

The OpenWrt embedded development framework

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Summary I

Introduction

- What is OpenWrt
- Challenges

Design

- What is OpenWrt
- Getting OpenWrt
- uClibc buildroot heritage
- Key directories
- Packages and external repositories
- Packages feeds
- Toolchain

Summary II

Software architecture
System and package configuration

Developing with OpenWrt

Creating packages
Package source download
Creating kernel modules packages
Adding support for a new target
Using quilt
Building an external kernel tree

Deploying OpenWrt

Supported root filesystems

Summary III

The Image builder
The SDK

Becoming a developer

What is OpenWrt

- ▶ Minimalistic Busybox/Linux distribution GPL licensed
- ▶ Set of Makefiles and tools building an embedded rootfs
- ▶ Packages and repositories
- ▶ Hardware donators, package maintainers and kernel hackers community

Challenges

- ▶ Lots of different hardware platform can run Linux
- ▶ Lots of binary drivers
- ▶ Strong memory footprint constraints
- ▶ Hardware configuration and maintenance abstraction

What is OpenWrt

OpenWrt is a set of Makefiles and sources that :

- ▶ Builds the appropriate toolchain for your device
- ▶ Compiles the appropriate kernel w/ patches and options
- ▶ Provides software as IPKG packages
- ▶ Builds the optionnal tools to flash your device

Getting OpenWrt

- ▶ Subversion repository at <https://svn.openwrt.org/openwrt> and Trac interface
- ▶ **trunk/** directory for development branch
- ▶ **kamikaze** and **whiterussian** tags for stable versions
- ▶ **packages/** directory for non-kernel related packages

uClibc buildroot heritage

OpenWrt was created in late 2003, and used a modified uClibc buildroot :

- ▶ Needed to be hacked to have support for a package maintainer
- ▶ Lots of Makefile writting to add support for a software
- ▶ Could use more Makefile templating

Key directories

There are four key directories in the base:

- ▶ tools
- ▶ toolchain
- ▶ package
- ▶ target

Packages and external repositories

OpenWrt uses IPKG as the package format and manager.

- ▶ OpenWrt provides essential and kernel-related packages in **trunk/**
- ▶ Other packages are split into a different repository **packages/** which subsections
- ▶ Support for external repository can be done either in **/etc/ipkg.conf** or in the **feeds**

Packages feeds

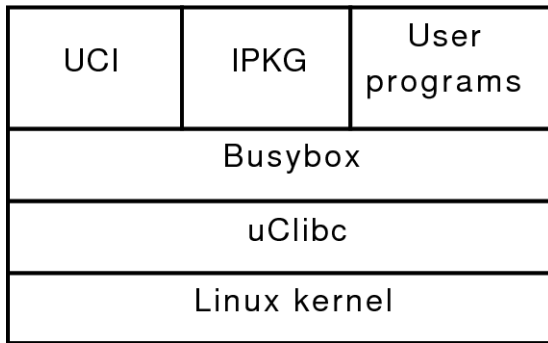
Package feeds allows you to provide your own set of packages :

- ▶ Source feeds can be fetched using svn
- ▶ They appear as packages while running make menuconfig
- ▶ User can choose to build them directly into the rootfs or as separate packages

Toolchain

- ▶ Switch between binutils, gcc, kernel-headers versions and uClibc tuples
- ▶ Change compiler CFLAGS to tune/optimize size and features
- ▶ Add custom patches to any of the above components

Software architecture



System and package configuration

OpenWrt uses UCI :

- ▶ Universal Configuration Interface
- ▶ MIB-like structure (**config.section.key=value**)
- ▶ Born from the lack of NVRAM on all supported hardware

UCI specificites

- ▶ C library, easy to link with
- ▶ program can interface with it to store their configuration
- ▶ Config to MIB bridges to easily manage devices using SNMP
- ▶ More configuration storage backends : LDAP, SQL
- ▶ Web interface with integrated UCI support

Add UCI configuration for your package

For instance adding a new configuration file is as simple as creating a new file in `/etc/config/package` which should contain the following lines:

```
config      <type> ["<name>"]      # Section
    option  <name> "<value>"      # Option
```

Creating packages

Typical package directory layout :

- ▶ `package/<name>/Makefile`
- ▶ `package/<name>/patches`
- ▶ `package/<name>/files`

Package source download

Support for different download methods :

- ▶ GIT
- ▶ Subversion
- ▶ CVS
- ▶ HTTP
- ▶ local source

Example

For instance, if you wish to checkout a particular revision of a package using Subversion, just define the following download method in your package Makefile

```
PKG_VER:=963
PKG_BRANCH:=batman-adv-userspace
PKG_VERSION:=r\$(PKG\_REV)
PKG_SOURCE_PROTO:=svn
PKG_SOURCE_URL:=http://downloads.open-mesh.net/svn/batman/
trunk/
```

Creating kernel modules packages

Extending the kernel/rootfs with modules is really easy within OpenWrt :

- ▶ Build-time update the kernel configuration based on your kernel modules selection
- ▶ External kernel modules are seen as packages, they use the KernelPackage instead

Adding support for a new target

Adding support for a new kernel is made easy :

- ▶ Create `target/linux/<my target>` directory
- ▶ Define the kernel version you want to use
- ▶ Add your additionnal patches in `target/linux/<my target>//patches`

Copying architecture files

You can also put your files in `target/linux/<my target>//files` :

- ▶ They will be copied at kernel build time
- ▶ They should match the kernel directory structure `arch/mips/kernel/*`
- ▶ You can directly version C files that are part of your drivers, architecture code ..
- ▶ Only need to generate patches against Kconfig and Makefiles

Using quilt

OpenWrt natively supports using quilt :

- ▶ Refresh, create and update patches for any component
- ▶ Test modifications with `make component/subcomponent/compile`
- ▶ Patches modifications are tracked with Subversion in your local copy

Building an external kernel tree

OpenWrt supports the building of an external kernel tree :

- ▶ Test a git kernel tree with your board code
- ▶ Use the OpenWrt toolchain to cross-compile for other architectures
- ▶ Test local modifications to a git subtree for later inclusion in mainline

Supported root filesystems

OpenWrt has currently support for :

- ▶ JFFS2, SquashFS, Ext2/3, CPIO, TGZ
- ▶ With LZMA, GZIP, BZIP2 compression (when applicable)
- ▶ Binary firmware generation tools (Broadcom, ZyXEL, Mikrotik ...)

The Image builder

- ▶ Deployment tools
- ▶ Contains compiled toolchain and kernel for your architecture
- ▶ Add custom files / IPKG packages to include in the rootfs

The SDK

- ▶ Contains the compiled toolchain
- ▶ Useful for packages upgrading and live testing
- ▶ Package maintainers tool

Becoming a developer

- ▶ Submit patches to the mainling-list
openwrt-devel@lists.openwrt.org
- ▶ Do as much test and bugreport as you can
- ▶ Port OpenWrt to a new device / architecture
- ▶ Write documentation

Promoting OpenWrt

- ▶ Ideal firmware for Wireless communities, Wireless ISPs ..
- ▶ Fastest embedded platform to port a new architecture on
- ▶ Abstracted network and Wireless configuration for all supported hardware

Thank you very much

Thank you very much for your attention, question session is now open.