

LFS, a tool to build Linux From Scratch based images

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Contents

1	Overview	3
2	Design notes	4
3	Theory of operation	5
4	Software installation process	7

1 Overview

LFS is a customisable tool automating the creation of *LINUX from scratch* based disk images. The target system is described by 3 components:

- a *board* describes the target platform, the software version and their corresponding configuration file for this platform,
- a set of *software* and packages, as well as the method to retrieve, build and install them if required by the board configuration,
- an *environment* that is used to setup the target system according to its operating context.

LFS is currently implemented as a monolithic but configurable BASH script and runs on a LINUX host. A minimal configuration is required:

- the basic LINUX system tools,
- a decent version of BASH, supporting arrays,
- loop device support if file based image is used,
- SFDISK partition the disk device,
- WGET if tarball retrieval is needed,
- the TAR decompression tool.

2 Design notes

LFS has been designed and implemented with the following considerations in mind:

- the core engine source code must be easy to understand, so that the code is part of the documentation. The number of source files is limited, keeping LFS monolithic yet fully tunable,
- tuning must not require LFS source modification. Tuning is done by passing variables to and from scripts sourced or executed by the core. The exported and required variables must be well known, and all start with the *LFS_* prefix,
- common operations, such as adding a new software, must be simple and must require a minimal amount of effort,
- specific operations must be possible, for instance, installing a software in a special location. It requires the execution of a user written script. In this case, all the LFS context is exported to the script. *LFS_* variables and internal routines can be used, limiting the code redundancy.

3 Theory of operation

This section describes the sequencing done by LFS. The main LFS script is invoked using:

```
LFS_THIS_BOARD_NAME={comex , rpib} \  
LFS_THIS_ENV_NAME={esrf , home} \  
$LFS_TOP_DIR/sh/do_lfs.sh
```

LFS_TOP_DIR is set to the LFS topmost directory. First, LFS sources the default global configuration in:

```
$LFS_TOP_DIR/sh/do_default_globals.sh
```

The following variables are set to default values:

```
LFS_WORK_DIR: the working directory path  
LFS_TAR_DIR: the directory to retrieve tarballs  
LFS_SRC_DIR: the directory to extract tarballs  
LFS_TARGET_INSTALL_DIR: the target system rootfs mountpoint  
LFS_HOST_INSTALL_DIR: the directory used to install host softwares  
LFS_BUILD_DIR: the directory used to build softwares  
LFS_CROSS_COMPILE: the toolchain compilation prefix  
LFS_HOST_ARCH: the host architecture  
LFS_DISK_DEV: the disk image device path  
LFS_DISK_IMAGE: the disk image file path  
LFS_DISK_EMPTY_SIZE: the disk empty partition size , in MB  
LFS_DISK_BOOT_SIZE: the dist boot partition size , in MB  
LFS_DISK_ROOT_SIZE: the disk root partition size , in MB
```

Then, LFS sources user specific global configuration in:

```
$LFS_TOP_DIR/sh/do_user_globals.sh
```

This file may overrides one of the previous variable, and set user specific variables such as proxy network settings ...

Then, the board configuration is sourced in:

```
$LFS_TOP_DIR/board/$LFS_THIS_BOARD_NAME/do_conf.sh
```

It is used to set partition sizes and types:

LFS_DISK_EMPTY_SIZE: the size of the empty partition , in MB
LFS_DISK_BOOT_SIZE: the boot partition size , in MB
LFS_DISK_BOOT_FS_TYPE: the boot filesystem type , (vfat or ext2)
LFS_DISK_ROOT_SIZE: the root partition size , in MB
LFS_DISK_ROOT_FS_TYPE= the root filesystem type , (vfat or ext2)

A missing or zero sized partition will not be present in the image. Note that the partitions are created in this order: empty, boot, root.

The board configuration script should also set a correct toolchain and architecture for the target platform:

LFS_TARGET_ARCH: the architecture type
LFS_CROSS_COMPILE: the toolchain prefix

Finally, it is used to select the software versions. For instance:

```
export LFS_LINUX_VERS=3.6.11
export LFS_PCIUTILS_VERS=3.1.10
...
```

Then, the root filesystem is installed. Enabled softwares are retrieved, configured, built and installed. This process is detailed in the section *Software installation process*.

Then, the environment configuration is applied. To do so, the script:

```
$LFS_TOP_DIR/env/$LFS_THIS_ENV_NAME/do_post_rootfs.sh
```

is executed. This script handles tasks such as user creation, network setup ...

Then, the disk image is finalized and available at:

```
$LFS_DISK_IMAGE
```

It can be put into a physical disk, for instance using the LINUX *dd* command:

```
$> dd if=$LFS_DISK_IMAGE of=/dev/sdX
```

NOTE

After this command, the SDCARD must be removed and reinsert for the kernel to see the new partition layout. otherwise, trying to mount one of the /dev/sdX partition will probably fail.

4 Software installation process

The software installation process iterates over subdirectories in:

`$LFS_TOP_DIR/soft`

For each directory, LFS sources the file:

`do_conf.sh`

This file sets the following variables:

`LFS_THIS_SOFT_IS_ENABLED`: set to 1 if the software is to be installed
`LFS_THIS_SOFT_DEPS`: the space separated names of softwares that must be installed before the software can be installed itself
`LFS_THIS_SOFT_URL`: the url the software tarball can be retrieved at
`LFS_IS_CROSS_COMPILED`: set to 0 if the software is compiled for the host system

NOTE

`LFS_THIS_SOFT_DEPS` will be replaced by `LFS_THIS_SOFT_DEP[]`, an array containing containing a list of dependencies.

NOTE

`LFS_THIS_SOFT_URL` will be replaced by `LFS_THIS_SOFT_URL[]`, an array containing a list of possible urls.

If a given software is enabled, an url is given and the tarball does not already exist, the source tarball is retrieved from:

`$LFS_THIS_SOFT_URL`

The retrieved tarball is put in:

`$LFS_TAR_DIR`

The following schemes are supported:

- `file://`,
- `http://`,
- `https://`,
- `ftp://`,
- `git://` (not implemented),
- `svn://` (not implemented)

The following extensions are supported:

- *.tar*,
- *.tar.gz*,
- *.tgz*,
- *.tar.bz2*,
- *.xz* (not implemented)

Then, if the source does not already exist, the tarball is extracted in the directory:

`$LFS_SRC_DIR/$LFS_THIS_SOFT_NAME`

A build directory is created:

`$LFS_BUILD_DIR/$LFS_THIS_SOFT_NAME`

If the build directory already exist, the software installation process stops. Otherwise, the installation process is then divided into 3 stages:

- *pre_build*, the preparing stage,
- *build*, the build stage,
- *post_build*, the finalisation stage.

These stages can be configured by variables specified in the configuration file, or fully driven by dedicated scripts, as explained in the following sections. The reason to split the installation is to minimize the overall efforts required if a software specific operations must be performed at a particular stage. For instance, finalizing *dropbear* installation requires creating symbolic links manually, but preparing and building are automatically handled.

4.1 The *pre_build* stage

The *pre_build* stage does whatever is needed to prepare the install process. The variable:

`LFS_THIS_SOFT_PRE_BUILD_METHOD={autotools , kbuild }`

may be set to indicate a default method to use.

If *autoconf* is used, the usual sequence:

`./bootstrap (optional)`
`./configure`

is used to prepare the build process.

If *kbuild* is used, the file:

```
$LFS_TOP_DIR/board/$LFS_BOARD_NAME/$LFS_THIS_SOFT_NAME-$LFS_THIS_SOFT_VERSION.config
```

is copied (linux kernel, busybox, crosstool-ng ...) .

In both cases, the arrays:

```
LFS_THIS_SOFT_PRE_BUILD_ARG []  
LFS_THIS_SOFT_PRE_BUILD_ENV []
```

can be used to pass values to the preparing stage.

If the variable:

```
LFS_THIS_SOFT_PRE_BUILD_METHOD
```

is left empty, the script:

```
do_pre_build.sh
```

is executed if existing. Otherwise, nothing is done.

4.2 The build stage

The *build* stage mainly consists of compiling the sources. The variable:

```
LFS_THIS_SOFT_BUILD_METHOD={make}
```

may be set to indicate the compilation method. In this case, make is run and the arrays:

```
LFS_THIS_SOFT_BUILD_ARG []  
LFS_THIS_SOFT_BUILD_ENV []
```

can be used to pass values to the process.

If the variable:

```
LFS_THIS_SOFT_BUILD_METHOD
```

is empty, the script:

```
do_build.sh
```

is executed if existing. Otherwise, nothing is done.

4.3 The `post_build` stage

The *post_build* stage finalizes the installation procedure. It mostly consists of installing the binaries and configuration files. The variable:

```
LFS_THIS_SOFT_POST_BUILD_METHOD={make_install}
```

may be set to indicate the installation method, in which case `make install` is run. In this case, the arrays:

```
LFS_THIS_SOFT_POST_BUILD_ARG []  
LFS_THIS_SOFT_POST_BUILD_ENV []
```

can be used to pass values to the process.

If the variable:

```
LFS_THIS_SOFT_POST_BUILD_METHOD
```

is empty, the script:

```
do_post_build.sh
```

is executed if existing. Otherwise, nothing is done.