

# U-Boot beagleboneblack Documentation

## Abstract

### *About this Document*

The documentation is written in [reStructuredText](#) and converted into a pdf document. Some parts of this document are created automatically out of the log files from the [tbot](#) build process.

This document is generated for the beagleboneblack with U-Boot version

U-Boot 2017.09-rc2-00151-g2d7cb5b (Aug 23 2017 - 08:35:31 +0200)

### *Introduction*

This document describes how to use the firmware U-Boot and the operating system Linux in Embedded Power Architecture®, ARM and MIPS Systems.

There are many steps along the way, and it is nearly impossible to cover them all in depth, but we will try to provide all necessary information to get an embedded system running from scratch. This includes all the tools you will probably need to configure, build and run U-Boot and Linux.

First, we describe how to install the Cross Development Tools Embedded Linux Development Kit which you probably need - at least when you use a standard x86 PC running Linux or a Sun Solaris 2.6 system as build environment.

Then we describe what needs to be done to connect to the serial console port of your target: you will have to configure a terminal emulation program like `cu` or `kermit`.

In most cases you will want to load images into your target using ethernet; for this purpose you need TFTP and DHCP / BOOTP servers. A short description of their configuration is given.

A description follows of what needs to be done to configure and build the U-Boot for the beagleboneblack board, and how to install it and get it working on that board.

The configuration, building and installing of Linux in an embedded configuration is the next step. We use SELF, our Simple Embedded Linux Framework, to demonstrate how to set up both a development system (with the root filesystem mounted over NFS) and an embedded target configuration (running from a ramdisk image based on busybox).

This document does not describe what needs to be done to port U-Boot or Linux to a new hardware platform. Instead, it is silently assumed that your board is already supported by U-Boot and Linux.

## ***Disclaimer***

Use the information in this document at your own risk. DENX disavows any potential liability for the contents of this document. Use of the concepts, examples, and/or other content of this document is entirely at your own risk. All copyrights are owned by their owners, unless specifically noted otherwise. Use of a term in this document should not be regarded as affecting the validity of any trademark or service mark. Naming of particular products or brands should not be seen as endorsements.

# U-Boot

## *Current Versions*

Das U-Boot (or just "U-Boot" for short) is Open Source Firmware for Embedded Power Architecture®, ARM, MIPS, x86 and other processors. The U-Boot project is hosted by DENX, where you can also find the project home page: <http://www.denx.de/wiki/U-Boot/>

The current version of the U-Boot source code can be retrieved from the DENX "git" repository.

You can browse the "git" repositories at <http://git.denx.de/>

The trees can be accessed through the git, HTTP, and rsync protocols. For example you can use one of the following commands to create a local clone of one of the source trees:

```
git clone git://git.denx.de/u-boot.git u-boot/  
git clone http://git.denx.de/u-boot.git u-boot/  
git clone rsync://git.denx.de/u-boot.git u-boot/
```

For details please see here.

Official releases of U-Boot are also available through FTP. Compressed tar archives can be downloaded from the directory <ftp://ftp.denx.de/pub/u-boot/>.

# ***Get U-Boot code for the beagleboneblack***

## ***define some PATH variables***

Export our workdirectory:

```
$ export TBOT_BASEDIR=/work/hs/tbot  
$
```

and cd into it

```
$ cd $TBOT_BASEDIR  
$
```

## ***clone the U-Boot code***

Now we simply clone the U-Boots source code with git:

```
$ git clone /home/hs/git/u-boot u-boot-am335x_evm
Klone nach 'u-boot-am335x_evm'...
Fertig.
$
```

cd into it

```
$ cd u-boot-am335x_evm
$
```

checkout the branch you want to test

```
$ git checkout master
Bereits auf 'master'
Ihr Branch ist auf dem selben Stand wie 'origin/master'.
$
```

just for the records, print some info of the branch

```
$ git describe --tags
v2017.09-rc2-151-g2d7cb5b
$
```

## ***setup toolchain***

This depends on the toolchain you use.

```
$ printenv PATH | grep --color=never /opt/eldk-5.4/armv5te/sysroots/i686-eldk-linux/usr/bin/armv5te-\  
linux-gnueabi  
$ export PATH=/opt/eldk-5.4/armv5te/sysroots/i686-eldk-linux/usr/bin/armv5te-linux-gnueabi:$PATH  
$ export CROSS_COMPILE=arm-linux-gnueabi-  
$
```

# ***compile U-Boot for the beagleboneblack***

Add the path to the dtc command to your PATH variable

```
$ export PATH=$TBOT_BASEDIR/dtc:$PATH
$
```

clean the source code

```
$ make mrproper
$
```

configure source for the beagleboneblack

```
$ make am335x_evm_defconfig
HOSTCC scripts/basic/fixdep
HOSTCC scripts/kconfig/conf.o
SHIPPED scripts/kconfig/zconf.tab.c
SHIPPED scripts/kconfig/zconf.lex.c
SHIPPED scripts/kconfig/zconf.hash.c
HOSTCC scripts/kconfig/zconf.tab.o
HOSTLD scripts/kconfig/conf
#
# configuration written to .config
#
$
```

Now compile it

```
$ make -s DTC_FLAGS="-S 0xb000" all
*** Your GCC is older than 6.0 and will not be supported starting in v2018.01.
===== WARNING =====
This board uses CONFIG_DM_I2C_COMPAT. Please remove
(possibly in a subsequent patch in your series)
before sending patches to the mailing list.
=====
$
```

after U-Boot is compiled, copy the resulting binaries we need later to our tftpboot directory.

```
$ cp u-boot.bin /var/lib/tftpboot/beagleboneblack/tbot
$
$ cp u-boot.img /var/lib/tftpboot/beagleboneblack/tbot
$
$ cp MLO /var/lib/tftpboot/beagleboneblack/tbot
$
```

We also copy the u-boot.dtb file to our tftp directory, as we do some testing with it later.

```
$ cp u-boot.dtb /var/lib/tftpboot/beagleboneblack/tbot
$
```

# ***U-Boot installation***

## ***install U-Boot***

for this example, we install the new U-Boot on the SD card, as we use SD card bootmode.

```
=> print tbot_upd_uboot load_uboot upd_uboot
tbot_upd_uboot=run load_uboot;run upd_uboot
load_uboot=tftp ${load_addr_r} ${ubfile}
upd_uboot=fatwrite mmc 1:1 ${load_addr_r} u-boot.img ${filesize}
=>
```

tftp the new u-boot image into ram and write it to the sd card.

```
=> run tbot_upd_uboot
link up on port 0, speed 100, full duplex
Using ethernet@4a100000 device
TFTP from server 192.168.2.1; our IP address is 192.168.2.11
Filename 'beagleboneblack/tbot/u-boot.img'.
Load address: 0x81000000
Loading: *■#####
          4.6 MiB/s
done
Bytes transferred = 734224 (b3410 hex)
writing u-boot.img
734224 bytes written
=>
```

## ***install SPL***

for this example, we install the new SPL on the SD card, as we use SD card bootmode.

```
=> print tbot_upd_spl load_mlo upd_mlo
tbot_upd_spl=run load_mlo;run upd_mlo
load_mlo=tftp ${load_addr_r} ${mlofile}
upd_mlo=fatwrite mmc 1:1 ${load_addr_r} mlo ${filesize}
=>
```

tftp the new SPL image into ram and write it to the sd card.

```
=> run tbot_upd_spl
link up on port 0, speed 100, full duplex
Using ethernet@4a100000 device
TFTP from server 192.168.2.1; our IP address is 192.168.2.11
Filename 'beagleboneblack/tbot/MLO'.
Load address: 0x81000000
Loading: *■#####
          4.3 MiB/s
done
Bytes transferred = 95468 (174ec hex)
writing mlo
95468 bytes written
=>
```



# Tool Installation

U-Boot uses a special image format when loading the Linux kernel or ramdisk or other images. This image contains (among other things) information about the time of creation, operating system, compression type, image type, image name and CRC32 checksums.

The tool **mkimage** is used to create such images or to display the information they contain. When using the **ELDK**, the **mkimage** command is already included with the other **ELDK** tools.

If you don't use the **ELDK** then you should install **mkimage** in some directory that is in your command search PATH, for instance:

```
$ cp tools/mkimage /usr/local/bin/
```

**mkimage** is readily available in several distributions; for example, in **Ubuntu** it is part of the **u-boot-tools** package, so it can be installed with:

```
$ sudo apt-get install u-boot-tools
```

In **Fedora** the package name is **uboot-tools**, and the command to install it is:

```
$ sudo dnf install uboot-tools
```

Finally, if you're building with **OpenEmbedded** or **Yocto Project**, you would want to add the **u-boot-fw-utils** recipe to your image.

# ***U-Boot Command Line Interface***

The following section describes the most important commands available in U-Boot. Please note that U-Boot is highly configurable, so not all of these commands may be available in the configuration of U-Boot installed on your hardware, or additional commands may exist. You can use the help command to print a list of all available commands for your configuration.

For most commands, you do not need to type in the full command name; instead it is sufficient to type a few characters. For instance, help can be abbreviated as h.



The behaviour of some commands depends on the configuration of U-Boot and on the definition of some variables in your U-Boot environment.

Almost all U-Boot commands expect numbers to be entered in hexadecimal input format. (Exception: for historical reasons, the sleep command takes its argument in decimal input format.)

Be careful not to use edit keys besides 'Backspace', as hidden characters in things like environment variables can be very difficult to find.

## Information Commands

### ***bdfinfo*** - print Board Info structure

```
=> help bdfinfo
bdfinfo - print Board Info structure

Usage:
bdfinfo
=>
```

The **bdfinfo** command (**bdi**) prints the information that U-Boot passes about the board such as memory addresses and sizes, clock frequencies, MAC address, etc. This information is mainly needed to be passed to the Linux kernel.

```
=> bdi
arch_number = 0x00000E05
boot_params = 0x80000100
DRAM bank   = 0x00000000
-> start     = 0x80000000
-> size      = 0x20000000
baudrate     = 115200 bps
TLB addr     = 0x9FFF0000
relocaddr    = 0x9FF4E000
reloc off    = 0x1F74E000
irq_sp       = 0x9DF21EC0
sp start     = 0x9DF21EB0
Early malloc usage: 188 / 400
fdt_blob = 9df21ed8
=>
```

## ***coninfo - print console devices and informations***

```
=> help conin
coninfo - print console devices and information

Usage:
coninfo
=>
```

The **coninfo** command (**conin**) displays information about the available console I/O devices.

```
=> conin
List of available devices:
serial@44e09000 00000007 IO stdin stdout stderr
serial 00000003 IO
=>
```

The output contains the device name, flags, and the current usage. For example, the output

```
serial@44e09000 00000003 IO stdin stdout stderr
```

means that the serial device provides input (flag 'I') and output (flag 'O') functionality and is currently assigned to the 3 standard I/O streams stdin, stdout and stderr.

## ***flinfo - print FLASH memory information***

```
=> help flinfo
Unknown command 'flinfo' - try 'help' without arguments for list of all known commands
=>
```

The command **flinfo** (**fli**) can be used to get information about the available flash memory (see Flash Memory Commands below).

```
=> flinfo
Unknown command 'flinfo' - try 'help'
=>
```

## ***help - print online help***

```
=> help help
help - print command description/usage

Usage:
help
    - print brief description of all commands
help command ...
    - print detailed usage of 'command'

=>
```

The **help** command (**h** or **?**) prints online help. Without any arguments, it prints a list of all U-Boot commands that are available in your configuration of U-Boot. You can get detailed information for a specific command by typing its name as argument to the help command:

```
=> help printenv tftp
printenv - print environment variables

Usage:
printenv [-a]
    - print [all] values of all environment variables
printenv name ...
    - print value of environment variable 'name'
tftpboot - boot image via network using TFTP protocol

Usage:
tftpboot [loadAddress] [[hostIPAddr:]bootfilename]

=>
```

## Memory Commands

### ***base - print or set address offset***

```
=> help base
base - print or set address offset

Usage:
base
- print address offset for memory commands
base off
- set address offset for memory commands to 'off'
=>
```

You can use the **base** command (**ba**) to print or set a "base address" that is used as the address offset for all subsequent memory commands; the default value of the base address is 0, so all addresses you enter are used unmodified. However, when you repeatedly have to access a certain memory region (like the internal memory of some embedded Power Architecture® processors) it can be very convenient to set the base address to the start of this area and then use only the offsets:

ToDo

### ***crc32 - checksum calculation***

The **crc32** command (**crc**) can be used to calculate a CRC32 checksum over a range of memory:

```
=> crc 0x80000004 0x3fc a6d53e40
=>
```

When used with 3 arguments, the command stores the calculated checksum at the given address:

```
=> crc 0x80000004 0x3fc 0x80000000 a6d53e40
=> md 0x80000000 4
80000000: 403ed5a6 b9070000 38000000 38070000    ..>@.....8...8
=>
```

As you can see, the CRC32 checksum was not only printed, but also stored at address passed in the 3th argument.

## cmp - memory compare

```
=> help cmp
cmp - memory compare

Usage:
cmp [.b, .w, .l] addr1 addr2 count
=>
```

With the **cmp** command you can test whether the contents of two memory areas are identical or not. The command will test either the whole area as specified by the 3rd (length) argument, or stop at the first difference.

```
=> cmp 0x80000000 0x80100000 40000
Total of 262144 word(s) were the same
=> md 0x80000000 0xc
80000000: 1cec5b8c 381401ad 6778e393 01fbbcc3  .[....8..xg....
80000010: 89e9712a 0fb40e16 6f236743 3b46fbe6  *q.....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f  .V#..T|nw.V....{
=> md 0x80100000 0xc
80100000: 1cec5b8c 381401ad 6778e393 01fbbcc3  .[....8..xg....
80100010: 89e9712a 0fb40e16 6f236743 3b46fbe6  *q.....Cg#o..F;
80100020: ea2356f6 6e7c540f e056e377 7bd28a9f  .V#..T|nw.V....{
=>
```

Like most memory commands the `:redtext:cmp`` can access the memory in different sizes: as 32 bit (long word), 16 bit (word) or 8 bit (byte) data. If invoked just as `cmp` the default size (32 bit or long words) is used; the same can be selected explicitly by typing `cmp.l` instead. If you want to access memory as 16 bit or word data, you can use the variant `cmp.w` instead; and to access memory as 8 bit or byte data please use `cmp.b`.



Please note that the count argument specifies the number of data items to process, i. e. the number of long words or words or bytes to compare.

```
=> cmp.l 0x80000000 0x80100000 40000
Total of 262144 word(s) were the same
=> cmp.w 0x80000000 0x80100000 80000
Total of 524288 halfword(s) were the same
=> cmp.b 0x80000000 0x80100000 100000
Total of 1048576 byte(s) were the same
=>
```



## ***cp - memory copy***

```
=> help cp
cp - memory copy

Usage:
cp [.b, .w, .l] source target count
=>
```

The **cp** command is used to copy memory areas.

```
=> cp 0x80000000 0x80100000 10000
=>
```

The **cp** command understands the type extensions **.l**, **.w** and **.b** :

```
=> cp.l 0x80000000 0x80100000 10000
=> cp.w 0x80000000 0x80100000 20000
=> cp.b 0x80000000 0x80100000 40000
=>
```

## md - memory display

```
=> help md
md - memory display

Usage:
md [.b, .w, .l] address [# of objects]
=>
```

The **md** command can be used to display memory contents both as hexadecimal and ASCII data.

```
=> md 0x80000000
80000000: 1cec5b8c 381401ad 6778e393 01fbbcc3      .[.....8..xg....
80000010: 89e9712a 0fb40e16 6f236743 3b46fbe6      *q.....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f      .V#..T|nw.V....{
80000030: cfa9bcec b19ace51 b27f4dc5 8eeca28b      ....Q....M.....
80000040: ee9b1d07 09f8e81f 969e7603 6be76204      .....v...b.k
80000050: b0de9f91 0b9a6062 825adf5e 6914b64e      ....b`..^.Z.N..i
80000060: 31eb81cc ec1b3009 b7096df7 0546f59b      ...l.0...m....F.
80000070: d94137a6 3d455f1d 01549ffb 4d7b0a2d      .7A..._E=..T.-.{M
80000080: 8e8650b9 e2101ce1 d705d373 34455d16      .P.....s....]E4
80000090: b3776306 bb40cb3b 246c65e8 25587336      .cw.;.@..el$6sX%
800000a0: 65f88ce1 33c09949 67ca3299 e88b24bf      ...eI..3.2.g.$..
800000b0: 2057a219 45fe820a c5ae6da8 e9b39578      ..W ...E.m..x...
800000c0: 0d27e891 5201230c da4c518d bfa2cc2b      ..'..#.R.QL.+...
800000d0: 98386a41 803c36df 1b0d4c5d 09e31558      Aj8..6<.]L..X...
800000e0: 58ae8bf1 681bc92b 752a350e 3f057db9      ...X+...h.5*u..}.?
800000f0: a5e3bbbd c7c2239e ecf15559 e91c4375      .....#..YU..uC..
=>
```

This command can also be used with the type extensions **.l**, **.w** and **.b** :

```
=> md.w 0x80000000
80000000: 5b8c 1cec 01ad 3814 e393 6778 bcc3 01fb      .[.....8..xg....
80000010: 712a 89e9 0e16 0fb4 6743 6f23 fbe6 3b46      *q.....Cg#o..F;
80000020: 56f6 ea23 540f 6e7c e377 e056 8a9f 7bd2      .V#..T|nw.V....{
80000030: bcec cfa9 ce51 b19a 4dc5 b27f a28b 8eec      ....Q....M.....
80000040: 1d07 ee9b e81f 09f8 7603 969e 6204 6be7      .....v...b.k
80000050: 9f91 b0de 6062 0b9a df5e 825a b64e 6914      ....b`..^.Z.N..i
80000060: 81cc 31eb 3009 ec1b 6df7 b709 f59b 0546      ...l.0...m....F.
80000070: 37a6 d941 5f1d 3d45 9ffb 0154 0a2d 4d7b      .7A..._E=..T.-.{M
=> md.b 0x80000000
80000000: 8c 5b ec 1c ad 01 14 38 93 e3 78 67 c3 bc fb 01      .[.....8..xg....
80000010: 2a 71 e9 89 16 0e b4 0f 43 67 23 6f e6 fb 46 3b      *q.....Cg#o..F;
80000020: f6 56 23 ea 0f 54 7c 6e 77 e3 56 e0 9f 8a d2 7b      .V#..T|nw.V....{
80000030: ec bc a9 cf 51 ce 9a b1 c5 4d 7f b2 8b a2 ec 8e      ....Q....M.....
=>
```

The last displayed memory address and the value of the count argument are remembered, so when you enter md again without arguments it will automatically continue at the next address, and use the same count again.

```
=> md.b 0x80000000 0x20
80000000: 8c 5b ec 1c ad 01 14 38 93 e3 78 67 c3 bc fb 01  .[.....8..xg....
80000010: 2a 71 e9 89 16 0e b4 0f 43 67 23 6f e6 fb 46 3b  *q.....Cg#o..F;
=> md.w 0x80000000
80000000: 5b8c 1cec 01ad 3814 e393 6778 bcc3 01fb  .[.....8..xg....
80000010: 712a 89e9 0e16 0fb4 6743 6f23 fbe6 3b46  *q.....Cg#o..F;
80000020: 56f6 ea23 540f 6e7c e377 e056 8a9f 7bd2  .V#..T|nw.V....{
80000030: bcec cfa9 ce51 b19a 4dc5 b27f a28b 8eec  ....Q....M.....
=> md 0x80000000
80000000: 1cec5b8c 381401ad 6778e393 01fbbcc3  .[.....8..xg....
80000010: 89e9712a 0fb40e16 6f236743 3b46fbe6  *q.....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f  .V#..T|nw.V....{
80000030: cfa9bcec b19ace51 b27f4dc5 8eeca28b  ....Q....M.....
80000040: ee9b1d07 09f8e81f 969e7603 6be76204  ....v....b.k
80000050: b0de9f91 0b9a6062 825adf5e 6914b64e  ....b`..^.Z.N..i
80000060: 31eb81cc ec1b3009 b7096df7 0546f59b  ...1.0...m....F.
80000070: d94137a6 3d455f1d 01549ffb 4d7b0a2d  .7A..._E=..T.-.{M
=>
```

## ***mm - memory modify (auto-incrementing)***

```
=> help mm
mm - memory modify (auto-incrementing address)

Usage:
mm [.b, .w, .l] address
=>
```

The **mm** command is a method to interactively modify memory contents. It will display the address and current contents and then prompt for user input. If you enter a legal hexadecimal number, this new value will be written to the address. Then the next address will be prompted. If you don't enter any value and just press ENTER, then the contents of this address will remain unchanged. The command stops as soon as you enter any data that is not a hex number (like **.**):

```
=> mm 0x80000000
80000000: 1cec5b8c ? 0
80000004: 381401ad ? 0xaabbccdd
80000008: 6778e393 ? 0x01234567
8000000c: 01fbbcc3 ? .
=> md 0x80000000 10
80000000: 00000000 aabbccdd 01234567 01fbbcc3 .....gE#....
80000010: 89e9712a 0fb40e16 6f236743 3b46fbe6 *q.....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f .V#..T|nw.V....{
80000030: cfa9bcec b19ace51 b27f4dc5 8eeca28b ....Q....M.....
=>
```

Again this command can be used with the type extensions **.l**, **.w** and **.b** :

```
=> mm.w 0x80000000
80000000: 0000 ? 0x0101
80000002: 0000 ? 0x0202
80000004: ccdd ? 0x4321
80000006: aabb ? 0x8765
80000008: 4567 ? .
=> md 0x80000000 10
80000000: 02020101 87654321 01234567 01fbbcc3 ....!Ce.gE#....
80000010: 89e9712a 0fb40e16 6f236743 3b46fbe6 *q.....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f .V#..T|nw.V....{
80000030: cfa9bcec b19ace51 b27f4dc5 8eeca28b ....Q....M.....
=>
=> mm.b 0x80000000
80000000: 01 ? 0x48
80000001: 01 ? 0x65
80000002: 02 ? 0x6c
80000003: 02 ? 0x6c
80000004: 21 ? 0x6f
80000005: 43 ? 0x20
80000006: 65 ? 0x20
80000007: 87 ? 0x20
80000008: 67 ? .
=> md 0x80000000 10
80000000: 6c6c6548 2020206f 01234567 01fbbcc3 Hello gE#....
80000010: 89e9712a 0fb40e16 6f236743 3b46fbe6 *q.....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f .V#..T|nw.V....{
80000030: cfa9bcec b19ace51 b27f4dc5 8eeca28b ....Q....M.....
=>
```

## ***mw - memory write (fill)***

```
=> help mw
mw - memory write (fill)

Usage:
mw [.b, .w, .l] address value [count]
=>
```

The **mw** command is a way to initialize (fill) memory with some value. When called without a count argument, the value will be written only to the specified address. When used with a count value, the entire memory area will be initialized with this value:

```
=> md 0x80000000 0x10
80000000: 6c6c6548 2020206f 01234567 01fbbcc3      Hello   gE#....
80000010: 89e9712a 0fb40e16 6f236743 3b46fbe6      *q.....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f      .V#..T|nw.V....{
80000030: cfa9bcec b19ace51 b27f4dc5 8eeca28b      ....Q....M.....
=> mw 0x80000000 0xaabbccdd
=> md 0x80000000 0x10
80000000: aabbccdd 2020206f 01234567 01fbbcc3      ....o   gE#....
80000010: 89e9712a 0fb40e16 6f236743 3b46fbe6      *q.....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f      .V#..T|nw.V....{
80000030: cfa9bcec b19ace51 b27f4dc5 8eeca28b      ....Q....M.....
=> mw 0x80000000 0 6
=> md 0x80000000 0x10
80000000: 00000000 00000000 00000000 00000000      .....
80000010: 00000000 00000000 6f236743 3b46fbe6      .....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f      .V#..T|nw.V....{
80000030: cfa9bcec b19ace51 b27f4dc5 8eeca28b      ....Q....M.....
=>
```

This is another command that accepts the type extensions **.l**, **.w** and **.b** :

```
=> mw.w 0x80000004 0x1155 6
=> md 0x80000000 0x10
80000000: 00000000 11551155 11551155 11551155      ....U.U.U.U.U.U.
80000010: 00000000 00000000 6f236743 3b46fbe6      .....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f      .V#..T|nw.V....{
80000030: cfa9bcec b19ace51 b27f4dc5 8eeca28b      ....Q....M.....
=> mw.b 0x80000007 0xff 7
=> md 0x80000000 0x10
80000000: 00000000 ff551155 ffffffff 1155ffff      ....U.U.....U.
80000010: 00000000 00000000 6f236743 3b46fbe6      .....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f      .V#..T|nw.V....{
80000030: cfa9bcec b19ace51 b27f4dc5 8eeca28b      ....Q....M.....
=>
```

## ***nm - memory modify (constant address)***

```
=> help nm
nm - memory modify (constant address)

Usage:
nm [.b, .w, .l] address
=>
```

The **nm** command (non-incrementing memory modify) can be used to interactively write different data several times to the same address. This can be useful for instance to access and modify device registers:

```
=> nm 0x80000000
80000000: 00000000 ? 0x48
80000000: 00000048 ? 0x65
80000000: 00000065 ? 0x6c
80000000: 0000006c ? 0x6c
80000000: 0000006c ? 0x6f
80000000: 0000006f ? .
=> md 0x80000000 10
80000000: 0000006f ff551155 ffffffff 1155ffff o...U.U.....U.
80000010: 00000000 00000000 6f236743 3b46fbe6 .....Cg#o..F;
80000020: ea2356f6 6e7c540f e056e377 7bd28a9f .V#..T|nw.V....{
80000030: cfa9bcec b19ace51 b27f4dc5 8eeca28b ....Q....M.....
=>
```

The **nm** command also accepts the type **.l**, **.w** and **.b**

## ***loop - infinite loop on address range***

```
=> help loop
loop - infinite loop on address range

Usage:
loop [.b, .w, .l] address number_of_objects
=>
```

The **loop** command reads in a tight loop from a range of memory. This is intended as a special form of a memory test, since this command tries to read the memory as fast as possible.



This command will never terminate. There is no way to stop it but to reset the board!

## Execution Control Commands

### source - run script from memory

```
=> help source
source - run script from memory

Usage:
source [addr]
    - run script starting at addr
    - A valid image header must be present
For FIT format uImage addr must include subimage
unit name in the form of addr:<subimg_uname>
=>
```

With the **source** command you can run "shell" scripts under U-Boot: You create a U-Boot script image by simply writing the commands you want to run into a text file; then you will have to use the **mkimage** tool to convert this text file into a U-Boot image (using the image type script).

This image can be loaded like any other image file, and with **source** you can run the commands in such an image. For instance, the following text file:

```
$ cat source_example.txt
echo
echo Network Configuration:
echo -----
echo Target:
printenv ipaddr hostname
echo
echo Server:
printenv serverip rootpath
echo
$
```

can be converted into a U-Boot script image using the **mkimage** command like this:

```
$ mkimage -A ppc -O linux -T script -C none -a 0 -e 0 -n "autoscr example script" -d\
$TBOT_BASEDIR/source_example.txt /var/lib/tftpboot/beagleboneblack/tbot/source.scr
Image Name:   autoscr example script
Created:      Wed Aug 23 09:23:32 2017
Image Type:   PowerPC Linux Script (uncompressed)
Data Size:    157 Bytes = 0.15 kB = 0.00 MB
Load Address: 00000000
Entry Point:  00000000
Contents:
  Image 0: 149 Bytes = 0.15 kB = 0.00 MB
$
```

Now you can load and execute this script image in U-Boot:

```
=> tftp 0x80000000 beagleboneblack/tbotrandom
link up on port 0, speed 100, full duplex
Using ethernet@4a100000 device
TFTP from server 192.168.2.1; our IP address is 192.168.2.10
Filename 'beagleboneblack/tbotrandom'.
Load address: 0x80000000
Loading: *#####
#####
4.4 MiB/s
done
Bytes transferred = 1048576 (100000 hex)
=>
=> imi 0x80000000

## Checking Image at 80000000 ...
```



```
Legacy image found
Image Name:   autoscr example script
Created:      2017-08-18   8:19:02 UTC
Image Type:   PowerPC Linux Script (uncompressed)
Data Size:    157 Bytes = 157 Bytes
Load Address: 00000000
Entry Point:  00000000
Contents:
    Image 0: 149 Bytes = 149 Bytes
    Verifying Checksum ... OK
=> source 0x80000000
## Executing script at 80000000

Network Configuration:
-----
Target:
ipaddr=192.168.2.10
## Error: "hostname" not defined

Server:
serverip=192.168.2.1
rootpath=/export/rootfs

=>
```

## ***bootm - boot application image from memory***

```
=> help bootm
bootm - boot application image from memory

Usage:
bootm [addr [arg ...]]
- boot application image stored in memory
  passing arguments 'arg ...'; when booting a Linux kernel,
  'arg' can be the address of an initrd image
  When booting a Linux kernel which requires a flat device-tree
  a third argument is required which is the address of the
  device-tree blob. To boot that kernel without an initrd image,
  use a '-' for the second argument. If you do not pass a third
  a bd_info struct will be passed instead

For the new multi component uImage format (FIT) addresses
must be extended to include component or configuration unit name:
addr:<subimg_name> - direct component image specification
addr:<conf_name> - configuration specification
Use iminfo command to get the list of existing component
images and configurations.

Sub-commands to do part of the bootm sequence. The sub-commands must be
issued in the order below (it's ok to not issue all sub-commands):
start [addr [arg ...]]
loados - load OS image
ramdisk - relocate initrd, set env initrd_start/initrd_end
fdt - relocate flat device tree
cmdline - OS specific command line processing/setup
bd_t - OS specific bd_t processing
prep - OS specific prep before relocation or go
go - start OS

=>
```

The **bootm** command is used to start operating system images. From the image header it gets information about the type of the operating system, the file compression method used (if any), the load and entry point addresses, etc. The command will then load the image to the required memory address, uncompressing it on the fly if necessary. Depending on the OS it will pass the required boot arguments and start the OS at it's entry point.

The first argument to **bootm** is the memory address (in RAM, ROM or flash memory) where the image is stored, followed by optional arguments that depend on the OS.

**Linux** requires the flattened device tree blob to be passed at boot time, and **bootm** expects its third argument to be the address of the blob in memory. Second argument to **bootm** depends on whether an initrd initial ramdisk image is to be used. If the kernel should be booted without the initial ramdisk, the second argument should be given as "-", otherwise it is interpreted as the start address of initrd (in RAM, ROM or flash memory).

To boot a Linux kernel image without a initrd ramdisk image, the following command can be used:

```
=> bootm ${kernel_addr} - ${fdt_addr}
```

If a ramdisk image shall be used, you can type:

```
=> bootm ${kernel_addr} ${ramdisk_addr} ${fdt_addr}
```

Both examples of course imply that the variables used are set to correct addresses for a kernel, fdt blob and a initrd ramdisk image.



When booting images that have been loaded to RAM (for instance using TFTP download) you have to be careful that the locations where the (compressed) images were stored do not overlap with the memory needed to load the uncompressed kernel. For instance, if you load a ramdisk image at a location

in low memory, it may be overwritten when the Linux kernel gets loaded. This will cause undefined system crashes.

## ***go - start application at address 'addr'***

```
=> help go
go - start application at address 'addr'

Usage:
go addr [arg ...]
    - start application at address 'addr'
      passing 'arg' as arguments
=>
```

U-Boot has support for so-called standalone applications. These are programs that do not require the complex environment of an operating system to run. Instead they can be loaded and executed by U-Boot directly, utilizing U-Boot's service functions like console I/O or malloc() and free().

This can be used to dynamically load and run special extensions to U-Boot like special hardware test routines or bootstrap code to load an OS image from some filesystem.

The **go** command is used to start such standalone applications. The optional arguments are passed to the application without modification.

TODO For more information see 5.12. U-Boot Standalone Applications.

## ***Download Commands***

### ***bootp - boot image via network using BOOTP/TFTP protocol***

```
=> help bootp
bootp - boot image via network using BOOTP/TFTP protocol

Usage:
bootp [loadAddress] [[hostIPAddr:]bootfilename]
=>
```

### ***dhcp - invoke DHCP client to obtain IP/boot params***

```
=> help dhcp
dhcp - boot image via network using DHCP/TFTP protocol

Usage:
dhcp [loadAddress] [[hostIPAddr:]bootfilename]
=>
```

## ***loadb - load binary file over serial line (kermit mode)***

```
=> help loadb
loadb - load binary file over serial line (kermit mode)

Usage:
loadb [ off ] [ baud ]
    - load binary file over serial line with offset 'off' and baudrate 'baud'
=>
```

With kermit you can download binary data via the serial line.

Make sure you use the following settings in kermit.

```
set carrier-watch off
($TBOT_BASEDIR/) C-Kermit>set handshake none
($TBOT_BASEDIR/) C-Kermit>set flow-control none
($TBOT_BASEDIR/) C-Kermit>robust
($TBOT_BASEDIR/) C-Kermit>set file type bin
($TBOT_BASEDIR/) C-Kermit>set file name lit
($TBOT_BASEDIR/) C-Kermit>set rec pack 100
($TBOT_BASEDIR/) C-Kermit>set send pack 100
($TBOT_BASEDIR/) C-Kermit>set window 5
($TBOT_BASEDIR/) C-Kermit>
```

If you have problems with downloading, may you set the values

```
set rec pack
set send pack
```

to smaller values.

Now for example download u-boot.img.

```
=> loadb 80000000
## Ready for binary (kermit) download to 0x80000000 at 115200 bps...

(Back at localhost.localdomain)
-----
($TBOT_BASEDIR/) C-Kermit>
C-Kermit 9.0.302 OPEN SOURCE:, 20 Aug 2011, localhost.localdomain [192.168.1.105]\
  Current Directory: $TBOT_BASEDIR\
Communication Device: /dev/ttybbb\
Communication Speed: 115200\
  Parity: none\
  RTT/Timeout: 01 / 02\
  SENDING: => /lib/tftpboot/beagleboneblack/tbot/u-boot.img\
  File Type: BINARY\
  File Size: 734224\
  Percent Done: 100 //////////////////////////////////////////\
:01    ...10...20...30...40...50...60...70...80...90...100\
:02
    teElapsed Time: 00:01:59\
5 Transfer67ate, CPS: 6197\
69
    55ndow Slots: 1 of 1\
2705
6    75cket Type: B6\
918482
0    P92let Count: 11819\
3276
cket Length:\
0(
resend) Error Count: 4\
    Last Error:\
    Last Message: SUCCESS. Files: 1, Bytes: 734224, 6167 CPS\
($TBOT_BASEDIR/) C-Kermit>connect\
Connecting to /dev/ttybbb, speed 115200\
Escape character: Ctrl-\ (ASCII 28, FS): enabled\
```

```

Type the escape character followed by C to get back,\
or followed by ? to see other options.\
-----\
CACHE: Misaligned operation at range [80000000, 800b3410]\
## Total Size      = 0x000b3410 = 734224 Bytes\
## Start Addr      = 0x80000000\
=>\

=> imi 80000000

## Checking Image at 80000000 ...
FIT image found
FIT description: Firmware image with one or more FDT blobs
Created:        2017-08-23   6:36:19 UTC
Image 0 (firmware@1)
Description:    U-Boot 2017.09-rc2-00151-g2d7cb5b for am335x board
Created:        2017-08-23   6:36:19 UTC
Type:          Firmware
Compression:   uncompressed
Data Start:    unavailable
Data Size:     unavailable
Architecture:  ARM
Load Address:  0x80800000
Image 1 (fdt@1)
Description:    am335x-evm
Created:        2017-08-23   6:36:19 UTC
Type:          Firmware
Compression:   uncompressed
Data Start:    unavailable
Data Size:     unavailable
Architecture:  ARM
Load Address:  unavailable
Image 2 (fdt@2)
Description:    am335x-bone
Created:        2017-08-23   6:36:19 UTC
Type:          Firmware
Compression:   uncompressed
Data Start:    unavailable
Data Size:     unavailable
Architecture:  ARM
Load Address:  unavailable
Image 3 (fdt@3)
Description:    am335x-boneblack
Created:        2017-08-23   6:36:19 UTC
Type:          Firmware
Compression:   uncompressed
Data Start:    unavailable
Data Size:     unavailable
Architecture:  ARM
Load Address:  unavailable
Image 4 (fdt@4)
Description:    am335x-evmsk
Created:        2017-08-23   6:36:19 UTC
Type:          Firmware
Compression:   uncompressed
Data Start:    unavailable
Data Size:     unavailable
Architecture:  ARM
Load Address:  unavailable
Image 5 (fdt@5)
Description:    am335x-bonegreen
Created:        2017-08-23   6:36:19 UTC
Type:          Firmware
Compression:   uncompressed
Data Start:    unavailable
Data Size:     unavailable
Architecture:  ARM
Load Address:  unavailable
Image 6 (fdt@6)
Description:    am335x-icev2
Created:        2017-08-23   6:36:19 UTC
Type:          Firmware
Compression:   uncompressed
Data Start:    unavailable
Data Size:     unavailable
Architecture:  ARM
Load Address:  unavailable
Default Configuration: 'conf@1'

```

```
Configuration 0 (conf@1)
  Description: am335x-evm
  Kernel:      unavailable
  FDT:         fdt@1
Configuration 1 (conf@2)
  Description: am335x-bone
  Kernel:      unavailable
  FDT:         fdt@2
Configuration 2 (conf@3)
  Description: am335x-boneblack
  Kernel:      unavailable
  FDT:         fdt@3
Configuration 3 (conf@4)
  Description: am335x-evmsk
  Kernel:      unavailable
  FDT:         fdt@4
Configuration 4 (conf@5)
  Description: am335x-bonegreen
  Kernel:      unavailable
  FDT:         fdt@5
Configuration 5 (conf@6)
  Description: am335x-icev2
  Kernel:      unavailable
  FDT:         fdt@6
## Checking hash(es) for FIT Image at 80000000 ...
  Hash(es) for Image 0 (firmware@1): error!
Can't get image data/size for '' hash node in 'firmware@1' image node
Bad hash in FIT image!
=>
```



### ***loads - load S-Record file over serial line***

```
=> help loads
loads - load S-Record file over serial line

Usage:
loads [ off ]
    - load S-Record file over serial line with offset 'off'
=>
```

### ***rarpboot- boot image via network using RARP/TFTP protocol***

```
=> help rarp
Unknown command 'rarp' - try 'help' without arguments for list of all known commands
=>
```

### ***tftpboot- boot image via network using TFTP protocol***

```
=> help tftp
tftpboot - boot image via network using TFTP protocol

Usage:
tftpboot [loadAddress] [[hostIPAddr:]bootfilename]
=>
```

## Environment Variables Commands

### **printenv**- print environment variables

```
=> help printenv
printenv - print environment variables

Usage:
printenv [-a]
    - print [all] values of all environment variables
printenv name ...
    - print value of environment variable 'name'
=>
```

The **printenv** command prints one, several or all variables of the U-Boot environment. When arguments are given, these are interpreted as the names of environment variables which will be printed with their values:

```
=> printenv ipaddr hostname netmask
ipaddr=192.168.2.10
## Error: "hostname" not defined
netmask=255.255.255.0
=>
```

Without arguments, **printenv** prints all a list with all variables in the environment and their values, plus some statistics about the current usage and the total size of the memory available for the environment.

```
=> printenv
Heiko=Schocher
arch=arm
args_mmc=run finduuid;setenv bootargs console=${console} ${optargs} root=PARTUUID=${uuid} rw\
    rootfstype=${mmccrootfstype}
baudrate=115200
board=am335x
board_name=A335BNLT
board_rev=00C0
board_serial=414BBBK0180
boot_a_script=load ${devtype} ${devnum}:${distro_bootpart} ${scriptaddr} ${prefix}${script}; source\
    ${scriptaddr}
boot_efi_binary=load ${devtype} ${devnum}:${distro_bootpart} ${kernel_addr_r} efi/boot/bootarm.efi;\
    if fdt addr ${fdt_addr_r}; then bootefi ${kernel_addr_r} ${fdt_addr_r};else bootefi ${kernel_addr_r}\
    ${fdtcontroladdr};fi
boot_extlinux=sysboot ${devtype} ${devnum}:${distro_bootpart} any ${scriptaddr}\
    ${prefix}extlinux/extlinux.conf
boot_fdt=try
boot_fit=0
boot_net_usb_start=usb start
boot_prefixes=/ /boot/
boot_script_dhcp=boot.scr.uimg
boot_scripts=boot.scr.uimg boot.scr
boot_targets=mmc0 legacy_mmc0 mmc1 legacy_mmc1 nand0 pxe dhcp
bootcmd=if test ${boot_fit} -eq 1; then run update_to_fit;fi;run findfdt; run init_console; run\
    envboot; run distro_bootcmd
bootcmd_dhcp=run boot_net_usb_start; if dhcp ${scriptaddr} ${boot_script_dhcp}; then source\
    ${scriptaddr}; fi;setenv efi_fdtfile ${fdtfile}; if test -z "${fdtfile}" -a -n "${soc}"; then setenv\
    efi_fdtfile ${soc}-${board}${boardver}.dtb; fi; setenv efi_old_vci ${bootp_vci};setenv efi_old_arch\
    ${bootp_arch};setenv bootp_vci PXEClient:Arch:00010:UNDI:003000;setenv bootp_arch 0xa;if dhcp\
    ${kernel_addr_r}; then tftpboot ${fdt_addr_r} dtb/${efi_fdtfile};if fdt addr ${fdt_addr_r}; then\
    bootefi ${kernel_addr_r} ${fdt_addr_r}; else bootefi ${kernel_addr_r} ${fdtcontroladdr};fi;fi;setenv\
    bootp_vci ${efi_old_vci};setenv bootp_arch ${efi_old_arch};setenv efi_fdtfile;setenv\
    efi_old_arch;setenv efi_old_vci;
bootcmd_legacy_mmc0=setenv mmcdev 0; setenv bootpart 0:2 ; run mmcboot
bootcmd_legacy_mmc1=setenv mmcdev 1; setenv bootpart 1:2 ; run mmcboot
bootcmd_mmc0=setenv devnum 0; run mmc_boot
bootcmd_mmc1=setenv devnum 1; run mmc_boot
bootcmd_nand=run nandboot
bootcmd_pxe=run boot_net_usb_start; dhcp; if pxe get; then pxe boot; fi
bootcount=5
```

```

bootdelay=2
bootdir=/boot
bootenvfile=uEnv.txt
bootfile=zImage
bootm_size=0x10000000
bootpart=0:2
bootscript=echo Running bootscript from mmc${mmcdev} ...; source ${loadaddr}
console=ttyO0,115200n8
cpu=armv7
dfu_alt_info_emmc=rawemmc raw 0 3751936
dfu_alt_info_mmc=boot part 0 1;rootfs part 0 2;MLO fat 0 1;MLO.raw raw 0x100 0x100;u-boot.img.raw\
raw 0x300 0x1000;u-env.raw raw 0x1300 0x200;spl-os-args.raw raw 0x1500 0x200;spl-os-image.raw raw\
0x1700 0x6900;spl-os-args fat 0 1;spl-os-image fat 0 1;u-boot.img fat 0 1;uEnv.txt fat 0 1
dfu_alt_info_nand=SPL part 0 1;SPL.backup1 part 0 2;SPL.backup2 part 0 3;SPL.backup3 part 0 4;u-boot\
part 0 5;u-boot-spl-os part 0 6;kernel part 0 8;rootfs part 0 9
dfu_alt_info_ram=kernel ram 0x80200000 0x4000000;fdt ram 0x80f80000 0x80000;ramdisk ram 0x81000000\
0x4000000
distro_bootcmd=for target in ${boot_targets}; do run bootcmd_${target}; done
efi_dtb_prefixes=/ /dtb/ /dtb/current/
envboot=mmc dev ${mmcdev}; if mmc rescan; then echo SD/MMC found on device ${mmcdev};if run\
loadbootscript; then run bootscript;else if run loadbootenv; then echo Loaded env from\
${bootenvfile};run importbootenv;fi;if test -n $uenvcmd; then echo Running uenvcmd ...;run\
uenvcmd;fi;fi;fi;
ethladdr=6c:ec:eb:83:40:33
ethact=ethernet@4a100000
ethaddr=6c:ec:eb:83:40:31
fdt_addr_r=0x88000000
fdtaddr=0x88000000
fdtcontroladdr=9df21ed8
fdtfile=undefined
fileaddr=80100000
filesize=b3410
findfdt=if test $board_name = A335BONE; then setenv fdtfile am335x-bone.dtb; fi; if test $board_name\
= A335BNLT; then setenv fdtfile am335x-boneblack.dtb; fi; if test $board_name = BBBW; then setenv\
fdtfile am335x-boneblack-wireless.dtb; fi; if test $board_name = BBG1; then setenv fdtfile am335x-\
bonegreen.dtb; fi; if test $board_name = BBGW; then setenv fdtfile am335x-bonegreen-wireless.dtb;\
fi; if test $board_name = BBBL; then setenv fdtfile am335x-boneblue.dtb; fi; if test $board_name =\
A33515BB; then setenv fdtfile am335x-evm.dtb; fi; if test $board_name = A335X_SK; then setenv\
fdtfile am335x-evmsk.dtb; fi; if test $board_name = A335_ICE; then setenv fdtfile am335x-icev2.dtb;\
fi; if test $fdtfile = undefined; then echo WARNING: Could not determine device tree to use; fi;
finduuid=part uuid mmc ${bootpart} uuid
fit_bootfile=fitImage
fit_loadaddr=0x88000000
importbootenv=echo Importing environment from mmc${mmcdev} ...; env import -t ${loadaddr}\
${filesize}
init_console=if test $board_name = A335_ICE; then setenv console ttyO3,115200n8;else setenv console\
ttyO0,115200n8;fi;
ipaddr=192.168.2.10
kernel_addr_r=0x82000000
load_efi_dtb=load ${devtype} ${devnum}:${distro_bootpart} ${fdt_addr_r} ${prefix}${efi_fdtfile}
loadaddr=0x82000000
loadbootenv=fatload mmc ${mmcdev} ${loadaddr} ${bootenvfile}
loadbootscript=load mmc ${mmcdev} ${loadaddr} boot.scr
loadfdt=load ${devtype} ${bootpart} ${fdtaddr} ${bootdir}/${fdtfile}
loadfit=run args_mmc; bootm ${loadaddr}#${fdtfile};
loadimage=load ${devtype} ${bootpart} ${loadaddr} ${bootdir}/${bootfile}
loadramdisk=load mmc ${mmcdev} ${rdaddr} ramdisk.gz
mmc_boot=if mmc dev ${devnum}; then setenv devtype mmc; run scan_dev_for_boot_part; fi
mmcboot=mmc dev ${mmcdev}; setenv devnum ${mmcdev}; setenv devtype mmc; if mmc rescan; then echo\
SD/MMC found on device ${mmcdev};if run loadimage; then if test ${boot_fit} -eq 1; then run loadfit;\
else run mmcloados;fi;fi;fi;
mmcdev=0
mmcloados=run args_mmc; if test ${boot_fdt} = yes || test ${boot_fdt} = try; then if run loadfdt;\
then bootz ${loadaddr} - ${fdtaddr}; else if test ${boot_fdt} = try; then bootz; else echo WARN:\
Cannot load the DT; fi; fi; else bootz; fi;
mmcrebootfstype=ext4 rootwait
mtdids=nand0=nand.0
mtdparts=mtdparts=nand.0:128k(NAND.SPL),128k(NAND.SPL.backup1),128k(NAND.SPL.backup2),128k(NAND.SPL.\
backup3),256k(NAND.u-boot-spl-os),1m(NAND.u-boot),128k(NAND.u-boot-env),128k(NAND.u-boot-\
env.backup1),8m(NAND.kernel),-(NAND.file-system)
nandargs=setenv bootargs console=${console} ${optargs} root=${nandroot} rootfstype=${nandrootfstype}\
nandboot=echo Booting from nand ...; run nandargs; nand read ${fdtaddr} NAND.u-boot-spl-os; nand\
read ${loadaddr} NAND.kernel; bootz ${loadaddr} - ${fdtaddr}
nandroot=ubi0:rootfs rw ubi.mtd=NAND.file-system,2048
nandrootfstype=ubifs rootwait=1
netargs=setenv bootargs console=${console} ${optargs} root=/dev/nfs\
nfsroot=${serverip}:${rootpath},${nfsopts} rw ip=dhcp
netboot=echo Booting from network ...; setenv autoload no; dhcp; run netloadimage; run netloadfdt;\

```

```

run netargs; bootz ${loadaddr} - ${fdtaddr}
netloadfdt=tftp ${fdtaddr} ${fdtfile}
netloadimage=tftp ${loadaddr} ${bootfile}
netmask=255.255.255.0
nfsops=nolock
partitions=uuid_disk=${uuid_gpt_disk};name=rootfs,start=2MiB,size=-,uuid=${uuid_gpt_rootfs}
pxefile_addr_r=0x80100000
ramargs=setenv bootargs console=${console} ${optargs} root=${ramroot} rootfstype=${ramrootfstype}
ramboot=echo Booting from ramdisk ...; run ramargs; bootz ${loadaddr} ${rdaddr} ${fdtaddr}
ramdisk_addr_r=0x88080000
ramroot=/dev/ram0 rw
ramrootfstype=ext2
rdaddr=0x88080000
rootpath=/export/rootfs
scan_dev_for_boot=echo Scanning ${devtype} ${devnum}:${distro_bootpart}...; for prefix in \
${boot_prefixes}; do run scan_dev_for_extlinux; run scan_dev_for_scripts; done; run scan_dev_for_efi;
scan_dev_for_boot_part=part list ${devtype} ${devnum} -bootable devplist; env exists devplist || \
setenv devplist 1; for distro_bootpart in ${devplist}; do if fstype ${devtype} \
${devnum}:${distro_bootpart} bootfstype; then run scan_dev_for_boot; fi; done
scan_dev_for_efi=setenv efi_fdtfile ${fdtfile}; if test -z "${fdtfile}" -a -n "${soc}"; then setenv \
efi_fdtfile ${soc}-${board}${boardver}.dtb; fi; for prefix in ${efi_dtb_prefixes}; do if test -e \
${devtype} ${devnum}:${distro_bootpart} ${prefix}${efi_fdtfile}; then run load_efi_dtb; fi; done; if \
test -e ${devtype} ${devnum}:${distro_bootpart} efi/boot/bootarm.efi; then echo Found EFI removable \
media binary efi/boot/bootarm.efi; run boot_efi_binary; echo EFI LOAD FAILED: continuing...; fi; \
setenv efi_fdtfile
scan_dev_for_extlinux=if test -e ${devtype} ${devnum}:${distro_bootpart} \
${prefix}extlinux/extlinux.conf; then echo Found ${prefix}extlinux/extlinux.conf; run boot_extlinux; \
echo SCRIPT FAILED: continuing...; fi
scan_dev_for_scripts=for script in ${boot_scripts}; do if test -e ${devtype} \
${devnum}:${distro_bootpart} ${prefix}${script}; then echo Found U-Boot script ${prefix}${script}; \
run boot_a_script; echo SCRIPT FAILED: continuing...; fi; done
scriptaddr=0x80000000
serverip=192.168.2.1
soc=am33xx
spiargs=setenv bootargs console=${console} ${optargs} root=${spiroot} rootfstype=${spirootfstype}
spiboot=echo Booting from spi ...; run spiargs; sf probe ${spibusno}:0; sf read ${loadaddr} \
${spisrcaddr} ${spiimgsize}; bootz ${loadaddr}
spibusno=0
spiimgsize=0x362000
spiroot=/dev/mtdblock4 rw
spirootfstype=jffs2
spisrcaddr=0xe0000
static_ip=${ipaddr}:${gatewayip}:${netmask}:${hostname}::off
stderr=serial@44e09000
stdin=serial@44e09000
stdout=serial@44e09000
test=test2
test2=echo This is another Test; printenv hostname; echo Done.
update_to_fit=setenv loadaddr ${fit_loadaddr}; setenv bootfile ${fit_bootfile}
usb_boot=usb start; if usb dev ${devnum}; then setenv devtype usb; run scan_dev_for_boot_part; fi
vendor=ti
ver=U-Boot 2017.09-rc2-00151-g2d7cb5b (Aug 23 2017 - 08:35:31 +0200)

Environment size: 9569/131068 bytes
=>

```

## saveenv - save environment variables to persistent storage

```

=> help saveenv
saveenv - save environment variables to persistent storage

Usage:
saveenv
=>

```

All changes you make to the U-Boot environment are made in RAM only. They are lost as soon as you reboot the system. If you want to make your changes permanent you have to use the **saveenv** command to write a copy of the environment settings to persistent storage, from where they are automatically loaded during startup:

```
=> saveenv
Saving Environment to FAT...
writing uboot.env
FAT: Misaligned buffer address (9df01d48)
done
=>
```

## ***setenv - set environment variables***

```
=> help setenv
setenv - set environment variables

Usage:
setenv [-f] name value ...
- [forcibly] set environment variable 'name' to 'value ...'
setenv [-f] name
- [forcibly] delete environment variable 'name'
=>
```

To modify the U-Boot environment you have to use the **setenv** command. When called with exactly one argument, it will delete any variable of that name from U-Boot's environment, if such a variable exists. Any storage occupied for such a variable will be automatically reclaimed:

```
=> setenv foo This is an example value.
=> printenv foo
foo=This is an example value.
=> setenv foo
=> printenv foo
## Error: "foo" not defined
=>
```

When called with more arguments, the first one will again be the name of the variable, and all following arguments will (concatenated by single space characters) form the value that gets stored for this variable. New variables will be automatically created, existing ones overwritten.

```
=> printenv bar
## Error: "bar" not defined
=> setenv bar This is a new example.
=> printenv bar
bar=This is a new example.
=> setenv bar
=>
```

Remember standard shell quoting rules when the value of a variable shall contain characters that have a special meaning to the command line parser (like the `$` character that is used for variable substitution or the semicolon which separates commands). Use the backslash (`\`) character to escape such special characters, or enclose the whole phrase in apostrophes (`'`). Use `"${name}"` for variable expansion.

```
=> setenv cons_opts 'console=tty0 console=ttyS0,\${baudrate}'
=> printenv cons_opts
cons_opts=console=tty0 console=ttyS0,\${baudrate}
=> setenv cons_opts
=>
```



There is no restriction on the characters that can be used in a variable name except the restrictions imposed by the command line parser (like using backslash for quoting, space and tab characters to separate arguments, or semicolon and newline to separate commands). Even strange input like `==/()+=` is a perfectly legal variable name in U-Boot.



A common mistake is to write

```
setenv name=value
```

instead of

```
setenv name value
```

There will be no error message, which lets you believe everything went OK, but it didn't: instead of setting the variable name to the value value you tried to delete a variable with the name name=value - this is probably not what you intended! Always remember that name and value have to be separated by space and/or tab characters!

## Flattened Device Tree support

U-Boot is capable of quite comprehensive handling of the flattened device tree blob, implemented by the **fdt** family of commands:

```
=> help fdt
fdt - flattened device tree utility commands

Usage:
fdt addr [-c] <addr> [<length>] - Set the [control] fdt location to <addr>
fdt apply <addr> - Apply overlay to the DT
fdt move <fdt> <newaddr> <length> - Copy the fdt to <addr> and make it active
fdt resize [<extrasize>] - Resize fdt to size + padding to 4k addr + some optional\
    <extrasize> if needed
fdt print <path> [<prop>] - Recursive print starting at <path>
fdt list <path> [<prop>] - Print one level starting at <path>
fdt get value <var> <path> <prop> - Get <property> and store in <var>
fdt get name <var> <path> <index> - Get name of node <index> and store in <var>
fdt get addr <var> <path> <prop> - Get start address of <property> and store in <var>
fdt get size <var> <path> [<prop>] - Get size of [<property>] or num nodes and store in <var>
fdt set <path> <prop> [<val>] - Set <property> [to <val>]
fdt mknnode <path> <node> - Create a new node after <path>
fdt rm <path> [<prop>] - Delete the node or <property>
fdt header - Display header info
fdt bootcpu <id> - Set boot cpuid
fdt memory <addr> <size> - Add/Update memory node
fdt rsvmem print - Show current mem reserves
fdt rsvmem add <addr> <size> - Add a mem reserve
fdt rsvmem delete <index> - Delete a mem reserves
fdt chosen [<start> <end>] - Add/update the /chosen branch in the tree
    <start>/<end> - initrd start/end addr
NOTE: Dereference aliases by omitting the leading '/', e.g. fdt print ethernet0.
=>
```

### **fdt addr - select FDT to work on**

First, the blob that is to be operated on should be stored in memory, and U-Boot has to be informed about its location by the **fdt addr** command. Once this command has been issued, all subsequent fdt handling commands will use the blob stored at the given address. This address can be changed later on by issuing **fdt addr** or **fdt move** command. Here's how to load the blob into memory and tell U-Boot its location:

```
=> setenv fdt_addr_r 0x80000000
=> tftp ${fdt_addr_r} beagleboneblack/tbot/u-boot.dtb
link up on port 0, speed 100, full duplex
Using ethernet@4a100000 device
TFTP from server 192.168.2.1; our IP address is 192.168.2.10
Filename 'beagleboneblack/tbot/u-boot.dtb'.
Load address: 0x80000000
Loading: *■####
        4.3 MiB/s
done
Bytes transferred = 45056 (b000 hex)
=>
=> fdt addr ${fdt_addr_r}
=>
```

### **fdt list - print one level**

Having selected the device tree stored in the blob just loaded, we can inspect its contents. As an FDT usually is quite extensive, it is easier to get information about the structure by looking at selected levels rather than full hierarchies. **fdt list** allows us to do exactly this. Let's have a look at the hierarchy one level below the cpus node:

```
=> fdt list /cpus
cpus {
    #address-cells = <0x00000001>;
    #size-cells = <0x00000000>;
    cpu@0 {
    };
};
=>
```

## ***fdt print - recursive print***

To print a complete subtree we use **fdt print**. In comparison to the previous example it is obvious that the whole subtree is printed:

```
=> fdt print /cpus
cpus {
    #address-cells = <0x00000001>;
    #size-cells = <0x00000000>;
    cpu@0 {
        compatible = "arm,cortex-a8";
        device_type = "cpu";
        reg = <0x00000000>;
        operating-points = <0x000afc80 0x00139b88 0x000927c0 0x0012b128 0x0007a120\
0x00112a88 0x00043238 0x00112a88>;
        voltage-tolerance = <0x00000002>;
        clocks = <0x00000002>;
        clock-names = "cpu";
        clock-latency = <0x000493e0>;
        cpu0-supply = <0x00000003>;
    };
};
=>
```

## ***fdt mknnode - create new nodes***

**fdt mknnode** can be used to attach a new node to the tree. We will use the **fdt list** command to verify that the new node has been created and that it is empty:

```
=> fdt list /
/ {
    #address-cells = <0x00000001>;
    #size-cells = <0x00000001>;
    compatible = "ti,am335x-evm", "ti,am33xx";
    interrupt-parent = <0x00000001>;
    model = "TI AM335x EVM";
    chosen {
    };
    aliases {
    };
    memory {
    };
    cpus {
    };
    pmu {
    };
    soc {
    };
    ocp {
    };
    fixedregulator@0 {
    };
    fixedregulator@1 {
    };
    fixedregulator@2 {
    };
    matrix_keypad@0 {
    };
};
```



```

        volume_keys@0 {
        };
        backlight {
        };
        panel {
        };
        sound {
        };
    };
=> fdt mknode / testnode
=> fdt list /
/ {
    #address-cells = <0x00000001>;
    #size-cells = <0x00000001>;
    compatible = "ti,am335x-evm", "ti,am33xx";
    interrupt-parent = <0x00000001>;
    model = "TI AM335x EVM";
    testnode {
    };
    chosen {
    };
    aliases {
    };
    memory {
    };
    cpus {
    };
    pmu {
    };
    soc {
    };
    ocp {
    };
    fixedregulator@0 {
    };
    fixedregulator@1 {
    };
    fixedregulator@2 {
    };
    matrix_keypad@0 {
    };
    volume_keys@0 {
    };
    backlight {
    };
    panel {
    };
    sound {
    };
};
=> fdt list /testnode
testnode {
};
=>

```

## ***fdt set - set node properties***

Now, let's create a property at the newly created node; again we'll use **fdt list** for verification:

```

=> fdt set /testnode testprop
=> fdt set /testnode testprop testvalue
=> fdt list /testnode
testnode {
    testprop = "testvalue";
};
=>

```

## ***fdt rm - remove nodes or properties***

The **fdt rm** command is used to remove nodes and properties. Let's delete the test property created in the previous paragraph and verify the results:

```
=> fdt rm /testnode testprop
=> fdt list /testnode
testnode {
};
=> fdt rm /testnode
=> fdt list /
/ {
    #address-cells = <0x00000001>;
    #size-cells = <0x00000001>;
    compatible = "ti,am335x-evm", "ti,am33xx";
    interrupt-parent = <0x00000001>;
    model = "TI AM335x EVM";
    chosen {
    };
    aliases {
    };
    memory {
    };
    cpus {
    };
    pmu {
    };
    soc {
    };
    ocp {
    };
    fixedregulator@0 {
    };
    fixedregulator@1 {
    };
    fixedregulator@2 {
    };
    matrix_keypad@0 {
    };
    volume_keys@0 {
    };
    backlight {
    };
    panel {
    };
    sound {
    };
};
=>
```

### ***fdt move - move FDT blob to new address***

To move the blob from one memory location to another we will use the **fdt move** command. Besides moving the blob, it makes the new address the "active" one - similar to **fdt addr**:

```
=> fdt move ${fdt_addr_r} 0x8000b000 b000
=>
=> fdt list /
/ {
    #address-cells = <0x00000001>;
    #size-cells = <0x00000001>;
    compatible = "ti,am335x-evm", "ti,am33xx";
    interrupt-parent = <0x00000001>;
    model = "TI AM335x EVM";
    chosen {
    };
    aliases {
    };
    memory {
    };
    cpus {
    };
    pmu {
    };
};
```

```

};
soc {
};
ocp {
};
fixedregulator@0 {
};
fixedregulator@1 {
};
fixedregulator@2 {
};
matrix_keypad@0 {
};
volume_keys@0 {
};
backlight {
};
panel {
};
sound {
};
};
=> fdt mknod / foobar
=> fdt list /
/ {
    #address-cells = <0x00000001>;
    #size-cells = <0x00000001>;
    compatible = "ti,am335x-evm", "ti,am33xx";
    interrupt-parent = <0x00000001>;
    model = "TI AM335x EVM";
    foobar {
    };
    chosen {
    };
    aliases {
    };
    memory {
    };
    cpus {
    };
    pmu {
    };
    soc {
    };
    ocp {
    };
    fixedregulator@0 {
    };
    fixedregulator@1 {
    };
    fixedregulator@2 {
    };
    matrix_keypad@0 {
    };
    volume_keys@0 {
    };
    backlight {
    };
    panel {
    };
    sound {
    };
};
=>
=> fdt addr ${fdt_addr_r}
=> fdt list /
/ {
    #address-cells = <0x00000001>;
    #size-cells = <0x00000001>;
    compatible = "ti,am335x-evm", "ti,am33xx";
    interrupt-parent = <0x00000001>;
    model = "TI AM335x EVM";
    chosen {
    };
    aliases {
    };
    memory {
    };
};

```

```

cpus {
};
pmu {
};
soc {
};
ocp {
};
fixedregulator@0 {
};
fixedregulator@1 {
};
fixedregulator@2 {
};
matrix_keypad@0 {
};
volume_keys@0 {
};
backlight {
};
panel {
};
sound {
};
};
=>

```

### ***fdt chosen - fixup dynamic info***

One of the modifications made by U-Boot to the blob before passing it to the kernel is the addition of the **/chosen** node. Linux 2.6 Documentation/powerpc/booting-without-of.txt says that this node is used to store "some variable environment information, like the arguments, or the default input/output devices." To force U-Boot to add the **/chosen** node to the current blob, **fdt chosen** command can be used. Let's now verify its operation:

```

=> fdt list /
/ {
    #address-cells = <0x00000001>;
    #size-cells = <0x00000001>;
    compatible = "ti,am335x-evm", "ti,am33xx";
    interrupt-parent = <0x00000001>;
    model = "TI AM335x EVM";
    chosen {
    };
    aliases {
    };
    memory {
    };
    cpus {
    };
    pmu {
    };
    soc {
    };
    ocp {
    };
    fixedregulator@0 {
    };
    fixedregulator@1 {
    };
    fixedregulator@2 {
    };
    matrix_keypad@0 {
    };
    volume_keys@0 {
    };
    backlight {
    };
    panel {
    };
    sound {
    };

```

```

    };
};
=> fdt chosen
=> fdt list /
/ {
    #address-cells = <0x00000001>;
    #size-cells = <0x00000001>;
    compatible = "ti,am335x-evm", "ti,am33xx";
    interrupt-parent = <0x00000001>;
    model = "TI AM335x EVM";
    chosen {
    };
    aliases {
    };
    memory {
    };
    cpus {
    };
    pmu {
    };
    soc {
    };
    ocp {
    };
    fixedregulator@0 {
    };
    fixedregulator@1 {
    };
    fixedregulator@2 {
    };
    matrix_keypad@0 {
    };
    volume_keys@0 {
    };
    backlight {
    };
    panel {
    };
    sound {
    };
};
=> fdt list /chosen
chosen {
    stdout-path = "/ocp/serial@44e09000";
    tick-timer = "/ocp/timer@48040000";
};
=>

```

Note: **fdt boardsetup** performs board-specific blob updates, most commonly setting clock frequencies, etc. Discovering its operation is left as an exercise for the reader.

## ***Special Commands***

### ***i2c - I2C sub-system***

```
=> help i2c
i2c - I2C sub-system

Usage:
i2c bus [muxtype:muxaddr:muxchannel] - show I2C bus info
crc32 chip address[.0, .1, .2] count - compute CRC32 checksum
i2c dev [dev] - show or set current I2C bus
i2c loop chip address[.0, .1, .2] [# of objects] - looping read of device
i2c md chip address[.0, .1, .2] [# of objects] - read from I2C device
i2c mm chip address[.0, .1, .2] - write to I2C device (auto-incrementing)
i2c mw chip address[.0, .1, .2] value [count] - write to I2C device (fill)
i2c nm chip address[.0, .1, .2] - write to I2C device (constant address)
i2c probe [address] - test for and show device(s) on the I2C bus
i2c read chip address[.0, .1, .2] length memaddress - read to memory
i2c write memaddress chip address[.0, .1, .2] length [-s] - write memory
    to I2C; the -s option selects bulk write in a single transaction
i2c flags chip [flags] - set or get chip flags
i2c olen chip [offset_length] - set or get chip offset length
i2c reset - re-init the I2C Controller
i2c speed [speed] - show or set I2C bus speed
=>
```

## ***links***

