Argonne NATIONAL LABORATORY

Linux-MVME Targets
Using Motorola Board Support

Epics Collaboration Meeting – June 2006

IOC Operation Systems

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THE UNIVERSITY OF CHICAGO

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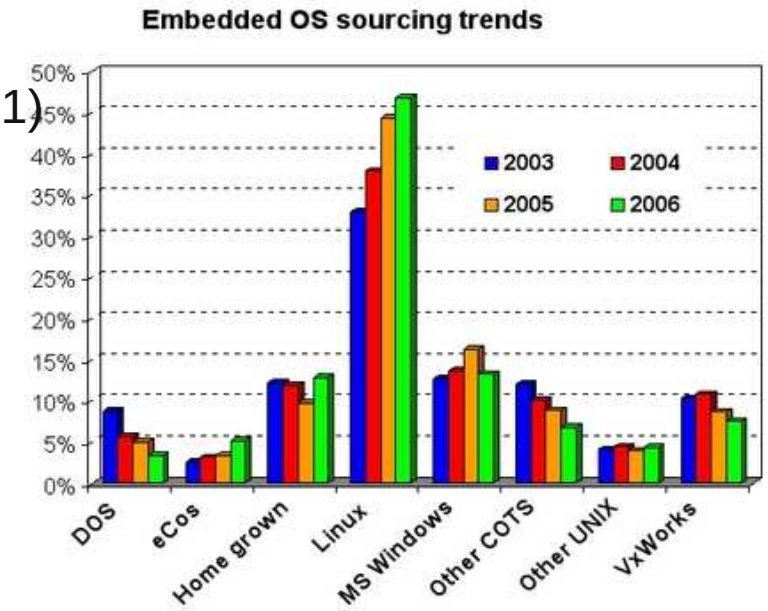
Overview

- Future of Embedded Linux
- Linux for vxWorks Developers
- Motorola MVME Linux Support
- Embedded Linux Development Kit
- Embedded Linux Installation and Implementation
- Linux Runtime
- EPICS Target Development
- EPICS Results
- Remaining Work

Future of Embedded Linux

Is Linux taking over the world?
The 'truthiness' is….

- Google "embedded linux" – 6,830,000
  - Sponsored Links (2 pages)
- Single Board Computer Vendors claim Linux support
  - Motorola, SBS, Xycom, …
- Web Magazine (www.linuxdevices.com)
  - Survey of Embedded Linux Distributions ('01)
    - *19 Commercial*
    - *13 Open Source*
- Wind River Workbench
  - Builds Linux targets.
- Popularity of EPICS Soft IOC's



Future of Embedded Linux

Embedded Linux for VxWorks Developers

- OS Kernel
  - Soft Realtime
  - Configurable
  - Small
- Board Support Package
  - Hardware device support (counter/timers, I/O Ports, mezzanine slots)
  - VME Bus Support (memory windows , interrupt service, DMA)
  - Customizable (source code)
- Build Tools
  - Support Libraries
  - Cross Compiler/Linker
- Network Booting (diskless)

Motorola MVME Linux Support

- Current MVME Products
  - MVME3100 512MB, 844MHz, $2100
  - MVME5500 512MB, 1GHz, $3200
  - MVME6100 1GMB, 1.2GHz, $4200
- Active in-house development to support Linux
  - Current Kernel Supported (v2.6.14)
    - *5 months behind the most recent: v2.6.16 (http://www.kernel.org/pub/linux/kernel)*
  - Improving VME bus memory and interrupt drivers based on customer feedback. *(Commercial RT Linux venders perhaps?).*
- Linux Kernel support for other SBC (CompactPCI, PMC, etc)

Motorola MVME Linux Support

- Distribution is currently…informal
  - Contact: Ajit Prem Ajit.Prem@motorola.com
- Distribution Contents
  - Generic linux kernel patch file
    - *patch-2.6.14-ecc.ir01.03282006.gz*
  - Documentation
    - *README (linux_2614_eec_readme.txt)*
    - *vme_driver.pdf*
  - Example code – VME drivers
    - *vme_utils.tar.gz*
- Recommended Embedded Linux Development Kit
    - *www.denx.de -> ELDK*

Embedded Linux Development Kit

- What is it?
  - Linux distribution targeting embedded system development
- Pre-built cross-platform software development tools for embedded processors (PowerPC, ARM, ….).
  - Make, cross-compiler/linker(gcc), libraries.
- Prebuilt root filesystem.
  - /bin, /dev, /etc, /lib, /proc, /sys, /var, /usr, …..
- Nothing that could not be produced in-house but ..it’s a pain!

ELDK Installation

- Distribution (eldk.tgz – 2Gigbytes)
  - Buy CD $99 Euro
  - Download:
    - *http://sunsite.utk.edu/ftp/pub/linux/eldk/4.0/ppc-linux-x86*
      Use gftp (recursive download ~ 4hrs)
- Unpack distribution
  - cd /local/eldk
  - tar xzf ~/eldk.tgz
- Documentation
  - file:///local/linux/eldk/4.0/ppc-linux-x86/distribution/README.html
- Check files for executable permission
  - tools/bin/rpm, tools/usr/lib/rpm/rpmd, install, ELDK_MAKEDEV, ELDK_FIXOWNER

ELDK Installation (cont)

- Install ELDK
  - ./install -d /local/eldk/eldk
- Setup cross-built environment variables
  - setenv CROSS_COMPILE ppc_74xx-
  - set path=($path /local/eldk/usr/bin /local/eldk/bin)

Embedded Linux Kernel Build

1) Get Kernel patch file and README from Ajit Prem Ajit.Prem@motorola.com
   Save: ~/patch-2.6.14-ecc.ir01.03282006.gz

2) Downloaded Linux 2.6.14 Kernel from http://www.kernel.org/pub/linux/
   Save: kernel/v2.6/linux-2.6.14.tar.gz -> ~/linux-2.6.14.tar.gz

3) Unzip Linux
   - cd /local/linux
   - tar xzf ~/linux-2.6.14.tar.gz

4) Patch Linux Kernel
   - cd linux-2.6.14
   - patch -Np1 < ~/patch-2.6.14-ecc.ir01.03282006

Embedded Linux Kernel Build (cont)

5) Configure build for target architecture

/local/linux/ linux-2.6.14/Makefile edit

ARCH ?= ppc

CROSS_COMPILE ?= ppc_74xx-

6) Build Kernel (using ELDK make)

- ppc-linux-make mrproper
- ppc-linux-make menuconfig *(text based screen menus)*

  - Load Default Configuration (Load an Alternate Configuration File)

    ./arch/ppc/configs/mvme5500_defconfig

  - Set kernel boot command string (Platform Options)

    See: Motorola README file.

    See: <linuxTop>/Documentation/nfsroot.txt
- ppc-linux-make zImage.initrd <*compressed kernel image*>

Embedded Linux Kernel Build (cont)

Example: CONFIG_CMDLINE="console=ttyS0,9600 root=/dev/nfs rw
nfsroot=/local/eldk/eldk/ppc_74xx
ip=164.54.8.189:164.54.8.137:164.54.8.1:255.255.252.0:iocxxx:eth0:off
vme=vme_slotnum=1"

Goal: One kernel built for all targets.

nfsroot can use RARP or BOOTP to fill the client IP and name from the server.

7) Copy kernel to tftp server: (required for MOTLoad's netboot util).

/local/linux/linux-2.6.14/arch/ppc/boot/images/zImage.initrd.pplus

Uncompress Kernel Size:

1676763 zImage.mv5500 (1.67Mb)

ELDK: Root file system setup *(must be done as root)*

1) Make root:/dev directory

   > cd /local/eldk/eldk/ppc_74xx/dev

   > sudo /local/eldk/distribution/ELDK_MAKEDEV

2) Change files to be owned by **root**

   > cd /local/eldk

   > sudo /local/eldk/distribution/ELDK_FIXOWNER

1) Create sysfs (/sys) (MVME hardware access)

   > mkdir (/local/elkd/elkd/ppc_74xx)/sys

   Add mount point to (/local/elkd/elkd/ppc_74xx)/etc/fstab

   none /sys sysfs defaults 0 0

Export IOC's root file system on NFS Server

- Add Linux IOC to server's export list
  - File: /etc/exports

    /local/eldk iocLinux(rw,no_root_squash,secure)
  - Command: *sudo exportfs -a*

MVME network boot of linux kernel (w/autoboot)

- Connect to MVME thru serial port

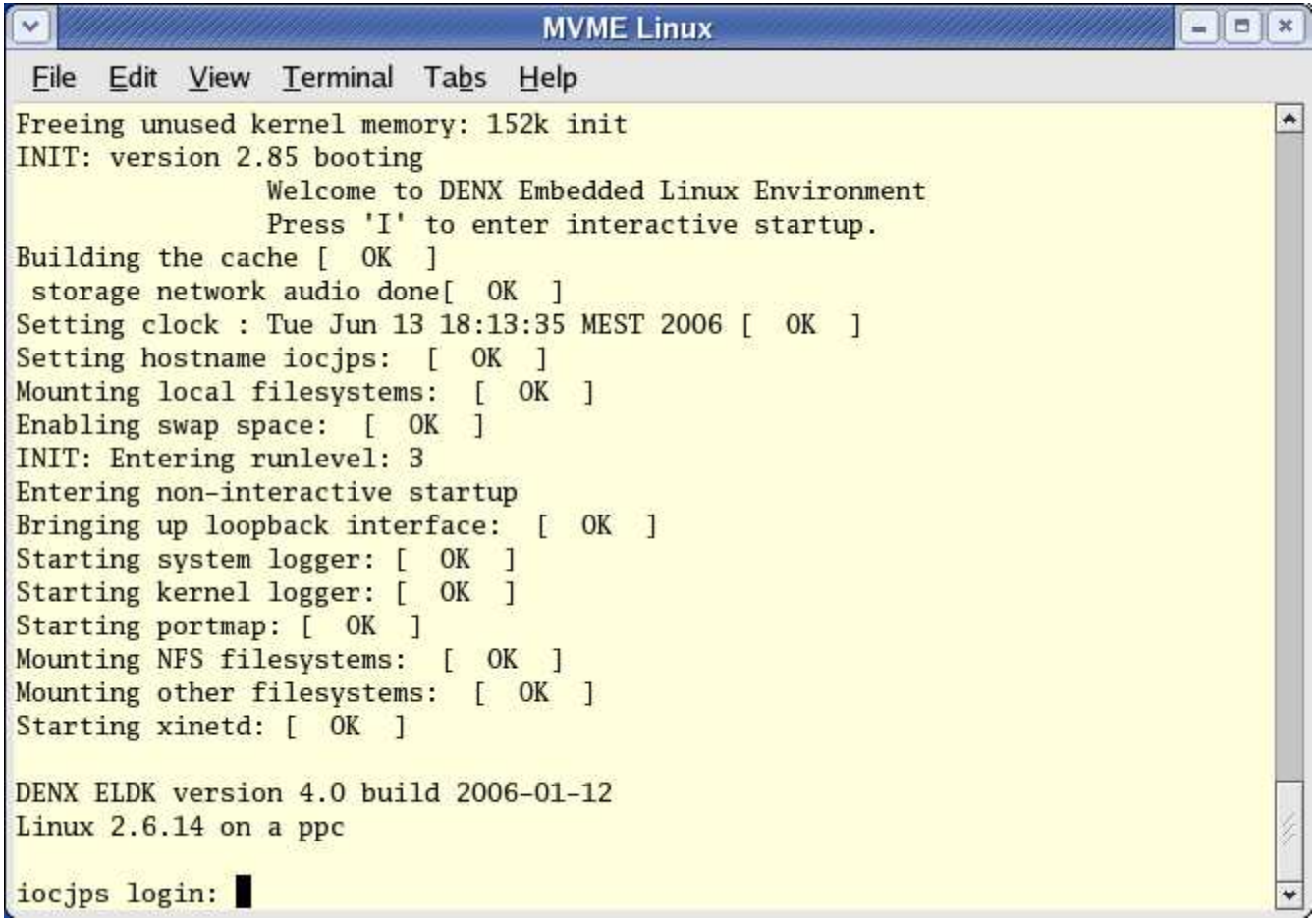
  MVME5500> gevInit

  MVME5500> gevEdit mot-script-boot

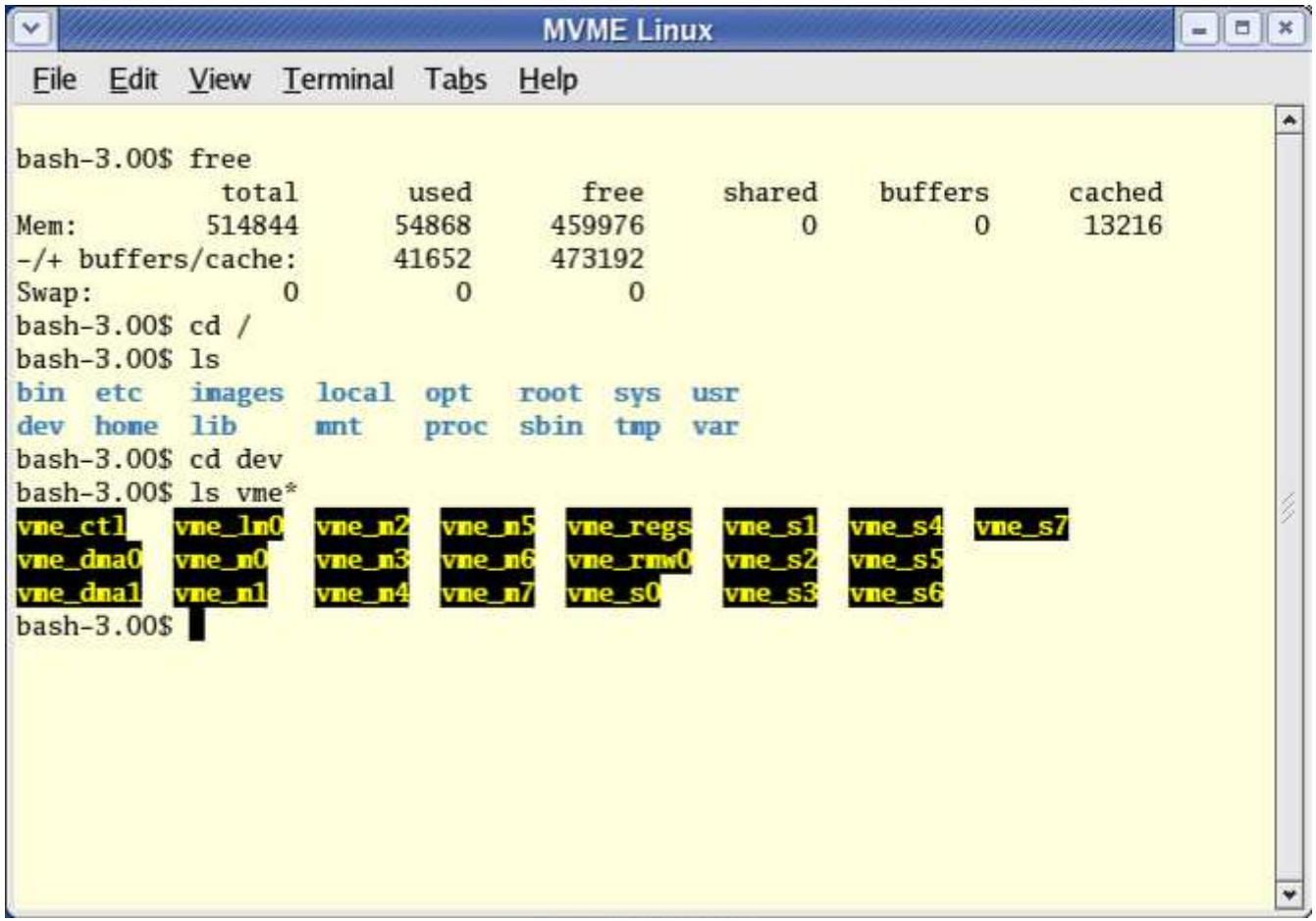
  netBoot -d/dev/enet1 -c164.54.8.189 -s164.54.8.103 -e400 –f vxworks/MCGLINUX/zImage.mv5500

  <cr>

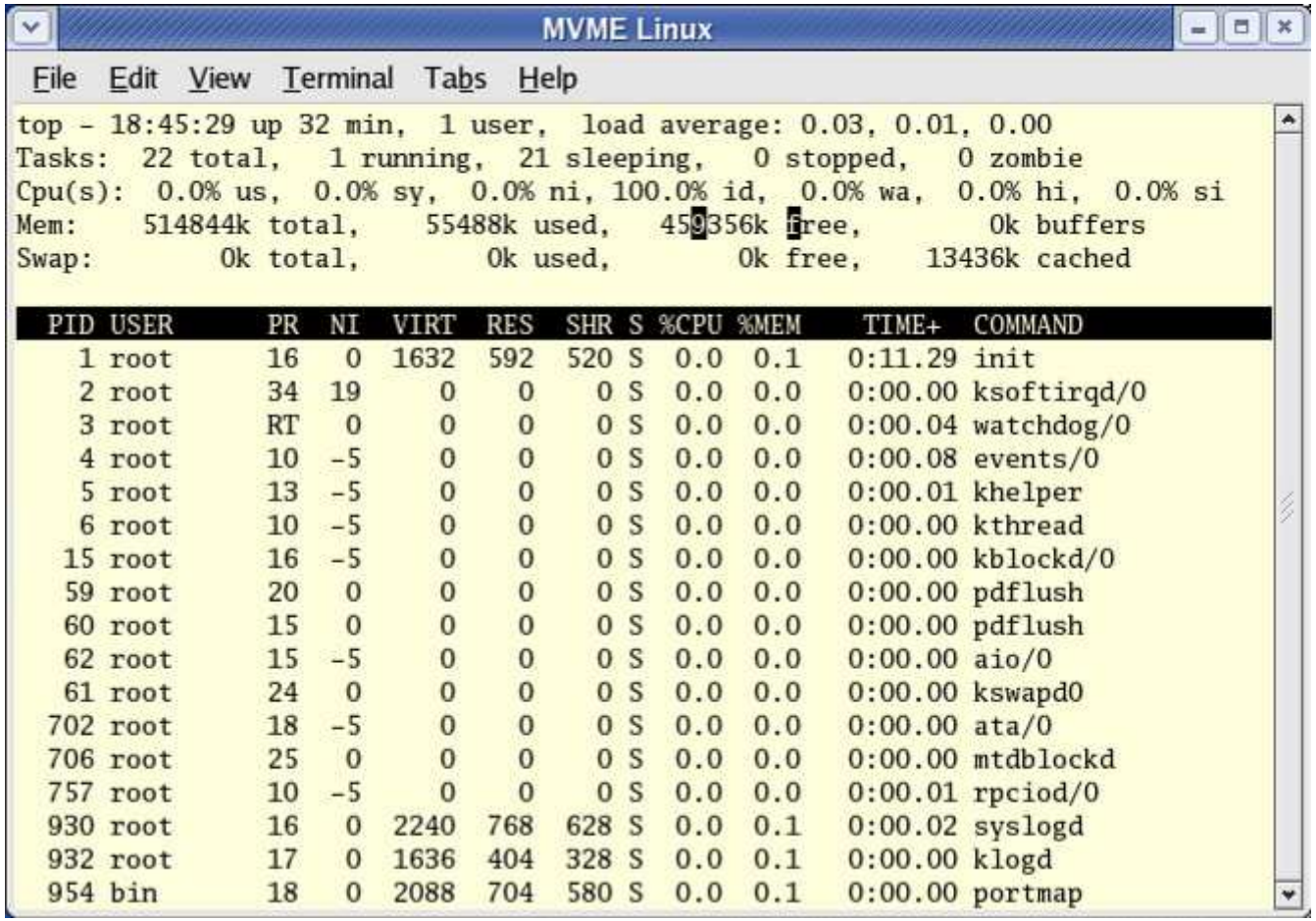
Linux Runtime



Linux Runtime



Linux Runtime



linuxELDK-ppc_74xx

- Create new EPICS target architecture **(use vxWorks as a model)**
  - See <epics base>/documentation/README.1st
- EPICS Configuration Files
  - <top>/configuration/CONFIG_SITE
    - *CROSS_COMPILER_TARGET_ARCHS = linuxELDK-ppc_74xx*
  - configure/os/
    - *CONFIG.Common.linuxELDK-ppc_74xx*
    - *CONFIG.linux-x86.linuxELDK-ppc_74xx*
    - *CONFIG_SITE.Common.linuxELDK-ppc_74xx*
- Use ELDK make *(with proper environment variables)*
  - ppc-linux-make

EPICS Results

- EPICS *linuxELDK-ppc_74xx* cross-compiler target
- EPICS Base - Built and Running (no problems)
  - EPICS 3.14.8.2
    - *exampleApp*
  - synApps 5.2
    - *Excluding (gensub, dxp, ccd, xxx)*
- iocxxx running synApps

  softIOC configuration

Remaining Work

- Figure out the Motorola VME interface
  - Memory windows and interrupt handling
- Benchmark MVME Linux performance
- Attempt a port of a vxWorks driver to Linux (OMS VME58).
- Investigate ucLinux (www.uclinux.org) kernel patches to get around the MMU (get direct access to VME memory and interrupts).

Future of Embedded Linux