atmark-dist
Developers Guide

1.0

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Atmark Techno, Inc.
http://www.atmark-techno.com/

Armadillo Official Site
http://armadillo.atmark-techno.com/

SUZAKU Official Site
http://suzaku.atmark-techno.com/

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1. Introduction

1.1. About This Manual

This document covers the following information necessary for using atmark-dist as distributed by Atmark Techno, Inc.

- Kernel and Userland Builds
- Customization
- Application Development
- Specific Applications

Unless otherwise specified, it is assumed that development is carried out on a PC running a Linux-based operating system.
Under Windows, a Linux environment can easily be constructed using coLinux.
For more information on coLinux, refer to http://www.colinux.org/.

We hope the information in this document will help you get the best functionality out of atmark-dist.

1.2. Typographical Conventions

The following typographical conventions are used in this manual.

Table 1-1 Typographical Conventions

Font Example	Description
Standard Font	Standard Text
`[PC ~]$ ls`	Prompt and user input character strings References to commands, files and directories
: :	Omission of output after command execution.

1.3. Command Input Example Conventions

The command input examples contained in this manual are based on the assumed execution environment associated with the respective display prompt. The directory part “/” will differ depending on the current directory. The home directory of each user is represented by “~”.

Table 1-2 Relationship between Display Prompt and Execution Environment

Prompt	Command Execution Environment
`[PC /]#`	To be executed by a privileged user on the PC
`[PC /]$`	To be executed by a non-privileged user on the PC
`[Target /]#`	To be executed by a privileged user on the target board
`[Target /]$`	To be executed by a non-privileged user on the target board

1.4. A Word of Thanks

atmark-dist is based on uClinux-dist.

The software used in uClinux-dist is composed of Free and Open Source Software (FOSS). FOSS is the result of efforts from developers from all over the world. We would like to take this chance to express our gratitude.
uClinux is supported by the work of Mr. D. Jeff Dionne, Mr. Greg Ungerer, Mr. David McCullough and all person's participating in the uClinux development list.

uClibc and Busybox are developed and maintained by Mr. Eric Andersen and their respective communities.

2. About uClinux-dist

uClinux-dist is a source code based distribution by uClinux.org.

While uClinux-dist was first made for uClinux[1], it is not solely for uClinux use. Modifications were made to be compatible with uClinux, and it can also be used with MMU CPUs such as i386, ARM, and PowerPC by selecting existing Linux at configuration time.

Due to restrictions in uClinux that Linux does not have, it was necessary to make existing Linux applications compatible with uClinux on an individual basis. uClinux-dist automates the process of combining the uClinux compatible application with the Linux Kernel build system and generating the write files to be written to flash memory etc.

Existing Linux distributions are mainly designed for desktop PCs and servers. Therefore, there were problems with file size and memory usage etc. when employing them as a base for embedded devices. As uClinux-dist assumes the use of embedded devices from the beginning, it allows for the selection of only the required functions at compile time.

uClinux-dist also has many other excellent features. By storing configuration settings for individual products, it allows for simple creation of image files for a specific product. Also, Kernel and Userland configuration can be carried out from the same menu, and then both outputted as one image file.

Therefore, the merits of uClinux-dist are not restricted to products that use uClinux, and even extend to embedded devices that run Linux and include a MMU.

[1] uClinux is a Linux kernel designed to run on microcomputers without a MMU. It is generally utilized in products that do not have large-capacity auxiliary storage such as a HDD. The results of uClinux development have been merged in Linux 2.6 series.

3. Default Image Build

This section describes how to make a default image for the chosen target board.
All operations should be performed as a non-privileged user. Any mistakes made while logged in as a root user may damage the operating environment of the development machine.

3.1. Acquiring Source Code

atmark-dist as distributed by Atmark Techno can be downloaded from the URL shown below:

http://download.atmark-techno.com/dist/

The original uClinux-dist as distributed by uClinux.org has a file name that includes the date, as in "uClinux-dist-YYYYMMDD.tar.gz". Here, "YYYY" stands for year, "MM" for month and "DD" for day. Files distributed by Atmark Techno have the name "atmark-dist-YYYYMMDD".

Example 3-1 File Name of atmark-dist

```
[PC ~]$ ls
atmark-dist-at20050413.tar.gz
```

3.2. Preparing Source Code Archive

atmark-dist source code can be expanded to anywhere in the system. Choose a place that is convenient to work with and where there is enough free hard drive space. Once expanded, around 500MB is required, with up to 1GB being required after compiling. Here, the atmark source code is expanded to the user home directory (~/) for convenience.

```
[PC ~]$ tar xvzf atmark-dist-YYYYMMDD.tar.gz
     :
     :
[PC ~]$ ls
atmark-dist-YYYYMMDD/
```

Hereinafter, atmark-dist-YYYMMDD will be referred to as atmark-dist.

Unlike uClinux-dist distributed by uClinux.org, atmark-dist distributed by Atmark Techno does not contain Linux kernel source code. The kernel source code suitable for the product being used can be downloaded from the product portal site, or obtained from the CD-ROM included in the development kit.

The Linux kernel source code should be expanded within atmark-dist. It is possible to expand the kernel for each product, and create a symbolic link with the name linux-2.4.x within the atmark-dist directory.

```
[PC ~]$ ls
linux-2.4.24-foo.tar.gz atmark-dist-YYYYMMDD/
atmark-dist-YYYYMMDD.tar.gz
[PC ~]$ tar xvzf linux-2.4.24-foo.tar.gz
     :
     :
[PC ~]$ cd atmark-dist
[PC ~/atmark-dist]$ ln -s ../linux-2.4.24-foo ./linux-2.4.x
[PC ~/atmark-dist]$ ls -l linux-2.4.x
lrwxrwxrwx           linux-2.4.x -> ../linux-2.4.24-foo
```

3.3. Configuration

Here, configure atmark-dist for the target board. Start configuration by entering the command in the following example.

```
 [PC ~/atmark-dist]$ make config
```

Enter “**AtmarkTechno**” when asked which board vendor to use.

```
[PC ~/atmark-dist]$ make config
config/mkconfig > config.in
#
# No defaults found
#
*
* Vendor/Product Selection
*
*
* Select the Vendor you wish to target
*
Vendor (3com, ADI, Akizuki, Apple, Arcturus, Arnewsh, AtmarkTechno, Atmel,
Avnet, Cirrus, Cogent, Conexant, Cwlinux, CyberGuard, Cytek, Exys, Feith,
Future, GDB, Hitachi, Imt, Insight, Intel, KendinMicrel, LEOX, Mecel,
Midas, Motorola, NEC, NetSilicon, Netburner, Nintendo, OPENcores, Promise,
SNEHA, SSV, SWARM, Samsung, SecureEdge, Signal, SnapGear, Soekris, Sony,
StrawberryLinux, TI, TeleIP, Triscend, Via, Weiss, Xilinx, senTec)
[SnapGear] (NEW) AtmarkTechno
```

You will then be prompted for the board name. Enter the board name being used. "**Armadillo-9**" is entered here as an example.

```
*
* Select the Product you wish to target
*
AtmarkTechno Products (Armadillo-9, SUZAKU) [Armadillo-9] (NEW) Armadillo-
9
```

The C library to be used is specified next. The supported library depends on the board being used.
For the Armadillo-9, select “None”. For more information, refer to the software manual of the product being used.

```
*
* Kernel/Library/Defaults Selection
*
*
* Kernel is linux-2.4.x
*
Libc Version (None, glibc, uC-libc, uClibc) [uClibc] (NEW) None
```

Next you will be asked whether or not to use default settings. Select “Yes”

```
Default all settings (lose changes) (CONFIG_DEFAULTS_OVERRIDE) [N/y/?]
(NEW) y
```

Enter “No” for the last three questions.

```
Customize Kernel Settings (CONFIG_DEFAULTS_KERNEL) [N/y/?] n
Customize Vendor/User Settings (CONFIG_DEFAULTS_VENDOR) [N/y/?] n
Update Default Vendor Settings (CONFIG_DEFAULTS_VENDOR_UPDATE) [N/y/?] n
```

The Build system will start configuration after all questions have been answered. You will be returned to the prompt once the configuration has finished.

3.4. Building

Enter the following command to execute a build. If asked any questions during the build process, hit the "Enter" key.

```
[PC ~/atmark-dist]$ make dep all
```

3.5. Image Files

Image files will be created in the `images` directory. The number and type of files created may differ dependant on the product selected. Refer to the software manual of the product being used.
Also refer to the respective software manual for information on writing the created image file to the product.

3.6. Summary

The series of commands entered and options selected in this chapter have been summarized below.

```
[PC ~]$ ls
linux-2.4.24-foo.tar.gz  atmark-dist-YYYYMMDD.tar.gz
[PC ~]$ tar xvzf atmark-dist-YYYYMMDD.tar.gz
[PC ~]$ tar xvzf linux-2.4.24-foo.tar.gz
[PC ~]$ cd atmark-dist
[PC ~/atmark-dist]$ ln -s ../linux-2.4.24-foo ./linux-2.4.x
[PC ~/atmark-dist]$ make config
  Vendor AtmarkTechno
  AtmarkTechno Products Armadillo-9
  Libc Version None
  Default all settings y
  Customize Kernel Settings n
  Customize Vendor/User Settings n
  Update Default Vendor Settings n
[PC ~/atmark-dist]$ make dep all
[PC ~/atmark-dist]$ ls image/
image.bin  linux.bin  romfs.img
```

4. Directory Structure

This chapter describes the directory structure of atmark-dist. Comprehending the directory structure is of great importance when carrying out development based on atmark-dist.

This chapter provides an overview of each directory while introducing any other chapters that contain related explanations.

```
[PC ~]$ cd atmark-dist
[PC ~/atmark-dist]$ tree -L 1 -F
.
|-- COPYING
|-- Documentation/
|-- Makefile
|-- README
|-- SOURCE
|-- bin/
|-- config/
|-- freeswan/
|-- glibc/
|-- lib/
|-- linux-2.4.x -> ../kernel/linux-suzaku/
|-- tools/
|-- uClibc/
|-- user/
`-- vendors/

11 directories, 4 files
```

4.1. Makefile

The `make` command is used to carry out all operations with atmark-dist. This `atmark-dist/Makefile` will be called the top level Makefile to distinguish it from Makefiles in other directories. The top level Makefile is an important file that controls the build of atmark-dist. The targets defined here are explained in detail in Chapter 6, “Basic Targets”. The `make` is command explained briefly in chapter 5, “Basics of Make”.

4.2. config

The `config` directory contains the scripts and Makefiles necessary for configuration.

Makefiles and `config.in` are covered in detail in chapter 10.2, “Product Specific Applications”.

4.3. tools

The `tools` directory contains various tools necessary for building. The `romfs-inst.sh` file in this directory is often used by the Makefile of product directories. It is explained in detail in chapter 9, “romfs Installation Tools”.

`cksum` is sometimes used with NetFlash. For information on NetFlash, refer to chapter 12.1, “NetFlash”.

4.4. glibc and uClibc

GNU C library (`glibc`) and `uClibc` are the C libraries employed in atmark-dist.

4.5. user

Userland applications are stored in this directory. While most are GNU/Linux applications adapted for use on both Linux and uClinux, applications developed specifically for uClinux are also included.

Applications characteristic of those produced from carrying out software development based on atmark-dist are detailed in chapter 12, "Specific Applications".

4.6. vendors

The `vendors` directory is shown below.

```
[PC ~/atmark-dist]$ tree vendors
vendors
    :
    :
|-- AtmarkTechno
|   |-- Armadillo
|   |-- Armadillo-9
|   |-- Armadillo-J
|       |-- Makefile
|       |-- config.arch
|       |-- config.linux-2.4.x
|       |-- config.uClibc
|       |-- config.vendor
|       |-- default
|       `-- etc
|   `-- SUZAKU
|       |-- Makefile
|       |-- config.arch
|       |-- config.linux-2.4.x
|       |-- config.uClibc
|       |-- config.vendor
|       |-- default
|       `-- etc
    :
    :
|-- config
|   |-- arm
|   |   `-- config.arch
|   |-- armnommu
|   |   `-- config.arch
|   |-- h8300
|   |   `-- config.arch
|   |-- i386
|    |     `-- config.arch
|    |-- i960
|    |     `-- config.arch
|    |-- m68knommu
|    |     `-- config.arch
|    |-- microblaze
     :
     :
```

The vendors directory contains many directories with vendor names, with AtmarkTechno being one of those. Each vendor directory contains subdirectories for their products. The AtmarkTechno directory contains various products compatible with atmark-dist including the Armadillo. These directories will be referred to as the product directories. The product directories contain the various files required to build the images for each product. For more information on the product directories, refer to chapter 8, “Product Directories”.

The `vendors` directory also contains the `config` directory. The default settings for each architecture are contained under the name `config.arch` in each directory. These `config.arch` files are referenced from the `config.arch` file in the product directories. For more information, refer to chapter 8.1, “config.arch”.

5. Basics of Make

The `make` command is widely used to compile programs. It decides what source code and in what way to compile and executes the necessary commands for compiling. A Makefile is required to use the `make` command. Information such as the dependency of source code to be compiled and the commands necessary for compiling is written in the Makefile.

The atmark-dist build system is also based on Makefiles. The following briefly explains about the `make` command and basics of Makefiles.

Firstly, create a directory for practice use. Here it is named `maketest`.

Example 5-1 Creating Directory for Makefile Practice

```
[PC ~]$ mkdir maketest
[PC ~]$ cd maketest
[PC ~/maketest]$
```

Next, create a simple Makefile in the `maketest` directory.

Example 5-2 A Simple Makefile

```
hello:
        echo ‘Hello World’

bye:
        echo ‘Bye bye’
```

In the Makefile, `hello` and `bye` are called targets. A target should always end with a colon. The line following the target is the command that will actually be executed. Here, the `echo` command is executed to output “Hello World” without compiling. Commands to be executed must be preceded by a tab.

Example 5-3 make Execution

```
[PC ~/maketest]$ ls
Makefile
[PC ~/maketest]$ make
echo ‘Hello World’
Hello World
[PC ~/maketest]$
```

The above is the result of actually executing the `make` command. Once the `make` command is executed, the command in the Makefile, echo ‘Hello World’ and its result “Hello World” are displayed.

The `make` command can accept targets defined in the Makefile as arguments. The specified target is called a goal.

Example 5-4 Execution of make Specifying a Goal

```
[PC ~/maketest]$ make hello
echo 'Hello World'
Hello World
[PC ~/maketest]$ make bye
echo 'Bye bye'
Bye bye
[PC ~/maketest]$
```

When the `make` command does not take an argument, it will execute the topmost target in the Makefile as the goal. Therefore, `make` and `make hello` produce the same result. In many Makefiles, the topmost target is defined with the name `all`.

Two or more goals can also be specified. In this case, they are sequentially executed from the left.

Example 5-5 Execution of "make" Specifying Two or More Goals

```
[PC ~/maketest]$ make hello bye
echo 'Hello World'
Hello World
echo 'Bye bye'
Bye bye
[PC ~/maketest]$
```

For more information on make and Makefiles, refer to a make manual or info.

6. Basic Targets

This section provides information on targets often used when building with atmark-dist. As has already been explained, the purpose of atmark-dist is to create image files to be written to a target board. The following describes in detail targets used for “default image builds”.

6.1. Configuration (config)

The following three kinds of targets have been prepared for configuration use. All three targets are used for atmark-dist configuration, differing only in the way the configuration process is displayed.

6.1.1. Text Screen Configuration (make config)

`make config` is the configuration method used in chapter 3, “Building Default Image”. It is useful when carrying out simple configuration like creating a default image.

Example 6-1 Text Based Configuration

```
[PC ~/atmark-dist]$ make config
config/mkconfig > config.in
#
# Using defaults found in .config
#
*
* Vendor/Product Selection
*
*
* Select the Vendor you wish to target
*
Vendor   (3com,   ADI,   Arcturus,   Arnewsh,   AtmarkTechno,   Atmel,   Avnet,
Conexant, Cwlinux, Cytek, Exys, Feith, Future, GDB, Hitachi, Imt, Insight,
Intel,  KendinMicrel,  LEOX,  Mecel,  Midas,  Motorola,  NEC,  NetSilicon,
Netburner, Nintendo, OPENcores, Promise, SSV, SWARM, Samsung, SecureEdge,
SnapGear,   Soekris,   TeleIP,   Triscend,   Via,   Weiss,   Xilinx,   senTec)
[AtmarkTechno]
  defined CONFIG_DEFAULTS_ATMARKTECHNO
*
* Select the Product you wish to target
*
AtmarkTechno Products (SUZAKU) [SUZAKU]
  defined CONFIG_DEFAULTS_ATMARKTECHNO_SUZAKU
*
* Kernel/Library/Defaults Selection
*
*
* Kernel is linux-2.4.x
*
Libc Version (glibc, uC-libc, uClibc) [uClibc]
```

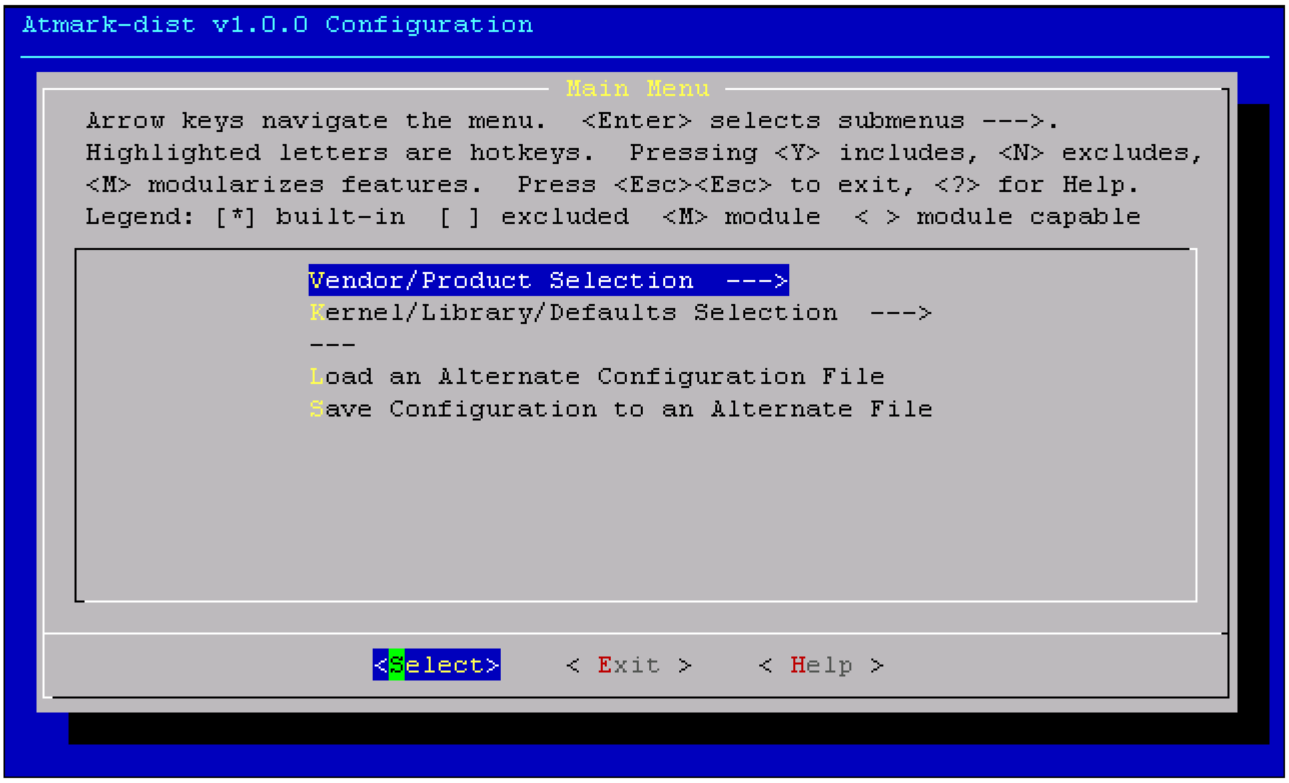
6.1.2. Menu Based Configuration (make menuconfig)

`make menuconfig` allows for configuration using a menu screen. The menu screen is drawn with Ncurses. The Ncurses library and header file are required to build programs that control the screen when this target is specified. Most distributions include a package for Ncurses development, so please do install it.

Example 6-2 Command for activating Menu Based Configuration

```
[PC ~/atmark-dist]$ make menuconfig
```

Figure 6-1 Menu Based Configuration Screen



```
Atmark-dist v1.0.0 Configuration

                         Main Menu
   Arrow keys navigate the menu.  <Enter> selects submenus --->.
   Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes,
   <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help.
   Legend: [*] built-in  [ ] excluded  <M> module  < > module capable

               Vendor/Product Selection  --->
               Kernel/Library/Defaults Selection  --->
               ---
               Load an Alternate Configuration File
               Save Configuration to an Alternate File

                  <Select>    < Exit >    < Help >
```

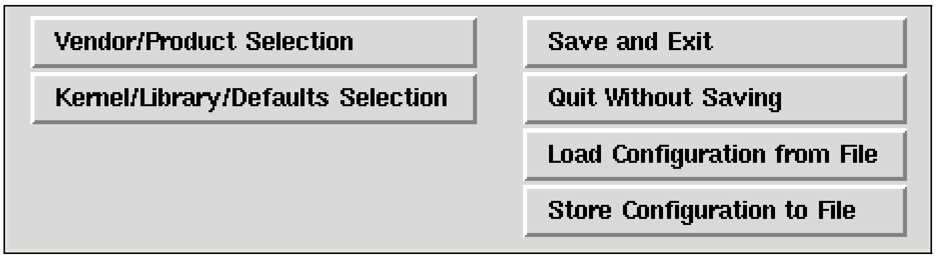
6.1.3. GUI Screen Configuration (make xconfig)

The `make xconfig` target can be used in an environment where the X Window System is available. Mouse operation is possible with make xconfig, unlike the Menu Screen in the terminal.

Example 6-3 Command for activating GUI Based Configuration

```
[PC ~/atmark-dist]$ make xconfig
```

Figure 6-2 GUI Based Configuration Screen


Vendor/Product Selection
Kernel/Library/Defaults Selection
Save and Exit
Quit Without Saving
Load Configuration from File
Store Configuration to File

6.2. Cleaning (clean)

This target is used to clean the inside of atmark-dist. The following three kinds of clean target are available in atmark-dist.

make clean
Cleans the kernel directory, and deletes files in the `romfs/image` directory.
make real_clean
Deletes the `romfs/image` directory, and deletes configuration files such as `.config`.
make distclean
Executes the distclean target in the kernel directory etc.

6.3. Resolving Dependency (dep)

It is necessary to resolve dependency before executing a make in Linux Kernel build systems 2.4 series and earlier. This target resolves dependency in the Kernel directory. This target should always be executed after restoring the atmark-dist source archive or after executing `distclean`.

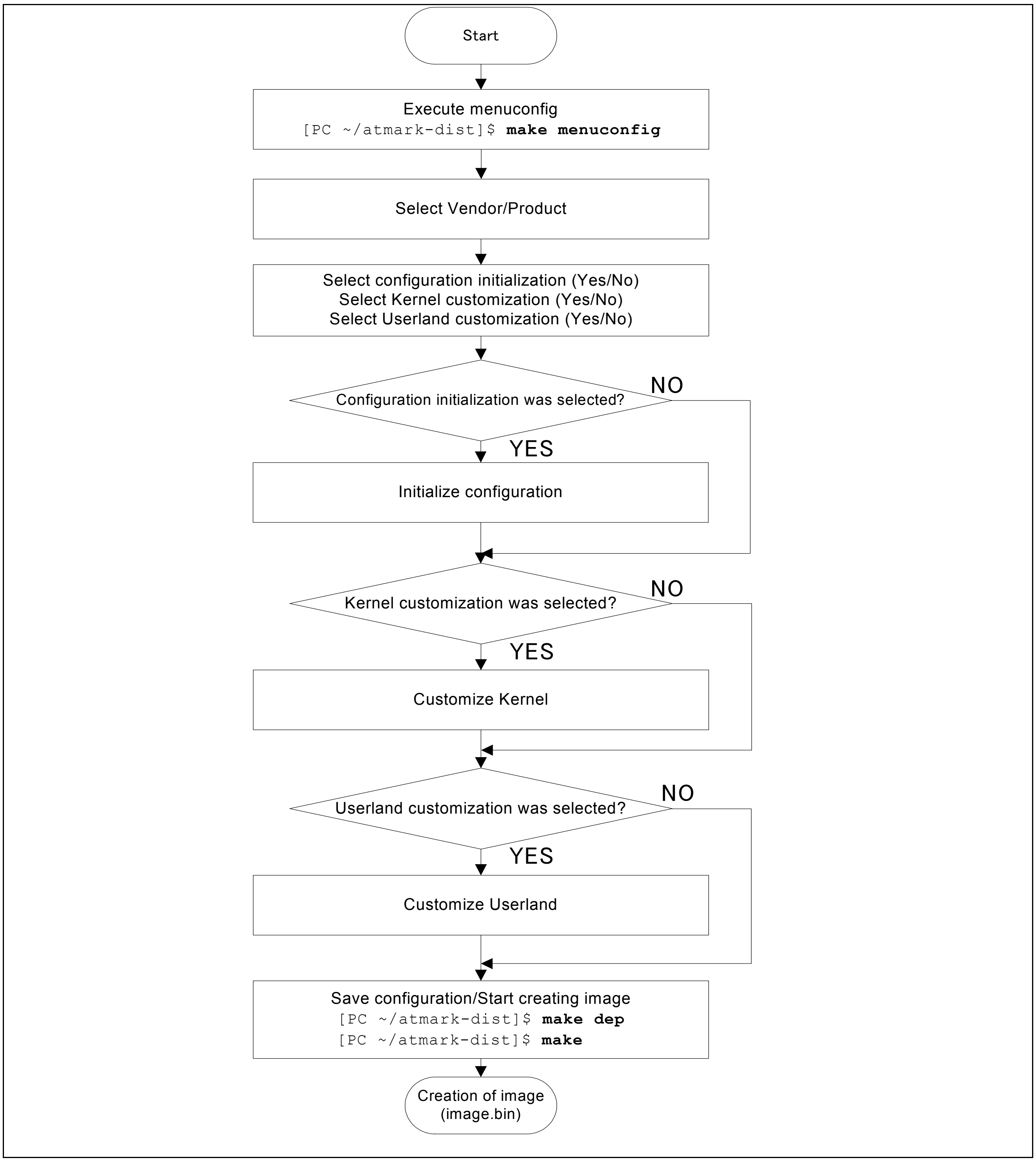
6.4. Default (all)

The `all` target is the atmark-dist default target. This target is executed by executing a make command without any options. The `all` target compiles necessary code (kernel, userland applications and libraries) and then creates the image file to be transferred to the target board.

7. Image File Creation

7.1. Overall Work Flow

Figure 7-1 Image Creation Work Flow


Start
Execute menuconfig
Select Vendor/Product
Select configuration initialization (Yes/No)
Select Kernel customization (Yes/No)
Select Userland customization (Yes/No)
Configuration initialization was selected?
NO
YES
Initialize configuration
Kernel customization was selected?
NO
YES
Customize Kernel
Userland customization was selected?
NO
YES
Customize Userland
Save configuration/Start creating image
Creation of image (image.bin)

```
[PC ~/atmark-dist]$ make menuconfig
```

```
[PC ~/atmark-dist]$ make dep
[PC ~/atmark-dist]$ make
```

The following explains the procedure for creating a default image. This procedure can be roughly divided into three stages.

- Configuration
- Resolving dependencies of kernel source code
- Building

7.2. Basic Operation of Menu Based Configuration

7.2.1. Navigation

Menus can be navigated using the cursor keys.

7.2.2. Submenu Selection

Submenus can be selected by hitting the Enter key. Submenus are indicated with "`--->`."

7.2.3. Selection from a List

Items displayed with parentheses "`()`" can be selected from a list. Move to the list screen with the "Enter" key, move to the target with the up and down cursor keys, and make the selection with the Enter hey.

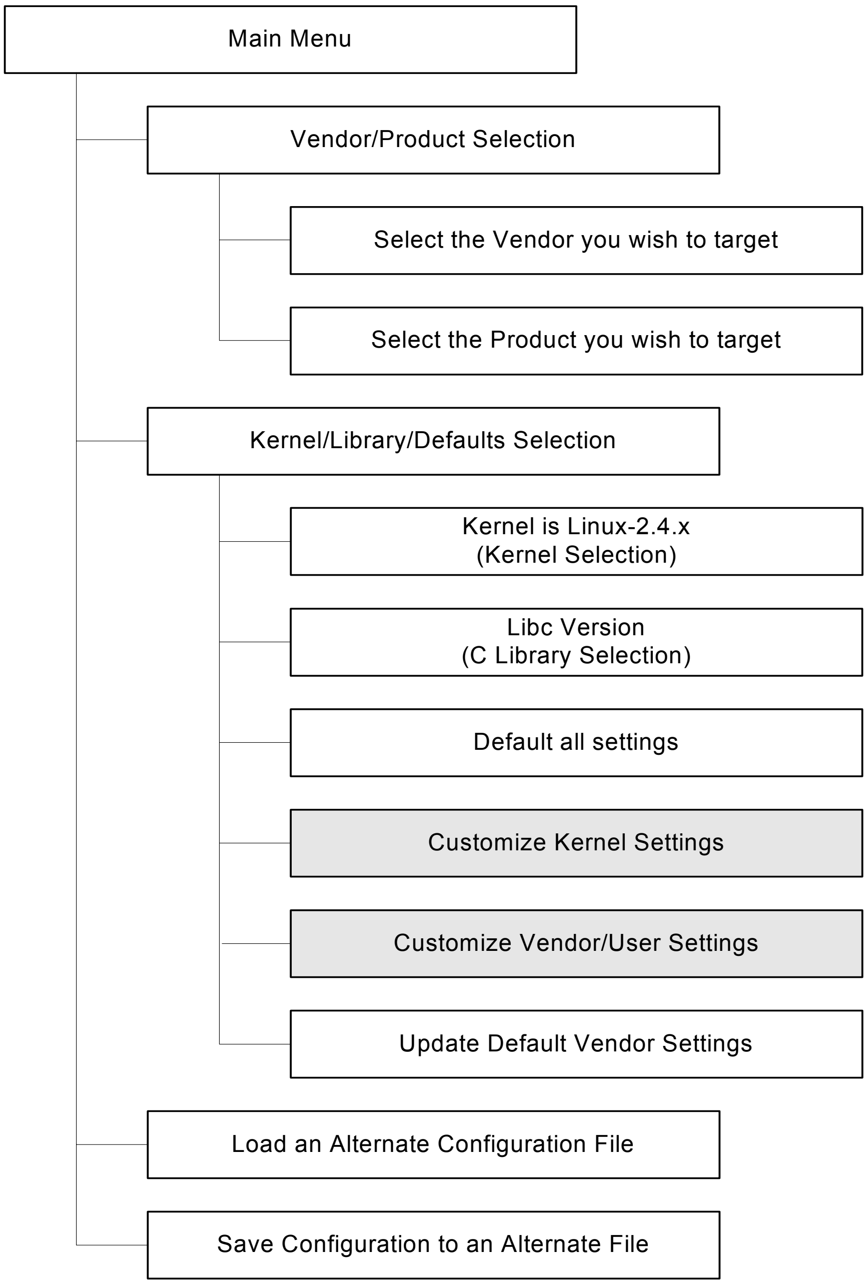
7.2.4. Applicable/Not-Applicable Selection

Items displayed with brackets "`[]`" can either be selected or deselected. An asterisk "`*`" is displayed in the brackets when the item is selected.

7.3. Configuration

Configuration can be carried out using either one of the commands introduced in 6.1, "Configuration (config)". The following explanation makes use of the `make menuconfig` command.

Configuration can be roughly divided as follows.


Main Menu
Vendor/Product Selection
Select the Vendor you wish to target
Select the Product you wish to target
Kernel/Library/Defaults Selection
Kernel is Linux-2.4.x (Kernel Selection)
Libc Version (C Library Selection)
Default all settings
Customize Kernel Settings
Customize Vendor/User Settings
Update Default Vendor Settings
Load an Alternate Configuration File
Save Configuration to an Alternate File

When “Kernel Customization” or “Vendor/User Customization” is selected, the appropriate configuration menu will be automatically displayed after the current menu is closed.

Configuration is started as follow.

```
[PC ~/atmark-dist]$ make menuconfig
```

7.3.1. Main Menu

The Main Menu Screen is displayed after executing the `menuconfig` command. Each submenu can be reached from this screen.

7.3.2. Vendor/Product Selection

Select the vendor and product. The vendor is selected first, followed by the product.

7.3.3. Kernel/Library/Defaults Selection

Select the kernel, library and defaults. The following menus are part of this submenu.

7.3.4. Kernel Version (Kernel Selection)

Select the kernel versions to build for products that support two or more kernels. Kernels currently supported by Atmark Techno are limited to 2.4 series, so other versions can not be selected.

7.3.5. Libc Version (C Library Selection)

Select the C libraries to build for products that support two or more C libraries. The following four choices can be selected.

- None
- gibc – GNU C library
- uC-libc
- uClibc

Binaries previously installed in the development environment are used when “None” is selected. Code included in atmark-dist is built in all other options.

As compatible libraries differ by product, please refer to the software manual of the product.

7.3.6. Default all settings

Sets all settings to their default state. Note that all previously changed configuration information will be lost.

7.3.7. Customize Kernel Settings

Select whether or not to perform Linux kernel configuration. When selected, the kernel configuration screen will appear automatically after atmark-dist configuration has completed.

7.3.8. Customize Vendor/User Settings

Select whether or not to perform vendor / userland configuration. When selected, the userland configuration screen will appear automatically after atmark-dist configuration has completed. The userland menu is detailed in the following section.

7.3.9. Update Default Vendor Settings

Replace default settings with present settings. Note that there is no way to return to previous defaults after this update has been made.

7.4. Userland Settings

The userland menu is divided into the following items. This section briefly describes each of these items.

7.4.1. Core Applications

Contains the basic applications required to operate as a system. `init` for system initialization and `login` for user identification can be selected in this section.

7.4.2. Library Configuration

Additional libraries can be selected here. Libraries required by in-tree applications are selected automatically.

7.4.3. Flash Tools

Applications related to flash memory can be selected. Netflash, a network update application described in a later chapter, can be selected here.

7.4.4. Filesystem Applications

Applications related to the file system can be selected. Flatfsd explained in a following chapter can be selected here. Apart from this, `mount`, `fdisk`, the ext2 file system, the Reiser file system and Samba etc. are included here.

7.4.5. Network Applications

Applications related to networking can be selected. `ppp` and utilities for wireless networks etc. are included as well as `dhcpcd-new`, `ftpd`, `ifconfig`, `inetd` and `thttpd`.

7.4.6. Miscellaneous Applications

Applications that do not belong to any other category described above are included here. General Unix commands (`cp`, `ls`, `rm`), editors, audio related applications, and a script language interpreter etc. are included.

7.4.7. Busybox

Customization of Busybox can be performed. Busybox is a single command that includes multiple functions, and is well used in embedded Linux. As it has many customizable items, it is categorized in its own seperate section.

7.4.8. Tinylogin

Tinylogin is also a single application that includes multiple functions. It offers functions related to user identification, such as `login`, `password` and `getty` etc. As it has many customizable items, it is categorized in its own seperate section.

7.4.9. MicroWindows

MicroWindows is a graphical window environment targeted towards embedded devices. It can be used when devices with LCDs etc. are developed.

7.4.10. Games

Games. No explanation should be needed, right?

7.4.11. Miscellaneous Configuration

Various settings have been brought together here. The root user password can be changed here.

7.4.12. Debug Builds

Various debug options have been brought together here. These can be used when debugging applications under development.

7.5. Resolving Kernel Source Code Dependencies

Image builds also include kernel builds. Dependencies must be resolved before carrying out a build of Linux kernels 2.4 or earlier. This applies to uClinux also.

The `make dep` command is used.

Example 7-1 Execution of make dep

```
[PC ~/atmark-dist]$ make dep
    :
    :
[PC ~/atmark-dist]$
```

7.6. Building

The build is carried out after resolving dependencies. As the build system will perform everything automatically, the developer only needs to enter the `make` command.

Example 7-2 Execution of make

```
[PC ~/atmark-dist]$ make
    :
    :
[PC ~/atmark-dist]$ ls images
image.bin  linux.bin  romfs.img
```

The image file or files should be created in the images directory after the make command has completed.

7.7. Build Work Flow in Depth

By understanding how the build proceeds internally and how it eventually produces the image file or files, it becomes possible to choose to build only the required parts. This can greatly reduce the time required for the build. Moreover, this understanding may be indispensable in performing customization for a specific product.

While carrying out a default build does create the image file, the build process actually executes many targets to achieve this. The build rule of the default target is defined in the Makefile in the atmark-dist root directory as follows.

```
ifeq (.config,$(wildcard .config))
include .config

all: subdirs romfs modules modules_install image
else
all: config_error
endif
```

From this, you can see that once the default build is executed, the build proceeds in the follwoing order: `subdirs`, `romfs`, `modules_install` and `image`.
Following this order, each target is explained below.

7.7.1. subdirs Target

The `subdirs` build rule of the Makefile in the atmark-dist root directory is shown below.

```
DIRS    = $(VENDOR_TOPDIRS) include lib include user
:
:
subdirs: linux
        for dir in $(DIRS) ; do [ ! -d $$dir ] || $(MAKEARCH_KERNEL) -C
$$dir ||
 exit 1 ; done
```

When building the `subdirs` target, the build proceeds in the order of `linux`, `$(VENDOR_TOPDIRS)`, `include lib` and `include user`.

The `linux` target performs the build for the selected Linux kernel. Although kernel versions 2.0, 2.4 and 2.6 are supported in atmark-dist, Atmark Techno products currently only support Linux Kernel 2.4.

While `VENDOR_TOPDIRS` can be specified by `config.arch` in the product directory, it seems that not many products do in fact specify this directory. Some products that do specify `VENDOR_TOPDIRS` specify a directory named boot. Atmark Techno products do not use this variable.

The `lib` directory contains libraries. While `uClibc` and `glibc` are not included in the `lib` directory, a symbolic link is created in the directory at time of configuration.

The `user` directory contains the userland applications. The `user` directory has an exclusive Makefile, and the top level Makefile hands control to this exclusive Makefile.

The Makefile in the product directory is called from the Makefile in the `user` directory. The following example is an extract from `user/Makefile`.

Example 7-3 Calling of Product Makefile From user/Makefile

```
VEND=$(ROOTDIR)/vendors

#
# must run the vendor build first
#
dir_v = $(VEND)/$(CONFIG_VENDOR)/$(CONFIG_PRODUCT)/.
dir_p = $(ROOTDIR)/prop

dir_y =
dir_n =
dir_  =
     :
     :
     :
     :

all: config
	for i in $(sort $(dir_y)) $(dir_v) $(dir_p); do \
		[ ! -d $$i ] || make -C $$i || exit $$? ; \
	done
```

7.7.2. romfs Target

The `romfs` target is called recursively for each directory. In most cases, `romfs-inst.sh` is used to install the necessary files to the `atmark-dist/romfs` directory.

Example 7-4 romfs Target Processing at The Top Level Makefile

```
DIRS    = $(VENDOR_TOPDIRS) include lib include user
        :
        :
        :
```

```
romfs:
        for dir in $(DIRS) ; do [ ! -d $$dir ] || $(MAKEARCH) -C $$dir
romfs || exit 1 ; done
        -find $(ROMFSDIR)/. -name CVS | xargs -r rm -rf
        done
```

Example 7-5 romfs Target Processing at user/Makefile

```
VEND=$(ROOTDIR)/vendors

#
# must run the vendor build first
#
dir_v = $(VEND)/$(CONFIG_VENDOR)/$(CONFIG_PRODUCT)/.
dir_p = $(ROOTDIR)/prop

dir_y =
dir_n =
dir_  =
    :
    :
    :
    :

romfs:
        for i in $(dir_v) $(sort $(dir_y)) $(dir_p) ; do \
                [ ! -d $$i ] || make -C $$i romfs || exit $$? ; \
        done
```

When the build is performed, the build for the selected applications in the `user` directory is performed first, and then the product Makefile is called.

However, the Makefile in the product directory is called first for the romfs target. While, this is to provide for flexibility for each product, it can be ignored unless performing a considerably complex build.

7.7.3. module

In the Linux kernel, a large number of device drivers, file systems and other components can separated in the form of a module. This target executes module targets within the Linux kernel build system.

7.7.4. module_install

The kernel modules built with the above target are installed in `romfs`. Specifically, they are installed in `romfs/lib/modules`.

7.7.5. image

The `image` target executes the image targets of product Makefiles. Many products combine the kernel image with the userland file system image file to make one image file.

As the targets of product Makefiles are called directly, the developer can freely handle the process. A general flow is shown below.

1. Create the Linux kernel binary file (Convert from elf to binary)
2. Create the image file from the `romfs` directory (Using genext2fs, genromfs, or mkjffs2)
3. Combine the above two files into one
4. Create the checksum etc. for NetFlash and attach it to the binary file

8. Product Directories

The product directories are a directory group that exist under `atmark-dist/vendors/[Vendor Name]/`. For instance, the products of Atmark Techno are listed under `atmark-dist/vendors/AtmarkTechno/`.

The product directory contains the various settings that differ product to product within the build system, such as the build process defining Makefiles, the config files used for defaults values at build time, and configuration files required by the applications.

The following describes the config files used for default settings as well as Makefiles.

8.1. config.arch

The config.arch files contain architecture dependent configuration information. As default values for each architecture are already entered, changes can be made by simply overwriting the appropriate values.

The following variables can be specified.

`CPUFLAGS`
  Compile flag for CPU can be specified.
`VENDOR_CFLAGS`
  CFLAGS for vendor dependence can be specified.
`DISABLE_XIP`
  Set to “1” to disable XIP (Execute In Place).
`DISABLE_SHARED_LIBS`
  Set to “1” to disable shared libraries.
`DISABLE_MOVE_RODATA`
  Set to “1” to disable read-only data area movement.
`LOPT`
  Specify options passed to the compiler when compiling libraries.
`UOPT`
  Specify options passed to the compiler when compiling Userland applications.
`CONSOLE_BAUD_RATE`
  Specify the serial console baud rate.

8.2. config.linux-2.4.x

`config.linux-2.4.x` stores the `.config` files created by the Linux kernel build system under a different name in the product directories.

These files are used as the kernel configuration default values. To change the kernel values and then use those values as the defaults, please overwrite these files. It is also possible to use the menu as shown in section 7.3.9, “Update Default Vendor Settings”.

8.3. config.vendor

`config.vendor` contains information on the userland applications. It maintains information that the atmark-dist build system sets with menuconfig etc.

This file is a copy of `atmark-dist/config/.config`.

Default values can be changed by overwriting in the same way as `config.linux-2.4.x`.

8.4. config.uClibc

`config.uClibc` is the configuration file of uClib. uClibc cannot currently be configured from the dist menu. uClibc configuration can however be performed by moving to the `uClibc` directory and using the uClibc configuration tools there. uClibc configuration employs the Linux kernel build system in the same way as atmark-dist.

8.5. Makefile

The Makefile controls the creation of the actual image file or files. This includes control of the program and device files install destinations, install destinations of data and configuration files required by the program, and checksum generation.

9. romfs Installation Tool

Compiled applications and the various configuration files are installed in the atmark-dist/romfs directory by the romfs target in the Makefiles. Configuration files and data files required by the applications are also installed in the atmark-dist/romfs directory at the same time.

The reason why romfs is used as the directory name is because, unlike the ext2, ext3, reiserfs, and xfs used in desktop and server Linux systems, romfs is used in most embedded systems. However, the directory itself is not dependant on romfs. As described later, jffs2 and others also use the same romfs directory.

The romfs directory structure is the same as the directory structure that can be seen on the target system when it is booted. The romfs directory becomes the root directory, and holds the bin, dev and etc and so on under it.

atmark-dist includes a script named romfs-inst.sh that allows for simple installation of files into the romfs directory. This script is contained in the atmark-dist/tools directory.
romfs-inst.sh is assigned to a variable named ROMFSINST by the Makefile in the atmark-dist directory. Therefore, it is common to use this script as the variable ROMFSINST without paying attention to where the script is in the Makefile of each directory in atmark-dist.

9.1. Overview

romfs-inst.sh displays a simple help when the romfs directory specifying environment variable ROMFSDIR is not set.

Example 9-1 Help for romfs-inst.sh

```
[PC ~/atmark-dist]$ tools/romfs-inst.sh
ROMFSDIR is not set
tools/romfs-inst.sh: [options] [src] dst
    -v          : output actions performed.
    -e env-var  : only take action if env-var is set to "y".
    -o option   : only take action if option is set to "y".
    -p perms    : chmod style permissions for dst.
    -a text     : append text to dst.
     -A pattern  : only append text if pattern doesn't exist in file
    -l link     : dst is a link to 'link'.
    -s sym-link : dst is a sym-link to 'sym-link'.

    if "src" is not provided,  basename is run on dst to determine the
    source in the current directory.

    multiple -e and -o options are ANDed together.  To achieve an OR
    affect use a single -e/-o with 1 or more y/n/"" chars in the
    condition.

    if src is a directory,  everything in it is copied recursively to
    dst with special files removed (currently CVS dirs).
```

The command syntax of `romfs-inst.sh` is shown below.

Example 9-2 romfs-inst.sh Command Syntax

```
romfs-inst.sh [options] [src] dst
```

The "[ ]" selections are optional and can be omitted. The `basename` command is applied to dst and the return value used when src has not been specified. `romfs-inst.sh` retrieves the value from the current directory (the product directory in the case of product Makefiles).

```
[PC ~]$ basename /foo/bar
bar
```

If a directory is specified as src, all files and directories except the 'CVS' directory under it are installed. The following section details an example of using `romfs-inst.sh`.

9.2. Installing Files

When you need to install a file, write a `romfs` target in the Makefile as follows.

```
romfs:
      $(ROMFSINST) src.txt /etc/dst.txt
```

This means that `scr.txt` in the product directory will be installed `as /etc/dst.txt` in the romfs directory. If the romfs directory name is `~/atmark-dist/romfs`, then the file `~/atmark-dist/romfs/etc/dst.txt` will be created.

If the `src.txt` file in the product directory is changed to `dst.txt`, the description can be simplified as follows.

```
$(ROMFSINST) /etc/dst.txt
```

As mentioned above, `romfs-inst.sh` retrieves the source file or directory from the current directory using the basename of dst when src is omitted.

Thus the basename of `/etc/dst.txt` is `dst.txt`, and the description above has same meaning as the one below.

```
$(ROMFSINST) dst.txt /etc/dst.txt
```

9.3. Installing Directories

Installing by directory makes installing many files to a target device easier, such as when installing many configuration files to the `/etc` directory of the target.

Create a directory named etc in the product directory and place the necessary files there. Then write the following in the Makefile.

```
$(ROMFSINST) /etc
```

As src is omitted in this example, `romfs-inst.sh` uses the basename of dst. With the basename of `/etc` being etc, `romfs-inst.sh` retrieves the file or directory with the name etc in the product directory. Then if the name specified is a directory, `romfs-inst.sh` installs the directory along with the contained files.

This can be easily confirmed by using the `tree` command as follows.

```
[PC ~]$ tree ~/atmark-dist/vendors/AtmarkTechno/test/etc
:
[PC ~]$ tree ~/atmark-dist/romfs/etc
:
```

Of course, it is also possible to install a directory with a name different to the orignal name.

```
  $(ROMFSINST) /etc /var
```

This command installs the directory named etc from the product directory to `romfs/var`.

9.4. Creating Links

Links can be easily created using `romfs-inst.sh`. However, it is important to fully understand both hard links and symbolic links.

The `-s` option is used to create a symbolic link. A symbolic link to `a.txt` is created here as an example. The `romfs` target of the product Makefile is as follows.

```
  romfs:
       [ -d $(ROMFSDIR) ] || mkdir -p $(ROMFSDIR)
       $(ROMFSINST) /a.txt
       $(ROMFSINST) -s a.txt /b.txt
```

```
[PC ~/atmark-dist]$ make clean; make romfs
    :
    :
[PC ~/atmark-dist]$ ls -l romfs
total 0
-rw-r--r--  1 guest guest 0 Sep 24 05:43 a.txt
lrwxrwxrwx  1 guest guest 5 Sep 24 05:43 b.txt -> a.txt
```

The following shows an example of a hard link, using the `-l` option.

```
  romfs:
       [ -d $(ROMFSDIR) ] || mkdir -p $(ROMFSDIR)
       $(ROMFSINST) /a.txt
       $(ROMFSINST) -l a.txt /b.txt
```

```
[PC ~/atmark-dist]$ make clean; make romfs
    :
    :
[PC ~/atmark-dist]$ ls -il romfs
6077732 a.txt
6296750 b.txt
[PC ~/atmark-dist]$ ls -il vendors/AtmarkTechno/test/a.txt
6296750 vendors/ATmarkTechno/test/a.txt
```

That `b.txt` in the `romfs` directory is a hard link to `a.txt` in the product directory and not a hard link to `a.txt` in romfs can be seen from the inode number.

As the use of hard links can be the source of confusion, their use is not recommended unless you have good reason to do so. It also seems that hard links are rarely used for a `romfs` target in the current atmark-dist.

9.5. Adding Information to Files

Information can be easily added to existing files using `rom-inst.sh.`

The syntax is as follows.

```
$(ROMFSINST) -a "Character strings" File name in romfs directory
```

```
  romfs:
        [ -d $(ROMFSDIR) ] || mkdir -p $(ROMFSDIR)
        $(ROMFSINST) -a 'Hello' /a.txt
        $(ROMFSINST) -a 'World' /a.txt
```

```
[PC ~/atmark-dist]$ make clean; make romfs
     :
     :
[PC ~/atmark-dist]$ cat romfs/a.txt
Hello
World
```

9.6. Conditional Execution

Conditional execution control is possible with `romfs-inst.sh`.

```
$(ROMFSINST) -e variable name command to be executed
```

Environment variable names often start with `CONFIG_` .

```
  romfs:
        [ -d $(ROMFSDIR) ] || mkdir -p $(ROMFSDIR)
        $(ROMFSINST) -e CONFIG_DEFAULTS_ATMARKTECHNO -a 'Hello' /a.txt
        $(ROMFSINST) -e CONFIG_DEFAULTS_UNKNOWN -a 'World' /a.txt
```

```
[PC ~/atmark-dist]$ make clean; make romfs
     :
     :
[PC ~/atmark-dist]$ cat romfs/a.txt
Hello
```

As `CONFIG_DEFAULTS_UNKNOWN` is not defined, it does not apply as a condition and the “World” character string is not written to `a.txt`. `CONFIG_DEFAULTS_ATMARKTECHNO` is defined in `atmark-dist/.config` when AtmarkTechno is selected as the vendor name.

10. Adding New Applications

This chapter explains how to create applications that operate on the target board and then how to add the created applications to atmark-dist.

10.1. Out of Tree Compiling

“Out of Tree” compiling is a method that allows for easy development without the need to make any changes to atmark-dist. As it uses the atmark-dist build system, there is no need to write complex Makefiles. It has this name as the directory structure of atmark-dist can be seen as a tree, and compiling is performed outside of that directory structure.

The following shows how to actually create “Hello World” for a target board.

10.1.2. Preparation

As the build system and library groups contained in atmark-dist are used in the “Out of Tree” compile, a atmark-dist that has been compiled once is required. First please check that the atmark-dist has been configured and built for the target board.

10.1.3. Source Code

Next make a directory for the application outside of the atmark-dist directory structure. The Makefile and necessary C source code and header files will be stored in this directory.

```
[PC ~]$ ls
atmark-dist
[PC ~]$ mkdir hello
[PC ~]$ ls
hello  atmark-dist
[PC ~]$ ls hello
Makefile  hello.c
```

`hello.c`, as shown below, is a simple program that can been seen in any C text book.

```
#include <stdio.h>

int main(int argc, char * argv[])
{
        printf(“Hello World\n”);
        return 0;
}
```

The Makefile shown below is used.

```
# ROOTDIR=/usr/src/atmark-dist --------------------------------------- ①
ifndef ROOTDIR
ROOTDIR=../atmark-dist
endif
ROMFSDIR  = $(ROOTDIR)/romfs
```

```
ROMFSINST = romfs-inst.sh
PATH      := $(PATH):$(ROOTDIR)/tools

ATMARK_BUILD_USER = 1
include $(ROOTDIR)/.config
LIBCDIR = $(CONFIG_LIBCDIR)
include $(ROOTDIR)/config.arch


EXEC = hello ---------------------------------------------------------- ②
OBJS = hello.o -------------------------------------------------------- ③


all: $(EXEC)

$(EXEC): $(OBJS)
     $(CC) $(LDFLAGS) -o $@ $(OBJS) $(LDLIBS)

clean:
     -rm -f $(EXEC) *.elf *.gdb *.o

romfs:
     $(ROMFSINST) /bin/$(EXEC)

%.o: %.c
     $(CC) -c $(CFLAGS) -o $@ $<
```

This Makefile can be used as a template when applications besides Hello World are developed. The following three points need to be changed in accordance with your environment.

① It is assumed that the `atmark-dist` directory exists in parallel to the current directory when `ROOTDIR` is not specified. When atmark-dist resides in a different place, remove the comment in this line and change directory name as appropriate.
② Specify the executable file name to be created. `hello` is specified here.
③ Specify the object file that the executable file is to be created from. `hello.o` is specified here.

10.1.4. Build (uClinux)

The build for "hello" can be carried out once the Makefile and `hello.c` are ready. The `make` command is used for the build. The executable file `hello` will be created in the directory when the build completes. (This example is for uClinux. Output files may be different in Linux).

```
[PC ~/hello]$ make
     :
     :
[PC ~/hello]$ ls hello*
hello  hello.c  hello.gdb  hello.o
[PC ~/hello]$ file hello*
hello:     BFLT executable - version 4 ram
```

```
  hello.c:    ASCII C program text
  hello.gdb:  ELF  32-bit  MSB  executable,  version  1  (SYSV),  statically
linked, not stripped
  hello.o:    ELF 32-bit MSB relocatable, version 1 (SYSV), not stripped
```

`hello.gbd` is an ELF format executable file and is used for debugging. `hello` is in the uClinux “Flat Binary” format.

10.1.5. Installing

To install the executable file in the atmark-dist romfs directory, specify `romfs` in the `make` command.

```
[PC ~/hello]$ make romfs
romfs-inst.sh /bin/hello
[PC ~/hello]$ ls ../atmark-dist/romfs/bin/hello
hello
```

10.1.6. Creating the Image File

After the `make romfs` command, move to the atmark-dist directory, execute the `make image` command, and a target board image file that includes hello will be generated in the image directory.

```
[PC ~/hello]$ cd ../atmark-dist
[PC ~/atmark-dist]$ make image
    :
    :
[PC ~/atmark-dist]$ ls images
image.bin  linux.bin  romfs.image
```

For more information on the image target, refer to section 7.7.5, “image”.

10.1.7. Multiple Source Code Files

Executables with multiple source code files can be supported by making changes in the Makefile. The following example generates the executable `hello` from `hello.c` and `print.c`.

```
[PC ~/hello]$ ls
Makefile  hello.c  print.c
```

`hello.c`

```
#include <stdio.h>

extern void print_hello(char * string);

int main(int argc, char * argv[])
{
        print_hello(“World”);
        return 0;
}
```

print.c

```
void print_hello(char * string)
{
        printf("Hello %s\n", string);
}
```

Add `print.o` to `OBJS` in the Makefile.

```
# ROOTDIR=/usr/src/atmark-dist
ifndef ROOTDIR
ROOTDIR=../atmark-dist
endif
ROMFSDIR  = $(ROOTDIR)/romfs
ROMFSINST = romfs-inst.sh
PATH      := $(PATH):$(ROOTDIR)/tools

ATMARK_BUILD_USER = 1
include $(ROOTDIR)/.config
LIBCDIR = $(CONFIG_LIBCDIR)
include $(ROOTDIR)/config.arch


EXEC = hello
OBJS = hello.o print.o ----------------------------------- Add "print.o"


all: $(EXEC)

$(EXEC): $(OBJS)
     $(CC) $(LDFLAGS) -o $@ $(OBJS) $(LDLIBS)

clean:
     -rm -f $(EXEC) *.elf *.gdb *.o

romfs:
     $(ROMFSINST) /bin/$(EXEC)

%.o: %.c
     $(CC) -c $(CFLAGS) -o $@ $<
```

```
[PC ~/hello]$ make
    :
    :
[PC ~/hello]$ ls
Makefile  hello  hello.c  hello.gdb  hello.o  print.c  print.o
```

10.1.8. pthread Support

It is necessary to link the thread specific libraries for applications that use threads. The Makefile is changed as follows.

```
# ROOTDIR=/usr/src/atmark-dist
ifndef ROOTDIR
ROOTDIR=../atmark-dist
endif
ROMFSDIR  = $(ROOTDIR)/romfs
ROMFSINST = romfs-inst.sh
PATH      := $(PATH):$(ROOTDIR)/tools

ATMARK_BUILD_USER = 1
include $(ROOTDIR)/.config
LIBCDIR = $(CONFIG_LIBCDIR)
include $(ROOTDIR)/config.arch


EXEC = hello
OBJS = hello.o


all: $(EXEC)

$(EXEC): $(OBJS)
	$(CC) $(LDFLAGS) -o $@ $(OBJS) $(LIBPTHREAD) $(LDLIBS) ---------- ①

clean:
	-rm -f $(EXEC) *.elf *.gdb *.o

romfs:
	$(ROMFSINST) /bin/$(EXEC)

%.o: %.c
	$(CC) -c $(CFLAGS) -o $@ $<
```

① Add “$(LIBPTHREAD)”.

10.2. Product Specific Applications

It is almost a certainty that product specific applications will exist when dealing with embedded devices. This section introduces the method of integrating these applications into atmark-dist.

10.2.1. Directory Creation

Make a directory for the application under
`atmark-dist/vendors/$(CONFIG_VENDOR)/$(CONFIG_PRODUCT).`
Change `$(CONFIG_VENDOR) and $(CONFIG_PRODUCT)` to correspond to the board being used. Here, it is assumed that the vendor is AtmarkTechno, the product is SUZAKU and the application is hello.

```
[PC ~]$ mkdir atmark-dist/vendors/AtmarkTechno/SUZAKU/hello
[PC ~]$ ls -d atmark-dist/vendors/AtmarkTechno/SUZAKU/hello
hello
```

10.2.2. Preparing Source Code

The `hello.c` used in the preceding section is used for the C source code here. The Makefile is simpler than the one used for the "Out of Tree" compile.

```
EXEC = hello
OBJS = hello.o


all: $(EXEC)

$(EXEC): $(OBJS)
     $(CC) $(LDFLAGS) -o $@ $(OBJS) $(LDLIBS)

clean:
     -rm -f $(EXEC) *.elf *.gdb *.o

romfs:
     $(ROMFSINST) /bin/$(EXEC)

%.o: %.c
     $(CC) -c $(CFLAGS) -o $@ $<
```

10.2.3. Application Configuration

The added application is then added to the product Makefile. The product Makefile contains the variable `DIRS` to which the directory name of the application is added.

```
     :
     :
DIRS = hello
     :
     :
```

10.2.4. Build

The build method is the same as the method described in section 7.6, "Building". As the `all`, `clean` and `romfs` targets are defined as follows, the appropriate commands will be executed for all directories specified with `DIRS`.

```
all:
     dirs=$(DIRS); \
     for i in $$dirs; do $(MAKE) –C $$i clean || exit $? ; done

clean:
     -dirs=$(DIRS); \
     for i in $$dirs; do [ ! -d $$I ] || $(MAKE) -C $$i clean; done
```

```
romfs:
     :
     :
     dirs=$(DIRS); \
     for I in $$dirs; do $(MAKE) –C $$i romfs || exit $?; done
```

10.3.Merging to The user Directory

There are times when an application first developed for a specific product later becomes used by various different products. In such cases, the application can be shared between the products by moving it to the user directory.

10.3.1. Directory Creation

Create a directory for the application under `atmark-dist/user`. Here, `hello` is created.

```
[PC ~]$ mkdir atmark-dist/user/hello
[PC ~]$ ls -d atmark-dist/user/hello
hello
```

10.3.2. Preparing Source Code

The same C source code and Makefile used in section 10.2, “Product Specific Applications” is used here.

10.3.3. Application Configuration

Changes are made `in atmark-dist/config/config.in` and `atmark-dist/user/Makefile`. In this example, the application is added to Miscellaneous Applications. It is entered in alphabetical order.

Example 10-1 atmark-dist/config/config.in Changes

```
--- config.in.orig      2004-04-18 04:03:57.000000000 +0900
+++ config.in    2004-05-26 17:58:38.000000000 +0900
@@ -515,6 +515,7 @@
 bool 'gdbreplay'       CONFIG_USER_GDBSERVER_GDBREPLAY
 bool 'gdbserver'       CONFIG_USER_GDBSERVER_GDBSERVER
 bool 'hd'              CONFIG_USER_HD_HD
+bool 'hello'                    CONFIG_USER_HELLO_HELLO
 bool 'lcd'                  CONFIG_USER_LCD_LCD
 bool 'ledcon'               CONFIG_USER_LEDCON_LEDCON
 bool 'lilo'                 CONFIG_USER_LILO_LILO
```

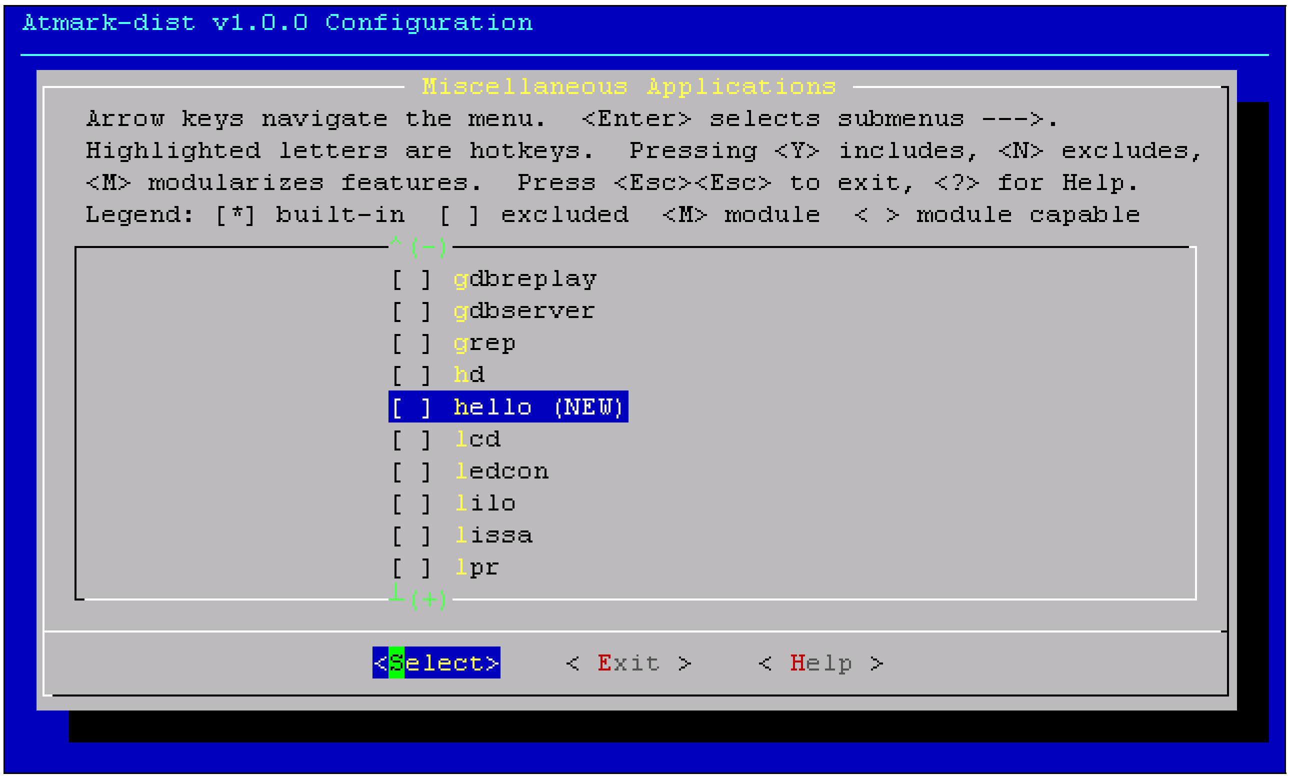
Example 10-2 atmark-dist/user/Makefile Changes

```
--- Makefile.orig       2004-02-20 13:22:55.000000000 +0900
+++ Makefile    2004-05-26 17:56:09.000000000 +0900
@@ -123,6 +123,7 @@
 dir_$(CONFIG_USER_GDBSERVER_GDBSERVER)      += gdbserver
 dir_$(CONFIG_USER_GETTYD_GETTYD)            += gettyd
 dir_$(CONFIG_USER_HD_HD)                    += hd
+dir_$(CONFIG_USER_HELLO_HELLO)              += hello
 dir_$(CONFIG_USER_HOSTAP_HOSTAP)            += hostap
 dir_$(CONFIG_USER_HTTPD_HTTPD)              += httpd
 dir_$(CONFIG_USER_HWCLOCK_HWCLOCK)          += hwclock
```

10.3.4. Application Selection

Make sure that the application added with make `menuconfig` is displayed in the Miscellaneous Applications section. Select the displayed hello and save the settings.

Figure 10-1 hello Added to the Menu



```
Atmark-dist v1.0.0 Configuration
                    Miscellaneous Applications
  Arrow keys navigate the menu.  <Enter> selects submenus --->.
  Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes,
  <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help.
  Legend: [*] built-in  [ ] excluded  <M> module  < > module capable
                      ^(-)
                      [ ]  gdbreplay
                      [ ]  gdbserver
                      [ ]  grep
                      [ ]  hd
                      [ ]  hello (NEW)
                      [ ]  lcd
                      [ ]  ledcon
                      [ ]  lilo
                      [ ]  lissa
                      [ ]  lpr
                      v(+)

                 <Select>    < Exit >    < Help >
```

10.3.5. Building

The “In Tree” compiling build is the same as the method described in section 7.6, “Building”. Transfer the generated image file to the target board and make sure that hello runs properly.

10.3.6. Configuration Naming Rule

The configuration name used here is `CONFIG_USER_HELLO_HELLO`.

In atmark-dist, the directory and applications names are used for userland application selection.

- All configuration options begin with `CONFIG_`.
- Those under `atmark-dist/user` begin with `CONFIG_USER_`.
- As the directory name is hello, the option begins with `CONFIG_USER_HELLO_`.
- Then after adding the application name, it becomes `CONFIG_USER_HELLO_HELLO`.

10.3.7. Multiple Applications

The following shows how to develop multiple applications in one directory. This is not limited to just "In Tree" compiling, and therefore can be applied to "Out of Tree" compiling as well.

Here, the application named hello2 is added to the `atmark-dist/user/hello` directory, with the configuration character string being `CONFIG_USER_HELLO_HELLO2`.

First are the changes to `atmark-dist/config/config.in` and `atmark-dist/user/Makefile` as shown below.

Example 10-3 Changes to atmark-dist/config/config.in (Multiple Applications)

```
--- config.in.orig      2004-04-18 04:03:57.000000000 +0900
+++ config.in    2004-05-26 17:58:38.000000000 +0900
@@ -515,6 +515,8 @@
 bool 'gdbreplay'       CONFIG_USER_GDBSERVER_GDBREPLAY
 bool 'gdbserver'       CONFIG_USER_GDBSERVER_GDBSERVER
 bool 'hd'              CONFIG_USER_HD_HD
+bool 'hello'                    CONFIG_USER_HELLO_HELLO
+bool 'hello2                    CONFIG_USER_HELLO_HELLO2
 bool 'lcd'                  CONFIG_USER_LCD_LCD
 bool 'ledcon'               CONFIG_USER_LEDCON_LEDCON
 bool 'lilo'                 CONFIG_USER_LILO_LILO
```

Example 10-4 Changes to atmark-dist/user/Makefile (Multiple Applications)

```
--- Makefile.orig       2004-02-20 13:22:55.000000000 +0900
+++ Makefile    2004-05-26 17:56:09.000000000 +0900
@@ -123,6 +123,8 @@
 dir_$(CONFIG_USER_GDBSERVER_GDBSERVER)      += gdbserver
 dir_$(CONFIG_USER_GETTYD_GETTYD)            += gettyd
 dir_$(CONFIG_USER_HD_HD)                    += hd
+dir_$(CONFIG_USER_HELLO_HELLO)              += hello
+dir_$(CONFIG_USER_HELLO_HELLO2)             += hello
 dir_$(CONFIG_USER_HOSTAP_HOSTAP)            += hostap
 dir_$(CONFIG_USER_HTTPD_HTTPD)              += httpd
 dir_$(CONFIG_USER_HWCLOCK_HWCLOCK)          += hwclock
```

In the Makefile, the configuration option is written on the left and the directory name on the right of the "+=". Therefore, the directory name specified for hello and hello2 will be the same hello.

Next is `atmark-dist/user/hello/Makefile`. This time, the application name is not assigned to a variable, but handled directly.

Example 10-5 Makefile (Multiple Applications)

```
OBJS_HELLO = hello.o
OBJS_HELLO2 = hello2.o


all: hello hello2

hello: $(OBJS_HELLO)
	$(CC) $(LDFLAGS) -o $@ $(OBJS_HELLO2) $(LDLIBS)

hello2: $(OBJS_HELLO2)
	$(CC) $(LDFLAGS) -o $@ $(OBJS_HELLO2) $(LDLIBS)

clean:
	-rm -f $(EXEC) *.elf *.gdb *.o

romfs:
	$(ROMFSINST) -e CONFIG_USER_HELLO_HELLO /bin/hello
	$(ROMFSINST) -e CONFIG_USER_HELLO_HELLO2 /bin/hello2


%.o: %.c
	$(CC) -c $(CFLAGS) -o $@ $<
```

Take note of the point that `-e CONFIG_USER_HELLO` is used in the `romfs` target.

The atmark-dist build system is set to build all applications in the hello directory when any one of the applications there is selected. Therefore, the application to be installed must be selected using a condition in the `romfs` target. As described above, the application to be installed can be determined by using a conditional branch configuration option.

For a detail explanation on `romfs-inst.sh`, refer to chapter 9, “romfs Installation Tool”.

11. Using Multiple Kernels

It is also possible to develop using multiple versions of Linux kernel source code. This can be achieved by changing over a symbolic link as shown below.

```
[PC ~]$ ls
kernel/   atmark-dist/
[PC ~]$ ls kernel
linux-foo/   linux-bar/
[PC ~]$ cd atmark-dist
[PC ~/atmark-dist]$ ln -s ../kernel/linux-foo linux-2.4.x
[PC ~/atmark-dist]$ ls -l linux-2.4.x
lrwxrwxrwx           linux-2.4.x -> ../kernel/linux-foo
```

12. Specific Applications

atmark-dist contains applications not found in standard Linux systems. This chapter introduces applications that are especially suitable for use with embedded equipment.

12.1. NetFlash

The NetFlash application is used to download image files via the network and write them to flash memory.
When using embedded systems, the ability to carry out system upgrades via the network brings great advantages, both for maintenance and user convenience. Using NetFlash, this can be done relatively simpily.

NetFlash can use the `http`, `ftp` and `tftp` protocols for file downloads. Therefore, a server that can transmit using one of these protocols is required to run NetFlash.
When no options are specified when executing NetFlash, the process of writing to flash memory followings these steps.

1. All processes are ended
2. The specified file is downloaded via the specified protocol from the server
3. The downloaded file's checksum is verified
4. The file is written to Flash memory
5. The system rebooted

These processes can be finely controlled by specifying the appropriate options. A command execution example and NetFlash's help are shown below for reference.

Example 12-1 neflash Execution

```
[Target /]# netflash http://myserver.local/images/base.img
netflash: killing tasks...
...
netflash: got "http://myserver.local/images/image.img", length=4194304
 :
 :
```

Example 12-2 neflash Help

```
[Targt /]# netflash –h
usage: netflash [-bCfFhijklntuv?] [-c <console-device>] [-d <delay>]
[-o <offset>] [-r <flash-device>] [<net-server>] <file-name>

        -b      don't reboot hardware when done
        -C      check that image was written correctly
        -f      use FTP as load protocol
        -F      force overwrite (do not preserve special regions)
        -h      print help
        -i      ignore any version information
        -H      ignore hardware type information
        -j      image is a JFFS2 filesystem
        -k      don't kill other processes
                (ignored when root filesystem is inside flash)
```

```
          -l      lock flash segments when done
          -n      file with no checksum at end (implies no version
                  information)
          -p      preserve portions of flash segments not actually
                  written.
          -s      stop erasing/programming at end of input data
          -t      check the image and then throw it away
          -u      unlock flash segments before programming
          -v      display version number
```

The process will be halted and no data written to flash memory if error occurs during processing.

As there is a possibility that the system will not reboot after a power outage occurs during writing, please do take care when executing NetFlash.

12.2.Flatfsd

One often requested function of embedded devices is the ability to upgrade the firmware without resetting any configuration information. In order to make this possible, it is common to build a file system allocated with a small memory area to hold the user settings.

The Flat Filesystem is well suited to this usage. The file system can be constructed from a minimum of just one sector, it is simply built and has proven stability.
The `flatfsd` program is used to produce these file systems.

`flatfsd` reads ands writes the contents of the `/etc/config` directory mounted in ramfs to and from the `/dev/flash/config` device file. `/dev/flash/config` is created by specifying the major and minor numbers of the device used to store the configuration files.

```
[Target /]# ls -l /dev/flash/
crw-------    1 root     root      90,  14 Jan  1 09:00 config
crw-------    1 root     root      90,   6 Jan  1 09:00 image
[Target /]#
```

The `flatfsd -r` command is executed to restore the previously saved configuration file data.
This command reads the file data previously saved in `/dev/flash/config`, and copies it to `/etc/config`.

```
[Target /]# flatfsd -r
FLATFSD: created 6 configuration files (507 bytes)
[Target /]#
```

At this time, the consistency of the file data is verified with the stored checksum, and if there is any abnormality the `/etc/config` directory is restored using the contents of `/etc/default`. The `flatfsd -r` command is usually executed at system boot time.

To save the changes made to the configuration files to flash memory, the `SIGUSR1` signal is sent to the `flatfsd` process. Therefore it is necessary to start the process by executing the `flatfsd` command when the system is booted. The process ID of the activated `flatfsd` can be acquired from the `/var/run/flatfsd.pid` file. The following example shows how to send the signal to `flatfsd` using the `killall` command.

```
[Target /]# killall -USR1 flatfsd
[Target /]#
```

Once the `flatfsd` process receives the `SIGUSR1` signal, it writes the contents of the `/etc/config` directory to `/dev/flash/config`. At this time, the checksum is calculated and recorded to allow for verification of file data consistency.

When the `flatfsd` application is selected in the configuration of atmark-dist, applications such as `dhcpcd` and `passwd` create their configuration files in `/etc/config` instead of `/etc`. Therefore, modified settings are preserved while the system is rebooted.

It is possible that saved data may be lost when `flatfsd` is writing data to the `/dev/flash/config` device and a power cut occurs.
Also note that the guaranteed number of times data can be written to flash memory is around 100,000.

Revision History

Ver.	Revision Date	Description of Revision
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