

# OpenEZX – unleashing the full potential of Motorola mobile phones

Stefan Schmidt  
stefan@openezx.org

LinuxTag 2008-05-28

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

# Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software Stacks

Summarize

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

## Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

# Introduction

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

- ▶ Motorola has been selling Linux smartphones in Asia for a long time
- ▶ They started selling the A780 in Europe end of 2005. Unfortunately they stopped in 2006
- ▶ In october 2005 Harald Welte started the OpenEZX project
- ▶ Currently there are more then 10 different EZX devices
- ▶ The upcoming MAGX linux platform already has 3 devices

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

# Why choose EZX mobile phones for hacking?

- ▶ **They already run linux**
- ▶ **Motorola sells millions of them**

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

Outline

**Introduction**

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

# First Generation Phones (EZX)

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org



Abbildung: E680



Abbildung: A780

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

# Second Generation Phones (EZX)

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org



Abbildung: ROKR E2



Abbildung: A1200 (Ming)

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZx

Future plans

Phone Software  
Stacks

Summarize

# Third Generation Phones (MAGX)

OpenEZx –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org



Abbildung: RAZR2 V8



Abbildung: ROKR Z6

Outline

Introduction

Hardware

Motorola

EZx Software

OpenEZx

Future plans

Phone Software  
Stacks

Summarize

# Core components

- ▶ Quad Band GSM CPU Neptun LTE
- ▶ GPRS, sometimes EDGE but no UMTS
- ▶ Intel Xscale (PXA271) for the application CPU
- ▶ MicroSD or SD card slot
- ▶ Bluetooth
- ▶ 320x240 LCD with touchscreen
- ▶ Camera
- ▶ FM-Radio (not all)
- ▶ A-GPS (European A780, A1600)
- ▶ Wlan (A910, A1600)
- ▶ Enhanced Mini USB

OpenEZx –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

Outline

Introduction

Hardware

Motorola

EZx Software

OpenEZx

Future plans

Phone Software  
Stacks

Summarize

# Enhanced Mini USB (EMU)

OpenEZx –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

- ▶ Mini USB plug
- ▶ The EMU can be changed between different modes:
  - ▶ USB device port
  - ▶ USB host port
  - ▶ Serial port
  - ▶ Stereo audio signal
  - ▶ 500mA charger
  - ▶ Carkit

Outline

Introduction

Hardware

Motorola

EZx Software

OpenEZx

Future plans

Phone Software  
Stacks

Summarize

# Motorola and the GPL

OpenEZx –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

- ▶ No GPL license or source in the shipping box
- ▶ Motorolafans requested the first kernel code
- ▶ Bootloader code followed
- ▶ <http://opensource.motorola.com/> was started as a place to store the code
- ▶ Still buggy kernel trees

Outline

Introduction

Hardware

Motorola

EZx Software

OpenEZx

Future plans

Phone Software  
Stacks

Summarize

# Motorola and the community

- ▶ Only contact about GPL compliance
- ▶ No contact to developers or engineers
- ▶ No upstream submission of patches
- ▶ Only tarball dumps, no feature specific patches
- ▶ No documentation
- ▶ No SDK for native Linux applications
- ▶ If Motorola is interested in community efforts about the EZX platform, they just should contact me

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

# Future wishes

- ▶ Publish per-feature patches instead of all-in-one tarballs
- ▶ Consider to release some hardware data sheets. (PCAP2)
- ▶ Contacts to engineers or developers
- ▶ Clarify licenses for some drivers

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

- ▶ 2.4.20 based kernel with many modifications from Montavista and Motorola
  - ▶ EZX ARM subarchitecture
  - ▶ Touchscreen
  - ▶ SD / MMC / Transflash
  - ▶ mux\_cli
  - ▶ GPRS
  - ▶ Bootloader
  - ▶ gcc and glibc
  - ▶ Userspace tools like modutils and findutils

Outline

Introduction

Hardware

Motorola

**EZX Software**

OpenEZx

Future plans

Phone Software  
Stacks

Summarize

# Closed software

- ▶ The GUI is based on Qt Embedded. Motorola added own EZX libraries
- ▶ PDA, PIM and dialer functions
- ▶ Opera webbrowser
- ▶ Real media player
- ▶ CoPilot navigation software
- ▶ Java VM

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

Outline

Introduction

Hardware

Motorola

**EZX Software**

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

# OpenEZX goals

- ▶ The goal is a complete free software stack on the application CPU
- ▶ Linux 2.6 kernel with complete hardware support
- ▶ Firmware updates
- ▶ Documentation of the hardware
- ▶ Cellphone suited GUI in cooperation with other projects

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

Outline

Introduction

Hardware

Motorola

EZX Software

**OpenEZX**

Future plans

Phone Software  
Stacks

Summarize

# User benefits

- ▶ Firmware images to flash the phone at home
- ▶ Security updates
- ▶ Updates for new software version
- ▶ Different phone stacks
- ▶ **The possibility to change the system to their own needs**

OpenEZ –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZ

Future plans

Phone Software  
Stacks

Summarize

# First own code

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

- ▶ For fast development cycle an easy kernel test method was needed
- ▶ Bootloader based on Blob (GPL)
- ▶ With this code as reference boot\_usb was written
- ▶ Load zImage from host over usb into phone RAM and execute it
- ▶ Unfortunately phone stays in flash mode and no interaction with BP is possible

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

# First own kernel

- ▶ The released kernel code needed some fixes
- ▶ After the 2.4 kernel was running Harald started porting it over to 2.6
- ▶ The core platform is mostly ported
- ▶ Many chips can be used with the already in-tree kernel driver
- ▶ The mux\_cli driver for GSM modem functionality gave us a harder fight

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

## 2.6 mux\_cli driver

- ▶ 3GPP TS07.10 standard for multiplexing channels over a serial link
- ▶ Used for communication with baseband CPU
- ▶ Without this driver no phone functionality is available
- ▶ Only useable with BP in non-flash mode
- ▶ Phone turns off after 60 seconds without a working mux\_cli driver
- ▶ It turned out that the mux devices needs to be opened within this 60s to turn off the BP watchdog

# Voice call and audio handling

OpenEZx –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

- ▶ Audio handling on mobile phones is pretty complicated
- ▶ You have to route audio between many different codecs, chips and applications:
  - ▶ Baseband CPU
  - ▶ Bluetooth headset
  - ▶ Cable headset
  - ▶ Earphone speaker
  - ▶ Other speaker
  - ▶ Microphone

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZx

Future plans

Phone Software  
Stacks

Summarize

# Status Table

Feature	A780	A910	A1200	E680	Rokr E2	Rokr E6
CPU	100%	100%	100%	100%	100%	100%
RAM	100%	80%	80%	100%	80%	80%
LCD	100%	50%	50%	100%	50%	50%
Internal Flash	50%	0%	0%	50%	0%	0%
External SD/MMC/TF	100%	50%	100%	100%	0%	100%
Camera	30%	0%	0%	0%	0%	0%
Power Management	80%	0%	0%	80%	0%	0%
USB Device	100%	30%	30%	100%	0%	0%
Touchscreen	100%	—	100%	100%	—	100%
Keypad	100%	0%	0%	100%	0%	0%
Vibrator	100%	100%	0%	—	0%	0%
Sound	95%	0%	50%	80%	0%	0%
FM Radio	—	0%	0%	20%	0%	0%
Bluetooth	90%	0%	0%	90%	0%	0%
GPS	80%	—	—	—	—	—
Serial	20%	0%	0%	20%	0%	0%
GSM, GPRS - Neptune LTE (mux_cli)	80%	0%	0%	80%	0%	0%
JTAG	20%	0%	20%	80%	20%	0%
WLAN	—	80%	—	—	—	—

OpenEZx –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

Outline

Introduction

Hardware

Motorola

EZx Software

OpenEZx

Future plans

Phone Software  
Stacks

Summarize

- ▶ Successor to EZX
- ▶ 2.6 based kernel, kernel code is way cleaner
- ▶ LiMo conformant?
- ▶ Same protocol for communication with the bootloader
- ▶ Executes only signed kernels
- ▶ Work is stopped due to the signing problem
- ▶ Different SoC (MXC91xxx): Dual core for AP and BP.

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZx

Future plans

Phone Software  
Stacks

Summarize

# OpenEZX status

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

- ▶ Port the architecture and driver from 2.4.20 to 2.6
- ▶ Biggest items left:
  - ▶ Better handling of the BP (reset)
  - ▶ Power-management
  - ▶ Camera driver
  - ▶ Support newer phones
  - ▶ Many many fixes all over the place
  - ▶ Start submitting upstream
- ▶ We were already able to send SMS and do voicecalls with a 2.6 kernel and free software only.

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

# Future plans

- ▶ OpenEZX should focus on system level and OpenEmbedded integration
- ▶ Porting drivers and adding support for more phones
- ▶ Submit code for review and mainline inclusion
- ▶ On top of our hardware support we need a free mobile phone framework

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

**Future plans**

Phone Software  
Stacks

Summarize

- ▶ <http://www.openmoko.org/>
- ▶ FIC sponsored free mobile phone software stack
- ▶ First iteration: Own GTK stack with gsmd
- ▶ Second iteration: Usage of qtopia phone edition combined with EFL
- ▶ Third iteration: Freesmartphone.org

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

- ▶ <http://www.freesmartphone.org/>
- ▶ Dbus APIs for linux smartphones
- ▶ Open source collaboration platform

# Qtopia Phone Edition

- ▶ <http://qtopia.net>
- ▶ GPLed phone stack from Trolltech
- ▶ Rootfs for EZX devices can be found at: <http://www.linuxtogo.org/~goxboxlive/A780/images/>

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
[stefan@openezx.org](mailto:stefan@openezx.org)

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

# GPE Phone Edition

OpenEZX –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
stefan@openezx.  
org

- ▶ <http://gpephone.linuxtogo.org/>
- ▶ Reference implementation for LiPS
- ▶ Some integration work was started

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZX

Future plans

Phone Software  
Stacks

Summarize

# Summarize

- ▶ Still much work to be done.
- ▶ <http://www.openezx.org/>
- ▶ #openezx on freenode
- ▶ You can find the slides later on <http://www.datenfreihafen.org/paper.html>

OpenEZx –  
unleashing the full  
potential of  
Motorola mobile  
phones

Stefan Schmidt  
[stefan@openezx.org](mailto:stefan@openezx.org)

Outline

Introduction

Hardware

Motorola

EZX Software

OpenEZx

Future plans

Phone Software  
Stacks

Summarize