

Broadcom BCM963xx

CFE Boot Loader and Flash Memory Structure

Application Notes

January 9, 2006

1. Introduction

This application notes explain the CFE (Common Firmware Environment) boot loader command line interface and the flash memory structure in BCM963xx DSL Router reference platforms.

It contains the following sections.

- CFE Boot Loader Command Line Interface
- CFE Boot Loader Commands
- CFE Boot Loader Command “c”
- CFE Boot Loader Command Examples
- Flash Memory Structure
- Dual Linux Image Support
- Linux Image File Tag Structure
- NVRAM Configuration Data Structure

2. CFE Boot Loader Command Line Interface

The following steps bring up the CFE boot loader console.

1. Connect a serial cable between a PC and the BCM963xx reference board serial console port.
2. Configure and start a serial port terminal emulator program such as minicom.
3. Reset the BCM963xx DSL Router.
4. In minicom, if the NVRAM configuration data section of flash memory is not valid, enter the board configuration parameters as is appropriate for the particular board.

```
Board Id Name (0-3)
96358VW          ----- 0
96358VW-16      ----- 1
96358GW         ----- 2
96358GW-16     ----- 3      : 0
Number of MAC Addresses (1-32) : 11
Base MAC Address : 02:10:18:38:38:01
```

OR

```
Board Id Name (0-10)
96348R          ----- 0
96348LV        ----- 1
96348GW        ----- 2
96348W2        ----- 3
96348W3        ----- 4
96348GW-10     ----- 5
96348GW-11     ----- 6
96348SV        ----- 7
96348GW-DualDSP ----- 8
BCMUST_01      ----- 9
96348M         ----- 10     : 0
Number of MAC Addresses (1-32) : 11
Base MAC Address : 02:10:18:01:00:01
```

OR

```
Board Id Name (0-2)
```

```

96338SV          ----- 0
96338L-2M-8M    ----- 1
96338W          ----- 2          : 1
Number of MAC Addresses (1-32)      : 11
Base MAC Address                       : 02:10:18:38:38:01

```

If the NVRAM configuration data section is valid, this step is skipped.

5. In minicom, press a key before the one-second countdown completes in order to get a boot prompt. The following messages and “CFE>” prompt will be printed to the screen.

```

CFE version 1.0.37-5.8 for BCM96348 (32bit,SP,BE)
Build Date: Wed Jan  4 14:24:36 PST 2006 (root@DT-lt-linux)
Copyright (C) 2000-2005 Broadcom Corporation.

Boot Address 0xbfc00000

Initializing Arena.
Initializing Devices.
Parallel flash device: name AM29LV320T, id 0x22f6, size 4096KB
100 MB Full-Duplex (auto-neg)
CPU type 0x29107: 256MHz, Bus: 128MHz, Ref: 32MHz
Total memory: 16777216 bytes (16MB)

Total memory used by CFE: 0x80401000 - 0x80524CA0 (1195168)
Initialized Data:      0x8041C500 - 0x8041E3C0 (7872)
BSS Area:              0x8041E3C0 - 0x80422CA0 (18656)
Local Heap:           0x80422CA0 - 0x80522CA0 (1048576)
Stack Area:          0x80522CA0 - 0x80524CA0 (8192)
Text (code) segment: 0x80401000 - 0x8041C500 (111872)
Boot area (physical): 0x00525000 - 0x00565000
Relocation Factor:    I:00000000 - D:00000000

Board IP address      : 192.168.1.1
Host IP address       : 192.168.1.100
Gateway IP address    :
Run from flash/host (f/h) : f
Default host run file name : vmlinux
Default host flash file name : bcm96348gw
Boot delay (0-9 seconds) : 1
Boot image (0=latest, 1=previous) : 0
Board Id Name         : 96348GW-10
Psi size in KB        : 24
Number of MAC Addresses (1-32) : 11
Base MAC Address      : 02:10:18:01:00:01
Ethernet PHY Type     : Internal
Memory size in MB     : 16
CMT Thread Number     : 0

*** Press any key to stop auto run (1 seconds) ***
Auto run second count down: 1
web info: Waiting for connection on socket 0.
CFE>

```

3. CFE Boot Loader Commands

Command	Description	Parameters
b	Set board id and MAC addresses 1). Board id string. 2). Number of MAC address (use default in most of cases) 3). Base MAC address	
c	Set/Modify boot line parameters	See section 4 for details
f	Write image to the flash from remote host. Use ‘c’ to set the proper “Host IP address” and “Default host flash file name”.	Image file name stored on the host. <u>Notice this image file is a special formatted non-executable file for</u>

	<p>Three examples how to use this command:</p> <ol style="list-style-type: none"> 1). 'f' to load an image defined in "Default host flash file name" from "Host IP address" . 2). 'f imageName' to load this imageName from "Host IP address" . 3). 'f 192.168.1.188:imageName' to load imageName from 192.168.1.188. 	<p><u>CFE Boot loader to write into the flash.</u></p> <p>Usage: f [hostip:][<i>image-name</i>]</p>
i	Erase profile storage data from flash	N/A
r	<p>Run program from image on flash or remote host depending on the value in the following configuration in "c" command:</p> <p>Run from flash/host (f/h) :</p> <p>If the value is "h", the boot loader will download "executable" image from the host to the SDRAM. It will not overwrite the image on the flash.</p> <p>Three examples how to use this command:</p> <ol style="list-style-type: none"> 1). Just 'r' to load an image defined in "Default host run file name" from "Host IP address" . 2). 'r imageName' to load this imageName from "Host IP address". 3). 'r 192.168.1.188:imageName' to load imageName from 192.168.1.188. 	Usage: r [hostip:][<i>image-name</i>]
w	<p>Write an image to flash memory starting at the first block. Useful for overwriting old version CFE with different TAG structure. Eg. "w bcm96345_cfe.w" or "w 192.168.1.100:bcm96348_cfe.w".</p>	<p>The image has special error checking code and it built by issuing command "hostTools\addvtoken cfe.bin bcm96345_cfe.w"</p> <p>NOTE: cfe.bin is the output from "gmake" from CFE build process.</p>
p	Print boot line information	N/A
e	Erase flash	<p>a erase all flash except boot loader</p> <p>n erase NVRAM</p> <p>usage: e a</p> <p>e n</p>
reset	Reset the modem	N/A

4. CFE Boot Loader Command “c”

CFE> c

Board IP address : AAA.BBB.CCC.XXX

This is the IP address for LAN bridge port shared by Ethernet and USB ports. The router software running in the CPU bridges packets between Ethernet and USB. Replace AAA.BBB.CCC.XXX or leave it as it is.

Host IP address : AAA.BBB.CCC.YYY

Replace AAA.BBB.CCC.YYY with the Host PC's IP address. The host PC is where the image is stored and TFTP server is running.

Gateway IP address :

Enter Gateway IP address only if the host is located in a different subnet. The gateway is a router between the ADSL router and the host. Type “Enter” key if there is no gateway between the host and the ADSL router.

Run from flash/host (f/h) : h

Type h if the image is to be downloaded from the host. Type f if the image is already stored on the flash memory and direct boot image from the local flash memory.

Default host run file name :

This is an “executable” image file name, such as *vmlinux*, stored on the host. This file name is only valid for “r” command (run command), which loads executable image to the SDRAM. This parameter is ignored by the “f *flash-file-name*” command, which downloads and writes a non-executable image file to the flash.

Default host flash file name :

This is the default “flash” image file name, such as *bcm96345R_fs_kernel*, stored on the host. This file name is only valid for “f” command (flash command), which loads executable image from host and programs the image to flash. This parameter is ignored by the “f *flash-file-name*” command, which downloads from host *flash-file-name* and programs it to the flash.

Boot delay (0-9 second) : 1

Enter the delay time for CFE Boot Loader to wait for any key input from the serial port in order to enter into command interface. The default value is 1.

Boot image (0=latest, 1=previous) : 0

This input is only displayed if there are two Linux router images on the flash. It indicates whether to boot the Linux image that was most recently flashed (value 0) or boot the Linux image that was flashed before the most recent one (value 1). See the *Dual Linux Image Support* section below. The default value is 0.

5. CFE Boot Loader Command Examples

Example 1: Updating the DSL Router Image Using TFTP

To update the BCM963xx DSL Router with a new image using TFTP, follow these steps.

1. Verify that a TFTP server is installed and started on your Linux PC and that the desired router image, such as *bcm96345R_fs_kernel*, *bcm96348R_fs_kernel* or *bcm96338R_fs_kernel*, is in the */tftpboot* directory.
2. Configure and start a serial port terminal emulator program such as *minicom*.
3. Reset the BCM963xx DSL Router.
4. In *minicom*, press a key before the one-second countdown completes in order to get a boot prompt.

CFE version 1.0.37-5.8 for BCM96348 (32bit,SP,BE)

```
Build Date: Wed Jan  4 14:24:36 PST 2006 (root@DT-lt-linux)
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```

```
Boot Address 0xbfc00000
```

```
Initializing Arena.
Initializing Devices.
Parallel flash device: name AM29LV320T, id 0x22f6, size 4096KB
100 MB Full-Duplex (auto-neg)
CPU type 0x29107: 256MHz, Bus: 128MHz, Ref: 32MHz
Total memory: 16777216 bytes (16MB)
```

```
Total memory used by CFE:  0x80401000 - 0x80524CA0 (1195168)
Initialized Data:          0x8041C500 - 0x8041E3C0 (7872)
BSS Area:                  0x8041E3C0 - 0x80422CA0 (18656)
Local Heap:                0x80422CA0 - 0x80522CA0 (1048576)
Stack Area:                0x80522CA0 - 0x80524CA0 (8192)
Text (code) segment:      0x80401000 - 0x8041C500 (111872)
Boot area (physical):      0x00525000 - 0x00565000
Relocation Factor:        I:00000000 - D:00000000
```

```
Board IP address           : 192.168.1.1
Host IP address            : 192.168.1.100
Gateway IP address         :
Run from flash/host (f/h) : f
Default host run file name : vmlinux
Default host flash file name : bcm96348gw
Boot delay (0-9 seconds)  : 1
Boot image (0=latest, 1=previous) : 0
Board Id Name              : 96348GW-10
Psi size in KB             : 24
Number of MAC Addresses (1-32) : 11
Base MAC Address           : 02:10:18:01:00:01
Ethernet PHY Type          : Internal
Memory size in MB          : 16
CMT Thread Number          : 0
```

```
*** Press any key to stop auto run (1 seconds) ***
Auto run second count down: 1
web info: Waiting for connection on socket 0.
CFE>
```

5. In minicom, enter 'c' to configure a TFTP download similar to the following.

```
Board IP address           : 192.168.1.1:ffffff00
Host IP address            : 192.168.1.100
Gateway IP address         :
Run from flash/host (f/h) : f
Default host run file name : vmlinux
Default host flash file name : bcm96348R_fs_kernel
Boot delay (0-9 seconds)  : 1
```

Replace IP address values with values that are appropriate for the network that the DSL Router is connected to.

6. In minicom, enter 'f' to download the Linux image (root file system and kernel) and write the image to the flash.

```
Loading 192.168.1.100:bcm96348R_fs_kernel ...
Finished loading 1685392 bytes

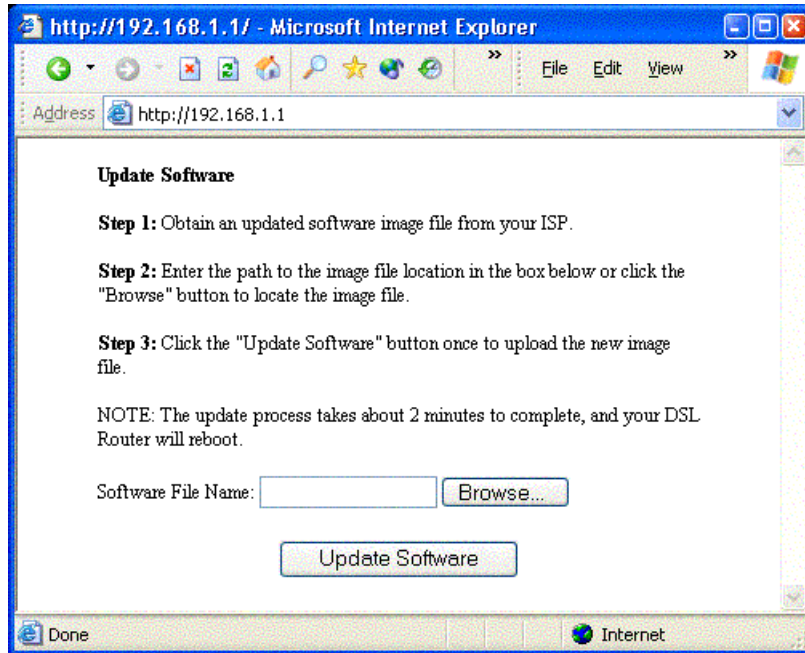
Flashing root file system and kernel: .....

.
*** Image flash done *** !
Resetting board...
```

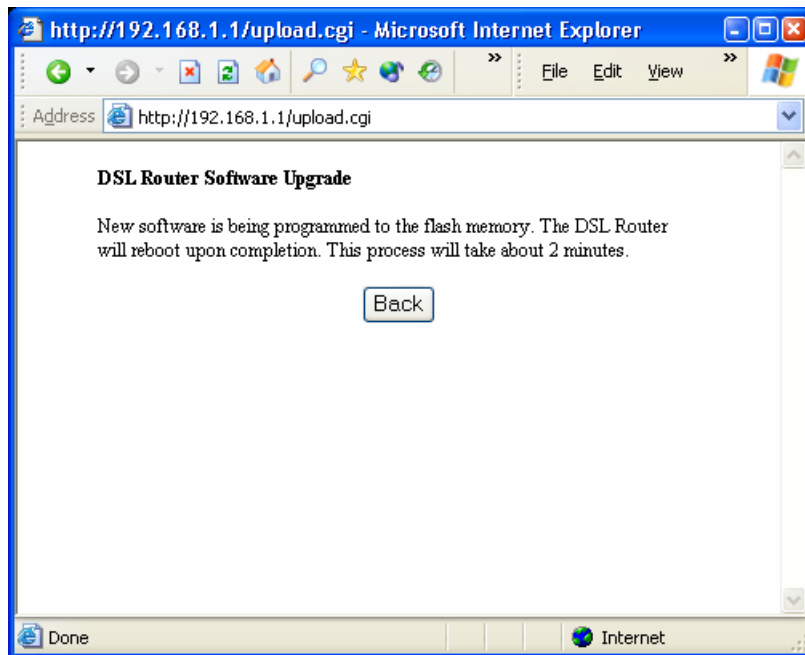
Example 2: Updating the DSL Router Image Using HTTP

To update the BCM963xx DSL Router with a new image using an HTTP Web server without needing a serial port, follow these steps.

1. Press and hold the reset button until the “DSL” LED goes on. It will take about 8 seconds.
2. Configure a PC Ethernet connection with a static IP address on subnet 192.168.1.x.
3. Open a Web browser to IP address 192.168.1.1. The following screen will appear.



4. Enter the name of the DSL router image in the “Software File Name” edit box.
5. Press the “Update Software” button. The following screen will appear in a few seconds after the image is downloaded onto the DSL router.



6. The new image will be written to flash memory.

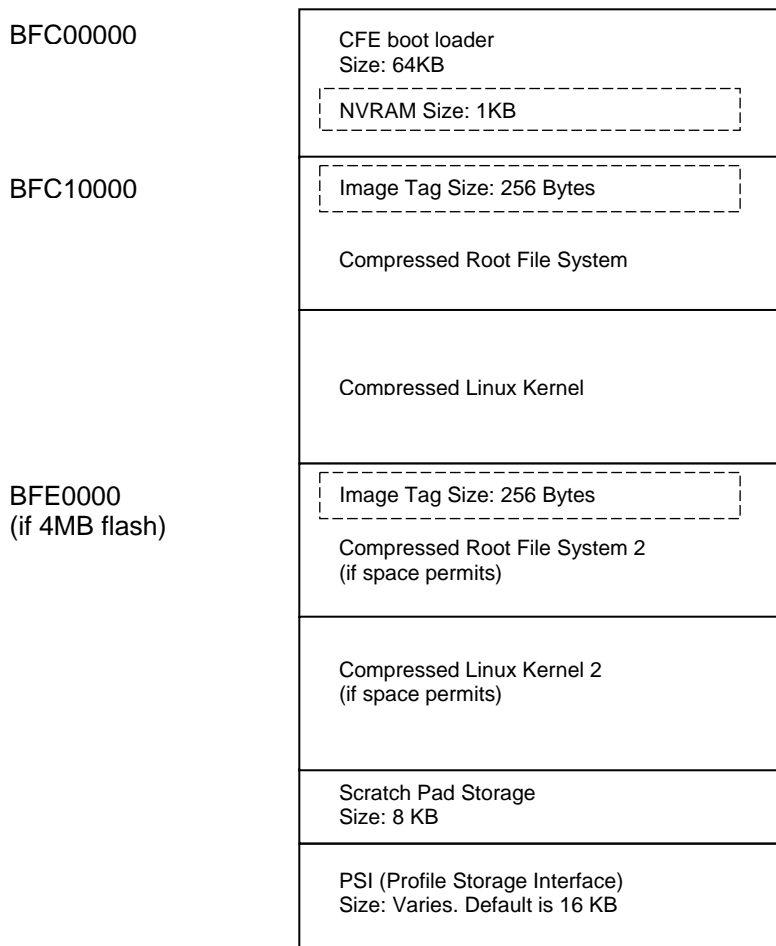
Example 3: Run Kernel Image from Host

To download and run the BCM963xx DSL Router vmlinux executable image (which is not a flash file and can not be written to flash by the CFE boot loader), follow these steps.

The flash memory consists of entities in the following order:

1. CFE boot loader / NVRAM
2. Linux Root File System
3. Linux Kernel
4. Second Linux Root File System if space permits
5. Second Linux Kernel if space permits
6. PSI (profile storage for configuration data)

The boot loader assumes the boot loader has a fixed size of 64KB. The size of the Linux root file system, Linux kernel and PSI may vary. The kernel can share the same flash block with PSI. A second Linux root file system and Linux kernel is included only if the combined size of the root file system and kernel is less than or equal to half the size of flash memory minus the size of the CFE boot loader.



7. Dual Linux Image Support

Two Linux images can reside on flash if the image size is less than or equal to half the size of flash memory minus the size of the CFE boot loader. The CFE boot loader and Linux router “update image” commands will flash a bcm963xx_fs_kernel image or bcm963xx_cfe_fs_kernel image to the other image location (see *Flash Memory Structure* section above) if the size requirement is satisfied. This capability occurs automatically and is not configurable.

If there are two images on flash, then all subsequent image updates must have a size that is also less than or equal to half of the size of flash memory minus the size of the CFE boot loader. Otherwise, an error is displayed and the image update is aborted. In this case, the image can still be flashed if it is less than the total flash memory size minus the size of the CFE boot loader by first issuing the CFE boot loader command to “erase all”, CFE> e a. Alternatively, a “whole flash image” (.w file) can be flashed.

The CFE boot loader boots the image specified in the “Boot Image” configuration value (see *CFE Boot Loader Command “c”* section above) which is either the “latest” image or the “previous” image. The boot loader validates the Linux image file tag CRC, the Linux file system CRC and the Linux kernel CRC. If all CRC values are correct, the Linux kernel is decompressed into SDRAM. If the decompression is successful, program execution jumps to the Linux kernel entry point address and the Linux image starts to execute. If one of the CRC values is not correct or the decompression fails, the same steps are done with the alternate flash image. If the alternate image is also has an invalid CRC or decompression failure, control stops in the CFE boot loader.

8. Linux Image File Tag Structure

```
typedef struct _FILE_TAG
{
    unsigned char tagVersion[TAG_VER_LEN];           // tag version 6
    unsigned char signature_1[SIG_LEN];             // text line for company info
    unsigned char signature_2[SIG_LEN];             // additional info (can be version number)
    unsigned char boardId[BOARD_ID_LEN];           // board id
    unsigned char bigEndian[FLAG_LEN];              // 1 = big endian, 0 = little endian
    unsigned char totalImageLen[IMAGE_LEN];         // the sum of all the following length
    unsigned char cfeAddress[ADDRESS_LEN];          // if non zero, cfe starting address
    unsigned char cfeLen[IMAGE_LEN];               // if non zero, cfe size in ASCII text.
    unsigned char rootfsAddress[ADDRESS_LEN];       // if non zero, filesystem starting address
    unsigned char rootfsLen[IMAGE_LEN];            // if non zero, filesystem size in ASCII text.
    unsigned char kernelAddress[ADDRESS_LEN];       // if non zero, kernel starting address
    unsigned char kernelLen[IMAGE_LEN];            // if non zero, kernel size in ASCII text.
    unsigned char imageSequence[FLAG_LEN * 2];     // increments everytime an image is flashed
    unsigned char reserved[RESERVED_LEN];          // reserved for later use
    unsigned char imageValidationToken[TOKEN_LEN]; // image validation token - 32 bit CRC
    unsigned char tagValidationToken[TOKEN_LEN];    // validation token for tag from
                                                    // signature_1 to end of imageValidationToken
} FILE_TAG, *PFILE_TAG;
```

9. NVRAM Configuration Data Structure

```
#define NVRAM_LENGTH             ONEK                // 1k nvram
#define NVRAM_VERSION_NUMBER     2
#define NVRAM_VERSION_NUMBER_ADDRESS 0
#define NVRAM_BOOTLINE_LEN      256
#define NVRAM_BOARD_ID_STRING_LEN 16
#define NVRAM_MAC_ADDRESS_LEN   6
#define NVRAM_MAC_COUNT_DEFAULT 0

typedef struct
{
    unsigned long ulVersion;                // configuration data version
    char szBootline[NVRAM_BOOTLINE_LEN];    // CFE boot loader IP address, subnet
                                           // mask and gateway address
    char szBoardId[NVRAM_BOARD_ID_STRING_LEN]; // board id string
    unsigned long ulReserved1[2];
    unsigned long ulNumMacAdrrs;            // number of MAC addresses needed by the
                                           // Linux router
    unsigned char ucaBaseMacAddr[NVRAM_MAC_ADDRESS_LEN]; // base MAC address
    char chReserved[2];
    unsigned long ulCheckSum;
} NVRAM_DATA, *PNVRAM_DATA;
```