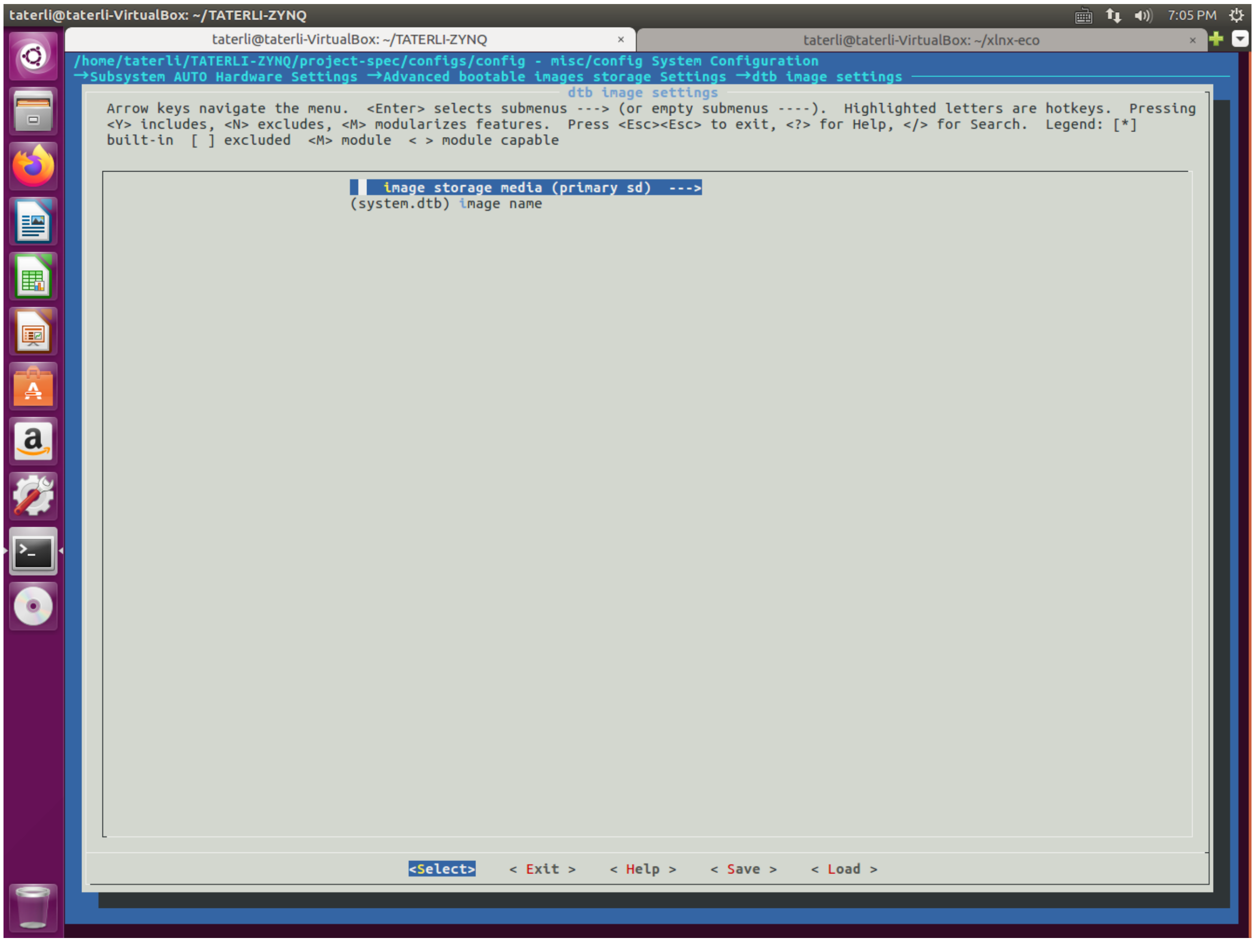
[L24]手动编译ZYNQ镜像

之前我们都用PYNQ或者PetaLinux进行试验,实际上除了这个方法还有一个手动方法,这个方法大家觉得怎样就见仁见智了,毕竟每个人习惯不同.这个毕竟是拆散开任何一步,这样改任何一步都代价最小.

首先需要创建工程,创建过程可以顺便选择源码路径,然后根据运行目标引导目标,这些应该难不倒大家了,毕竟前面的教程已经折腾很多次了,这里就不展开说了.


taterli@taterli-VirtualBox: ~/TATERLI-ZYNQ
7:05 PM
taterli@taterli-VirtualBox: ~/TATERLI-ZYNQ
taterli@taterli-VirtualBox: ~/xlnx-eco

```
/home/taterli/TATERLI-ZYNQ/project-spec/configs/config - misc/config System Configuration
→Subsystem AUTO Hardware Settings →Advanced bootable images storage Settings →dtb image settings
                                dtb image settings
  Arrow keys navigate the menu.  <Enter> selects submenus ---> (or empty submenus ----).  Highlighted letters are hotkeys.  Pressing
  <Y> includes, <N> excludes, <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help, </> for Search.  Legend: [*]
  built-in  [ ] excluded  <M> module  < > module capable

                    image storage media (primary sd)  --->
                    (system.dtb) image name

                 <Select>    < Exit >    < Help >    < Save >    < Load >
```

```
taterli@taterli-VirtualBox:~$ petalinux-create -t project --template zynq -n TATERLI-ZYNQ
INFO: Create project: TATERLI-ZYNQ
INFO: New project successfully created in /home/taterli/TATERLI-ZYNQ
taterli@taterli-VirtualBox:~$ cd TATERLI-ZYNQ/
taterli@taterli-VirtualBox:~/TATERLI-ZYNQ$ petalinux-config --get-hw-description ~/zynq_project/hello_pynq/hello_pynq.sdk
INFO: Getting hardware description...
INFO: Rename design_1_wrapper.hdf to system.hdf
[INFO] generating Kconfig for project
[INFO] menuconfig project
configuration written to /home/taterli/TATERLI-ZYNQ/project-spec/configs/config

*** End of the configuration.
*** Execute 'make' to start the build or try 'make help'.

[INFO] sourcing bitbake
[INFO] generating plnxtool conf

# 省略更多
```

然后编译uboot和BOOT.BIN:

```
taterli@taterli-VirtualBox:~/TATERLI-ZYNQ$ petalinux-build -c u-boot
[INFO] building u-boot
[INFO] sourcing bitbake
INFO: bitbake virtual/bootloader
Loading cache: 100% |########################################################################################################| Time: 0:00:0
Loaded 3442 entries from dependency cache.
Parsing recipes: 100% |######################################################################################################| Time: 0:00:0
Parsing of 2569 .bb files complete (2530 cached, 39 parsed). 3445 targets, 149 skipped, 0 masked, 0 errors.
NOTE: Resolving any missing task queue dependencies
Initialising tasks: 100% |#####################################################################################################| Time: 0:00:0
Checking sstate mirror object availability: 100% |################################################################################| Time: 0:00:0
NOTE: Executing SetScene Tasks
NOTE: Executing RunQueue Tasks
NOTE: linux-xlnx: compiling from external source tree /home/taterli/xlnx-eco
WARNING: petalinux-user-image-1.0-r0 do_rootfs: [log_check] petalinux-user-image: found 1 warning message in the logfile:
[log_check] warning: %post(sysvinit-inittab-2.88dsf-r10.plnx_zynq7) scriptlet failed, exit status 1

NOTE: Tasks Summary: Attempted 2361 tasks of which 2124 didn't need to be rerun and all succeeded.

Summary: There was 1 WARNING message shown.
INFO: Copying Images from deploy to images
INFO: Creating images/linux directory
NOTE: Successfully copied built images to tftp dir:  /tftpboot
[INFO] successfully built u-boot
taterli@taterli-VirtualBox:~/TATERLI-ZYNQ$ petalinux-package --boot --fsbl --u-boot --force
INFO: File in BOOT BIN: "/home/taterli/TATERLI-ZYNQ/images/linux/zynq_fsbl.elf"
INFO: File in BOOT BIN: "/home/taterli/TATERLI-ZYNQ/images/linux/u-boot.elf"
INFO: Generating Zynq binary package BOOT.BIN...


****** Xilinx Bootgen v2018.3
  **** Build date : Dec  6 2018-23:41:49
    ** Copyright 1986-2018 Xilinx, Inc. All Rights Reserved.

INFO: Binary is ready.
```

现在的BOOT.bin只有fsbl和u-boot,除非我们要针对u-boot开发,否则这个文件是不用动的,现在已经根据硬件生成了合适的device-tree.

```
taterli@taterli-VirtualBox:~/TATERLI-ZYNQ/components/plnx_workspace/device-tree/device-tree$ ls -alh
总用量 6.4M
drwxr-xr-x 2 taterli taterli 4.0K Mar 16 19:08 .
drwxr-xr-x 3 taterli taterli 4.0K Mar 16 19:08 ..
-rw-r--r-- 1 taterli taterli 2.0M Mar 16 19:08 design_1_wrapper.bit
-rw-r--r-- 1 taterli taterli 3.3K Mar 16 19:08 device-tree.mss
-rw-r--r-- 1 taterli taterli 602K Mar 16 19:08 hardware_description.hdf
-rw-r--r-- 1 taterli taterli  756 Mar 16 19:08 pcw.dtsi # 重点
-rw-r--r-- 1 taterli taterli 1.5K Mar 16 19:08 pl.dtsi # 重点
-rw-r--r-- 1 taterli taterli 521K Mar 16 19:08 ps7_init.c
-rw-r--r-- 1 taterli taterli 521K Mar 16 19:08 ps7_init_gpl.c
-rw-r--r-- 1 taterli taterli 4.2K Mar 16 19:08 ps7_init_gpl.h
-rw-r--r-- 1 taterli taterli 4.8K Mar 16 19:08 ps7_init.h
-rw-r--r-- 1 taterli taterli 2.7M Mar 16 19:08 ps7_init.html
-rw-r--r-- 1 taterli taterli  35K Mar 16 19:08 ps7_init.tcl
-rw-r--r-- 1 taterli taterli  297 Mar 16 19:08 skeleton.dtsi
-rw-r--r-- 1 taterli taterli  265 Mar 16 19:08 system-conf.dtsi # 重点
-rw-r--r-- 1 taterli taterli  428 Mar 16 19:08 system-top.dts # 重点
-rw-r--r-- 1 taterli taterli  11K Mar 16 19:08 zynq-7000.dtsi # 重点
taterli@taterli-VirtualBox:~/TATERLI-ZYNQ/components/plnx_workspace/device-tree/device-tree$
```

如果下次要生成新的设备树这么做就可以了.

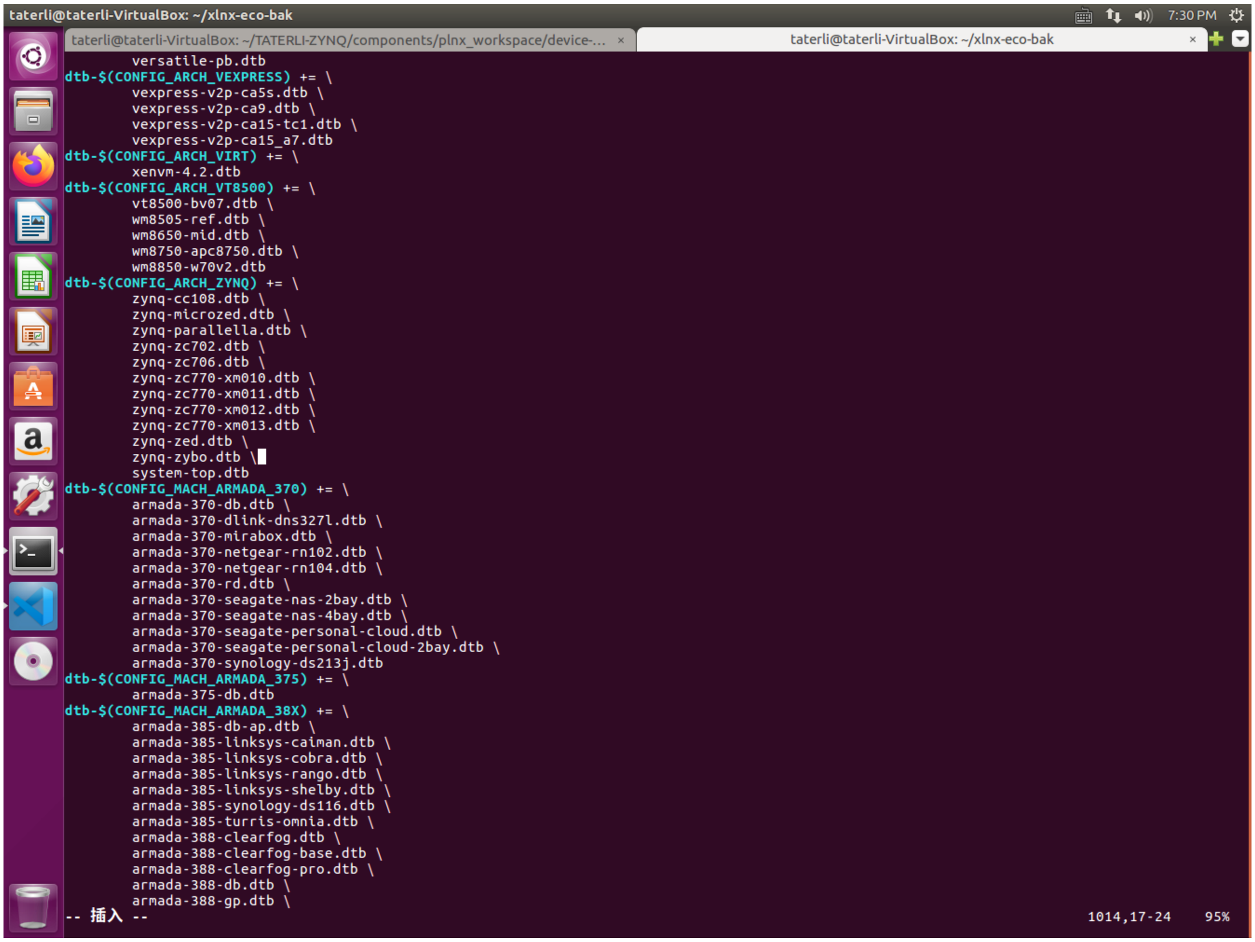
注:网上也有说可以用hsi等工具,但是步骤比较多,我实际试过每次构建也就一分钟不到,不至于说等待很久,编译u-boot只是为了随便构建一个依赖dts的东西.

```
petalinux-config --get-hw-description ~/zynq_project/hello_pynq/hello_pynq.sdk
petalinux-build -c u-boot
```

做一份内核的副本,把上面重点的dts/dtsi复制过去,并新建system-user.dtsi并放入适当的内容,比如之前我们用的内容.

```
cp ~/TATERLI-ZYNQ/components/plnx_workspace/device-tree/device-tree/pcw.dtsi ~/xlnx-eco-bak/arch/arm/boot/dts/
cp ~/TATERLI-ZYNQ/components/plnx_workspace/device-tree/device-tree/pl.dtsi ~/xlnx-eco-bak/arch/arm/boot/dts/
cp ~/TATERLI-ZYNQ/components/plnx_workspace/device-tree/device-tree/system-conf.dtsi ~/xlnx-eco-bak/arch/arm/boot/dts/
cp ~/TATERLI-ZYNQ/components/plnx_workspace/device-tree/device-tree/system-top.dts ~/xlnx-eco-bak/arch/arm/boot/dts/
cp ~/TATERLI-ZYNQ/components/plnx_workspace/device-tree/device-tree/zynq-7000.dtsi ~/xlnx-eco-bak/arch/arm/boot/dts/
vim ~/xlnx-eco-bak/arch/arm/boot/dts/system-user.dtsi
vim ~/xlnx-eco-bak/arch/arm/boot/dts/Makefile
```

关于dts的Makefile中要添加system-top.dtb.


taterli@taterli-VirtualBox: ~/xlnx-eco-bak
7:30 PM
taterli@taterli-VirtualBox: ~/TATERLI-ZYNQ/components/plnx_workspace/device-...
taterli@taterli-VirtualBox: ~/xlnx-eco-bak

```
        versatile-pb.dtb
dtb-$(CONFIG_ARCH_VEXPRESS) += \
        vexpress-v2p-ca5s.dtb \
        vexpress-v2p-ca9.dtb \
        vexpress-v2p-ca15-tc1.dtb \
        vexpress-v2p-ca15_a7.dtb
dtb-$(CONFIG_ARCH_VIRT) += \
        xenvm-4.2.dtb
dtb-$(CONFIG_ARCH_VT8500) += \
        vt8500-bv07.dtb \
        wm8505-ref.dtb \
        wm8650-mid.dtb \
        wm8750-apc8750.dtb \
        wm8850-w70v2.dtb
dtb-$(CONFIG_ARCH_ZYNQ) += \
        zynq-cc108.dtb \
        zynq-microzed.dtb \
        zynq-parallella.dtb \
        zynq-zc702.dtb \
        zynq-zc706.dtb \
        zynq-zc770-xm010.dtb \
        zynq-zc770-xm011.dtb \
        zynq-zc770-xm012.dtb \
        zynq-zc770-xm013.dtb \
        zynq-zed.dtb \
        zynq-zybo.dtb \
        system-top.dtb
dtb-$(CONFIG_MACH_ARMADA_370) += \
        armada-370-db.dtb \
        armada-370-dlink-dns327l.dtb \
        armada-370-mirabox.dtb \
        armada-370-netgear-rn102.dtb \
        armada-370-netgear-rn104.dtb \
        armada-370-rd.dtb \
        armada-370-seagate-nas-2bay.dtb \
        armada-370-seagate-nas-4bay.dtb \
        armada-370-seagate-personal-cloud.dtb \
        armada-370-seagate-personal-cloud-2bay.dtb \
        armada-370-synology-ds213j.dtb
dtb-$(CONFIG_MACH_ARMADA_375) += \
        armada-375-db.dtb
dtb-$(CONFIG_MACH_ARMADA_38X) += \
        armada-385-db-ap.dtb \
        armada-385-linksys-caiman.dtb \
        armada-385-linksys-cobra.dtb \
        armada-385-linksys-rango.dtb \
        armada-385-linksys-shelby.dtb \
        armada-385-synology-ds116.dtb \
        armada-385-turris-omnia.dtb \
        armada-388-clearfog.dtb \
        armada-388-clearfog-base.dtb \
        armada-388-clearfog-pro.dtb \
        armada-388-db.dtb \
        armada-388-gp.dtb \
-- 插入 --                                                                    1014,17-24     95%
```

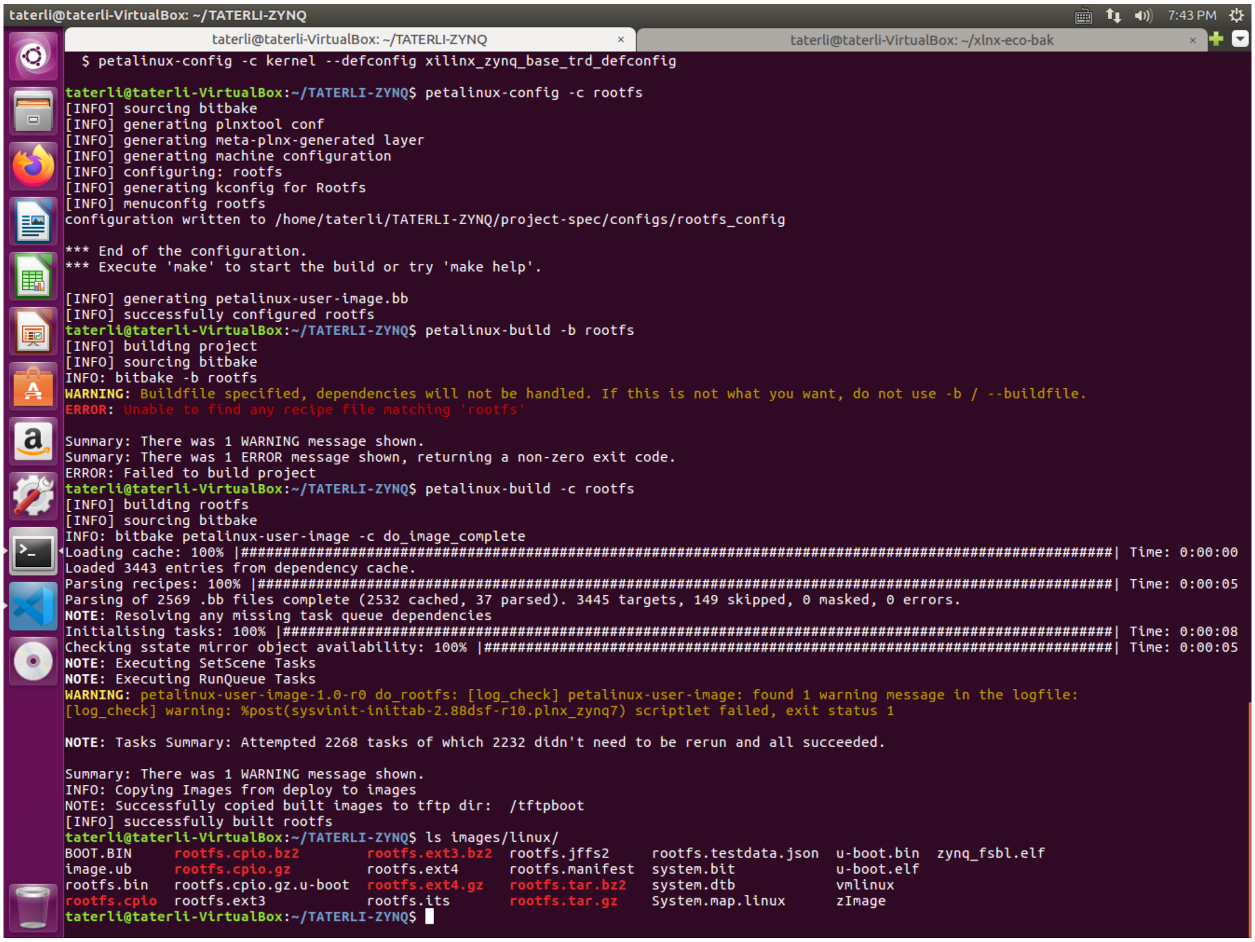
回到内核主目录开始编译.

```
make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- xilinx_zynq_defconfig
make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- menuconfig
make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- zImage -j 64
make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- system-top.dtb
```

单独构建rootfs.

```
petalinux-config -c rootfs # 配置,为了方便一般打开Image Features的debug-tweaks,会做很多方便调试的预设.
petalinux-build -c rootfs # 单纯构建不配置可以省略上一步.
```

然后就看到构建出来的rootfs的多种格式,当然选择合适的释放到rootfs分区.


taterli@taterli-VirtualBox: ~/TATERLI-ZYNQ
7:43 PM
taterli@taterli-VirtualBox: ~/TATERLI-ZYNQ
taterli@taterli-VirtualBox: ~/xlnx-eco-bak

```
 $ petalinux-config -c kernel --defconfig xilinx_zynq_base_trd_defconfig

taterli@taterli-VirtualBox:~/TATERLI-ZYNQ$ petalinux-config -c rootfs
[INFO] sourcing bitbake
[INFO] generating plnxtool conf
[INFO] generating meta-plnx-generated layer
[INFO] generating machine configuration
[INFO] configuring: rootfs
[INFO] generating kconfig for Rootfs
[INFO] menuconfig rootfs
configuration written to /home/taterli/TATERLI-ZYNQ/project-spec/configs/rootfs_config

*** End of the configuration.
*** Execute 'make' to start the build or try 'make help'.

[INFO] generating petalinux-user-image.bb
[INFO] successfully configured rootfs
taterli@taterli-VirtualBox:~/TATERLI-ZYNQ$ petalinux-build -b rootfs
[INFO] building project
[INFO] sourcing bitbake
INFO: bitbake -b rootfs
WARNING: Buildfile specified, dependencies will not be handled. If this is not what you want, do not use -b / --buildfile.
ERROR: Unable to find any recipe file matching 'rootfs'

Summary: There was 1 WARNING message shown.
Summary: There was 1 ERROR message shown, returning a non-zero exit code.
ERROR: Failed to build project
taterli@taterli-VirtualBox:~/TATERLI-ZYNQ$ petalinux-build -c rootfs
[INFO] building rootfs
[INFO] sourcing bitbake
INFO: bitbake petalinux-user-image -c do_image_complete
Loading cache: 100% |##########################################################################################################| Time: 0:00:00
Loaded 3443 entries from dependency cache.
Parsing recipes: 100% |########################################################################################################| Time: 0:00:05
Parsing of 2569 .bb files complete (2532 cached, 37 parsed). 3445 targets, 149 skipped, 0 masked, 0 errors.
NOTE: Resolving any missing task queue dependencies
Initialising tasks: 100% |#####################################################################################################| Time: 0:00:08
Checking sstate mirror object availability: 100% |#############################################################################| Time: 0:00:05
NOTE: Executing SetScene Tasks
NOTE: Executing RunQueue Tasks
WARNING: petalinux-user-image-1.0-r0 do_rootfs: [log_check] petalinux-user-image: found 1 warning message in the logfile:
[log_check] warning: %post(sysvinit-inittab-2.88dsf-r10.plnx_zynq7) scriptlet failed, exit status 1

NOTE: Tasks Summary: Attempted 2268 tasks of which 2232 didn't need to be rerun and all succeeded.

Summary: There was 1 WARNING message shown.
INFO: Copying Images from deploy to images
NOTE: Successfully copied built images to tftp dir:  /tftpboot
[INFO] successfully built rootfs
taterli@taterli-VirtualBox:~/TATERLI-ZYNQ$ ls images/linux/
BOOT.BIN     rootfs.cpio.bz2       rootfs.ext3.bz2  rootfs.jffs2     rootfs.testdata.json  u-boot.bin  zynq_fsbl.elf
image.ub     rootfs.cpio.gz        rootfs.ext4      rootfs.manifest  system.bit            u-boot.elf
rootfs.bin   rootfs.cpio.gz.u-boot rootfs.ext4.gz   rootfs.tar.bz2   system.dtb            vmlinux
rootfs.cpio  rootfs.ext3           rootfs.its       rootfs.tar.gz    System.map.linux      zImage
taterli@taterli-VirtualBox:~/TATERLI-ZYNQ$ 
```

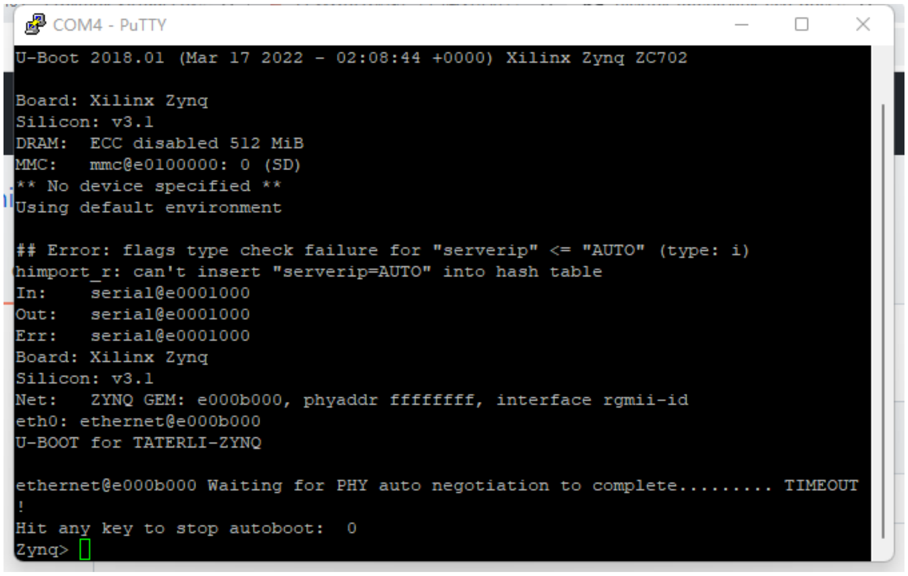
当然也可以不用这里的roofs,现在探讨一下image.ub是怎么来的,我这里是从PYNQ镜像中看.

```
taterli@taterli-VirtualBox:/media/taterli/6D21-54E9$ mkimage -l image.ub
FIT description: U-Boot fitImage for PYNQ arm kernel
Created:         Wed Mar 16 00:20:08 2022
 Image 0 (kernel@0)
  Description:  Linux Kernel
  Created:      Wed Mar 16 00:20:08 2022
  Type:         Kernel Image
  Compression:  uncompressed
  Data Size:    4482000 Bytes = 4376.95 kB = 4.27 MB
  Architecture: ARM
  OS:           Linux
  Load Address: 0x00080000
  Entry Point:  0x00080000
  Hash algo:    sha1
  Hash value:   4ef51adc7d169b16475dd05f94fb86c054ce75ec
 Image 1 (fdt@0)
  Description:  Flattened Device Tree blob
  Created:      Wed Mar 16 00:20:08 2022
  Type:         Flat Device Tree
  Compression:  uncompressed
  Data Size:    16597 Bytes = 16.21 kB = 0.02 MB
  Architecture: ARM
  Hash algo:    sha1
  Hash value:   64c58fd816259cae2f2dff4282c49ebcb8413c44
 Default Configuration: 'conf@1'
 Configuration 0 (conf@1)
  Description:  Boot Linux kernel with FDT blob
  Kernel:       kernel@0
  FDT:          fdt@0
```

可见他只包含了内核和配置,因此完全可以不要他,直接我们拆开来.

```
taterli@taterli-VirtualBox:/media/taterli/6D21-54E9$ cp ~/xlnx-eco-bak/arch/arm/boot/zImage .
taterli@taterli-VirtualBox:/media/taterli/6D21-54E9$ cp ~/xlnx-eco-bak/arch/arm/boot/dts/system-top.dtb system.dtb
taterli@taterli-VirtualBox:/media/taterli/6D21-54E9$ cp ~/TATERLI-ZYNQ/images/linux/system.bit .
taterli@taterli-VirtualBox:/media/taterli/6D21-54E9$ cp ~/TATERLI-ZYNQ/images/linux/BOOT.BIN .
taterli@taterli-VirtualBox:/media/taterli/6D21-54E9$ ls -alh
总用量 6.5M
drwxr-xr-x  3 taterli taterli  16K Mar 16 19:48 .
drwxr-x---+ 4 root    root    4.0K Mar 16 19:45 ..
-rw-r--r--  1 taterli taterli 601K Mar 16 19:49 BOOT.BIN
-rw-r--r--  1 taterli taterli 2.0M Mar 16 19:48 system.bit
-rw-r--r--  1 taterli taterli  12K Mar 16 19:48 system.dtb
-rw-r--r--  1 taterli taterli 3.8M Mar 16 19:48 zImage
taterli@taterli-VirtualBox:/media/taterli/6D21-54E9$
```

现在插入然后应该启动不了的.因为启动方法和传统已经不一样了.



```
U-Boot 2018.01 (Mar 17 2022 - 02:08:44 +0000) Xilinx Zynq ZC702

Board: Xilinx Zynq
Silicon: v3.1
DRAM:  ECC disabled 512 MiB
MMC:   mmc@e0100000: 0 (SD)
** No device specified **
Using default environment

## Error: flags type check failure for "serverip" <= "AUTO" (type: i)
himport_r: can't insert "serverip=AUTO" into hash table
In:    serial@e0001000
Out:   serial@e0001000
Err:   serial@e0001000
Board: Xilinx Zynq
Silicon: v3.1
Net:   ZYNQ GEM: e000b000, phyaddr ffffffff, interface rgmii-id
eth0: ethernet@e000b000
U-BOOT for TATERLI-ZYNQ

ethernet@e000b000 Waiting for PHY auto negotiation to complete......... TIMEOUT
!
Hit any key to stop autoboot:  0
Zynq>
```

设置一下启动环境(命令很简单,大家不懂就网上学习一些U-Boot常用命令):

```
setenv bitstream_load_address 0x100000
setenv bitstream_image system.bit
setenv bitstream_size 0x300000
setenv kernel_img zImage
setenv dtbnetstart 0x2000000
setenv netstart 0x2080000
setenv default_bootcmd 'if mmcinfo; then run uenvboot; echo Copying Linux from SD to RAM... && load mmc
0 ${bitstream_load_address} ${bitstream_image} && fpga loadb 0 ${bitstream_load_address} ${bitstream_size}
&& run cp_kernel2ram && run cp_dtb2ram && bootz ${netstart} - ${dtbnetstart}; fi;'
saveenv
```

测试效果和正常启动一样.