uCLinux -
State of the Nation

Presented by

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uClinux

Pronounced "you-see-linux", the name uClinux comes from combining the greek letter "mu" and the english capital "C". "Mu" stands for "micro", and the "C" is for "controller".

- Linux for processors that have no memory management
- targets classic embedded 32bit micro-controllers
- modifications to standard Linux kernel source
History

1998  Kenneth Albanowski and D.Jeff Dione release 2.0.33 kernel for Motorola DragonBall
1999  Motorola ColdFire support 2.0.38 kernel ARM support
2000  2.4.0 test kernel support
2002  shared libraries 2.5.46 uClinux merged with mainline

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Status of uClinux-2.0.x

• separate patch, and cvs repository
• currently at 2.0.39
• support for m68k, arm, i960, sh2, h8/300, sparc, or32, nios
• flat format application binaries
• no active development?
Status of uClinux-2.4.x

- separate patch, and cvs repository
- currently at 2.4.32
- support for m68k, arm, h8/300, nios, microblaze, blackfin, e1, frv, v850
- forks available for sparc, mips, sh2
- non-integrated mm code
- flat and elf_fdpic format application binaries
- still actively developed and used

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Status of uClinux-2.6.x

- fully merged
- mainline support for m68k, h8/300, v850, frv
- in the process of merging ARM
- want to merge blackfin, microblaze
- integrated mm code
- flat and elf_fdpic format application binaries
Popular Architectures?

ucdot poll of most popular architecture

<table>
<thead>
<tr>
<th>Architecture</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARM</td>
<td>37.5</td>
</tr>
<tr>
<td>Blackfin</td>
<td>25</td>
</tr>
<tr>
<td>M68k/Coldfire</td>
<td>15</td>
</tr>
<tr>
<td>Microblaze</td>
<td>10</td>
</tr>
<tr>
<td>SuperH</td>
<td>5</td>
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<tr>
<td>H8</td>
<td>5</td>
</tr>
<tr>
<td>v850</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
</tr>
</tbody>
</table>
Architectures - M68K

- well supported
- good support for 68328 series (Dragonball)
- good support for ColdFire (520x, 523x, 5249, 527x, 528x, 5307, 532x, 5407)
- some support 68360
- supported in the past 68000, 68302, 68332
- shared libraries
- XIP for kernel and applications
Architectures - ARM

- well supported
- parts from many vendors
- Atmel, Conexant, TI, Samsung, Philips/NXP...
- shared libraries (not integrated at uclinux.org)
- common merged ARM in 2.6 kernels coming
- XIP for kernel and applications

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Architectures

NEC v850
- maintained, up to date in 2.6 kernels

Hitachi H8/300
- H and S series processors
- maintained, up to date in 2.6 kernels

Fujitsu FR-V
- variants with MMU and without
- same ELF_FDPIC applications can run on both MMU and MMUless platforms

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Architectures - Blackfin

- Analog Devices DSP
- fast and cheap processors
- actively vendor supported
- supports flat and elf_fdpic application binaries
- merged into Andrew Mortons -mm tree
- blackfin.uclinux.org
Architectures

Xilinx Microblaze
- FPGA soft core processor
- active development community
- commercially and freely supported
- potential merge into main line kernel

Altera NIOS-II
- FPGA soft core processor
- vendor/commercial supported
- attempt to main line unknown

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Architectures

MIPS
- known ports to Brecis parts, Sony PS1 and PSP
- XIPtech support at 2.4.19

Sparc
- LEON from Gaisler Research
- uClinux version using 2.0.x kernel

Hitachi SuperH SH2
- support in 2.6 kernels
- status unknown?
Architectures

Hyperstone E1
- active development unknown?
- last kernel support known 2.4.x

OpenCores OR1000
- general software CPU for FPGA
- current status unknown?
- last known kernel support 2.4.x
Limitations

- `vfork` (and `clone`) – no true fork
- `sbrk` – limited use/functionality
  use of `mmap` largely hides this
- `mmap, mremap` – some restrictions
- no memory protection
- no paging
- memory fragmentation
  (some limited protection on some architectures)
- fixed size user space stacks
  cannot be dynamically grown
non MM Status

- recent *mmap* clean ups
- standard buddy allocator fragments badly need to be able to do large chunk allocations
- `page_alloc2` in 2.0 and 2.4 kernels
- “sidekick” allocator by Phil Wilshire for 2.6 kernels
- ideas for use of specific MPU's
Application Binary Formats

*flat format*
- small header + text + data + relocs
- supports shared libs
- supports PIC
- supports storing compress text

*elf_fdpic format*
- elf object format
- supports shared libs

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Tools

- standard linux targeted too chain usually ok
- “uclinux” targets for some architectures (eg m68k-uclinux)
- historically “elf” target was used (eg arm-elf)
- gcc main line supports PIC, msep-data, id-shared-library options on some architectures (m68k, blackfin)
- elf2flt easily adds onto existing architecture tool chain if using flat format binaries
Simulators

• Skyeye (www.skyeye.org)
  supports ARM, blackfin, coldfire
• GDB/ARMulator
• NEC v850 GDB simulator
• Sparc LEON TSIM
• ...

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Myths

1. **But all processors will have MMUs soon?**

   Many vendors still developing new silicon
   Price/complexity lower

2. **But it is not real Linux right?**

   Get linux-2.6.20 and compile for non-MMU, how can you get more Linux than that!
Resources

www.uclinux.org

www.ucdot.org