How to port GNU / Linux on your PDA

Error ✕

⊗ Fatal System Error

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Why GNU/Linux? Because it's next

OS roadmap
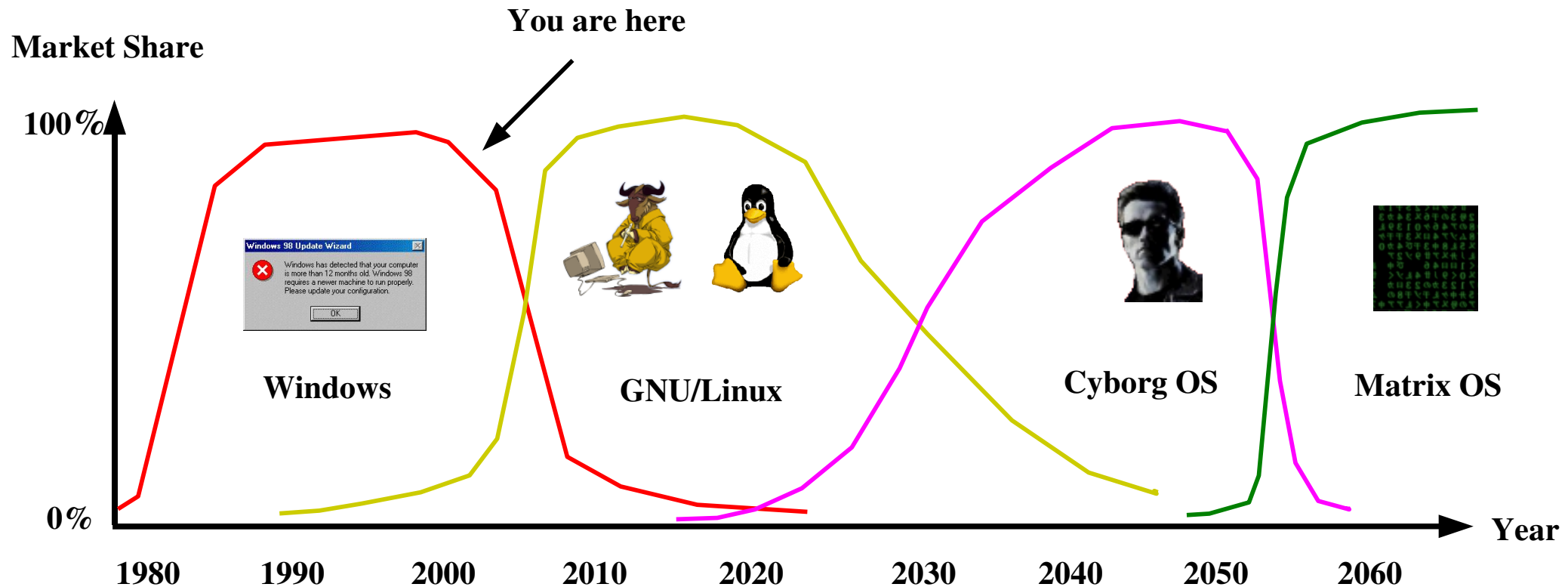
Your cool new PDA

▶ Lots of OS options, frequent updates.

▶ Lots of proprietary tools included in the price. You need them all and they perfectly suit your needs.

▶ Easy to write and add your own applications.

▶ Plenty of space left for extra stuff

▶ Seamless data exchange with your favorite desktop OS and applications.

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Linux on PDAs: easy and difficult parts

Easy

▶ Standard parts: CPU, chips available in other PDAs.

▶ Reusable drivers (from x86 and same arch)

Difficult

▶ Custom chips with no existing drivers (yet), sometimes with no available documentation.

▶ Undocumented wiring

▶ Undocumented interfaces: SD, SDIO...

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Start the project

- Check if anybody has already started this work.

- Ask admin-lists@handhelds.org
  to create an acme-pda-port@handhelds.org list for you.

- Create a home page and a wiki for the project (can use handhelds.org's wiki).

- Tell other people that the project starts:

    - handhelds@handhelds.org mailing list

    - Google: link to your home page and / or wiki.

    - Use Free Software news media

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Create a team

- Let everyone contribute according to their skills and interests.

- Encourage information sharing: wiki, mailing list (+ archives)

- Release early, release often

- Recognize contributions

- Make sure status and documentation are up to date

- Publicize your progress to broader audiences

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Identify hardware components

▶ Check whether somebody already opened your device and took pictures (use http://repair4pda.org/ or search engines)

▶ Read consumer specifications

▶ Find the FCC number (on the back of the device), get pictures and info from http://www.fcc.gov/oet/fccid/

▶ Open the device and take pictures
(see http://repair4pda.org/
 for guidelines and experience from other users)

▶ Ask the team for help identifying the chips

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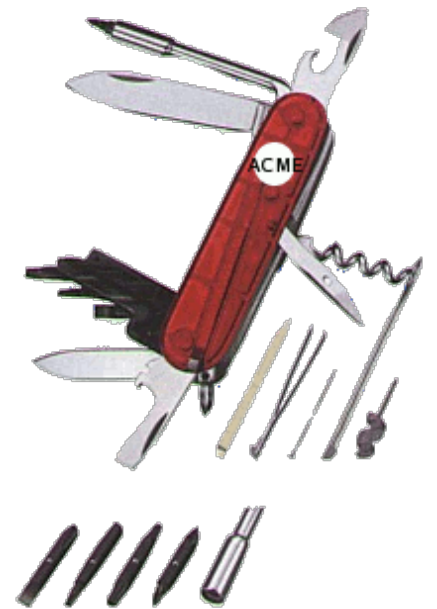
Find component specifications

- Search through the World Wide Web

- Ask the manufacturer

- Ask the PDA manufacturer

- Keep a safe copy of them

- Find other devices using these components and try to look for existing Linux drivers

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Requirements

- ▶ Serial port: cable or IrDA

- ▶ JTAG equipment / find JTAG pins

- ▶ GNU / Linux computer

- ▶ And a reliable... coffee machine!

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Choose your kernel

- Mainstream, or handhelds.org?

- Choosing Linux 2.4:

    - Mature

    - But fewer and fewer kernel developers willing to help

- Choosing Linux 2.6:

    - Helps Linux development, support from kernel hackers

    - Fully mature and exhaustive

    - Cutting edge features not found in 2.4

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Apply for a machine number

- Used by the kernel to identify your machine

- Machine number registration for ARM PDAs:
  http://www.arm.uk.linux.org/developer/machines/

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Get a cross-compiling toolchain

- Contains: gcc, binutils, glibc headers

- uClibc based toolchains (create much smaller binaries): Download one from http://free-electrons.com/community/tools/uclibc or build your own toolchain with Buildroot http://buildroot.uclibc.org/

- Handhelds.org (glibc: bigger binaries): ftp://ftp.handhelds.org/projects/toolchain/

- Build it yourself using crosstool (glibc) http://kegel.com/crosstool/

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Setup and compile your kernel

- Add the toolchain to your path

- `make xconfig`

  - Just select minimum features

  - Modules not needed yet

- `make`

- copy `arch/<arch>/boot/zImage` to your PDA

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Boot Linux from PocketPC

▶ You can use HaRET from Andrew Zabolotny:

http://handhelds.org/moin/moin.cgi/HaRET

▶ HaRET will load zImage (and initrd) in RAM and will execute the kernel in privileged mode.

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HaRET setup.txt example

```
set KERNEL zImage

set MTYPE 341

set INITRD initrd

set CMDLINE "root=/dev/ram0 rw
  init=/linuxrc console=ttyS0,115200n8
  console=tty0 ramdisk_size=8192
  cachepolicy=writethrough"

bootlinux
```

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Figuring out internal wiring

- ▶ Need to figure out how the internal devices are connected to the CPU (GPIO registers, interrupts...)

- ▶ HaRET can help you to find out

- ▶ Lots of experiments are needed in Windows, e.g.:

    - ▶ Dump GPIOs

    - ▶ Plug in USB

    - ▶ Dump GPIOs

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Build your first initrd

▶ Minimum Linux root filesystem in a ramdisk

▶ Contains shell utilities and modules

▶ Busybox: provides most Unix commands in a single executable (~ 700 KB!)

▶ `/linuxrc`: first script executed after booting

```
mkdir /mnt/initrd
dd if=/dev/zero of=initrd.img bs=1k count=2048
mkfs.ext2 -F initrd.img
mount -o loop initrd.img /mnt/initrd
<populate: busybox, modules, linuxrc script>
umount /mnt/initrd
gzip --best -c initrd.img > initrd
```

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Usefulness of networking

- Either Ethernet over USB (`g_ether` gadget driver)

- Or using a PCMCIA ethernet adapter

Useful to:

- pivot_root to a NFS share on the PC. Very easy to update and test module files

- Connect to the Internet and download packages

- Go very far in the development without having to reflash the device

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Use your original bootloader

Lots of useful features found in most bootloaders:

▶ Backup the system in flash ROM!

▶ Upgrade the system

▶ Reflash from a system backup

▶ Dump internal information

▶ Read and write flash

▶ Load a system and boot it

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Reflashing your device

▶ First make flash read and write work on Linux

▶ Keep existing bootloader or not?

▶ LAB: Linux As Bootloader

- ▶ Uses Linux drivers to provide bootloader functionality (flash or card access, lcd, buttons...)

- ▶ Try it from PocketPC first, as a regular Linux kernel.

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Boot possibilities

- Boot from PocketPC

- Single boot

- Dual boot... to keep your precious proprietary tools

  - Keep PocketPC in flash

  - Boot GNU / Linux from external media

- Triple boot...

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Handle floating point

No floating point units in many embedded processors!

▶ In your programs: use integers whenever possible

▶ When you need floating point numbers

- ▶ Never let the kernel handle them (time consuming kernel exception)

- ▶ Either use gcc's floating point emulation

- ▶ Or use fixed point

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Use BitBake / OpenEmbedded!

http://oe.handhelds.org

▶ Distribution generator: creates a complete root filesystem image

▶ Also creates packages

▶ Leverages porting effort on other devices

▶ Thousands of packages available!

open embedded

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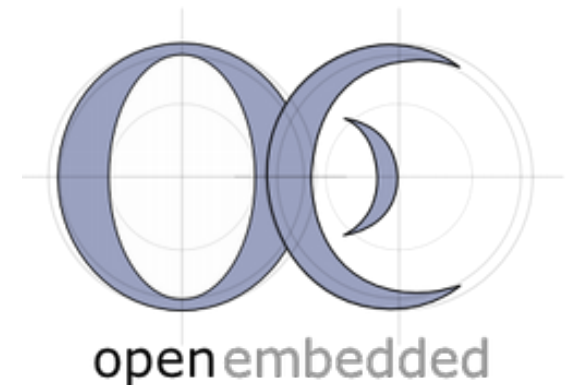
Your cool new PDA

- ▶ Free Operating system, with frequent updates

- ▶ Lots of free tools

- ▶ Easy to write and add your own applications.

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Handhelds.org

▶ Home page:
http://handhelds.org/

▶ Mailing lists:
http://www.handhelds.org/email_lists.html

▶ Wiki:
http://handhelds.org/moin/moin.cgi/

▶ Porting project status:
http://handhelds.org/projects/

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ARM Linux Project

▶ Home page:
http://www.arm.linux.org.uk/

▶ Developer documentation:
http://www.arm.linux.org.uk/developer/

▶ FAQ:
http://www.arm.linux.org.uk/armlinux/mlfaq.php

▶ How to post kernel fixes:
http://www.arm.uk.linux.org/developer/patches/

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▶ http://linuxdevices.com/articles/AT8728350077.html
LinuxDevices.com's exhaustive catalog of fully supported Linux PDAs.

▶ http://tuxmobil.org/pda_linux.html
Linux resources for lots of PDA devices (fully or partially supported)

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Linux kernel

Linux device drivers
Board support code
Mainstreaming kernel code
Kernel debugging

Embedded Linux Training

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Linux kernel and drivers development
Real-time Linux, uClinux
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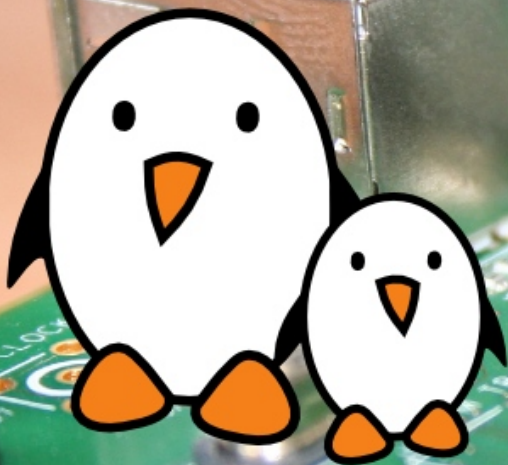
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