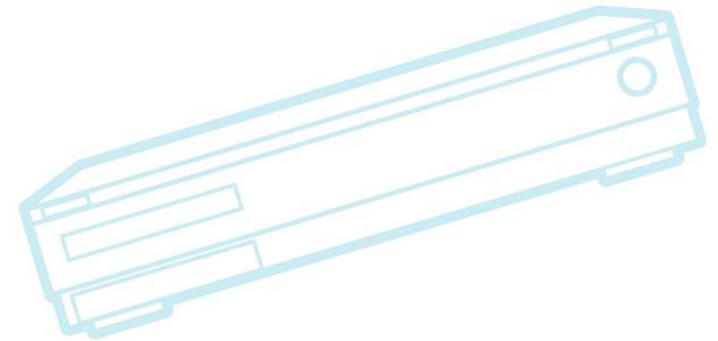
Bootup Time (cont.)

- 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
- Filesystem speedups
  - CELF funding work in this area (more later)
  - Readahead getting lots of attention
    - Ureadahead in Ubuntu
    - See Tim Bird presentation at ABS 2011 about readahead with Android

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
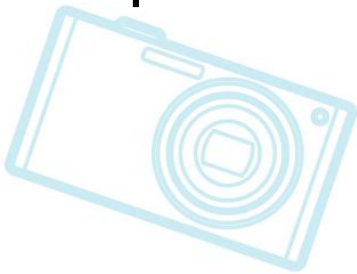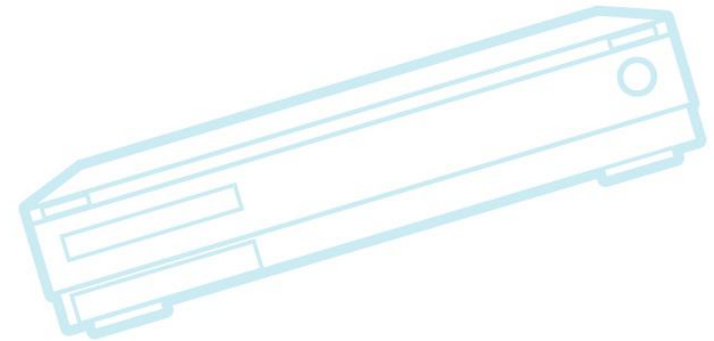
Graphics (cont.)

- 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
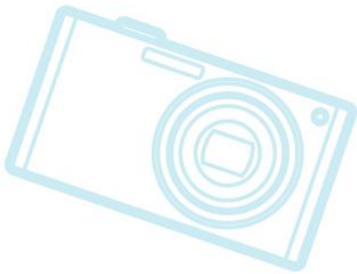
# **Graphics Drivers**

- 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
  - 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
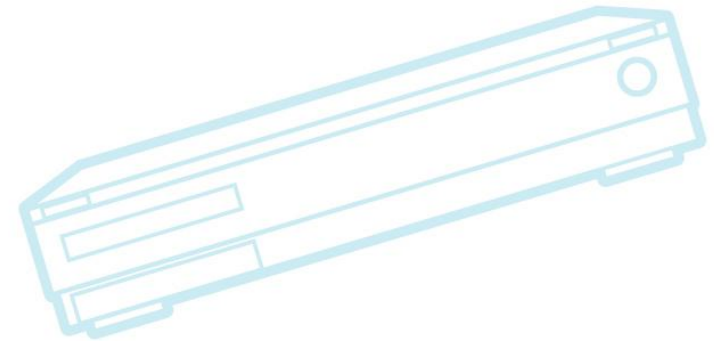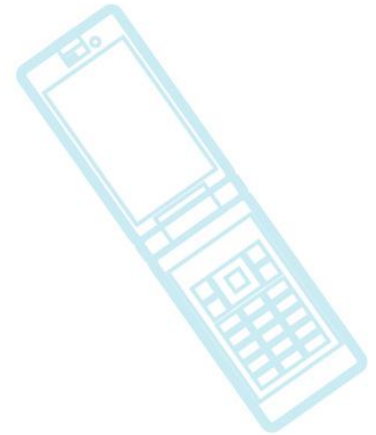
File Systems

- 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
  - See Ken Tough's ELC talk on Thursday

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

- 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
- Poky-tiny
- 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

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

Outline
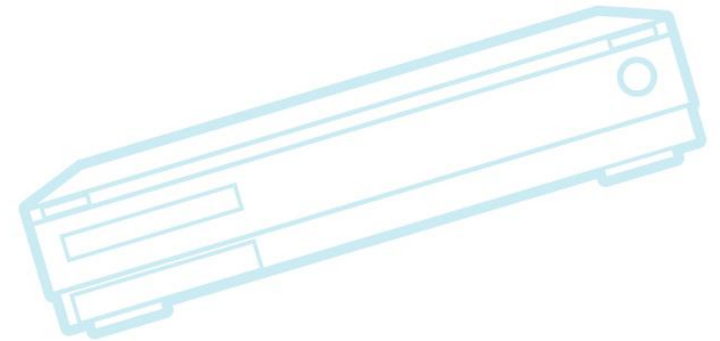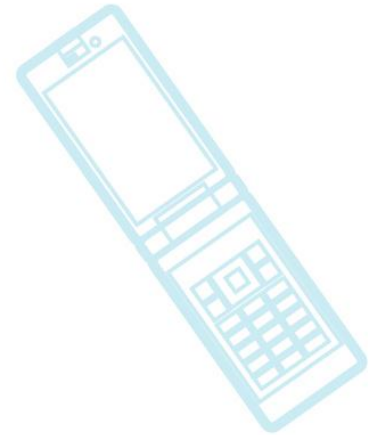
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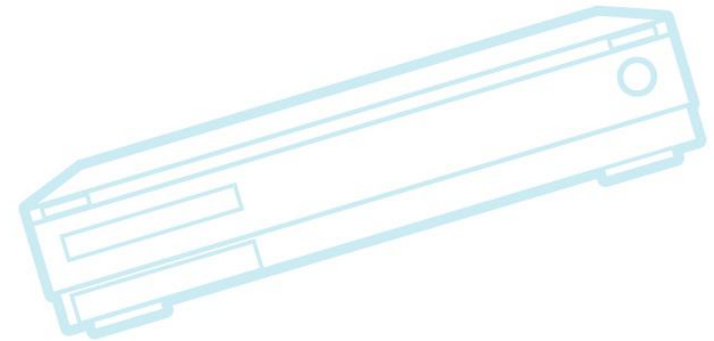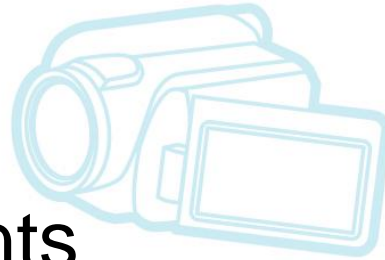
Technology Areas

CE Workgroup Projects

Other Stuff

Resources

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

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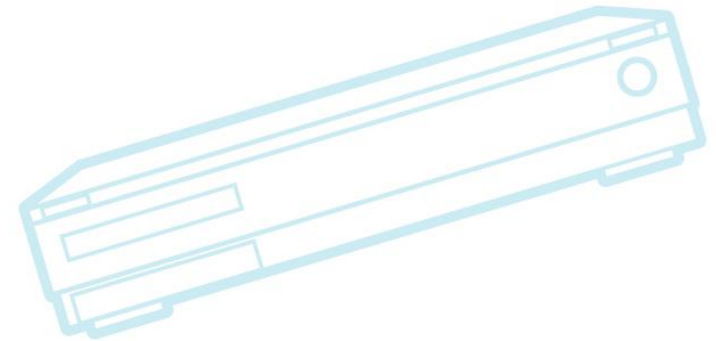- Kexecboot enhancements
- Flash filesystem testing

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
- Mainline the watchdog framework
- Extend bluetooth stack
- Kernel trace and debug documentation

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
  - 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

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
  - Supposed to see patches this week…
- 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

Contract Work Details (3)

- 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

Projects

- Android mainline project
- Long Term Support Initiative (LTSI)
- Open Project Proposals for 2012
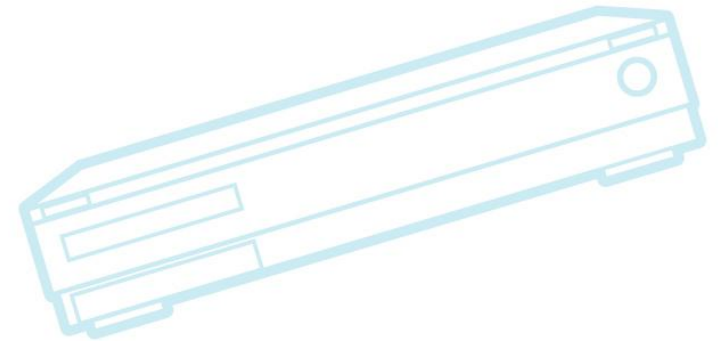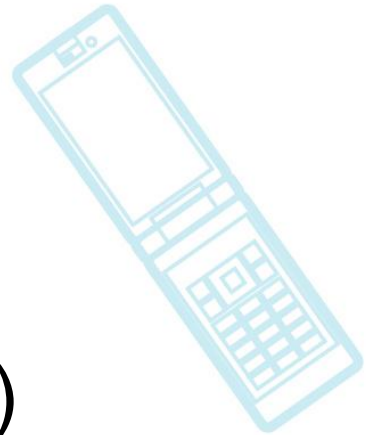
Android Mainline Project

- 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 discussion last week at Linaro Connect
- 3.3 kernel (with 12 lines of patches) boots AOSP

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
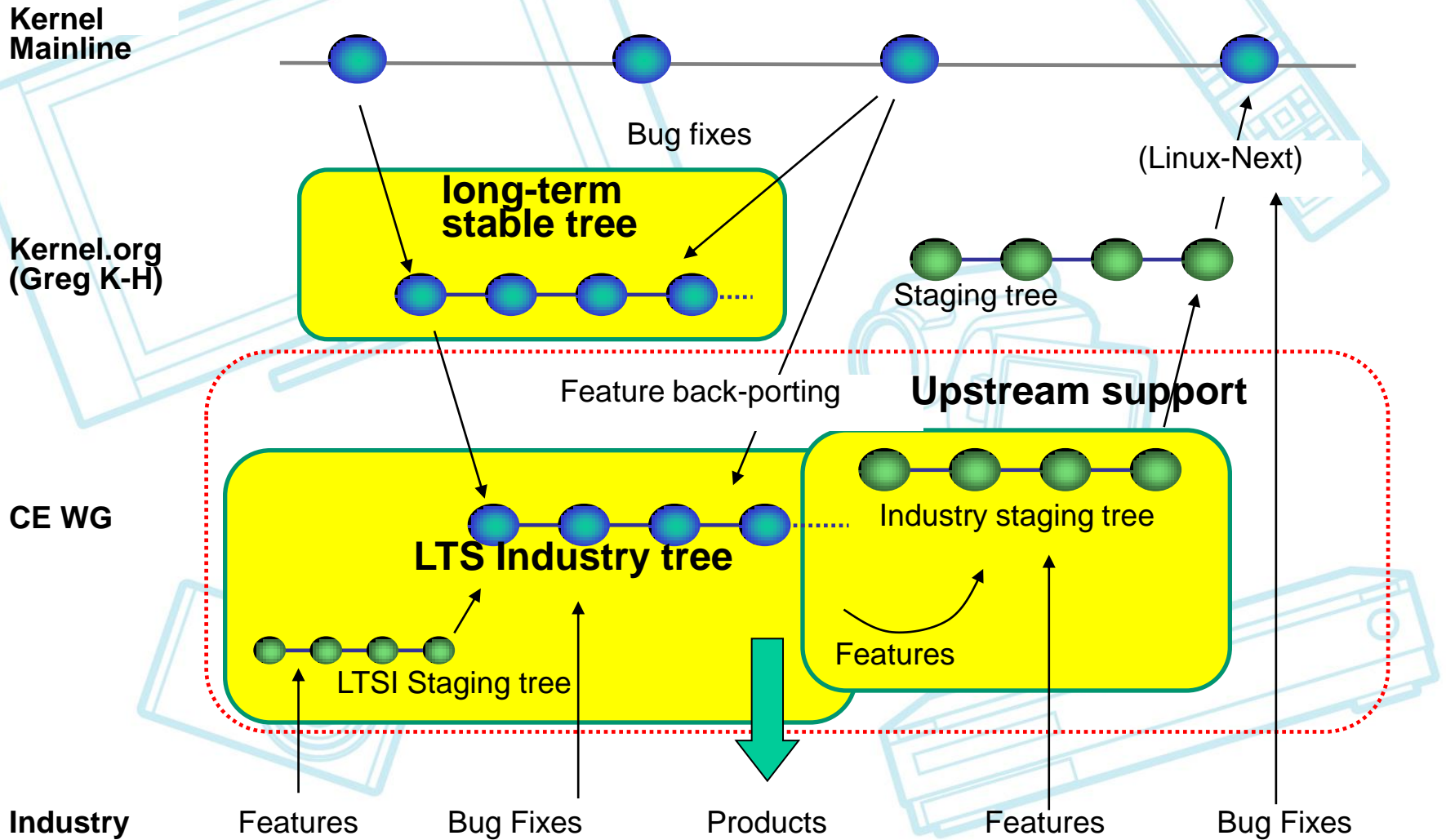- See presentation by Tsugikazu Shibata
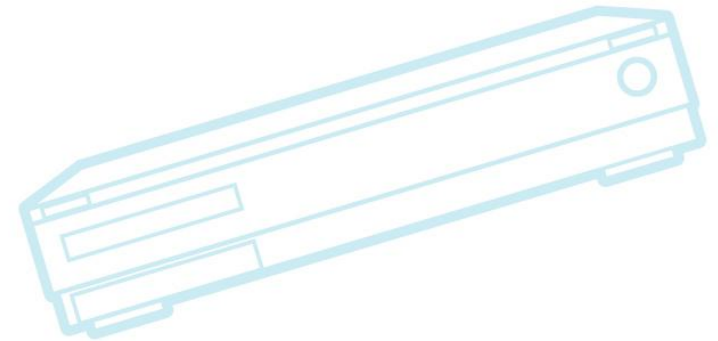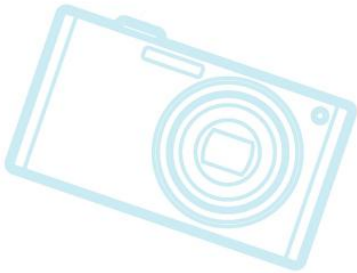
LSTI reasons

- 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

Bug fixes

(Linux-Next)

Kernel.org (Greg K-H)

long-term stable tree

Staging tree

Feature back-porting

Upstream support

CE WG

LTS Industry tree

Industry staging tree

LTSI Staging tree

Features

Industry

Features   Bug Fixes   Products   Features   Bug Fixes

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

Open Project Proposals

- Will be announced on celinux-dev mailing list
- Look for announcement, and proposal instructions on eLinux wiki very soon
  - http://elinux.org/CELF_Open_Project_Proposal_2012
- Please propose a project you think would benefit embedded Linux

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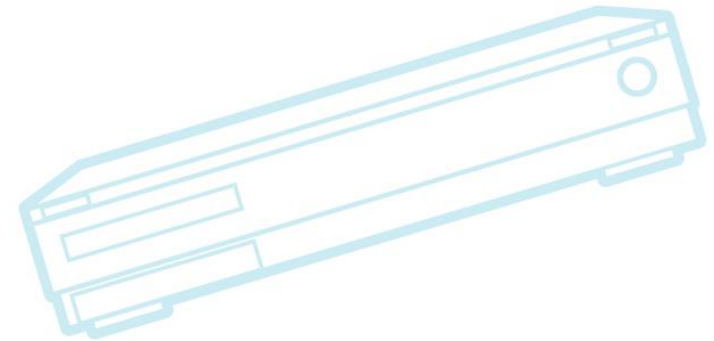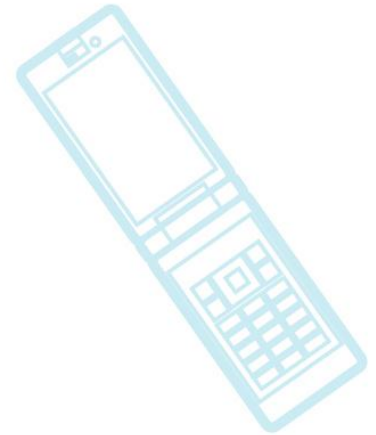
Other Stuff

- Tools
- Build Systems
- Distributions
- Android
- Industry Organizations
- Events
- Miscellaneous
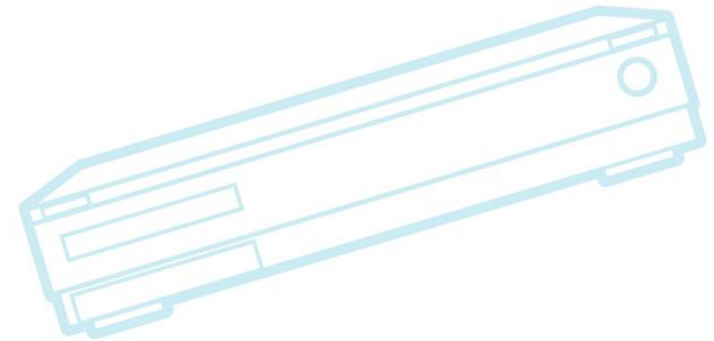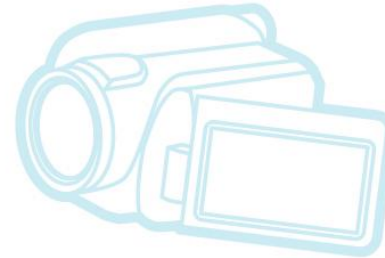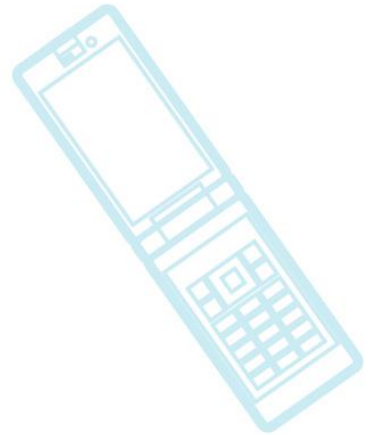
Tools
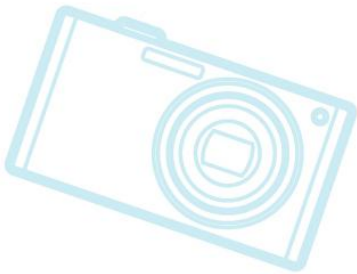
- QEMU
  - QEMU is being used everywhere, for device emulation (Android, Yocto)
  - Javascript QEMU implementation (!!)
- Eclipse
  - Is now de-facto "umbrella" tool for development
  - Need to pry seasoned developers away from command line
- Tracing
  - Perf, ftrace and LTTng 2.0
  - Common Trace Format 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
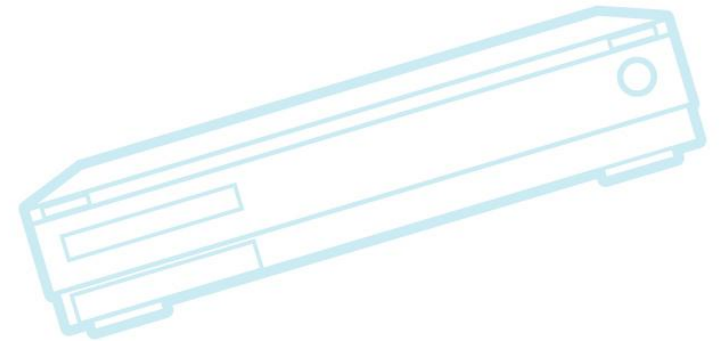
Embedded Distributions

- 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
- Legacy custom embedded
  - Still no "standard" embedded distribution

Android

- Android 4.0 SDK (Ice Cream Sandwhich) released October 2011
  - Source released this week!
- Ice Cream Sandwich unifies mobile, tablet and TV platforms in one codebase
- Phone activations at 700,000 per day
- Dalvik ported to non-Android
  - Myriad Alien Dalvik for Meego
  - IcedRobot for native Linux
  - OpenMobile's ACL (Application Compatibility Layer)

Distributions

1998	2000	2002	2004	2006	2008	2010

Embedix

Hardhat — MontaVista

Denx ELDK

TimeSys Linux RT

LynuxWorks

Wind River Linux

Ångström

Poky — Yocto

Maemo

Moblin — Meego — Tizen

Limo

Embedded Debian

Ubuntu (embedded)

Android

Fire ?
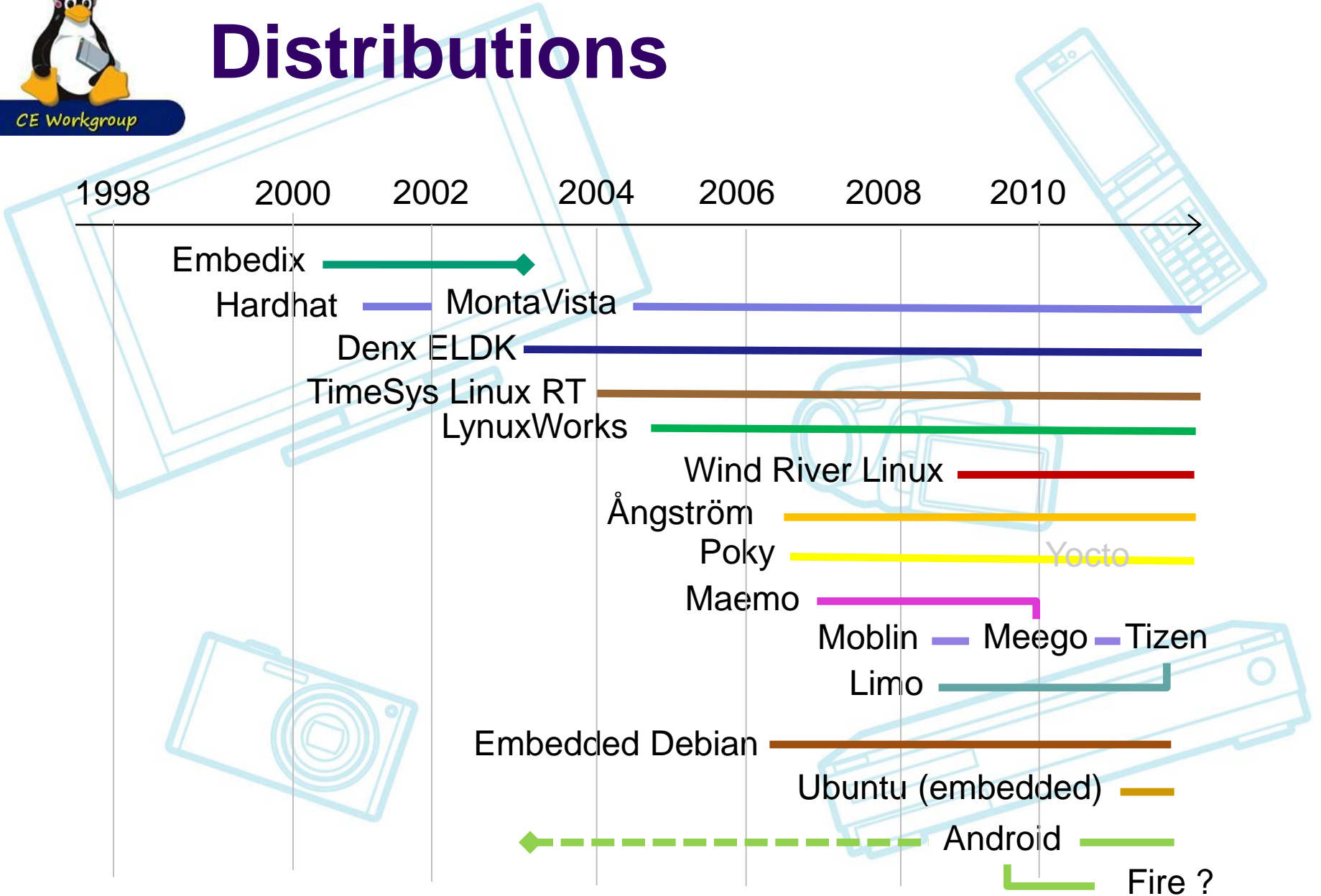
Industry organizations
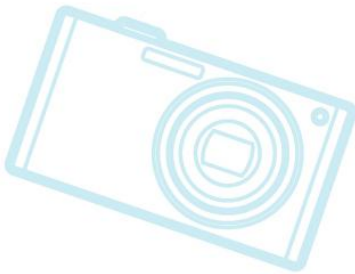
- ## Linux Foundation
  - ### Has lots of embedded-related projects
    - Yocto, Meego, CE Workgroup
- ## CE Workgroup
  - ### Now utilizing LF infrastructure
    - Should mean it's easier for public to participate in CE WG initiatives
      - Was out of commission in fall
- ## Linaro
  - ### Doing lots 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
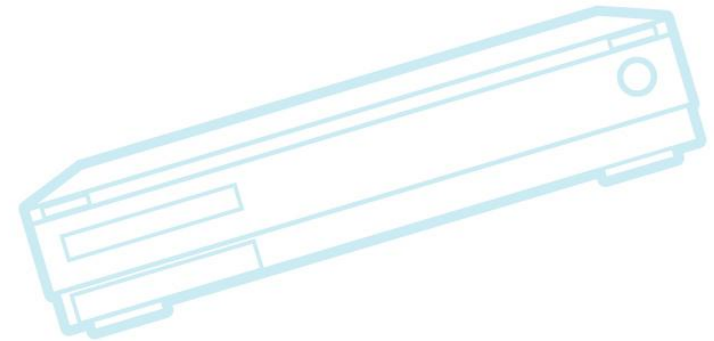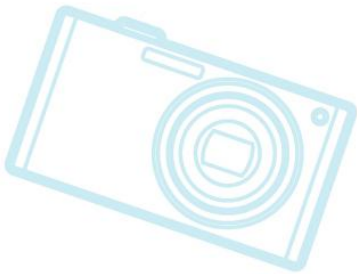 - November 7-9, 2012
  - Barcelona, Spain
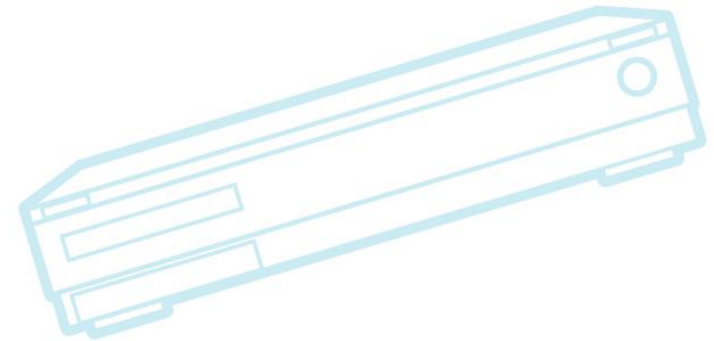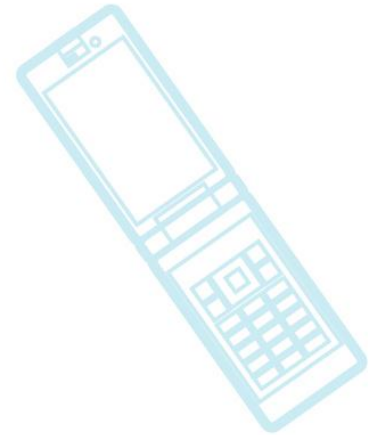
Miscellaneous

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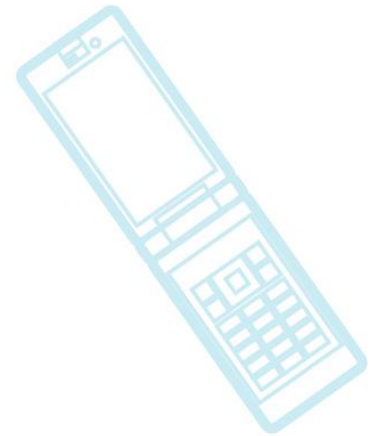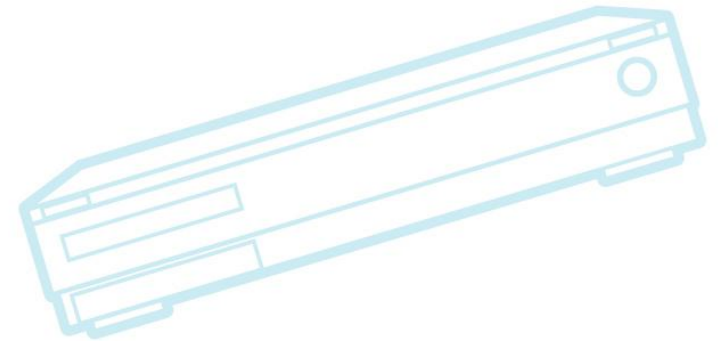
eLinux wiki

- 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

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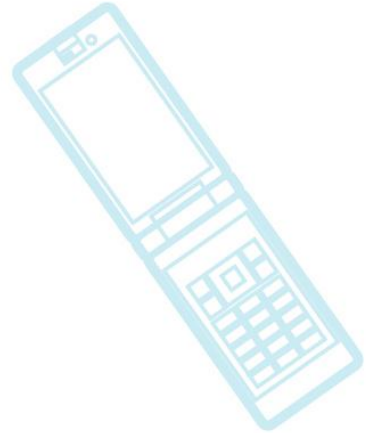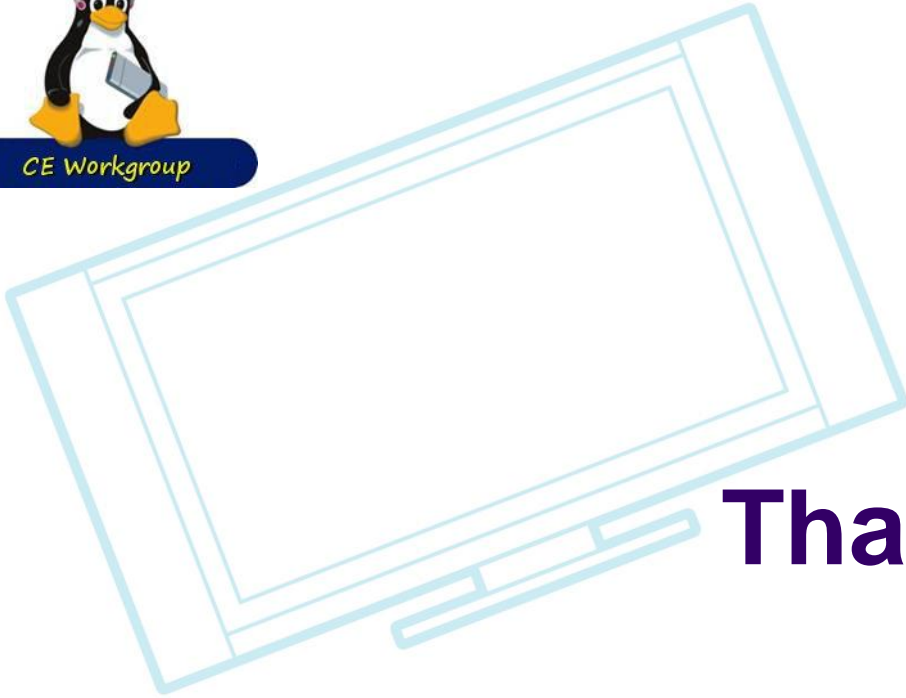Technology Areas
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Resources

- 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!