*******************DRAFT****************
Testing Docker image zipcpu:0.62
01/20/20
*******************DRAFT****************

The docker image starts with ubuntu:16.04. Adds several package needed to support Starting the docker image on Ubuntu 16.04 ws009. The Dockerfile found at Appendix A was The Dockerfile used to create the docker image. The file build.sh found at Append B was the command run to create the docker image zipcpu:0.62. Current packages installed is 609, the list of packages is found at Appendix C. The lines in the Dockerfile is what installs the dependencies to install zipcpu, verilator, autofpga, icestorm, nextpnr, and yosys.

*RUN apt-get update && apt-get -y install gawk wget git-core diffstat unzip texinfo gcc-multilib *
    *build-essential chrpath socat cpio python python3 python3-pip python3-pexpect *
    *xz-utils debianutils iputils-ping libsdl1.2-dev xterm tar locales *
    *bison flex autoconf automake libtool libgmp3-dev *
    *libmpfr-dev libmpfr-doc libmpfr4 libmpfr4-dbg libmpc-dev libelf-dev bc *
    *ncurses-dev ctags mercurial gperf *
    *clang libreadline-dev tcl-dev libffi-dev pkg-config libftdi-dev libboost-all-dev *
    cmake libeigen3-dev

The boot time is extremely quick.

On the host system user vidal is 1000 in group 1000.   This matched in the Dockerfile with the lines
 # The running container writes all the build artefacts to a host directory (outside the container).
 # The container can only write files to host directories, if it uses the same user ID and
 # group ID owning the host directories. The host_uid and group_uid are passed to the docker build
 # command with the --build-arg option. By default, they are both 1000. The docker image creates
 # a group with host_gid and a user with host_uid and adds the user to the group. The symbolic

 # name of the group and user is cuteradio.
ARG host_uid=1000
ARG host_gid=1000

Setup the enviorment to work on catzip.

```
File  Edit  Tabs  Help
vidal@ws009:~/docker-examples/zipcpu/src$ docker run -it --rm -v $PWD/yocto/outp
ut:/home/zipcpu/yocto/output zipcpu:0.62
zipcpu@a9221c1b52c6:/$ cd /home/zipcpu/yocto/output/catzip/
zipcpu@a9221c1b52c6:~/yocto/output/catzip$ . ./dockerenv.sh
/usr/local/share/zipcpu/sw/install/cross-tools/bin:/usr/local/sbin:/usr/local/bi
n:/usr/sbin:/usr/bin:/sbin:/bin
zipcpu@a9221c1b52c6:~/yocto/output/catzip$
```

Execute the autofpga program.

```
File  Edit  Tabs  Help
zipcpu@a9221c1b52c6:~/yocto/output/catzip/auto-data$ make
autofpga -d -o . global.txt bkram.txt buserr.txt clockpll40.txt pic.txt pwrcount
.txt version.txt hbconsole.txt gpio.txt dlyarbiter.txt zipbones.txt sdramdev.txt
 mem_sdram_bkram.txt sdramscope.txt
Opened autofpga.dbg
ADDING CLOCK: clk, i_clk, at 40000000 Hz
All clocks enumerated
ADDING BUS: wb (default)
Files toplevel.v and ../rtl/catzip/toplevel.v differ
Files main.v and ../rtl/catzip/main.v differ
Files regdefs.h and ../sw/host//regdefs.h differ
Files board.h and ../sw/board//board.h differ
Files board.ld and ../sw/board//board.ld differ
zipcpu@a9221c1b52c6:~/yocto/output/catzip/auto-data$
```

Create the catzip.bin using yosys, nexpnr, icepack and icetime.

```
zipcpu@a9221c1b52c6:~/yocto/output/catzip/rtl/catzip$ make
Building cpudefs.h
Building design.h
verilator -O3 -Mdir ./obj-pc -trace -cc -y cpu -y ../hexbus -y ../pport main.v
cd ./obj-pc; make -f Vmain.mk
make[1]: Entering directory '/home/zipcpu/yocto/output/catzip/rtl/catzip/obj-pc'
/usr/bin/perl /usr/local/share/verilator/bin/verilator_includer -DVL_INCLUDE_OPT
=include Vmain.cpp > Vmain__ALLcls.cpp
g++   -I.   -MMD -I/usr/local/share/verilator/include -I/usr/local/share/verilator
/include/vltstd -DVL_PRINTF=printf -DVM_COVERAGE=0 -DVM_SC=0 -DVM_TRACE=1 -Wno-s
ign-compare -Wno-uninitialized -Wno-unused-but-set-variable -Wno-unused-paramete
r -Wno-unused-variable -Wno-shadow       -c -o Vmain__ALLcls.o Vmain__ALLcls.cpp
/usr/bin/perl /usr/local/share/verilator/bin/verilator_includer -DVL_INCLUDE_OPT
=include Vmain__Dpi.cpp Vmain__Trace.cpp Vmain__Syms.cpp Vmain__Trace__Slow.cpp
> Vmain__ALLsup.cpp
g++   -I.   -MMD -I/usr/local/share/verilator/include -I/usr/local/share/verilator
/include/vltstd -DVL_PRINTF=printf -DVM_COVERAGE=0 -DVM_SC=0 -DVM_TRACE=1 -Wno-s
ign-compare -Wno-uninitialized -Wno-unused-but-set-variable -Wno-unused-paramete
r -Wno-unused-variable -Wno-shadow       -c -o Vmain__ALLsup.o Vmain__ALLsup.cpp
     Archiving Vmain__ALL.a ...
ar r Vmain__ALL.a Vmain__ALLcls.o Vmain__ALLsup.o
ar: creating Vmain__ALL.a
ranlib Vmain__ALL.a
make[1]: Leaving directory '/home/zipcpu/yocto/output/catzip/rtl/catzip/obj-pc'
yosys -ql simple.log -p synth_ice40 -blif catzip.blif -json catzip.json -top top
level ...
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:83.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:84.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:85.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:86.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:87.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:88.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:89.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:90.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:91.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:92.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:93.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:94.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:95.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:96.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:97.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:98.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:100.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:101.
Warning: wire '\w_gx_char' is assigned in a block at ../hexbus/hbgenhex.v:102.
```

When the catzip is created icetime checks the clock used passes.

```
File  Edit  Tabs  Help
Info: [ 17916,   18672) |*******************************+
Info: [ 18672,   19428) |*****************************+
Info: [ 19428,   20184) |*********************************+
Info: [ 20184,   20940) |***********************************************+
Info: [ 20940,   21696) |*********************************************+
Info: [ 21696,   22452) |*******************************************************
*+
Info: [ 22452,   23208) |*******************************************************
****
Info: [ 23208,   23964) |*********************************+
3 warnings, 0 errors
icepack catzip.asc catzip.bin
icetime -d hx8k -c 40 catzip.asc
// Reading input .asc file..
// Reading 8k chipdb file..
// Creating timing netlist..
// Timing estimate: 16.03 ns (62.39 MHz)
// Checking 25.00 ns (40.00 MHz) clock constraint: PASSED.
zipcpu@a9221c1b52c6:~/yocto/output/catzip/rtl/catzip$
```

Create the simulator using verilator.

```
File  Edit  Tabs  Help
e/verilator/include -I/usr/local/share/verilator/include/vltstd -DNEW_VERILATOR
-I../../rtl/catzip -I../../rtl/catzip/obj-pc/ -I/usr/local/share/verilator/inclu
de -I/usr/local/share/verilator/include/vltstd -c sdramsim.cpp -o obj-pc/sdramsi
m.o
g++ -I../../rtl/catzip -I../../rtl/catzip/obj-pc/ -I/usr/local/share/verilator/i
nclude -I/usr/local/share/verilator/include/vltstd obj-pc/verilated.o obj-pc/ver
ilated_vcd_c.o ../../rtl/catzip/obj-pc/Vmain__ALL.a obj-pc/automaster_tb.o obj-p
c/zipelf.o obj-pc/memsim.o obj-pc/byteswap.o obj-pc/pportsim.o obj-pc/sdramsim.o
 ../../rtl/catzip/obj-pc/Vmain__ALL.a -lelf -o pc-main_tb
zipcpu@a9221c1b52c6:~/yocto/output/catzip/sim/verilated$
```

Create the software to communicate with the simulator or FPGA.

```
File  Edit  Tabs  Help
zipcpu@a9221c1b52c6:~/yocto/output/catzip/sw/host$ make
```

The pc-files are the green ones needed to communicate with simulator or FPGA.

Creare the libcatzip.a

Create cputest, hello, and jpeg programs which execute on the simulator or FPGA.

Determing the ip of docker container.

```
File  Edit  Tabs  Help
vidal@ws009:~/docker-examples/zipcpu/src/yocto/output/catzip/sw/host$ ./pc-wbreg
s -p 8363 -n 172.17.0.3 version
00800010 ( VERSION) : [....] 20200116
vidal@ws009:~/docker-examples/zipcpu/src/yocto/output/catzip/sw/host$ ▌



roup default
    link/ether 02:42:ac:11:00:03 brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 172.17.0.3/16 brd 172.17.255.255 scope global eth0
       valid_lft forever preferred_lft forever
zipcpu@a9221c1b52c6:~/yocto/output/catzip/sim/verilated$ ▌
```

Start the simulator


```
File  Edit  Tabs  Help
zipcpu@a9221c1b52c6:~/yocto/output/catzip/sim/verilated$ ./pc-main_tb
Listening on port 8363
Listening on port 8364
> T
CMD: Only sent 0 bytes of 3!
▌
```

Check the build date.


```
File  Edit  Tabs  Help
vidal@ws009:~/docker-examples/zipcpu/src/yocto/output/catzip/sw/host$ ./pc-wbreg
s -p 8363 -n 172.17.0.3 version
00800010 ( VERSION) : [....] 20200116
vidal@ws009:~/docker-examples/zipcpu/src/yocto/output/catzip/sw/host$ ▌
```

The cputest program


```
File  Edit  Tabs  Help
vidal@ws009:~/docker-examples/zipcpu/src/yocto/output/catzip/sw/host$ ./cputest_
hello.sh ▌
```

Results of cputest

```
< A02000001W40f
> A02000001K00000000
POLL = 1
RCVD: 18 bytes
< A02000005W1000000
> A02000005K00000000
POLL = 1
RCVD: 11 bytes
< A02000001R
> A02000001R0000060f
POLL = 1
RCVD: 0 bytes
<  [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 12 bytes
< A02000001Wf
> A02000001K00000000
POLL = 1
RCVD: 0 bytes
<  [CLOSED]

Running CPU self-test
---------------------------------
SIM Instructions              Is this a simulator?
CIS Instructions              Supported
Break test #1                 Pass
Break test #2                 Pass
Break test #3                 Pass
Early Branch test             Pass
Trap test/AND                 Pass
Trap test/CLR                 Pass
Overflow test                 Pass
Carry test                    Pass
Loop test                     Pass
Shift test                    Pass
Pipeline test                 Pass
Mem-Pipeline test             Pass
Conditional Execution test    Pass
No-waiting pipeline test      Pass
Conditional Branching test    Pass
Ill Instruction test, NULL PC Pass
Ill Instruction test, two     Pass
Comparison test, ==           Pass
Comparison test, !=           Pass
CC Register test              Pass
Multi-Arg test                Pass
Multiply test                 Pass
```

```
File  Edit  Tabs  Help
RCVD: 11 bytes
< A02000005W
> A02000005K00000000
POLL = 1
RCVD: 14 bytes
< A02000001W41e
> A02000001K00000000
POLL = 1
RCVD: 11 bytes
< A02000005W
> A02000005K00000000
POLL = 1
RCVD: 14 bytes
< A02000001W41f
> A02000001K00000000
POLL = 1
RCVD: 11 bytes
< A02000005W
> A02000005K00000000
POLL = 1
RCVD: 14 bytes
< A02000001Wc00
> A02000001K00000000
POLL = 1
RCVD: 14 bytes
< A02000001W40f
> A02000001K00000000
POLL = 1
RCVD: 18 bytes
< A02000005W1000000
> A02000005K00000000
POLL = 1
RCVD: 11 bytes
< A02000001R
> A02000001R0000060f
POLL = 1
RCVD: 0 bytes
<   [CLOSED]
Accepted CMD connection
POLL = 1
RCVD: 12 bytes
< A02000001Wf
> A02000001K00000000
POLL = 1
RCVD: 0 bytes
<   [CLOSED]
Multiply HI-word test          Hello, World

zipcpu@a9221c1b52c6:~/yocto/output/catzip/sim/verilated$ 
```

zipcpu@a9221c1b52c6:~/yocto/output/catzip/rtl/catzip$ md5sum catzip.bin
a7e9e8c6687702feecbe4fbf7b918797 catzip.bin
zipcpu@a9221c1b52c6:~/yocto/output/catzip/rtl/catzip$ scp catzip.bin
devel@192.168.1.69:~/testbuilds/catzip/rtl/catzip/
The authenticity of host '192.168.1.69 (192.168.1.69)' can't be established.
ECDSA key fingerprint is
SHA256:Bbi9VZShq4oPPLO/2sdVWLqT9dfufvoWSumdyGevmZk.

Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '192.168.1.69' (ECDSA) to the list of known hosts.
devel@192.168.1.69's password:
catzip.bin   100% 132KB 131.9KB/s   00:00

devel@mypi3-16:~/testbuilds/catzip/rtl/catzip $ md5sum catzip.bin
a7e9e8c6687702feecbe4fbf7b918797 catzip.bin

Load the catzip.bin on catboard.

```
File  Edit  Tabs  Help
devel@mypi3-16:~/testbuilds/catzip/rtl/catzip $ sudo config_cat catzip.bin

GPIO 25 not exported, trying to export...
GPIO 17 not exported, trying to export...
GPIO 22 not exported, trying to export...

OK: SPI driver loaded

Setting GPIO directions
out
out
in
Setting output to low
0
Reseting FPGA
0
1
Checking DONE pin
0
Continuing with configuration procedure
263+1 records in
263+1 records out
135100 bytes (135 kB, 132 KiB) copied, 0.0180811 s, 7.5 MB/s
Setting output to high
1
Checking DONE pin
1
devel@mypi3-16:~/testbuilds/catzip/rtl/catzip $ 
```

```
File  Edit  Tabs  Help
devel@mypi3-16:~/testbuilds/catzip/sw/host $ ./arm-netpport
Listening on port 8363
Listening on port 8364

```

```
> A02000001K00000000
< A02000005W
> A02000005K00000000
< A02000001Wc00
> A02000001K00000000
< A02000001W40f
> A02000001K00000000
< A02000005W1000000
> A02000005
> K00000000
< A02000001R
> A02000001R0000060f
Command port disconnect
Command port is now connected
< A02000001Wf
> A02000001K00000000
Command port disconnect
.
. Running CPU self-test
. --------------------------------
. SIM Instructions              Pass
. CIS Instructions              Supported
. Break test #1                 Pass
. Break test #2                 Pass
. Break test #3                 Pass
. Early Branch test             Pass
. Trap test/AND                 Pass
. Trap test/CLR                 Pass
. Overflow test                 Pass
. Carry test                    Pass
. Loop test                     Pass
. Shift test                    Pass
. Pipeline test                 Pass
. Mem-Pipeline test             Pass
. Conditional Execution test    Pass
. No-waiting pipeline test      Pass
. Conditional Branching test    Pass
. Ill Instruction test, NULL PC Pass
. Ill Instruction test, two     Pass
. Comparison test, ==           Pass
. Comparison test, !=           Pass
. CC Register test              Pass
. Multi-Arg test                Pass
. Multiply test                 Pass
```

```
Section 0: 01000000 - 01003e94
Writing to MEM: 01000000-01003e94
Clearing the CPUs registers
Setting PC to 01000000
The CPU should be fully loaded, you may now
start it (from reset/reboot) with:
> wbregs cpu 0x0f

CPU Status is: 0000060f
02000000 (          )-> 0000000f
```

```
File  Edit  Tabs  Help
> A02000005K00000000
< A02000001W419
> A02000001K00000000
< A02000005W
> A02000005K00000000
< A02000001W41a
> A02000001K00000000
< A02000005W
> A02000005K00000000
< A02000001W41b
> A02000001K00000000
< A02000005W
> A02000005K00000000
< A02000001W41c
> A02000001K00000000
< A02000005W
> A02000005K00000000
< A02000001W41d
> A02000001K00000000
< A02000005W
> A02000005K00000000
< A02000001W41e
> A02000001K00000000
< A02000005W
> A02000005K00000000
< A02000001W41f
> A02000001K00000000
< A02000005W
> A02000005K00000000
< A02000001Wc00
> A02000001K00000000
< A02000001W40f
> A02000001K00000000
< A02000005W1000000
> A02000005
> K00000000
< A02000001R
> A02000001R0000060f
Command port disconnect
Command port is now connected
< A02000001Wf
> A02000001K00000000
Command port disconnect
. Hello, World!
```

Check the build date
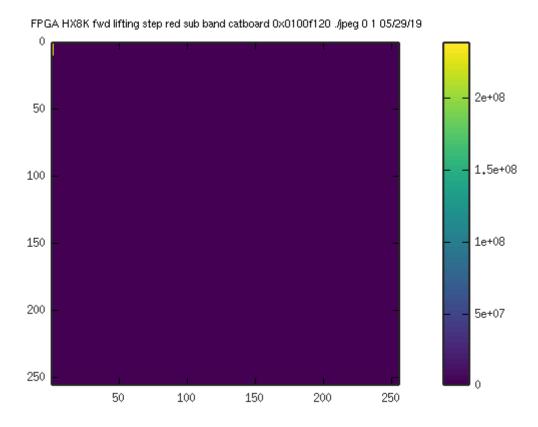
```
vidal@ws009:~/docker-examples/zipcpu/src/yocto/output/catzip/sw/host$ ./pc-wbreg
s -p 8363 -n mypi3-16 version
00800010 ( VERSION) : [....] 20200120
vidal@ws009:~/docker-examples/zipcpu/src/yocto/output/catzip/sw/host$
```
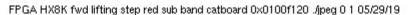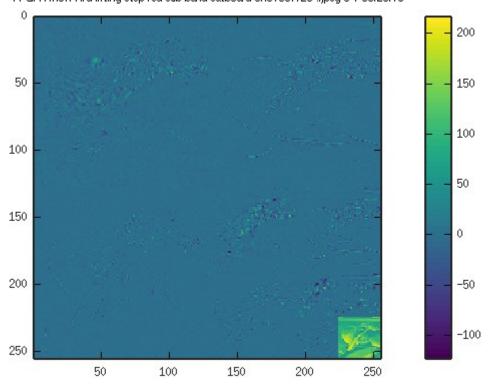
zipcpu ver 752bcc

FPGA HX8K fwd lifting step red sub band catboard 0x0100f120 ./jpeg 0 1 05/29/19

y2= 2.52058e+08

zipcpu ver 006f4c

FPGA HX8K fwd lifting step red sub band catboard 0x0100f120 ./jpeg 0 1 05/29/19

y2= 246.835

Appendix A: Dockerfile.

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In any directory on the docker host, perform the following actions:
* Copy this Dockerfile in the directory.
* Create input and output directories: mkdir -p yocto/output yocto/input
* Build the Docker image with the following command:
docker build --no-cache --build-arg "host_uid=$(id -u)" --build-arg "host_gid=$(id -g)" \
--tag "cuteradio-image:latest" .
* Run the Docker image, which in turn runs the Yocto and which produces the Linux rootfs,
with the following command:
docker run -it --rm -v $PWD/yocto/output:/home/zipcpu/yocto/output zipcpu:0.62

Use Ubuntu 16.04 LTS as the basis for the Docker image.
FROM ubuntu:16.04

Install all the Linux packages required for Yocto builds. Note that the packages python3,
tar, locales and cpio are not listed in the official Yocto documentation. The build, however,
without them.
RUN apt-get update && apt-get -y install gawk wget git-core diffstat unzip texinfo gcc-multilib \
    build-essential chrpath socat cpio python python3 python3-pip python3-pexpect \
    xz-utils debianutils iputils-ping libsdl1.2-dev xterm tar locales \
    bison flex autoconf automake libtool libgmp3-dev \
    libmpfr-dev libmpfr-doc libmpfr4 libmpfr4-dbg libmpc-dev libelf-dev bc \
    ncurses-dev ctags mercurial gperf \
    clang libreadline-dev tcl-dev libffi-dev pkg-config libftdi-dev libboost-all-dev \

```
    cmake libeigen3-dev
#The following packages are needed when creating zipcpu:06
#with docker-fpga-builder
#    clang libreadline-dev tcl-dev libffi-dev pkg-config libftdi-dev libboost-all-dev \
#    cmake libeigen3-dev



# By default, Ubuntu uses dash as an alias for sh. Dash does not support the source command
# needed for setting up the build environment in CMD. Use bash as an alias for sh.
RUN rm /bin/sh && ln -s bash /bin/sh

# Set the locale to en_US.UTF-8, because the Yocto build fails without any locale set.
RUN locale-gen en_US.UTF-8 && update-locale LC_ALL=en_US.UTF-8 LANG=en_US.UTF-8
ENV LANG en_US.UTF-8
ENV LC_ALL en_US.UTF-8

ENV USER_NAME zipcpu
ENV PROJECT zipcpu

# The running container writes all the build artefacts to a host directory (outside the container).
# The container can only write files to host directories, if it uses the same user ID and
# group ID owning the host directories. The host_uid and group_uid are passed to the docker build
# command with the --build-arg option. By default, they are both 1001. The docker image creates
# a group with host_gid and a user with host_uid and adds the user to the group. The symbolic
# name of the group and user is cuteradio.
ARG host_uid=1000
ARG host_gid=1000
RUN groupadd -g $host_gid $USER_NAME && useradd -g $host_gid -m -s /bin/bash -u $host_uid
$USER_NAME

# Perform the Yocto build as user cuteradio (not as root).
# NOTE: The USER command does not set the environment variable HOME.

RUN git clone https://github.com/develone/icestorm.git icestorm \
    && cd icestorm \
    && make -j$(nproc) \
    && make install \
    && cd .. && rm -rf icestorm

RUN git clone https://github.com/develone/nextpnr nextpnr \
    && cd nextpnr \
    && cmake -DARCH=ice40 -DBUILD_GUI=OFF -DCMAKE_INSTALL_PREFIX=/usr/local . \
    && make -j$(nproc) \
    && make install \
    && cd .. && rm -rf nextpnr

RUN git clone https://github.com/develone/yosys.git yosys \
    && cd yosys \
    && make -j$(nproc) \
    && make install \
    && cd .. && rm -rf yosys
```

```
#/using ver from mypi3-15
RUN git clone https://git.veripool.org/git/verilator \
    && cd verilator && git checkout v3.926 \
    && autoconf \
    && ./configure --prefix /usr/local \
    && make \
    && make install \
    && cd ../ \
    && rm -rf verilator

#/using ver from mypi3-15
RUN git clone https://github.com/develone/zipcpu.git \
    && cd zipcpu && git checkout  006f4c \
    && make \
    && tar -cvf /usr/local/share/zipcpu.tar ../zipcpu  \
    && cd /usr/local/share \
    && tar -xvf zipcpu.tar \
    && rm -f zipcpu.tar

RUN git clone https://github.com/develone/autofpga.git autofpga \
    && cd autofpga \
    && make \
    && cp sw/autofpga /usr/local/bin \
    && cd .. && rm -rf autofpga
# By default, docker runs as root. However, Yocto builds should not be run as root, but as a
# normal user. Hence, we switch to the newly created user cuteradio.
USER $USER_NAME

# Create the directory structure for the Yocto build in the container. The lowest two directory
# levels must be the same as on the host.
ENV BUILD_INPUT_DIR /home/$USER_NAME/yocto/input
ENV BUILD_OUTPUT_DIR /home/$USER_NAME/yocto/output
RUN mkdir -p $BUILD_INPUT_DIR $BUILD_OUTPUT_DIR
```

Appendix B: build.sh

```
#!/bin/bash
docker build -t="zipcpu:0.62" .
```

Appendix C: list of packages.

```
+++-======================================-
======================================-=============-
======================================================================
=========================
Desired=Unknown/Install/Remove/Purge/Hold
|/ Err?=(none)/Reinst-required (Status,Err: uppercase=bad)
ii  adduser                    3.113+nmu3ubuntu4          all       add and remove users and
groups
ii  apt                        1.2.32                     amd64     commandline package manager
```

ii	autoconf	2.69-9	all	automatic configure script builder
ii	automake	1:1.15-4ubuntu1	all	Tool for generating GNU Standards-compliant Makefiles
ii	autotools-dev	20150820.1	all	Update infrastructure for config.{guess,sub} files
ii	base-files	9.4ubuntu4.11	amd64	Debian base system miscellaneous files
ii	base-passwd	3.5.39	amd64	Debian base system master password and group files
ii	bash	4.3-14ubuntu1.4	amd64	GNU Bourne Again SHell
ii	bc	1.06.95-9build1	amd64	GNU bc arbitrary precision calculator language
ii	binfmt-support	2.1.6-1	amd64	Support for extra binary formats
ii	binutils	2.26.1-1ubuntu1~16.04.8	amd64	GNU assembler, linker and binary utilities
ii	bison	2:3.0.4.dfsg-1	amd64	YACC-compatible parser generator
ii	bsdutils	1:2.27.1-6ubuntu3.9	amd64	basic utilities from 4.4BSD-Lite
ii	build-essential	12.1ubuntu2	amd64	Informational list of build-essential packages
ii	bzip2	1.0.6-8ubuntu0.2	amd64	high-quality block-sorting file compressor - utilities
ii	ca-certificates	20170717~16.04.2	all	Common CA certificates
ii	chrpath	0.16-1	amd64	Tool to edit the rpath in ELF binaries
ii	clang	1:3.8-33ubuntu3.1	amd64	C, C++ and Objective-C compiler (LLVM based)
ii	clang-3.8	1:3.8-2ubuntu4	amd64	C, C++ and Objective-C compiler (LLVM based)
ii	cmake	3.5.1-1ubuntu3	amd64	cross-platform, open-source make system
ii	cmake-data	3.5.1-1ubuntu3	all	CMake data files (modules, templates and documentation)
ii	coreutils	8.25-2ubuntu3~16.04	amd64	GNU core utilities
ii	cpio	2.11+dfsg-5ubuntu1.1	amd64	GNU cpio -- a program to manage archives of files
ii	cpp	4:5.3.1-1ubuntu1	amd64	GNU C preprocessor (cpp)
ii	cpp-5	5.4.0-6ubuntu1~16.04.12	amd64	GNU C preprocessor
ii	dash	0.5.8-2.1ubuntu2	amd64	POSIX-compliant shell
ii	dbus	1.10.6-1ubuntu3.5	amd64	simple interprocess messaging system (daemon and utilities)
ii	debconf	1.5.58ubuntu2	all	Debian configuration management system
ii	debianutils	4.7	amd64	Miscellaneous utilities specific to Debian
ii	dh-python	2.20151103ubuntu1.2	all	Debian helper tools for packaging Python libraries and applications
ii	diffstat	1.61-1	amd64	produces graph of changes introduced by a diff file
ii	diffutils	1:3.3-3	amd64	File comparison utilities

ii dpkg   1.18.4ubuntu1.6   amd64   Debian package
management system
ii dpkg-dev   1.18.4ubuntu1.6   all   Debian package
development tools
ii e2fslibs:amd64   1.42.13-1ubuntu1.1   amd64   ext2/ext3/ext4 file
system libraries
ii e2fsprogs   1.42.13-1ubuntu1.1   amd64   ext2/ext3/ext4 file
system utilities
ii exuberant-ctags   1:5.9~svn20110310-11   amd64   build tag file
indexes of source code definitions
ii fakeroot   1.20.2-1ubuntu1   amd64   tool for simulating
superuser privileges
ii file   1:5.25-2ubuntu1.3   amd64   Determines file type using
"magic" numbers
ii findutils   4.6.0+git+20160126-2   amd64   utilities for finding
files--find, xargs
ii flex   2.6.0-11   amd64   fast lexical analyzer generator
ii fontconfig-config   2.11.94-0ubuntu1.1   all   generic font
configuration library - configuration
ii fonts-dejavu-core   2.35-1   all   Vera font family derivate with
additional characters
ii g++   4:5.3.1-1ubuntu1   amd64   GNU C++ compiler
ii g++-5   5.4.0-6ubuntu1~16.04.12   amd64   GNU C++ compiler
ii gawk   1:4.1.3+dfsg-0.1   amd64   GNU awk, a pattern
scanning and processing language
ii gcc   4:5.3.1-1ubuntu1   amd64   GNU C compiler
ii gcc-5   5.4.0-6ubuntu1~16.04.12   amd64   GNU C compiler
ii gcc-5-base:amd64   5.4.0-6ubuntu1~16.04.12   amd64   GCC, the GNU
Compiler Collection (base package)
ii gcc-5-multilib   5.4.0-6ubuntu1~16.04.12   amd64   GNU C compiler
(multilib support)
ii gcc-6-base:amd64   6.0.1-0ubuntu1   amd64   GCC, the GNU
Compiler Collection (base package)
ii gcc-multilib   4:5.3.1-1ubuntu1   amd64   GNU C compiler
(multilib files)
ii git   1:2.7.4-0ubuntu1.7   amd64   fast, scalable, distributed
revision control system
ii git-core   1:2.7.4-0ubuntu1.7   all   fast, scalable, distributed
revision control system (obsolete)
ii git-man   1:2.7.4-0ubuntu1.7   all   fast, scalable, distributed
revision control system (manual pages)
ii gnupg   1.4.20-1ubuntu3.3   amd64   GNU privacy guard - a
free PGP replacement
ii gperf   3.0.4-2   amd64   Perfect hash function generator
ii gpgv   1.4.20-1ubuntu3.3   amd64   GNU privacy guard -
signature verification tool
ii grep   2.25-1~16.04.1   amd64   GNU grep, egrep and fgrep
ii gzip   1.6-4ubuntu1   amd64   GNU compression utilities
ii hostname   3.16ubuntu2   amd64   utility to set/show the host
name or domain name
ii icu-devtools   55.1-7ubuntu0.4   amd64   Development utilities for
International Components for Unicode

ii	ifupdown	0.8.10ubuntu1.4	amd64	high level tools to configure network interfaces
ii	init	1.29ubuntu4	amd64	System-V-like init utilities - metapackage
ii	initscripts	2.88dsf-59.3ubuntu2	amd64	scripts for initializing and shutting down the system
ii	init-system-helpers	1.29ubuntu4	all	helper tools for all init systems
ii	insserv	1.14.0-5ubuntu3	amd64	boot sequence organizer using LSB init.d script dependency information
ii	iproute2	4.3.0-1ubuntu3.16.04.5	amd64	networking and traffic control tools
ii	iputils-ping	3:20121221-5ubuntu2	amd64	Tools to test the reachability of network hosts
ii	isc-dhcp-client	4.3.3-5ubuntu12.10	amd64	DHCP client for automatically obtaining an IP address
ii	isc-dhcp-common	4.3.3-5ubuntu12.10	amd64	common files used by all of the isc-dhcp packages
ii	javascript-common	11	all	Base support for JavaScript library packages
ii	krb5-locales	1.13.2+dfsg-5ubuntu2.1	all	Internationalization support for MIT Kerberos
ii	less	481-2.1ubuntu0.2	amd64	pager program similar to more
ii	lib32asan2	5.4.0-6ubuntu1~16.04.12	amd64	AddressSanitizer -- a fast memory error detector (32bit)
ii	lib32atomic1	5.4.0-6ubuntu1~16.04.12	amd64	support library providing __atomic built-in functions (32bit)
ii	lib32cilkrts5	5.4.0-6ubuntu1~16.04.12	amd64	Intel Cilk Plus language extensions (32bit)
ii	lib32gcc1	1:6.0.1-0ubuntu1	amd64	GCC support library (32 bit Version)
ii	lib32gcc-5-dev	5.4.0-6ubuntu1~16.04.12	amd64	GCC support library (32 bit development files)
ii	lib32gomp1	5.4.0-6ubuntu1~16.04.12	amd64	GCC OpenMP (GOMP) support library (32bit)
ii	lib32itm1	5.4.0-6ubuntu1~16.04.12	amd64	GNU Transactional Memory Library (32bit)
ii	lib32mpx0	5.4.0-6ubuntu1~16.04.12	amd64	Intel memory protection extensions (32bit)
ii	lib32quadmath0	5.4.0-6ubuntu1~16.04.12	amd64	GCC Quad-Precision Math Library (32bit)
ii	lib32stdc++6	5.4.0-6ubuntu1~16.04.12	amd64	GNU Standard C++ Library v3 (32 bit Version)
ii	lib32ubsan0	5.4.0-6ubuntu1~16.04.12	amd64	UBSan -- undefined behaviour sanitizer (32bit)
ii	libacl1:amd64	2.2.52-3	amd64	Access control list shared library
ii	libalgorithm-diff-perl	1.19.03-1	all	module to find differences between files
ii	libalgorithm-diff-xs-perl	0.04-4build1	amd64	module to find differences between files (XS accelerated)

ii libalgorithm-merge-perl   0.08-3   all   Perl module for three-way merge of textual data

ii libapparmor1:amd64   2.10.95-0ubuntu2.11   amd64   changehat AppArmor library

ii libapt-pkg5.0:amd64   1.2.32   amd64   package management runtime library

ii libarchive13:amd64   3.1.2-11ubuntu0.16.04.7   amd64   Multi-format archive and compression library (shared library)

ii libasan2:amd64   5.4.0-6ubuntu1~16.04.12   amd64   AddressSanitizer -- a fast memory error detector

ii libasn1-8-heimdal:amd64   1.7~git20150920+dfsg-4ubuntu1.16.04.1 amd64 Heimdal Kerberos - ASN.1 library

ii libasound2:amd64   1.1.0-0ubuntu1   amd64   shared library for ALSA applications

ii libasound2-data   1.1.0-0ubuntu1   all   Configuration files and profiles for ALSA drivers

ii libasound2-dev:amd64   1.1.0-0ubuntu1   amd64   shared library for ALSA applications -- development files

ii libasyncns0:amd64   0.8-5build1   amd64   Asynchronous name service query library

ii libatm1:amd64   1:2.5.1-1.5   amd64   shared library for ATM (Asynchronous Transfer Mode)

ii libatomic1:amd64   5.4.0-6ubuntu1~16.04.12   amd64   support library providing __atomic built-in functions

ii libattr1:amd64   1:2.4.47-2   amd64   Extended attribute shared library

ii libaudit1:amd64   1:2.4.5-1ubuntu2.1   amd64   Dynamic library for security auditing

ii libaudit-common   1:2.4.5-1ubuntu2.1   all   Dynamic library for security auditing - common files

ii libauthen-sasl-perl   2.1600-1   all   Authen::SASL - SASL Authentication framework

ii libbison-dev:amd64   2:3.0.4.dfsg-1   amd64   YACC-compatible parser generator - development library

ii libblkid1:amd64   2.27.1-6ubuntu3.9   amd64   block device ID library

ii libboost1.58-dev:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   Boost C++ Libraries development files

ii libboost1.58-tools-dev   1.58.0+dfsg-5ubuntu3.1   amd64   Boost C++ Libraries development tools

ii libboost-all-dev   1.58.0.1ubuntu1   amd64   Boost C++ Libraries development files (ALL) (default version)

ii libboost-atomic1.58.0:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   atomic data types, operations, and memory ordering constraints

ii libboost-atomic1.58-dev:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   atomic data types, operations, and memory ordering constraints

ii libboost-atomic-dev:amd64   1.58.0.1ubuntu1   amd64   atomic data types, operations, and memory ordering constraints (default version)

ii libboost-chrono1.58.0:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   C++ representation of time duration, time point, and clocks

ii libboost-chrono1.58-dev:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   C++ representation of time duration, time point, and clocks

ii libboost-chrono-dev:amd64 1.58.0.1ubuntu1 amd64 C++ representation of time duration, time point, and clocks (default version)
ii libboost-context1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 provides a sort of cooperative multitasking on a single thread
ii libboost-context1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 provides a sort of cooperative multitasking on a single thread
ii libboost-context-dev:amd64 1.58.0.1ubuntu1 amd64 provides a sort of cooperative multitasking on a single thread (default version)
ii libboost-coroutine1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 provides a sort of cooperative multitasking on a single thread
ii libboost-coroutine1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 provides a sort of cooperative multitasking on a single thread
ii libboost-coroutine-dev:amd64 1.58.0.1ubuntu1 amd64 provides a sort of cooperative multitasking on a single thread (default version)
ii libboost-date-time1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 set of date-time libraries based on generic programming concepts
ii libboost-date-time1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 set of date-time libraries based on generic programming concepts
ii libboost-date-time-dev:amd64 1.58.0.1ubuntu1 amd64 set of date-time libraries based on generic programming concepts (default version)
ii libboost-dev:amd64 1.58.0.1ubuntu1 amd64 Boost C++ Libraries development files (default version)
ii libboost-exception1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 library to help write exceptions and handlers
ii libboost-exception-dev:amd64 1.58.0.1ubuntu1 amd64 library to help write exceptions and handlers (default version)
ii libboost-filesystem1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 filesystem operations (portable paths, iteration over directories, etc) in C++
ii libboost-filesystem1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 filesystem operations (portable paths, iteration over directories, etc) in C++
ii libboost-filesystem-dev:amd64 1.58.0.1ubuntu1 amd64 filesystem operations (portable paths, iteration over directories, etc) in C++ (default version)
ii libboost-graph1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 generic graph components and algorithms in C++
ii libboost-graph1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 generic graph components and algorithms in C++
ii libboost-graph-dev:amd64 1.58.0.1ubuntu1 amd64 generic graph components and algorithms in C++ (default version)
ii libboost-graph-parallel1.58.0 1.58.0+dfsg-5ubuntu3.1 amd64 generic graph components and algorithms in C++
ii libboost-graph-parallel1.58-dev 1.58.0+dfsg-5ubuntu3.1 amd64 generic graph components and algorithms in C++
ii libboost-graph-parallel-dev 1.58.0.1ubuntu1 amd64 generic graph components and algorithms in C++ (default version)
ii libboost-iostreams1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 Boost.Iostreams Library
ii libboost-iostreams1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 Boost.Iostreams Library development files
ii libboost-iostreams-dev:amd64 1.58.0.1ubuntu1 amd64 Boost.Iostreams Library development files (default version)
ii libboost-locale1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 C++ facilities for localization

ii libboost-locale1.58-dev:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   C++ facilities
for localization
ii libboost-locale-dev:amd64   1.58.0.1ubuntu1   amd64   C++ facilities for
localization (default version)
ii libboost-log1.58.0   1.58.0+dfsg-5ubuntu3.1   amd64   C++ logging library
ii libboost-log1.58-dev   1.58.0+dfsg-5ubuntu3.1   amd64   C++ logging
library
ii libboost-log-dev   1.58.0.1ubuntu1   amd64   C++ logging library
(default version)
ii libboost-math1.58.0:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   Boost.Math
Library
ii libboost-math1.58-dev:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   Boost.Math
Library development files
ii libboost-math-dev:amd64   1.58.0.1ubuntu1   amd64   Boost.Math
Library development files (default version)
ii libboost-mpi1.58.0   1.58.0+dfsg-5ubuntu3.1   amd64   C++ interface to
the Message Passing Interface (MPI)
ii libboost-mpi1.58-dev   1.58.0+dfsg-5ubuntu3.1   amd64   C++ interface to
the Message Passing Interface (MPI)
ii libboost-mpi-dev   1.58.0.1ubuntu1   amd64   C++ interface to the
Message Passing Interface (MPI) (default version)
ii libboost-mpi-python1.58.0   1.58.0+dfsg-5ubuntu3.1   amd64   C++ interface
to the Message Passing Interface (MPI), Python Bindings
ii libboost-mpi-python1.58-dev   1.58.0+dfsg-5ubuntu3.1   amd64   C++ interface
to the Message Passing Interface (MPI), Python Bindings
ii libboost-mpi-python-dev   1.58.0.1ubuntu1   amd64   C++ interface to the
Message Passing Interface (MPI), Python Bindings (default version)
ii libboost-program-options1.58.0:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   program
options library for C++
ii libboost-program-options1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1   amd64   program
options library for C++
ii libboost-program-options-dev:amd64   1.58.0.1ubuntu1   amd64   program
options library for C++ (default version)
ii libboost-python1.58.0   1.58.0+dfsg-5ubuntu3.1   amd64   Boost.Python
Library
ii libboost-python1.58-dev   1.58.0+dfsg-5ubuntu3.1   amd64   Boost.Python
Library development files
ii libboost-python-dev   1.58.0.1ubuntu1   amd64   Boost.Python Library
development files (default version)
ii libboost-random1.58.0:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   Boost
Random Number Library
ii libboost-random1.58-dev:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   Boost
Random Number Library
ii libboost-random-dev:amd64   1.58.0.1ubuntu1   amd64   Boost Random
Number Library (default version)
ii libboost-regex1.58.0:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   regular
expression library for C++
ii libboost-regex1.58-dev:amd64   1.58.0+dfsg-5ubuntu3.1   amd64   regular
expression library for C++
ii libboost-regex-dev:amd64   1.58.0.1ubuntu1   amd64   regular expression
library for C++ (default version)

ii libboost-serialization1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 serialization library for C++
ii libboost-serialization1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 serialization library for C++
ii libboost-serialization-dev:amd64 1.58.0.1ubuntu1 amd64 serialization library for C++ (default version)
ii libboost-signals1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 managed signals and slots library for C++
ii libboost-signals1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 managed signals and slots library for C++
ii libboost-signals-dev:amd64 1.58.0.1ubuntu1 amd64 managed signals and slots library for C++ (default version)
ii libboost-system1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 Operating system (e.g. diagnostics support) library
ii libboost-system1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 Operating system (e.g. diagnostics support) library
ii libboost-system-dev:amd64 1.58.0.1ubuntu1 amd64 Operating system (e.g. diagnostics support) library (default version)
ii libboost-test1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 components for writing and executing test suites
ii libboost-test1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 components for writing and executing test suites
ii libboost-test-dev:amd64 1.58.0.1ubuntu1 amd64 components for writing and executing test suites (default version)
ii libboost-thread1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 portable C++ multi-threading
ii libboost-thread1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 portable C++ multi-threading
ii libboost-thread-dev:amd64 1.58.0.1ubuntu1 amd64 portable C++ multi-threading (default version)
ii libboost-timer1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 C++ wall clock and CPU process timers
ii libboost-timer1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 C++ wall clock and CPU process timers
ii libboost-timer-dev:amd64 1.58.0.1ubuntu1 amd64 C++ wall clock and CPU process timers (default version)
ii libboost-tools-dev 1.58.0.1ubuntu1 amd64 Boost C++ Libraries development tools (default version)
ii libboost-wave1.58.0:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 C99/C++ preprocessor library
ii libboost-wave1.58-dev:amd64 1.58.0+dfsg-5ubuntu3.1 amd64 C99/C++ preprocessor library
ii libboost-wave-dev:amd64 1.58.0.1ubuntu1 amd64 C99/C++ preprocessor library (default version)
ii libbsd0:amd64 0.8.2-1 amd64 utility functions from BSD systems - shared library
ii libbz2-1.0:amd64 1.0.6-8ubuntu0.2 amd64 high-quality block-sorting file compressor library - runtime
ii libc6:amd64 2.23-0ubuntu11 amd64 GNU C Library: Shared libraries
ii libc6-dev:amd64 2.23-0ubuntu11 amd64 GNU C Library: Development Libraries and Header Files

ii libc6-dev-i386   2.23-0ubuntu11   amd64   GNU C Library: 32-bit development libraries for AMD64
ii libc6-dev-x32   2.23-0ubuntu11   amd64   GNU C Library: X32 ABI Development Libraries for AMD64
ii libc6-i386   2.23-0ubuntu11   amd64   GNU C Library: 32-bit shared libraries for AMD64
ii libc6-x32   2.23-0ubuntu11   amd64   GNU C Library: X32 ABI Shared libraries for AMD64
ii libcaca0:amd64   0.99.beta19-2ubuntu0.16.04.1   amd64   colour ASCII art library
ii libcaca-dev   0.99.beta19-2ubuntu0.16.04.1   amd64   development files for libcaca
ii libcap2:amd64   1:2.24-12   amd64   POSIX 1003.1e capabilities (library)
ii libcap2-bin   1:2.24-12   amd64   POSIX 1003.1e capabilities (utilities)
ii libcap-ng0:amd64   0.7.7-1   amd64   An alternate POSIX capabilities library
ii libc-bin   2.23-0ubuntu11   amd64   GNU C Library: Binaries
ii libcc1-0:amd64   5.4.0-6ubuntu1~16.04.12   amd64   GCC cc1 plugin for GDB
ii libc-dev-bin   2.23-0ubuntu11   amd64   GNU C Library: Development binaries
ii libcilkrts5:amd64   5.4.0-6ubuntu1~16.04.12   amd64   Intel Cilk Plus language extensions (runtime)
ii libclang1-3.8:amd64   1:3.8-2ubuntu4   amd64   C interface to the clang library
ii libclang-common-3.8-dev   1:3.8-2ubuntu4   amd64   clang library - Common development package
ii libcomerr2:amd64   1.42.13-1ubuntu1.1   amd64   common error description library
ii libcryptsetup4:amd64   2:1.6.6-5ubuntu2.1   amd64   disk encryption support - shared library
ii libcurl3:amd64   7.47.0-1ubuntu2.14   amd64   easy-to-use client-side URL transfer library (OpenSSL flavour)
ii libcurl3-gnutls:amd64   7.47.0-1ubuntu2.14   amd64   easy-to-use client-side URL transfer library (GnuTLS flavour)
ii libdb5.3:amd64   5.3.28-11ubuntu0.2   amd64   Berkeley v5.3 Database Libraries [runtime]
ii libdbus-1-3:amd64   1.10.6-1ubuntu3.5   amd64   simple interprocess messaging system (library)
ii libdebconfclient0:amd64   0.198ubuntu1   amd64   Debian Configuration Management System (C-implementation library)
ii libdevmapper1.02.1:amd64   2:1.02.110-1ubuntu10   amd64   Linux Kernel Device Mapper userspace library
ii libdns-export162   1:9.10.3.dfsg.P4-8ubuntu1.15   amd64   Exported DNS Shared Library
ii libdpkg-perl   1.18.4ubuntu1.6   all   Dpkg perl modules
ii libdrm2:amd64   2.4.91-2~16.04.1   amd64   Userspace interface to kernel DRM services -- runtime
ii libdrm-amdgpu1:amd64   2.4.91-2~16.04.1   amd64   Userspace interface to amdgpu-specific kernel DRM services -- runtime

ii libdrm-common   2.4.91-2~16.04.1   all   Userspace interface to kernel DRM services -- common files

ii libdrm-dev:amd64   2.4.91-2~16.04.1   amd64   Userspace interface to kernel DRM services -- development files

ii libdrm-intel1:amd64   2.4.91-2~16.04.1   amd64   Userspace interface to intel-specific kernel DRM services -- runtime

ii libdrm-nouveau2:amd64   2.4.91-2~16.04.1   amd64   Userspace interface to nouveau-specific kernel DRM services -- runtime

ii libdrm-radeon1:amd64   2.4.91-2~16.04.1   amd64   Userspace interface to radeon-specific kernel DRM services -- runtime

ii libedit2:amd64   3.1-20150325-1ubuntu2   amd64   BSD editline and history libraries

ii libeigen3-dev   3.3~beta1-2   all   lightweight C++ template library for linear algebra

ii libelf1:amd64   0.165-3ubuntu1.2   amd64   library to read and write ELF files

ii libelf-dev:amd64   0.165-3ubuntu1.2   amd64   libelf1 development libraries and header files

ii libencode-locale-perl   1.05-1   all   utility to determine the locale encoding

ii liberror-perl   0.17-1.2   all   Perl module for error/exception handling in an OO-ish way

ii libexpat1:amd64   2.1.0-7ubuntu0.16.04.5   amd64   XML parsing C library - runtime library

ii libexpat1-dev:amd64   2.1.0-7ubuntu0.16.04.5   amd64   XML parsing C library - development kit

ii libfakeroot:amd64   1.20.2-1ubuntu1   amd64   tool for simulating superuser privileges - shared libraries

ii libfdisk1:amd64   2.27.1-6ubuntu3.9   amd64   fdisk partitioning library

ii libffi6:amd64   3.2.1-4   amd64   Foreign Function Interface library runtime

ii libffi-dev:amd64   3.2.1-4   amd64   Foreign Function Interface library (development files)

ii libfile-fcntllock-perl   0.22-3   amd64   Perl module for file locking with fcntl(2)

ii libfile-listing-perl   6.04-1   all   module to parse directory listings

ii libflac8:amd64   1.3.1-4   amd64   Free Lossless Audio Codec - runtime C library

ii libfl-dev:amd64   2.6.0-11   amd64   static library for flex (a fast lexical analyzer generator)

ii libfont-afm-perl   1.20-1   all   Font::AFM - Interface to Adobe Font Metrics files

ii libfontconfig1:amd64   2.11.94-0ubuntu1.1   amd64   generic font configuration library - runtime

ii libfontenc1:amd64   1:1.1.3-1   amd64   X11 font encoding library

ii libfreetype6:amd64   2.6.1-0.1ubuntu2.4   amd64   FreeType 2 font engine, shared library files

ii libftdi1:amd64   0.20-4build1   amd64   Library to control and program the FTDI USB controller

ii libftdi-dev   0.20-4build1   amd64   Development files for libftdi

ii libgcc1:amd64   1:6.0.1-0ubuntu1   amd64   GCC support library
ii libgcc-5-dev:amd64   5.4.0-6ubuntu1~16.04.12   amd64   GCC support
library (development files)
ii libgcrypt20:amd64   1.6.5-2ubuntu0.5   amd64   LGPL Crypto library
- runtime library
ii libgdbm3:amd64   1.8.3-13.1   amd64   GNU dbm database
routines (runtime version)
ii libgl1-mesa-dev:amd64   18.0.5-0ubuntu0~16.04.1   amd64   free
implementation of the OpenGL API -- GLX development files
ii libgl1-mesa-dri:amd64   18.0.5-0ubuntu0~16.04.1   amd64   free
implementation of the OpenGL API -- DRI modules
ii libgl1-mesa-glx:amd64   18.0.5-0ubuntu0~16.04.1   amd64   free
implementation of the OpenGL API -- GLX runtime
ii libglapi-mesa:amd64   18.0.5-0ubuntu0~16.04.1   amd64   free
implementation of the GL API -- shared library
ii libglib2.0-0:amd64   2.48.2-0ubuntu4.4   amd64   GLib library of C
routines
ii libglib2.0-bin   2.48.2-0ubuntu4.4   amd64   Programs for the GLib
library
ii libglib2.0-data   2.48.2-0ubuntu4.4   all   Common files for GLib
library
ii libglib2.0-dev   2.48.2-0ubuntu4.4   amd64   Development files for
the GLib library
ii libglu1-mesa:amd64   9.0.0-2.1   amd64   Mesa OpenGL utility
library (GLU)
ii libglu1-mesa-dev:amd64   9.0.0-2.1   amd64   Mesa OpenGL utility
library -- development files
ii libgmp10:amd64   2:6.1.0+dfsg-2   amd64   Multiprecision
arithmetic library
ii libgmp3-dev   2:6.1.0+dfsg-2   amd64   Multiprecision arithmetic
library developers tools
ii libgmp-dev:amd64   2:6.1.0+dfsg-2   amd64   Multiprecision
arithmetic library developers tools
ii libgmpxx4ldbl:amd64   2:6.1.0+dfsg-2   amd64   Multiprecision
arithmetic library (C++ bindings)
ii libgnutls30:amd64   3.4.10-4ubuntu1.6   amd64   GNU TLS library -
main runtime library
ii libgnutls-openssl27:amd64   3.4.10-4ubuntu1.6   amd64   GNU TLS library
- OpenSSL wrapper
ii libgomp1:amd64   5.4.0-6ubuntu1~16.04.12   amd64   GCC OpenMP
(GOMP) support library
ii libgpg-error0:amd64   1.21-2ubuntu1   amd64   library for common
error values and messages in GnuPG components
ii libgssapi3-heimdal:amd64   1.7~git20150920+dfsg-4ubuntu1.16.04.1 amd64
Heimdal Kerberos - GSSAPI support library
ii libgssapi-krb5-2:amd64   1.13.2+dfsg-5ubuntu2.1   amd64   MIT Kerberos
runtime libraries - krb5 GSS-API Mechanism
ii libhcrypto4-heimdal:amd64   1.7~git20150920+dfsg-4ubuntu1.16.04.1 amd64
Heimdal Kerberos - crypto library
ii libheimbase1-heimdal:amd64   1.7~git20150920+dfsg-4ubuntu1.16.04.1 amd64
Heimdal Kerberos - Base library

ii	libheimntlm0-heimdal:amd64	1.7~git20150920+dfsg-4ubuntu1.16.04.1	amd64	Heimdal Kerberos - NTLM support library
ii	libhogweed4:amd64	3.2-1ubuntu0.16.04.1	amd64	low level cryptographic library (public-key cryptos)
ii	libhtml-format-perl	2.11-2	all	module for transforming HTML into various formats
ii	libhtml-form-perl	6.03-1	all	module that represents an HTML form element
ii	libhtml-parser-perl	3.72-1	amd64	collection of modules that parse HTML text documents
ii	libhtml-tagset-perl	3.20-2	all	Data tables pertaining to HTML
ii	libhtml-tree-perl	5.03-2	all	Perl module to represent and create HTML syntax trees
ii	libhttp-cookies-perl	6.01-1	all	HTTP cookie jars
ii	libhttp-daemon-perl	6.01-1	all	simple http server class
ii	libhttp-date-perl	6.02-1	all	module of date conversion routines
ii	libhttp-message-perl	6.11-1	all	perl interface to HTTP style messages
ii	libhttp-negotiate-perl	6.00-2	all	implementation of content negotiation
ii	libhwloc5:amd64	1.11.2-3	amd64	Hierarchical view of the machine - shared libs
ii	libhwloc-dev:amd64	1.11.2-3	amd64	Hierarchical view of the machine - static libs and headers
ii	libhwloc-plugins	1.11.2-3	amd64	Hierarchical view of the machine - plugins
ii	libhx509-5-heimdal:amd64	1.7~git20150920+dfsg-4ubuntu1.16.04.1	amd64	Heimdal Kerberos - X509 support library
ii	libibverbs1	1.1.8-1.1ubuntu2	amd64	Library for direct userspace use of RDMA (InfiniBand/iWARP)
ii	libibverbs-dev	1.1.8-1.1ubuntu2	amd64	Development files for the libibverbs library
ii	libice6:amd64	2:1.0.9-1	amd64	X11 Inter-Client Exchange library
ii	libicu55:amd64	55.1-7ubuntu0.4	amd64	International Components for Unicode
ii	libicu-dev:amd64	55.1-7ubuntu0.4	amd64	Development files for International Components for Unicode
ii	libidn11:amd64	1.32-3ubuntu1.2	amd64	GNU Libidn library, implementation of IETF IDN specifications
ii	libio-html-perl	1.001-1	all	open an HTML file with automatic charset detection
ii	libio-socket-ssl-perl	2.024-1	all	Perl module implementing object oriented interface to SSL sockets
ii	libisc-export160	1:9.10.3.dfsg.P4-8ubuntu1.15	amd64	Exported ISC Shared Library
ii	libisl15:amd64	0.16.1-1	amd64	manipulating sets and relations of integer points bounded by linear constraints
ii	libitm1:amd64	5.4.0-6ubuntu1~16.04.12	amd64	GNU Transactional Memory Library

ii libjs-excanvas   0.r3-4   all   HTML5 Canvas for Internet
Explorer
ii libjson-c2:amd64   0.11-4ubuntu2   amd64   JSON manipulation
library - shared library
ii libjsoncpp1:amd64   1.7.2-1   amd64   library for reading and
writing JSON for C++
ii libk5crypto3:amd64   1.13.2+dfsg-5ubuntu2.1   amd64   MIT Kerberos
runtime libraries - Crypto Library
ii libkeyutils1:amd64   1.5.9-8ubuntu1   amd64   Linux Key
Management Utilities (library)
ii libkmod2:amd64   22-1ubuntu5.2   amd64   libkmod shared library
ii libkrb5-26-heimdal:amd64   1.7~git20150920+dfsg-4ubuntu1.16.04.1 amd64
Heimdal Kerberos - libraries
ii libkrb5-3:amd64   1.13.2+dfsg-5ubuntu2.1   amd64   MIT Kerberos
runtime libraries
ii libkrb5support0:amd64   1.13.2+dfsg-5ubuntu2.1   amd64   MIT Kerberos
runtime libraries - Support library
ii libldap-2.4-2:amd64   2.4.42+dfsg-2ubuntu3.7   amd64   OpenLDAP
libraries
ii libllvm3.8:amd64   1:3.8-2ubuntu4   amd64   Modular compiler and
toolchain technologies, runtime library
ii libllvm6.0:amd64   1:6.0-1ubuntu2~16.04.1   amd64   Modular compiler
and toolchain technologies, runtime library
ii liblsan0:amd64   5.4.0-6ubuntu1~16.04.12   amd64   LeakSanitizer -- a
memory leak detector (runtime)
ii libltdl7:amd64   2.4.6-0.1   amd64   System independent dlopen
wrapper for GNU libtool
ii libltdl-dev:amd64   2.4.6-0.1   amd64   System independent
dlopen wrapper for GNU libtool
ii liblwp-mediatypes-perl   6.02-1   all   module to guess media type
for a file or a URL
ii liblwp-protocol-https-perl   6.06-2   all   HTTPS driver for
LWP::UserAgent
ii liblz4-1:amd64   0.0~r131-2ubuntu2   amd64   Fast LZ compression
algorithm library - runtime
ii liblzma5:amd64   5.1.1alpha+20120614-2ubuntu2   amd64   XZ-format
compression library
ii liblzo2-2:amd64   2.08-1.2   amd64   data compression library
ii libmagic1:amd64   1:5.25-2ubuntu1.3   amd64   File type
determination library using "magic" numbers
ii libmailtools-perl   2.13-1   all   Manipulate email in perl
programs
ii libmnl0:amd64   1.0.3-5   amd64   minimalistic Netlink
communication library
ii libmount1:amd64   2.27.1-6ubuntu3.9   amd64   device mounting
library
ii libmpc3:amd64   1.0.3-1   amd64   multiple precision complex
floating-point library
ii libmpc-dev:amd64   1.0.3-1   amd64   multiple precision
complex floating-point library development package
ii libmpdec2:amd64   2.4.2-1   amd64   library for decimal
floating point arithmetic (runtime library)

ii libmpfr4:amd64   3.1.4-1   amd64   multiple precision floating-point computation

ii libmpfr4-dbg:amd64   3.1.4-1   amd64   multiple precision floating-point computation (debug symbols)

ii libmpfr-dev:amd64   3.1.4-1   amd64   multiple precision floating-point computation developers tools

ii libmpfr-doc   3.1.4-1   all   multiple precision floating-point computation documentation

ii libmpx0:amd64   5.4.0-6ubuntu1~16.04.12   amd64   Intel memory protection extensions (runtime)

ii libncurses5:amd64   6.0+20160213-1ubuntu1   amd64   shared libraries for terminal handling

ii libncurses5-dev:amd64   6.0+20160213-1ubuntu1   amd64   developer's libraries for ncurses

ii libncursesw5:amd64   6.0+20160213-1ubuntu1   amd64   shared libraries for terminal handling (wide character support)

ii libnet-http-perl   6.09-1   all   module providing low-level HTTP connection client

ii libnet-smtp-ssl-perl   1.03-1   all   Perl module providing SSL support to Net::SMTP

ii libnet-ssleay-perl   1.72-1build1   amd64   Perl module for Secure Sockets Layer (SSL)

ii libnettle6:amd64   3.2-1ubuntu0.16.04.1   amd64   low level cryptographic library (symmetric and one-way cryptos)

ii libnuma1:amd64   2.0.11-1ubuntu1.1   amd64   Libraries for controlling NUMA policy

ii libnuma-dev:amd64   2.0.11-1ubuntu1.1   amd64   Development files for libnuma

ii libobjc4:amd64   5.4.0-6ubuntu1~16.04.12   amd64   Runtime library for GNU Objective-C applications

ii libobjc-5-dev:amd64   5.4.0-6ubuntu1~16.04.12   amd64   Runtime library for GNU Objective-C applications (development files)

ii libogg0:amd64   1.3.2-1   amd64   Ogg bitstream library

ii libopenmpi1.10   1.10.2-8ubuntu1   amd64   high performance message passing library -- shared library

ii libopenmpi-dev   1.10.2-8ubuntu1   amd64   high performance message passing library -- header files

ii libp11-kit0:amd64   0.23.2-5~ubuntu16.04.1   amd64   library for loading and coordinating access to PKCS#11 modules - runtime

ii libpam0g:amd64   1.1.8-3.2ubuntu2.1   amd64   Pluggable Authentication Modules library

ii libpam-modules:amd64   1.1.8-3.2ubuntu2.1   amd64   Pluggable Authentication Modules for PAM

ii libpam-modules-bin   1.1.8-3.2ubuntu2.1   amd64   Pluggable Authentication Modules for PAM - helper binaries

ii libpam-runtime   1.1.8-3.2ubuntu2.1   all   Runtime support for the PAM library

ii libpciaccess0:amd64   0.13.4-1   amd64   Generic PCI access library for X

ii libpcre16-3:amd64   2:8.38-3.1   amd64   Perl 5 Compatible Regular Expression Library - 16 bit runtime files

ii libpcre32-3:amd64   2:8.38-3.1   amd64   Perl 5 Compatible
Regular Expression Library - 32 bit runtime files
ii libpcre3:amd64   2:8.38-3.1   amd64   Perl 5 Compatible Regular
Expression Library - runtime files
ii libpcre3-dev:amd64   2:8.38-3.1   amd64   Perl 5 Compatible
Regular Expression Library - development files
ii libpcrecpp0v5:amd64   2:8.38-3.1   amd64   Perl 5 Compatible
Regular Expression Library - C++ runtime files
ii libperl5.22:amd64   5.22.1-9ubuntu0.6   amd64   shared Perl library
ii libpipeline1:amd64   1.4.1-2   amd64   pipeline manipulation
library
ii libpng12-0:amd64   1.2.54-1ubuntu1.1   amd64   PNG library -
runtime
ii libpng12-dev:amd64   1.2.54-1ubuntu1.1   amd64   PNG library -
development
ii libpopt0:amd64   1.16-10   amd64   lib for parsing cmdline
parameters
ii libprocps4:amd64   2:3.3.10-4ubuntu2.4   amd64   library for accessing
process information from /proc
ii libpthread-stubs0-dev:amd64   0.3-4   amd64   pthread stubs not
provided by native libc, development files
ii libpulse0:amd64   1:8.0-0ubuntu3.10   amd64   PulseAudio client
libraries
ii libpulse-dev:amd64   1:8.0-0ubuntu3.10   amd64   PulseAudio client
development headers and libraries
ii libpulse-mainloop-glib0:amd64   1:8.0-0ubuntu3.10   amd64   PulseAudio
client libraries (glib support)
ii libpython2.7:amd64   2.7.12-1ubuntu0~16.04.9   amd64   Shared Python
runtime library (version 2.7)
ii libpython2.7-dev:amd64   2.7.12-1ubuntu0~16.04.9   amd64   Header files
and a static library for Python (v2.7)
ii libpython2.7-minimal:amd64   2.7.12-1ubuntu0~16.04.9   amd64   Minimal
subset of the Python language (version 2.7)
ii libpython2.7-stdlib:amd64   2.7.12-1ubuntu0~16.04.9   amd64   Interactive
high-level object-oriented language (standard library, version 2.7)
ii libpython3.5:amd64   3.5.2-2ubuntu0~16.04.9   amd64   Shared Python
runtime library (version 3.5)
ii libpython3.5-dev:amd64   3.5.2-2ubuntu0~16.04.9   amd64   Header files and
a static library for Python (v3.5)
ii libpython3.5-minimal:amd64   3.5.2-2ubuntu0~16.04.9   amd64   Minimal
subset of the Python language (version 3.5)
ii libpython3.5-stdlib:amd64   3.5.2-2ubuntu0~16.04.9   amd64   Interactive
high-level object-oriented language (standard library, version 3.5)
ii libpython3-dev:amd64   3.5.1-3   amd64   header files and a static
library for Python (default)
ii libpython3-stdlib:amd64   3.5.1-3   amd64   interactive high-level
object-oriented language (default python3 version)
ii libpython-dev:amd64   2.7.12-1~16.04   amd64   header files and a
static library for Python (default)
ii libpython-stdlib:amd64   2.7.12-1~16.04   amd64   interactive high-level
object-oriented language (default python version)

ii libquadmath0:amd64   5.4.0-6ubuntu1~16.04.12   amd64   GCC Quad-Precision Math Library

ii libreadline6:amd64   6.3-8ubuntu2   amd64   GNU readline and history libraries, run-time libraries

ii libreadline6-dev:amd64   6.3-8ubuntu2   amd64   GNU readline and history libraries, development files

ii libreadline-dev:amd64   6.3-8ubuntu2   amd64   GNU readline and history libraries, development files

ii libroken18-heimdal:amd64   1.7~git20150920+dfsg-4ubuntu1.16.04.1 amd64   Heimdal Kerberos - roken support library

ii librtmp1:amd64   2.4+20151223.gitfa8646d-1ubuntu0.1   amd64   toolkit for RTMP streams (shared library)

ii libsasl2-2:amd64   2.1.26.dfsg1-14ubuntu0.1   amd64   Cyrus SASL - authentication abstraction library

ii libsasl2-modules:amd64   2.1.26.dfsg1-14ubuntu0.1   amd64   Cyrus SASL - pluggable authentication modules

ii libsasl2-modules-db:amd64   2.1.26.dfsg1-14ubuntu0.1   amd64   Cyrus SASL - pluggable authentication modules (DB)

ii libsdl1.2debian:amd64   1.2.15+dfsg1-3ubuntu0.1   amd64   Simple DirectMedia Layer

ii libsdl1.2-dev   1.2.15+dfsg1-3ubuntu0.1   amd64   Simple DirectMedia Layer development files

ii libseccomp2:amd64   2.4.1-0ubuntu0.16.04.2   amd64   high level interface to Linux seccomp filter

ii libselinux1:amd64   2.4-3build2   amd64   SELinux runtime shared libraries

ii libsemanage1:amd64   2.3-1build3   amd64   SELinux policy management library

ii libsemanage-common   2.3-1build3   all   Common files for SELinux policy management libraries

ii libsensors4:amd64   1:3.4.0-2   amd64   library to read temperature/voltage/fan sensors

ii libsepol1:amd64   2.4-2   amd64   SELinux library for manipulating binary security policies

ii libsigsegv2:amd64   2.10-4   amd64   Library for handling page faults in a portable way

ii libslang2:amd64   2.3.0-2ubuntu1.1   amd64   S-Lang programming library - runtime version

ii libslang2-dev:amd64   2.3.0-2ubuntu1.1   amd64   S-Lang programming library, development version

ii libsm6:amd64   2:1.2.2-1   amd64   X11 Session Management library

ii libsmartcols1:amd64   2.27.1-6ubuntu3.9   amd64   smart column output alignment library

ii libsndfile1:amd64   1.0.25-10ubuntu0.16.04.2   amd64   Library for reading/writing audio files

ii libsqlite3-0:amd64   3.11.0-1ubuntu1.3   amd64   SQLite 3 shared library

ii libss2:amd64   1.42.13-1ubuntu1.1   amd64   command-line interface parsing library

ii libssl1.0.0:amd64   1.0.2g-1ubuntu4.15   amd64   Secure Sockets Layer toolkit - shared libraries

ii libstdc++-5-dev:amd64   5.4.0-6ubuntu1~16.04.12   amd64   GNU Standard
C++ Library v3 (development files)
ii libstdc++6:amd64   5.4.0-6ubuntu1~16.04.12   amd64   GNU Standard
C++ Library v3
ii libsystemd0:amd64   229-4ubuntu21.23   amd64   systemd utility
library
ii libtasn1-6:amd64   4.7-3ubuntu0.16.04.3   amd64   Manage ASN.1
structures (runtime)
ii libtcl8.6:amd64   8.6.5+dfsg-2   amd64   Tcl (the Tool Command
Language) v8.6 - run-time library files
ii libtext-unidecode-perl   1.27-1   all   Text::Unidecode -- US-
ASCII transliterations of Unicode text
ii libtimedate-perl   2.3000-2   all   collection of modules to
manipulate date/time information
ii libtinfo5:amd64   6.0+20160213-1ubuntu1   amd64   shared low-level
terminfo library for terminal handling
ii libtinfo-dev:amd64   6.0+20160213-1ubuntu1   amd64   developer's
library for the low-level terminfo library
ii libtool   2.4.6-0.1   all   Generic library support script
ii libtsan0:amd64   5.4.0-6ubuntu1~16.04.12   amd64   ThreadSanitizer -- a
Valgrind-based detector of data races (runtime)
ii libtxc-dxtn-s2tc0:amd64   0~git20131104-1.1   amd64   Texture
compression library for Mesa
ii libubsan0:amd64   5.4.0-6ubuntu1~16.04.12   amd64   UBSan --
undefined behaviour sanitizer (runtime)
ii libudev1:amd64   229-4ubuntu21.23   amd64   libudev shared
library
ii liburi-perl   1.71-1   all   module to manipulate and access
URI strings
ii libusb-0.1-4:amd64   2:0.1.12-28   amd64   userspace USB
programming library
ii libusb-dev   2:0.1.12-28   amd64   userspace USB
programming library development files
ii libustr-1.0-1:amd64   1.0.4-5   amd64   Micro string library:
shared library
ii libutempter0:amd64   1.1.6-3   amd64   privileged helper for
utmp/wtmp updates (runtime)
ii libuuid1:amd64   2.27.1-6ubuntu3.9   amd64   Universally Unique ID
library
ii libvorbis0a:amd64   1.3.5-3ubuntu0.2   amd64   decoder library for
Vorbis General Audio Compression Codec
ii libvorbisenc2:amd64   1.3.5-3ubuntu0.2   amd64   encoder library for
Vorbis General Audio Compression Codec
ii libwind0-heimdal:amd64   1.7~git20150920+dfsg-4ubuntu1.16.04.1 amd64
Heimdal Kerberos - stringprep implementation
ii libwrap0:amd64   7.6.q-25   amd64   Wietse Venema's TCP
wrappers library
ii libwww-perl   6.15-1   all   simple and consistent interface
to the world-wide web
ii libwww-robotrules-perl   6.01-1   all   database of robots.txt-
derived permissions
ii libx11-6:amd64   2:1.6.3-1ubuntu2.1   amd64   X11 client-side library

ii	libx11-data	2:1.6.3-1ubuntu2.1	all	X11 client-side library
ii	libx11-dev:amd64	2:1.6.3-1ubuntu2.1	amd64	X11 client-side library (development headers)
ii	libx11-doc	2:1.6.3-1ubuntu2.1	all	X11 client-side library (development documentation)
ii	libx11-xcb1:amd64	2:1.6.3-1ubuntu2.1	amd64	Xlib/XCB interface library
ii	libx11-xcb-dev:amd64	2:1.6.3-1ubuntu2.1	amd64	Xlib/XCB interface library (development headers)
ii	libx32asan2	5.4.0-6ubuntu1~16.04.12	amd64	AddressSanitizer -- a fast memory error detector (x32)
ii	libx32atomic1	5.4.0-6ubuntu1~16.04.12	amd64	support library providing __atomic built-in functions (x32)
ii	libx32cilkrts5	5.4.0-6ubuntu1~16.04.12	amd64	Intel Cilk Plus language extensions (x32)
ii	libx32gcc1	1:6.0.1-0ubuntu1	amd64	GCC support library (x32)
ii	libx32gcc-5-dev	5.4.0-6ubuntu1~16.04.12	amd64	GCC support library (x32 development files)
ii	libx32gomp1	5.4.0-6ubuntu1~16.04.12	amd64	GCC OpenMP (GOMP) support library (x32)
ii	libx32itm1	5.4.0-6ubuntu1~16.04.12	amd64	GNU Transactional Memory Library (x32)
ii	libx32quadmath0	5.4.0-6ubuntu1~16.04.12	amd64	GCC Quad-Precision Math Library (x32)
ii	libx32stdc++6	5.4.0-6ubuntu1~16.04.12	amd64	GNU Standard C++ Library v3 (x32)
ii	libx32ubsan0	5.4.0-6ubuntu1~16.04.12	amd64	UBSan -- undefined behaviour sanitizer (x32)
ii	libxau6:amd64	1:1.0.8-1	amd64	X11 authorisation library
ii	libxau-dev:amd64	1:1.0.8-1	amd64	X11 authorisation library (development headers)
ii	libxaw7:amd64	2:1.0.13-1	amd64	X11 Athena Widget library
ii	libxcb1:amd64	1.11.1-1ubuntu1	amd64	X C Binding
ii	libxcb1-dev:amd64	1.11.1-1ubuntu1	amd64	X C Binding, development files
ii	libxcb-dri2-0:amd64	1.11.1-1ubuntu1	amd64	X C Binding, dri2 extension
ii	libxcb-dri2-0-dev:amd64	1.11.1-1ubuntu1	amd64	X C Binding, dri2 extension, development files
ii	libxcb-dri3-0:amd64	1.11.1-1ubuntu1	amd64	X C Binding, dri3 extension
ii	libxcb-dri3-dev:amd64	1.11.1-1ubuntu1	amd64	X C Binding, dri3 extension, development files
ii	libxcb-glx0:amd64	1.11.1-1ubuntu1	amd64	X C Binding, glx extension
ii	libxcb-glx0-dev:amd64	1.11.1-1ubuntu1	amd64	X C Binding, glx extension, development files
ii	libxcb-present0:amd64	1.11.1-1ubuntu1	amd64	X C Binding, present extension

ii	libxcb-present-dev:amd64	1.11.1-1ubuntu1	amd64	X C Binding, present extension, development files
ii	libxcb-randr0:amd64	1.11.1-1ubuntu1	amd64	X C Binding, randr extension
ii	libxcb-randr0-dev:amd64	1.11.1-1ubuntu1	amd64	X C Binding, randr extension, development files
ii	libxcb-render0:amd64	1.11.1-1ubuntu1	amd64	X C Binding, render extension
ii	libxcb-render0-dev:amd64	1.11.1-1ubuntu1	amd64	X C Binding, render extension, development files
ii	libxcb-shape0:amd64	1.11.1-1ubuntu1	amd64	X C Binding, shape extension
ii	libxcb-shape0-dev:amd64	1.11.1-1ubuntu1	amd64	X C Binding, shape extension, development files
ii	libxcb-sync1:amd64	1.11.1-1ubuntu1	amd64	X C Binding, sync extension
ii	libxcb-sync-dev:amd64	1.11.1-1ubuntu1	amd64	X C Binding, sync extension, development files
ii	libxcb-xfixes0:amd64	1.11.1-1ubuntu1	amd64	X C Binding, xfixes extension
ii	libxcb-xfixes0-dev:amd64	1.11.1-1ubuntu1	amd64	X C Binding, xfixes extension, development files
ii	libxcomposite1:amd64	1:0.4.4-1	amd64	X11 Composite extension library
ii	libxdamage1:amd64	1:1.1.4-2	amd64	X11 damaged region extension library
ii	libxdamage-dev:amd64	1:1.1.4-2	amd64	X11 damaged region extension library (development headers)
ii	libxdmcp6:amd64	1:1.1.2-1.1	amd64	X11 Display Manager Control Protocol library
ii	libxdmcp-dev:amd64	1:1.1.2-1.1	amd64	X11 authorisation library (development headers)
ii	libxext6:amd64	2:1.3.3-1	amd64	X11 miscellaneous extension library
ii	libxext-dev:amd64	2:1.3.3-1	amd64	X11 miscellaneous extensions library (development headers)
ii	libxfixes3:amd64	1:5.0.1-2	amd64	X11 miscellaneous 'fixes' extension library
ii	libxfixes-dev:amd64	1:5.0.1-2	amd64	X11 miscellaneous 'fixes' extension library (development headers)
ii	libxft2:amd64	2.3.2-1	amd64	FreeType-based font drawing library for X
ii	libxi6:amd64	2:1.7.6-1	amd64	X11 Input extension library
ii	libxinerama1:amd64	2:1.1.3-1	amd64	X11 Xinerama extension library
ii	libxml2:amd64	2.9.3+dfsg1-1ubuntu0.6	amd64	GNOME XML library
ii	libxml-libxml-perl	2.0123+dfsg-1ubuntu0.1	amd64	Perl interface to the libxml2 library
ii	libxml-namespacesupport-perl	1.11-1	all	Perl module for supporting simple generic namespaces

ii	libxml-parser-perl	2.44-1build1	amd64	Perl module for parsing XML files
ii	libxml-sax-base-perl	1.07-1	all	base class for SAX drivers and filters
ii	libxml-sax-expat-perl	0.40-2	all	Perl module for a SAX2 driver for Expat (XML::Parser)
ii	libxml-sax-perl	0.99+dfsg-2ubuntu1	all	Perl module for using and building Perl SAX2 XML processors
ii	libxmu6:amd64	2:1.1.2-2	amd64	X11 miscellaneous utility library
ii	libxmuu1:amd64	2:1.1.2-2	amd64	X11 miscellaneous micro-utility library
ii	libxpm4:amd64	1:3.5.11-1ubuntu0.16.04.1	amd64	X11 pixmap library
ii	libxrandr2:amd64	2:1.5.0-1	amd64	X11 RandR extension library
ii	libxrender1:amd64	1:0.9.9-0ubuntu1	amd64	X Rendering Extension client library
ii	libxshmfence1:amd64	1.2-1	amd64	X shared memory fences - shared library
ii	libxshmfence-dev:amd64	1.2-1	amd64	X shared memory fences - development files
ii	libxt6:amd64	1:1.1.5-0ubuntu1	amd64	X11 toolkit intrinsics library
ii	libxtables11:amd64	1.6.0-2ubuntu3	amd64	netfilter xtables library
ii	libxtst6:amd64	2:1.2.2-1	amd64	X11 Testing -- Record extension library
ii	libxv1:amd64	2:1.0.10-1	amd64	X11 Video extension library
ii	libxxf86dga1:amd64	2:1.1.4-1	amd64	X11 Direct Graphics Access extension library
ii	libxxf86vm1:amd64	1:1.1.4-1	amd64	X11 XFree86 video mode extension library
ii	libxxf86vm-dev:amd64	1:1.1.4-1	amd64	X11 XFree86 video mode extension library (development headers)
ii	linux-libc-dev:amd64	4.4.0-171.200	amd64	Linux Kernel Headers for development
ii	llvm-3.8	1:3.8-2ubuntu4	amd64	Modular compiler and toolchain technologies
ii	llvm-3.8-dev	1:3.8-2ubuntu4	amd64	Modular compiler and toolchain technologies, libraries and headers
ii	llvm-3.8-runtime	1:3.8-2ubuntu4	amd64	Modular compiler and toolchain technologies, IR interpreter
ii	locales	2.23-0ubuntu11	all	GNU C Library: National Language (locale) data [support]
ii	login	1:4.2-3.1ubuntu5.4	amd64	system login tools
ii	lsb-base	9.20160110ubuntu0.2	all	Linux Standard Base init script functionality
ii	m4	1.4.17-5	amd64	macro processing language
ii	make	4.1-6	amd64	utility for directing compilation
ii	makedev	2.3.1-93ubuntu2~ubuntu16.04.1	all	creates device files in /dev

ii manpages   4.04-2   all   Manual pages about using a
GNU/Linux system
ii manpages-dev   4.04-2   all   Manual pages about using
GNU/Linux for development
ii mawk   1.3.3-17ubuntu2   amd64   a pattern scanning and text
processing language
ii mercurial   3.7.3-1ubuntu1.2   amd64   easy-to-use, scalable
distributed version control system
ii mercurial-common   3.7.3-1ubuntu1.2   all   easy-to-use, scalable
distributed version control system (common files)
ii mesa-common-dev:amd64   18.0.5-0ubuntu0~16.04.1   amd64   Developer
documentation for Mesa
ii mime-support   3.59ubuntu1   all   MIME files 'mime.types' &
'mailcap', and support programs
ii mount   2.27.1-6ubuntu3.9   amd64   tools for mounting and
manipulating filesystems
ii mpi-default-bin   1.4   amd64   Standard MPI runtime
programs (metapackage)
ii mpi-default-dev   1.4   amd64   Standard MPI development
files (metapackage)
ii multiarch-support   2.23-0ubuntu11   amd64   Transitional package to
ensure multiarch compatibility
ii ncurses-base   6.0+20160213-1ubuntu1   all   basic terminal type
definitions
ii ncurses-bin   6.0+20160213-1ubuntu1   amd64   terminal-related
programs and man pages
ii netbase   5.3   all   Basic TCP/IP networking system
ii ocl-icd-libopencl1:amd64   2.2.8-1   amd64   Generic OpenCL ICD
Loader
ii openmpi-bin   1.10.2-8ubuntu1   amd64   high performance
message passing library -- binaries
ii openmpi-common   1.10.2-8ubuntu1   all   high performance
message passing library -- common files
ii openssh-client   1:7.2p2-4ubuntu2.8   amd64   secure shell (SSH)
client, for secure access to remote machines
ii openssl   1.0.2g-1ubuntu4.15   amd64   Secure Sockets Layer
toolkit - cryptographic utility
ii passwd   1:4.2-3.1ubuntu5.4   amd64   change and administer
password and group data
ii patch   2.7.5-1ubuntu0.16.04.2   amd64   Apply a diff file to an
original
ii perl   5.22.1-9ubuntu0.6   amd64   Larry Wall's Practical
Extraction and Report Language
ii perl-base   5.22.1-9ubuntu0.6   amd64   minimal Perl system
ii perl-modules-5.22   5.22.1-9ubuntu0.6   all   Core Perl modules
ii pkg-config   0.29.1-0ubuntu1   amd64   manage compile and link
flags for libraries
ii procps   2:3.3.10-4ubuntu2.4   amd64   /proc file system utilities
ii python   2.7.12-1~16.04   amd64   interactive high-level
object-oriented language (default version)
ii python2.7   2.7.12-1ubuntu0~16.04.9   amd64   Interactive high-level
object-oriented language (version 2.7)

ii python2.7-dev   2.7.12-1ubuntu0~16.04.9   amd64   Header files and a static library for Python (v2.7)

ii python2.7-minimal   2.7.12-1ubuntu0~16.04.9   amd64   Minimal subset of the Python language (version 2.7)

ii python3   3.5.1-3   amd64   interactive high-level object-oriented language (default python3 version)

ii python3.5   3.5.2-2ubuntu0~16.04.9   amd64   Interactive high-level object-oriented language (version 3.5)

ii python3.5-dev   3.5.2-2ubuntu0~16.04.9   amd64   Header files and a static library for Python (v3.5)

ii python3.5-minimal   3.5.2-2ubuntu0~16.04.9   amd64   Minimal subset of the Python language (version 3.5)

ii python3-dev   3.5.1-3   amd64   header files and a static library for Python (default)

ii python3-minimal   3.5.1-3   amd64   minimal subset of the Python language (default python3 version)

ii python3-pexpect   4.0.1-1   all   Python 3 module for automating interactive applications

ii python3-pip   8.1.1-2ubuntu0.4   all   alternative Python package installer - Python 3 version of the package

ii python3-pkg-resources   20.7.0-1   all   Package Discovery and Resource Access using pkg_resources

ii python3-ptyprocess   0.5-1   all   Run a subprocess in a pseudo terminal from Python 3

ii python3-setuptools   20.7.0-1   all   Python3 Distutils Enhancements

ii python3-wheel   0.29.0-1   all   built-package format for Python

ii python-dev   2.7.12-1~16.04   amd64   header files and a static library for Python (default)

ii python-minimal   2.7.12-1~16.04   amd64   minimal subset of the Python language (default version)

ii python-pip-whl   8.1.1-2ubuntu0.4   all   alternative Python package installer

ii readline-common   6.3-8ubuntu2   all   GNU readline and history libraries, common files

ii rename   0.20-4   all   Perl extension for renaming multiple files

ii rsync   3.1.1-3ubuntu1.2   amd64   fast, versatile, remote (and local) file-copying tool

ii sed   4.2.2-7   amd64   The GNU sed stream editor

ii sensible-utils   0.0.9ubuntu0.16.04.1   all   Utilities for sensible alternative selection

ii sgml-base   1.26+nmu4ubuntu1   all   SGML infrastructure and SGML catalog file support

ii shared-mime-info   1.5-2ubuntu0.2   amd64   FreeDesktop.org shared MIME database and spec

ii socat   1.7.3.1-1   amd64   multipurpose relay for bidirectional data transfer

ii systemd   229-4ubuntu21.23   amd64   system and service manager

ii	systemd-sysv	229-4ubuntu21.23	amd64	system and service manager - SysV links
ii	sysvinit-utils	2.88dsf-59.3ubuntu2	amd64	System-V-like utilities
ii	sysv-rc	2.88dsf-59.3ubuntu2	all	System-V-like runlevel change mechanism
ii	tar	1.28-2.1ubuntu0.1	amd64	GNU version of the tar archiving utility
ii	tcl	8.6.0+9	amd64	Tool Command Language (default version) - shell
ii	tcl8.6	8.6.5+dfsg-2	amd64	Tcl (the Tool Command Language) v8.6 - shell
ii	tcl8.6-dev:amd64	8.6.5+dfsg-2	amd64	Tcl (the Tool Command Language) v8.6 - development files
ii	tcl-dev:amd64	8.6.0+9	amd64	Tool Command Language (default version) - development files
ii	tcpd	7.6.q-25	amd64	Wietse Venema's TCP wrapper utilities
ii	tex-common	6.04ubuntu1	all	common infrastructure for building and installing TeX
ii	texinfo	6.1.0.dfsg.1-5	amd64	Documentation system for on-line information and printed output
ii	tzdata	2019c-0ubuntu0.16.04	all	time zone and daylight-saving time data
ii	ubuntu-keyring	2012.05.19	all	GnuPG keys of the Ubuntu archive
ii	ucf	3.0036	all	Update Configuration File(s): preserve user changes to config files
ii	unzip	6.0-20ubuntu1	amd64	De-archiver for .zip files
ii	util-linux	2.27.1-6ubuntu3.9	amd64	miscellaneous system utilities
ii	wget	1.17.1-1ubuntu1.5	amd64	retrieves files from the web
ii	x11-common	1:7.7+13ubuntu3.1	all	X Window System (X.Org) infrastructure
ii	x11proto-core-dev	7.0.31-1~ubuntu16.04.2	all	X11 core wire protocol and auxiliary headers
ii	x11proto-damage-dev	1:1.2.1-2	all	X11 Damage extension wire protocol
ii	x11proto-dri2-dev	2.8-2	all	X11 DRI2 extension wire protocol
ii	x11proto-fixes-dev	1:5.0-2ubuntu2	all	X11 Fixes extension wire protocol
ii	x11proto-gl-dev	1.4.17-1	all	X11 OpenGL extension wire protocol
ii	x11proto-input-dev	2.3.1-1	all	X11 Input extension wire protocol
ii	x11proto-kb-dev	1.0.7-0ubuntu1	all	X11 XKB extension wire protocol
ii	x11proto-xext-dev	7.3.0-1	all	X11 various extension wire protocol
ii	x11proto-xf86vidmode-dev	2.3.1-2	all	X11 Video Mode extension wire protocol
ii	x11-utils	7.7+3	amd64	X11 utilities

ii	xauth	1:1.0.9-1ubuntu2	amd64	X authentication utility
ii	xbitmaps	1.1.1-2	all	Base X bitmaps
ii	xdg-user-dirs	0.15-2ubuntu6.16.04.1	amd64	tool to manage well known user directories
ii	xml-core	0.13+nmu2	all	XML infrastructure and XML catalog file support
ii	xorg-sgml-doctools	1:1.11-1	all	Common tools for building X.Org SGML documentation
ii	xterm	322-1ubuntu1	amd64	X terminal emulator
ii	xtrans-dev	1.3.5-1	all	X transport library (development files)
ii	xz-utils	5.1.1alpha+20120614-2ubuntu2	amd64	XZ-format compression utilities
ii	zlib1g:amd64	1:1.2.8.dfsg-2ubuntu4.1	amd64	compression library - runtime
ii	zlib1g-dev:amd64	1:1.2.8.dfsg-2ubuntu4.1	amd64	compression library - development
||/ Name	Version	Architecture	Description	
Status=Not/Inst/Conf-files/Unpacked/halF-conf/Half-inst/trig-aWait/Trig-pend