Linaro's Android Platform

LinuxCon Europe 2011

Zach Pfeffer
Linaro Android Platform Lead

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Android Toolchain Engineer
Mission Statement

Linaro's Android platform is

- Open
- Continuously Improving
- Validated
- Easy-to-Use
- Fully-Enabled
- Optimized
- Built from the best open source components for all member boards
Achieving our Mission

Release Android builds for our member's boards

- TI
  - Panda, Beagle, Beagle xM
- Freescale
  - iMX53
- ST-Ericsson
  - Snowball
- Samsung
  - Origen
All Member Boards

Pictures and more details...
Achieving our Mission

- Produce “Android-Next” with
  - Linaro GCC 4.6
  - Linux Kernel 3.1
  - Android Platform Source 2.3.5
  - Other components (libjpeg-turbo, libpng)
  - Busybox, ffmpeg, lrzsz

- Provide a CI loop
- Accept changes through Gerrit
- Provide pre-built images
Open

- All work is submitted to its upstream
  - AOSP, kernel, GCC, vendor patches
- Instructions for building and loading builds are open and easy to use
  - Build Linaro Android from Source
  - Try a Pre-Built Build
- All builds provided without “registering”
  - http://android-build.linaro.org
Open

- **Source**
  - git://android.git.linaro.org
  - git://git.linaro.org

- **Vibrant community**
  - IRC
    - #linaro, #linaro-android on Freenode
    - The Android team will answer your questions live!
  - Mumble
  - Lists
    - linaro-dev
Continuously Improving

- Monthly milestones
  - [https://launchpad.net/linaro-android/+milestone/11.06](https://launchpad.net/linaro-android/+milestone/11.06)
    - 14 blueprints, 18 bugs
  - [https://launchpad.net/linaro-android/+milestone/11.07](https://launchpad.net/linaro-android/+milestone/11.07)
    - 12 blueprints, 7 bugs
  - [https://launchpad.net/linaro-android/+milestone/11.08](https://launchpad.net/linaro-android/+milestone/11.08)
    - 14 blueprints, 5 bugs
  - [https://launchpad.net/linaro-android/+milestone/11.09](https://launchpad.net/linaro-android/+milestone/11.09)
    - 27 blueprints, 19 bugs
  - [https://launchpad.net/linaro-android/+milestone/11.10](https://launchpad.net/linaro-android/+milestone/11.10)
    - 31 blueprints, 33 bugs (in progress)
Continuously Improving

- New release the last Thursday of the month
- Release Candidate available the Monday before
- Next cycle planning begins during release week
Continuously Improving

- **Toolchain Benchmarking**
  - Linaro performs monthly benchmarking tests to help gauge toolchain:
    - **Android Toolchain Benchmarks**
      - 11.09, 11.08, 11.07
  - **Comparisons are made between:**
    - Current Android NDK
    - Current month's 4.5 and 4.6 toolchains
    - Previous month's 4.6 toolchain
Continuously Improving

- Toolchain Benchmarking
  - Fully automated source available [here](#)
Validated

Continuous Integration

- Change Management
  Gerrit
- Automated Regression Testing
  LAVA (Linaro Automated Validation Architecture)
  - Monkey
  - 0xbench
  - busybox
  - mmtest
  - glmark
- Pre-merge Testing
Validated

The CI Loop
Easy-to-Use

- Trying Android on a member board should be easy
- Building Android and programming it on a member board should be easy
Try a Build
5 Commands and 1 minute

```bash
wget --no-check-certificate https://android-build.linaro.org/.../boot.tar.bz2
wget --no-check-certificate https://android-build.linaro.org/.../system.tar.bz2
wget --no-check-certificate https://android-build.linaro.org/.../userdata.tar.bz2
bzr branch lp:linaro-image-tools
./linaro-image-tools/linaro-android-media-create --mmc /dev/sdc
--dev panda
--system system.tar.bz2
--userdata userdata.tar.bz2
--boot boot.tar.bz2
```
Make and Try a Build
7 Commands (and 1 hour)

wget –no-check-certificate https://android-build.linaro.org/.../android-toolchain-eabi-linaro-4.6-...-linux-x86.tar.bz2

tar -jxvf android-toolchain-eabi-*_.tar.bz2

repo init
-u git://android.git.linaro.org/platform/manifest.git
-b linaro_android_2.3.5
-m LEB-panda.xml

repo sync

make -j4 TARGET_PRODUCT=pandaboard
TARGET_TOOLS_PREFIX=/workspace/.../arm-eabi- boottarball systemtarball userdatatarball

bzr branch lp:linaro-image-tools
./linaro-image-tools/linaro-android-media-create --mmc /dev/sdc
--dev panda
--system system.tar.bz2
--userdata userdata.tar.bz2
--boot boot.tar.bz2
Validated

- QA
  - 3 build/test sets a cycle
  - Release Candidate (RC) builds enter week-long QA cycle before final builds
  - QA Tests
Optimize

Let's make Android fast!!!
Optimize

Switched compiler flags

- **AOSP default**
  - `-O2 -fno-strict-aliasing`

- **New**
  - `-O3 -fmodulo-sched -fmodulo-sched-allow-regmoves -Wl,--hash-style=gnu -Werror=strict-aliasing`

Remove `-fno-strict-aliasing`
-O3

- Optimize for speed over code size
- Speed over compilation time
- Includes
  - finline-functions
  - funswitch-loops
  - fpredictive-commoning
  - fgcsse-after-reload
  - ftree-vectorize
  - fipa-cp-clone
Optimize

-\texttt{-fmodulo-sched -fmodulo-sched-allow-regmoves}

- Improve loop scheduling
- More info
Optimize

-Wl,--hash-style=gnu

- Improves program startup time via new hashing algorithm
- Needed to patch the AOSP dynamic linker
Optimize

Remove `-fno-strict-aliasing`

- Enables better optimizations
- Requires a stricter coding style
  
  **Example 1**
  
  **Example 2**

- Most violations can be found with `-Werror=strict-aliasing`

- Cheat!
  
  Override with `-fno-strict-aliasing`
Optimize

-ffast-math

- Dangerous
  - Breaks IEEE standards

- Useful in the skia 2D graphics and OpenGL libraries
Optimize

Board specific optimizations

- Cortex-A9 for Panda, Origen, Snowball
- Cortex-A8 for iMX53, Beagle, Beagle xM
Optimize

Graphite related optimizations

- fgraphite-identity
- flop-block
- flop-interchage
- flop-strip-mine
- ftree-loop-distribution
- ftree-loop-linear

Optimization effectiveness increases with better compiler SMP support
Future Improvements

- OpenMP
  API for easy multi-core parallelization
- `-ftree-parallelize-loops` for multi-core boards
  requires android-eabi toolchain
- ARM vs Thumb2
- Locate detrimental `-O3` code size
  `-fno-inline-functions` may help
- Find more `-ffast-math` compatible code
Future Improvements

- **binutils**: `-Bsymbolic-functions`  
  - Speed up the dynamic linker
- **binutils/gcc**: `-flto`, `-fwhole-program`  
  - Link time optimization
- **gcc**: `-fvisibility-inlines-hidden`  
  - Improve start-up time
- Move to GCC 4.7
Optimize

More info here!
Thanks
All Member Boards

- TI: PandaBoard
  - OMAP4430
    - Dual Core 1 Gz Cortex-A9
  - 1 GB LPDDR2
  - 1080p@30fps
    - Encode/Decode H.264, MPEG-4, H.263
    - Decode VP6, VP7
  - DSP, IVA-HD, 2 Cortex-M3 Ducati, Audio back-end (ABE), Imaging Subsystem (ISS), SGX, Image Signal Processor (ISP), still image co-processor (SIMCOP)
- JTAG, UART, HDMI, DVI-D, Camera Connector, USB OTG/HOST, Microphone Jack, Headphone Jack, 10/100 Ethernet
All Member Boards

- **TI: BeagleBoard**
- **OMAP3530**
  - 720 Mhz Cortex-A8
- **110 MHz SGX**
- **256 MB NAND, 256MB DDR @ 166 MHz**
- **JTAG, UART, DVI-D, USB OTG/HOST, Microphone Jack, Headphone Jack**

http://beagleboard.org/static/BBSRM_latest.pdf
All Member Boards

- TI: BeagleBoard xM
- DM373
  - 1 GHz Cortex-A8
- 200 MHz SGX
- 512 MB DDR @ 166MHz
- JTAG, UART, DVI-D, USB OTG/HOST, Microphone Jack, Headphone Jack, 10/100 Ethernet

http://beagleboard.org/static/BBSRM_latest.pdf
All Member Boards

- Freescale: i.MX53 Quick Start
  - i.MX53
    - 1 GHz ARM Cortex™-A8
  - 1 GB DDR3
  - SGTL5000 Audio Codec
  - HDMI, camera connector SATA, 10/100 Ethernet, Microphone Jack, Headphone Jack
  - 3D Accelerometer
  - I2C, SSI, SPI
All Member Boards

- **ST-Ericsson: Snowball**
  - Nova A9500
    - Dual Cortex 1 GHz Cortex-A9 with Advanced SIMD (Neon) Extensions
- Mali-400 GPU
- 1080p
- 1 GB of DDR2
- HDMI, WLAN, Bluetooth, USB OTG, 10/100 Ethernet
- 3D Accelerometer, 3D Magnetometer, 3D Gyroscope, Barometer
All Member Boards

- Samsung: ‘Origen’ low cost development board
  - Exynos4210
    - Dual Core 1 GHz Cortex-A9 with Advanced SIMD (Neon) Extensions
  - Mali400 MP4 GPU
  - 1080p@30fps Hardware Decode of
  - 1GB of High Bandwidth DDR3
  - HDMI, WLAN, Bluetooth, Camera Connector, USB 2.0 OTG/HOST, SD/MMC
  - 8ch, I2C, SATA, PCI Express

http://www.linaro.org/assets/PDF/LinaroOrigenLowCostBoard.pdf
Some Interesting Results

- **0xbench 3-D**
  - Across all boards
  - Across all builds
# Panda 0xbench 3-D Test Result

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iMX53 0xbench 3-D Test Result

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--- | --- | --- | --- |
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Origen 0xbench 3-D Test Result

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Snowball Oxbench 3-D Test Result

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Results

- Slowdowns
  - TARGET_CPU_SMP increases locking overhead
  - GCC 4.6 performance regressions
  - Using Linaro Android build parameterization to track down regressions
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- Samsung
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Continuous Integration
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  LAVA (Linaro Automated Validation Architecture)
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  - glmark
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The CI Loop
Easy-to-Use

- Trying Android on a member board should be easy
- Building Android and programming it on a member board should be easy
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5 Commands and 1 minute

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**bzr branch lp:linaro-image-tools**

./linaro-image-tools/linaro-android-media-create  --mmc
/dev/sdc
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--system system.tar.bz2
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--boot boot.tar.bz2
Make and Try a Build
7 Commands (and 1 hour)

wget --no-check-certificate https://android-build.linaro.org/.../android-toolchain-eabi-linaro-4.6-...-linux-x86.tar.bz2
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- b linaro.android_2.3.5
- m LEB-panda.xml
repo sync
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  - 3 build/test sets a cycle
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  - QA Tests
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Let's make Android fast!!!
Optimize

Switched compiler flags

- AOSP default
  -O2 -fno-strict-aliasing
- New
  -O3 -fmodular-sched -fmodular-sched-allow-removes -Wl,---hash-style=gnu -Werror=strict-aliasing
  Remove -fno-strict-aliasing
Optimize

-O3

- Optimize for speed over code size
- Speed over compilation time
- Includes
  - finline-functions
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  - fpredictive-commoning
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  - ftree-vectorize
  - fipa-cp-clone
Optimize

-ffmodeso-sched -ffmodos-sched-allow-regmoves
- Improve loop scheduling
- More info
Optimize

-Wl,--hash-style=gnu

- Improves program startup time via new hashing algorithm
- Needed to patch the AOSP dynamic linker
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Remove -fno-strict-aliasing

- Enables better optimizations
- Requires a stricter coding style

Example 1
Example 2

- Most violations can be found with
  -Werror=strict-aliasing

- Cheat!
  Override with -fno-strict-aliasing
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-ffast-math

- Dangerous
  - Breaks IEEE standards
- Useful in the skia 2D graphics and OpenGL libraries
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Graphite related optimizations
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   - floop-block
   - floop-interchage
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   - ftree-loop-distribution
   - ftree-loop-linear

Optimization effectiveness increases with better compiler SMP support
Future Improvements

- OpenMP
  API for easy multi-core parallelization
- -ftree-parallelize-loops for multi-core boards
  requires android-eabi toolchain
- ARM vs Thumb2
- Locate detrimental -O3 code size
  -fno-inline-functions may help
- Find more -ffast-math compatible code
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- binutils: -Bsymbolic-functions
  - Speed up the dynamic linker
- binutils/gcc: -flto, -fwhole-program
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More info here!
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Panda 0xbench 3-D Test Result

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iMX53 0xbench 3-D Test Result

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Origen 0xbench 3-D Test Result

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Snowball 0xbench 3-D Test Result

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Results

- Slowdowns
  - TARGET_CPU_SMP increases locking overhead
  - GCC 4.6 performance regressions
  - Using Linaro Android build parameterization to track down regressions