실습 2-2: BBB용 u-boot 빌드하기

1. 준비

장비: USB-TTL Serial 3.3V 케이블, SD card, SD card reader기

$HOME/ESP2018/chap02/bootloader 디렉토리를 만든다. 다음과 같이 먼저 git을 설치한다.

```
ohheum@ubuntu:~$ sudo apt-get install git
ohheum@ubuntu:~$ git config --global user.email "ohheum@gmail.com"
ohheum@ubuntu:~$ git config --global user.name "Oh-Heum Kwon"
```

2. u-boot 다운로드 및 빌드하기

```
ohheum@ubuntu:~/ESP2018/chap02/bootloader$ git clone https://github.com/u-boot/u-boot

ohheum@ubuntu:~/ESP2018/chap02/bootloader$ cd u-boot/
```

이전 상태로 되돌리는 명령어

```
ohheum@ubuntu:~/ESP2018/chap02/bootloader/u-boot$ git checkout v2018.01 -b tmp

ohheum@ubuntu:~/ESP2018/chap02/bootloader/u-boot$ wget -c https://rcn-ee.com/repos/git/
u-boot-patches/v2018.01/0001-am335x_evm-uEnv.txt-bootz-n-fixes.patch

ohheum@ubuntu:~/ESP2018/chap02/bootloader/u-boot$ wget -c https://rcn-ee.com/repos/git/
u-boot-patches/v2018.01/0002-U-Boot-BeagleBone-Cape-Manager.patch

ohheum@ubuntu:~/ESP2018/chap02/bootloader/u-boot$ patch -p1 < 0001-am335x_evm-uEnv.txt-
bootz-n-fixes.patch

ohheum@ubuntu:~/ESP2018/chap02/bootloader/u-boot$ patch -p1 < 0002-U-Boot-BeagleBone-
Cape-Manager.patch

ohheum@ubuntu:~/ESP2018/chap02/bootloader/u-boot$ export ARCH=arm CROSS_COMPILE=arm-
linux-gnueabihf-
```

변수 선언=값

모든 프로세스에 대해서 propagation.

```
ohheum@ubuntu:~/ESP2018/chap02/bootloader/u-boot$ make distclean
```

잘못했을때 이전에 했던것을 지우고 다시 시작해야할때 사용

```
ohheum@ubuntu:~/ESP2018/chap02/bootloader/u-boot$ make am335x_evm_defconfig

ohheum@ubuntu:~/ESP2018/chap02/bootloader/u-boot$ make

ohheum@ubuntu:~/ESP2018/chap02/bootloader/u-boot$ ls
0001-am335x_evm-uEnv.txt-bootz-n-fixes.patch  include      snapshot.commit
api                                           Kbuild       spl
arch                                          Kconfig      System.map
board                                         lib          test
common                                        Licenses     tools
config.mk                                     MAINTAINERS  u-boot
configs                                       MAKEALL      u-boot.bin
disk                                          Makefile     u-boot.cfg
doc                                           MLO          u-boot.img
drivers                                       net          u-boot.lds
dts                                           post         u-boot.map
examples                                      README       u-boot.srec
fs                                            scripts
```

MLO와 u-boot.img 파일을 확인한다.

3. SD 카드 포맷하기

SD 카드를 꽂는다. /media/<user-id> 디렉토리를 확인한다. 만약 자동으로 mount되면 다음과 같이 umount한다. (GUI에서 eject하면 안됨)

```
$ sudo umount /dev/sdc1
$ sudo umount /dev/sdc2
```

이때 디바이스명(sdc1, sdc2)은 PC마다 다를 수 있다. 보통 sda는 OS가 설치된 하드디스크이고, 그 외의 추가 블록 저장 장치들은 sdb, sdc등으로 이름이 정해진다. 이 예에서는 sdc로 잡힌 것이다. 그리고 노트북의 sd card slot에 꽂았을 경우에는 디바이스 명이 mmcblk이 된다. 이 경우 이하에서 sdc를 mmcblk로 바꾸면 된다.

```
ohheum@ubuntu:~$ ls /dev/sd*
/dev/sda  /dev/sda1  /dev/sda2  /dev/sda5   /dev/sdc
```

파티션 하기:

```
ohheum@ubuntu:~$ sudo fdisk /dev/sdc

Command (m for help): m
Command action
   a   toggle a bootable flag
   b   edit bsd disklabel
   c   toggle the dos compatibility flag
   d   delete a partition
   l   list known partition types
   m   print this menu
   n   add a new partition
   o   create a new empty DOS partition table
   p   print the partition table
   q   quit without saving changes
   s   create a new empty Sun disklabel
   t   change a partition's system id
   u   change display/entry units
   v   verify the partition table
   w   write table to disk and exit
   x   extra functionality (experts only)

Command (m for help): l

 0  Empty           24  NEC DOS         81  Minix / old Lin bf  Solaris
 1  FAT12           27  Hidden NTFS Win 82  Linux swap / So c1  DRDOS/sec (FAT-
 2  XENIX root      39  Plan 9          83  Linux           c4  DRDOS/sec (FAT-
 3  XENIX usr       3c  PartitionMagic  84  OS/2 hidden C:  c6  DRDOS/sec (FAT-
 4  FAT16 <32M      40  Venix 80286     85  Linux extended  c7  Syrinx
 5  Extended        41  PPC PReP Boot   86  NTFS volume set da  Non-FS data
 6  FAT16           42  SFS             87  NTFS volume set db  CP/M / CTOS / .
 7  HPFS/NTFS/exFAT 4d  QNX4.x          88  Linux plaintext de  Dell Utility
 8  AIX             4e  QNX4.x 2nd part 8e  Linux LVM       df  BootIt
 9  AIX bootable    4f  QNX4.x 3rd part 93  Amoeba          e1  DOS access
 a  OS/2 Boot Manag 50  OnTrack DM      94  Amoeba BBT      e3  DOS R/O
 b  W95 FAT32       51  OnTrack DM6 Aux 9f  BSD/OS          e4  SpeedStor
```

```
 c  W95 FAT32 (LBA) 52  CP/M            a0  IBM Thinkpad hi eb  BeOS fs
 e  W95 FAT16 (LBA) 53  OnTrack DM6 Aux a5  FreeBSD         ee  GPT
 f  W95 Ext'd (LBA) 54  OnTrackDM6      a6  OpenBSD         ef  EFI (FAT-12/16/
10  OPUS            55  EZ-Drive        a7  NeXTSTEP        f0  Linux/PA-RISC b
11  Hidden FAT12    56  Golden Bow      a8  Darwin UFS      f1  SpeedStor
12  Compaq diagnost 5c  Priam Edisk     a9  NetBSD          f4  SpeedStor
14  Hidden FAT16 <3 61  SpeedStor       ab  Darwin boot     f2  DOS secondary
16  Hidden FAT16    63  GNU HURD or Sys af  HFS / HFS+      fb  VMware VMFS
17  Hidden HPFS/NTF 64  Novell Netware  b7  BSDI fs         fc  VMware VMKCORE
18  AST SmartSleep  65  Novell Netware  b8  BSDI swap       fd  Linux raid auto
1b  Hidden W95 FAT3 70  DiskSecure Mult bb  Boot Wizard hid fe  LANstep
1c  Hidden W95 FAT3 75  PC/IX           be  Solaris boot    ff  BBT
1e  Hidden W95 FAT1 80  Old Minix

Command (m for help): p

Disk /dev/sdc: 15.9 GB, 15931539456 bytes
64 heads, 32 sectors/track, 15193 cylinders, total 31116288 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x000b4911

   Device Boot      Start         End      Blocks   Id  System
/dev/sdc1   *        2048      100351       49152    e  W95 FAT16 (LBA)
/dev/sdc2          100352    31115263    15507456   83  Linux

Command (m for help): d
Partition number (1-4): 2

Command (m for help): p

Disk /dev/sdc: 15.9 GB, 15931539456 bytes
64 heads, 32 sectors/track, 15193 cylinders, total 31116288 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x000b4911

   Device Boot      Start         End      Blocks   Id  System
/dev/sdc1   *        2048      100351       49152    e  W95 FAT16 (LBA)

Command (m for help): d 1
Selected partition 1

Command (m for help): p

Disk /dev/sdc: 15.9 GB, 15931539456 bytes
64 heads, 32 sectors/track, 15193 cylinders, total 31116288 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x000b4911

   Device Boot      Start         End      Blocks   Id  System
```

```
Command (m for help): n
Partition type:
   p   primary (0 primary, 0 extended, 4 free)
   e   extended
Select (default p): p
Partition number (1-4, default 1): 1
First sector (2048-31116287, default 2048):
Using default value 2048
Last sector, +sectors or +size{K,M,G} (2048-31116287, default 31116287): +48M

Command (m for help): p

Disk /dev/sdc: 15.9 GB, 15931539456 bytes
64 heads, 32 sectors/track, 15193 cylinders, total 31116288 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x000b4911

   Device Boot      Start         End      Blocks   Id  System
/dev/sdc1            2048      100351       49152   83  Linux

Command (m for help): n
Partition type:
   p   primary (1 primary, 0 extended, 3 free)
   e   extended
Select (default p): p
Partition number (1-4, default 2): 2
First sector (100352-31116287, default 100352):
Using default value 100352
Last sector, +sectors or +size{K,M,G} (100352-31116287, default 31116287):
Using default value 31116287

Command (m for help): p

Disk /dev/sdc: 15.9 GB, 15931539456 bytes
64 heads, 32 sectors/track, 15193 cylinders, total 31116288 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x000b4911

   Device Boot      Start         End      Blocks   Id  System
/dev/sdc1            2048      100351       49152   83  Linux
/dev/sdc2          100352    31116287    15507968   83  Linux

Command (m for help): a
Partition number (1-4): 1

Command (m for help): p

Disk /dev/sdc: 15.9 GB, 15931539456 bytes
64 heads, 32 sectors/track, 15193 cylinders, total 31116288 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
```

```
Disk identifier: 0x000b4911

   Device Boot      Start         End      Blocks   Id  System
/dev/sdc1   *        2048      100351       49152   83  Linux
/dev/sdc2          100352    31116287    15507968   83  Linux

Command (m for help): t
Partition number (1-4): 1
Hex code (type L to list codes): L

 0  Empty           24  NEC DOS         81  Minix / old Lin bf  Solaris
 1  FAT12           27  Hidden NTFS Win 82  Linux swap / So c1  DRDOS/sec (FAT-
 2  XENIX root      39  Plan 9          83  Linux           c4  DRDOS/sec (FAT-
 3  XENIX usr       3c  PartitionMagic  84  OS/2 hidden C:  c6  DRDOS/sec (FAT-
 4  FAT16 <32M      40  Venix 80286     85  Linux extended  c7  Syrinx
 5  Extended        41  PPC PReP Boot   86  NTFS volume set da  Non-FS data
 6  FAT16           42  SFS             87  NTFS volume set db  CP/M / CTOS / .
 7  HPFS/NTFS/exFAT 4d  QNX4.x          88  Linux plaintext de  Dell Utility
 8  AIX             4e  QNX4.x 2nd part 8e  Linux LVM       df  BootIt
 9  AIX bootable    4f  QNX4.x 3rd part 93  Amoeba          e1  DOS access
 a  OS/2 Boot Manag 50  OnTrack DM      94  Amoeba BBT      e3  DOS R/O
 b  W95 FAT32       51  OnTrack DM6 Aux 9f  BSD/OS          e4  SpeedStor
 c  W95 FAT32 (LBA) 52  CP/M            a0  IBM Thinkpad hi eb  BeOS fs
 e  W95 FAT16 (LBA) 53  OnTrack DM6 Aux a5  FreeBSD         ee  GPT
 f  W95 Ext'd (LBA) 54  OnTrackDM6      a6  OpenBSD         ef  EFI (FAT-12/16/
10  OPUS            55  EZ-Drive        a7  NeXTSTEP        f0  Linux/PA-RISC b
11  Hidden FAT12    56  Golden Bow      a8  Darwin UFS      f1  SpeedStor
12  Compaq diagnost 5c  Priam Edisk     a9  NetBSD          f4  SpeedStor
14  Hidden FAT16 <3 61  SpeedStor       ab  Darwin boot     f2  DOS secondary
16  Hidden FAT16    63  GNU HURD or Sys af  HFS / HFS+      fb  VMware VMFS
17  Hidden HPFS/NTF 64  Novell Netware  b7  BSDI fs         fc  VMware VMKCORE
18  AST SmartSleep  65  Novell Netware  b8  BSDI swap       fd  Linux raid auto
1b  Hidden W95 FAT3 70  DiskSecure Mult bb  Boot Wizard hid fe  LANstep
1c  Hidden W95 FAT3 75  PC/IX           be  Solaris boot    ff  BBT
1e  Hidden W95 FAT1 80  Old Minix
Hex code (type L to list codes): e
Changed system type of partition 1 to e (W95 FAT16 (LBA))

Command (m for help): p

Disk /dev/sdc: 15.9 GB, 15931539456 bytes
64 heads, 32 sectors/track, 15193 cylinders, total 31116288 sectors
Units = sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disk identifier: 0x000b4911

   Device Boot      Start         End      Blocks   Id  System
/dev/sdc1   *        2048      100351       49152    e  W95 FAT16 (LBA)
/dev/sdc2          100352    31116287    15507968   83  Linux

Command (m for help): w
The partition table has been altered!

Calling ioctl() to re-read partition table.
```

```
WARNING: Re-reading the partition table failed with error 16: Device or
resource busy.
The kernel still uses the old table. The new table will be used at
the next reboot or after you run partprobe(8) or kpartx(8)

WARNING: If you have created or modified any DOS 6.x
partitions, please see the fdisk manual page for additional
information.
Syncing disks.
```

포맷하기:

```
ohheum@ubuntu:~$ sudo mkfs.vfat -F 16 /dev/sdc1 -n boot

ohheum@ubuntu:~$ sudo mkfs.ext4 /dev/sdc2 -L rootfs
```

마운트하기:

```
ohheum@ubuntu:~$ sudo mkdir -p /media/boot

ohheum@ubuntu:~$ sudo mkdir /media/rootfs

ohheum@ubuntu:~$ sudo umount /dev/sdc1

ohheum@ubuntu:~$ sudo umount /dev/sdc2

ohheum@ubuntu:~$ sudo mount /dev/sdc1 /media/boot/

ohheum@ubuntu:~$ sudo mount /dev/sdc2 /media/rootfs/
```

원하는 곳에 붙이는걸 mount라 한다.

SD 카드로 부트로더 복사하기:

ESP를 따라들어간 u-boot

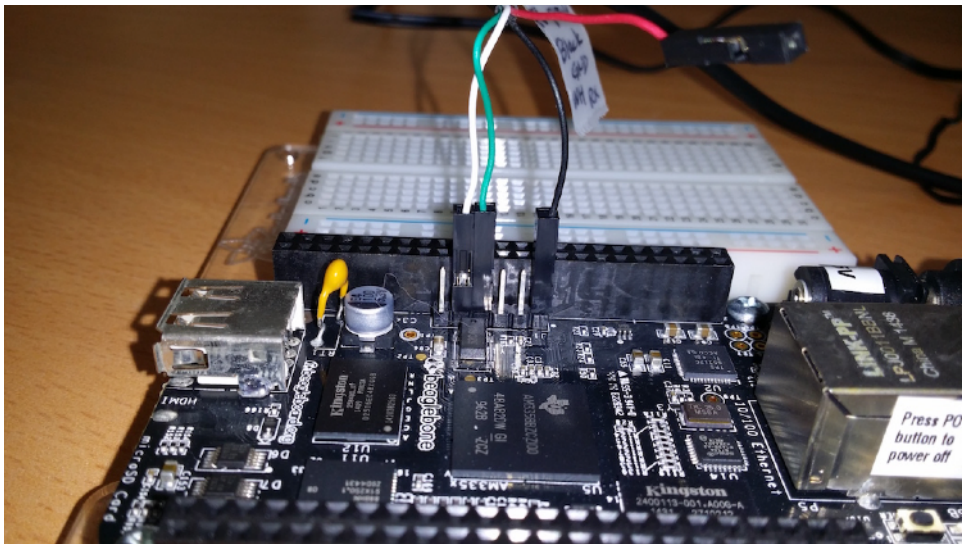
```
ohheum@ubuntu:~$  cd u-boot/

ohheum@ubuntu:~/u-boot$  sudo cp MLO /media/boot/

ohheum@ubuntu:~/u-boot$  sudo cp u-boot.img /media/boot/
```

Ubuntu에서 sd카드를 eject한다.

4. USB-To-Serial 케이블 연결하기



USB-to-TTL Cable: https://www.adafruit.com/products/954
(There are four wires: red power, black ground, white RX into USB port, and green TX out of the USB port. The power pin provides the 5V @ 500mA direct from the USB port and the RX/TX pins are 3.3V level for interfacing with the most common 3.3V logic level chipsets.)

5. BBB에서 부터로더 실행하기

```
ohheum@ubuntu:~$ sudo apt-get install picocom
ohheum@ubuntu:~$ ls /dev/ttyUSB0
/dev/ttyUSB0
ohheum@ubuntu:~$ sudo picocom -b 115200 /dev/ttyUSB0
```

BBB의 “Boot 버튼”을 누른 상태에서 Power On하여 SD 카드로 부터 부팅한다.

```
U-Boot 2018.01-rc1-dirty (Feb 10 2017 - 17:07:40 -0800)

CPU  : AM335X-GP rev 2.1
I2C:   ready
DRAM:  512 MiB
Reset Source: Power-on reset has occurred.
MMC:   OMAP SD/MMC: 0, OMAP SD/MMC: 1
Using default environment

<ethaddr> not set. Validating first E-fuse MAC
BeagleBone Black:
BeagleBone: cape eeprom: i2c_probe: 0x54:
BeagleBone: cape eeprom: i2c_probe: 0x55:
BeagleBone: cape eeprom: i2c_probe: 0x56:
BeagleBone: cape eeprom: i2c_probe: 0x57:
Net:   eth0: MII MODE
cpsw
Press SPACE to abort autoboot in 2 seconds
=>
=>
```