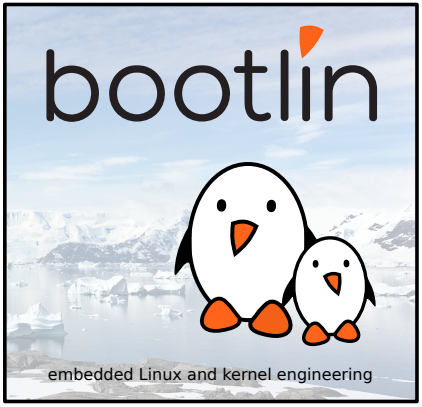
Introduction to Buildroot



Buildroot at a glance

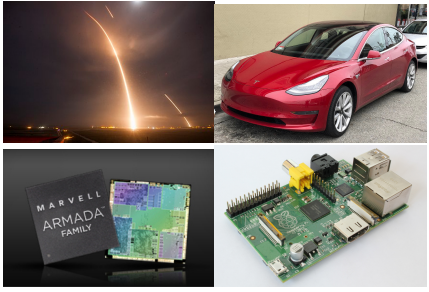
- Can build a toolchain, a rootfs, a kernel, a bootloader
- **Easy to configure**: menuconfig, xconfig, etc.
- **Fast**: builds a simple root filesystem in a few minutes
- Easy to understand: written in make, extensive documentation
- **Small** root filesystem, starting at 2 MB
- **2800+ packages** for user space libraries/apps available
- **Many architectures** supported
- **Well-known technologies**: *make* and *kconfig*
- Vendor neutral
- Active community, regular releases
  - The present slides cover *Buildroot 2022.02*. There may be some differences if you use older or newer Buildroot versions.
- https://buildroot.org

Buildroot design goals

- Buildroot is designed with a few key goals:
  - Simple to use
  - Simple to customize
  - Reproducible builds
  - Small root filesystem
  - Relatively fast boot
  - Easy to understand
- Some of these goals require to not necessarily support all possible features
- There are some more complicated and featureful build systems available (Yocto Project, OpenEmbedded)

Who's using Buildroot?

- **System makers**
  - SpaceX
  - Tesla
  - GoPro
  - Barco
  - Rockwell Collins
- **Processor vendors**
  - Marvell
  - Microchip
  - Rockchip
- **SoM and board vendors**
- Many companies when doing *R&D* on products
- Many, many **hobbyists** on development boards: Raspberry Pi, BeagleBone Black, etc.



Getting Buildroot

- Stable Buildroot releases are published every three months
  - `YYYY.02`, `YYYY.05`, `YYYY.08`, `YYYY.11`
- Tarballs are available for each stable release
  - `https://buildroot.org/downloads/`
- However, it is generally more convenient to clone the Git repository
  - Allows to clearly identify the changes you make to the Buildroot source code
  - Simplifies the upstreaming of the Buildroot changes
  - `git clone https://git.buildroot.net/buildroot`
  - Git tags available for every stable release.
- One **long term support** release published every year
  - Maintained during one year
  - Security fixes, bug fixes, build fixes
  - Current LTS is release is `2021.02`, maintained until March-April 2022, next one will be `2022.02`.

Using Buildroot

- Implemented in `make`
  - With a few helper shell scripts
- All interaction happens by calling `make` in the main Buildroot sources directory.

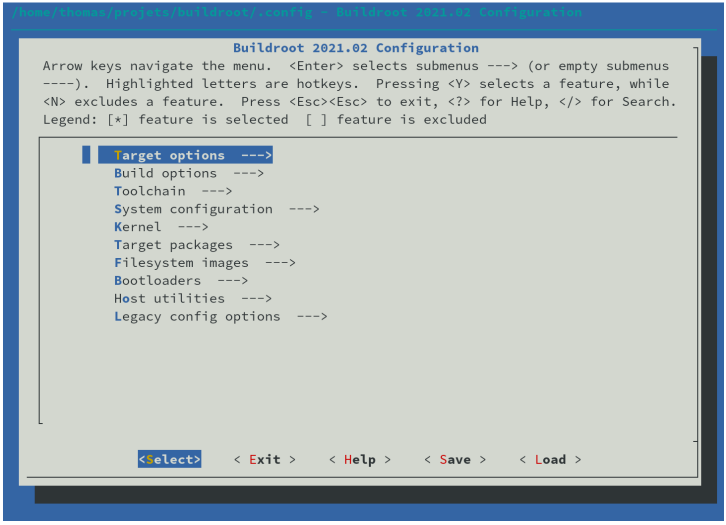
```
$ cd buildroot/
$ make help
```

- No need to run as `root`, Buildroot is designed to be executed with normal user privileges.
  - Running as root is even strongly discouraged!

Configuring Buildroot

- Like the Linux kernel, uses *Kconfig*
- A choice of configuration interfaces:
  - `make menuconfig`
  - `make nconfig`
  - `make xconfig`
  - `make gconfig`
- Make sure to install the relevant libraries in your system (*ncurses* for menuconfig/nconfig, *Qt* for xconfig, *Gtk* for gconfig)

Main menuconfig menu



Running the build

- As simple as:

```
$ make
```

- Often useful to keep a log of the build output, for analysis or investigation:

```
$ make 2>&1 | tee build.log
```

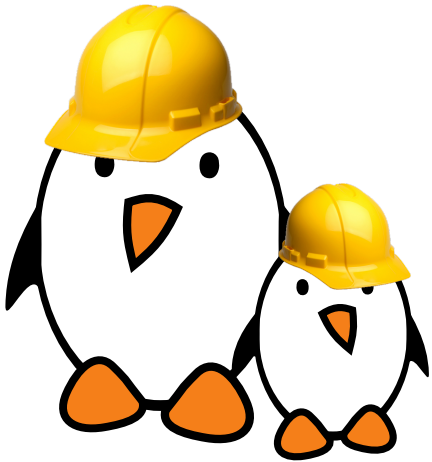
- Or the helper shell script provided by Buildroot:

```
$ ./utils/brmake
```

Build results

- The build results are located in `output/images`
- Depending on the configuration, this directory will contain:
  - One or several root filesystem images, in various formats
  - One kernel image, possibly one or several Device Tree blobs
  - One or several bootloader images
- There is no standard way to install the images on any given device
  - Those steps are very device specific
  - Buildroot provides some tools to generate SD card / USB key images (*genimage*) or directly to flash or boot specific platforms: SAM-BA for Microchip, imx-usb-loader for i.MX6, OpenOCD, etc.

Practical lab - Basic Buildroot usage



- Get Buildroot
- Configure a minimal system with Buildroot for the target hardware
- Do the build
- Prepare the target hardware for usage
- Flash and test the generated system