

Hacking LG 32LH3000 lcd tv set and family..

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Introduction

This document is about hacking a broad range of LG tv set that do have a large diffusion and some already interesting features.

The family is formed by: xxLH2000, xxLF25yy, xxLH3000, xxLH4000 and xxLH5000 (where xx is a number of inches of the display)

Some feature more or less available in the different sets:

- DTT HD DVB decoder (MPEG2 HD, H264)
- USB 2.0 port
- RS232 serial port
- HDMI
- Bluetooth (BT) dongle
- uboot, linux kernel, busybox open source software stack
- UI navigator and MHEG rendering engine (proprietary)

For example, one of the easier hacks is about permitting in the entry level version to [enable the USB port](#) (marked as a service only port) as a multimedia port for viewing Photo, Divx, Mkv and listening MP3 from storage media (disk or mem key)

Disclaimer

Everything written in this paper is for information and educational purposes only.

In some countries, using these techniques can be prosecuted or unlawful. Beware!

There is **NO WARRANTY** at all about successful results or improvement. YOU CAN DAMAGE your device if you do something without understanding exactly the issues behind.

The theory of the toy and some practice off-line

Let's begin with some chapters dealing with the theory and some practice that can be done without having the tv set. This is a good starting for people just interested in the educational aspects of this hacking project.

Also people afraid of damage the tv set can be interested in knowing a little more deeply the machinery inside this device.

As you'll understand, linux is such a powerful environment that also big corporations leverage it's power and control with a proper attention to simplicity and lightness over the standard bloated approach.

There's clearly no sign of technical obfuscation of the powerful processes running in this box. Let's hope to get more signs of openness from the marketing point of view.

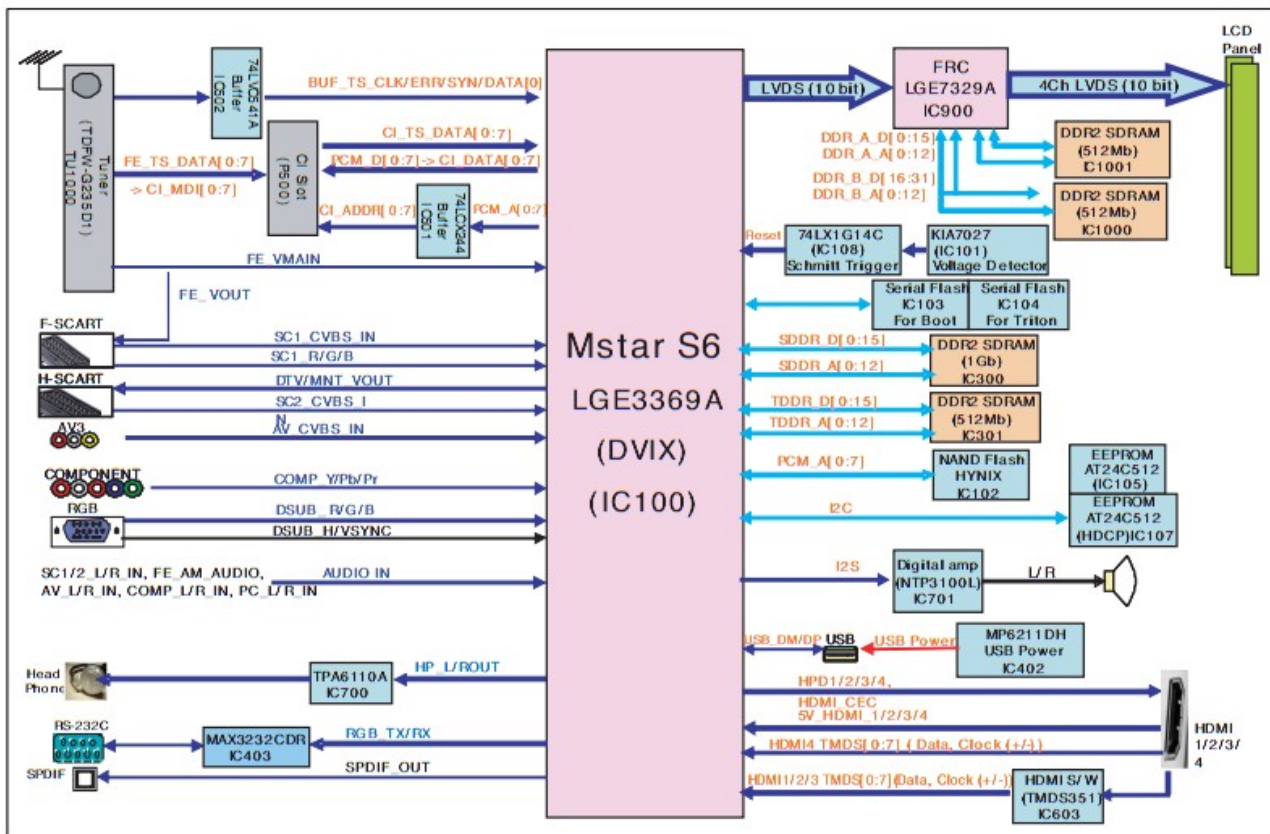
An open source firmware should be seen as a proper value point and people should be let in the box and toy with it.

Inside the LG TV set.

The main board is based on a **Mstar Saturn6** solution.

As far as we know, the various TV flavours can vary only slightly for some different number of HDMI ports, some added hardware (like the BT dongle in the LH7000 family) or video coprocessor (200Hz refresh feature) or LCD panel.

This is a sample picture related to the schema of the LH4000 tv hardware:



As you can see this is a fully integrated television set, with only 1 main chip doing both digital and analog television tuning and all the multimedia features.

Decompress and study a firmware

There many firmware available for this family of tv set on the net. Ranging from 3.15, 3.24, 3.37

and 3.40

The typical file package is called ***.epk**, and is a compressed set of filesystem of a linux embedded distribution.

Here you can find [some relevant information](#) about how the epk is made of and the tools to decompress it too (but the tools are win32 executable running only linux using **wine**, wine is a “Ms windows”-clone “wannabe” environment, not exactly an emulator..., that can be installed in your linux box)

This is the command for extracting the various partitions from firmware 3.15 epk:

```
$ wine Decompress.exe fw315.epk
E-Pack Decompressor v1.04 (c) 2009 by tester13

Epack unpacking
E-Pack size : 20639946
E-Pack files : 8
$ ls -l
-rw-r--r-- 1 andrea andrea 222184 15 ott 15:41 boot
-rw-r--r-- 1 andrea andrea 4198404 15 ott 15:41 eman.squashfs
-rw-r--r-- 1 andrea andrea 3145732 15 ott 15:41 ezca.squashfs
-rw-r--r-- 1 andrea andrea 20640157 15 ott 15:28 fw315.epk
-rw-r--r-- 1 andrea andrea 2176038 15 ott 15:41 kern.img
-rw-r--r-- 1 andrea andrea 6730920 15 ott 15:41 lgap.lzo
-rw-r--r-- 1 andrea andrea 204804 15 ott 15:41 lgfo.squashfs
-rw-r--r-- 1 andrea andrea 3645444 15 ott 15:41 lgre.squashfs
-rw-r--r-- 1 andrea andrea 315396 15 ott 15:41 root.squashfs
```

Let's get a feeling of the CPU arch and the kernel version:

```
$ strings kern.img | head -1
MIPS Linux-2.6.26
```

Let's note that since 3.24 firmware revision there's another file in the package, called **mode.jffs2**. Decompress this file is a bit trickier but surely doable as a root user.

```
modprobe mtd
modprobe jffs2
modprobe mtdram
modprobe mtdchar
modprobe mtdblock
dd if=./mode.jffs2 of=/dev/mtd0
# 256+1 records in
# 256+1 records out
# 131076 bytes (131 kB) copied, 0,000575632 s, 228 MB/s
mkdir ./mode_unpack/
mount -t jffs2 /dev/mtdblock0 ./mode_unpack
```

Inside this jffs2 filesystem there's only one file named **RELEASE.cfg**; this is the 3.40 dump:

```
# cat RELEASE.cfg
[i2c]MICOM:4:0x52
[i2c]FRCMST7323S:2:0xB4
[i2c]FRCSPIFLASH:2:0x94
[i2c]LG5110:2:0x1E
[i2c]HDCP:1:0xA8
[i2c]NTP3100:4:0x54
[i2c]TUA:6:0xFF
[i2c]TUD:2:0xFF
[i2c]RGBSENSOR:4:0x90
[i2c]NVM:1:0xA0
[i2c]BUF16821:2:0xe8
[i2c]HDMI_A_EDID:8:0xA0
[i2c]HDMI_B_EDID:9:0xA0
[i2c]HDMI_C_EDID:10:0xA0
modelName,DVB-SATURN
szCountryGroupCode,EU
szOtaid,HE_DTV_GP_M_AAAAABAA
eModuleInchType,INCH_42
eToolType,TOOL_LH40
```

```

eModuleMakerType,MODULE_LGD
eModuleVersionType,MODULE_VER0
nMaxNumOfHDMIInput,4
eHDMISwitchType,HDMI_SWITCH_GPIO
nMaxNumOfCOMPInput,1
bSupportSideSVHS,0
nMaxNumOfAVInput,1
nMaxNumOfSCARTInput,2
bNoSupportISF,0
bNoSupportPictureWizard,0
bSupportEMF,1
eDIVXType,DIVX_HD
bSupportBT,0
bSupportDigitalEye,1
bSupportHeadPhone,1
bSupportOPC,0
bSupportEPA,1
bSupportEManual,1
eAMPChipType,AMP_NTP3100
eBreathingLEDType,LCD_BREATHING_LED_ONLY
bSupportNewECON,0
eDigitalDemodType,DRXK
eAnalogDemodType,TDFWDRXK
bSupportTHX,0
bSupportLocalDimming,0
bSupportChinaClearQAM,0
bSupportMediaDirector,0
bSupportPictureWizard,0
eDispType,LCD_DISPLAY
eDispResolution,0x780438
eFrcChipType,FRC_CHIP_NONE
bSupportLVDSwap,0
eDebugMode,RELEASE
eMICOMType,MICOM_INTERNAL
eOSDResolution,0x556300
eDisplvdsType,LVDS_VESA
eAMPTType,AMP_42LG60
ePIPTType,0
szFE_TunerName,TDFWDRXK_DRXK
szFE_TunerCFG,ZZ_SbXXXXXXXXXX
nMaxNumOfMediaPath,1
nMaxNumOfTvPath,1
nMaxNumOfTVInput,4
nMaxNumOfAUTOAVInput,2
nMaxNumOfRGBInput,1
nMaxNumOfTvtuner,1
nHDMIPortSwapOrder,0x4321
bSupportGameMode,1
sPqlConfig.eDisplayModule,PQL_LCD_FLAT
sPqlConfig.eDisplaySize,42
sPqlConfig.eDisplayResolution,PQL_1920x1080P
sPqlConfig.eModuleOption,PQL_LPL_ÄTW
sPqlConfig.eRegion,0
sPqlConfig.ePipType,0
bSupportJackBoard,0
bSupportVcomPgamma,1
nWhiteBalanceNpoint,10
bSupportDimmingCtrl,1
[end]

```

These seems the variables you could change using the service menu (for example, the DIVX support should be defined here: **eDIVXType,DIVX_HD**; as the var begin with **e** it seems an enumerator, other values should be: **DIVX_SD** and maybe **NONE**), this filesystem is mounted r/w but we don't know of a local editor (vi is missing and nano too from the busybox alias!)

Now we have left two kind of compressed images: squashed fs like ***.squashfs** and cramfs compressed file with the LZ algorithm **lgap.lzo**.

To read this last one you'll need some more tweaking. If you try to mount as is you'll get an error. LZ compression scheme is not standard support in our debian distro kernel.

```

$mkdir lgap
$sudo mount -t cramfs -o loop ./lgap.lzo lgap

```

the mount doesn't work as we don't support LZ compression so you'll find in **dmesg**:

```
...
[ 7024.450096] loop: module loaded
[ 7024.473254] cramfs: wrong magic
```

so you can use another win32 app called **lpak.exe** still through **wine**:

```
user@nb-user:~/progetti/decoders/lg/tmp$ wine ./lpak.exe -d lgap.lzo lgap.cromfs

LZO real-time data compression library (v1.08, Jul 12 2002).
Copyright (C) 1996-2002 Markus Franz Xaver Johannes Oberhumer

*** DISCLAIMER ***
  This is an example program, do not use to backup your data !
  Get LZOP if you're interested into a full-featured packer.
  See http://www.oberhumer.com/opensource/lzop/

Z:\home\user\progetti\decoders\lg\tmp\lpak.exe: decompressed 6730916 into 14581760 bytes
```

now we can mount the uncompressed image with this standard mount command over a loopback:

```
$ sudo mount -t cramfs -o loop ./lgap.cromfs lgap
```

the squashfs compressed images are fairly easy to decompress on the fly with an user level command line; you'll need to run it as root as you want to recreate all the special filename like dev node and so on (security concern here, anyway.):

```
# unsquashfs *.squashfs
```

Beware, this tool creates always the same temp directory named **squashfs-root/**, so you'll need to rename each before proceeding with the work. Let's suppose to have this directory tree with relevant names:

```
$ ls -ld *-squashed
drwxr-sr-x 4 user user 4096 16 apr 2009 eman-squashed
drwxr-sr-x 2 user user 4096 16 apr 2009 ezca-squashed
drwxr-sr-x 2 user user 4096 16 apr 2009 lgfo-squashed
drwxr-sr-x 2 user user 4096 16 apr 2009 lgre-squashed
drwxr-sr-x 19 user user 4096 20 gen 2009 root-squashed
$ ls -ld lgap
drwxr-xr-x 2 user user 4096 1 gen 1970 lgap
```

Now let's study what's inside these filesystem! Some time well spent.

Root filesystem

let's give a **tree root-squashed** to grasp the idea behind the root fs.

```
root-squashed/
|-- bin
|   |-- ash -> busybox
|   |-- busybox
|   |-- cat -> busybox
|   |-- cp -> busybox
|   |-- d -> busybox
|   |-- date -> busybox
|   |-- dmesg -> busybox
|   |-- echo -> busybox
|   |-- grep -> busybox
|   |-- kill -> busybox
|   |-- ls -> busybox
|   |-- mkdir -> busybox
|   |-- mount -> busybox
|   |-- ps -> busybox
|   |-- r -> busybox
|   |-- rm -> busybox
```

```
| -- sh -> busybox
| -- sync -> busybox
| -- umount -> busybox
| -- w -> busybox
-- boot
-- dev
| -- 8051
| -- 8051lite
| -- aeon
| -- bt_usb
| -- cc
| -- ci
| -- console
| -- core -> /proc/kcore
| -- creader
| -- dac
| -- deb
| -- dvbc
| -- eeprom
| -- emac
| -- fb0
| -- flash
| -- full
| -- ge
| -- gop
| -- gpio
| -- h264
| -- hdmi
| -- iic
| -- ir
| -- jpeg
| -- keypad
| -- kmem
| -- loop0
| -- loop1
| -- loop2
| -- loop3
| -- loop4
| -- loop5
| -- loop6
| -- loop7
| -- m4vd
| -- mad
| -- malloc
| -- mem
| -- miu
| --mlink
| --msmailbox
| -- msttx
| -- mtd0
| -- mtd1
| -- mtd10
| -- mtd11
| -- mtd12
| -- mtd13
| -- mtd14
| -- mtd15
| -- mtd16
| -- mtd17
| -- mtd18
| -- mtd19
| -- mtd2
| -- mtd3
| -- mtd4
| -- mtd5
| -- mtd6
| -- mtd7
| -- mtd8
| -- mtd9
| -- mtdblock0
| -- mtdblock1
| -- mtdblock10
| -- mtdblock11
| -- mtdblock12
| -- mtdblock13
| -- mtdblock14
| -- mtdblock15
| -- mtdblock16
```

```
-- mtblock17
-- mtblock18
-- mtblock19
-- mtblock2
-- mtblock3
-- mtblock4
-- mtblock5
-- mtblock6
-- mtblock7
-- mtblock8
-- mtblock9
-- mvd
-- mvop
-- null
-- oprofile
-- port
-- power
-- ptmx
-- pts
-- pwm
-- ram -> ram1
-- ram0
-- ram1
-- ram2
-- ram3
-- ram4
-- ram5
-- ram6
-- ram7
-- ram8
-- ram9
-- random
-- rld
-- rtc
-- sar
-- scaler
-- sda
-- sda1
-- sda10
-- sda11
-- sda12
-- sda13
-- sda14
-- sda15
-- sda2
-- sda3
-- sda4
-- sda5
-- sda6
-- sda7
-- sda8
-- sda9
-- sdb
-- sdb1
-- sdb10
-- sdb11
-- sdb12
-- sdb13
-- sdb14
-- sdb15
-- sdb2
-- sdb3
-- sdb4
-- sdb5
-- sdb6
-- sdb7
-- sdb8
-- sdb9
-- sdc
-- sdc1
-- sdc10
-- sdc11
-- sdc12
-- sdc13
-- sdc14
-- sdc15
-- sdc2
-- sdc3
```



```
-- sdc4
-- sdc5
-- sdc6
-- sdc7
-- sdc8
-- sdc9
-- sdd
-- sdd1
-- sdd10
-- sdd11
-- sdd12
-- sdd13
-- sdd14
-- sdd15
-- sdd2
-- sdd3
-- sdd4
-- sdd5
-- sdd6
-- sdd7
-- sdd8
-- sdd9
-- sde
-- sde1
-- sde10
-- sde11
-- sde12
-- sde13
-- sde14
-- sde15
-- sde2
-- sde3
-- sde4
-- sde5
-- sde6
-- sde7
-- sde8
-- sde9
-- sdf
-- sdf1
-- sdf10
-- sdf11
-- sdf12
-- sdf13
-- sdf14
-- sdf15
-- sdf2
-- sdf3
-- sdf4
-- sdf5
-- sdf6
-- sdf7
-- sdf8
-- sdf9
-- smart
-- spi
-- stderr -> console
-- stdout -> console
-- system
-- tsp
-- tty
-- tty0
-- tty1
-- tty2
-- tty3
-- tty4
-- tty5
-- tty6
-- tty7
-- tty8
-- tty9
-- ttyS0
-- tvencoder
-- uart
-- urandom
-- usb
-- vcs -> vcs0
-- vcs0
```

```

|-- vcs1
|-- vcs2
|-- vcs3
|-- vcs4
|-- vcs5
|-- vcs6
|-- vcs7
|-- vcs8
|-- vcs9
|-- vcsa -> vcsa0
|-- vcsa0
|-- vcsa1
|-- vcsa2
|-- vcsa3
|-- vcsa4
|-- vcsa5
|-- vcsa6
|-- vcsa7
|-- vcsa8
|-- vcsa9
|-- vd
|-- zero
-- etc
|-- fstab
|-- go.sh
|-- group
|-- init.d
|   |-- rcS
|-- inittab
|-- mtab
|-- nfs.sh
|-- passwd
|-- profile
|-- rc.d
|   |-- rc.local
|   |-- rc.sysinit
|-- security
|-- shadow
|-- version_for_lg
-- home
-- initrd
-- lg -> mnt/lg
-- lgsw
-- lib
-- mnt
|   |-- flash
|   |-- lg
|   |   |-- bt
|   |   |-- lgapp
|   |   |-- model
|   |   |-- pqldb
|   |   |-- recdb
|   |   |-- res
|   |   |   |-- emanual
|   |   |   |-- ezcal
|   |   |   |-- lgfont
|   |   |   |-- lgres
|   |-- user
|-- nfs
|-- usb1
|   |-- Drive1
|   |-- Drive2
|   |-- Drive3
|   |-- Drive4
-- opt
-- proc
-- root
-- sbin
|   |-- halt -> ../bin/busybox
|   |-- init -> ../bin/busybox
|   |-- insmod -> ../bin/busybox
|   |-- lsmod -> ../bin/busybox
|   |-- poweroff -> ../bin/busybox
|   |-- reboot -> ../bin/busybox
|   |-- rmmmod -> ../bin/busybox
-- sys
-- tmp
-- usr

```

```

|-- bin
|   |-- [ -> ../../bin/busybox
|   |-- [[ -> ../../bin/busybox
|   |-- awk -> ../../bin/busybox
|   |-- chrt -> ../../bin/busybox
|   |-- free -> ../../bin/busybox
|   |-- killall -> ../../bin/busybox
|   |-- renice -> ../../bin/busybox
|   |-- test -> ../../bin/busybox
|   |-- time -> ../../bin/busybox
|-- lib
-- var
|   |-- log
|   |-- run
45 directories, 298 files

```

As you can see, nothing special here. Just a stripped down embedded linux environment.

Main software: lgap filesystem

In this file system few fatty files, indeed:

```

$ ls -l lgap
totale 15468
-rwxr-xr-x 1 user user 13152388 1 gen 1970 RELEASE
-rw-r--r-- 1 user user 2360102 1 gen 1970 RELEASE.sym
-rw-r--r-- 1 user user 287848 1 gen 1970 u-boot-spi.bin

```

RELEASE is the name of the main program driving the whole tv during normal execution. Strangely enough, when you compress on the host system, there's only a file packed of 0x00 bytes. Need to investigate better on the running system

Pay attention it's a “execute in place” (**XIP**) software and so the cramfs is mounted like this on the real box:

```
mount -t cramfs -o physaddr=`cat /proc/xipfs` lgapp /mnt/lg/lgapp
```

RELEASE.sym contains all the symbols of that program. Many things to be understood, studying the content in a next chapter.

U-boot-spi is a copy of the boot loader (i think here for backup purposes, who knows now?)

The list of the source code file creating the release

There **RELEASE.sym** contains the list of the file of the source code project: I put it in appendix B as it would be too long here to not be a problem for a reader.

Other mounted filesystems

Inside the other filesystems there's not so much to be seen, fonts, manual, other resources. Maybe i'll describe them later.

Creating a modified image

Let's suppose you want to modify the root filesystem.

You could expand the compressed image, modify as you like the file then create back the image and upload to tv.

Open one squashed compressed image, as root for special dev nodes in the root filesystem.

```
#unsquashfs root.squashfs
```

Recreate the image for uploading to box (with zmodem)

```
$ mksquashfs squashfs-root/ root-mod2.sqfs
```

It's that simple!

Creating a home-brewed epk complete package

This would be of course the next stage hacking the box; this way you could prepare your own image and share it with your friends. Of course a public distribution of this software could be involving some third parties right. Do what you make feel better.

Now back to business.

How can you prepare the final epk, create the right version? Make the right CRC signature whatever? Then package everything to the epk format?

We really don't know. Everyone helping here is welcomed.

Understanding the tv process model during standard working.

Here we try to clarify what's working inside the TV when you normally use it.

As you can see, there are lots of dump full of info coming from the console.

Phase 0: from cold off to stand by

When you plug the power cord, the tv starts from off (no light on the front panel led) with a cold boot to a warm off, stand by (with the front panel led to a red fixed light)

Here is what you can see on the serial port when logging is on.

```
U-Boot 1.1.6 (Mar  5 2009 - 16:24:56)

[CP0config] 0x80840483
[ Baudrate] 115200
Board   : MSTAR TITANIA (CPU Speed 216 MHz)
TB:0x81000000,MB:0x80fc0000,GD:0x80f9ffa4,SP:0x80f9ff80
[194] Copy "kernel (2176038 bytes)" from 0x02340000 to 0x80c00000
[404] ...done (10362 KB/s)
[407] Copy "lgapp (6793743 bytes)" from 0x025c0000 to 0x82000000
[1050] ...done (10565 KB/s)
read filesystem type
This is not xip image!
[2073] ## Booting image at 80c00000 ...
  Image Name:   MIPS Linux-2.6.26
  Image Type:   MIPS Linux Kernel Image (lzo compressed)
  Data Size:    2175970 Bytes =  2.1 MB
  Load Address: 80400000
  Entry Point:  80658b00
  Uncompressing Kernel Image ... OK

[2426] Starting kernel ...

[ 0.000000] Wasting 71616 bytes for tracking 2238 unused pages
[ 0.000000] Zone PFN ranges:
[ 0.000000] DMA             1023 ->   28928
[ 0.000000] Normal         28928 ->   28928
[ 0.000000] Movable zone start PFN for each node
[ 0.000000] early_node_map[2] active PFN ranges
[ 0.000000] 0             1023 ->    3261
[ 0.000000] 0             16896 ->   28928
[ 0.000000] Built 1 zonelists in Zone order, mobility grouping on. Total pages: 1
[ 0.000000] Kernel command line: root=/dev/mtdblock3 rootfstype=squashfs lpj=10598
[ 0.000000] Primary instruction cache 4kB, VIPT, 4-way, linesize 16 bytes.
[ 0.000000] Primary data cache 4kB, 2-way, VIPT, no aliases, linesize 16 bytes
[ 0.000000] PID hash table entries: 256 (order: 8, 1024 bytes)
```

```

[ 0.000000] CPU freq count = 108000000
[ 0.000000] CPU frequency 216.00 MHz
[ 0.000000] Dentry cache hash table entries: 8192 (order: 3, 32768 bytes)
[ 0.001000] Inode-cache hash table entries: 4096 (order: 2, 16384 bytes)
[ 0.019000] Memory: 50164k/51208k available (2421k kernel code, 984k reserved, 17)
[ 0.020000] SLUB: Genslabs=6, HWalign=32, Order=0-3, MinObjects=0, CPUs=1, Nodes=1
[ 0.021000] Calibrating delay loop (skipped)... 211.96 BogoMIPS preset
[ 0.022000] Mount-cache hash table entries: 512
[ 0.044000] net_namespace: 192 bytes
[ 0.046000] NET: Registered protocol family 16
[ 0.082000] SCSI subsystem initialized
[ 0.086000] usbcore: registered new interface driver usbfs
[ 0.089000] usbcore: registered new interface driver hub
[ 0.091000] usbcore: registered new device driver usb
[ 0.108000] BOOTSTRAP 13(2)
[ 0.117000] MICOM NVM 0[00 00 01 00 00 00 ]
[ 0.122000] MICOM(LCD 2)
[ 0.130000] MICOM(00,01,01)

```

Now “something”, like a process?, is waiting for some **Power-on** key is pressed, both on the TV front panel or from the remote control.

Phase 1: from stand by to running

Now if you press the **Power on** button, you'll see this logging on the serial port.

U-Boot 1.1.6 (Mar 5 2009 - 16:24:56)

```

[CP0config] 0x80840483
[ Baudrate] 115200
Board   : MSTAR TITANIA (CPU Speed 216 MHz)
TB:0x81000000,MB:0x80fc0000,GD:0x80f9ffa4,SP:0x80f9ff80
[192] Copy "kernel (2176038 bytes)" from 0x02340000 to 0x80c00000
[403] ...done (10312 KB/s)
[405] Copy "lgapp (6793743 bytes)" from 0x025c0000 to 0x82000000
[1049] ...done (10549 KB/s)
read filesystem type
This is not xip image!
[2072] ## Booting image at 80c00000 ...
      Image Name:   MIPS Linux-2.6.26
      Image Type:   MIPS Linux Kernel Image (lzo compressed)
      Data Size:    2175970 Bytes = 2.1 MB
      Load Address: 80400000
      Entry Point:  80658b00
      Uncompressing Kernel Image ... OK

[2425] Starting kernel ...

[ 0.000000] Wasting 71616 bytes for tracking 2238 unused pages
[ 0.000000] Zone PFN ranges:
[ 0.000000] DMA          1023 -> 28928
[ 0.000000] Normal         28928 -> 28928
[ 0.000000] Movable zone start PFN for each node
[ 0.000000] early_node_map[2] active PFN ranges
[ 0.000000] 0           1023 -> 3261
[ 0.000000] 0           16896 -> 28928
[ 0.000000] Built 1 zonelists in Zone order, mobility grouping on. Total pages: 1
[ 0.000000] Kernel command line: root=/dev/mtdblock3 rootfstype=squashfs lpj=10598
[ 0.000000] Primary instruction cache 4kB, VIPT, 4-way, linesize 16 bytes.
[ 0.000000] Primary data cache 4kB, 2-way, VIPT, no aliases, linesize 16 bytes
[ 0.000000] PID hash table entries: 256 (order: 8, 1024 bytes)
[ 0.000000] CPU freq count = 108000000
[ 0.000000] CPU frequency 216.00 MHz
[ 0.000000] Dentry cache hash table entries: 8192 (order: 3, 32768 bytes)
[ 0.001000] Inode-cache hash table entries: 4096 (order: 2, 16384 bytes)
[ 0.019000] Memory: 50164k/51208k available (2421k kernel code, 984k reserved, 17)
[ 0.020000] SLUB: Genslabs=6, HWalign=32, Order=0-3, MinObjects=0, CPUs=1, Nodes=1
[ 0.021000] Calibrating delay loop (skipped)... 211.96 BogoMIPS preset
[ 0.022000] Mount-cache hash table entries: 512
[ 0.044000] net_namespace: 192 bytes
[ 0.046000] NET: Registered protocol family 16
[ 0.082000] SCSI subsystem initialized
[ 0.086000] usbcore: registered new interface driver usbfs
[ 0.089000] usbcore: registered new interface driver hub
[ 0.091000] usbcore: registered new device driver usb

```

```
[ 0.108000] BOOTSTRAP 13(2)
[ 0.113000] NET: Registered protocol family 2
[ 0.127000] IP route cache hash table entries: 1024 (order: 0, 4096 bytes)
[ 0.138000] TCP established hash table entries: 2048 (order: 2, 16384 bytes)
[ 0.146000] TCP bind hash table entries: 2048 (order: 1, 8192 bytes)
[ 0.153000] TCP: Hash tables configured (established 2048 bind 2048)
[ 0.160000] TCP reno registered
[ 0.166000] NET: Registered protocol family 1
[ 0.254000] squashfs: version 3.4 (2008/08/26) Phillip Lougher
[ 0.264000] NTFS driver 2.1.29 [Flags: R/O].
[ 0.274000] JFFS2 version 2.2. (NAND) © 2001-2006 Red Hat, Inc.
[ 0.289000] msgmni has been set to 98
[ 0.295000] io scheduler noop registered (default)
[ 0.303000] Serial: 8250/16550 driver $Revision: 1.90 $ 4 ports, IRQ sharing disad
[ 0.317000] serial8250: ttyS0 at I/O 0xbf801300 (irq = 8) is a 16550
[ 0.353000] loop: module loaded
[ 0.358000] Driver 'sd' needs updating - please use bus_type methods
[ 0.369000] NAND device: Manufacturer ID: 0xad, Chip ID: 0x76 (Hynix NAND 64MiB 3)
[ 0.378000] Loading nand bad block info...
[ 0.383000] Loading nand bad block info(00000000+00004000)...
[ 0.393000] nand_bbm_info_load: Loading nand bad block info...ok
[ 0.399000] nand bad block information:
[ 0.403000] magic = 0x8192a5a6
[ 0.407000] bad block count = 0
[ 0.410000] assign index = 4095
[ 0.414000] Mstar nand-flash partition definition
[ 0.419000] mtd info : # of partition = 19
[ 0.424000] Creating 19 MTD partitions on "NAND 64MiB 3,3V 8-bit":
[ 0.430000] 0x00000000-0x00020000 : "bbminfo"
[ 0.443000] 0x00020000-0x00060000 : "boot"
[ 0.453000] 0x00080000-0x000a0000 : "mtdinfo"
[ 0.464000] 0x000a0000-0x00220000 : "rootfs"
[ 0.474000] 0x00220000-0x00240000 : "model"
[ 0.484000] 0x00240000-0x00740000 : "emanual"
[ 0.495000] 0x00740000-0x00b40000 : "ezcal"
[ 0.505000] 0x02340000-0x025c0000 : "kernel"
[ 0.515000] 0x025c0000-0x02ec0000 : "lgapp"
[ 0.526000] 0x02ec0000-0x03240000 : "lgres"
[ 0.536000] 0x03240000-0x03b40000 : "lgfont"
[ 0.546000] 0x00b40000-0x00dc0000 : "kernel"
[ 0.557000] 0x00dc0000-0x016c0000 : "lgapp"
[ 0.567000] 0x016c0000-0x01a40000 : "lgres"
[ 0.577000] 0x01a40000-0x02340000 : "lgfont"
[ 0.588000] 0x03b40000-0x03b60000 : "recdb"
[ 0.598000] 0x03b60000-0x03ba0000 : "system"
[ 0.608000] 0x03ba0000-0x03e00000 : "user"
[ 0.618000] 0x03e00000-0x04000000 : "reserved"
[ 0.629000] Disable power down for H.264 firmware
[ 0.634000] GE driver inits
[ 0.637000] GOP driver inits
[ 0.641000] GPIO Init(LCD)
[ 0.652000] [SCALER][000132] _mod_scaler_init
[ 0.657000] [MADMOD][002762] _mod_mad_init is invoked
[ 0.663000] init 160
[ 0.665000] [MVDMOD][000610] H264 bit-stream buffer addr 0xa9c00000; size 4194
[ 0.674000] CI driver inits
[ 0.677000] [RLDMOD][000430] mod_rld_init is invoked
[ 0.683000] [RLDMOD][000434] call register_chrdev_region
[ 0.689000] [RLDMOD][000463] Init RLD successfully
[ 0.695000] [TTX_DRV][00559]init 170
[ 0.699000] [VE_DRV][00469]MDrv_VE_Module_Init is invoked
[ 0.704000] [VE_DRV][00473]call register_chrdev_region
[ 0.710000] [VE_DRV][00499]Init VE successfully
[ 0.715000] MDrv_CC_Init
[ 0.718000] init 172
[ 0.720000] <MHal_JPD_Initialize>
[ 0.724000] BT_USB initialized
[ 0.727000] Hello~ this is kernel module on MIPS MSB
[ 0.733000] BT_USB for INSTANT_INTERRUPT scheme rev2
[ 0.738000] SCHED: init_sched
[ 0.742000] bt_usb: Bluetooth USB driver for LGE DTV
[ 0.749000] usbcore: registered new interface driver csr_usb
[ 0.755000] bt_usb: BT USB driver registered
[ 0.760000] BlueCore transport started... May
[ 0.770000] TCP cubic registered
[ 0.774000] NET: Registered protocol family 17
[ 0.783000] Adding user_initcall[0] = 0x80581360
[ 0.788000] Adding user_initcall[1] = 0x80581340
```

```

[ 0.793000] Adding user_initcall[2] = 0x805845c4
[ 0.804000] VFS: Mounted root (squashfs filesystem) readonly.
[ 0.812000] Freeing unused kernel memory: 112k freed
[ 1.176000] CLEANMARKER node found at 0x00000000 has totlen 0xc != normal 0x0
[ 1.356000] cramfs: checking physical address 0x7100000 for linear cramfs image
[ 1.364000] cramfs: linear cramfs image appears to be 14416 KB in size
Non-LG Driver Mode!
MAPS_INFO_T Init Error!!
001.498:__main()] >> Entering osadap_init(0,0)
001.499:__main()] >> Structure size :: mt(36), st(28), qt(52), tt(128)
Memory Caller Tracer is off
001.509:__main()] << Exiting osadap_init()
001.510:__main()] >> InitPool ]]] [0x2ab29000-0x2cb29000]
001.511:__main()] SM_MAT_POOL[ 8] = 0x2ab29000(0x028000)
001.511:__main()] SM_MAT_POOL[ 16] = 0x2ab51000(0x0a0000)
001.512:__main()] SM_MAT_POOL[ 32] = 0x2abf1000(0x0f0000)
001.513:__main()] SM_MAT_POOL[ 64] = 0x2ace1000(0x0a0000)
001.514:__main()] SM_MAT_POOL[128] = 0x2ad81000(0x640000)
001.514:__main()] SM_MAT_POOL[256] = 0x2b3c1000(0x780000)
001.515:__main()] >> InitBuddy ]] Addr=0x2bb41000, Size=0xfe8000
001.521:__main()] >> Total Free Heap Size = 0x1fce000
001.526:__main()] MODEL NAME : DVB-SATURN
001.530:__main()] OTA_ID : HE_DTV_GP_M_AAAAABAA[HE_DTV_GP_M_AAAAABAA]
001.538:RootInit] Start root... [ 1.538]
001.542:RootInit] H/W port ---- HD/FHD panel detect

001.603:RootInit] -----
001.604:RootInit] Found valid NVM Backup Data at Flash
001.604:RootInit] => Use this at Bootup time!
001.605:RootInit] -----
001.637:RootInit] NVM] ID set as 0xa0 : PageSize 128
001.657:RootInit] Sensor LGE TV : 60 , Sensor Module : 255
001.658:RootInit] Touch Sensor Value is different, set to default value..
001.663:Keyboard] Enter Product mode if you want exit form Product, input "debug"
[ 1.800000] [SYS][000124] MDrv_SYS_SetPanelInfo
001.806:RootInit] DDM_INIT_OEMChipTask Done!
001.833:RootInit] *IC Version = 30000
001.833:RootInit] *NO[ 1.838000] [MADMOD][002139] _mod_mad_open is invoked
W Version = 30000
001.834:RootI[ 1.847000] [MADMOD][002241] ioctl: receive MDrv_MAD_INITIALIZE_
nit] Spi is not new version.
001.835:RootInit] [PRJ_NAME: dvb_saturn6] <UI_MAIN_PreInitializeCountry:258>
001.836:RootInit] [RMM_GROUP_CODE: 0x4555: EU] <UI_MAIN_PreInitializeCountry:2583>
001.837:RootInit] [RMM_COUNTRY_CODE: 0x4954: IT] <UI_MAIN_PreInitializeCountry:2585>
[ 1.980000] MDrv_MAD_Se_SetMemInfo: DSPMadBaseBufferAdr[DSP_SE] = 0x00C00000
MDrv_MAD_ISRInit(101)...
[ 2.104000] MDrv_MAD_SoundEffectOnOff(1)...
[ 2.406000] TSP Fw=0xbc0000
[ 2.428000] [SCALER][000180] _mod_scaler_open
[ 2.473000] [HDMI][01446] =====enInputPortType=====0
[ 2.473000] 002Hal HDCP_InitProductionKey f8 85 e4 33 b1
[42m[F_ ___] FE_InitializeModule(Italy) START
002.483:tFEInit ] [F_ ___] Tuner CFG : ZZ_SbBXXXXXXXXXX ==> ZZ_SbBXXXXXXXXXX
002.484:tFEInit ] [F_ ___] DDI_TU_Probe()
002.485:tFEInit ] [T_ DDI] Tuner Name : TDFWDRXK_DRXK
002.486:tFEInit ] [T0 DDI] PROBING .... !!!
002.504[ 2.519000] COLOR KILL BOUND: 08 08
:tUiPInit]
002[ 2.525000] [VE_DRV][00313]MDrv_VE_Open is invoked
.505:tUiPInit] =[ 2.531000] _MDrv_VE_TransferInputMux
=====
002.506:tUiPIni[ 2.541000] [SYS][000124] MDrv_SYS_SetPanelInfo
t] Power On Mode : REMOTE K[ 2.550000] _GE opens successfully
EY(0x20)
002.50[ 2.554000] GOP opens successfully
6:tUiPInit] =====
002.548:RootInit] OSAD: (E) There is no task configuration matching with tOEMInit

002.571:tFEInit ] ##### DVB T/C Hybrid DRXK Probe OK !!
002.571:tFEInit ] [T0 DDI] >>> PROBE DEMOD(DRXK) OK <<<
002.572:tFEInit ] [T0 DDI] >>> PROBE ATV(TDFWDRXK) OK <<<
002.686:tFEInit ] [T0 DDI] >>> PROBE PLL(TDFWDRXK) OK <<<
002.687:tFEInit ] [F_ ___] FE_ATV_Initialize()
[ 2.697000] GwinID 3 used
002.687:tFEInit ] [F_ ___] FE_DTV_Initialize()
003.169:tFEInit ] [F_ ___] FE_InitializeModule() END
003.170:tFEInit ]
003.174:tFEInit ] FE PreinitTask Done!

```

```

003.175:tFEInit ] Now task is exiting
task is not thread ID
OSA_DeleteTask(taskId = 11) called, tId = 11
[   3.256000] GwinID 5 used
003.487:tUiPInit] =====
003.488:tUiPInit]           System activated by POWER_ON_BY_REMOTE_KEY[20]
003.489:tUiPInit] =====
003.496:tUiPInit] #####_MAIN_PreInitialize :: AUTO NUMBER[ 1 ]#####
003.497:tUiPInit] cableMode: 0
003.506:tUiPInit] Now task is exiting
task is not thread ID
OSA_DeleteTask(taskId = 10) called, tId = 10
003.927:tCMNvmRd] Now task is exiting
task is not thread ID
OSA_DeleteTask(taskId = 20) called, tId = 20
003.947:RootInit]   country code: [0x4954]
003.959:RootInit] *****
003.959:RootInit]   _MAIN_InitCountry [country:0x4954][RMM_COUNTRY_CODE:0x4954:IT]
003.960:RootInit] *****
004.105:RootInit] Font(/mnt/lg/res/lgfont/lg_display_eu_newdingbet.utf) has opened
004.357:RootInit]   MRE_SYS_SetOnlyMainSource, mainWinSrcInfo.Index =0
004.398:RootInit] API_AUDIO_SetTVSpeakerOnOff(): Skip mute delay(400) at boottime
[   4.479000] MDrv_MAD_DVB_PcmLevelControl:0
[   4.902000] MDrv_MAD_DVB_PcmLevelControl:0
004.993:tUiMain ] Model Name[   4.995000] MDrv_MAD_DVB_PcmLevelControl:0
= 32LF2500-ZA

```

Again the bootloader, the kernel, but now the main application named RELEASE is finally run.

Let's begin working hands on our tv set

In the next chapters will begin practicing the tv for real.

Beware, this is a potentially dangerous activity. There's no warranty here. YOU ARE ON YOUR OWN. you could make errors and the tv could be broken.

We strive to reduce the risks at minimum and signal where potentially critical activities are performed but we cannot be kept responsible.

The student should need only a serial terminal software (like telix, minicom) then when the exercises will become more complex, we'll use a bunch of utilities installed in any linux environment and we'll use a simple usb memory key to transfer files.

Later some more pieces could be useful for extreme practicing, like a bluetooth dongle, a network adapter and eventually a usb hub as there's only one single usb port and you'd like to eventually put all this stuff playing together!

Studying the boot process

It's very easy to stop the boot process and jump directly into the boot process (uboot) prompt: Just link a null modem serial cable between the TV set serial port and the PC, fire a serial terminal program (like minicom in linux) and power on the television. Now press some time the ESC key and way, you should see a **mstar#** prompt blinking in front of your eyes.

By the way, the default config of the tv set is to be silent on the serial console. You'll need to change some env variables to get info, check the “**how to enable system printout**” paragraph or give the **silent nothing** command on the **mstar#** prompt and then **reboot**.

```
U-Boot 1.1.6 (Mar  5 2009 - 16:24:56)

[CP0config] 0x80840483
[ Baudrate] 115200
Board      : MSTAR TITANIA (CPU Speed 216 MHz)
TB:0x81000000,MB:0x80fc0000,GD:0x80f9ffa4,SP:0x80f9ff80
[194] Copy "kernel (2176038 bytes)" from 0x02340000 to 0x80c00000
[404] ...done (10362 KB/s)
[407] Copy "lgapp (6793743 bytes)" from 0x025c0000 to 0x82000000
[1050] ...done (10565 KB/s)
read filesystem type
This is not xip image!

-----
Fast-boot interrupted. (key=0x1b)
Stop kernel booting.
-----

In       : serial
Out      : serial
Err      : serial
USB      : Host type : 2

>>> Fail => Time Out for Send qTD...
unable to get device descriptor (error=-1)

>>> Fail => Scanning USB devices... T.T

USB      :
??? Waiting for Peripheral Connecting Fail...
usb init failed
Error, couldn't init Lowlevel part
Hit any key to stop autoboot:  0
mstar #

Type help to get a short list of commands available:

mstar # help
?          - alias for 'help'
appxip    - copy to ram for appxip
base      - print or set address offset
bbm       - nand bad block management
```

```

bootm - boot application image from memory
bootp - boot image via network using BootP/TFTP protocol
cmp - memory compare
cp - memory copy
cp2ram - copy to ram for partition name
crc32 - checksum calculation
dcache - enable or disable data cache
defaultenv - set default env
go - start application at address 'addr'
help - print online help
load - download image file, and write on flash
loadz - download image file using zmodem, and write on flash
loop - infinite loop on address range
md - memory display
mm - memory modify (auto-incrementing)
mtdinfo - edit or add or remove mtdinfo
mtest - simple RAM test
mw - memory write (fill)
nand - NAND sub-system
nboot - boot from NAND device
nm - memory modify (constant address)
nvmdbg - eeprom test program
ping - send ICMP ECHO_REQUEST to network host
printenv - print environment variables
rarpboot - boot image via network using RARP/TFTP protocol
reboot - Perform RESET of the CPU
reset - Perform RESET of the CPU
rs - download image file, though zmodem
run - run commands in an environment variable
rz - download image file, though zmodem
saveenv - save environment variables to persistent storage
setboot - set boot type (root filesystem)
setenv - set environment variables
silent - silent all or nothing
swu - download epk image file, and write on flash
swuz - download epk image file, and write on flash
tftpboot - boot image via network using TFTP protocol
usb - USB sub-system
version - print monitor version
xip - copy to ram for xip

```

We'll not cover here all the commands as many are quite easy to understand.

Beware some commands can destroy your firmware and disable the tv from working again.

Disclaimer: **what you do here is your sole responsibility!**

We were unable to start the usb sub-system (timeout on some descriptors when we linked the usb key). So we cannot say you could transfer images from usb memory stick to flash partition using a fast memory card.

Environment variables

Another interesting source of information is the **env**, you can dump the default status using the **printenv** command:

```

mstar # printenv
bootcmd=cp2ram kernel 0x80C00000; xip app; xip font; bootm 0x80C00000
bootdelay=3
baudrate=115200
ethaddr=00:02:3e:26:0a:55
lserverip=156.147.69.181
ipaddr=192.168.0.10
serverip=192.168.0.1
gatewayip=192.168.0.1
netmask=255.255.255.0
bootargs=root=/dev/mtdblock3 rootfstype=squashfs lpj=105984
userpath=
hostname=saturn6
rootfs=flash
autoboot=n
verify=n

```

```
appxip=y
fontxip=y
silent=y
silent_app=y
silent_ker=y
memsize=128
stdin=serial
stdout=serial
stderr=serial
```

Environment size: 461/131068 bytes

As you can see there are many interesting env variables.

One set of vars deal with an IP network config. We can't say which kind of net equipment is supported in this boot loader, maybe a usb network adapter.

Enabling boot, kernel and process printout

As you can see all over this text, the system dumps lots of information over the serial port (AKA **console**, AKA **/dev/ttyS0**). This is not the default behaviour.

We had to modify the env variables: **silent** **silent_app** and **silent_ker**.

They are assigned with a **y** by default, if you change them to **n** and then give the **saveenv** command, you'll see at next boot all this useful info flowing over the serial port.

Another simpler way could be giving the **silent nothing** command at the boot prompt.

The partition table of the NAND flash

Giving the **mtdinfo** command in the boot process, you'll see this list of partitions into the flash.

```
mstar # mtdinfo
MTD Partition Information -----
cur epk ver : 0x033700
old epk ver : 0x000000

[ 0] "bbminfo"   : 0x00000000-0x00020000 (0x00020000)
[ 1] "boot"      : 0x00020000-0x00060000 (0x00040000) : "u-boot-nand.bin"[222180] -)
[ 2] "mtdinfo"   : 0x00080000-0x000a0000 (0x00020000) : "MTD.INFO"[0] - 0x000000 :)
[ 3] "rootfs"    : 0x000a0000-0x00220000 (0x00180000) : "rootfs.squashfs"[315392] -)
[ 4] "model"     : 0x00220000-0x00240000 (0x00020000) : "model.jffs2"[131072] - 0x0)
[ 5] "emanual"   : 0x00240000-0x00740000 (0x00500000) : "emanual.squashfs"[4571136]
[ 6] "ezcal"     : 0x00740000-0x00b40000 (0x00400000) : "ezcal.squashfs"[3145728] -)
[ 7] "kernel"    : 0x02340000-0x025c0000 (0x00280000) : "uImage"[2176038] - 0x00000)
[ 8] "lgapp"     : 0x025c0000-0x02ec0000 (0x00900000) : "lgapp.lzo"[6793743] - 0x03)
[ 9] "lgres"     : 0x02ec0000-0x03240000 (0x00380000) : "lgres.squashfs"[3252224] -)
[10] "lgfont"    : 0x03240000-0x03b40000 (0x00900000) : "lgfont.img"[204800] - 0x00)
[11] "kernel"    : 0x00b40000-0x00dc0000 (0x00280000) : "uImage"[0] - 0x000000 : (u)
[12] "lgapp"     : 0x00dc0000-0x016c0000 (0x00900000) : "lgapp.lzo"[0] - 0x000000 :)
[13] "lgres"     : 0x016c0000-0x01a40000 (0x00380000) : "lgres.squashfs"[0] - 0x000)
[14] "lgfont"    : 0x01a40000-0x02340000 (0x00900000) : "lgfont.img"[0] - 0x000000)
[15] "recdb"     : 0x03b40000-0x03b60000 (0x00020000)
[16] "system"    : 0x03b60000-0x03ba0000 (0x00040000)
[17] "user"      : 0x03ba0000-0x03e00000 (0x00260000)
[18] "reserved"  : 0x03e00000-0x04000000 (0x00200000)
```

Beware, with this internal menu you can destroy your working firmware and disable proper usage of television.

As you can see there are many partitions available.

Partition #1 is the bootloader. There is only one boot loader. **If you crash this partition you are done. BEWARE!**

Partition #3 is the root filesystem (with tools like busybox, libraries and the /etc system config tree)

As you can see four partition names are present two times: **kernel**, **lgapp**, **lgres** **lgfont**, from

partition #7 to partition #14.

```
MTD Partition Information -----
cur epk ver : 0x034000
old epk ver : 0x031500

[ 0] "bbminfo"   : 0x00000000-0x00020000 (0x00020000)
[ 1] "boot"      : 0x00020000-0x00060000 (0x00040000) : "u-boot-nand.bin"[222180] - 0x031500 : (U/V)
[ 2] "mtdinfo"  : 0x00080000-0x000a0000 (0x00020000) : "MTD.INFO"[0] - 0x000000 : (U/V)
[ 3] "rootfs"   : 0x000a0000-0x00220000 (0x00180000) : "rootfs_flash.squashfs"[315392] - 0x000001 : (U/V)
[ 4] "model"    : 0x00220000-0x00240000 (0x00020000) : "model.jffs2"[131072] - 0x034000 : (U/V)
[ 5] "emanual"  : 0x00240000-0x00740000 (0x00500000) : "emanual.squashfs"[4726784] - 0x000001 : (U/V)
[ 6] "ezcal"    : 0x00740000-0x00b40000 (0x00400000) : "ezcal.squashfs"[3145728] - 0x000001 : (U/V)
[ 7] "kernel"   : 0x00b40000-0x00dc0000 (0x00280000) : "uImage_flash"[2176595] - 0x000001 : (U/V)
[ 8] "lgapp"    : 0x00dc0000-0x016c0000 (0x00900000) : "lgapp_flash.lzo"[6801700] - 0x034000 : (U/V)
[ 9] "lgres"    : 0x016c0000-0x01a40000 (0x00380000) : "lgres.squashfs"[3252224] - 0x000001 : (U/V)
[10] "lgfont"   : 0x01a40000-0x02340000 (0x00900000) : "lgfont.img"[204800] - 0x000001 : (U/V)
[11] "kernel"   : 0x02340000-0x025c0000 (0x00280000) : "uImage_flash"[2176034] - 0x000001 : (u/V)
[12] "lgapp"    : 0x025c0000-0x02ec0000 (0x00900000) : "lgapp_flash.lzo"[6730916] - 0x031500 : (u/V)
[13] "lgres"    : 0x02ec0000-0x03240000 (0x00380000) : "lgres.squashfs"[3645440] - 0x000001 : (u/V)
[14] "lgfont"   : 0x03240000-0x03b40000 (0x00900000) : "lgfont.img"[204800] - 0x000001 : (u/V)
[15] "recdb"    : 0x03b40000-0x03b60000 (0x00020000)
[16] "system"   : 0x03b60000-0x03ba0000 (0x00040000)
[17] "user"     : 0x03ba0000-0x03e00000 (0x00260000)
[18] "reserved" : 0x03e00000-0x04000000 (0x00200000)
```

You can upload two system software (epk), here you can see a running (cur) 3.40 and a backup (old) 3.15 (the last one good to get on the service menu using only pressing the OK keys both on remote control and side of the tv).

So, it seems you can switch from one to the other version. It's unknown how to do it from the tv user interface.

Recover from a broken firmware.

Don't worry (too much..) You can always recover from a broken or zapped firmware upgrade **IF** you still have a working boot loader uboot.

Using the **loadz** command you can upload a working epk package and return the tv set to a consistent state..

Beware, it's a lengthy process (30 minutes for a 20MB firmware at 115200 bps).

This is the terminal output after a successful transfer of the 3.37 version in epk package, the prints show the process of flashing the various partitions:

```
mstar # swuz
PAK Model : DVB-SATURN6
  Dev mode : Release Mode
  PAK type : root
  SW Version : 1
  SW Date : 20090723
Erasing Nand(a0000+50000)... OK
Update Nand BBM Info... OK
Writing to Nand(a0000+50000)...OK

PAK Model : DVB-SATURN6
  Dev mode : Release Mode
  PAK type : mode
  SW Version : 33700
  SW Date : 20090723
Erasing Nand(220000+20000)... OK
Update Nand BBM Info... OK
Writing to Nand(220000+20000)...OK

PAK Model : DVB-SATURN6
  Dev mode : Release Mode
  PAK type : kern
  SW Version : 1
  SW Date : 20090723
Erasing Nand(2340000+2140000)... OK
Update Nand BBM Info... OK

PAK Model : DVB-SATURN6
```

```

    Dev mode : Release Mode
    PAK type : lgap
    SW Version : 33700
    SW Date : 20090723
Erasing Nand(25c0000+67c000)... OK
Update Nand BBM Info... OK
Writing to Nand(25c0000+67c000)...OK

PAK Model : DVB-SATURN6
    Dev mode : Release Mode
    PAK type : lgre
    SW Version : 1
    SW Date : 20090723
Erasing Nand(2ec0000+31c000)... OK
Update Nand BBM Info... OK
Writing to Nand(2ec0000+31c000)...OK

PAK Model : DVB-SATURN6
    Dev mode : Release Mode
    PAK type : lgfo
    SW Version : 1
    SW Date : 20090723
Erasing Nand(3240000+34000)... OK
Update Nand BBM Info... OK
Writing to Nand(3240000+34000)...OK

PAK Model : DVB-SATURN6
    Dev mode : Release Mode
    PAK type : eman
    SW Version : 1
    SW Date : 20090723
Erasing Nand(240000+45c000)... OK
Update Nand BBM Info... OK
Writing to Nand(240000+45c000)...OK

PAK Model : DVB-SATURN6
    Dev mode : Release Mode
    PAK type : ezca
    SW Version : 1
    SW Date : 20090723
Erasing Nand(740000+300000)... OK
Update Nand BBM Info... OK
Writing to Nand(740000+300000)...OK

PAK Model : DVB-SATURN6
    Dev mode : Release Mode
    PAK type : boot
    SW Version : 33700
    SW Date : 20090723
Erasing Nand(20000+38000)... OK
Update Nand BBM Info... OK
Writing to Nand(20000+38000)...OK
Erasing Nand(80000+4000)... OK
Update Nand BBM Info... OK
Writing to Nand(80000+4000)...OK
mstar #

```

Now if you check the flash partition with the **mtinfo** command, you'll see that a working epk is present again. If you give a **reboot** command the system should come back alive.

Acquire root access to system

The easiest way should be to have root shell blinking straight from the serial port when there's the kernel and processes running.

Let's change the first script that's executed in the kernel boot chain.

After kernel start, there is /sbin/init launched that is a symbolic link to busybox.

The init execute the /etc/init.d/rcS script that launch these two scripts:

```

/etc/rc.d/rc.sysvinit
/etc/rc.d/rc.local

```

The first one just set some env variables and mount all the filesystems. The second one is the right

one, near the end:

```
...
export LOG_CALLER=YES
export OSAMEM_SIZE=0x200000
export LOAD_SYM=1
export HOOK_SEGV=YES

cd /mnt/lg/lgapp
./RELEASE
```

Let's edit the **rc.local** file, before the end, when it starts the **RELEASE** navigator, let's put some smart command:

```
...
export LOG_CALLER=YES
export OSAMEM_SIZE=0x200000
export LOAD_SYM=1
export HOOK_SEGV=YES

echo "THIS IS RC.LOCAL MODIFIED!"
/bin/ash
exit

cd /mnt/lg/lgapp
./RELEASE
```

now create the new **root.squashfs** image and upload to the right partition on the flash with **zmodem** (pay attention here) then give the **reboot** command to the bot loader and check. **WHOOAAA!!** a root prompt!

```
mstar # loadz rootfs
..#Erasing Nand(a0000+50000)... OK
Update Nand BBM Info... OK
Writing to Nand(a0000+50000)...OK
Erasing Nand(80000+4000)... OK
Update Nand BBM Info... OK
Writing to Nand(80000+4000)...OK
mstar #
mstar # reboot

U-Boot 1.1.6 (Mar  5 2009 - 16:24:56)

[CP0config] 0x80840483
[Baudrate] 115200
Board   : MSTAR TITANIA (CPU Speed 216 MHz)
TB:0x81000000,MB:0x80fc0000,GD:0x80f9ffa4,SP:0x80f9ff80
[194] Copy "kernel (2176038 bytes)" from 0x02340000 to 0x80c00000
[404] ...done (10362 KB/s)
[407] Copy "lgapp (6793743 bytes)" from 0x025c0000 to 0x82000000
[1051] ...done (10549 KB/s)
read filesystem type
This is not xip image!
[2074] ## Booting image at 80c00000 ...
  Image Name:   MIPS Linux-2.6.26
  Image Type:   MIPS Linux Kernel Image (lzo compressed)
  Data Size:    2175970 Bytes =  2.1 MB
  Load Address: 80400000
  Entry Point:  80658b00
  Uncompressing Kernel Image ... OK

[2427] Starting kernel ...

[ 0.000000] Wasting 71616 bytes for tracking 2238 unused pages
[ 0.000000] Zone PFN ranges:
[ 0.000000] DMA          1023 ->  28928
[ 0.000000] Normal      28928 -> 28928
[ 0.000000] Movable zone start PFN for each node
[ 0.000000] early_node_map[2] active PFN ranges
[ 0.000000] 0             1023 ->   3261
[ 0.000000] 0             16896 -> 28928
[ 0.000000] Built 1 zonelists in Zone order, mobility grouping on. Total pages: 14051
```

```
[ 0.000000] Kernel command line: root=/dev/mtdblock3 rootfstype=squashfs lpj=105984 host=saturno
noinitrd ramdisk=0 console=ttyS0,8
[ 0.000000] Primary instruction cache 4kB, VIPT, 4-way, linesize 16 bytes.
[ 0.000000] Primary data cache 4kB, 2-way, VIPT, no aliases, linesize 16 bytes
[ 0.000000] PID hash table entries: 256 (order: 8, 1024 bytes)
[ 0.000000] CPU freq count = 108000000
[ 0.000000] CPU frequency 216.00 MHz
[ 0.000000] Dentry cache hash table entries: 8192 (order: 3, 32768 bytes)
[ 0.001000] Inode-cache hash table entries: 4096 (order: 2, 16384 bytes)
[ 0.019000] Memory: 50164k/51208k available (2421k kernel code, 984k reserved, 1753k data, 112k
init, 0k highmem)
[ 0.020000] SLUB: Genslabs=6, HWalig=32, Order=0-3, MinObjects=0, CPUs=1, Nodes=1
[ 0.021000] Calibrating delay loop (skipped)... 211.96 BogoMIPS preset
[ 0.022000] Mount-cache hash table entries: 512
[ 0.044000] net_namespace: 192 bytes
[ 0.046000] NET: Registered protocol family 16
[ 0.082000] SCSI subsystem initialized
[ 0.086000] usbcore: registered new interface driver usbfs
[ 0.089000] usbcore: registered new interface driver hub
[ 0.091000] usbcore: registered new device driver usb
[ 0.108000] BOOTSTRAP 13(2)
[ 0.113000] NET: Registered protocol family 2
[ 0.127000] IP route cache hash table entries: 1024 (order: 0, 4096 bytes)
[ 0.138000] TCP established hash table entries: 2048 (order: 2, 16384 bytes)
[ 0.146000] TCP bind hash table entries: 2048 (order: 1, 8192 bytes)
[ 0.153000] TCP: Hash tables configured (established 2048 bind 2048)
[ 0.160000] TCP reno registered
[ 0.166000] NET: Registered protocol family 1
[ 0.254000] squashfs: version 3.4 (2008/08/26) Phillip Lougher
[ 0.264000] NTFS driver 2.1.29 [Flags: R/O].
[ 0.274000] JFFS2 version 2.2. (NAND) © 2001-2006 Red Hat, Inc.
[ 0.289000] msgmni has been set to 98
[ 0.295000] io scheduler noop registered (default)
[ 0.303000] Serial: 8250/16550 driver $Revision: 1.90 $ 4 ports, IRQ sharing disabled
[ 0.317000] serial8250: ttyS0 at I/O 0xbf801300 (irq = 8) is a 16550
[ 0.353000] loop: module loaded
[ 0.358000] Driver 'sd' needs updating - please use bus_type methods
[ 0.369000] NAND device: Manufacturer ID: 0xad, Chip ID: 0x76 (Hynix NAND 64MiB 3,3V 8-bit)
[ 0.378000] Loading nand bad block info...
[ 0.383000] Loading nand bad block info(00000000+00004000)...
[ 0.393000] nand_bbm_info_load: Loading nand bad block info...ok
[ 0.399000] nand bad block information:
[ 0.403000] magic = 0x8192a5a6
[ 0.407000] bad block count = 0
[ 0.410000] assign index = 4095
[ 0.414000] Mstar nand-flash partition definition
[ 0.419000] mtd info : # of partition = 19
[ 0.424000] Creating 19 MTD partitions on "NAND 64MiB 3,3V 8-bit":
[ 0.430000] 0x00000000-0x00020000 : "bbminfo"
[ 0.443000] 0x00020000-0x00060000 : "boot"
[ 0.453000] 0x00080000-0x000a0000 : "mtdinfo"
[ 0.464000] 0x000a0000-0x00220000 : "rootfs"
[ 0.474000] 0x00220000-0x00240000 : "model"
[ 0.484000] 0x00240000-0x00740000 : "emanual"
[ 0.495000] 0x00740000-0x00b40000 : "ezcal"
[ 0.505000] 0x02340000-0x025c0000 : "kernel"
[ 0.515000] 0x025c0000-0x02ec0000 : "lgapp"
[ 0.526000] 0x02ec0000-0x03240000 : "lgres"
[ 0.536000] 0x03240000-0x03b40000 : "lgfont"
[ 0.546000] 0x00b40000-0x00dc0000 : "kernel"
[ 0.557000] 0x00dc0000-0x016c0000 : "lgapp"
[ 0.567000] 0x016c0000-0x01a40000 : "lgres"
[ 0.577000] 0x01a40000-0x02340000 : "lgfont"
[ 0.588000] 0x03b40000-0x03b60000 : "recdb"
[ 0.598000] 0x03b60000-0x03ba0000 : "system"
[ 0.608000] 0x03ba0000-0x03e00000 : "user"
[ 0.618000] 0x03e00000-0x04000000 : "reserved"
[ 0.629000] Disable power down for H.264 firmware
[ 0.634000] GE driver inits
[ 0.637000] GOP driver inits
[ 0.641000] GPIO Init(LCD)
[ 0.652000] [SCALER][000132] _mod_scaler_init
[ 0.657000] [MADMOD][002762] _mod_mad_init is invoked
[ 0.663000] init 160
[ 0.665000] [MVDMOD][000610] H264 bit-stream buffer addr 0xa9c00000; size 4194304
[ 0.674000] CI driver inits
[ 0.677000] [RLDMOD][000430] mod_rld_init is invoked
[ 0.683000] [RLDMOD][000434] call_register_chrdev_region
```

```

[ 0.689000] [RLDMOD][000463] Init RLD successfully
[ 0.695000] [TTX_DRV][00559]init 170
[ 0.699000] [VE_DRV][00469]MDrv_VE_Module_Init is invoked
[ 0.704000] [VE_DRV][00473]call_register_chrdev_region
[ 0.710000] [VE_DRV][00499]Init VE successfully
[ 0.715000] MDrv_CC_Init
[ 0.718000] init 172
[ 0.720000] <MHal_JPD_Initialize>
[ 0.724000] BT_USB initialized
[ 0.727000] Hello~ this is kernel module on MIPS MSB
[ 0.733000] BT_USB for INSTANT_INTERRUPT scheme rev2
[ 0.738000] SCHED: init_sched
[ 0.742000] bt_usb: Bluetooth USB driver for LGE DTV
[ 0.749000] usbcore: registered new interface driver csr_usb
[ 0.755000] bt_usb: BT USB driver registered
[ 0.760000] BlueCore transport started... May
[ 0.770000] TCP cubic registered
[ 0.774000] NET: Registered protocol family 17
[ 0.783000] Adding user_initcall[0] = 0x80581360
[ 0.788000] Adding user_initcall[1] = 0x80581340
[ 0.793000] Adding user_initcall[2] = 0x805845c4
[ 0.804000] VFS: Mounted root (squashfs filesystem) readonly.
[ 0.812000] Freeing unused kernel memory: 112k freed
[ 1.176000] CLEANMARKER node found at 0x00000000 has totlen 0xc != normal 0x0
[ 1.355000] cramfs: checking physical address 0x7100000 for linear cramfs image
[ 1.363000] cramfs: linear cramfs image appears to be 14416 KB in size

```

```

THIS IS RC.LOCAL MODIFIED!!
/bin/ash: can't access tty; job control turned off
#

```

Navigating the running linux system inside the TV set

Now we can improve our knowledge about the tv software environment wading through the filesystem and the running kernel.

BTW Let remember that we can always put in place the original root.squashfs image so to get back a working tv set!

Let's check the mounted filesystem:

```

# mount
rootfs on / type rootfs (rw)
/dev/root on / type squashfs (ro)
proc on /proc type proc (rw)
ramfs on /lgsw type ramfs (rw)
ramfs on /tmp type ramfs (rw)
sysfs on /sys type sysfs (rw)
usbfs on /proc/bus/usb type usbfs (rw)
/dev/mtdblock4 on /mnt/lg/model type jffs2 (rw)
/dev/mtdblock5 on /mnt/lg/res/emanual type squashfs (ro)
/dev/mtdblock6 on /mnt/lg/res/ezcal type squashfs (ro)
/dev/mtdblock9 on /mnt/lg/res/lgres type squashfs (ro)
/dev/mtdblock15 on /mnt/lg/recdb type jffs2 (rw)
/dev/mtdblock17 on /mnt/lg/user type jffs2 (rw)
lgapp on /mnt/lg/lgapp type cramfs (ro)
/dev/mtdblock10 on /mnt/lg/res/lgfont type squashfs (ro)
tmpfs on /mnt/lg/bt type tmpfs (rw,size=10240k)

```

As you can see, some are read only (squashfs) and large (for system data and apps) and some are rw (jffs2) but small (for persistent configuration and some database, mainly).

The **/dev/mtdblock17** mounted as **/mnt/lg/user** seem promising, anyway, as a repository of some user provided data and programs. (but it's just a bit more 2MB long..)

Now check the processor capability:

```

# cat /proc/cpuinfo
system type      : MStar Titania
processor        : 0
cpu model       : MIPS 4KEc V6.12
BogoMIPS        : 211.96

```



```
wait instruction      : yes
microsecond timers  : yes
tlb_entries          : 16
extra interrupt vector : yes
hardware watchpoint  : no
ASEs implemented     : mips16
shadow register sets : 1
core                 : 0
VCEd exceptions     : not available
VCEI exceptions     : not available
```

Some ideas and future enhancements

Here we'd like to imagine and present some ideas about what could be inserted into this device to let it become more or less a general purpose server in the digital home, or at least improve some of the present features, like DTS decoding.

As it's quite an open platform, we think that many new und never heard concept will be experimented.

Execute third party (our..) code on the tv set

Of course one of the first idea should be to put in place a huge local storage, a network adapter and some bit-torrent process to feed the tv with some good content from the network.

Cross compile for a MIPS CPU

Here we describe how to set up a cross compiler for this SOC.

This SOC is a MIPS as you can check with `cat /proc/cpuinfo`

Set up the correct debian source list: add to the `/etc/apt/sources.list` this lines:

```
# -- Emdebian cross toolchains
#
# deb http://www.emdebian.org/debian/ unstable main
# deb http://www.emdebian.org/debian/ testing main
deb http://www.emdebian.org/debian/ lenny main
```

Now you should add the signature so install the right keys for signed packages:

```
$ sudo apt-get install emdebian-archive-keyring
```

Now you should install the cross compiling tools:

```
$ apt-cache search mips
```

now let's install the utility to do cross compiling:

```
sudo apt-get install libc6-mips-cross libc6-dev-mips-cross
sudo apt-get install binutils-mips-linux-gnu
sudo apt-get install gcc-4.3-base-mips-cross
```

Porting the first useful stuff for file transfer over terminal: **lrzsz**

get the package from official repository: <http://www.ohse.de/uwe/software/lrzsz.html>

Annex A the original firmware 3.24 information.

Boh, just for history. If i have to send the tv back to service! :-)

Annex B: the list of source code for the 3.15 firmware:

```
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/audio/ntp3100/audio_ntp3100.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/audio/sta339/audio_sta339.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/audio/tas5707/audio_tas5707.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/osa/linux/osadap/osa_main.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/osa/linux/osadap/osadap.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/osa/linux/osadap/osamem.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/osa/linux/osadap/osa_linux.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/osa/linux/osadap/osa_timer.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/osa/linux/osadap/osa_clock.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/osa/linux/osadap/osa_exception.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/osa/linux/osadap/callout.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/osa/linux/osadap/osa_model_utils.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/xlibc/dbgprint.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/xlibc/addr2line.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/xlibc/cmd_io.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/xlibc/cmd_debug.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/xlibc/xlibc_string.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/xlibc/xlibc_utils.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/xlibc/print_expand.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/xlibc/xlibc_vasprintf.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/xlibc/fmtxlong.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/xlibc/lg_hotfix.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/xlibc/keyboard.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/rmm/rmm.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/arch/mips/arch_mips.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/arch/mips/dsm_mips.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/common/arch/mips/byte_lib_mips.S
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/audio/audio_ddi.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/audio/audio_task.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/audio/tea6420/audio_tea6420.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/nvm/nvm_ddi.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/nvm/nvmdb_ddi.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/frc/frc_ddi.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/frc/madp_mfc.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/frc/madp_mfc_spi.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/i2c/i2c_ddi.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/i2c/i2c_conf.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/gpio/gpio_ddi.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/gpio/gpio_func.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/gpio/gpio_ioexp.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/drivers/gpio/gpio_i2c.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/cm/cm_api.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/cm/cm_chch.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/cm/cm_list.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/cm/cm_main.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/cm/cm_memory.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/cm/cm_nvm.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/cm/cm_scan.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/cm/cm_stat.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/cm/cm_sort.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/ddm/ddm_power_api.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/ddm/ddm_micom_api.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/ddm/ddm_gpio_api.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/ddm/ddm_nvm_api.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/ddm/ddm_gfx_api.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/ddm/ddm_display_api.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/mre/mre_api.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/mre/mre_sys.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/mre/mre_cmh.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/mre/mre_info.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/mre/mre_automata.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/mre/mre_av.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/audio/audio_api.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/util/util_api.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/video/video_api.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/video/video_status.c
/home/work/balupzillot/PATH_V3.15_0.1.50.97/src/mw/video/video_win.c
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