It's Linux Jim.....but not as we know it.....

Linux most popular on PCs

Actually quite portable

* Most architecture dependent sections separated out

Lots of choice - you don't have to use PCs!
What is a PC?

A computer with:

- An x86 processor (32 or 64bit)
- A standard BIOS or **EFI** firmware
- **Standard basic support**
  - *All in a standard location/address (or small choice)*
  - Interrupt controllers
  - Timers
  - Ways to get to busses with devices on
- **Special x86 systems without these aren't quite PCs**
  - e.g. SGI Ultraviolet supercomputers, Intel Quark
Some (modern) non-PCs that run Linux

- Raspberry Pi, Beagle Board, MIPS Creator C120
- Most phones/Tablets (but some are PCs!)
- Wireless/Cable/DSL router
- Some Supercomputers (e.g. K computer); (most supercomputers run Linux, but a lot are PCs now)
- 64bit ARM servers, IBM Mainframes, Itanium, Power
- Wireless SD card for camera (Transcend and others)
- Some Smart TVs (Sony Bravia)
- Kitchen blender (Thermomix)
- Or with some hacking:
  - Canon DSLR cameras, anything with an accessible CPU!
## Modern kernel and distro arch list

<table>
<thead>
<tr>
<th>Arch</th>
<th>Count</th>
<th>Arch</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>alpha</td>
<td>2428</td>
<td>nios2</td>
<td>584</td>
</tr>
<tr>
<td>arc</td>
<td>972</td>
<td>openrisc</td>
<td>524</td>
</tr>
<tr>
<td>arm</td>
<td>31356</td>
<td>parisc</td>
<td>2324</td>
</tr>
<tr>
<td>arm64</td>
<td>2136</td>
<td>powerpc</td>
<td>15648</td>
</tr>
<tr>
<td>avr32</td>
<td>1312</td>
<td>s390</td>
<td>3280</td>
</tr>
<tr>
<td>blackfin</td>
<td>6012</td>
<td>score</td>
<td>640</td>
</tr>
<tr>
<td>c6x</td>
<td>640</td>
<td>sh</td>
<td>5092</td>
</tr>
<tr>
<td>cris</td>
<td>4876</td>
<td>sparc</td>
<td>4792</td>
</tr>
<tr>
<td>frv</td>
<td>1324</td>
<td>tile</td>
<td>2772</td>
</tr>
<tr>
<td>hexagon</td>
<td>632</td>
<td>um</td>
<td>1284</td>
</tr>
<tr>
<td>ia64</td>
<td>4028</td>
<td>unicore32</td>
<td>820</td>
</tr>
<tr>
<td>m32r</td>
<td>1404</td>
<td>x86</td>
<td>12112</td>
</tr>
<tr>
<td>m68k</td>
<td>6448</td>
<td>xtensa</td>
<td>1424</td>
</tr>
<tr>
<td>metag</td>
<td>1216</td>
<td></td>
<td></td>
</tr>
<tr>
<td>microblaze</td>
<td>1192</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mips</td>
<td>14796</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mn10300</td>
<td>1748</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Just CPU architectures listed
- Some common (x86, ARM, etc)
- Some obsolete (alpha, parisc)
- Some obscure (m32r, mn10300)
- Some upcoming (arm64)
- Some very open (openrisc)
The Linux world (1999)

- Plenty of home users running it on PCs
- Some people running it on weirder stuff
- Red Hat Linux on i386, SPARC and Alpha
- Yellow Dog on PPC
- Debian 2.1 on i386, Alpha, SPARC and 680x0
- Kernel at 2.2
Linux on non-PCs in '99

- **PowerPC Macs**
- **Mostly workstations**
  - SPARC workstations very common 2nd hand/out of skips
  - MIPS SGI box (SGI Indy especially), Cobalt Qube
  - Alpha both workstations and motherboards
  - ARM Archimedes, Netwinder
  - Old 680x0 (Sun3, Amiga etc)
  - Also HP-PA
- **Starting to be some embedded**
  - Empeg car audio system
Booting

PC: BIOS loads 1st sector → Loads 2\textsuperscript{nd} stage GRUB (using BIOS calls) → Loads Linux + Initramfs (using BIOS calls)

PC: EFI + GPT Partitions → Loads shim/GRUB → Loads Linux + initramfs (using EFI calls)

PowerPC: Open Firmware → Yaboot → Loads Linux + initramfs

ARM (some): uBoot → Loads Linux + initramfs

Each architecture has different boot processes, and sometimes vary per board not just by CPU type

GRUB2 now not just on PC

Updating boot process can be different
Integration & standardisation made things easier

Workstations were all different

Proprietary busses
Some shared chips – but all wired differently

PCI & PCIe & USB helped
Share the same network/IO and maybe video cards with PCs (some boot problems)

Integration simplified
Mostly one chip/IO card
Most of the time if a card has that chip it's now likely to work.
Rise of the SoCs aka why Integration made it harder

**System on Chip** - most stuff on a single chip, specialised for a class of applications

- Even sometimes the RAM in the same package
- Maybe no external 'bus'
- Not much commonality
  - e.g. common to have specialised ways to access the main flash memory
  - Sometimes need drivers for each chip type just to boot
  - Specific bootloader types
More SoCs

• Very varied
  • Some short lifespan
    • Next one being designed/built before this one is being sold
  • Badly documented
  • No upstream/distro support

• Some well documented/supported
  • Much easier to work with
  • Often normal kernels with special build

• Attempts to define SoCs
  • 'device tree'
Emulation

- QEMU for most architectures
  - special versions in Android devkits

- Individual emulators for popular micros
## Installations

<table>
<thead>
<tr>
<th>Modular/PC like setups</th>
<th>Embedded/SoCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Traditional distro</td>
<td>• Typically special instructions</td>
</tr>
<tr>
<td>• Check the distro install notes to make sure that hardware is supported</td>
<td>• Prebuilt images</td>
</tr>
<tr>
<td>• After boot very similar</td>
<td>• Userspace of other distros+kernel+bootloader+update scripts</td>
</tr>
<tr>
<td></td>
<td>• Often critical binary blobs</td>
</tr>
</tbody>
</table>
Programming on something else

- **Endianness: 0123 vs 3210**
  - X86 is 'little endian', 680x0 is 'big endian'
  - PowerPC used to be BE but now moving towards LE
  - ARM mostly LE, some BE uses

- **Alignment**
  - X86 'anything goes' – most others are fussy

- **Memory ordering**
  - X86 mostly does what you ask – ARM, PPC reorder a lot

- **FP formats**

- **Function descriptors (rare)**

- **Don't assume PCI, SCSI discs, a lot of RAM, the boot process**
Now & the future?

• **Linux is everywhere on non-PCs**
  • The PCs are fighting back a bit! (phones, tablets etc)

• **Servers/workstations mostly PCs**
  • The old technical workstations have gone
  • Still none-PC servers, but rarer – almost all now explicitly support Linux
  • 64-bit ARM just arriving