Bootstrapping the Debian and Ubuntu ARM64 Ports

Wookey

Linaro/ARM/Debian

18th January 2014

Who am I

- Free Software developer since 1990
- Unix sysadmin since 1996
- Arm Linux developer since 1999
- Debian developer since 2000
- Ubuntu development since 2010

Some things I had something to do with:
Survex, PsiLinux, ArmLinux book, Emdebian, bootfloppies, Therion, apt-cross, dpkg-cross, Debian cross-toolchains, OpenEmbedded, Netbook Project, LART, YAFFS, Balloonboard, xdeb, multiarch, sbuild, build profiles

- Currently an ARM secondee to Linaro

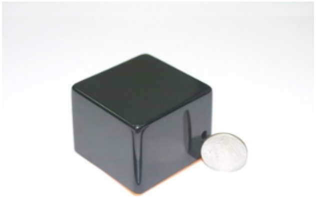
Outline

Outline

ARM desktops and servers

Acorn Risc PC (1994)

Rebel Netwinder (2000)


Solidrun Cubox (2012)

Dell/Calxeda server (2012)

ARM laptops

Psion Netbook Pro (2003)

Toshiba AC100 (2010)

Genesi Smartbook (2010)

Samsung Chromebook (2012)

Debian ports

Name	Bits	ABI	ISA	Released
arm	32	OABI	v3	2000:Potato (discontinued 2011)
armeb	32	OABI	v3	2006:unofficial big endian
armel	32	EABI	v4t/v5	2009:Lenny, Ubuntu 9.05
armhf	32	EABI	v7	2012:Wheezy, Ubuntu 12.04
arm64	64	v8	v8	2013:Jessie?, Ubuntu 13.10 (Saucy)

Nomenclature (architectures)

Simple version

arm64, aarch64, ARMv8 are all the same thing

More details:

arm64	Debian and Ubuntu architecture name
aarch64	ARM 64-bit execution mode
aarch64-linux-gnu	GNU triplet name
ARMv8	ARM CPU architecture name
A64	64-bit instruction set
A32	32-bit ARMv8 instruction set
aarch32	ARM 32-bit execution mode

Nomenclature (building)

`Build`	: Machine/architecture you are building on
`Host`	: Machine/architecture package is being built for
`Target`	: Machine/architecture a compiler generates code for

Bootstrapping

23 Debian ports in 21 years

i386, 68000, Alpha, Sparc, PowerPC, ARM, IA64, PA-RISC, MIPS (big endian), MIPS (little endian), S/390, AMD64, FreeBSD-i386, FreeBSD-amd64, armel, armhf, sh4, s390x, PowerPC64, Hurd-i386, x32, arm64, Mips64el

Bootstrapping

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Bootstrapping is normal, not exceptional
We bootstrap more often than we release
A 'Universal OS' should be able to bootstrap itself

Why arm64 matters

- arm64 is going to be a big deal
- arm64 will be fast
- arm64 will have plenty of RAM
- Good to get into Jessie
- Buildd hardware could be late - please fix filed bugs
- One machine could run arm64, armhf, and armel buildds

Outline

The Bootstrap Problem

- Build-dependency loops

The Bootstrap Problem

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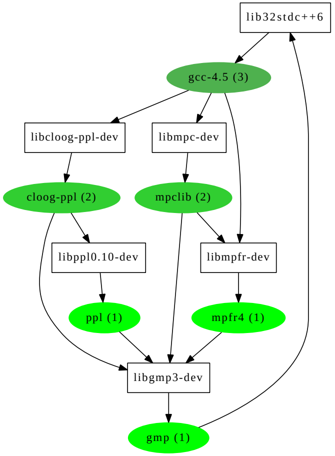

The Bootstrap Problem

- Build-dependency loops
- Natively built
- Maximally configured
- Much worse for binary distros than source-based
- Lack of flexibility in packaging, not upstream

Outline

Linaro

Bootstrap solutions

Traditionally

- Cheat and use something else
- Bodgery and Hackery
- No hardware yet - models are really slow

'Universal OS' solution

- Cross Build at least initial chroot
- Linearise build order by reducing dependencies
- Switch to native building when you have *'enough'*

Build Profiles

debian/control

1
```
Build-Depends:  debhelper,..., libsql-dev
Build-Depends-stage1:  debhelper,...
```
2
```
Build-Depends:  debhelper,..., libsql-dev <!stage1>
```
3
```
Build-Depends:  debhelper,..., libsql-dev [profile.!stage1]
```
4
```
Build-Depends:  debhelper,..., libsql-dev <!profile.stage1>
```

https://wiki.debian.org/BuildProfileSpec

debian/rules

```
ifneq (,$(filter stage1,$(DEB_BUILD_PROFILES)))
  # stage1 profile build
  DH_OPTIONS += -Nlibdb5.1-sql
  CONFIGURE_SWITCHES += --disable sql
else
  CONFIGURE_SWITCHES += --enable-sql
fi
```

Multiarch

- Install libraries side-by side: i386/amd64, arm/arm64, amd64/arm64
  - /usr/lib/libfoo (amd64)→/usr/lib/x86_64-linux-gnu/libfoo
  - /usr/lib/libfoo (armel)→/usr/lib/arm-linux-gnueabi/libfoo
  - /usr/lib/libfoo (arm64)→/usr/lib/aarch64-linux-gnu/libfoo
- Packages arch-qualified: libfoo:arm64, wine:i386
- Canonical file locations: Runtime is the same as build-time.
- Run foreign binaries in-place (natively or with qemu)
- 32/64 special casing goes away (/lib64, /emul/ia32-linux)
- Build/host version lockstep

Usage example

```
dpkg --add-architecture i386
apt-get install skype:i386
```

Multiarch dependencies

Packages are given an extra field Multi-Arch

- same *(libraries)*
  can be co-installed and can only satisfy deps within the arch
- foreign *(tools)*
  can not be co-installed can satisfy deps for any arch
- allowed *(both)*
  can be either. Depending packages specify which is wanted

dpkg has support for reference-counting of (doc-) files from co-installable packages that overlap

Modifed by

:any	treat M-A:allowed package as M-A:foreign (e.g. perl:any)
:native	install build-arch version (e.g. libnih-dbus-dev:native)

Cross-dependencies

Example: slang2

```
Build-Depends: debhelper (>= 9), autoconf, autotools-dev,
       chrpath, docbook-to-man, dpkg-dev (>= 1.16.1~),
       libncurses-dev,
       libpcre3-dev,
       libpng-dev,
       zlib1g-dev
```

- Build-arch: debhelper, autoconf, autotools-dev, chrpath, docbook-to-man, dpkg-dev
- Host-arch: libncurses-dev, libpcre3-dev, libpng-dev, zlib1g-dev

```
apt-get install debhelper autoconf autotools-dev chrpath docbook-to-man
dpkg-dev libncurses-dev:arm64 libpcre3-dev:arm64 libpng-dev:arm64
zlib1g-dev:arm64
```

Outline

ARM internal Bootstrap (2011)

- Ubuntu Maverick
- Using xdeb, with staging support
- Equivs to fake toolchain dependencies
- Manual build order
- LAMP stack built

So it's all done already?

ARM is an IP Company

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Now I can be rude about ARM legal

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- Paranoid about patent grants in FLOSS licences
- No cross-fixes, bootstrapping or arm64 support upstreamed
- Engineers annoyed

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Now I can be rude about ARM legal

- Paranoid about patent grants in FLOSS licences
- No cross-fixes, bootstrapping or arm64 support upstreamed
- Engineers annoyed
- All has to be done again

Valuable IP - avert your eyes:

```
+export DEB_BUILD_GNU_TYPE ?= $(shell dpkg-architecture -qDEB_BUILD_GNU_TYPE)
+
+ifeq ($(DEB_BUILD_GNU_TYPE), $(DEB_HOST_GNU_TYPE))
+  confflags += --build $(DEB_HOST_GNU_TYPE)
+  CROSS=""
+else
+  confflags += --build $(DEB_BUILD_GNU_TYPE) --host $(DEB_HOST_GNU_TYPE)
+  CROSS=$(DEB_HOST_GNU_TYPE)-
+endif
```

On the one hand great early community engagement

On the other complete failure to give back

Illustrates community/corporate culture clash
Linaro helps mitigate

Outline

Debian/Ubuntu Bootstrap Overview

Overview

- Initially Quantal, then Raring -based
  (and Debian Wheezy/Experimental)
- All done in public from start - upstreaming as we go along
- Multiarch building and cross-dependencies
- Profiles used but not upstreamable yet
- Standard tools: sbuild, reprepro, apt, dpkg, dpkg-cross
- Modified dpkg, apt, sbuild for build-profile support
- cross-build-essential: toolchain, libc:arm64, <triplet>-pkg-config
- No qemu available

Linaro

Debian/Ubuntu Bootstrap Process

1. Prepare repository
2. Add new arch support to dpkg-architecture
3. Set up build chroot
4. Toolchain bootstrap
5. Fix support packages: dpkg-cross, cross-build-essential, autoconf
6. Build stuff...

How much 'stuff' do we need?

Binary(source) packages needed

	Debian Sid src/binary	Ubuntu Saucy src/binary
Base system	65/116	75/128
+ `build-essential`	69/128	79/140
Sources including build-deps	119/503	
Main SCC	383/2500	

Set up a chroot

http://wiki.linaro.org/Platform/DevPlatform/CrossCompile/arm64bootstrap

Create chroot

```
apt-get install sbuild
sudo sbuild-createchroot
  --make-sbuild-tarball=/srv/chroots/raring-cross-arm64.tgz raring
  /srv/chroots/raring http://archive.ubuntu.com/ubuntu/
```

Build flags

```
STRIP CFLAGS -fstack-protector
```

Apt preferences

```
Package:  *
Pin:  release n=raring-bootstrap
Pin-Priority:  1001
```

Building Packages

Getting Build-Deps and building is simple

Manually

```
apt-get install crossbuild-essential-arm64
apt-get build-dep -aarm64 acl
apt-get source acl; cd acl-2.2.51
dpkg-buildpackage -aarm64
```

Better

```
CONFIG_SITE=/etc/dpkg-cross/cross-config.arm64
     DEB_BUILD_OPTIONS=nocheck dpkg-buildpackage -aarm64
```

Using sbuild

```
sbuild -c raring-bootstrap -d raring
  --host=arm64 acl_2.2.51
```

Profiled Package Build

Manually

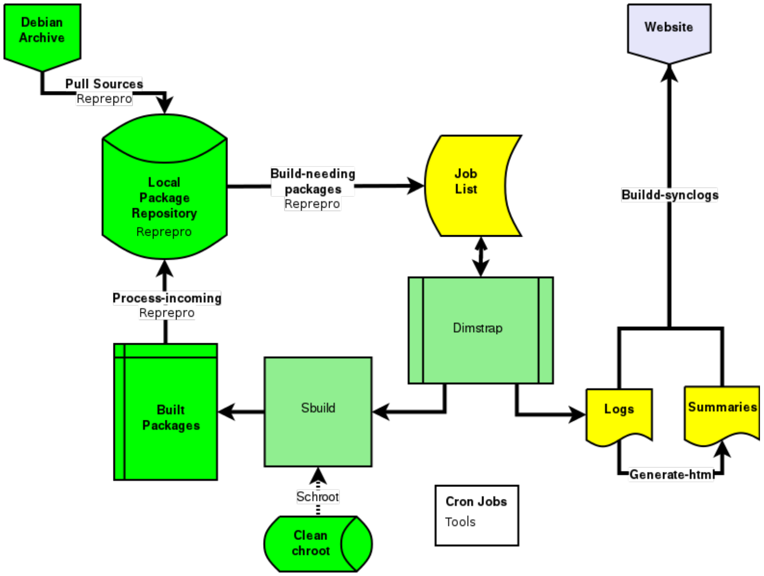
```
apt-get install crossbuild-essential-arm64
apt-get -o APT::Build-Profile=stage1 build-dep -aarm64 acl
apt-get source acl; cd acl-2.2.51
DEB_BUILD_PROFILES=stage1 dpkg-buildpackage -aarm64
```

Using sbuild

```
sbuild -c raring-bootstrap --profile=stage1 -d raring
  --host=arm64 acl_2.2.51
```

- update, build, sign, upload, process loop scripted with dimstrap

Cross Build Daemon



Dependency analysis

Dependency analysis

```
dose-debbuildcheck --deb-native-arch=amd64
--deb-foreign-archs=arm64 --deb-host-arch=arm64 <packages
files> <source file> -f -e -s --checkonly <package>
```

Output

```
      package: src:dpkg
      version: 1.16.7ubuntu3profile1
      architecture: any,all
      essential: false
      unsat-dependency: arm64:liblzma-dev
```

New tools

http://bootstrap.debian.net/

Daily analysis of 'bootstrapability'
Runs botch - 'Boot Ordering Tool'
Proposed to link this from the PTS: #728298

https://gitorious.org/debian-bootstrap/gsoc2013

Tool to automate bootstrapping
Uses pre-calculated botch ordering
Sets up repos, Builds from snapshot
Supports native and cross bootstrapping

Modified Packages/Build-deps

Build-deps skipped with profiles - 10 example packages

eglibc:	libselinux, libaudit
libselinux:	gem2deb, swig, python-all-dev
libsemanage:	gem2deb, swig, python-all-dev
cracklib2:	python-all-dev, python3-all-dev, python-setuptools, python3-setuptools
dbus:	libdbus-glib-1-dev, libglib2.0-dev, libsystemd-daemon-dev, libsystemd-login-dev, python, python-dbus, python-gobject
db:	gcj-native-helper, javahelper, default-jdk
glib2.0:	python-dbus, python-gi, dbus, dbus-x11
gnupg:	libldap2-dev
linux:	binutils-dev, libaudit-dev, libunwind8-dev, libnewt-dev, libelf0-dev, libdw-dev
udev:	libgirepository1.0-dev, gir1.2-glib-2.0

Ubuntu Bootstrap Timeline

Overview

- Start Oct 2012 (Quantal)
- December: moved to raring, dropped Debian
- Linaro doing upstream work in parallel, testing in OE with models
- Debootstrapable Feb 2013.
- Canonical continued from ˜June with secret hardware
- New box arrived 3 weeks before Saucy. 2/3rds built
- 'Soft' Saucy release

Outline

Debconf Activity

I had to do other stuff Feb to Oct...

- debian-ports space added at Debconf13:

  Machine is too full

  - Port instance appeared < 1 week later
- Embedded interpreters multiarch discussion
  `https://wiki.debian.org/HelmutGrohne/MultiarchSpecChanges`
  Multiarch perl in `git://anonscm.debian.org/perl/perl.git`

Debian Bootstrap

Method

- Native build Debian sources in Saucy chroot
- Nobble dpkg origin and lsb_release info
- Clean Saucy tarball chroot + debianise script
- All deps available - take care to only use debian libs
- Pin debian bootstrap repo as preferred
- debootstrap unstable once build-essential is done
- clean rebuild once SCC done and hardware available

No arm64 hardware

- 80-core, 128G Xeon box in Huawei lab - no root access
- Model very slow and annoying (X, network tap)
- qemu-arm64 released Nov 2013 - Way better!
- Linaro has hardware I can't use due to incompatible lawyers

Qemu-arm64

- Developed by SuSE
- Userspace only
- `https://github.com/susematz/qemu/tree/aarch64-1.6` qemu-arm64 branch
- `https://wiki.debian.org/Arm64Qemu`
- Package at `http://repo.linaro.org/`

Issues

Qemu

Undefined instructions - (tests)
Java doesn't install or run (threading)
cc1 has different magic

Debian Bootstrap Issues

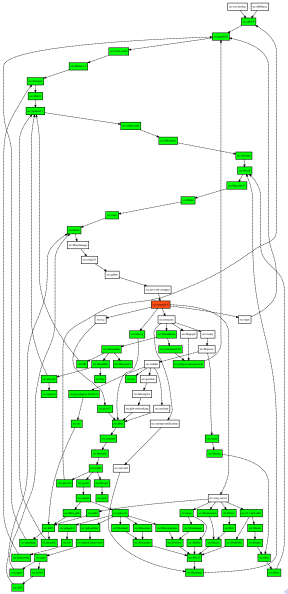
- Cyclic dependencies
  - pulseaudio→bluez→gst-base-plugins→libtheora→libsdl1.2→pulseaudio
  - cups→cups-filters→ cups
  - dbus→systemd→audit→dbus
- perl 5.18 vs 5.16
- extra /etc/lsb-release file
- debian/ubuntu verison skew
- config.(sub/guess)
- random FTBFS in unstable

Debian Bootstrap Status

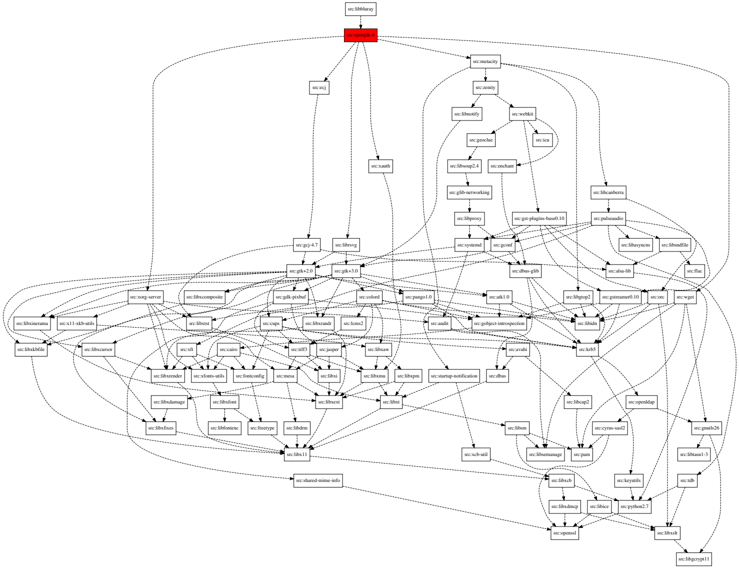
Status

- Arch all packages are easy
- gtk,cups,poppler,bluez,avahi,pulseaudio untangled
- qt4 built. CLA may be needed.
- sbuild,schroot,pybit so now self-hosting buildd
- 348 source Packages, 2109 binaries built
- 523 bugs filed
- Some things broken
  - transfig, graphviz, guile-1.8, apr, xorg-server
- Waiting for a buildd. . .

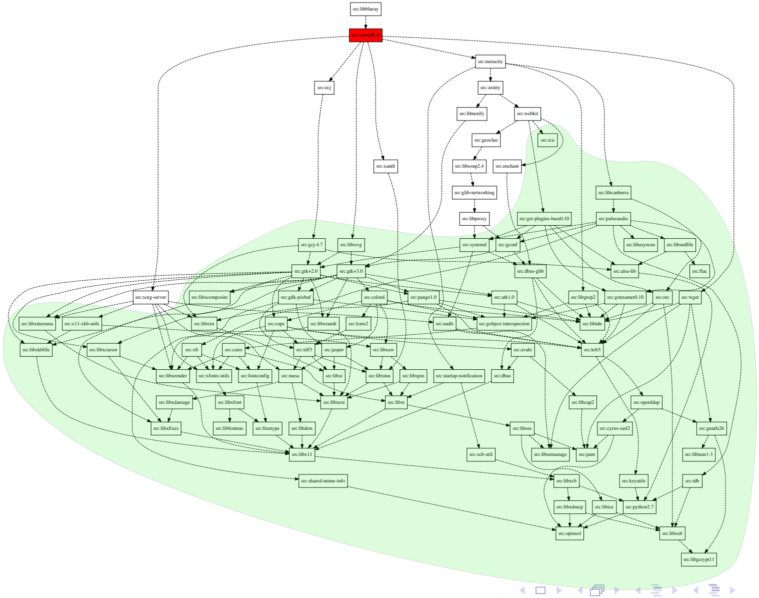
Openjdk build-dependencies



After botch - openjdk acyclic



Openjdk acyclic - built status



Getting involved

Help is welcome - much easier with qemu

Just trying arm64

- https://wiki.debian.org/Arm64Port#Pre-built_Rootfs

Resources

- http://wiki.debian.org/Arm64Port
- http://people.debian.org/~wookey/bootstrap.html

Thanks

To Linaro, ARM, Canonical for support of this work
To Debian for the huge playground

Wookey
`wookey@wookware.org`
`http://wookware.org`

`http://wiki.debian.org/Arm64Port`

Linaro