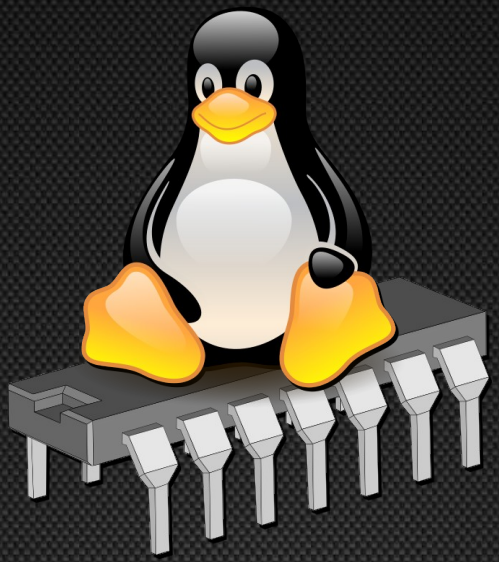


Tux Under the Hood!

Adventures with GNU/Linux on Embedded Devices

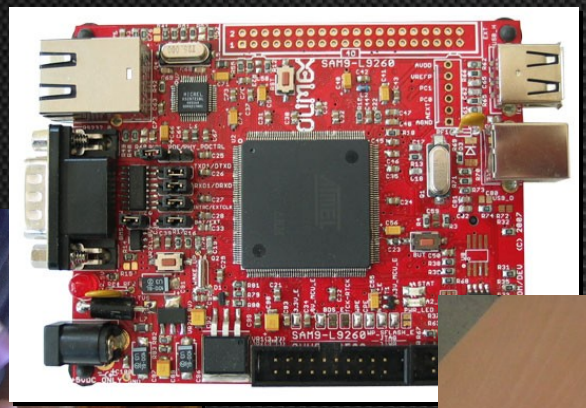
Suchakra

It runs Linux but

Guess what this is...

Holy Cow!

What am I playing with?



android

OpenCV

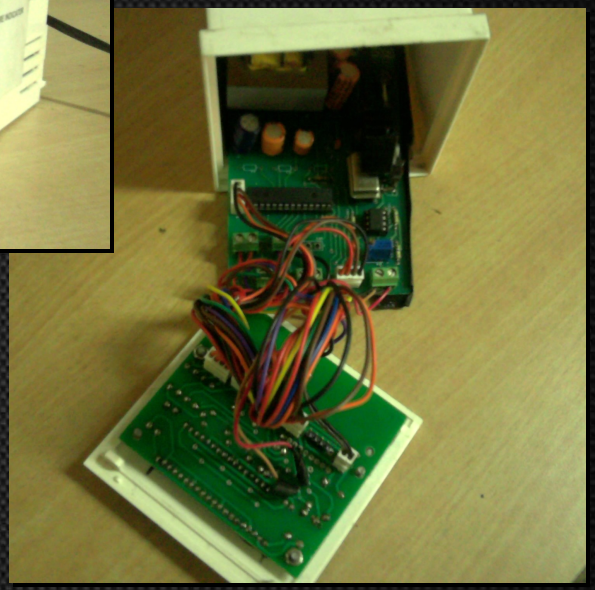
The Platter

- The Story
  - Encounters with Chips
  - Accidental Discoveries
- The Gyaan
  - Embedded Systems – Programmer's View
  - Embedding Linux on Devices
  - Lifting the hood
- Building A System
  - Tools of the Trade
  - Tips and Tricks
  - An Example to Mess Around
- Some More Stuff

Chips for Diet

8-Bit Microcontrollers

- AVRs (ATMega16)
- 8051s (AT89C51/S51)
- PICs (PIC16Fxx/18Fxx)



16-Bit Microcontrollers

- PIC24x, dsPIC33

32-Bit Microcontrollers

- ARM7 (AT91SAM7S25, LPC2148 - ARM7TDMI)
- ARM9 (AT91SAM9260 - ARM926-EJ-S)

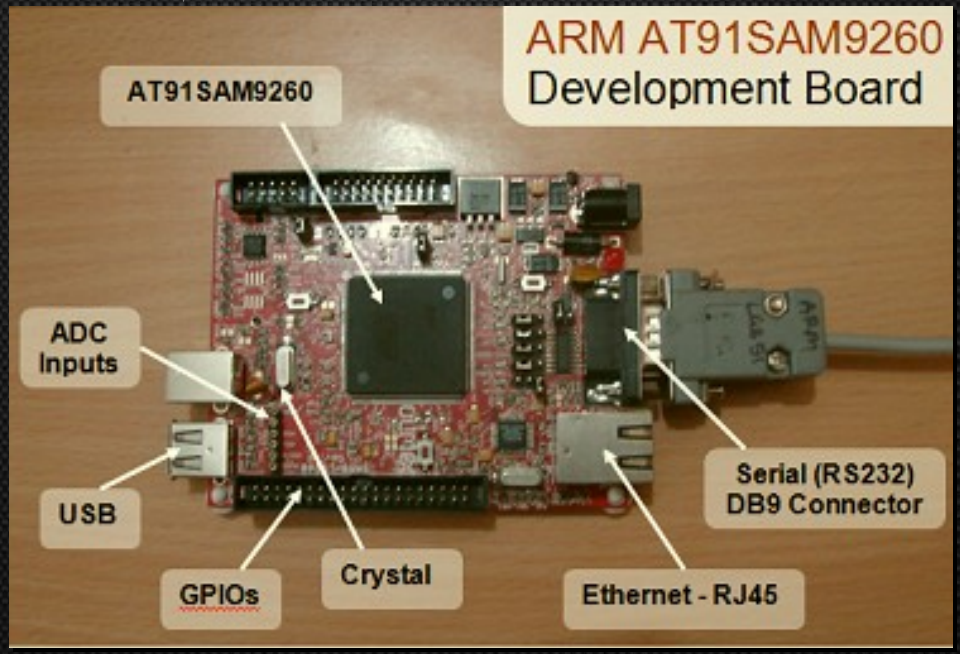
The Platter

- The Story
  - First Encounters with Chips
  - Accidental Discoveries
- The Gyaan
  - Embedded Systems – Programmer's View
  - Embedding Linux on Devices
  - Lifting the hood
- Building A System
  - Tools of the Trade
  - Tips and Tricks
  - An Example to Mess Around
- Some More Stuff

Accidents at Lab

The discovery of an ARM9 Board

- Was bored with limited possibilities
- Saw this



Accidents at Lab

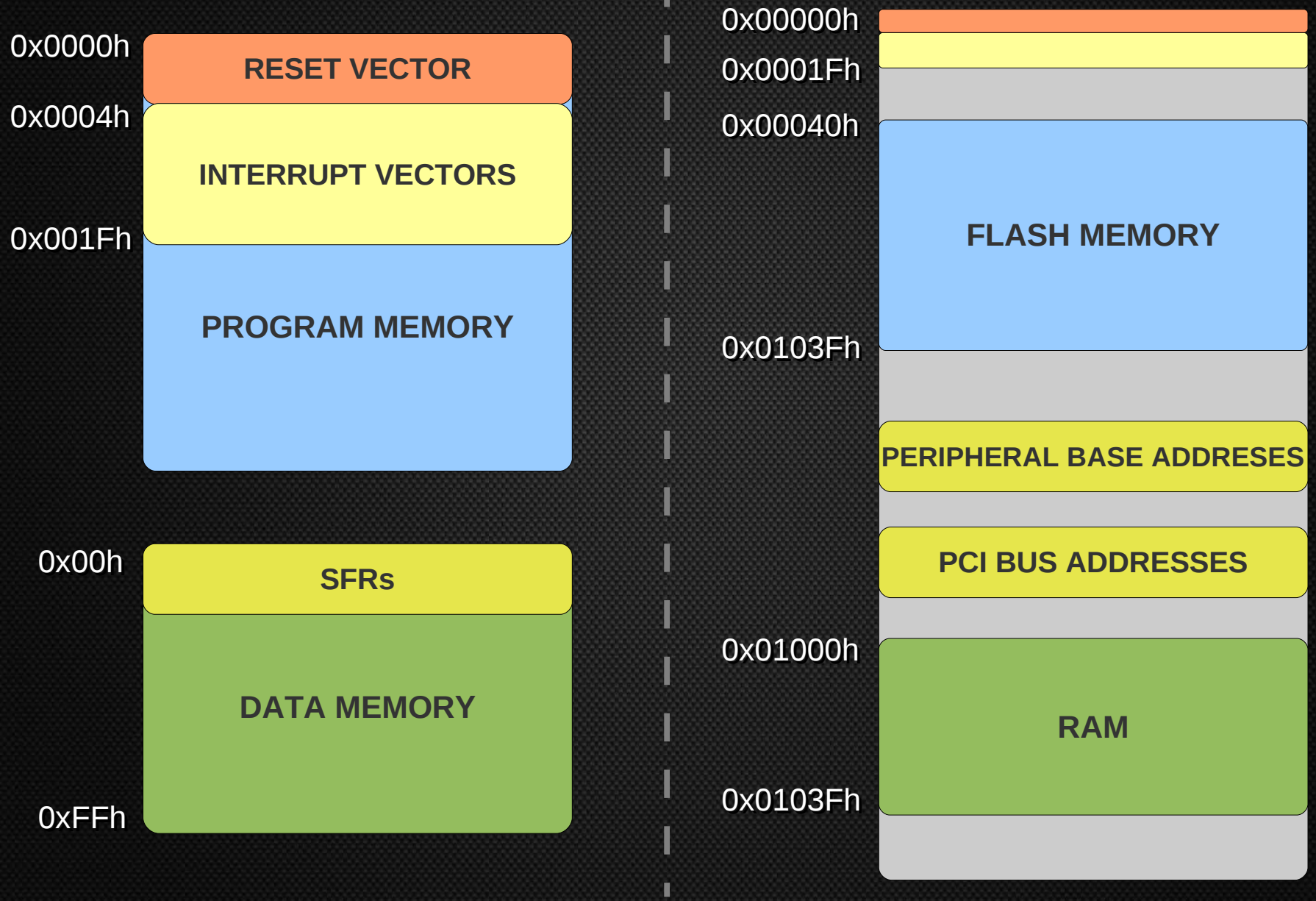
The discovery of an ARM9 Board

- The thing had a full-fledged OS on it – A Debian based distro
- One thing lead to another ; heavy Googling and book reading followed
- Learnt to develop Apps, compile/modify kernel
- Began to understand what role the OS played
- Started forgetting Process Instrumentation ;-)

The Platter

- The Story
  - First Encounters with Chips
  - Accidental Discoveries
- The Gyaan
  - Embedded Systems – Programmer's View
  - Embedding Linux on Devices
  - Lifting the hood
- Building A System
  - Tools of the Trade
  - Tips and Tricks
  - An Example to Mess Around
- Some More Stuff

Memory is the Key



The Platter

- The Story
  - First Encounters with Chips
  - Accidental Discoveries
- The Gyaan
  - Embedded Systems – Programmer's View
  - Embedding Linux on Devices
  - Lifting the hood
- Building A System
  - Tools of the Trade
  - Tips and Tricks
  - An Example to Mess Around
- Some More Stuff

Why have an OS?

The Need of An OS :

- Resources and the computing power at our disposal has increased drastically
- Birth of the SoC concept has left no choice but to manage the resources somehow
- Bridging the Computer-Embedded Device gap
  - The advent of handhelds, smartphones, MIDs
  - The HMIs in industry - the nature of their applications

Why Linux Kernel on Devices?

Why Choose Linux :

- Open Source - Need I say more? ;-)
- Vendor Independent
- Supports multiple architectures
- Its already got thousands of device drivers (built by a dedicated strong community)
  - Well defined hardware interfaces
  - Think more about the application and less about datasheet

What Hardware do I Need?

The Absolute Minimal :

- A 32-Bit processor
- MMU on processor
  - Though uCLinux has ports for non-MMU systems too
- 8MB RAM
- 4MB Flash

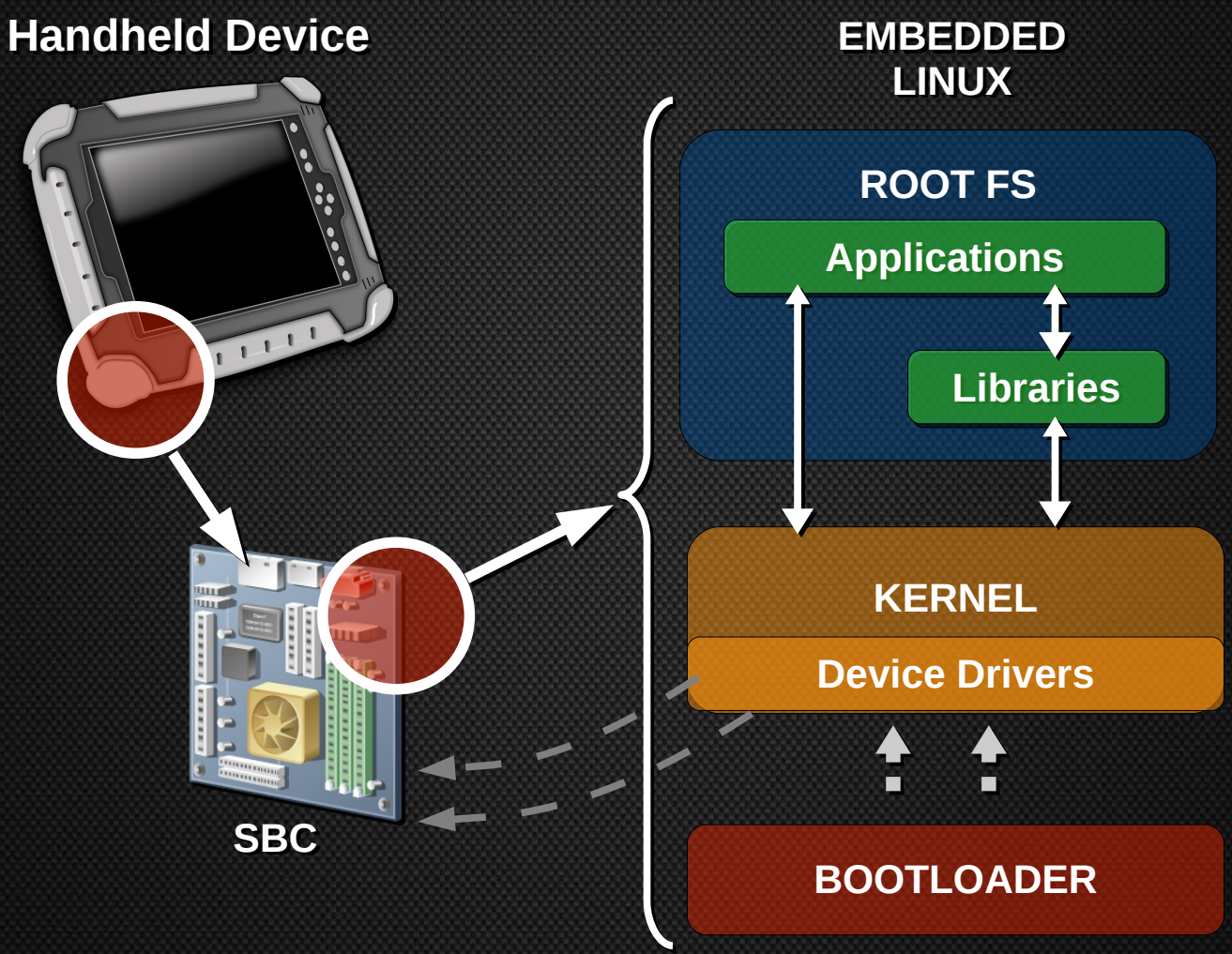
Today's Needs :

- 32-Bit, > 400MHz, 256MB Flash, 128MB RAM

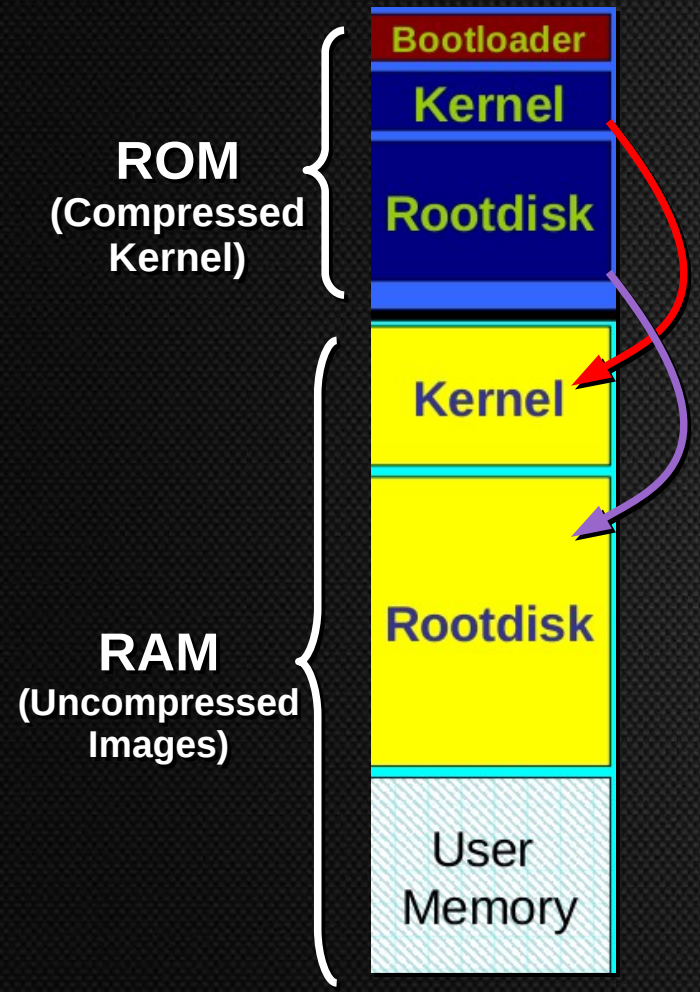
The Platter

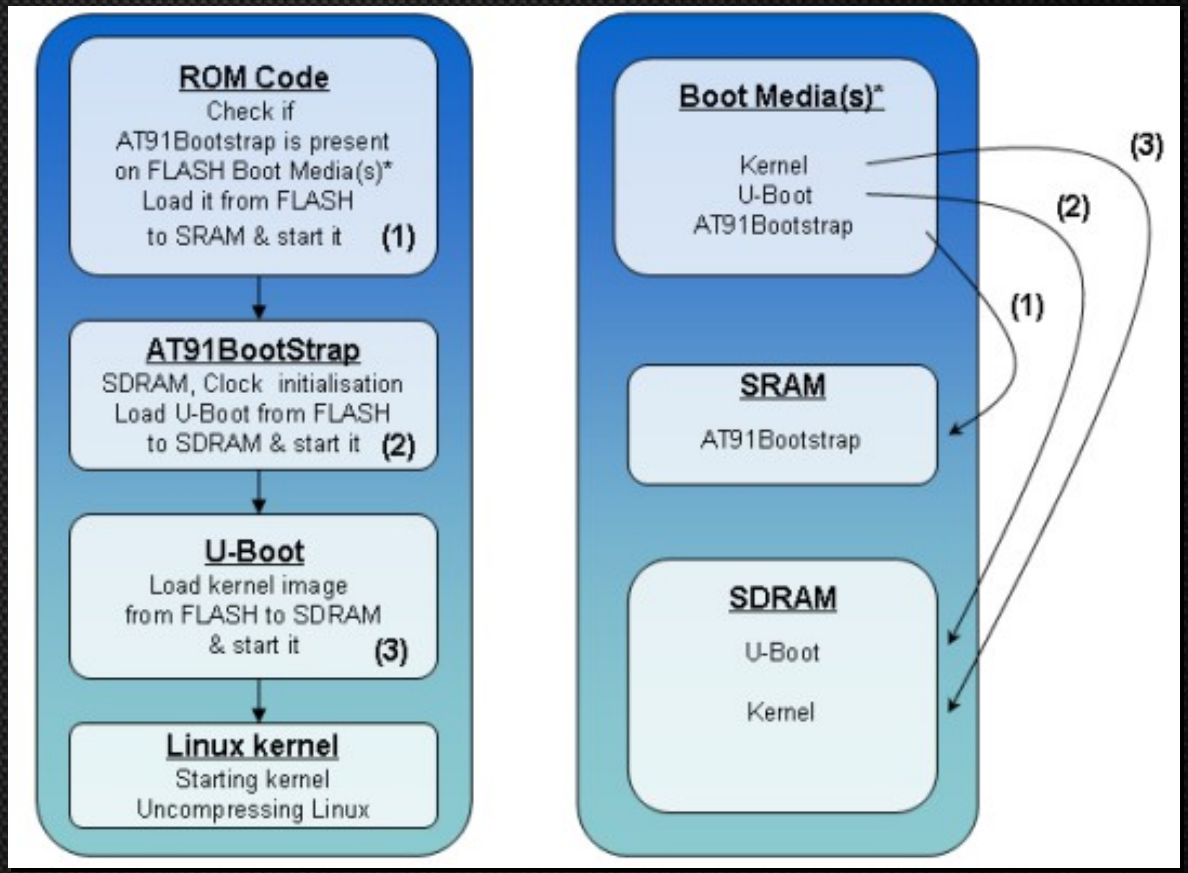
- The Story
  - First Encounters with Chips
  - Accidental Discoveries
- The Gyaan
  - Embedded Systems – Programmer's View
  - Embedding Linux on Devices
  - Lifting the hood
- Building A System
  - Tools of the Trade
  - Tips and Tricks
  - An Example to Mess Around
- Some More Stuff

Under the Hood



Boot Me Up!


ROM
(Compressed Kernel)
RAM
(Uncompressed Images)
Bootloader
Kernel
Rootdisk
Kernel
Rootdisk
User Memory


ROM Code
Check if AT91Bootstrap is present on FLASH Boot Media(s)*
Load it from FLASH to SRAM & start it (1)
AT91BootStrap
SDRAM, Clock initialisation
Load U-Boot from FLASH to SDRAM & start it (2)
U-Boot
Load kernel image from FLASH to SDRAM & start it (3)
Linux kernel
Starting kernel
Uncompressing Linux
Boot Media(s)*
Kernel
U-Boot
AT91Bootstrap
SRAM
AT91Bootstrap
SDRAM
U-Boot
Kernel
(1)
(2)
(3)

Root Filesystems

Options :

- BusyBox: The Swiss Army Knife of Embedded Linux
- Ångström Distribution
- Emdebian
- Fedora-ARM

Types :

- NFS, CramFS, JFFS, YAFFS2

The Platter

- The Story
  - First Encounters with Chips
  - Accidental Discoveries
- The Gyaan
  - Embedded Systems – Programmer's View
  - Embedding Linux on Devices
  - Lifting the hood
- Building A System
  - Tools of the Trade
  - An Example to Mess Around
  - Tips and Tricks
- Some More Stuff

Load Your Toolbox

Essentials :

- Toolchains (compilers, binutils, libs)
  - CodeSourcery, Crosstool, GNU, Fedora
- QEMU
  - qemu-system-arm

Other Tools :

- minicom, cutecom
- mkimage, mkjffs2, mkyaffs2
- tftp deamons, NFS Server, httpd (maybe)

The Platter

- The Story
  - First Encounters with Chips
  - Accidental Discoveries
- The Gyaan
  - Embedded Systems – Programmer's View
  - Embedding Linux on Devices
  - Lifting the hood
- Building A System
  - Tools of the Trade
  - An Example to Mess Around
  - Tips and Tricks
- Some More Stuff

Test Drive

Integrator/CP Board

- Quickest way to ride the horse
- Get a prebuilt kernel, root filesystem, setup QEMU and done!

VersatilePB Board

- Lets build some *semi-actual* stuff :-)
  - Patch & Compile U-boot, kernel, get a rootfs ready and test it on QEMU

The Platter

- The Story
  - First Encounters with Chips
  - Accidental Discoveries
- The Gyaan
  - Embedded Systems – Programmer's View
  - Embedding Linux on Devices
  - Lifting the hood
- Building A System
  - Tools of the Trade
  - An Example to Mess Around
  - Tips and Tricks
- Some More Stuff

Issued in Public Interest

Root Filesystem

- Narcissus online image builder (Ångström) can be used
  - Supports most of the hardware platform
  - Elaborate configuration but can't be customized much

Kernel

- Backup your '.config' somewhere (or whine like me later if you choose not to)
- Don't start from scratch.

Need Help?

- QEMU
  - http://balau82.wordpress.com/2010/04/12/booting-linux-with-u-boot-on-qemu-arm/
  - http://balau82.wordpress.com/2010/03/22/compiling-linux-kernel-for-qemu-arm-emulator/
  - http://balau82.wordpress.com/2010/03/27/busybox-for-arm-on-qemu/
- Olimex SAM9-L9260
  - http://www.olimex.com/dev/sam9-L9260.html
- FriendlyARM mini2440
  - http://friendlyarm.net/forum
  - http://friendlyarm.net/downloads

Need Help?

suchakra@fedoraproject.org

http://suchakra.wordpress.com

@tuxology on Twitter

suchakra on

#embeddednirvana and #fedora-india @ irc.freenode.net