Connect your device to application

親手打造
特製的
Android Toolchain

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親手打造

- 得以從原始程式碼建構

特製的

- 加入自訂的特徵

Android Toolchain

- 一片藍色，不知道搞什麼？

這是 Blue 流

- 搞系統程式絕對不是「不入流」！

BLUE = Build Linux Utilities for Embedded

- 警告：為提昇學習興趣，簡報不時加入宅男的幻想元素，僅供參考

How?

提綱

回顧 GNU Toolchain 嶄新發展

開發模式與分支

Toolchain 建構方案

jserv 說 我愛 GCC

delete - edit - like

Recent plurk responses:

Robert 說 GCC 愛你

laneser 我是博愛型的, 愛 C , 愛 C++ , 愛 C# ...(好像只要吸就好?)

作為具備工業強度與活躍開發的專案，GNU Toolchain 不該只被視為單純編譯器，而是完整編譯系統架構

原來 GNU Toolchain 離我們這麼近

GCC 嶄新發展

http://multimedia.cx/eggs/compiler-smackdown-2010-1-64-bit/

GCC 嶄新發展 (1/N)

- ARM EABI (Embedded ABI)

  允許混用 soft/hard-floating point code，跨越編譯器的標準 , Thumb interworking, alignment/padding, system call (swi → r7 for syscall number)

  - gcc-4.1.0 + linux-2.6.16 (CONFIG_AEABI)
- GCC Plugins

  GPL / GNU Runtime license，擴充能力
- PGO (Profile-Guided Optimization) / FDO (Feedback-Directed Optimization)

  Firefox 已充分整合
- Inter-Procedural Optimization (IPO)

  Google 提出整合 FDO 優化技術到 IPO 的機制 (LIPO)

GCC 嶄新發展 (2/N)

- PGO (Profile-Guided Optimization) / FDO (Feedback-Directed Optimization)

  Firefox 已充分整合

Firefox Startup Time		RSS (KB)
firefox.stock	**2515**ms	**49452**
firefox.ordered	1919ms	45344
firefox.static	2321ms	49616
firefox.static.ordered	1577ms	37072
firefox.static.pgo	**1619**ms	**38436**

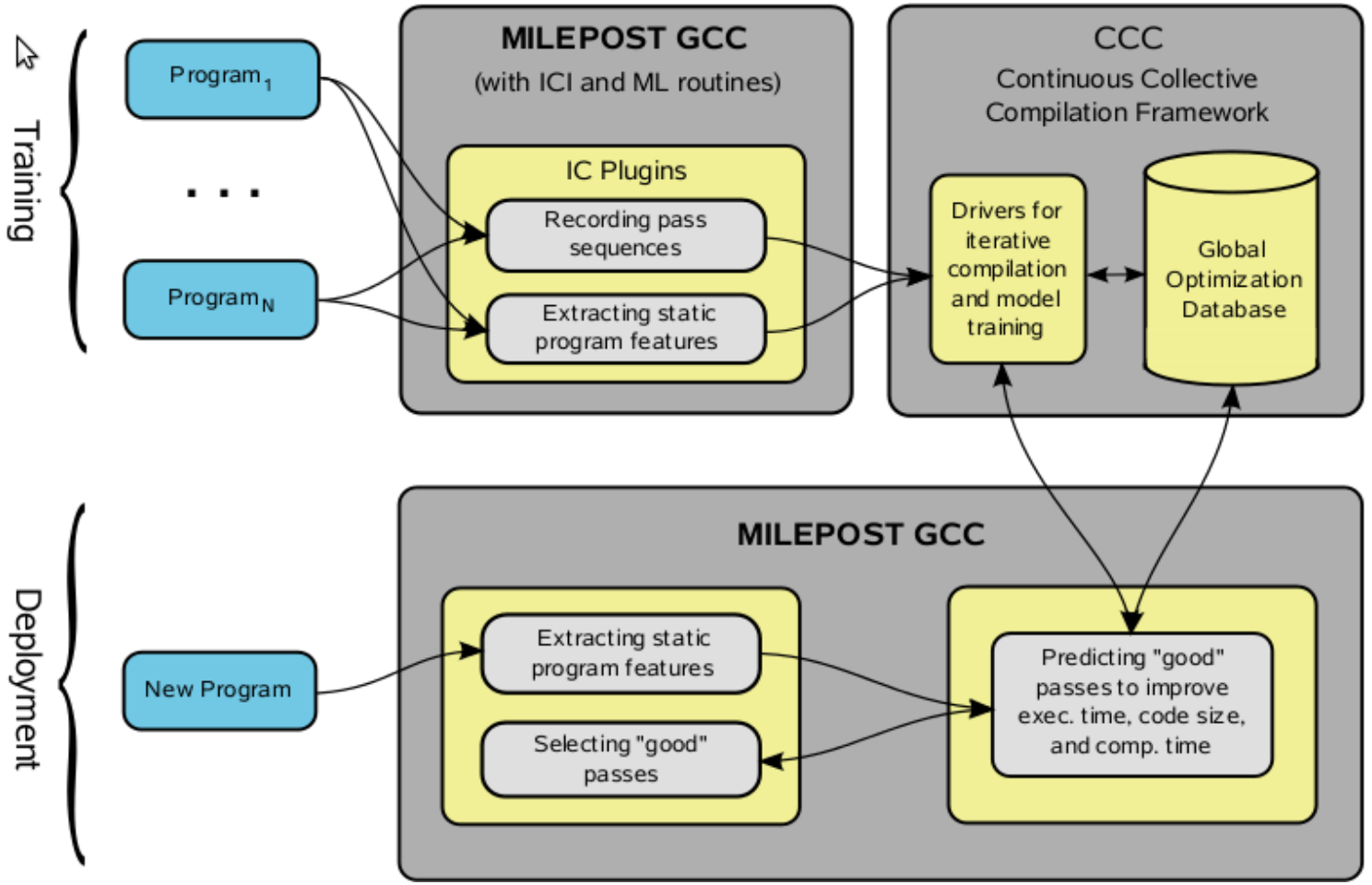
From http://blog.mozilla.com/tglek/2010/04/12/squeezing-every-last-bit-of-performance-out-of-the-linux-toolchain/

- Inter-Procedural Optimization (IPO) + FDO

SPECint2000 Performance (LIPO vs FDO)			
	LIPO	FDO	improvement
164.gzip	1392	1309	6.3%
186.crafty	2509	2324	8.0%
197.parser	1665	1630	2.1%
252.eon	2650	2488	6.5%
254.gap	2156	2055	4.9%
255.vortex	3246	2649	22.5%

GCC 嶄新發展 (3/N)

- MILEPOST GCC：用機器學習的手法，來優化整個編譯程序，甚至進一步提供 web service



Binutils 嶄新發展


想到 Binutils 活躍 / 活潑的開發，
走路都有風

Binutils 嶄新發展 (1/N)

- 全新的 linker: “gold” by Ian Lance Taylor (Google)

  Why? GNU ld 太遲緩、難以用新的技術來改良

  - 快！支援 Multi-Threaded – 45% Faster
  - 提供 Plugin 機制，讓 GCC 與 LLVM 作全域的優化處理
  - 允許配合 GCC 的 Redundancy Elimination 的優化 – ICF (Identical Comdat/Code Folding), option: "`--icf`"
  - 強化的 garbage collection
- DT_GNU_HASH

  為解決 OpenOffice.org 面臨的動態連結效能問題，先後提出 "-Bdirect" 與 "DT_GNU_HASH"(gnu.hash) 的方案

  - 預先計算出連結，可改善 50% 的動態連結時間成本
    - 仍可搭配 prelink

GDB 嶄新發展


「想做你的 Code 」


「想做你的 Compiler 」
「想做你的 Code 」


「想做你的 Compiler 」
「想做你的 Code 」
「想要慢慢 Debug 你的一切」

GDB 嶄新發展 (1/N)

- GDB 7.x 已實現現有大部分商業 Debugger 的關鍵特徵
- Reservse Debugging
- Tracepoint / Record
- Extended C++ support (STL)
- Python integration
- ...


「葛格， GNU Toolchain 好棒唷」
「快給人家啦～」
GCC

回顧 Android Toolchain 發展藍圖

- 廖世偉教授 (Google) 在 COSCUP 2009 的演講「 Smaller and Faster Android 」 (P.6)

Android Toolchain Roadmap

	Cupcake	Donut	Éclair (armv7a)
gcc	4.2.1	4.2.1	4.4.0
binutils	2.17	2.17	2.19
gdb	6.6	6.6	6.6
gmp	4.2.2	4.2.2	4.2.4
mpfr	2.3.0	2.3.0	2.4.1

Froyo(Android 2.2) 還是跟 Eclair 一樣的組合？！

- …(無力)…
- …(無言)…
- 自力救濟！

Connect your device to application

開發模式與分支

開發模式與分支

- FSF (Free Software Foundation)

  以 GPL 發布 GNU Toolchain 及相關的套件，開發者必須將著作權移轉給 FSF ，也就是得先簽署 Copyright Assignment 。 RedHat 是重要盟友

- CodeSourcery

  GCC 主力的開發廠商，提供主流指令集高度優化的 GNU Toolchain 。分若干版本，有純粹的 GPL 軟體，也包含特定的封閉軟體。注意：有部份程式碼從未提交到 FSF

- Linaro

  ARM 陣營的系統優化 Linux 解決方案，整合 CodeSourcery 的貢獻

- Google

  有一票 GCC, binutils, LLVM 的開發者，部份未提交給 FSF

Linaro 陣營

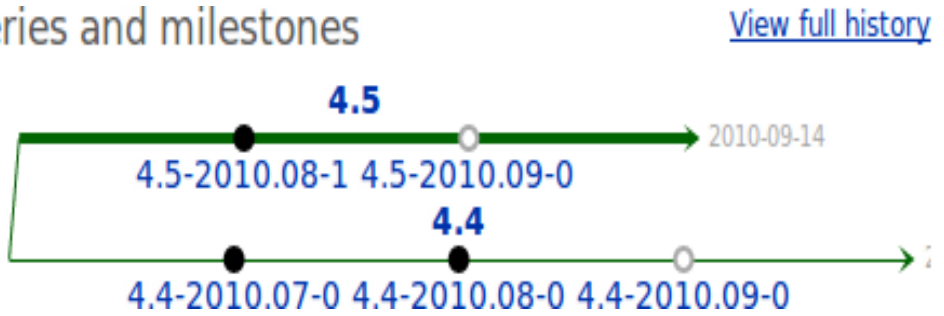
- 新聞稿： Linaro: Accelerating Linux on ARM (2010-06-03)

  “***Linaro*** is impressively open: www.linaro.org has details of open engineering summits, an open wiki, mailing lists etc. The teams behind the work are committed to upstreaming their output so it will appear in all the distributions, sooner or later. The images produced will all be royalty free. And we’re working closely with the Linaro team, so the cadence of the releases will be rigorous, with a six month cycle that enables Linaro to include all work that happens in ***Ubuntu*** in each release of Linaro. There isn’t a “whole new distribution”, because a lot of the work will happen upstream, and where bits are needed, they will be derived from Ubuntu and Debian, which is quite familiar to many developers."

- Toolchain 參與廠商： ARM, CodeSource, Canonical
- Ubuntu maverick (10.10) 的 gcc 已整合 linaro

Linaro 陣營

```
$ gcc -v
Using built-in specs.
Target: i686-linux-gnu
…
gcc version 4.4.5 20100728 (prerelease) (Ubuntu/Linaro 4.4.4-8ubuntu1)
```



https://wiki.linaro.org/WorkingGroups/ToolChain
We're working towards the 2010.09 release that is due on 14/09/2010.

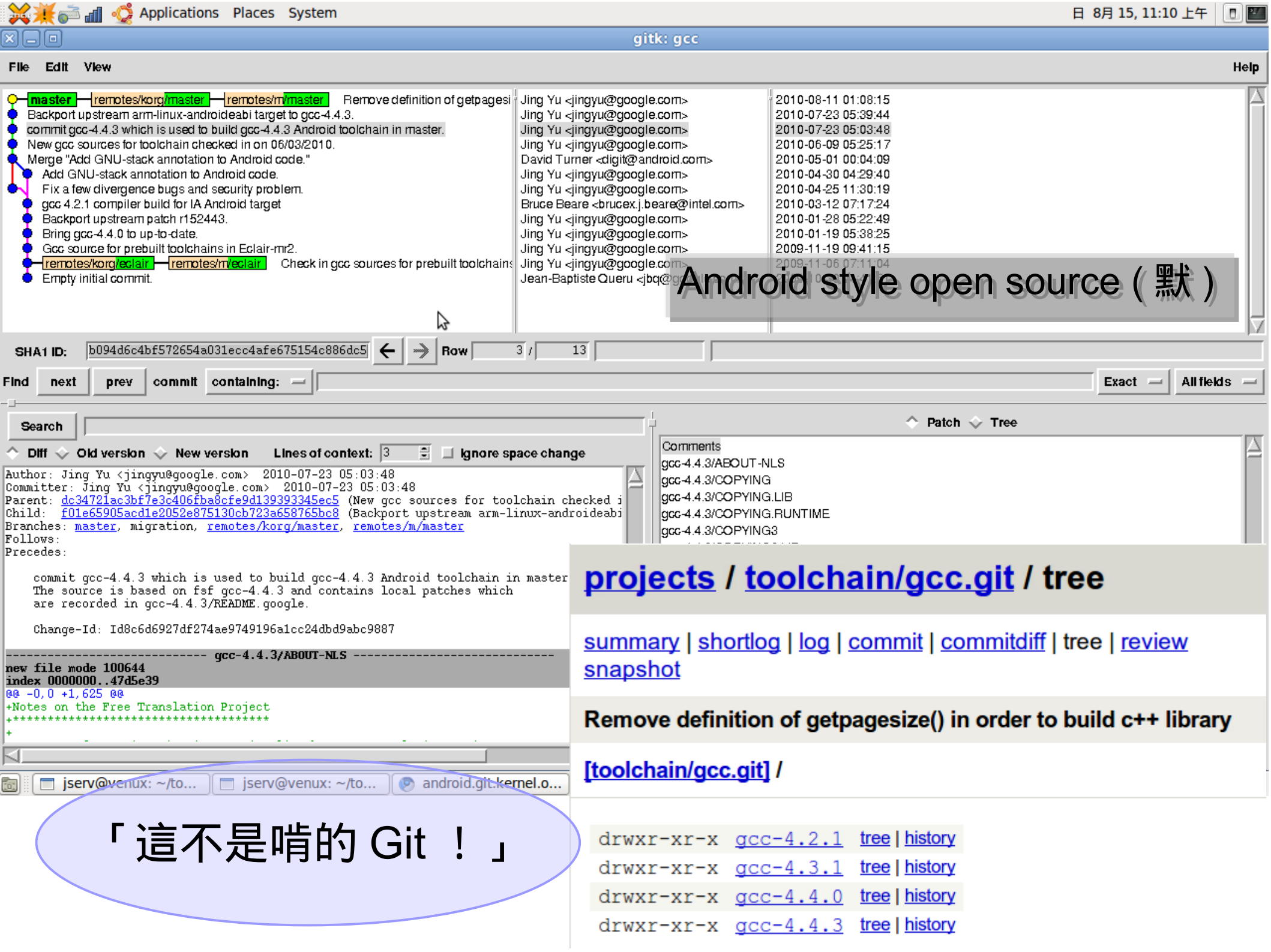
Merging the 4.5 CodeSourcery patch set into the Linaro 4.5 branch (ams, jbrown)
Begin into the GDB ARM faults (uweigand, yao)
First pass at hard float performance numbers (cltang)
Patch tracking write-up (michaelh)
Talk about memcpy() and friends with glibc (michaelh)

版本控制系統

- FSF (Free Software Foundation): Git, SVN, CVS
- CodeSourcery: no public
- Linaro: Git (linux-kernel), bzr (toolchain/packages)

  cvs2svn → svn2bzr
- Google: internal tree → “stripped-down" Git

  「閹割」太多資訊，公開的源頭根本不是 FSF ，無法透過版本控制系統去 Merge!


Applications Places System
日 8月 15, 11:10 上午
gitk: gcc
File Edit View Help
master remotes/korg/master remotes/m/master Remove definition of getpagesi
Backport upstream arm-linux-androideabi target to gcc-4.4.3.
commit gcc-4.4.3 which is used to build gcc-4.4.3 Android toolchain in master.
New gcc sources for toolchain checked in on 06/03/2010.
Merge "Add GNU-stack annotation to Android code."
Add GNU-stack annotation to Android code.
Fix a few divergence bugs and security problem.
gcc 4.2.1 compiler build for IA Android target
Backport upstream patch r152443.
Bring gcc-4.4.0 to up-to-date.
Gcc source for prebuilt toolchains in Eclair-mr2.
remotes/korg/eclair remotes/m/eclair Check in gcc sources for prebuilt toolchains
Empty initial commit.
Jing Yu <jingyu@google.com> 2010-08-11 01:08:15
Jing Yu <jingyu@google.com> 2010-07-23 05:39:44
Jing Yu <jingyu@google.com> 2010-07-23 05:03:48
Jing Yu <jingyu@google.com> 2010-06-09 05:25:17
David Turner <digit@android.com> 2010-05-01 00:04:09
Jing Yu <jingyu@google.com> 2010-04-30 04:29:40
Jing Yu <jingyu@google.com> 2010-04-25 11:30:19
Bruce Beare <brucex.j.beare@intel.com> 2010-03-12 07:17:24
Jing Yu <jingyu@google.com> 2010-01-28 05:22:49
Jing Yu <jingyu@google.com> 2010-01-19 05:38:25
Jing Yu <jingyu@google.com> 2009-11-19 09:41:15
Jing Yu <jingyu@google.com> 2009-11-06 07:11:04
Jean-Baptiste Queru <jbq@g
Android style open source (默)
SHA1 ID: b094d6c4bf572654a031ecc4afe675154c886dc5 Row 3 / 13
Find next prev commit containing: Exact All fields
Search
Diff Old version New version Lines of context: 3 Ignore space change
Author: Jing Yu <jingyu@google.com> 2010-07-23 05:03:48
Committer: Jing Yu <jingyu@google.com> 2010-07-23 05:03:48
Parent: dc3472lac3bf7e3c406fba8cfe9d139393345ec5 (New gcc sources for toolchain checked i
Child: f01e65905acd1e2052e875130cb723a658765bc8 (Backport upstream arm-linux-androideabi
Branches: master, migration, remotes/korg/master, remotes/m/master
Follows:
Precedes:
commit gcc-4.4.3 which is used to build gcc-4.4.3 Android toolchain in master
The source is based on fsf gcc-4.4.3 and contains local patches which
are recorded in gcc-4.4.3/README.google.
Change-Id: Id8c6d6927df274ae9749196a1cc24dbd9abc9887
---------- gcc-4.4.3/ABOUT-NLS ----------
new file mode 100644
index 0000000..47d5e39
@@ -0,0 +1,625 @@
+Notes on the Free Translation Project
+*************************************
+
Patch Tree
Comments
gcc-4.4.3/ABOUT-NLS
gcc-4.4.3/COPYING
gcc-4.4.3/COPYING.LIB
gcc-4.4.3/COPYING.RUNTIME
gcc-4.4.3/COPYING3
projects / toolchain/gcc.git / tree
summary | shortlog | log | commit | commitdiff | tree | review
snapshot
Remove definition of getpagesize() in order to build c++ library
[toolchain/gcc.git] /
drwxr-xr-x gcc-4.2.1 tree | history
drwxr-xr-x gcc-4.3.1 tree | history
drwxr-xr-x gcc-4.4.0 tree | history
drwxr-xr-x gcc-4.4.3 tree | history
jserv@venux: ~/to...
jserv@venux: ~/to...
android.git.kernel.o...
「這不是啃的 Git ！」

Toolchain 建構方案

「小姐，我可以跟你一起體驗 XXX 嗎？」

0xlab Toolchain

- 原則：善用既有資源，在產品開發前期，導入若干創新
- 首要問題：解決版本控制系統的分歧，統一用 Git
  - Linaro: 雖然 Bzr → Git 有很多工具，但是 GCC 太龐大
    - 將 Google 的修改抽離，並整合到 Linaro 的開發分支
- 關鍵技術的移轉
  - Google 特有修改： LIPO (FDO + IPO), ICF (Identical Comdat/Code Folding), gold linker
    - Linaro 包含若干 CodeSourcey/ARM 特有的平台優化修正，很可能無法銜接
    - Mega bytes code review!
- 0xdroid: 0xlab 的參考 Android 分支
  - 「親手打造」原則的實現，並在 bionic 整合 ARM 效能優化或 DT_GNU_HASH 等機制

0xlab Toolchain

- 首要問題：解決版本控制系統的分歧，統一用 Git

  Linaro: 雖然 Bzr → Git 有很多工具，但是 GCC 太龐大

  - 將 Google 的修改抽離，並整合到 Linaro 的開發分支

- 工具

  Tailor → 失敗

  - Bzr plugin → 成功，大約要 8 hr+ 才能移轉完畢
  - http://blog.agoragames.com/2010/03/08/bzr-to-git-migration/

  linaro-gcc.git$ du -sh

  12G.

  沒錯，即使扣除若干分支，Git 仍佔 12 GB 的空間

- 整理 Google 的修改，基於 gcc-4.4.3

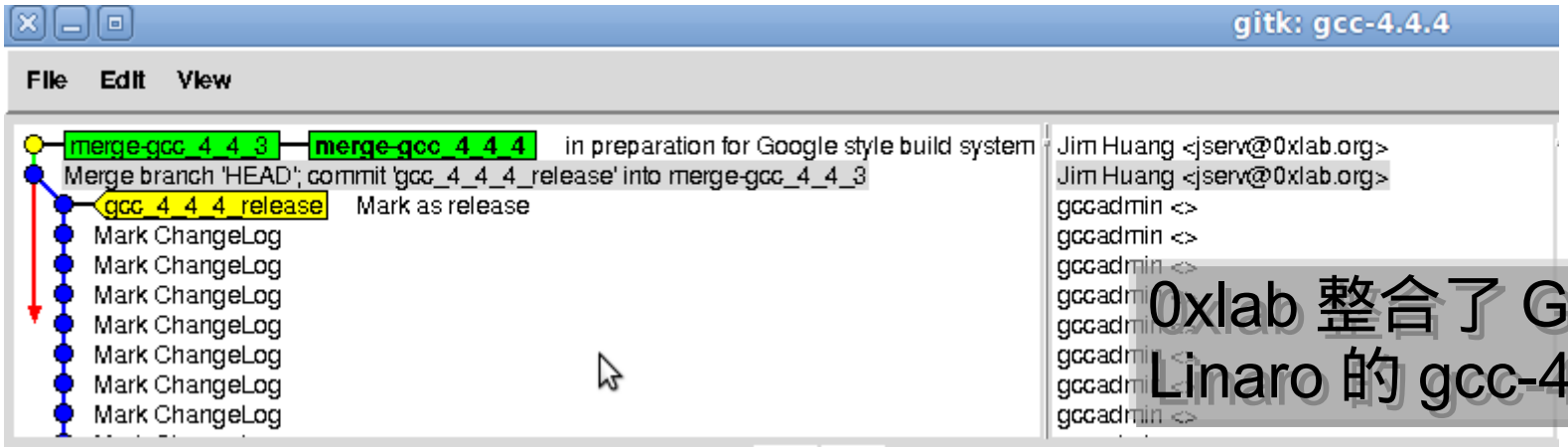
  要搭配對應的 binutils-2.19，才會有最新的 gold linker

  ICF 也才會運作

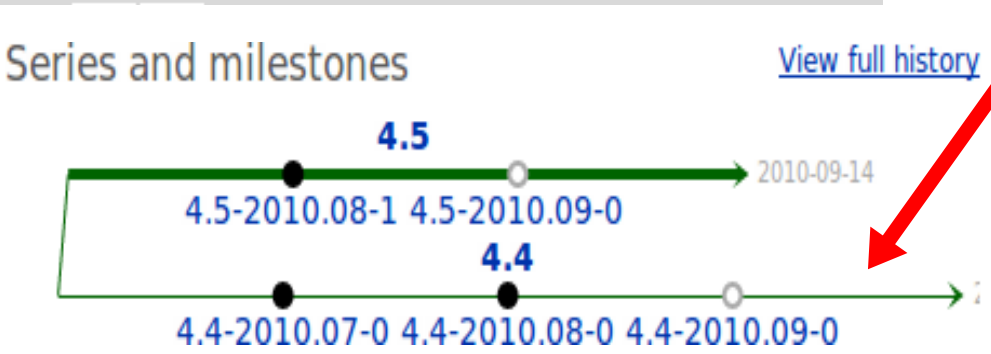
0xlab Toolchain

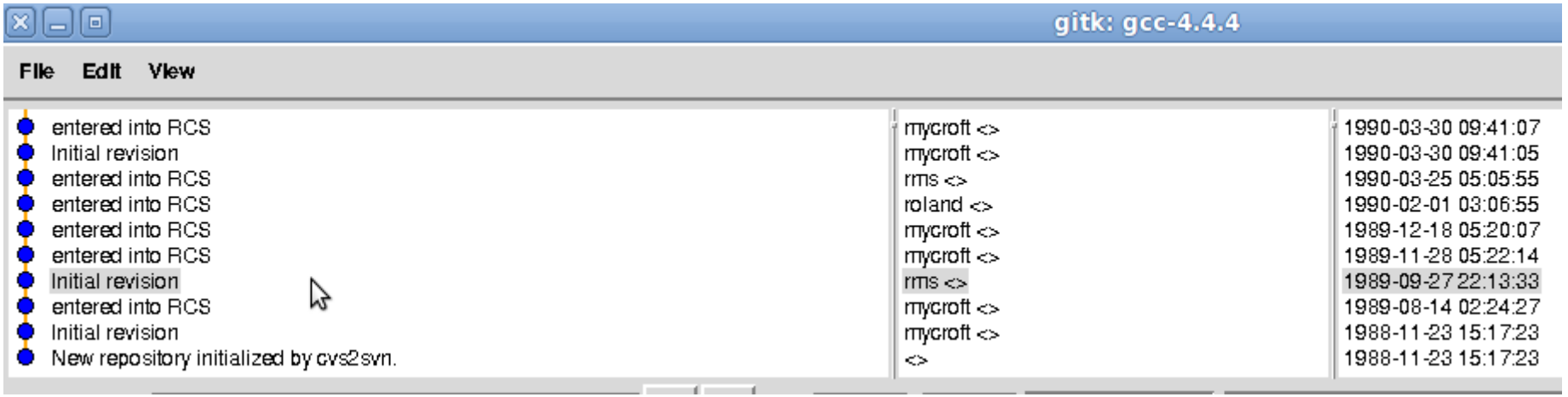
- 整理 Google 的修改

```
$ ls -lh gcc-4.4.3-google.patch

-rw-r--r-- 1 jserv jserv 3.0M 2010-08-1412:35 gcc-4.4.3-
google.patch


$ diffstat gcc-4.4.3-google.patch

...

 ltmain.sh                                          |    2

 ltoptions.m4                                       |   17

 zlib/configure                                     |   37

 332 files changed, 50766 insertions(+), 16126 deletions(-)
```



0xlab 整合了 Google 的修改到 Linaro 的 gcc-4.4 開發分支





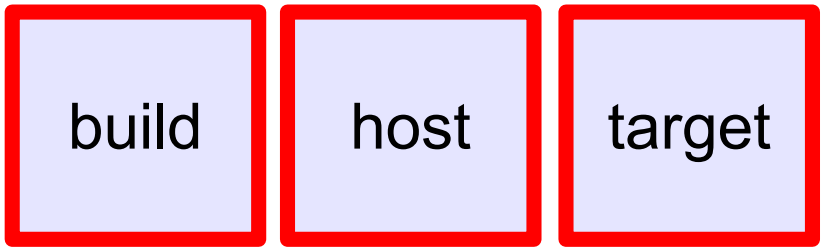
Android Toolchain 建構方式

```
$ mkdir android-toolchain && cd android-toolchain

$ repo init -u \
git://android.git.kernel.org/toolchain/manifest.git \
-b master

$ repo sync

$ cd build

$ ./build-sysroot <Android-Build-Product-
Directory> <sysroot-directory>

./configure –sysroot=<sysroot-directory> ...
```

也可更換成 0xlab Toolchain 的 manifest 路徑

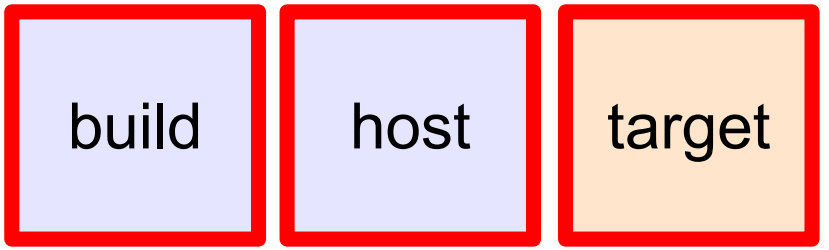
只要有經驗，就不需要讀文件，
反正也沒有這回事 :)

Building a toolchain



Native build

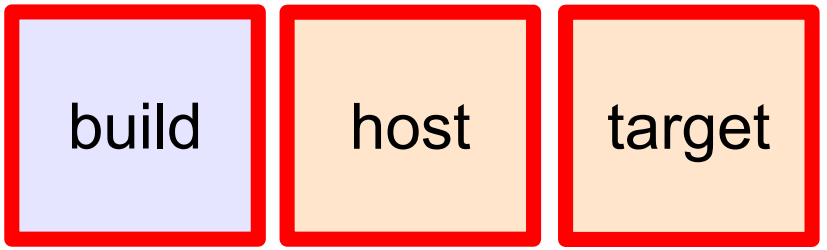
used to build the normal gcc of a workstation



Cross build

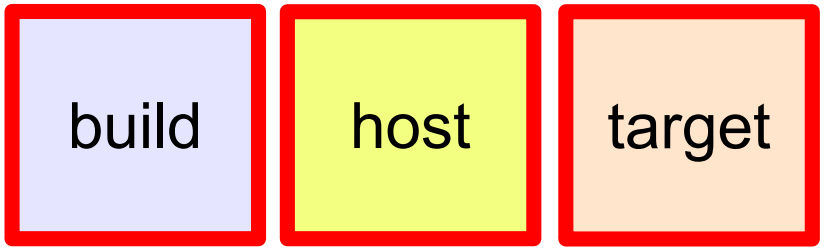
used to build a toolchain that runs on your workstation but generates binaries for the target

The most common solution in embedded



Cross-native build

used to build a toolchain that runs on your target and generates binaries for the target



Canadian build

used to build on architecture A a toolchain that runs on architecture B and generates binaries for architecture C

0xlab Toolchain

- 初步成果 : http://gitorious.org/android-toolchain

```
$ ./prebuilt/linux-x86/toolchain/arm-eabi-4.4.4/bin/arm-eabi-gcc -v

Using built-in specs.

Target: arm-eabi

...

--with-gcc-version=4.4.4 --with-binutils-version=2.19 --with-arch=armv5te --with-sysroot=/home/jserv/toolchain/sysroot --with-gmp-version=4.2.4 --with-mpfr-version=2.4.1 --with-gdb-version=7.1.x --with-multilib-list=mthumb-interwork,mandroid --program-transform-name='s&^&arm-eabi-&'

Thread model: single

gcc version 4.4.4 (0xlab)
```

- 測試環境: Qualcomm MSM7x25 (armv6), Beagleboard (armv7)

Android Toolchain Benchmark

- 內建的評測項目 : gcstone(Dalvik), skia, webkit

```
$ android-toolchain/benchmark/skia$ ../scripts/bench.py --help

Options:

   [ --action=build|build-fdo|clean|export|runcmd|getsize ]

   [ --mode=arm|thumb ]

   [ --toolchain= (toolchain path) ]

   [ --add_cflags= (additional flags for compilation) ]

   [ --add_ldflags= (additional flags for linking) ]

   [ --disable_cflags= (default cflags to remove) ]

   [ --android_branch=eclair|mainline|cupcake ]

   [ --build_target=lib|bench ]

   [ --mute=on|off ]

   [ --asm=on|off ]

   [ --makeopts= (override make options (default -j4 --warn-undefined_variables)) ]

   [ --serial= ("emulator" or device serial number) ]

   [ --help ]
```

bench.py 提供的重要 action:
build, build-fdo, runcmd

Android Toolchain Benchmark

- 參考執行輸出

```
android-toolchain/benchmark/skia$ ../scripts/bench.py --action=build --toolchain=/opt/android
make -j4 --warn-undefined-variables -f ../scripts/build/main.mk  TOOLCHAIN=/opt/android build
CPP ARM obj/src/core/Sk64.o <= src/src/core/Sk64.cpp
CPP ARM obj/src/core/SkAlphaRuns.o <= src/src/core/SkAlphaRuns.cpp
CPP ARM obj/src/core/SkBitmapProcShader.o <= src/src/core/SkBitmapProcShader.cpp
...
LINK STATIC: out/libskia.a
LINK out/SYMBOL/skia_bench
STRIP out/skia_bench
```

- 支援 FDO 的 Build-Execute-Build，不過缺少一個檔案 (尚未 open source)，所以不會真的動

0xlab Toolchain's Integrated Builder

0xlab Toolchain Builder

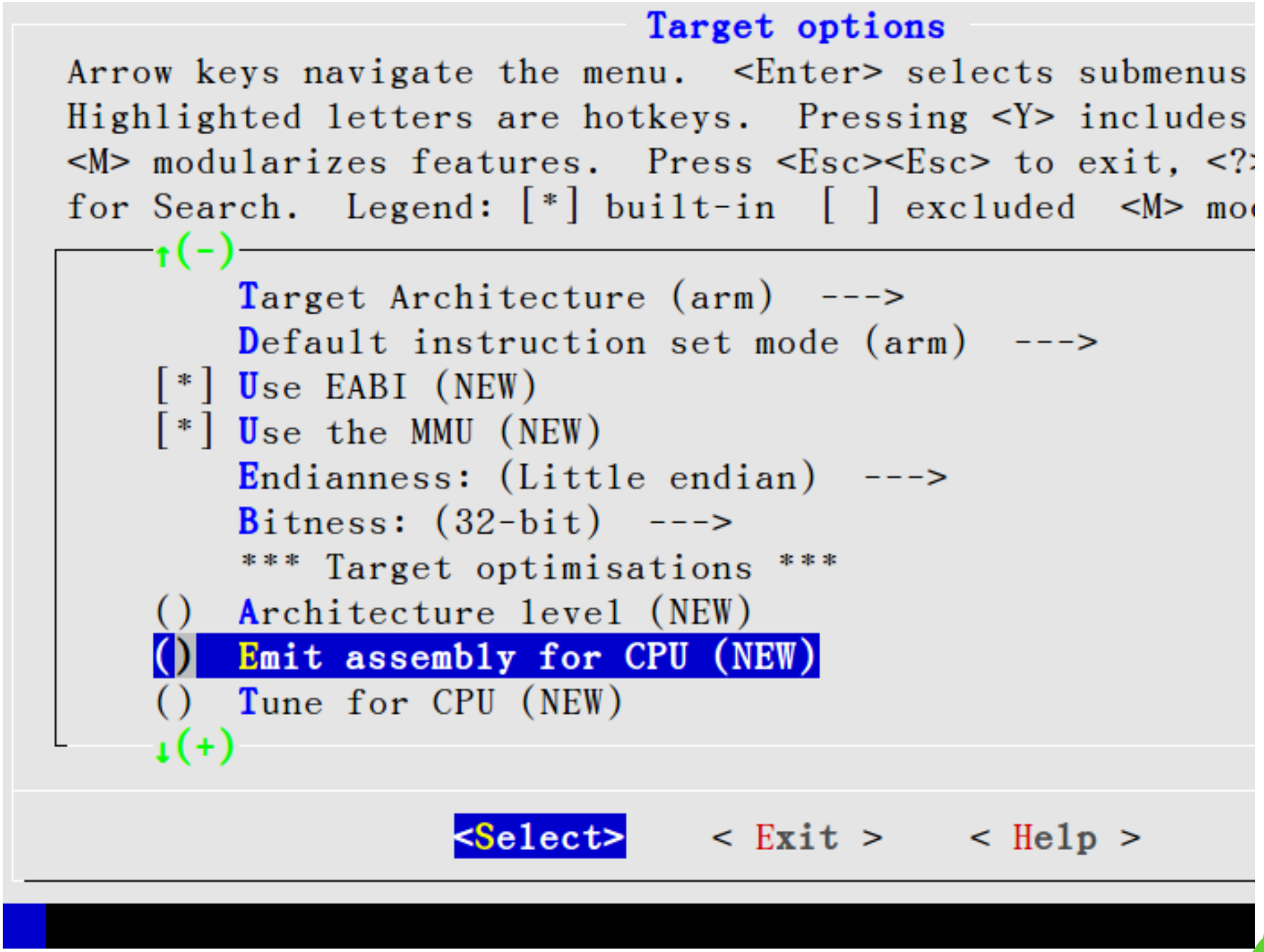
- 背景因素： target 正在從 arm-eabi → arm-linux-androideabi (伴隨一堆八卦？)

  CodeSourcery 重寫 Google Android 相關的系統描述

- 基於 crosstool-NG， 支援 bionic libc/header
- 「親手打造」
- 在若干 ARM 平台驗證過

  0xDroid

  0xBench


Target options
Arrow keys navigate the menu. <Enter> selects submenus
Highlighted letters are hotkeys. Pressing <Y> includes
<M> modularizes features. Press <Esc><Esc> to exit, <?
for Search. Legend: [*] built-in [ ] excluded <M> mo
↑(-)
Target Architecture (arm) --->
Default instruction set mode (arm) --->
[*] Use EABI (NEW)
[*] Use the MMU (NEW)
Endianness: (Little endian) --->
Bitness: (32-bit) --->
*** Target optimisations ***
() Architecture level (NEW)
() Emit assembly for CPU (NEW)
() Tune for CPU (NEW)
↓(+)
<Select> < Exit > < Help >

後記：「發表是最好的記憶」

心得

- 施比受有福，對 Android 更是如此
- 若不去提交 patch 、參與技術討論，根本就是霧裡看花
- 什麼都是假的，只有原始程式碼是真的

Code Review Dashboard for Jim Huang

	ID	Subject	Owner	Project	Branch	Updated	V	R
Started by Jim Huang								
▸ ☆	Iff6a0fea	[libpixelflinger] Introduced ARM NEON optimized scanline_t32cb16	Jim Huang	platform/system/core	master	Aug 9		+1
☆	I793fb014	init: Let console applications have a controlling tty	Jim Huang	platform/system/core	master	Aug 8		
☆	Ie6f8aa7f	elfcopy: support unordered .debug_info references to .debug_range	Jim Huang	platform/external/elfcopy	master	Aug 11		✓
☆	Icb9226d7	[zlib] Upgraded to version 1.2.4 (March 14, 2010)	Jim Huang	platform/external/zlib	master	Aug 9		-1
☆	I685fac4f	[zlib] Upgraded to version 1.2.5 (April 19, 2010)	Jim Huang	platform/external/zlib	master	Aug 9		-1
☆	I9b718a6a	libpng: use GCC visibility to reduce shared library size	Jim Huang	platform/external/libpng	master	Aug 8		
☆	I6763ce2b	bionic: Rename _ARM_HAVE_LDREX_STREX to __ARM_HAVE_LDREX_STREX for consistency	Jim Huang	platform/bionic	master	Aug 9		
☆	I03e8b9f9	libcutils: Reflect the naming change, __ARM_HAVE_LDREX_STREX, in bionic	Jim Huang	platform/system/core	master	Aug 9		
☆	Ic5b0bd1f	libpixelflinger: Move codeflinger test function to test-opengl-codegen	Jim Huang	platform/system/core	master	Aug 10		✓
☆	I0e26fa2c	libpixelflinger: ARMv6 specific objects are not used. Remove.	Jim Huang	platform/system/core	master	Aug 10		✓
☆	I23886623	pixelflinger: Fix function naming typo: gglBitBlti	Jim Huang	platform/system/core	master	Aug 10		✓
☆	I54cc03f1	bootanimation: Don't open non-existing bootanimation.zip	Jim Huang	platform/frameworks/base	master	Aug 10		✓
☆	I906ac53b	bionic: Add ARM optimized strcpy()	Jim Huang	platform/bionic	master	Aug 10		
☆	Ia0191dfa	openssl: Fix build fail with binutils-gold/indirect linking	Jim Huang	platform/external/openssl	master	Aug 12		
☆	I3a7dde79	gdb: Build static expat internally. Do not install expat	Jim Huang	toolchain/gdb	master	Aug 13		
Reviewable by Jim Huang								
	(None)							
Recently closed								
☆	I412d7e8f	Add 'distclean' rule to delete intermediate build files (MERGED)	Jim Huang	toolchain/build	master	Aug 13	✓	✓
☆	Ie0c5e7a2	binutils: Fix build error due to improper use of as fatal (ABANDONED)	Jim Huang	toolchain/binutils	master	Aug 11		✘

參考資訊

- GCC Wiki

  http://gcc.gnu.org/wiki

- Linaro

  http://www.linaro.org/

- Linaro Toolchain Work Group

  https://wiki.linaro.org/WorkingGroups/ToolChain

- CodeSourcery

  http://www.codesourcery.com/

- Android Toolchain maintained by 0xlab

  http://gitorious.org/android-toolchain

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15 August 2010

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