LANTRONIX®

MatchPort®

XPort® Pro™

EDS1100/2100

Linux Software Developer's Kit (SDK) User Guide

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Contacts

Lantronix Corporate Headquarters

167 Technology
Irvine, CA 92618, USA

Phone: 949-453-3995
Fax: 949-450-7249

Technical Support

Online: www.lantronix.com/support

Sales Offices

For a current list of our domestic and international sales offices, go to the Lantronix Web site at www.lantronix.com/about/contact.

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Revision History

Date	Rev.	Comments
5/09	A	Initial Document
9/09	B	Updated for the XPort Pro support.
6/10	C	Updated for SDK Version 2.0 and support for EDS 1100/2100
3/11	D	Updated SDRAM information.

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1. Overview

The Lantronix Linux Software Developer's Kit (SDK) is an embedded hardware and software suite that enables Linux developers to create applications on Lantronix embedded networking modules. Detailed instructions for installing the SDK on your host Linux system are provided in this guide. It also describes the embedded module, its boot loader, flash partitioning schemes, and the build environment in detail. Information about many common embedded Linux utilities and configuration tasks is included. Sample programs, in addition to debugging and profiling tools, are provided and described in order to assist in the application development process.

Hardware Specifications

MatchPort AR

- Memory:
  - RAM 8MB
  - FLASH 8MB
- Serial Interface:
  - Two COM ports (CON1 using console)
  - Max baud rate 230400 bps (default 115200 bps)
- Ethernet:
  - 10/100 base TX with Auto Negotiation
- GPIO:
  - 7 pins

XPort Pro

- Memory:
  - SDRAM 8/16MB
  - FLASH 16MB
- Serial Interface:
  - One COM port
  - Max baud rate 921600 bps (default 115200 bps)
- Ethernet:
  - 10/100 base TX with Auto Negotiation
- GPIO:
  - 3 pins
    (2 shared with serial driver)

EDS1100 Specs

- Memory:
  - RAM 8MB
  - FLASH 8MB
- Serial Interface:
  - One COM port
  - Max baud rate 921600 bps (default 115200 bps)
- Ethernet:
  - 10/100 base TX with Auto Negotiation

EDS2100 Specs

- Memory:
  - RAM 8MB
  - FLASH 8MB
- Serial Interface:
  - Two COM ports
    (CON1 using console)
  - Max baud rate 921600 bps (default 115200 bps)
- Ethernet:
  - 10/100 base TX with Auto Negotiation

Software

- **Boot loader:** customized dBUG
- **OS:** custom µClinux distribution
- **Linux Kernel:** 2.6.30

Terms and Abbreviations

Table 1-1. Terms and Abbreviations

Term	Description
dBUG	Linux boot loader
host	Machine onto which the SDK gets installed and is used for cross-compiling for the embedded platform
SDK	Software development kit
target	Embedded development module

2. Installing the SDK

Host Requirements

Please make sure that at least 2.5 GB of disk space are available before installation.

Root permissions are needed for very few operations. Please refer to the following section on ‘sudo Configuration’ for details.

Linux Distributions

This SDK was validated on these Linux distributions:

Redhat-based distributions

Fedora 9, 10, 11, 12, Fedora Core 5 & 6

CentOS 5.2, 5.3, 5.4

- groupinstall 'Development Tools' (installs a lot of additional development tools not necessary for the SDK)
  or gcc, make, glibc-devel
- python
- sudo
- libacl-devel
- tftp-server or tftpd-hpa
- libtasn1-devel
- zlib-devel
- rsync

Optional but recommended packages

- openssh, openssh-clients, openssh-server
- nfs-utils
- ncurses-devel (for the ncurses-based configuration utility)
- libglade2-devel (for the GTK-based graphical configuration utility)
- qt-devel (for the Qt3-based graphical configuration utility)

Debian-based distributions

Debian Lenny 5.0.2 & 5.0.4

Ubuntu 8.04, 8.10, 9.04, 9.10, 10.04

- build-essential
- python
- sudo
- libacl1-dev
- tftpd or tftpd-hpa
- patch
- libtasn1-3-dev
- zlib1g-dev
- rsync

Optional but recommended packages

- ssh
- nfs-kernel-server
- libncurses5-dev (for the ncurses-based configuration utility)
- libglade2-dev (for the GTK-based graphical configuration utility)
- libqt3-mt-dev (for the Qt3-based graphical configuration utility)

Other distributions

OpenSUSE 11.2

- pattern install devel_C_C++
- pattern install devel_kernel
- python
- sudo
- libacl-devel
- tftp or tftpd-hpa
- libtasn1-devel
- zlib-devel
- rsync

Optional but recommended packages

- openssh, openssh-clients, openssh-server
- nfs-utils
- ncurses-devel (for the ncurses-based configuration utility)
- libglade2-devel (for the GTK-based graphical configuration utility)
- qt-devel (for the Qt3-based graphical configuration utility)

NOTE

If you are able to compile the Linux kernel on your host machine, you will also be able to build the SDK images. Lantronix highly recommends that the machine also act as an NFS-server.

sudo Configuration

Root permissions are needed for these operations that might need to be performed occasionally:

- installation of additional packages on the host
- configuring the TFTP- and NFS-servers
- creating the target file system so it can be mounted via NFS

If you plan to use the NFS functionality then we recommend making sure that the sudo package is installed. Configure it so your user can run sudo [command] without having to provide root's password. This can be achieved by adding an entry for your login (in the example below: sally) or for one of the groups you belong to (in the example below: adm) to /etc/sudoers. Beware that this might be considered a security risk in your organization.

A sample /etc/sudoers could look like this:

```
# /etc/sudoers
#
# This file MUST be edited with the 'visudo' command as root.
#
# See the man page for details on how to write a sudoers file.
# Host alias specification

# User alias specification

# Cmnd alias specification

# Defaults

Defaults !lecture,tty_tickets,!fqdn

# User privilege specification
root ALL=(ALL) ALL
sally ALL=(ALL) NOPASSWD: ALL

# Members of the admin group may gain root privileges
%adm ALL=(ALL) NOPASSWD: ALL
```

Host TFTP Server Configuration

To transfer files from your host system to the target you may need to setup a TFTP server on your host machine. The following steps describe how to setup a TFTP server on a Fedora based distribution. The details of how to configure this server may vary among platforms. Consult your distribution's documentation for further information.

To run the following commands as root or with sudo:

1. Install the tftp-server package (rpm)

   ```
   yum install tftp-server
   ```

2. Edit /etc/xinetd.d/tftp and change the value of disable to "no".

   ```
   service tftp
   ```

Figure 2-1. Values

```
{
    socket_type    = dgram
    protocol       = udp
    wait           = yes
    user           = root
    server         = /usr/sbin/in.tftpd
    server_args    = -s /tftpboot –c
    disable        = no
    per_source     = 11
    cps            = 100 2
    flags          = IPv4
}
```

3. Restart the xinetd service.

   ```
   service xinetd restart
   ```

CD Contents

Files

Below is a brief description of the files on the CD. Filenames printed in italic are unmodified. All necessary modifications Lantronix has made to make them run better under the µClinux environment are in **uClinux-linux_sdk-patch-R*.tar.gz**.

Table 2-1. CD Files

CD File	Description
Linux_SDK_Release_Notes.txt	release note
install.sh	install script
Makefile	Makefile
freescale-coldfire-*.bz2	cross-compile toolchain from codesourcery
mtd-utils-1.2.0.patch	Memory Technology Device utilities
uClinux-dist-20090618.tar.bz2	uClinux-dist-20090618.tar.bz2
uClinux-dist-20090618-20091129.patch.gz	uClinux-dist-20090618-20091129.patch.gz
uClinux-linux_sdk-patch-R*.tar.gz	Lantronix' collection of modifications to the original files
linux_sdk_host.tar.bz2	SDK host tools
netcon-terminal.tar.bz2	UDP terminal for dBUG network console
avahi-0.6.25.tar.gz	free Zeroconf implementation
axTLS-1.2.4.tar.gz	small SSL enabled webserver
boa-0.94.14rc21.tar.g	small web server
busybox-1.13.3.tar.bz2	collection of Linux utilities optimized for embedded platforms
dropbear-0.52.tar.bz2	small SSH server
iperf-2.0.4.tar.gz	network testing tool
libdaemon-0.14.tar.gz	library that eases the writing of UNIX daemons
libgcrypt-1.4.5.tar.bz2	general purpose cryptographic library
libgpg-error-1.7.tar.bz2	common error values for all GnuPG components
libpcap-1.0.0.tar.gz	network packet capture library
libssh-0.4.0.tar.gz	library to access SSH services
mbus-0.1.2.tar.gz	Modbus/TCP – RTU gateway
mDNSResponder-214.3.tar.gz	mDNS service responder daemon
mii-tool-1.9.1.1.tar.bz2	media-independent interface tool
openssh-5.2p1.tar.gz	SSH module
openssl-0.9.8k.tar.gz	SSL library
tcpdump-3.9.8.tar.gz	packet analyzer

CD File	Description
vipaccess.tar.gz	VIP (virtual IP) Access technology module
Documentation/	Documentations
DeviceInstaller/	Lantronix DeviceInstaller utility
dBUG/	Linux boot loader
jffs2/	files for jffs2 partitioning
scripts/	scripts for build environment
images/	pre-built images for the supported platforms
firmware_update/	files related to firmware upgrades

Pre-built Images

For each supported platform there are 6 pre-built images in **<cdrom directory>/images/<platform>**.

Table 2-2. Pre-built Images

Image	Description
linux.bin	Linux kernel This is just the Linux kernel.
linuz.bin	Compressed Linux kernel This is gzip compressed linux.bin
linux.without_header	linux.bin without header This is for dBUG of Linux SDK 1.0.0.5 or before.
romfs.img	romfs image This is just the romfs image.
image.bin	Linux kernel + romfs. Linux kernel and romfs image
imagez.bin	Compressed Linux kernel + romfs. This is gzip compressed image.bin
image.without_header	image.bin without header This is for dBUG of Linux SDK 1.0.0.5 or before.
rootfs.img	JFFS2 image (full image). This is JFFS2 root filesystem image that built user application directory. It's assumed that this is used without romfs (use linux.bin for kernel).
imageu.bin	Compressed Linux Kernel + uncompressed romfs

Copy these files to your TFTP server directory.(e.g. '/tftpboot/')

Installation

To install software on your host machine:

1. Make sure you can get root access via sudo with your account.
2. Verify if your Linux host distribution automatically mounted the installation CD with:

```
$ mount | grep iso9660
```

- If you see a line similar to:

  ```
  /dev/hdc on /media/CDROM type iso9660 (ro,nosuid,nodev,uid=500)
  ```

  Then the CD is already mounted. Please pay attention to the highlighted options in the brackets behind type iso9660. If it contains noexec, you have to issue the following command to allow the execution of scripts directly from the CD:

  ```
  $ sudo mount -o remount -o exec /media/CDROM
  ```

3. Validate that the noexec flag is gone with:

   ```
   $ mount | grep iso9660
   ```

- If you forget this step you will get an error message like:

  ```
  bash: /media/CDROM/install.sh: /bin/sh: bad interpreter: Permission denied
  ```

- If you have access to the ISO image of the installation CD, then you can mount the ISO file directly with:

  ```
  $ sudo mount -o loop <iso image>.iso <cdrom directory>
  ```

- If you only have the CD use:

  ```
  $ sudo mount -rt isofs9660 /dev/cdrom <cdrom directory>
  ```

4. Choose an <install directory> wherever you want and have write access to. This will also be your development directory.

   ```
   $ cd <install directory>
   ```

   ```
   $ <cdrom directory>/install.sh
   ```

- If you run into an error message like this:

  ```
  bash: /media/CDROM/install.sh: /bin/sh: bad interpreter: Permission denied
  ```

  Then your media was mounted with the noexec option. Please check the previous paragraph carefully about mounting the installation CD.

5. Verify that the following message appears, which indicates that everything is working fine:

   ```
   Install directory [<install directory>] ? (Y/n) : Y
   ```

6. Specify the full path to the <cdrom directory>.

- If you see the questions, do the following:

  ```
  You are using /bin/sh -> dash.
  ```

  ```
  To use Linux SDK, you cannot use /bin/sh -> dash.
  ```

  ```
  Attempt to automatically relink /bin/sh -> bash? (y/N): y
  ```

  ```
  Missing needed host development packages.
  ```

  ```
  Note that sudo privileges are required for installation.
  ```

  ```
  Attempt to automatically install missing packages? (y/N): y
  ```

After the installation your directory structure should look as described in the following section, *Installed Directories*

Installed Directories

```
<install directory>
   |
   |- dBUG/              boot loader binary
   |- Documentation/     documents
   |- host/              host tools
   |- hostsrc/           source code for host tools
   |
   |- linux/             µClinux directory
   |  |- images/         kernel, romfs, and jffs2 images
   |  |- linux-2.6.x/    Linux kernel
   |  |- uClibc          C library
   |  |- user            Applications
   |     |- lantronix    Lantronix applications
   |
   |- pre-built-images/  pre built images
   |- toolchains/        toolchains directory
   |- Makefile           Makefile
   |- env_m68k-uclinux   environment file
```

3. dBUG Boot loader

Introduction

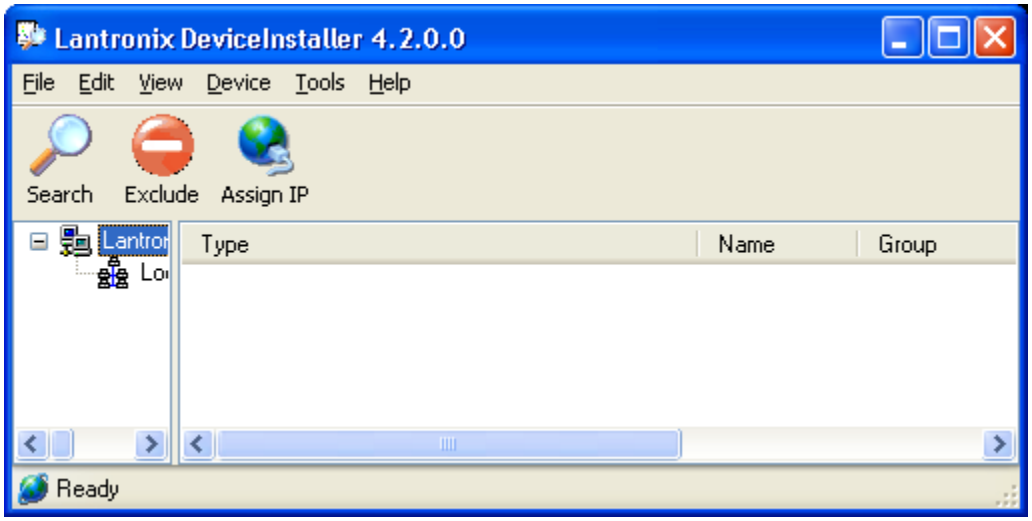
Linux on the supported platform (MatchPort AR, XPort Pro, or EDS1100 / 2100) is loaded through two boot loader stages. The first stage is the Lantronix boot loader, which is present on both the Evolution OS and Linux based products. The Lantronix boot loader is marked as read-only, so it cannot be overwritten accidentally. The second stage is the dBUG boot loader, which is responsible for loading Linux. It also contains options for downloading and flashing new kernel and filesystem images. This section describes dBUG in more detail.

Installing dBUG

The dBUG boot loader comes pre-installed with the Linux development kits. Replacing the boot loader image should not be necessary, but instructions for doing so are given below.

1. Connect an RS232 cable between a Windows PC COM Port (e.g. COM1 for the following steps) and one of serial ports on the target device e.g. MatchPort AR (CON1 on the eval board), XPort Pro (Port A on the demo board), EDS1100 (Serial), or EDS2100 (Serial 1). Close any existing software connections to COM1.
2. Run the Lantronix DeviceInstaller Utility on the Windows computer. The most recent version at the time of publication is provided on the installation CD for your convenience under DeviceInstaller/. The latest version can be downloaded from our Web site: www.lantronix.com/device-networking/utilities-tools/device-installer.

Figure 3-1. DeviceInstaller Window

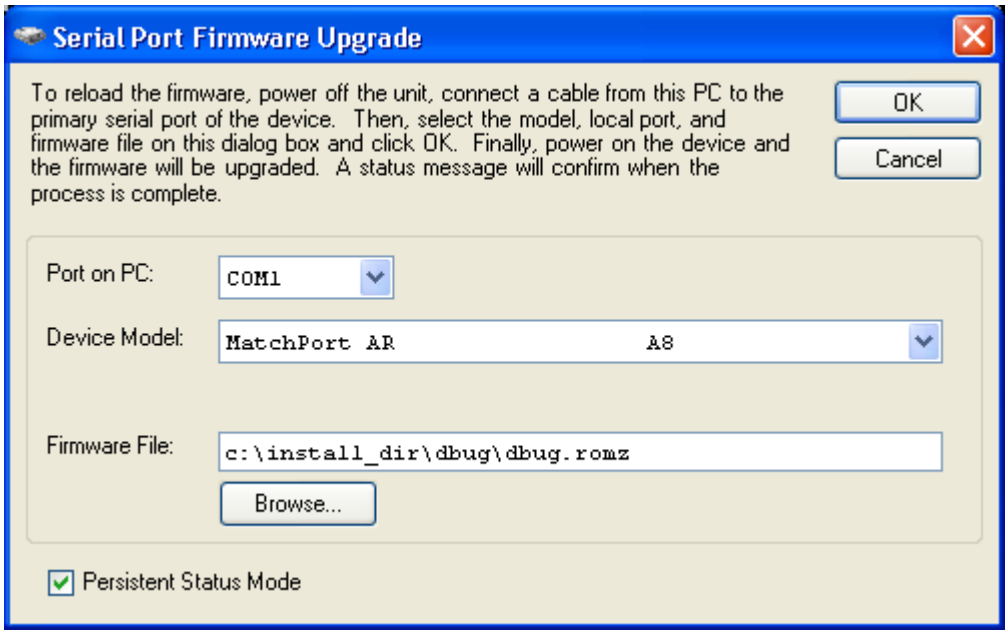


3. From the **Tools** menu, select **Advanced**, then **Recover Firmware**.
4. Set the Port on PC to **COM1**.

5. Set the Device Model to match your embedded module (MatchPort AR, XPort Pro, or EDS1100/2100).
6. Click **Browse** to select the path to the dBUG image file.

   For example, the path for the MatchPort AR would be:
   `c:\install directory>/dBUG/dbug-R<ver>.romz`

Figure 3-2. Firmware Upgrade Window

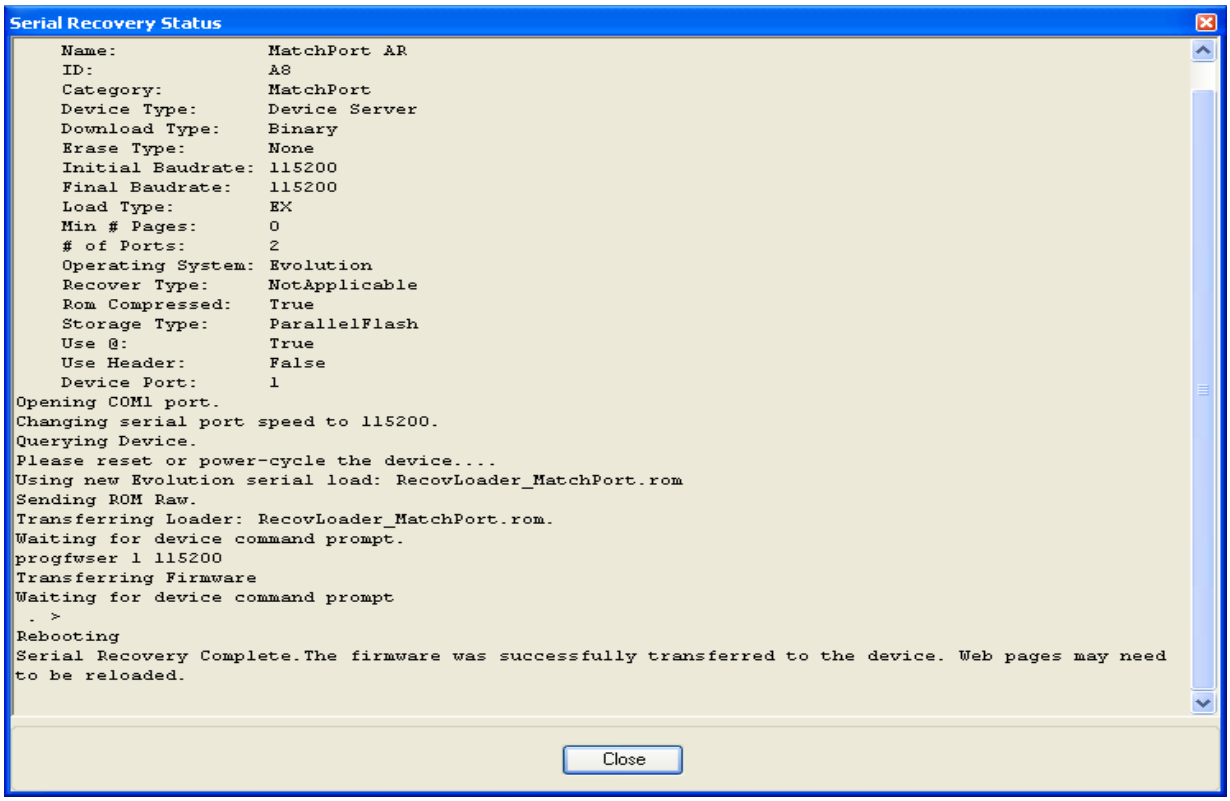


7. Click **OK** and follow the prompts for power cycling the target.

Figure 3-3. Serial Recovery Window

Wait for the firmware transfer to complete.

Figure 3-4. Serial Recovery Status Window Example for a MatchPort AR



8. Click **OK** when prompted. The dBUG boot loader should now be installed on the target.

Figure 3-5. Serial Recovery Results Window

Basic Configuration

1. Connect an RS232 cable between your host computer COM1 and any of the MatchPort AR (CON1 on the eval board), XPort Pro (Port A on the demo board), EDS1100 (Serial), or EDS2100 (Serial 1). Serial port settings are as follows:

   ```
   baud rate: 115200
   data length: 8
   parity: None
   stop bit: 1
   flow control: None
   ```

2. Turn on the target.
3. If autoboot starts, press any key to stop autoboot.

4. At the dBUG> console prompt, configure the dBUG settings. Use the following instructions for configuring dBUG to boot an image containing the kernel and a ROMFS root file system over the network.

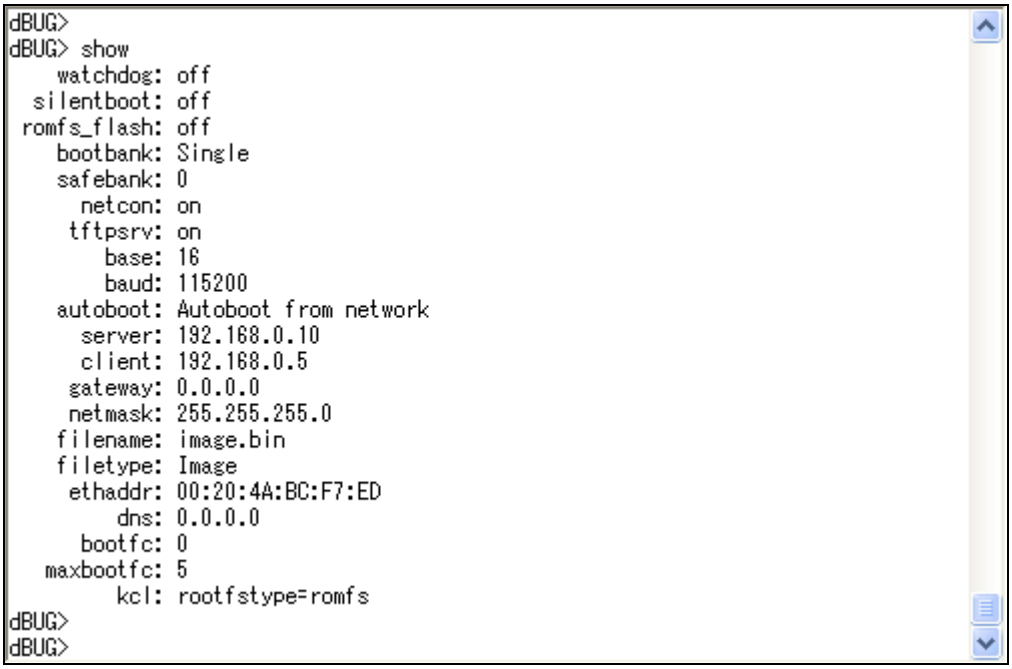
NOTE

A TFTP server with the image.bin file must be configured on the server with the specified address.

```
dBUG> set watchdog off
dBUG> set base hex
dBUG> set baud 115200
dBUG> set autoboot net
dBUG> set server <TFTP server address(e.g. 192.168.0.10)>
dBUG> set client <target IP address(e.g. 192.168.0.1)>
dBUG> set gateway <gateway address(e.g. 0.0.0.0)>
dBUG> set netmask <network mask(e.g. 255.255.255.0]>
dBUG> set filename image.bin
dBUG> set filetype image
dBUG> set ethaddr default
dBUG> set dns <DNS server address(e.g. 0.0.0.0)>
dBUG> set kcl rootfstype=romfs
```

5. Display the dBUG configuration using the 'show' command.

Figure 3-6. dBug Configuration Window



6. Issue a 'reset' at the dBUG prompt for the changes to take effect. Repeat step 3 to get back to the dBUG prompt.
7. Clear the flash space for the JFFS2 partition using the ‘fl e’ command. The command below erases 4MB of flash starting at address 0x00400000. This can be mounted as a JFFS2 partition from Linux.

- For the MatchPort AR or EDS1100 / 2100

```
dBUG> fl e 0x00400000 0x00400000
```

- For the XPort Pro

```
dBUG> fl e 0x00400000 0x00C00000
```

8. Download the firmware image with ‘dn’ and boot Linux using the ‘go’ command. The target should now boot Linux via TFTP.

```
dBUG>dn
dBUG>go
```

Boot Failure Detection

When enabled, the dBUG boot failure counter (bootfc) parameter is incremented each time dBUG starts booting, and reset from within Linux after a successful boot. When Linux fails to boot successfully, bootfc will increment each boot. When bootfc reaches maxbootfc dBUG will stop trying to boot Linux, and will await manual recovery. To enable the boot failure counter, set the maxbootfc parameter to the desired numeric value. Set maxbootfc to 0 or ‘off’ to disable the boot failure counter.

Silent Boot Option

The dBUG silent boot option disables both the display of dBUG boot messages, and the autoboot countdown. To enable the silent booting perform the following:

```
dBUG> set silentboot on
```

When silent boot mode is enabled, it is still possible to break into the dBUG command line. To do so, reset the target unit by cycling the unit's power (turning the power off and back on). Immediately upon resetting the device, enter three ^x (Ctrl+x) characters.

Restoring Ethernet Address

To reset the Ethernet address used by dBUG and Linux back to the factory default setting, perform the following:

```
dBUG> set ethaddr defaults
```

Dual Bank

When dual bank is disabled, Linux can use the entire flash memory for the kernel and root file system.

When dual bank is enabled, flash is divided into two banks. Linux boots using a bank and keeps another bank unused. The second bank is used automatically during a firmware upgrade and provides redundant flash storage space that is useful in recovery scenarios when firmware upgrade fails. For more information about Flash mapping, see Chapter 5 *Flash Partitioning*.

To use dual bank:

1. Disable dual bank.

   ```
   dBUG> set bootbank single
   ```

2. Enable dual bank and use bank 1 as boot bank.

   ```
   dBUG> set bootbank 1
   ```

3. Enable dual bank and use bank 2 as boot bank.

   ```
   dBUG> set bootbank 2
   ```

dBUG Command Summary

Table 3-1. dBug Command Summary

Command	Description
dnfl	download and write a kernel containing image file to flash
dn	download an image file into RAM
fl	write ‘w’ or erase ‘e’ flash
gfl	boot from flash
go	boot from RAM
help	display available commands and their descriptions
set	set dBUG configuration option
show	display dBUG configuration
reset	reset device

dBUG Set Command Options

Table 3-2. dBug Set Command Options

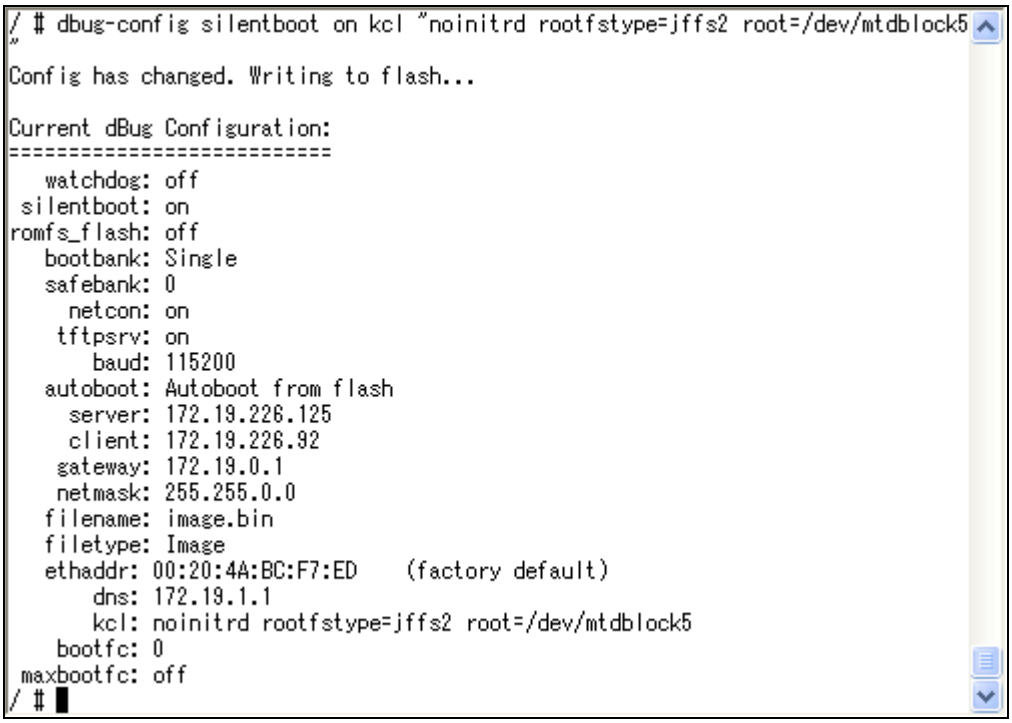
Option	Values	Description
watchdog	on|off	Enable/disable watchdog timer.
silentboot	on|off	Enable/disable dBUG silent booting.
netcon	on|off	Enable/disable netcon (see Netcon section below)
tftpsvr	on|off	Enable/disable TFTP server to allow firmware update pushes
base	hex|dec|bin|oct|unknown	Radix of numerical arguments
baud	9600|19200|38400|…	Serial baud rate.
autoboot	stop|net|flash	Boot source after reset, if any.
server	<host IP>	IP address of TFTP server to load image from.
client	<board IP>	IP address to be used by target. "0.0.0.0" for BOOTP
gateway	<gateway IP>	IP address of gateway (default router).
netmask	<netmask>	Subnet mask to be used by target.

Option	Values	Description
filename	<filename>	File path for image transfer via TFTP.
filetype	<srec|coff|elf|image>	File image type. Only "image" is supported.
ethaddr	<aa:bb:cc:dd:ee:ff>|default	Ethernet MAC address. "default" resets the MAC to factory default.
dns	<dns IP>	IP address of DNS server.
bootfc	reset	Reset boot failure counter
maxbootfc	<count>|0|off	Value of max boot failure count. "0" or "off" to disable.
kcl	<commands>|erase	Kernel command line options.
romfs_flash	on|off	Enable/disable XIP for ROMFS
bootbank	single|1|2	Enable/disable Dual bank
safebank	reset	Firmware upgrade status

dbug-config Linux Utility

The dbug-config program is a Linux utility for viewing and updating the dBUG configuration parameters. To display the current dBUG settings, run dbug-config with no arguments. To change settings run dbug-config with the setting name as the first argument and its new value as the second. Multiple attribute value pairs may be combined with the dbug-config command line. Values containing spaces must be enclosed within double quotes.

Figure 3-7. Output from dbug-config program



Netcon

The netcon network console program allows dBUG console access over the network. This is useful in situations where the device (MatchPort AR, XPort Pro, or EDS1100 / 2100) is remote, or when the console is otherwise unavailable. The path to the netcon client program in the SDK is `<install_directory>/host/usr/sbin/netcon`.

By default the dBUG netcon server is active during the autoboot countdown and when the dBUG shell is active. This includes the failure recovery case where the max boot failure count has been triggered (if maxbootfc is enabled).

To connect to the dBUG netcon server:

4. Issue the following command on the host system.

   ```
   $ netcon <target-ip>
   ```

5. Press **Enter** to get the dBUG prompt. If this does not work, it may be necessary to reset the target, and press enter repeatedly within the netcon client session until the dBUG prompt appears. The netcon program uses the connectionless UDP protocol, which makes it possible for a session to persist across target resets.

6. Press the **ESC** key to exit the netcon session.

Disabling netcon

In some situations it may be desirable to disable netcon access for security reasons.

To disable netcon, issue the following command at the dBUG prompt.

```
dBUG> set netcon off
```

The change will take effect after the next reset. Use 'set netcon on' to re-enable netcon access.

Updating the Target IP Address with netcon

When the target's MAC address is known and its IP address is unknown, it is possible to update the target's IP address using netcon. Note that the host system must be on the same subnet as the target for this to work. The procedure for doing this is given below.

1. Set a static arp entry on the host, associating it's MAC address with the new IP address. Note that the arp syntax may differ depending on the platform. Consult the arp man page on your host machine for the exact syntax

   ```
   $ /sbin/arp -s <new-IP> <target-MAC-address>
   ```

2. Start the netcon client.

   ```
   $ netcon <new-IP>
   ```

3. Power on the target and press the **Enter** key repeatedly within the netcon client session. Once the dBUG prompt appears, the IP address will have been updated. Note that the updated IP will be lost upon a reset unless the 'set client <target-IP>' command is executed to write the new value to flash.

4. Supported File Systems

Introduction

Linux supports a wide range of file systems. Most of them were created with certain characteristics in mind: high performance, reliability, compatibility with other operating systems, general purpose, etc.

Raw flash devices have inherently different characteristics than block devices such as hard drives and USB flash drives:

- Flash areas have to get explicitly erased before they can be overwritten
- Erase blocks, the smallest entities that can be erased on a flash, are usually considerably larger then sectors on hard drives
- Limited number of rewrites (memory wear)

To address these constraints numerous file systems for raw flash devices exist. Among the most popular are:

- ROMFS
- JFFS2
- CRAMFS
- SQUASHFS

ROMFS and JFFS2 are supported in this SDK and described in detail below. Both CRAMFS and SQUASHFS are read-only file systems that support compression. They are not currently supported in this SDK since they are not part of the standard Linux kernel as of version 2.6.30. It should be relatively straightforward for the adventurous to add support for them.

The home page of the maintainers of JFFS2 (www.linux-mtd.infradead.org) provides excellent information about raw flash devices.

ROMFS

What Does ROMFS Offer

ROMFS is the default file system for the µClinux distribution. It is a read-only uncompressed file system with minimal overhead.

The boot loader copies or decompresses the Linux kernel and the ROMFS into RAM (if romfs_flash is disabled) before jumping into the kernel. This has a few implications:

- Since the root file system and the kernel are in RAM they can be easily overwritten on the fly by the firmware update process (unless ROMFS is executed from flash fr).
- Only applications that need to run all the time should be kept in ROMFS because everything consumes valuable RAM space.
- This may compensate easily for the waste of RAM if multiple instances of an application run at the same time.

- ROMFS being a read-only file system, makes it easy to guarantee its integrity during runtime. On the other hand, all variable data like configuration files that might need to be updated during runtime need to be stored on a separate file system.
- All applications in ROMFS can be run with XIP: eXecute In Place (set romfs_flash to on in dBug) – see (www.ucdot.org/article.pl?sid=02/08/28/0434210&mode=thread)

All applications in the distribution get compiled with the XIP flag set by default.

Configure the Boot Loader for ROMFS as Root Partition

To tell µClinux kernel to look for a ROMFS root file system, the kernel command line (kcl) has to be set accordingly. To validate this, boot the target into dBUG and issue the following:

```
dBUG> show

        watchdog:   on
     silentboot:   off
    romfs_flash:   off
       bootbank:   Single
       safebank:   0
         netcon:   on
        tftpsrv:   on
           base:   16
           baud:   115200
       autoboot:   Stop at prompt
         server:   172.19.239.1
         client:   172.19.239.77
        gateway:   172.19.0.1
        netmask:   255.255.0.0
       filename:   /tftpboot/image.bin
       filetype:   Image
        ethaddr:   00:20:4A:80:8C:7E
            dns:   172.19.1.1
         bootfc:   0
      maxbootfc:   off
            kcl:   rootfstype=romfs
```

If kcl is not set to `rootfstype=romfs` it can be fixed by issuing the command

```
dBUG> set kcl rootfstype=romfs
```

and the target will try to mount the ROMFS.

JFFS2

What Does JFFS2 Offer

JFFS2 is a sophisticated writeable log-structured file system that supports wear-leveling. JFFS2 does not support XIP. One disadvantage of having a JFFS2 root file system is that it is extremely difficult to upgrade the firmware from within Linux without sufficient flash space (see Chapter 13 *Firmware Updates*). At minimum, the configuration files should be stored in a separate file system that does not get overwritten by a firmware update.

UBIFS, LogFS, and YAFFS are promising new file systems trying to become the heir to JFFS2. They attempt to resolve many of its shortcomings.

Configure the Boot Loader for JFFS2 as Root Partition

To tell µClinux kernel to look for a JFFS2 root file system, the kernel command line (kcl) has to be set accordingly. To validate this, boot the target into dBUG and issue the following command:

```
dBUG> show
   watchdog: on
       ...
       kcl: rootfstype=romfs
```

If kcl is not set to “noinitrd rw rootfstype=jffs2 root=/dev/mtdblock5” it can be fixed by issuing the command

```
dBUG> set kcl noinitrd rw rootfstype=jffs2 root=/dev/mtdblock5
```

and the target will try to mount its root file system from the JFFS2 partition.

NFS

µClinux comes with support for mounting directories from a remote computer via NFS. This can be very useful in many scenarios:

- To speed up development: mount the development directory on the target from the host to eliminate time consuming manual transfer of the compiled files via ftp or scp.
- To save data permanently (e.g. for logging or backing up data to a server)

Be aware that most sample profiles provided by Lantronix do not include support for NFS to save precious RAM. Depending on the chosen profile, you might have to activate the relevant configuration switches in the Linux kernel:

- CONFIG_NFS_FS
- CONFIG_NFS_V3
- CONFIG_NFS_COMMON
- CONFIG_IP_PNP_DHCP (optional)
- CONFIG_IP_PNP_BOOTP (optional)

NFS as root File System – The Option for Development

Mounting the whole root file system via NFS can be a great time saver. Without it, a typical development cycle would look like this:

1. Make a minor change to an application.
2. Create a new firmware image.
3. Flash it to the device (MatchPort AR, XPort Pro, or EDS1100 / 2100).
4. Reboot.
5. Validate the changes.

Consequently the developer would waste productive time with tedious tasks. Thus, we recommend using the NFS as a root file system during development and debugging. This allows the developer to try out the changes on the device as soon as they are compiled. If none of the core components (kernel and BusyBox) were modified, the target does not even have to be rebooted.

All details can be found in `<install-dir>/linux/linux-2.6.x/Documentation/filesystems/nfsroot.txt`

There are a few onetime steps involved to enable this mode as identified below:

µClinux kernel configuration

`CONFIG_ROOT_NFS` needs to be enabled in the kernel configuration. If a BOOTP or DHCP server is available on your network you might want to enable `CONFIG_IP_PNP_BOOTP` or `CONFIG_IP_PNP_DHCP` as well.

dBUG Configuration

Within dBUG, the kernel command line kcl needs to be set for NFS.

You have 2 options: use a fixed IP address or enable DHCP or BOOTP in the kernel.

- Static IP

For example, if one of the host network cards is configured with an IP of 192.168.3.1 and the SDK is installed under <install-dir>/, then the target IP should be 192.168.3.88. Set the kcl using the following command:

NOTE:

The following code must be entered as one line.

```
dBUG> set kcl noinitrd rw root=/dev/nfs
ip=192.168.3.88:255.255.0.0:192.168.3.1:::eth0
nfsroot=192.168.3.1:<install-dir>/linux/nfs
```

- Dynamic IP

If a DHCP server is running on host, it can be used by performing the following:

1. Enable `CONFIG_IP_PNP_DHCP` in the kernel.
2. Set `kcl noinitrd rw root=/dev/nfs ip=bootp nfsroot=192.168.3.1:<install-dir>/linux/nfs`

NOTE:

The preceding code must be entered as one line.

Host Configuration

In order for the build process to produce a file system that can be mounted via NFS, the developer needs to manually create a directory named 'nfs' in <install-dir>. This is the trigger for the build process to create the NFS-mountable directory structure. The user will also need sudo permissions without having to provide a password as described in Chapter 2: *Installing the SDK*

.

On the host machine, NFS server support needs to be installed and enabled. The `<install-dir>` needs to be made accessible via NFS by explicitly exporting it. This can be done with a line like

```
install-dir>/linux 192.168.0.0/255.255.0.0(rw, no_root_squash,
anonuid=500,anongid=500,insecure,sync,no_subtree_check)
```

in **/etc/exports**

You will need to adjust the IP address and the netmask to match your network configuration. The 500 in the example above should reflect your user id on the host system.

Don't forget to execute "`sudo exportfs -av`" after modifying **/etc/exports**. If you do this the first time, make sure that you can mount the exported file system on your host or a different machine on the same network before trying to boot your MatchPort from it.

Mounting NFS File Systems During Runtime

Client Side Prerequisites

In addition to the basic kernel support for NFS please ensure that the following two options are enabled in your build:

```
CONFIG_USER_BUSYBOX_FEATURE_MOUNT_NFS
CONFIG_USER_PORTMAP_PORTMAP
```

The kernel configuration options `CONFIG_IP_PNP_DHCP and CONFIG_IP_PNP_BOOTP` are not needed for this configuration.

portmap needs to run to support user space NFS mounting. Make sure that it is running or start it like this from the command line:

```
/ # portmap &
```

Consider including the portmap call in a startup script if needed regularly.

AUFS

AUFS is an implementation of the idea to support mounts of several file systems into one single mount point, one overlaying each other. This might be used to cleanly separate read-only data from variable data.

We included a snapshot of AUFS into the kernel for your convenience. To see how this can be utilized, refer to Chapter 5 *Flash Partitioning*.

5. Flash Partitioning

Intro to Partitioning

The idea of partitioning is to optimize the usage of the available flash space to meet your requirements. A Linux file system encompasses many files with different characteristics. There are binaries and data files. Some of them are crucial for the operation of the system all the time, while some need to be available in certain conditions only. Most files do not need to (and must not) be modified, some files are important, but variable (e.g. persistent configuration files) and then there are temporary files like logs.

Linux supports these requirements by letting the user mount different file system types into one file system tree. Some of them were described in the previous chapter.

Ideally all crucial static files should reside on a compressed read-only file system, nice to have ones on a separate read-only file system so they can be updated independently, variable files on a compressed write-enabled file system, and volatile files on a RAM disk.

This luxury comes at a price:

- Each supported file system type costs scarce RAM
- Managing different file systems on one flash chip is not trivial - what do you do when file system sizes have to be adjusted to accommodate the space requirements of a new firmware version?

Depending on the requirements of your application you will have to make your choice between the various tradeoffs. To keep things reasonably simple, but still extensible, we went with a rather minimalist default flash layout.

Dual Bank

Flash Partitioning depends on the Dual Bank setting of dBUG (single|1|2).

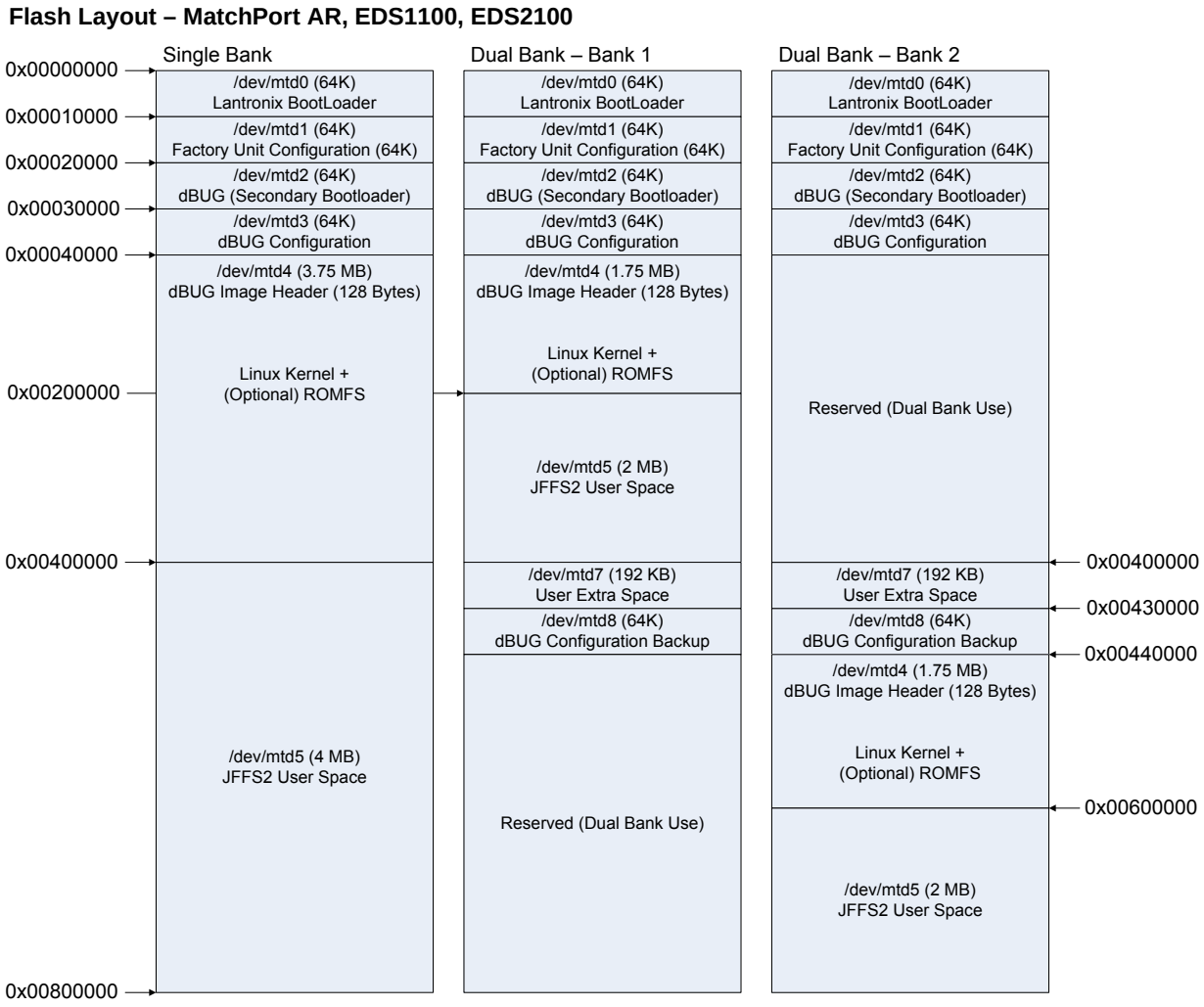
When using flash in a single bank configuration, Linux can use the entire flash memory for kernel and root file system.

When using flash in a dual bank configuration, the flash space is divided into two banks. Linux boots using one bank and keeps another bank unused. The bootbank parameter of dBUG specifies the bank to be used.

Default Flash Memory Map for MatchPort AR, EDS1100, and EDS2100

The following figure shows the flash layout as it is hard-coded in the Linux kernel.

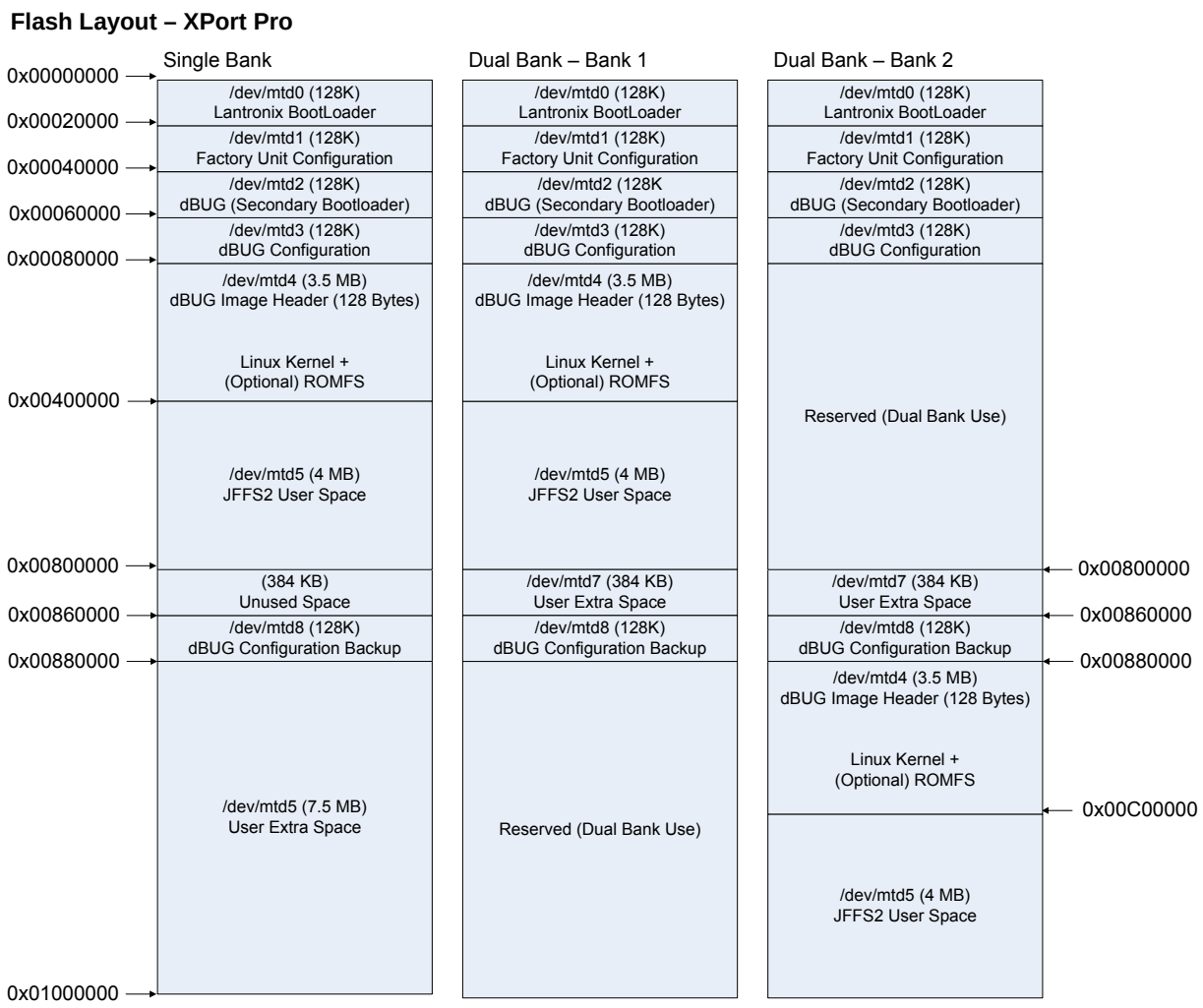
Figure 5-1. Flash Layout – MatchPort AR, EDS1100, and EDS2100



Default Flash Memory Map for XPort Pro

The following figure shows the flash layout as it is hard-coded in the Linux kernel.

Figure 5-2. Flash Layout – XPort Pro



You can easily make adjustments to better fit your needs. Partition sizes and locations that should not be altered are the first 4 flash areas. They are essential to be able to boot and configure the Linux kernel. Additional partitions can be added, and existing ones can be increased or shrunk (e.g. to adjust the space reserved for the kernel and ROMFS).

Please keep in mind, that some of the utilities like dbug-config and firmware update depend on the partition names and won't work anymore if you rename the partitions without adjusting those utilities.

The partition definitions can be found in *linux-2.6.x/drivers/mtd/maps/m520x.c:*

```
static struct mtd_partition m520x_partitions_including_kernel[] = {
        {
                .name   = "LTRXbloader",
                .size   = 0x10000,
                .offset = 0x0,
                .mask_flags   = MTD_WRITEABLE   /* force read-only */
```

```
        },
        {
                .name   = "LTRXconfig",
                .size   = 0x10000,
                .offset = MTDPART_OFS_NXTBLK,
                .mask_flags   = MTD_WRITEABLE   /* force read-only */
        },
        {
                .name   = "dBug",
                .size   = 0x10000,
                .offset = MTDPART_OFS_NXTBLK,
                .mask_flags   = MTD_WRITEABLE   /* force read-only */
        },
        {
                .name   = "dBugConfig",
                .size   = 0x10000,
                .offset = MTDPART_OFS_NXTBLK,
        },
        {
                .name   = "Kernel",
                .size   = (DEFAULT_FLASH_SIZE / 2) - 0x40000,
                .offset = MTDPART_OFS_NXTBLK,
                .mask_flags   = MTD_WRITEABLE   /* force read-only */
        },
};

static struct mtd_partition m520x_romfs_in_flash_partition[] = {
        {
                .name   = "Romfs",
                .size   = 0,  /* needs to be adjusted dynamically */
                .offset = 0,  /* needs to be adjusted dynamically */
                .mask_flags   = MTD_WRITEABLE   /* force read-only */
        },
};

static struct mtd_partition m520x_partitions_after_romfs[] = {
        {
                .name   = "UserSpace",
                .size   = MTDPART_SIZ_FULL,   // gets overwritten below
                .offset = MTDPART_OFS_NXTBLK
        },
        {
                .name   = "WritableFlash",
                .size   = MTDPART_SIZ_FULL,
                .offset = 0x40000
        }
#ifdef CONFIG_MTD_RECOVER_PARAMS
        ,
        {
                .name   = "UserExtra",
                .size   = 0x30000,
                .offset = 0x400000  // gets overwritten below
        },
        {
                .name   = "dBugConfBackup",
                .size   = 0x10000,
                .offset = 0x430000  // gets overwritten below
```

```
        }
#else /* CONFIG_MTD_RECOVER_PARAMS */
#ifdef CONFIG_MTD_BOOT_BANK
        ,
        {
                .name   = "UserExtra",
                .size   = 0x40000,
                .offset = 0x400000  // gets overwritten below
        }
#endif /* CONFIG_MTD_BOOT_BANK */
#endif /* CONFIG_MTD_RECOVER_PARAMS */
};
```

kernel + ROMFS root + blank JFFS2

This is the easiest deployable configuration available. The build process creates a ROMFS from the root file system and appends the Linux kernel to it. This layout is supported in two variations - both are created in the images/ directory per default:

- Uncompressed: image.bin (dBUG copies the image (a concatenation of kernel and ROMFS) from flash to RAM)
- Compressed: imagez.bin (dBUG uncompresses the compressed image (a concatenation of kernel and ROMFS) from flash to RAM)

Both files contain a small header for dBUG with a checksum and the destination address for the image in RAM.

The advantage of copying the ROMFS image into RAM is that the flash area where it resides on can be easily overwritten during a firmware update without interrupting normal operation of the device since the changes won't come into effect until after the next reboot.

The provided startup script (<install-dir>/linux/linux-2.6.x/drivers/mtd/maps/m520x.c) tries to mount the JFFS2 file system (/dev/mtd5) under /mnt/flash. Modify the script accordingly if you want to use this flash area for other purposes (e.g. splitting it up into multiple partitions).

To convert a unit from any other flash layout to this layout:

1. Boot into dBUG and issue these commands (assuming that the network settings are properly configured, your TFTP server on your hosts is configured to serve files from /tftpboot and make copied the images in that location:

```
dBUG> dnfl /tftpboot/image.bin
or
dBUG> dnfl /tftpboot/imagez.bin
Address: 0x4001FF80
Downloading Image 'imagez.bin' from 172.19.239.1
TFTP transfer completed
Read 1255499 bytes (2453 blocks)
Must erase complete sectors (0x00080000 to 0x001BFFFF)
Continue (yes | no)? yes
.....................
Flash Erase complete. 0x140000 bytes erased
Program successfully flashed...
```

2. Validate that the kernel command line is set to rootfstype=romfs:

```
dBUG> show
   watchdog:  on
 silentboot:  off
romfs_flash:  off
   bootbank:  Single
   safebank:  0
     netcon:  on
    tftpsrv:  on
       base:  16
       baud:  115200
   autoboot:  Stop at prompt
     server:  172.19.239.1
     client:  172.19.239.77
    gateway:  172.19.0.1
    netmask:  255.255.0.0
   filename:  /tftpboot/image.bin
   filetype:  Image
    ethaddr:  00:20:4A:80:8C:7E
        dns:  172.19.1.1
     bootfc:  0
  maxbootfc:  off
        kcl:  rootfstype=romfs
```

3. Otherwise issue:

```
dBUG> set kcl rootfstype=romfs
```

4. Initialize/Erase the JFFS2 file system with:

   For all platforms (Single bank configuration)

```
dBUG> fl e 0x00400000 0x00400000
```

5. And run the freshly installed new kernel + ROMFS with:

```
dBUG> gfl
```

kernel + ROMFS root, preserving the JFFS2 partition

This configuration is almost identical to the previous one except that the JFFS2 area does not get touched. It is also the default configuration of the original µClinux distribution.

Follow the same steps as in the previous chapter but omit the flash erase command:

For all platforms (Single bank configuration)

```
dBUG> fl e 0x00400000 0x00400000
```

kernel + JFFS2 root

This configuration is intended to free up RAM for applications that require a considerable amount of memory (e.g. ssh, tcpdump). These applications cannot be run from a ROMFS configuration. One downside is that is very hard to implement a reliable firmware upgrade process for this flash layout. It is also more prone to file system corruption of important files then ROMFS, since everything is stored on a single write-enabled partition.

On a MatchPort AR it would look like this:

1. Download and flash the kernel image (you can use either linux.bin or the compressed version linuz.bin)

```
dBUG> dnfl linux.bin
Address:  0x4001FF80
Downloading Image 'linux.bin' from 172.19.39.1
TFTP transfer completed
Read 1605760 bytes (3137 blocks)
Must erase complete sectors (0x00040000 to 0x001CFFFF)
Continue (yes | no)? yes
......................
Flash Erase complete. 0x190000 bytes erased
Program successfully flashed...
```

2. Download and flash the jffs2 root image to its default location 0x400000. This has to be done in two steps. First download the JFFS2 partition image into RAM. dBUG always loads files to this address: 0x4001FF80. Then that RAM area can be flashed to the destination address in FLASH.

```
dBUG> dn rootfs.img
Address:  0x4001FF80
Downloading Image 'rootfs.img' from 172.19.39.1
TFTP transfer completed
Read 4194304 bytes (8193 blocks)
For all platform (Single bank)
dBUG> fl w 0x00400000 0x4001FF80 0x400000
..............................................................
Flash Write complete. 0x400000 bytes written
```

3. Validate that the kernel command line is set to noinitrd rw rootfstype=jffs2 root=/dev/mtdblock5

```
dBUG> show
    watchdog:  on
...
       kcl:  noinitrd rw rootfstype=jffs2 root=/dev/mtdblock5
```

```
Otherwise issue:
dBUG> set kcl noinitrd rw rootfstype=jffs2 root=/dev/mtdblock5
And run the freshly installed new kernel + ROMFS with
dBUG> gfl
```

kernel + ROMFS root + JFFS2 + AUFS

This variation is created when you use the AUFS profile. The instruction to get the resulting files on the flash are identical to the ones described in the “kernel + ROMFS root + blank JFFS2” section.

One area where this feature might be very handy is configuration files. Just think of storing a static ip address for the device. Since the end user should be able to assign a static IP to the device, it needs to be stored on persistent storage. The problem is that /etc resides on a read-only file system. There are 3 possible solutions to this approach:

- Put /etc on a writeable file system - this was the approach taken in the previous section.
- Create a symbolic link for /etc/netcfg to a different file system that is write-enabled - that approach is used by the ROMFS + JFFS2 file system layouts.
- Use a stackable file system like AUFS

Let's look into the last solution.

Here we create /etc on our ROMFS partition. But we overlay /etc with a write-enabled JFFS2 partition. That means that Linux can use the files from ROMFS unless there is a version of the same file stored in the corresponding directory on the JFFS2 partition. For applications it looks like /etc is a regular write-enabled file system. But the big difference to the JFFS2 only solution we discussed in a previous section is that we always have a known good configuration in ROMFS to which can reverted to if something goes wrong with the JFFS2 partition. By omitting the overlay mount and since configuration and applications are cleanly separated, a firmware update is now possible.

Let's assume we have mounted our JFFS2 partition under /usr/local.

```
mkdir /etc.romfs
mount -o rebind /etc /etc.romfs
```

This allows access to the files that are really on the ROMFS partition in /etc via /etc.romfs.

```
[ -d /usr/local/etc ] || mkdir /usr/local/etc
mount -t aufs -o br:/usr/local/etc:/etc.romfs none /etc
```

From now on all changes made to files in /etc are actually written to /usr/local/etc.

This is exactly how the aufs profile is implemented. It can be found in <install-dir>/linux/linux-2.6.x/drivers/mtd/maps/m520x.c

This approach could be easily extended to overlap /bin for example. The ROMFS partition could include all absolutely essential software and additional applications could be stored in a separate partition. Even more layers are thinkable (JFFS2 on top of CRAMFS on top of ROMFS)

Custom Layout

It is possible to customize the flash layout by writing the image files to the desired addresses, and modifying the kernel command line options appropriately. But the recommended approach is to adjust <install-dir>/linux/linux-2.6.x/drivers/mtd/maps/m520x.c and recompile the kernel.

Let's assume you want an image consisting of the kernel followed by a JFFS2 root partition that uses all available flash space. Perform the following steps:

1. Download and flash the kernel image

```
dBUG> dnfl linux.bin
Address:  0x4001FF80
Downloading Image 'linux.bin' from 172.19.39.1
TFTP transfer completed
Read 1396736 bytes (2729 blocks)
Must erase complete sectors (0x00040000 to 0x0019FFFF)
Continue (yes | no)? yes
.....................
Flash Erase complete. 0x160000 bytes erased
Program successfully flashed...
```

2. Determine the address where the jffs2 image will go to.

   Since the dnfl command output from step 1 shows that the kernel was written to 0x001CFFFF, we will have to write the jffs2 image past this address. Note that the address must be at the start of a flash erase block. Flash erase blocks are 64KB (128KB on XPort Pro). In this example, the minimum address we can use would be 0x00200000, though in many cases it is a good idea to leave extra room for future upgrades of the kernel. For now we'll just use 0x00200000.

3. The default size for the JFFS2 file system is 4MB. It is hard-coded in <install-dir>/linux/vendors/Lantronix/<platform>/config.arch. Since we have 6MB available, we want to make use of it. Look for the lines:

```
JFFS2_SIZE            = 0x400000
in Config.arch and adjust the JFFS2_SIZE to 0x600000.
```

   You need to rebuild rootfs.img to honor the last change. This can be achieved by just typing make under linux/

4. Download and flash the jffs2 root image. The starting address used here is 0x00200000, but it will vary depending on the feature set enabled in the kernel. The size of the jffs2 image used here is 6MB.

```
dBUG> dn rootfs.img
Address:  0x4001FF80
Downloading Image 'rootfs.img' from 172.19.39.1
TFTP transfer completed
Read 6291456 bytes (12289 blocks)
For all platforms
dBUG> fl w 0x00200000 0x4001FF80 0x600000
.............................................................
Flash Write complete. 0x600000 bytes written
```

5. Since you have decided not to change the partition layout in the kernel source (maybe changing the kernel source would require intensive testing of the whole kernel again), the mptpart kernel command line option can be used to overwrite the partition scheme that is hard coded in the kernel.

   To do this we will need to determine the sizes in KB of the kernel and jffs2 partitions. The size of the kernel partition here is 0x1C0000 bytes (0x180000 bytes on XPort Pro), which works out to be 1792KB (1536KB on XPort Pro). The size of the jffs2 partition is 0x600000 bytes (6144KB). Note that a flash partition may be larger than its corresponding image because they must begin and end on flash erase block boundaries.

   ```
   For MatchPort AR or EDS1100 / 2100

   dBUG> set kcl noinitrd rw rootfstype=jffs2 root=/dev/mtdblock5
   mtdparts=mpt:64k(LTRXbloader),64k(LTRXconfig),64k(bootloader),64k(dB
   ugConfig),1792k(kernel),6144k(jffs2)


   For XPort Pro

   ‘dBUG> set kcl noinitrd rw rootfstype=jffs2 root=/dev/mtdblock5
   mtdparts=mpt:128k(LTRXbloader),128k(LTRXconfig),128k(bootloader),128
   k(dBugConfig),1536k(kernel),6144k(jffs2)
   ```

6. And run the freshly installed new kernel + ROMFS with:

   ```
   dBUG> gfl
   ```

Further details about the mtdparts kcl option can be found in (<install-dir>/linux/linux-2.6.x /drivers/mtd/cmdlinepart.c)

6. Building µClinux

Configuration Profiles

Configuration profiles are used to configure the µClinux initial settings. The actual differences between the provided profiles are very subtle. They differ mostly in the number of applications that get activated and a few kernel settings. We highly encourage the user to compare them with each other and make necessary adjustments. A profile is selected during the initial make of µClinux but can be exchanged any time.

The profiles are located under **<install_directory>/linux/vendor/Lantronix/<platform>/profile/<profile-name>**.

A table describing these profiles is given below.

Table 6-1. Configuration Profiles

PROFILE	ROMFS	JFFS2	NFS	IPv6	BUSYBOX
default	yes	yes	no	yes	normal
compact	yes	yes	no	no	compact
no_ipv6	yes	yes	no	no	normal
develop	yes	yes	yes	yes	normal
aufs	yes	yes	root only	no	normal
shared	yes	yes	no	yes	normal

The configuration profiles are comprised of the following files:

```
config.linux-2.6.x configuration file for the Linux kernel
config.uClibc configuration file for uClibc
config.vendor-2.6.x configuration file for user applications
```

The developer will be prompted to select a profile during the initial make. The profile can be changed later with the following commands:

```
$ cd <install-dir>
$ make config
...
Configuration Profile
> 1. DEFAULT (LTRX_PROFILE_DEFAULT) (NEW)
  2. DEVELOPMENT (LTRX_PROFILE_DEVELOP) (NEW)
  3. NO_IPV6 (LTRX_PROFILE_NO_IPV6) (NEW)
  4. COMPACT (LTRX_PROFILE_COMPACT) (NEW)
  5. AUFS (LTRX_PROFILE_AUFS) (NEW)
  6. SHARED (LTRX_PROFILE_SHARED) (NEW)
choice[1-6?]:
...
Default all settings (lose changes) (DEFAULTS_OVERRIDE) [N/y] (NEW)y
```

Kernel and Application Options

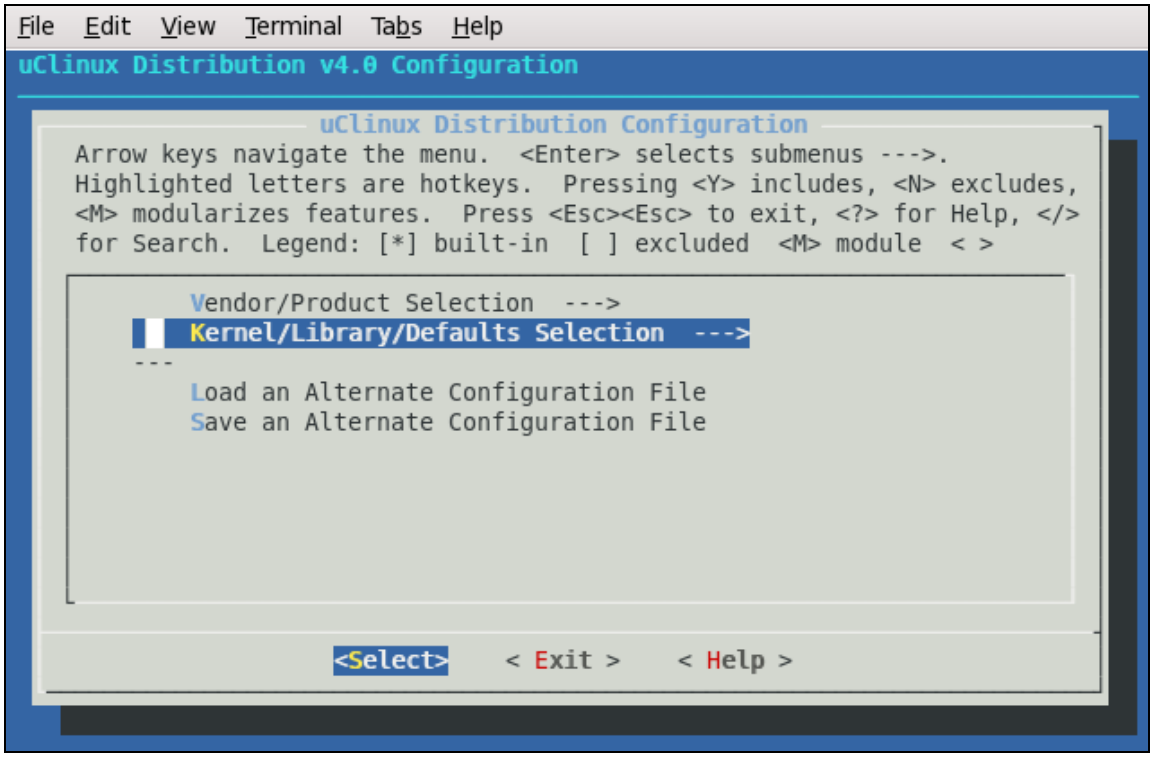
The simplest way to modify the kernel and/or application options or switch to a different profile is to run one of these commands from the installation directory.

Command	Interface Type
`make menuconfig`	`ncurses/terminal window`
`make xconfig`	`graphical GTK`
`make qconfig`	`graphical QT3 (does not work to change kernel)`

Although the look and feel for these options differ, they are identical in functionality.

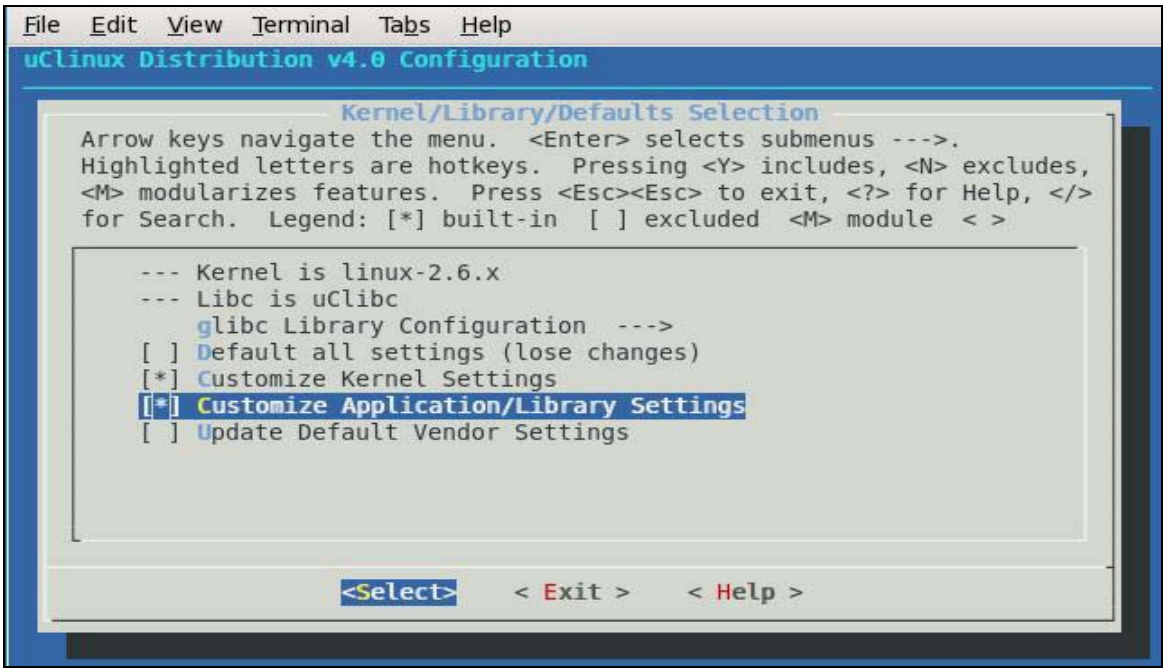
1. Select **Kernel/Library/Defaults Selection** and press **Enter**.

Figure 6-1. uClinux Kernel/Library/Defaults Window



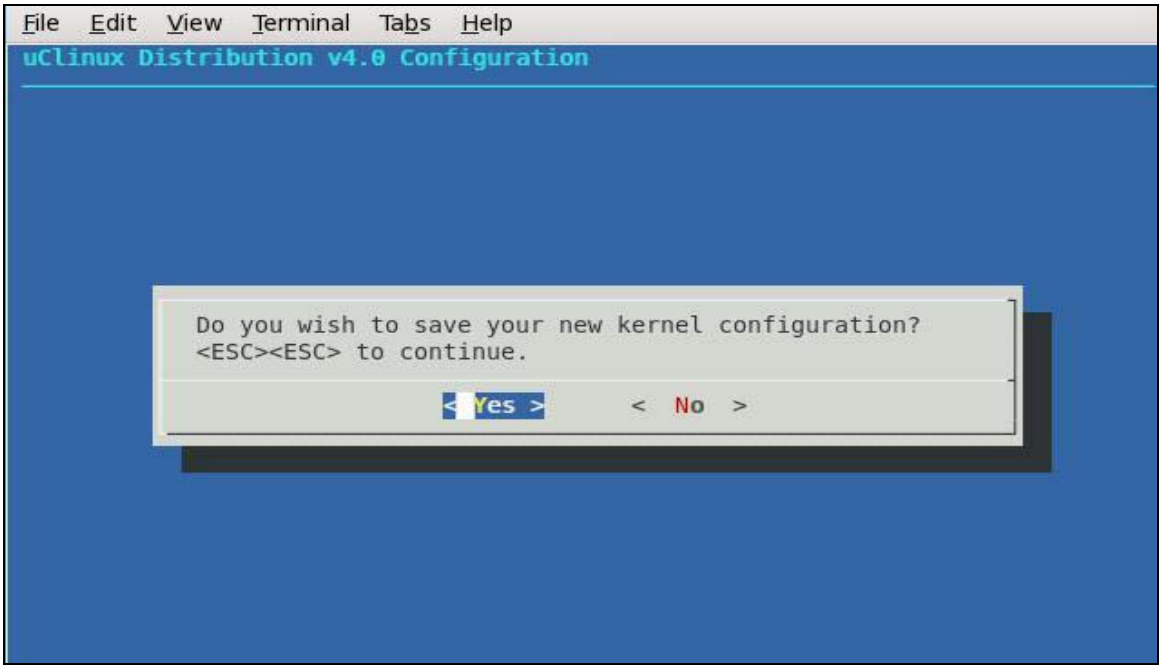
2. To modify the kernel settings, select **Customize Kernel Settings**, and press **Y** to include features.
3. Repeat this step for **Customize Application/Library Settings** as desired.

Figure 6-2. uClinux Customize Application/Library Settings Window



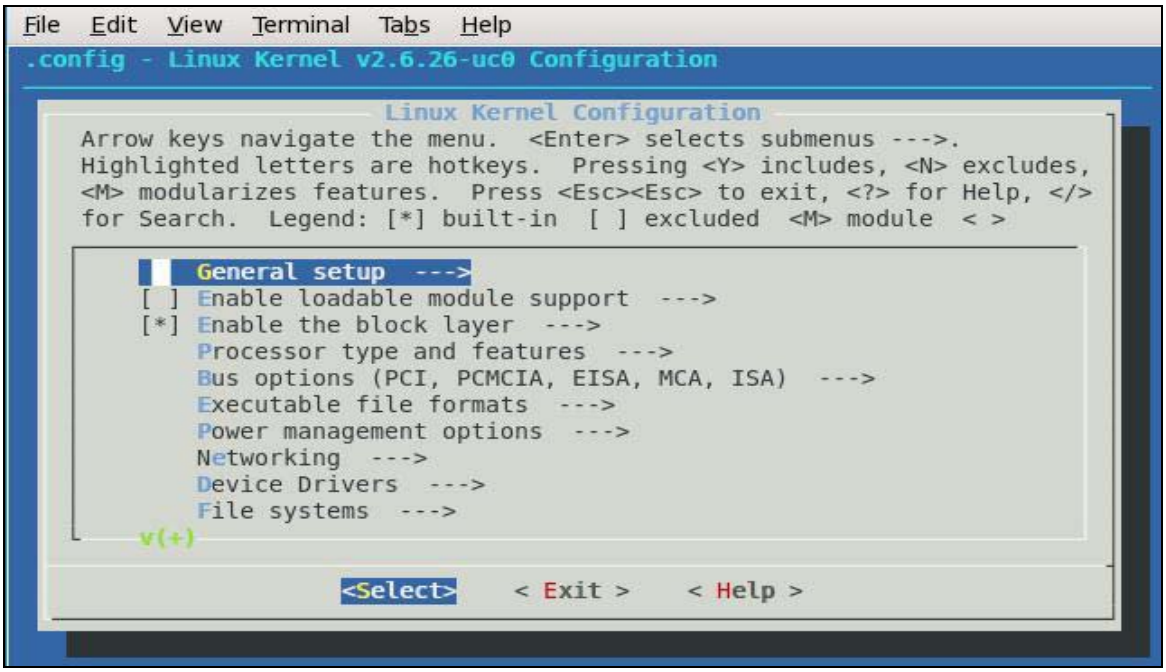
4. At the bottom of the screen, select **Exit** and press **Enter**. Repeat this process for the parent window.
5. When prompted to save your new kernel configuration, select **Yes** and press **Enter**.

Figure 6-3. uClinux Save Configurations Window



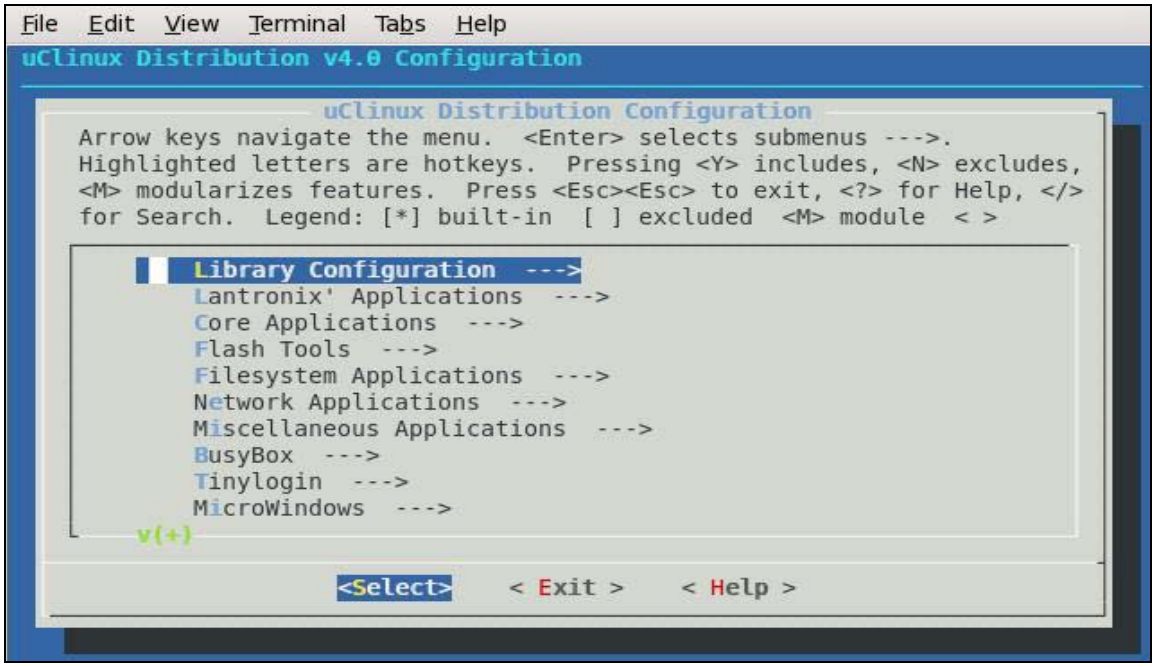
6. To customize the kernel selected earlier, navigate to the kernel configuration and enable or disable the desired options. When finished, select **Exit** and press **Enter**.

Figure 6-4. uClinux Save Configurations Window



7. To customize the application/library settings selected earlier, navigate through the configuration the menu and enable or disable the desired options. When finished, select **Exit** and press **Enter**.

Figure 6-5. uClinux Distribution Configuration Window



8. Once the configuration options are updated, execute the make command to rebuild µClinux.

Building

To build images, perform the following on the development host:

```
$ cd <install directory>
$ . env_m68k-uclinux
$ make
…
Vendor
> 1. Lantronix (DEFAULTS_LANTRONIX) (NEW)
choice[1]: 1
*
* Select the Product you wish to target
*
Lantronix Products
> 1. XPort_Pro (DEFAULTS_LANTRONIX_XPORT_PRO) (NEW)
  2. MatchPort_AR (DEFAULTS_LANTRONIX_MATCHPORT_AR) (NEW)
  3. EDS2100 (DEFAULTS_LANTRONIX_EDS2100) (NEW)
  4. EDS1100 (DEFAULTS_LANTRONIX_EDS1100) (NEW)
choice[1-4]: 1
Configuration Profile
> 1. DEFAULT (LTRX_PROFILE_DEFAULT) (NEW)
  2. DEVELOPMENT (LTRX_PROFILE_DEVELOP) (NEW)
  3. NO_IPV6 (LTRX_PROFILE_NO_IPV6) (NEW)
  4. COMPACT (LTRX_PROFILE_COMPACT) (NEW)
  5. AUFS (LTRX_PROFILE_AUFS) (NEW)
  6. SHARED (LTRX_PROFILE_SHARED) (NEW)
choice[1-6?]: 1
*
* Kernel/Library/Defaults Selection
*
*
* Kernel is linux-2.6.x
*
*
* Libc is uClibc
*
*
```

```
* glibc Library Configuration
*
Default all settings (lose changes) (DEFAULTS_OVERRIDE) [N/y] (NEW)
Customize Kernel Settings (DEFAULTS_KERNEL) [N/y] (NEW)
Customize Application/Library Settings (DEFAULTS_VENDOR) [N/y] (NEW)
Update Default Vendor Settings (DEFAULTS_VENDOR_UPDATE) [N/y] (NEW).
…
```

And then these images are made in the linux/images directory.

```
$ ls linux/images
image.bin image.without_header linux.bin linuz.bin romfs-inst.log
imageu.bin imagez.bin linux.without_header romfs.img rootfs.img
```

To make the images available for transfer to the target, copy the contents of the linux/images/ directory to your tftp boot directory. Your tftp boot directory must have write permissions enabled. The following example assumes a tftp boot directory of '/tftpboot'.

```
$ cp linux/images/* /tftpboot
```

It is possible to have the build process automatically copy the image files to your tftp boot directory. To enable this, edit linux/vendors/Lantronix/<platform>/Makefile and set the TFTP_DIRECTORY variable to your tftp boot directory, and the COPY_BUILD_TO_TFTP_DIRECTORY variable to 'y'.

```
COPY_BUILD_TO_TFTP_DIRECTORY=y
TFTP_DIRECTORY=<your_tftp_boot_directory>
```

To build the root file system for NFS, perform the following:

```
$ mkdir linux/nfs
$ make
```

7. µClinux Startup Scripts

Introduction

Various startup scripts are called during the Linux boot process. These initialization files are found in the build environment under
<install directory>/linux/vendors/Lantronix/<platform>/romfs_extra/.

Edit them as appropriate.

/etc/inittab

The /etc/inittab file controls the configuration for the init process. It is here that the various startup and shutdown scripts are configured, and the console device is specified. The default /etc/inittab file is setup so that /etc/init.d/rcS will be called at startup.

/etc/init.d/rcS

The /etc/init.d/rcS script is responsible for mounting the target's file systems, and calling the next stage of initialization scripts.

/etc/start

The /etc/start script is called by /etc/init.d/rcS. It calls the /etc/netstart script to initialize networking, and various other scripts if they are present. It also calls dBUG-config to reset the boot failure counter which was previously incremented by dBUG.

8. µClinux Networking

Introduction

µClinux supports a full TCP/IP networking stack. Several networking protocols are supported through the kernel and various shell utilities. Networking is initialized on the target through the /etc/netstart script.

DHCP

The target can obtain an IP address automatically through the DHCP protocol. Two DHCP clients are supported, udhcpc and dhcpcd. Udhcpc is included as part of busybox and takes up less flash and RAM space. Dhcpcd is a standalone program with more options than udhcpc. The /etc/netstart script will attempt to start whichever one is present, starting with udhcpc. Select the client that best suits your needs.

Static Address Configuration

By default Linux will attempt to get an IP address through DHCP. To set a static address, perform the following steps on the target:

1. Use the vi text editor to create and edit **/etc/netcfg**. Note that by default **etc/netcfg** is a symlink to **/usr/local/etc/netcfg**. You can either delete this symlink and create **/etc/netcfg**, or make sure that the path to **/usr/local/etc/netcfg** exists.
2. Add lines to /etc/netcfg as follows:

   IPADDR=<target_ip>

   NETMASK=<target_netmask>

   GATEWAY=<target_gateway>
3. Reboot the target for the changes to take effect.

NOTE:

The static address in the dBUG configuration will also be updated during the reboot.

DNS

The target supports name resolution via the DNS protocol. The DNS configuration is found in **/etc/resolv.conf**.

inetd

The inetd program listens for connections to network services such as telnet, ftp, and ssh. The /etc/inetd.conf configuration file specifies the ports to listen to, and their associated programs. The mapping of network port numbers to names is found in /etc/services.

telnetd

The telnet daemon allows for shell connections over the network. Note that telnet sessions are not encrypted.

ftpd

The ftp daemon waits for connections using the File Transfer Protocol (FTP). The FTP protocol allows for copying files to and from the target.

dropbear

The dropbear program is a small footprint SSH server and client. The SSH protocol allows for secure shell connections over the network.

axhttpd

The axhttp daemon is a small footprint web server that is part of the axTLS package. It includes support for SSL encrypted sessions.

mii-tool

The mii-tool program allows for viewing and modifying the Ethernet port's speed and duplex settings.

ifconfig

The ifconfig command allows for viewing the target's IP address, subnet mask, and MAC address. It can also be used to configure the IP address and subnet mask at runtime. Changes made by ifconfig will not be preserved across a system reboot.

mDNSResponder

The mDNSResponder daemon is a service that implements Multicast DNS Service Discovery for discovery of services on the local network. It enables you to find your device (e.g. XPort Pro) if you don't know the IP address.

9. BusyBox

Intro to BusyBox

The busybox command incorporates the functionality of several common Linux utilities into a single binary file. The utilities have been optimized for space by supporting fewer options. Flash and RAM space have also been saved by eliminating the overhead of having multiple binary files. Symbolic links to the busybox program are used in place of the utility binaries, as busybox uses the calling link to determine which command to invoke.

Enabling/Disabling Utilities

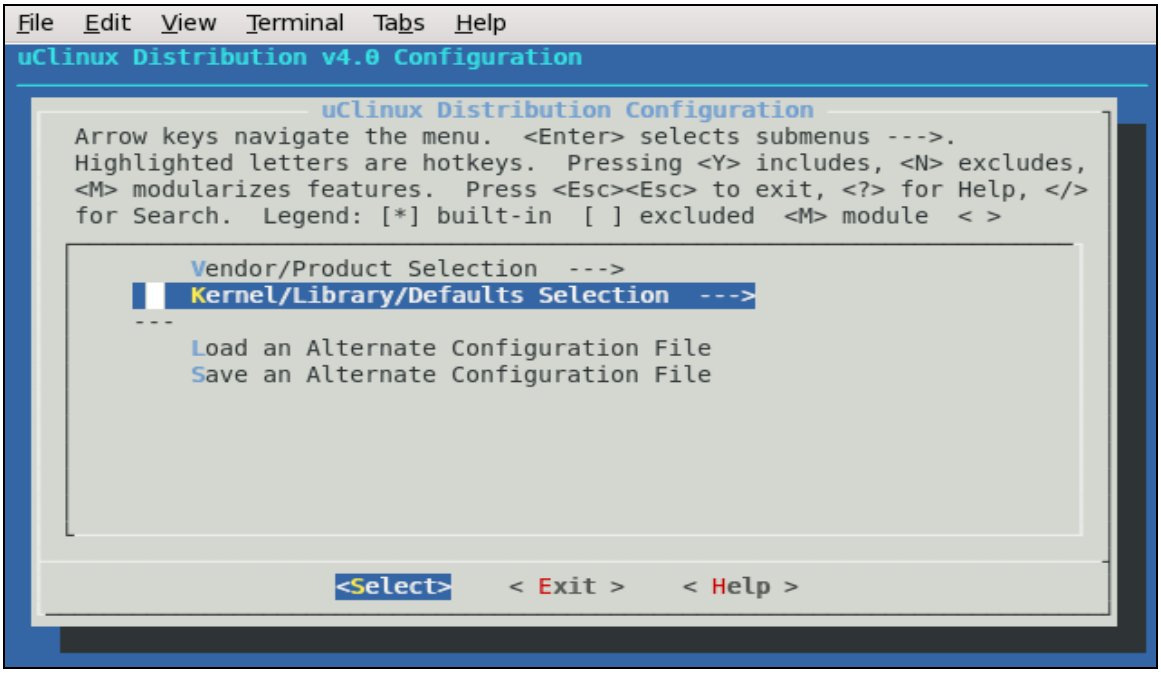
The simplest way to modify the list of utilities included by busybox is to run one of these commands from the installation directory:

- Make menuconfig (# for a ncurses/terminal window based configuration tool)
- Make xconfig (# for a graphical GTK based configuration tool)
- Make qconfig (# for a graphical QT3 based configuration tool)

Although the look and feel for these options differ, they are identical in functionality.

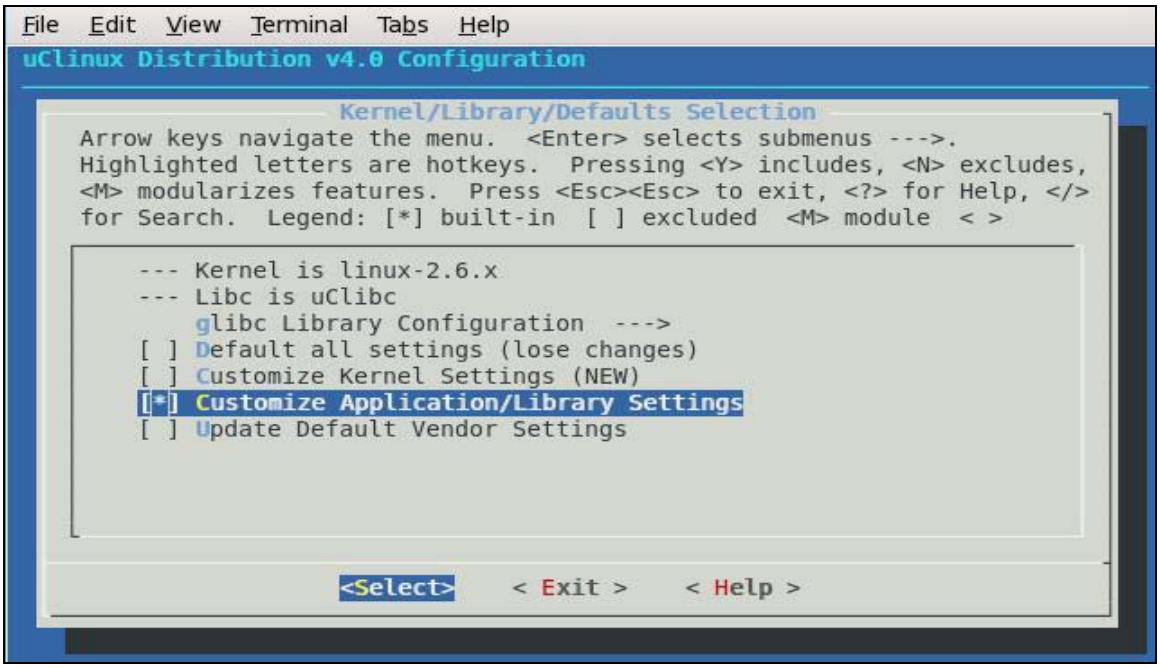
1. Select **Kernel/Library/Defaults Selection** and press **Enter**.

Figure 9-1. uClinux Distribution Configuration Window



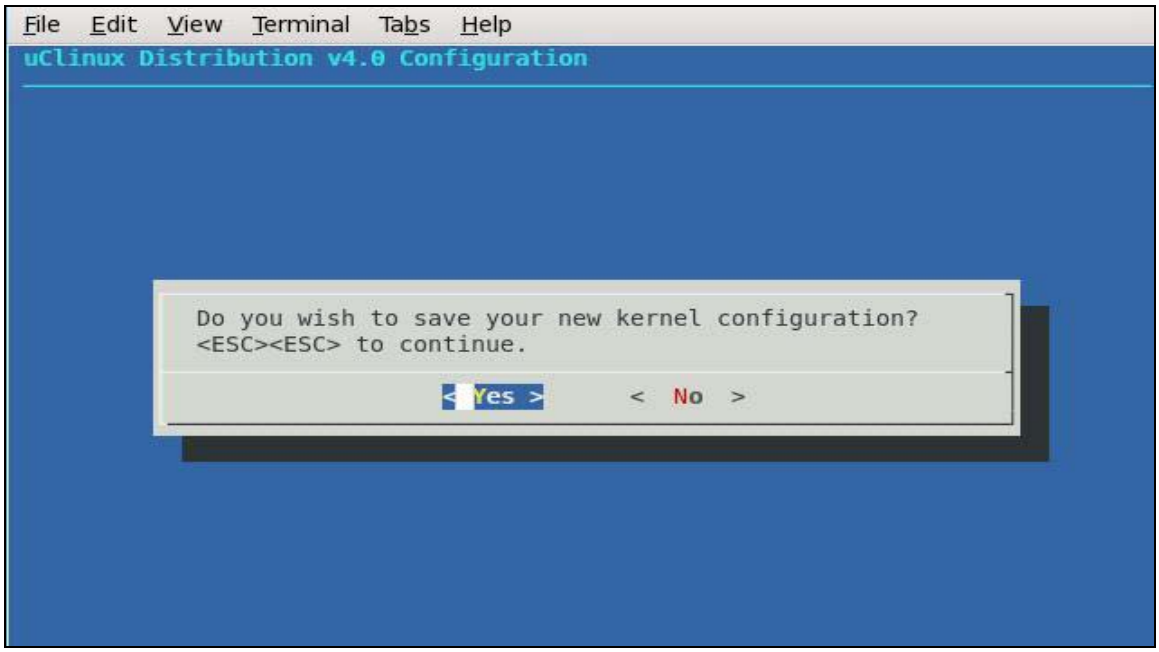
2. Select **Customize Application/Library Settings** then press **Y** to include features.

Figure 9-2. uClinux Kernel/Library/Defaults Selection Window



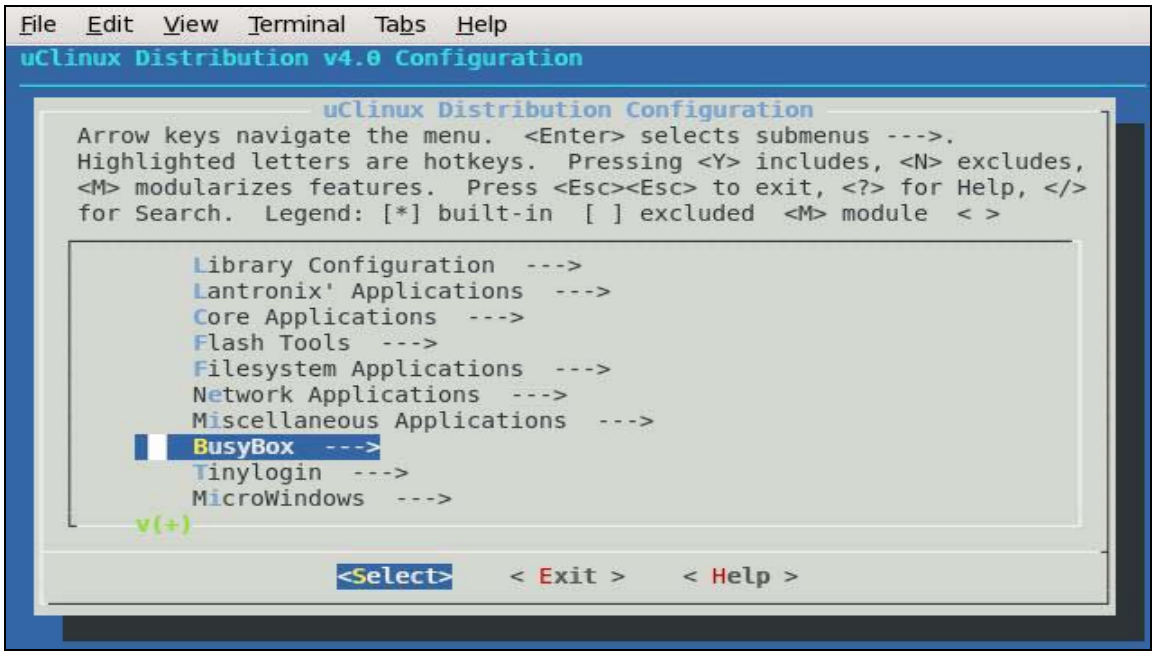
3. At the bottom of the screen, select **Exit** and press **Enter**. Repeat this process for the parent window which opens.
4. When prompted to save your new kernel configuration, select **Yes** and press **Enter**.

Figure 9-3. uClinux Save Settings Window



5. Select **BusyBox** from the µClinux Distribution Configuration menu and press **Enter**.

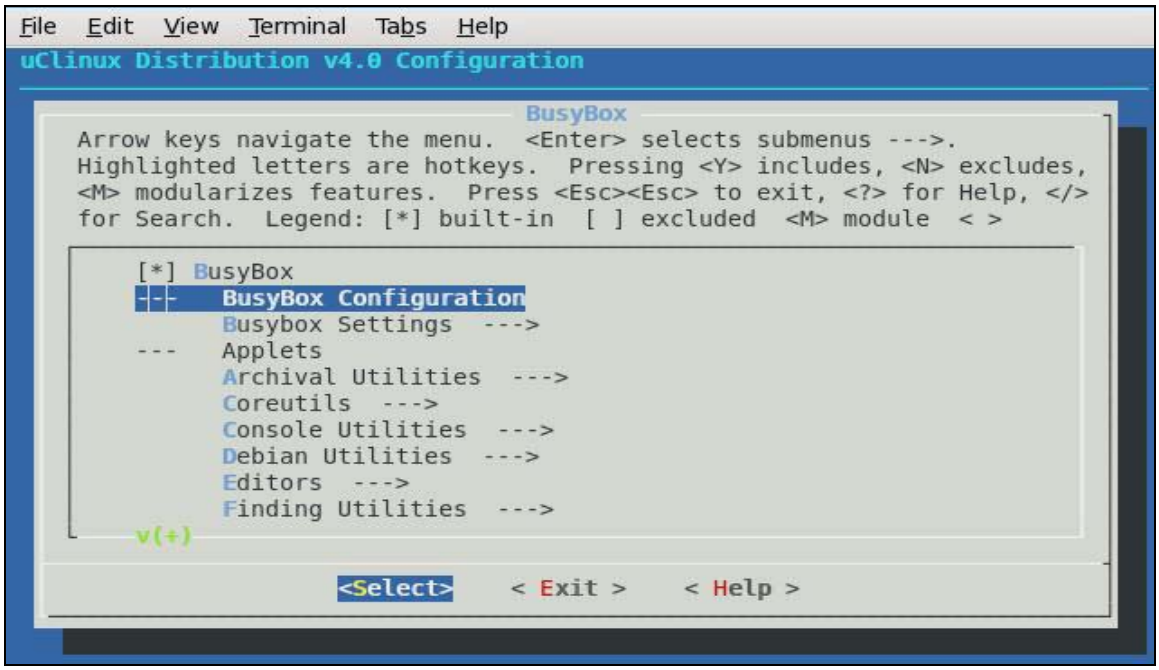
Figure 9-4. uClinux BusyBox Selection Window



6. Navigate the menu for each category of utilities to be modified. At each utility option to be modified, select **Y** to enable, or **N** to disable. When finished, select **Exit** and press **Enter**.

   The BusyBox options will now be updated.

Figure 9-5. uClinux BusyBox Configuration Window



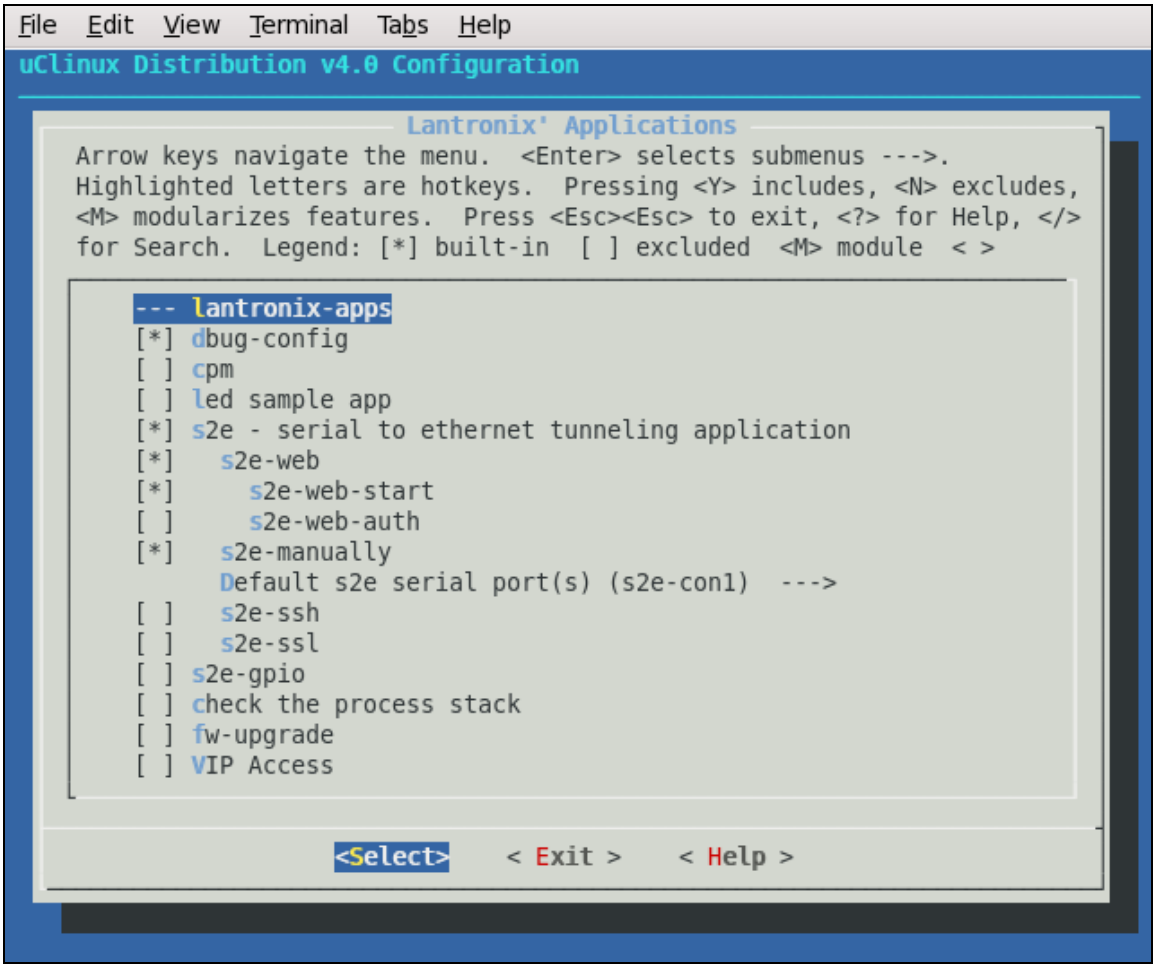
7. Execute the make command to rebuild busybox within µClinux.

10. Sample Applications

Intro to Sample Applications

Lantronix provides some sample applications to demonstrate how to develop custom applications with the SDK. These applications show examples of how to access the network, serial port and CPs. The Lantronix sample applications are found in the SDK under linux/user/lantronix. The libcp CP API library is also found in this directory. Descriptions of the sample applications are provided below. Use **make menuconfig** to enable or disable Lantronix sample applications, and then run **make** to rebuild.

Figure 10-1. Lantronix Applications Configuration Window

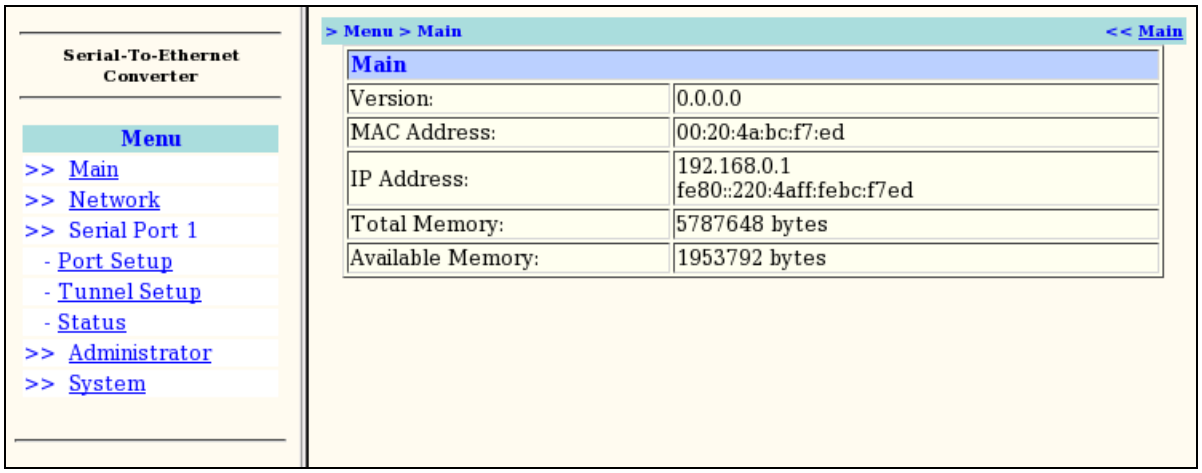


s2e (Serial to Ethernet)

The s2e program demonstrates serial to Ethernet tunneling and a configuration web interface. Note that the boa web server must be enabled with 'make menuconfig' in order to take advantage of the web interface.

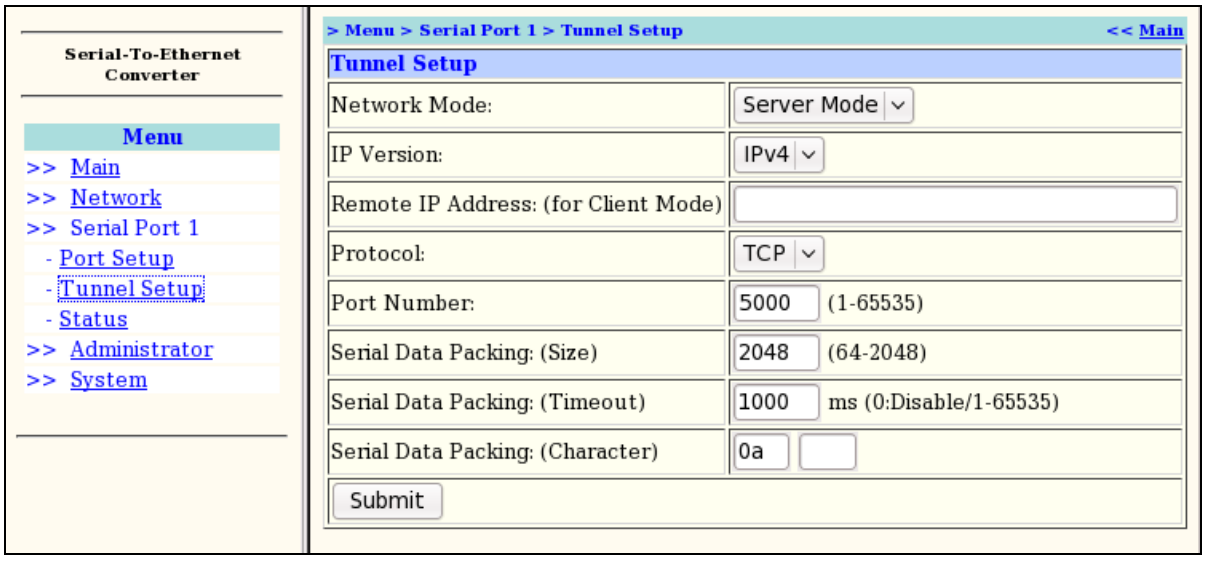
To access the s2e settings when the s2e and boa processes are running, use your web browser to connect to: http://<target_ip>/

Figure 10-2. Serial-To-Ethernet Converter Screen



To setup a serial to Ethernet tunnel, click **Tunnel Setup** under the desired serial port and configure the tunnel settings. When finished, click **Submit**.

Figure 10-3. Serial-To-Ethernet Tunnel Setup Screen



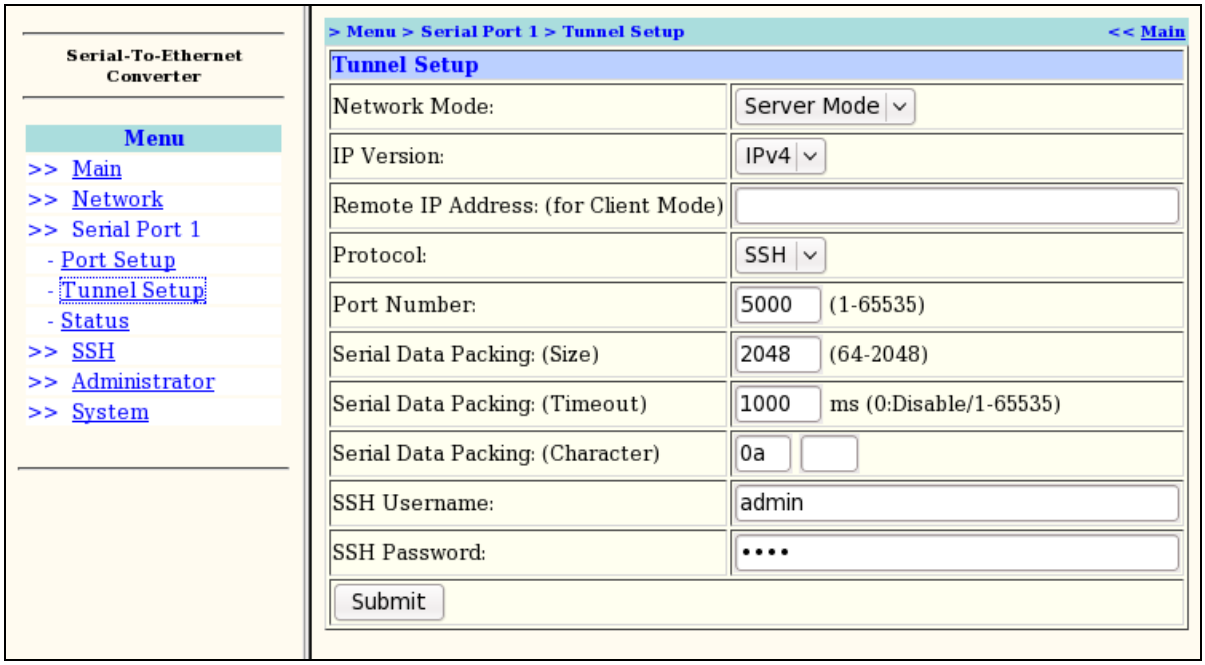
If the tunnel is configured for server mode, you can now telnet to the target's IP address at the configured TCP port number to access the serial port.

```
telnet <target_ip> <tcp_port_for_tunnel>
```

s2e-ssh

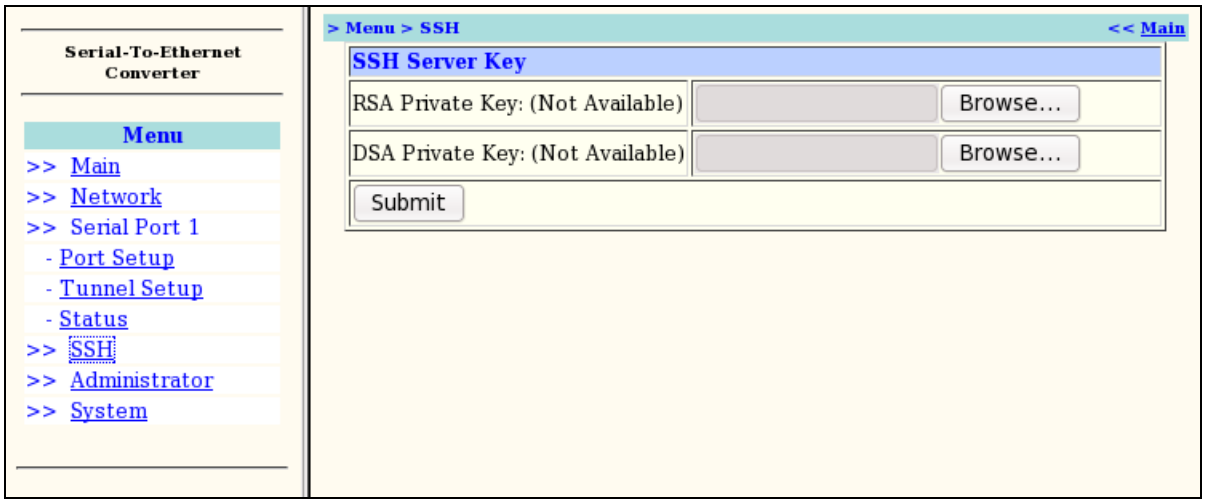
The s2e-ssh program demonstrates serial to Ethernet tunneling with ssh. Note that this program requires a large amount of memory, so you have to reduce memory usage which is used by any other applications.

Figure 10-4. Serial-To-Ethernet Tunnel Setup Screen with SSH



To setup a serial to Ethernet tunnel with SSH server mode, you have to set SSH server keys at SSH Setup Screen.

Figure 10-5. Serial-To-Ethernet SSH Setup Screen



The keys are OpenSSH PEM. Format as follows:

- RSA Private Key:

```
-----BEGIN RSA PRIVATE KEY-----
MIICWgIBAAKBgQCpcN0ROVbOHydDuE3/kKeS/DNq6CUEKLhZM7z/R8p7dGUwWirX
...
dE+IapyOCaRMfKPJftWUkb4/H1KEAVpfRZKFeK+Q
-----END RSA PRIVATE KEY-----
```

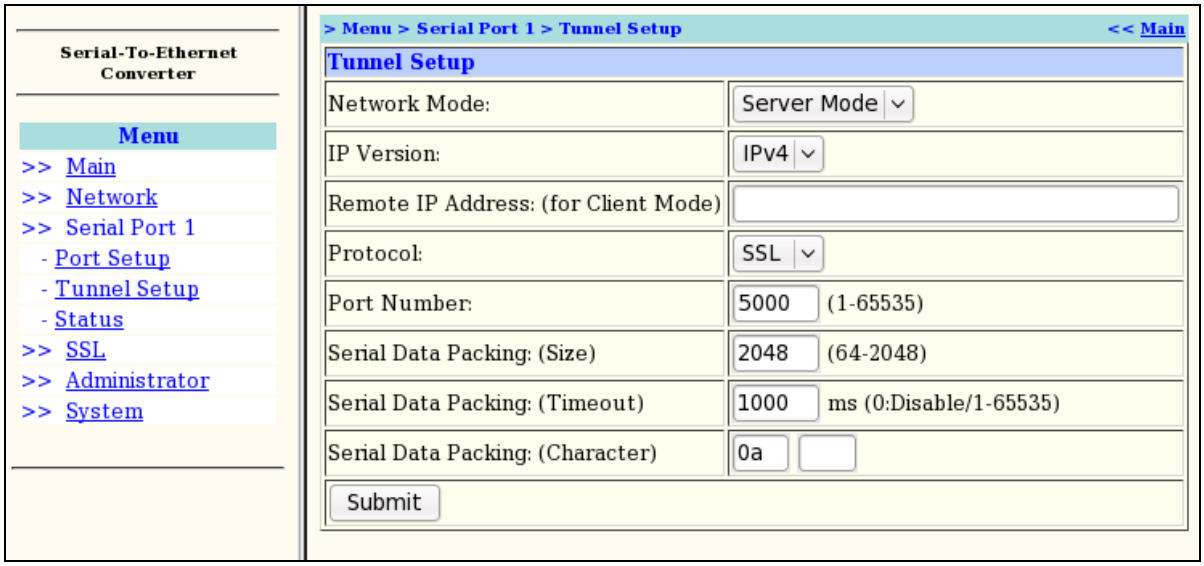
- DSA Private Key:

```
-----BEGIN DSA PRIVATE KEY-----
MIIBuwIBAAKBgQC89M2rttMbT5azCaxmY0szUPWlWK1T2Z2ewihJ68PoS/wqNPun
...
FyuhK3qSn3cvdvDoUdQ4
-----END DSA PRIVATE KEY-----
```

s2e-ssl

The s2e-ssl program demonstrates serial to Ethernet tunneling with ssl. Note that this program requires a large amount of memory, so you have to reduce memory usage which is used by any other applications.

Figure 10-6. Serial-To-Ethernet Tunnel Setup Screen with SSL



To setup a serial to Ethernet tunnel with SSL server mode, you have to set SSL server keys at SSL Setup Screen.

Figure 10-7. Serial-To-Ethernet SSL Setup Screen

The keys are OpenSSL PEM Format like following.

- Certificate:

```
-----BEGIN CERTIFICATE-----
MIIDkjCCAvugAwIBAgIBADANBgkqhkiG9w0BAQQFADCBkzELMAkGA1UEBhMCSlAx
...
MUiNfOVv
-----END CERTIFICATE-----
```

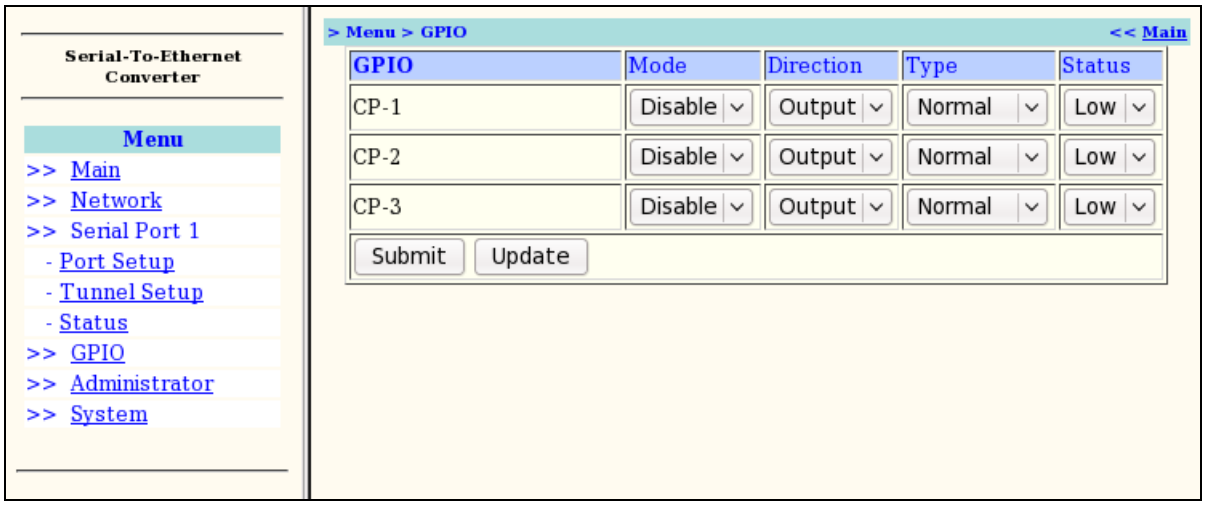
- Private Key:

```
-----BEGIN RSA PRIVATE KEY-----
MIICXQIBAAKBgQC2QJSCGFUjsegEQbZl1ylVOi48ZcTJG1wRfyJ854V5+wpk2r7r
...
vjkwxbSeE/Qj5L3hJPrnBap5qqPBfZhe8WIqdMXxKrma
-----END RSA PRIVATE KEY-----
```

s2e-gpio

The s2e-gpio program demonstrates how to access and control to the device's Configurable Pins via the Web. To use CPs as GPIO, you have to configure the kernel. (see CONFIG_LTRX_CPM_DEFAULT_GPIO of Appendix A *Important Configuration Switches*)

Figure 10-8. Serial-To-Ethernet GPIO Setup Screen



cpm (CP Manager)

The Configurable Pin Manager (cpm) provides shell level access to the device's GPIO pins. It also provides an example of how to use the libcp API to communicate with the CP GPIO driver.

To use CPs as GPIO, you have to configure the kernel. (see CONFIG_LTRX_CPM_DEFAULT_GPIO of Appendix A *Important Configuration Switches*)

The cpm.conf configuration file is used to group CPs into bit patterns. Note that the MatchPort AR has seven GPIO pins, whereas the XPort Pro has three of which 2 are shared with the serial driver. The cpm.conf file is of the following format:

```
config cp<num[1-7]> {
      type  <output|input>    # direction
      state <enable|disable>  # pin assign
      inverted  <enable|disable>    # active low or high
}
group <name> {
      type <output|input>     # direction
      state <enable|disable>  # group status
      bit<num[0-31]> CP<num[1-7]>   # CP pin assign
}
```

Below is an example configuration file for creating a group called LED to control output for CP1 to CP4

NOTE:

The XPort Pro supports only 3 GPIO pins.

```
[cpm.conf]

config cp1 {
type output
state enable
invert disable
```

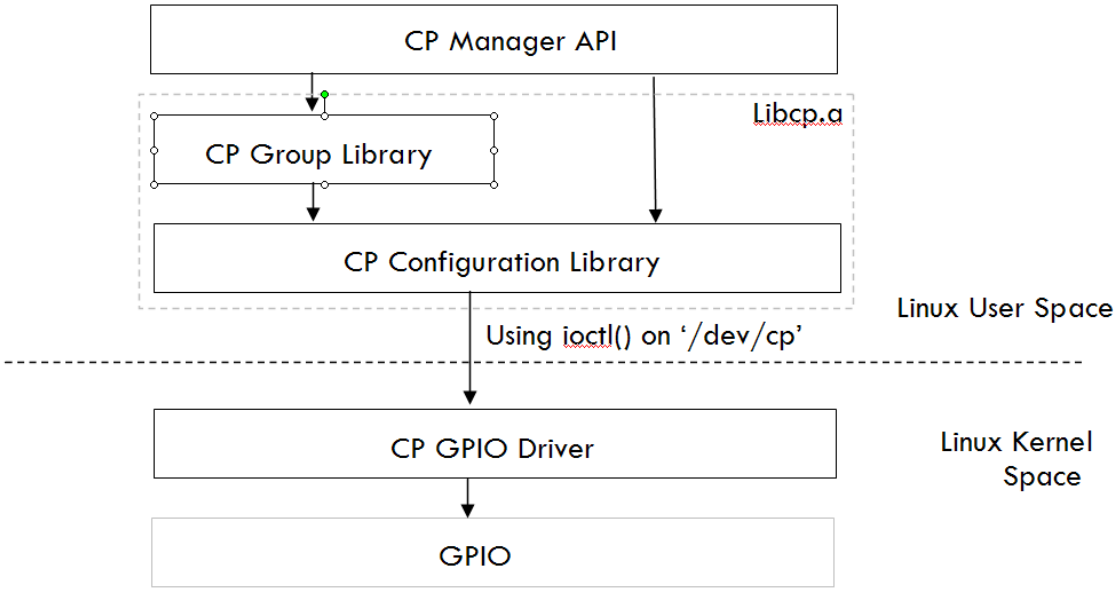
```
}
config cp2 {
type output
state enable
invert disable
}
config cp3 {
      type output
      state enable
      invert disable
}
config cp4 {
      type output
      state enable
      invert disable
}
group LED {
      type output
      state enable
      bit0 CP1
      bit1 CP2
      bit2 CP3
      bit3 CP4
}
```

The cpm program can then be invoked to light all four LEDs with the following:

```
$ cpm -N LED -V 15
```

The '-N' argument is for specifying the CP group name, and the '-V' argument for specifying which GPIOs to enable. Below is a high level diagram showing how the CP Manager interfaces with the GPIO pins.

Figure 10-9. CP Manager Interface Overview



LED

The led program is a simple LED demo intended to demonstrate the use of the CP API library. Run led from the shell with no arguments to observe the LED demo.

Check the Process Stack

The check the process stack (chkstk) is a tool which enables you to see the using stack size of working process like following:

```
/ # chkstk
 PID STACK      SIZE   USED MARGIN  CODESZ DATASZ
   1 404c8180  16000   1708  14292  272000  53248 (init)
  35 40548180  16000   1829  14171  272000  53248 (/sbin/syslogd)
  37 40558180  16000   5004  10996  272000  65536 (-/bin/sh)
  53 40598180  16000   2297  13703  272000  53248 (/sbin/inetd)
  67 40606000   8192   1865   6327  113792  36864 (boa)
  79 4052f000   4096   1656   2440   30240  12288 (chkstk)
```

Adding a New Application

To add an application, perform the following on the development host:

```
$ cd <install directory>/linux/user/lantronix
$ mkdir <app_dir>
- Add the source files into <app_dir>
- Sample source file (test.c)
/* Start test.c */
#include <stdio.h>
int main(void)
{
    printf("Testing 1,2,3\n");

    return 0;
}
/* End test.c */
```

1. Create make file as linux/user/lantronix/<app_dir>/Makefile. Use linux/usr/lantronix/hello_world/Makefile as a reference, and adjust for your application.
2. Add application to <install directory>/linux/user/lantronix/Makefile

   See hello_world rules and add in the same manner.
3. Edit <install directory>/linux/user/Kconfig

   See hello_world config and add in the same manner.
4. Run make config (or menuconfig) from <install_directory/linux), and enable the application when prompted.

11. VIP Access Software

Introduction

VIP Access Software provides secure remote Internet access to control almost any electronic equipment behind firewalls with ManageLinx. See the documents of ManageLinx for details.

Enable VIP Access Software

To compile and install vipaccess (VIP Access Software), enable the CONFIG_USER_LANTRONIX_VIP_ACCESS option and then rebuild µClinux with "make distclean" followed by "make" from the installation directory.

Register the device on DSM

To register your device on DSM, register it as DEVICELINX-DSC.

Bootstrap

VIP Access Software requires bootstrap file (bootstrap.xml). Push the bootstrap file obtained from DSM to /usr/local/etc/bootstrap.xml on the target.

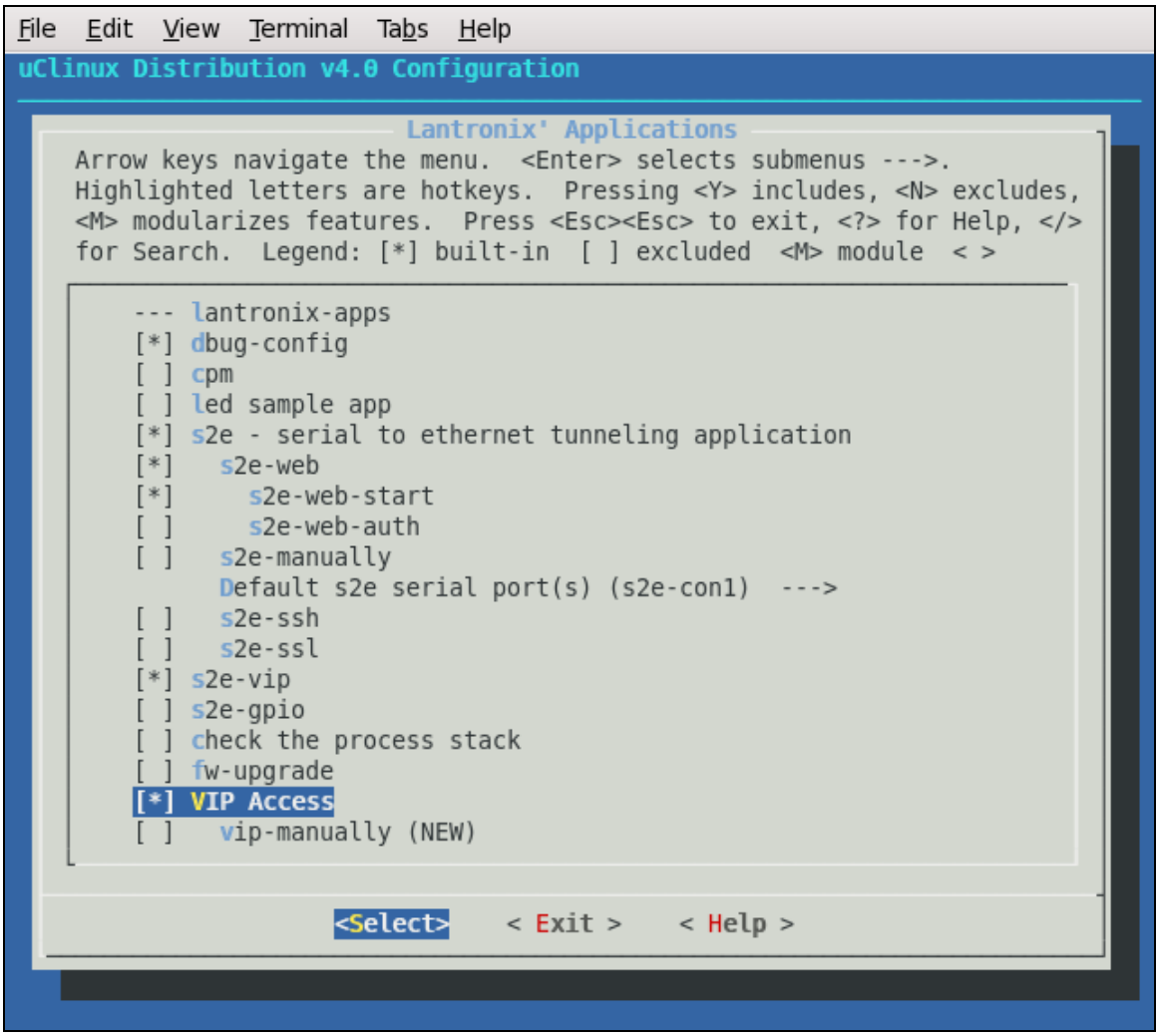
Demo application

VIP Access Demo is integrated with the s2e sample application.

To create an image with VIP Access Demo:

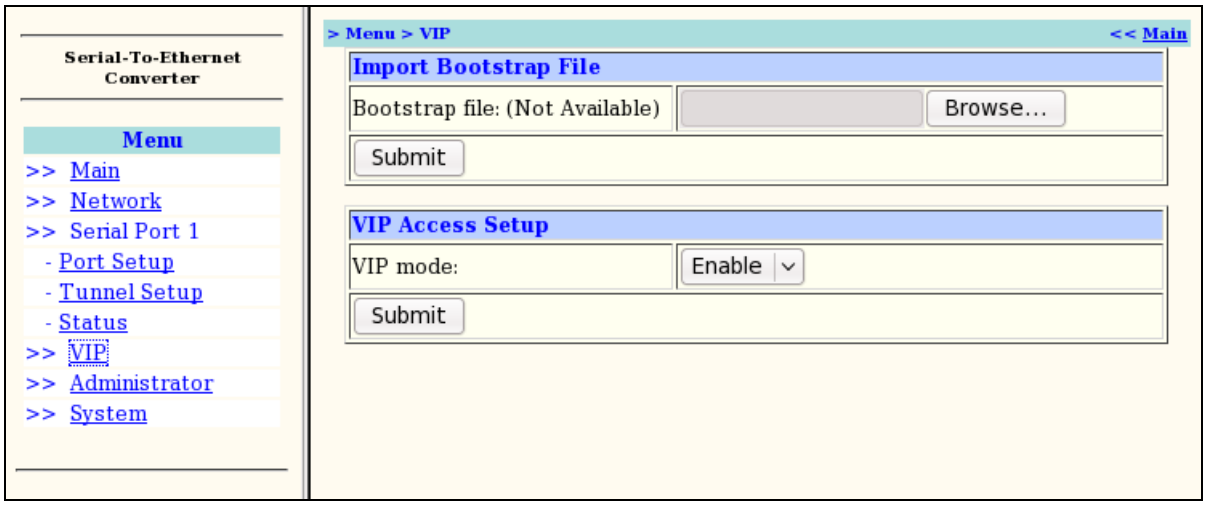
1. Enable CONFIG_USER_LANTRONIX_VIP_ACCESS and CONFIG_USER_LANTRONIX_S2E_VIP.

Figure 11-1. Lantronix Applications Configuration Window



2. Make the Linux image and boot it.
3. Connect to http://<target_ip_address>/ by Web Browser.
4. Click **VIP** from Menu, select the `bootstrap.xml` from the directory where it resides and click **Submit**.
5. Toggle the VIP mode to **Enable**, and click **Submit**.

Figure 11-2. Serial-To-Ethernet VIP Setup Screen



Your device can accept connections on TCP ports (e.g. HTTP, TELNET, s2e) via VIP, after the VIP session is visible on DSM via its Web UI.

12. Profiling & Debugging

Introduction

Various tools are provided in Linux for profiling system performance and debugging applications. These include utilities for symbolic debugging, logging, and tracking of cpu, memory, network, and file system usage. Descriptions of many of these programs are provided below.

gdbserver

The gdbserver program can be installed on the target to aid in debugging. To compile and install gdbserver, enable the CONFIG_USER_GDBSERVER_GDBSERVER option in linux/vendors/Lantronix/<platform>/config.vendor-2.6.x (or use 'make menuconfig'), and then rebuild µClinux with "make distclean" followed by "make" from the installation directory.

To start debugging an application on the target, enter the following at the Linux shell prompt:

```
gdbserver :<tcp_port> <app_path> <app_args>
```

This will make gdbserver wait on port <tcp_port> for a gdb session of the desired application.

Each application built in µClinux has an associated <app_name>.gdb file in its build directory (typically linux/user/<app_name>). You must use the gdb executable that is compiled for the Coldfire architecture. Under <install_directory>/toolchains/freescale-coldfire-4.3/bin/ you will find m68k-µClinux-gdb.

To connect to the gdbserver running on the target perform the following from your host system.

m68k-µClinux-gdb <app_path>/<app_name>.gdb

target remote <target_ip>:<tcp_port>

Perform gdb commands (e.g. set breakpoints, print variables, step through the code, ...). Refer to a gdb manual for details.

Note that by default µClinux applications are compiled with space optimization on. This optimization can make debugging with gdb more difficult.

To disable space optimization comment out (prefix with a '#') the following line from `<install_dir>/linux/config/config.make:`

```
COMMON_CFLAGS_OPTIMIZE = -0s
```

syslog

The syslog daemon is responsible for recording log messages. The Lantronix SDK uses the syslogd functionality provided by busybox. By default the target will write syslog messages in the /var ramdisk partion to /var/log/messages. While syslog is useful for target development, it may be best to disable it on production units in order to reduce memory usage.

iperf

The iperf program measures networking throughput between two systems. The program can be run on the target in either client or server mode. If client mode is chosen, iperf must first be run in server mode on the second system. With server mode, iperf must first be started on the target, and then run in client mode on the second system.

Command Syntax:

```
Server Mode:       iperf -s
Client Mode:       iperf -c <server_ip>
```

Other Profiling and Debugging Utilities

Below is a list of other profiling and debugging utilities supported on the target.

Table 12-1. Other Profiling and Debugging Utilities

Utility	Description
df	Displays partition usage information.
dmesg	Displays kernel ring buffer.
free	Displays available memory statistics.
mount	Set or display active partitions.
netstat	Displays network connection statistics.
ping	Tests network connectivity to a remote host.
ps	Display list of active processes
top	Displays cpu and memory usage in real time. (Enable with make menuconfig)

13. Firmware Updates

Introduction

Firmware updates of embedded Linux devices are usually a compromise of your requirements:

- Are online updates within Linux needed?
- Is there enough flash space to store the whole update file before starting the update?
- Is it acceptable to force the unit into an upgrade mode in which it is not responsive otherwise?
- What should happen if the upgrade fails?

There is no one approach that fits all needs. The most desirable approach, to mimic the online update process of Linux desktops and servers via a package management system like rpm or dpkg does not work because those systems tend to require more resources (memory and hard drive space for metadata) than are available on this platform.

Ipkg (http://handhelds.org/moin/moin.cgi/Ipkg) and Opkg (http://wiki.openmoko.org/wiki/Opkg) try to provide similar tools for embedded devices. But they focus on handhelds and cell phones with much more memory than our platform has to offer.

Firmware Updates by File System

Firmware update processes for embedded Linux devices usually are based on the idea of replacing entire file systems at once. This comes with various pros and cons.

Pros

- Updates and their validation are easier to predict and test because complete file systems are replaced.
- Updates can be performed offline through the boot loader.

Cons

- Changing file system sizes via updates can be complicated if not impossible. Updating active file systems can be difficult because mounted files systems cannot be overwritten without potentially causing harm.

Lantronix' Sample Update Process Implementation

Overview

The firmware update process highly depends on the flash memory layout you have chosen for your build. Lantronix provides an implementation with the following features and restrictions:

Features

- Same process for updates via boot loader and within Linux.
- Easily adjustable to customer's needs.
- Disaster recovery feature available.

Restrictions

- Update from within Linux can only update kernel, ROMFS and partitions that are not mounted.
- Update from within Linux updates 64k flash areas incrementally; so if the update process gets interrupted, the file system will be corrupted and must be caught by disaster recovery.
- No authentication and encryption of firmware upgrade files is implemented.
- Only relatively weak CRC against firmware corruption.

The upgrade process will likely require adjustments for production devices.

Implementation

The fw-upgrade application enables you to write firmware to flash via /var/firmware.img (pipe file). If you enable CONFIG_USER_LANTRONIX_FW_UPGRADE, this application runs automatically on a target.

To update the firmware, write the firmware image created by makeimage2.py (see below) to /var/firmware.img. You can write it via any protocol like TFTP, FTP or HTTP.

makeimage2.py

makeimage2.py (provided under <install_dir>/host/usr/sbin/ and on the installation CD under the firmware_update directory) wraps (file system) images in headers with information about the address on the flash they should be written to and concatenates them all together in a single file. To provide a basic protection against file corruption during the transfer, each data block is protected by a CRC.

The boot loader also expects the kernel (and optionally the ROMFS partition) to be wrapped in its own header. makeimage2.py also adds that one to the file identified as kernel.

Below are some example invocations of the makeimage2.py script.

1. Installing a compressed linux+ROMFS image and erasing the flash area used for the JFFS2 /usr/local partition:

   For MatchPort AR

   ```
   makeimage2.py images/imagez.bin:kernel:0x40000:ROMFS:
   erase:0x400000:-1 /tmp/uclinux-kernel-and-romfs-and-erase-jffs2-
   area.bin
   ```

   For XPort Pro

   ```
   makeimage2.py images/imagez.bin:kernel:0x40000:ROMFS:
   erase:0x800000:-1 /tmp/uclinux-kernel-and-romfs-and-erase-jffs2-
   area.bin
   ```

2. Installing an uncompressed linux+ROMFS image only, keeping the JFFS2 area untouched:

   For MatchPort AR

   ```
   makeimage2.py images/image.bin:kernel:0x40000:ROMFS: /tmp/uclinux-
   kernel-and-romfs.bin
   ```

For XPort Pro

```
makeimage2.py images/image.bin:kernel:0x80000:ROMFS: /tmp/uclinux-kernel-and-romfs.bin
```

3. Installing an uncompressed linux kernel and using a JFFS2 root partition:

   For MatchPort AR

   ```
   makeimage2.py images/linux.bin:kernel:0x40000:bin: images/rootfs.img:jffs2:0x400000:bin: /tmp/uclinux-kernel-and-jffs2.bin
   ```

   For XPort Pro

   ```
   makeimage2.py images/linux.bin:kernel:0x80000:bin: images/rootfs.img:jffs2:0x400000:bin: /tmp/uclinux-kernel-and-jffs2.bin
   ```

Updating via a TFTP Client

To update the target via TFTP with an image file generated by makeimage2.py (see the previous section), perform the following steps:

1. From your host system, launch a TFTP session to the target. Note that this can be done when the target is in dBUG with the TFTP server enabled, or when the target is running Linux provided that the root file system is ROMFS, and a JFFS2 partition is not mounted.

   ```
   $ tftp <target-ip>
   ```

2. From within the TFTP client program, set the file transfer mode to ‘octet’.

   ```
   tftp> mode octet
   ```

3. Now set the timeout value to a high value. The TFTP upgrade may take some time due to flash writes, so the timeout should be set to a suitably high value.

   ```
   tftp> timeout 999999
   ```

4. Push the firmware update file to the target. Note that firmware updates must be pushed to the /var/firmware.img.

   ```
   tftp> put uclinux-kernel-and-romfs-and-erase-jffs2-area.bin /var/firmware.img
   ```

5. Reset the target once the TFTP upgrade is complete. The target will now boot with the updated file system(s).

Updating via a FTP Client

To update the target via FTP with an image file generated by makeimage2.py (see the previous section), perform the following steps:

1. From your host system, launch a FTP session to the target. Note that this can be done when the target is running Linux provided that the root file system is ROMFS, and a JFFS2 partition is not mounted.

   ```
   $ ftp <target-ip>
   ```

2. Log in to prompt (default username and password is root:root).

3. Change to binary mode.

   ```
   ftp> binary
   200 Type set to I.
   ```

4. Push the firmware update file to the target. Note that firmware updates must be pushed to /var/firmware.img.

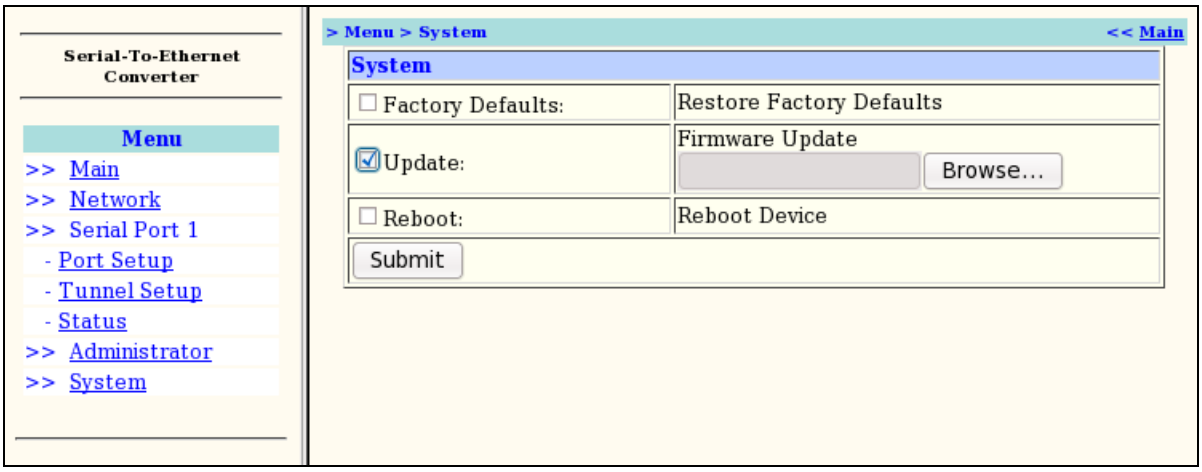
```
ftp> put uclinux-kernel-and-romfs-and-erase-jffs2-area.bin
/var/firmware.img
```

Updating via a WEB Browser

To update the target via WEB Browser with an image file generated by makeimage2.py (see the previous section), perform the following steps:

1. From your host system, launch an HTTP session to the target via WEB Browser. Note that this can be done when the target is running with CONFIG_USER_LANTRONIX_S2E_UPDATE.

Figure 13-1. Serial-To-Ethernet System Setup Screen



2. Click **Browse** and select the firmware file.
3. Select **Update** and then click **Submit**.

14. Resources

Lantronix Open Linux SDK Forum

The Lantronix Linux SDK forum Web site (http://forums.lantronix.com) is the primary resource to obtain updated revisions of the SDK. The SDK and related documentation are also available via the Downloads page (www.lantronix.com/support/downloads). Please visit the Lantronix Web site or the Forums page to determine if a more current version of the SDK is available.

Individual forum topics are monitored by Lantronix engineers and technical support staff and may be used to ask questions regarding any aspect of the SDK. Complete the registration process to obtain a logon ID and post your question. If enabled in your user profile, you will receive an email message when a response to your post is available. Other options for interacting with the forum are described on the forum site itself.

Links to Related Web Sites

- www.uclinux.org – µClinux home page
- www.ucdot.org/faq.pl – very valuable documents describing details about µClinux
- http://www.linux-mtd.infradead.org/ – JFFS2 and mtdutils home page
- www.uclibc.org – uClibc home page
- www.codesourcery.com/archives/coldfire-gnu-discuss/maillist
- http://forums.freescale.com/freescale/board?board.id=CFCOMM – Freescale Coldfire forum

A. Important Configuration Switches

Table A-1. Important Configuration Switches

Switch	Path in Configuration Utility	Description
CONFIG_NFS_FS	KERN->File systems->Network File Systems->NFS file system support	Enables Network file system.
CONFIG_NFS_V3	KERN->File systems->Network File Systems->NFS file system support->Provide NFSv3 client support	Enables NFS version 3.
CONFIG_NFS_COMMON		automatically selected when CONFIG_NFS_FS gets selected
CONFIG_IP_PNP_DHCP	KERN->Networking->Networking options->TCP/IP networking->IP: kernel level autoconfiguration->IP: DHCP support	Enables kernel level IP configuration using DHCP.
CONFIG_IP_PNP_BOOTP	KERN->Networking->TCP/IP networking->IP: kernel level autoconfiguration->IP: DHCP support	Enables kernel level IP configuration using BOOTP.
CONFIG_ROOT_NFS	KERN->File systems->Network File Systems->Root file system support on NFS	Enables NFS mount as RFS.
CONFIG_LTRX_CPDRV	KERN->Processor type and features->CP driver support	Enables CP driver (/dev/cp)
CONFIG_LTRX_CPM_DEFAULT_DEVICE CONFIG_LTRX_CPM_DEFAULT_GPIO CONFIG_LTRX_CPM_MANUALY CONFIG_LTRX_CPM_MANUALY_CP*	KERN->Processor type and features->Lantronix CP Manager	Specify usage of CP. DEVICE maps CP as pre-defined use. GPIO maps all CP as GPIO. MANUALY maps each CP by user.
CONFIG_NOMMU_INITIAL_TRIM_EXCESS	KERN->Processor type and features->Turn on mmap() excess space trimming before booting	Enables page triming in mmap. Effective for memory fragmentation avoidance with Shared profile.
CONFIG_RECLAIM_PAGE_BEFORE_LOADING	KERN->Processor type and features->Reclaim page before process loading	Enables that reclaim pages before loading a process. Effective for memory fragmentation avoidance.
CONFIG_NOMMU_NUMERICAL_ALLOC_PAGES	KERN->Processor type and features->Turn on mmap that allocates memory per page	Enables that mmap allocates pages by numeric instead of order.

Switch	Path in Configuration Utility	Description
CONFIG_SERIAL_MCF_RS485	KERN->Device Drivers->Character devices->Serial drivers->Enable RS485 support in the new style ColdFire serial driver	Enables RS-485 support.
CONFIG_USER_BUSYBOX_FEATURE_MOUNT_NFS	BUSY->Linux System Utlilites->mount->Support mounting NFS file systems	Enables NFS support on mount command.
CONFIG_USER_PORTMAP_PORTMAP	USER->Network Applications->portmap	Enables NFS support on mount command.
CONFIG_USER_GDBSERVER_GDBSERVER	USER->Miscellaneous Applications->gdbserver	Build gdbserver.
CONFIG_USER_CONSOLE_DEFAULT	USER->Console Login Configuration	Use console depends on linux/vendor/Lantronix/<platform>/romfs_extra/etc/inittab
CONFIG_USER_CONSOLE_NONE	USER->Console Login Configuration	Don’t use console
CONFIG_USER_CONSOLE_CON1	USER->Console Login Configuration	Use CON1 (ttyS0) as console
CONFIG_USER_CONSOLE_CON2	USER->Console Login Configuration	Use CON2 (ttyS1) as console
CONFIG_USER_CONSOLE_LOGIN_AUTH	USER->Console Login Configuration	Use login authentication for console

Abbreviations used in the table above

Table A-2. Configuration Switch Abbreviations

Abbreviations	Description
BUSY	USER->BusyBox->BusyBox (NEW)
KERN	Kernel/Library/Defaults Selection -> Customize Kernel Settings
USER	Kernel/Library/Defaults Selection -> Customize Application/Library Settings

B. Differences Between µClinux and Standard Linux

The µClinux kernel is a collection of patches to make the standard Linux kernel run on CPUs that do not have an MMU. As a consequence you will encounter some differences between the µClinux and the standard Linux behavior. While porting existing Linux applications to µClinux/ColdFire you should be aware of these limitations:

- no fork() – consider using vfork() instead but beware of the difference of their semantics
- no daemon() – it is usually implemented on top of fork and cannot be easily replaced without changing the semantics.
- fixed stack size -- the stack of an application is set at execution time and cannot grow during runtime. The default stack size is 4k! It can be increased with the "-s" option of m68k-uClinux-elf2flat.
- limited libc compared to glibc -- either add more to libc, or remove some functionality.
- no support for ELF binary file format
- very limited support for shared libraries due to missing MMU -- all applications get linked statically
- mmap() is very inefficient
- no paging -- applications have to be loaded completely into RAM, the heap is very susceptible to fragmentation.
- processes do not run in their isolated virtual memory -- they can corrupt other processes and even the kernel.

C. Troubleshooting

Technical Support

Technical Support US

Check our online knowledge base or send a question to Technical Support at http://www.lantronix.com/support.

Phone: (800) 422-7044 (US Only)
(949) 453-7198

Technical Support Europe, Middle East, and Africa

Phone: +33 (0)1 39 30 41 72
+49 (0) 180 500 13 53 (Germany Only)

Email: eu_techsupp@lantronix.com or eu_support@lantronix.com

Firmware downloads, FAQs, and the most up-to-date documentation are available at www.lantronix.com/support.

When you report a problem, please provide the following information:

- Your name, and your company name, address, and phone number
- Lantronix model number
- Lantronix MAC number
- Software version (on the first screen shown when you Telnet to port 9999)
- Description of the problem
- Status of the unit when the problem occurred (please try to include information on user and network activity at the time of the problem).