A timeline for embedded Linux

Chris Simmonds

2net Ltd.

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License

About Chris Simmonds

- Consultant and trainer
- Working with embedded Linux since 1999
- Android since 2009
- Speaker at many conferences and workshops

"Looking after the Inner Penguin" blog at `http://2net.co.uk/`

`https://uk.linkedin.com/in/chrisdsimmonds/`

`https://google.com/+chrissimmonds`

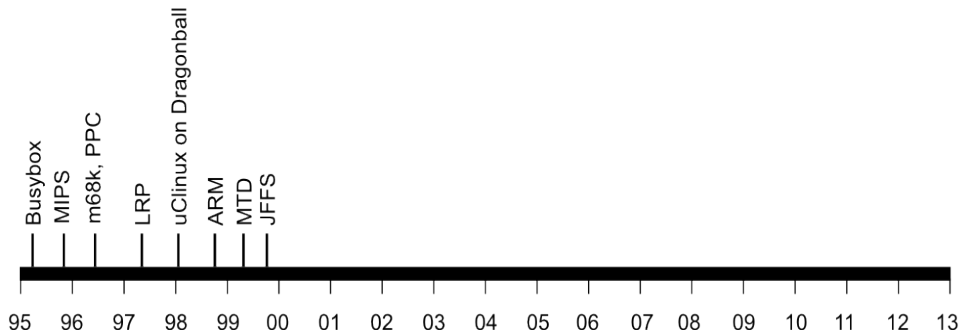# The early days: 1995 to 1999

- By 1995 Linux was already attracting attention beyond desktop and server
- It just needed a few more steps to make it a real contender...

Making Linux small

1995
Busybox: a collection of command-line utilities

Created by Bruce Perens so that he could put the Debian installer on to a single 1.44 MiB floppy disk

Also ideal for embedded devices with limited storage

The Linux Router Project

1997
The Linux Router Project (LRP): Dave Cinege used Busybox to create a Linux distribution on a floppy disk that turns a PC into a router

1998
David Täht and Greg Retkowski publish the "Arlan Wireless Howto"
The first embedded Linux wireless router

Making the Linux code portable

1995: MIPS
1996: m68k, ppc
1998: uClinux for m68k Dragonball on 3Com Palm Pilot
1999: ARM

Flash memory

1999
David Woodhouse begins work on the Memory Technology
Devices (MTD) layer

Axis create a robust file system for the flash memory in the AXIS
2100 Network Camera. It was called JFFS (Journaling Flash
File System)

Things start to happen: 1999

- The first products based on Embedded Linux appear
- Embedded Linux software companies emerge
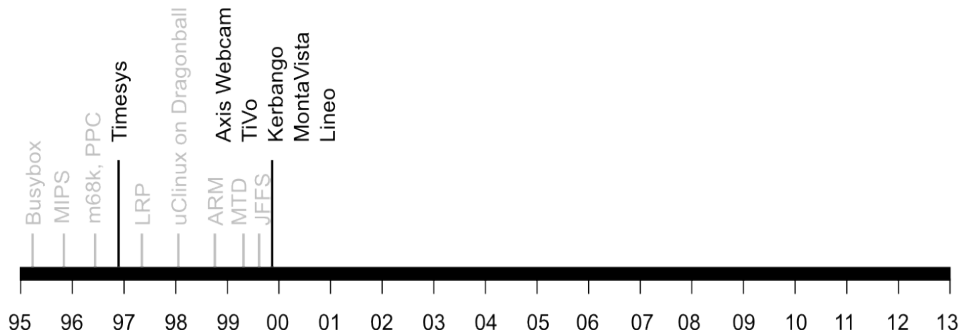
Things start to happen: 1999

AXIS 2100 Network
Camera

TiVo DVR

Kerbango Internet
radio

Professional help

1996: Timesys
1999: MontaVista
1999: Lineo
1999: Denx

Linux goes mobile: 2000 to 2005

- From early beginnings hacking on mobile hardware to a full mobile operating system

A timeline showing embedded Linux milestones from 1995 to 2013. Greyed-out entries: Busybox (95), MIPS (96), m68k, PPC (96), Timesys (97), LRP (97), uClinux on Dragonball (98), ARM (99), MTD (99), JFFS (99), Axis Webcam, TiVo, MontaVista (00). Highlighted entries: handhelds.org (00), Unobtainium (01), Sharp Zaurus (02), Motorola A 760 (03), Nokia 770 (05).
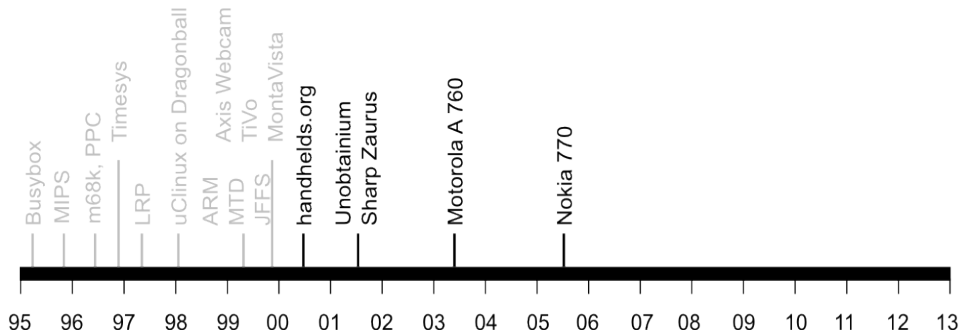
handhelds.org

2000
handhelds.org was a focus for porting Linux to a variety of portable devices, starting with the Compaq iPAQ H3600

iPaq running X11
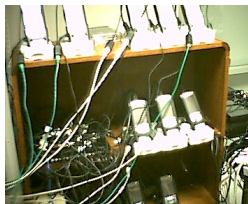
The build cluster

The unobtainium

2001
Project Mercury at Compaq put together a prototype mobile handset nicknamed the "Unobtainium"
*   iPaq 3600*
*   GSM/CDMA/802.11b/Bluetooth*
*   640x480 camera*
*   1 GiB of storage on an IBM Microdrive*

Zaurus

2001
Sharp create the Zaurus SL-5000D PDA running Linux 2.4.10
(provided by Lineo)

Motorola handsets

2003
Motorola A 760 handset (MontaVista Linux)

Nokia

2005
Nokia 770 Internet Tablet running Maemo Linux

Embedded Linux gets easier: 2001 onwards

- Move away from RYO (Roll Your Own) embedded Linux distributions

A timeline chart spanning years 95 to 13, with the following labels:

- Busybox (95)
- MIPS (96)
- m68k, PPC (97)
- Timesys (97)
- LRP (97)
- uClinux on Dragonball (98)
- ARM (99)
- MTD (99)
- JFFS (99)
- Axis Webcam (99)
- TiVo (99)
- MontaVista (99)
- handhelds.org (00)
- Unobtainium (01)
- Sharp Zaurus (01)
- Buildroot (01)
- Motorola A 760 (03)
- OpenEmbedded (03)
- Poky (04)
- Nokia 770 (05)
- Yocto (10)
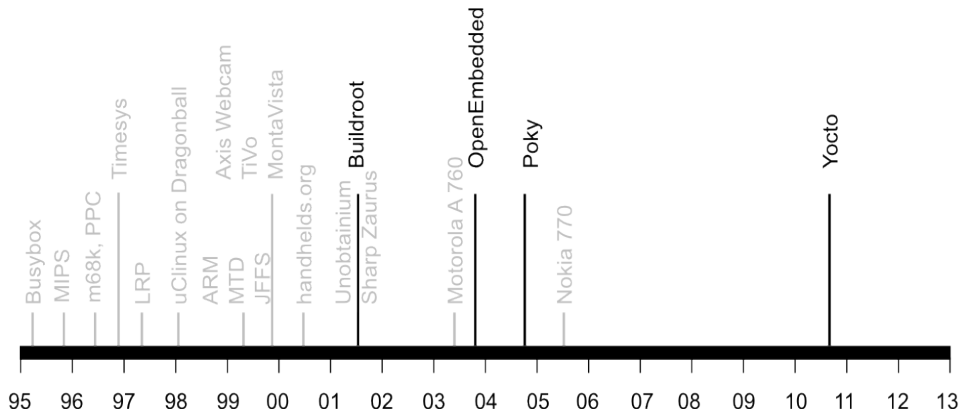
Embedded Linux build tools

2001
Buildroot emerges from the uClinux/uClibc project

2003
OpenEmbedded Project is born, creating a common build system and code base for Familiar Linux, OpenZaurus and OpenSIMpad
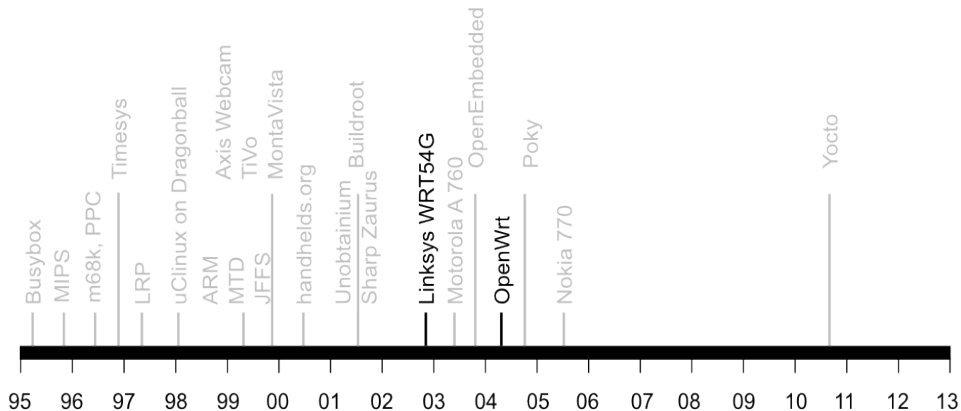
2004
OpenedHand employee Richard Purdie creates Poky Linux based on OpenEmbedded

2010
Intel spin off Poky Linux, acquired as part of OpenedHand, as the Yocto Project

Continuing the router story: 2002 onwards

- Linux becomes accepted in consumer WiFi routers

A timeline chart showing embedded Linux milestones from 1995 to 2013:

- Busybox — 95
- MIPS — 96
- m68k, PPC — 96
- Timesys — 97
- LRP — 97
- uClinux on Dragonball — 98
- ARM — 99
- MTD — 99
- JFFS — 99
- Axis Webcam — 00
- TiVo — 00
- MontaVista — 00
- handhelds.org — 01
- Unobtainium — 02
- Buildroot — 02
- Sharp Zaurus — 02
- Linksys WRT54G — 03
- Motorola A 760 — 03
- OpenEmbedded — 04
- OpenWrt — 04
- Poky — 05
- Nokia 770 — 05
- Yocto — 11

The WRG54G and OpenWrt

2002: December: Linksys release the WRT54G
2003: July Linksys post GPL source components of the
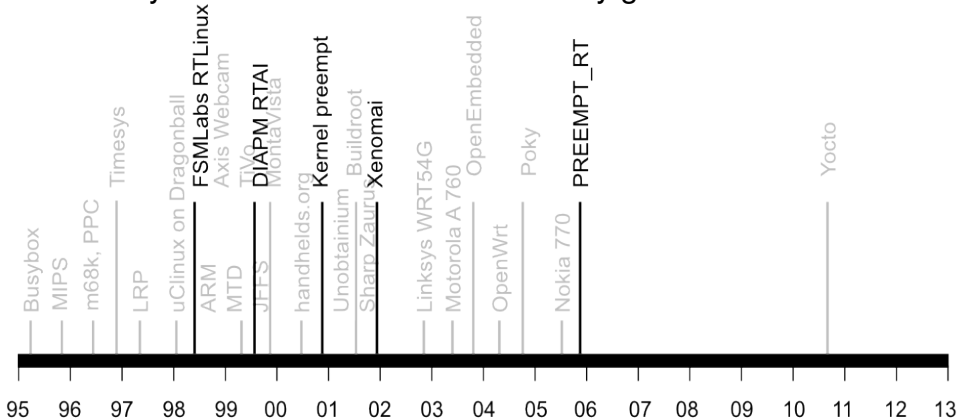*WRT54G firmware*
2004: OpenWRT project starts
2004 onwards: a large proportion of WiFi routers run Linux

Real-time: 1998 to present day

- Sometimes, real-world events require a deterministic response
- Early versions of Linux were not very good at real-time

Sub-kernels

1998: FSMLabs RTLinux
1999: DIAPM RTAI
2001: Xenomai
2002: DIAPM Adeos/RTAI

Patents
FSMLabs patented techniques used in both RTLinux and RTAI
(associated with interrupt dispatching)
Adeos "nano kernel" implemented a different method, resolving
the patent issue (probably)

Native real-time

2000: Timesys launch Linux/RT 1.0

2000: voluntary preempt patch (Ingo Molnar and Andrew Morton)
2001: kernel preemption patch (Robert Love)
2003: Linux 2.6 includes voluntary preempt and kernel preemption patches
2005: PREEMPT_RT kernel patch (Ingo Molnar, Thomas Gleixner and others) 2013: PREEMPT_RT still not in mainline kernel

Where are we today?

Android has 1.5 million activations per day, installed base 900 million

250 million set top boxes and smart TVs per annum

200 million WiFi routers per annum

Embedded Linux is the default OS

- Any questions?

Slides on Slide Share: `slideshare.net/`

Expanded timeline at `http://2net.co.uk/embedded-history`