Hacking the TiVo

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Introduction

This talk is about a variety of hacks on a Linux based digital VCR called a "TiVo". The aim of the talk is to present some of the techniques used which may be applicable to other projects. A project of this nature tends to expose some of the quite dirty but useful tricks which are commonly used by Linux hackers but which often go undocumented.

The hacks presented range from simple application porting within the unusual embedded environment of the TiVo to the development of new hardware which enabled the addition of a ethernet card.

The talk will first cover the hacks that already existed for the TiVo when I started then I'll explain each of the hacks that we added and the techniques used with each one.

Existing hacks

Hacking the TiVo was already a popular sport in the US when I got mine on a trip I made to the US in July 2000. The main hacks were:

- getting into the TiVo
- setting up a PPP link
- adding a second hard disk
- avoiding the Sony locked drives
- adding basic utilities

More utilities

After getting my TiVo the next step was to enhance the development environment a bit to make hacking more of a pleasure and less of a chore.

- setting up the cross compiler
- porting rsync
- building ps

I2C hacking

As many of the chips in the TiVo are controlled using an I2C bus the next step was writing some I2C utilities. The main aim of these utilities was to allow I2C operations on the command line for playing with the devices and intercepting I2C calls within the proprietry TiVo software so I could work out how they were controlling the devices.

- working out an ioctl
- intercepting calls to a module
- adding persistent dmesg

PAL Conversion

The primary hack needed for using a TiVo in Australia is PAL conversion. This involves a number of steps:

- researching the chips involved
- converting the 7114 driver
- converting the CXD driver
- converting the CS22 driver
- converting the 7120 driver

As docs on some of the video chips in the TiVo were not available a primary technique used was to do random register operations until the desired result was achieved. This is a rather dodgy technique but luckily it payed off in the case of the TiVo.

PAL Conversion - 2nd version

The first palkit consisted of a binary patch to the proprietry TiVo kernel module fpga7114.o. That worked but was very fiddly. The second version of this patch used a much more useful technique of installing a bypass on function calls inside binary kernel modules.

- how a bypass works
- replacing functions

Australian guide data

Once the TiVo was converted to PAL the next step was working out how to load Australian guide data. A lot of the appeal of a TiVo comes from having all the guide data loaded so this was very important for a complete "Australian TiVo".

- working out slice files
- writing a slice decoder/encoder
- should it be distribted?
- getting Australian guide data from web sites
- handling series, repeats etc

Adding IR codes

The TiVo can control other devices (such as a VCR or a Satellite receiver) via two IR emitters. The problem is that that TiVo comes with a limited database of IR codes and lacks the ability to learn more. To allow control of my Foxtel receiver I needed to work out how to add a new IR record to the TiVo.

- capturing IR codes
- working out the database format
- converting IR records

Changing the tuner module

With the IR blaster decoded the TiVo became useful in Australia, but still required an external tuner (such as a old VCR) for broadcast channels. To fix this we took a PAL tuner module from a BTTV card and hooked it into the TiVo, replacing the existing NTSC tuner module.

- mapping the pins
- redirecting I2C traffic
- bypassing the AFT code

Adding an ethernet card

One big complaint from hard-core TiVo hackers is the lack of an ethernet interface. To address this we set about adding an ISA bus interface so that ISA bus ethernet adapter could be used in the TiVo. This effort (spear-headed by Bob Edwards) worked out surprisingly well.

- designing the ISA adapter
- 8/16 bit bus issues
- writing a driver
- using shell script interrupts for debugging

Miscellaneous hacks

A number is miscellaneous hacks that cropped up during the whole process ...

- a web server for the TiVo
- adding more RAM
- adding a parallel port reset line

Video distribution

So what can we do with the ethernet interface? The obvious thing is distributing video over a LAN so you can watch programs off the TiVo elsewhere in your geek-house.

- capturing video
- playing video
- the MFS filesystem

More work

The TiVo is the sort of project that can absorb an unlimited amount of hacking time. The main things that remain to be done include:

- coping with the 2.0 software upgrade
- getting stereo with the Philips tuner
- writing a MFS server

Credits

Lots of people contributed to the various TiVo hacks presented here.

- The TiVo hackers on #tivo
- Bob Edwards
- Paul Mackerras
- Stephen Rothwell
- Chris Yeoh