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Porting Android on Arm Based Platform

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ABSTRACT: Today Android operating system (OS) is HOT in market for entertainment devices like mobile phones and tablet and TV and industry is exploring the ability of Android within other embedded platforms. Some industries replace with exiting operating system with Android because main reason is open source operating system (OS). Today industries select Android OS reason behind this big application market and easy to available to application development tools and also available many on-line group to resolve your issue. In this paper, we will explain the concept of porting android to any arm based devices. We will explain the basics of kernel, how to make android specific, how to compile kernel for ARM. In Android section, we will explain architecture of Android, how to compile android for specific board. For understanding, we will use Linux 2.6.32 kernel version and android 2.3.7 (Gingerbread). We will port android to d2plug board which is product of Marvell Semiconductor.

Keywords*:* porting android, porting kernel, compile kernel, compile android.

I. INTRODUCTION

First android is open source. Android has binder ipc, lowmemorykiller, pmem driver etc which is used for mobile platform (Arm based platform).This feature increasing the performance of arm based device. Android also provide tools for creating apps. Also user uses thousand of application from android market apps. Android easily porting on any arm based devices with minimum changes. So android is better than the other Embedded OS. So, today Most of the people uses devices like mobiles, tablets which has android OS.

The term port means portare and its meaning is "to carry" when code is not compatible with specific architecture, the code must be "carried" to the new platform without major change. Here we define steps for android porting on any arm base devices. We will take a Linux 2.6.32 kernel for kernel porting and for android we will take a android 2.3.7(gingerbread).we will take a d2plug which is Marvell developing board for understanding whole porting process.

II. PREREQUIREMENTS FOR PORTING

A. First Download the kernel from www.kernel.org. it is generic for all platform like omap.dove etc. For d2plug, download the kernel from *www.plugcomputer.org/downloads/d2plug/* which has a already d2plug support and don't need to more changes.
B. Download the android Source code from *http://source.android.com/source/downloading.html* .
C. Extract Android source code.
D. Make kernel folder in android directory and extract kernel in kernel folder like <android directory>/kernel.

III. PORTING

Android porting is divided into two steps:

A) *Kernel porting*
   1) *First understand basic information of kernel and its important files.*
   2) *Add the android features in kernel.*
   3) *Compile the kernel.*

B) *Android porting*
   1) *System requirement for build android.*
   2) *Add new platform support in android.*
   3) *Compile android.*
   4) *Booting from USB.*

A) *Kernel Porting*

1) *Basic information of kernel:*

The starting point here is that you have set up your kernel source tree with the ARM patches. This description covers the 2.6 series kernels, specifically 2.6.32. The ARM-specific files are in linux/arch/arm (code), and linux/include/asm-arm (header files). Within the ARM-specific directories your new or changed files go in appropriate linux/arch/arm/mach-dove and linux/include/asm-arm/arch-arm/mach-dove and dove directories e.g. linux/arch/arm/mach-dove and linux/include/asm-arm/arch-dove. After configuration your headers directory linux/include/asm-arm/arch-dove appears as linux/include/asm-arm/arch so that the correct machine header files can be included by using this path.

The other directories in linux/arch/arm/ contain the generic ARM code.

- kernel - core kernel code.
- mm - memory management code.
- lib - ARM-specific or optimised internal library functions (backtrace, memcpy, io functions, bit-twiddling etc).
- nwfpe and fastfpe - two different floating-point implementations.
- boot - the directory in which the final compiled kernel is left and contains stuff for generating compressed kernels.
- tools - has scripts for auto generating files, such as mach-types (see section Registering a Machine ID) .
- configs - contains the default configuration files for each machine.

The non machine-specific directories in linux/include/asm-arm are:

- arch - the link to the configured machine headers sub-directory arch-XXX.
- hardware - headers for ARM-specific companion chips or devices.
- mach - generic interface definitions for things used by many machines (irq, dma, pci) and the machine description macros.

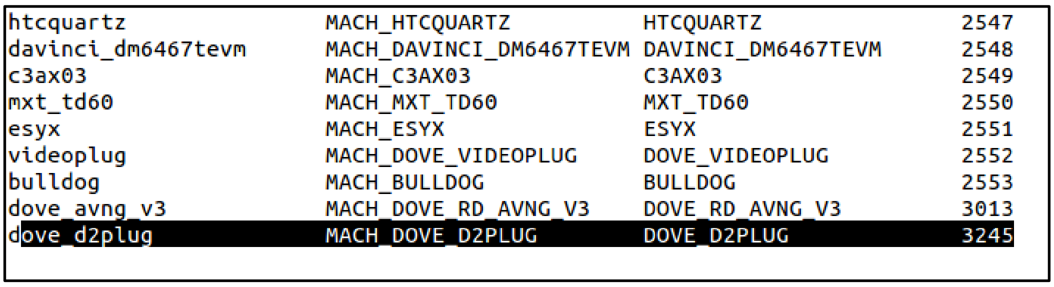
- Registering a Machine Id:

Each device is identified in the kernel tree by a machine ID. These are allocated by the kernel maintainer to keep the huge number of ARM device variants manageable in the source trees.

The first thing you need to do in your port is register your new machine with the kernel maintainer to get a number for it. This is not actually necessary to begin work, but you'll need to do this eventually so it's best to do it at the beginning and not have to change your machine name or ID later.

You register a new architecture by mailing <rmk@arm.linux.org.uk>, or filling in an on-line form at *http://www.armlinux.org.uk/developer/machines/.*

machine_is_xxx	CONFIG_xxx	MACH_TYPE_xxx	machine_ID
dove_d2plug	MACH_DOVE_D2PLUG	DOVE_D2PLUG	3245



```
htcquartz            MACH_HTCQUARTZ         HTCQUARTZ              2547
davinci_dm6467tevm   MACH_DAVINCI_DM6467TEVM DAVINCI_DM6467TEVM    2548
c3ax03               MACH_C3AX03            C3AX03                 2549
mxt_td60             MACH_MXT_TD60          MXT_TD60               2550
esyx                 MACH_ESYX              ESYX                   2551
videoplug            MACH_DOVE_VIDEOPLUG    DOVE_VIDEOPLUG         2552
bulldog              MACH_BULLDOG           BULLDOG                2553
dove_avng_v3         MACH_DOVE_RD_AVNG_V3   DOVE_RD_AVNG_V3        3013
dove_d2plug          MACH_DOVE_D2PLUG       DOVE_D2PLUG            3245
```

Fig. 1 Add Machine ID in Mach-types

Then you need to add the info to linux/arch/arm/tools/mach-types with a line like this or go to: http://www.arm.linux.org.uk/developer/machines/ where you can download the latest version of mach-types.

- Def-config file:

Add a new config file in linux/arch/arm/configs/ named <machine-name>, containing the default configuration options for your machine or you can select specification as per board using "make menuconfig" .When you will fire "make <machine-name>_defconfig" e.g. "make dove_d2plug_android__USB_defconfig" command, it is copied out of linux/arch/arm/defconfigs/ to linux/.config.

Here we list the most important files, and describe their purpose and the sort of things you should put in them. It looks daunting to start with but most of what is required is just a matter of filling in the numbers appropriate to your hardware. Now

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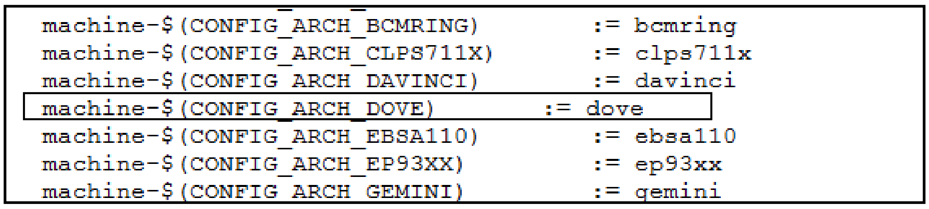
that so many different machines are supported it is rare that you have to write much new code - nearly everything can be taken from a suitable donor machine. This is easier to do if you know which machines have a similar architecture to your own .

- arch/arm/Makefile:
  Insert the following to this file (replace dove with your machine name):

For D2plug:



```
machine-$(CONFIG_ARCH_BCMRING)          := bcmring
machine-$(CONFIG_ARCH_CLPS711X)         := clps711x
machine-$(CONFIG_ARCH_DAVINCI)          := davinci
machine-$(CONFIG_ARCH_DOVE)         := dove
machine-$(CONFIG_ARCH_EBSA110)          := ebsa110
machine-$(CONFIG_ARCH_EP93XX)           := ep93xx
machine-$(CONFIG_ARCH_GEMINI)           := gemini
```

Fig. 2 Makefile

- arch/arm/kernel/entry-armv.S:

Machine-specific IRQ functions. You provide the assembly macros disable_fiq, get_irqnr_and_base, and irq_prio_table here. disable_fiq and irq_prio_table is usually empty, but get_irqnr_and_base must be implemented carefully: you should use the zero flag to indicate the presence of interrupts,and put the correct IRQ number in irqnr.

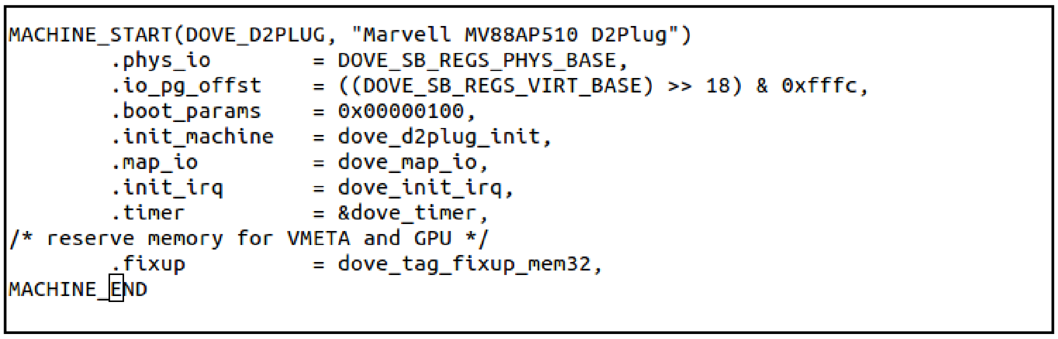
- arch/arm/kernel/debug.S:

These are the low-level debug functions, which talk to a serial port without relying on interrupts or any other kernel functionality. You'll need to use these functions if it won't boot. The functions you need to implement are addruart, senduart and waituart, using ARM assembly. They give you the address of the debug UART, send a byte to the debug UART, and wait for the debug UART, respectively.

- arch/arm/mach-dove/Makefile:
  You need to add a target for your machine, listing the object files in this directory. That will be at least the following:
  obj-$(CONFIG_MACH_DOVE_D2PLUG) += dove-d2plug-setup.o

- arch/arm/mach-dove/dove-d2plug-setup.c:

The setup for your machine is done with a set of macros, starting with MACHINE_START. The parameters you give are filled in to a data structure machine_desc describing the machine. One of the items is the fixup function which, if specified, will be called to fill in or adjust entries dynamically at boot time. This is useful for detecting optional items needed at boot-time (e.g.VRAM in a Risc PC).
For Example:



```
MACHINE_START(DOVE_D2PLUG, "Marvell MV88AP510 D2Plug")
        .phys_io        = DOVE_SB_REGS_PHYS_BASE,
        .io_pg_offst    = ((DOVE_SB_REGS_VIRT_BASE) >> 18) & 0xfffc,
        .boot_params    = 0x00000100,
        .init_machine   = dove_d2plug_init,
        .map_io         = dove_map_io,
        .init_irq       = dove_init_irq,
        .timer          = &dove_timer,
/* reserve memory for VMETA and GPU */
        .fixup          = dove_tag_fixup_mem32,
MACHINE_END
```

Fig. 3 Dove-d2plug-setup.c

2) *Add Android Configuration in defconfig :*

In kernel, Android drivers is in driver/staging folder like lowmemory killer,binder etc.For d2plug Android driver is in driver/staging folder, just add in d2plug defconfig shown in fig. 4.

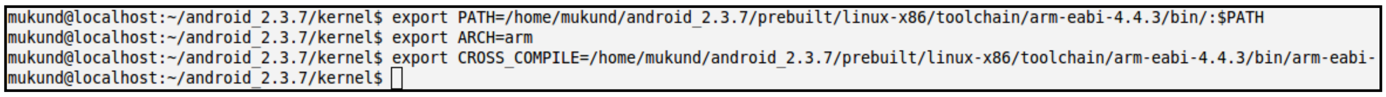
```
CONFIG_BLK_DEV_INITRD=y
CONFIG_INITRAMFS_SOURCE="root"
CONFIG_INITRAMFS_ROOT_UID=0
CONFIG_INITRAMFS_ROOT_GID=0
CONFIG_ASHMEM=y
CONFIG_ARM_THUMB=y

CONFIG_ANDROID_RAM_CONSOLE=y
CONFIG_ANDROID_RAM_CONSOLE_ENABLE_VERBOSE=y
CONFIG_ANDROID_POWER=y
CONFIG_ANDROID_POWER_ALARM=y
CONFIG_ANDROID_POWER_STAT=y
CONFIG_ANDROID_LOGGER=y
CONFIG_ANDROID_TIMED_GPIO=y
CONFIG_ANDROID_BINDER_IPC=y
CONFIG_ANDROID_PARANOID_NETWORK=y
```

Fig. 4 Android Driver Configuration

3) *Compile Kernel:*

➢ first set the toolchain path then set architecture and tool chain prefix . we use android toolchain which is in prebuilt folder. Then export a ARCH and CROSSCOMIPLE environment variable. Here we are using toolchain which is in <android_directory>/prebuilt folder because kernel and file system both are compile using same toolchain.



```
mukund@localhost:~/android_2.3.7/kernel$ export PATH=/home/mukund/android_2.3.7/prebuilt/linux-x86/toolchain/arm-eabi-4.4.3/bin/:$PATH
mukund@localhost:~/android_2.3.7/kernel$ export ARCH=arm
mukund@localhost:~/android_2.3.7/kernel$ export CROSS_COMPILE=/home/mukund/android_2.3.7/prebuilt/linux-x86/toolchain/arm-eabi-4.4.3/bin/arm-eabi-
mukund@localhost:~/android_2.3.7/kernel$ 
```

Fig. 5 Tool-chain environment

Set the environment in kernel directory and type command as shown in fig 5.

➢ When you will type " make dove_d2plug_android__USB_defconfig" command in consol, its copy in .config file.

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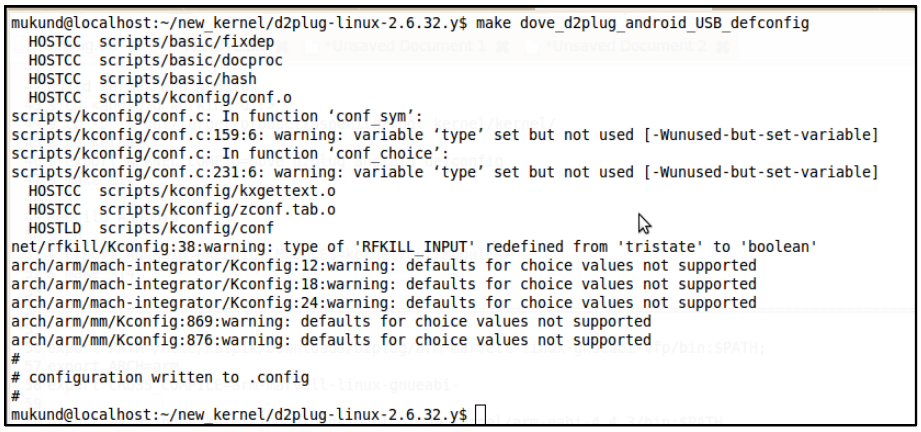
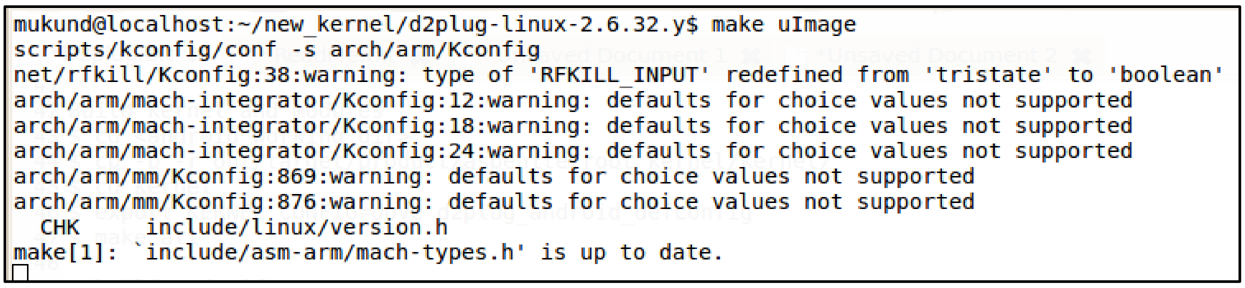


```
mukund@localhost:~/new_kernel/d2plug-linux-2.6.32.y$ make dove_d2plug_android_USB_defconfig
  HOSTCC  scripts/basic/fixdep
  HOSTCC  scripts/basic/docproc
  HOSTCC  scripts/basic/hash
  HOSTCC  scripts/kconfig/conf.o
scripts/kconfig/conf.c: In function ‘conf_sym’:
scripts/kconfig/conf.c:159:6: warning: variable ‘type’ set but not used [-Wunused-but-set-variable]
scripts/kconfig/conf.c: In function ‘conf_choice’:
scripts/kconfig/conf.c:231:6: warning: variable ‘type’ set but not used [-Wunused-but-set-variable]
  HOSTCC  scripts/kconfig/kxgettext.o
  HOSTCC  scripts/kconfig/zconf.tab.o
  HOSTLD  scripts/kconfig/conf
net/rfkill/Kconfig:38:warning: type of 'RFKILL_INPUT' redefined from 'tristate' to 'boolean'
arch/arm/mach-integrator/Kconfig:12:warning: defaults for choice values not supported
arch/arm/mach-integrator/Kconfig:18:warning: defaults for choice values not supported
arch/arm/mach-integrator/Kconfig:24:warning: defaults for choice values not supported
arch/arm/mm/Kconfig:869:warning: defaults for choice values not supported
arch/arm/mm/Kconfig:876:warning: defaults for choice values not supported
#
# configuration written to .config
#
mukund@localhost:~/new_kernel/d2plug-linux-2.6.32.y$
```

Fig. 6 compile configuration

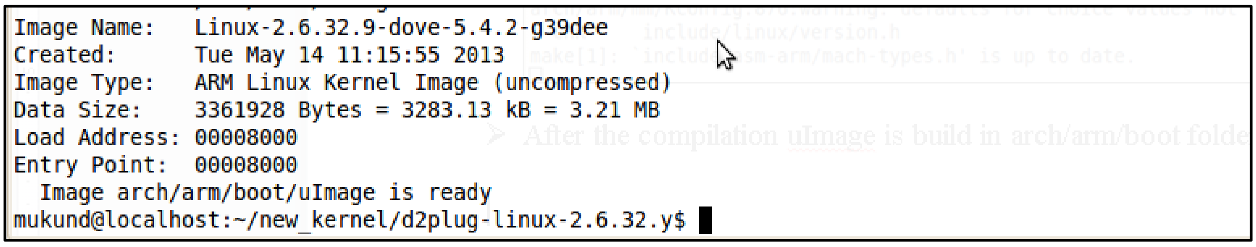
➢ Then finally type command “make uImage” for making uImage .



```
mukund@localhost:~/new_kernel/d2plug-linux-2.6.32.y$ make uImage
scripts/kconfig/conf -s arch/arm/Kconfig
net/rfkill/Kconfig:38:warning: type of 'RFKILL_INPUT' redefined from 'tristate' to 'boolean'
arch/arm/mach-integrator/Kconfig:12:warning: defaults for choice values not supported
arch/arm/mach-integrator/Kconfig:18:warning: defaults for choice values not supported
arch/arm/mach-integrator/Kconfig:24:warning: defaults for choice values not supported
arch/arm/mm/Kconfig:869:warning: defaults for choice values not supported
arch/arm/mm/Kconfig:876:warning: defaults for choice values not supported
  CHK     include/linux/version.h
make[1]: `include/asm-arm/mach-types.h' is up to date.
```

Fig. 7 make uImage

➢ After the compilation, uImage is generated which is in arch/arm/boot directory shown in fig. 8.



```
Image Name:   Linux-2.6.32.9-dove-5.4.2-g39dee
Created:      Tue May 14 11:15:55 2013
Image Type:   ARM Linux Kernel Image (uncompressed)
Data Size:    3361928 Bytes = 3283.13 kB = 3.21 MB
Load Address: 00008000
Entry Point:  00008000
  Image arch/arm/boot/uImage is ready
mukund@localhost:~/new_kernel/d2plug-linux-2.6.32.y$
```

Fig. 8 : uImage location

B. *Android Porting:*

1) *System Requirements:*

- ➢ ARM Processor base development board
- ➢ Host PC with operating system Ubuntu 10.04 with minimum 12 GB free space.

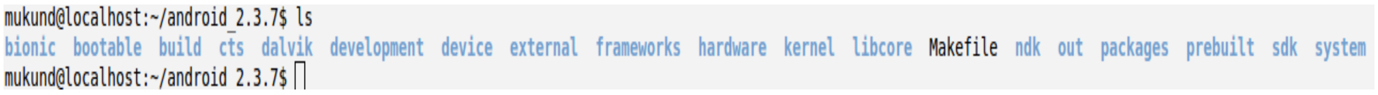
Setup Ubuntu 10.04 for Android Compilation

Below for list of package are required to build android

1. $ sudo apt-get install liblzo2-dev
2. $ sudo apt-get install bison
3. $ sudo apt-get install uuid-dev
4. $ sudo apt-get install libncurses5-dev
5. $ sudo apt-get install sun-java6-jdk
6. $ sudo apt-get install libglib2.0-dev

7. $ sudo apt-get install flex
8. $ sudo apt-get install g++
9. $ sudo apt-get install libz-dev
10. $ sudo apt-get install gperf
11 .$ sudo apt-get install libx11-dev

Note: If we build Android Version below 2.3 we require java5-jdk So we refers all the above package exception sudo apt-get install sun-java6-jdk. And we refer sudo apt-get install sun-java5-jdk.
Below Snapshot of the downloaded directory of <android directory>.



```
mukund@localhost:~/android_2.3.7$ ls
bionic  bootable  build  cts  dalvik  development  device  external  frameworks  hardware  kernel  libcore  Makefile  ndk  out  packages  prebuilt  sdk  system
mukund@localhost:~/android 2.3.7$
```

Fig. 9 Android Directory

Android has defined a framework to add a new platform in the source code. Any platform specific configuration can be added in the ~/<android directory>/devices directory.
Under devices directory vendor names are mentioned and each vendor can have different types of platforms.

3) *Add New Platform support in Android:*
In below Figure, Marvell is the vendor name and d2plug is the platform for which android is to be built. Same as TI is vendor and panda board as platform.

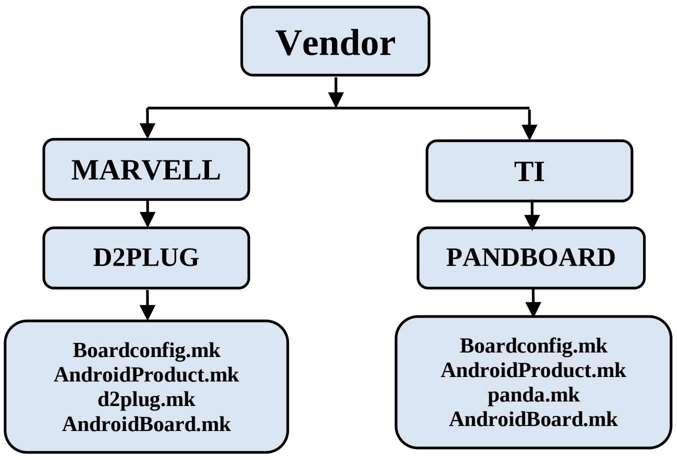


Fig.10 Block Diagram of Add a new platform in Android

Following files Boardconfig.mk AndroidProduct.mk product.mk and AndroidBoard.mk are add under ~/<android directory>/devices/<vendor>/<platform> directory.

For adding a files we list below snapshots for reference

➢ Boardconfig.mk

In this file we define the board configuration like which processor and also defined hardware component support like HDMI Bluetooth, Wi-Fi Ethernet etc. So we define that component in this file.

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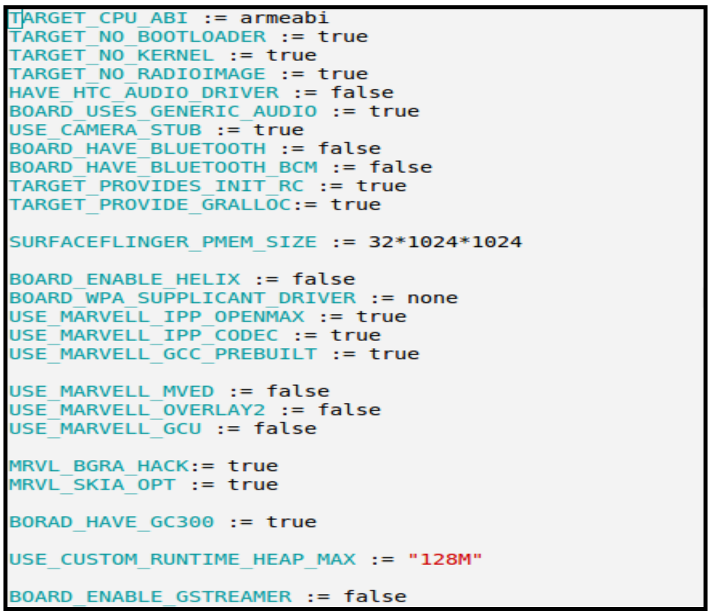
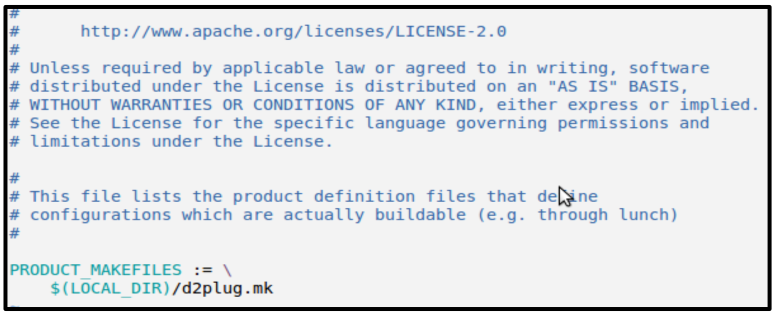


```
TARGET_CPU_ABI := armeabi
TARGET_NO_BOOTLOADER := true
TARGET_NO_KERNEL := true
TARGET_NO_RADIOIMAGE := true
HAVE_HTC_AUDIO_DRIVER := false
BOARD_USES_GENERIC_AUDIO := true
USE_CAMERA_STUB := true
BOARD_HAVE_BLUETOOTH := false
BOARD_HAVE_BLUETOOTH_BCM := false
TARGET_PROVIDES_INIT_RC := true
TARGET_PROVIDE_GRALLOC:= true

SURFACEFLINGER_PMEM_SIZE := 32*1024*1024

BOARD_ENABLE_HELIX := false
BOARD_WPA_SUPPLICANT_DRIVER := none
USE_MARVELL_IPP_OPENMAX := true
USE_MARVELL_IPP_CODEC := true
USE_MARVELL_GCC_PREBUILT := true

USE_MARVELL_MVED := false
USE_MARVELL_OVERLAY2 := false
USE_MARVELL_GCU := false

MRVL_BGRA_HACK:= true
MRVL_SKIA_OPT := true

BORAD_HAVE_GC300 := true

USE_CUSTOM_RUNTIME_HEAP_MAX := "128M"

BOARD_ENABLE_GSTREAMER := false
```

Fig. 11 Boardconfig.mk

➢ AndroidProduct.mk

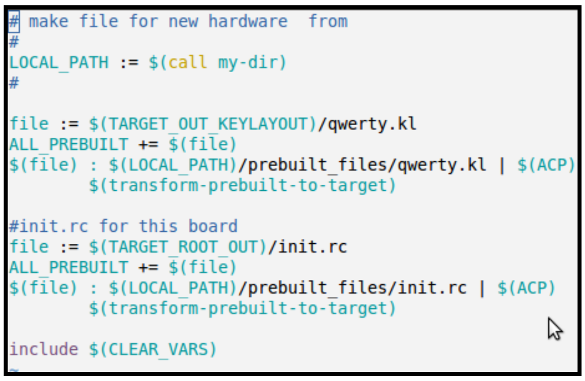


```
#
#      http://www.apache.org/licenses/LICENSE-2.0
#
# Unless required by applicable law or agreed to in writing, software
# distributed under the License is distributed on an "AS IS" BASIS,
# WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
# See the License for the specific language governing permissions and
# limitations under the License.

#
# This file lists the product definition files that define
# configurations which are actually buildable (e.g. through lunch)
#

PRODUCT_MAKEFILES := \
    $(LOCAL_DIR)/d2plug.mk
```

Fig. 12 AndroidProduct.mk

In this file we including <product>.mk file.In above snapshot we include d2plug.mk for our product.

➢ AndroidBoard.mk



```
# make file for new hardware  from
#
LOCAL_PATH := $(call my-dir)
#

file := $(TARGET_OUT_KEYLAYOUT)/qwerty.kl
ALL_PREBUILT += $(file)
$(file) : $(LOCAL_PATH)/prebuilt_files/qwerty.kl | $(ACP)
        $(transform-prebuilt-to-target)

#init.rc for this board
file := $(TARGET_ROOT_OUT)/init.rc
ALL_PREBUILT += $(file)
$(file) : $(LOCAL_PATH)/prebuilt_files/init.rc | $(ACP)
        $(transform-prebuilt-to-target)

include $(CLEAR_VARS)
```

Fig. 13 AndroidBoard.mk

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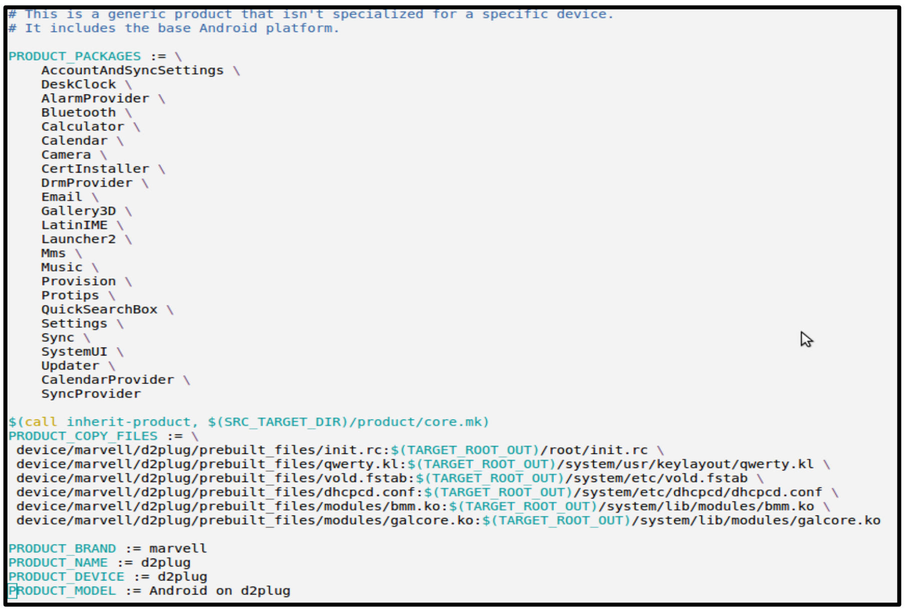
In this file we define some hardware specific file like keyboard supported file for example above snapshot we add two specific file qwerty.kl and init.rc so final build image including this thing . In init.rc file we define which services are start on boot time or after boot for example Ethernet services is not require to start at boot time so we start this services after completion of booting process.

➢ d2plug.mk

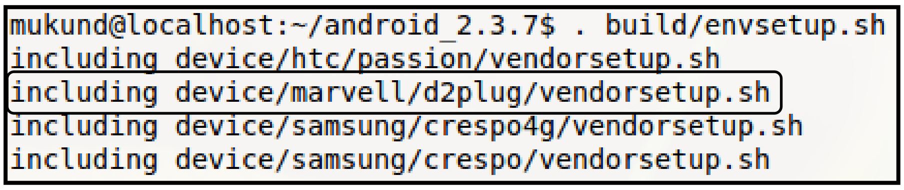


```
# This is a generic product that isn't specialized for a specific device.
# It includes the base Android platform.

PRODUCT_PACKAGES := \
    AccountAndSyncSettings \
    DeskClock \
    AlarmProvider \
    Bluetooth \
    Calculator \
    Calendar \
    Camera \
    CertInstaller \
    DrmProvider \
    Email \
    Gallery3D \
    LatinIME \
    Launcher2 \
    Mms \
    Music \
    Provision \
    Protips \
    QuickSearchBox \
    Settings \
    Sync \
    SystemUI \
    Updater \
    CalendarProvider \
    SyncProvider

$(call inherit-product, $(SRC_TARGET_DIR)/product/core.mk)
PRODUCT_COPY_FILES := \
 device/marvell/d2plug/prebuilt_files/init.rc:$(TARGET_ROOT_OUT)/root/init.rc \
 device/marvell/d2plug/prebuilt_files/qwerty.kl:$(TARGET_ROOT_OUT)/system/usr/keylayout/qwerty.kl \
 device/marvell/d2plug/prebuilt_files/vold.fstab:$(TARGET_ROOT_OUT)/system/etc/vold.fstab \
 device/marvell/d2plug/prebuilt_files/dhcpcd.conf:$(TARGET_ROOT_OUT)/system/etc/dhcpcd/dhcpcd.conf \
 device/marvell/d2plug/prebuilt_files/modules/bmm.ko:$(TARGET_ROOT_OUT)/system/lib/modules/bmm.ko \
 device/marvell/d2plug/prebuilt_files/modules/galcore.ko:$(TARGET_ROOT_OUT)/system/lib/modules/galcore.ko

PRODUCT_BRAND := marvell
PRODUCT_NAME := d2plug
PRODUCT_DEVICE := d2plug
PRODUCT_MODEL := Android on d2plug
```

Fig. 14 d2plug.mk

In this file we define which application package are including build for our product. For example If we remove the Calculator application package in this file the final build images is without calculator application package in our product..

4) *Android Source Code Compilation:*
To build android images:
$ cd ~/ <android directory>
$. build/envsetup.sh



```
mukund@localhost:~/android_2.3.7$ . build/envsetup.sh
including device/htc/passion/vendorsetup.sh
including device/marvell/d2plug/vendorsetup.sh
including device/samsung/crespo4g/vendorsetup.sh
including device/samsung/crespo/vendorsetup.sh
```

Fig. 15 build/envsetup

Above command is set environment of existing platform in source code.

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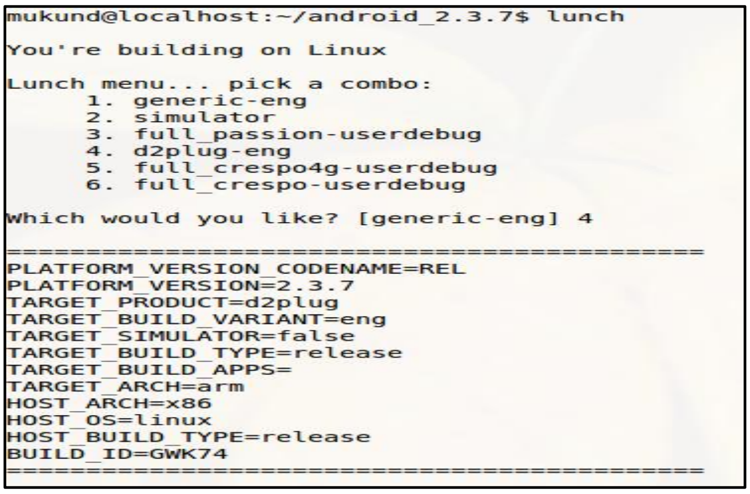
$ lunch



```
mukund@localhost:~/android_2.3.7$ lunch

You're building on Linux

Lunch menu... pick a combo:
     1. generic-eng
     2. simulator
     3. full_passion-userdebug
     4. d2plug-eng
     5. full_crespo4g-userdebug
     6. full_crespo-userdebug

Which would you like? [generic-eng] 4

============================================
PLATFORM_VERSION_CODENAME=REL
PLATFORM_VERSION=2.3.7
TARGET_PRODUCT=d2plug
TARGET_BUILD_VARIANT=eng
TARGET_SIMULATOR=false
TARGET_BUILD_TYPE=release
TARGET_BUILD_APPS=
TARGET_ARCH=arm
HOST_ARCH=x86
HOST_OS=linux
HOST_BUILD_TYPE=release
BUILD_ID=GWK74
============================================
```

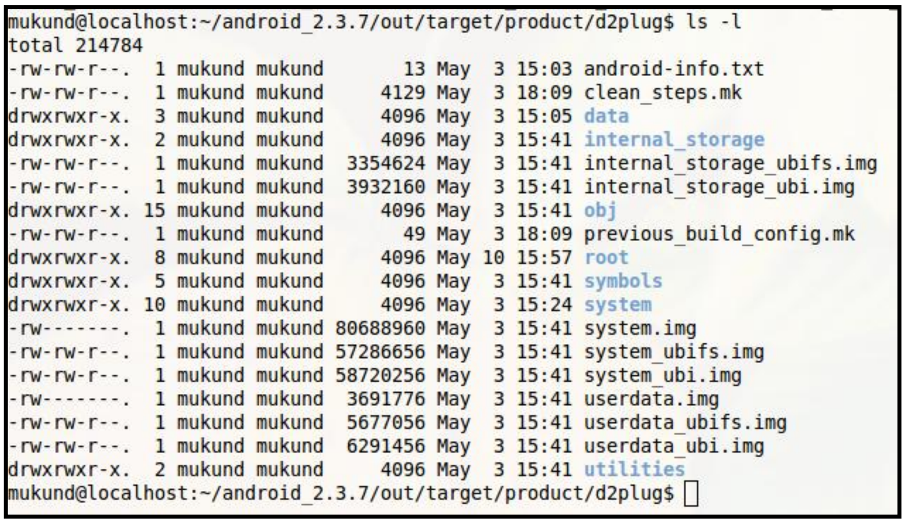
Fig. 16 lunch

Above command execute in console and select your product. For example above snapshot we select 4 for our product d2plug. Above command is list the existing product in the source code and also give the information about product name, target architecture , platform version and host architecture etc.

$ make -j40

Above command will start to build android source code.

After successful build source code the following result should be generated under <android directory>/out /target /product /<platform>.



```
mukund@localhost:~/android_2.3.7/out/target/product/d2plug$ ls -l
total 214784
-rw-rw-r--.  1 mukund mukund       13 May  3 15:03 android-info.txt
-rw-rw-r--.  1 mukund mukund     4129 May  3 18:09 clean_steps.mk
drwxrwxr-x.  3 mukund mukund     4096 May  3 15:05 data
drwxrwxr-x.  2 mukund mukund     4096 May  3 15:41 internal_storage
-rw-rw-r--.  1 mukund mukund  3354624 May  3 15:41 internal_storage_ubifs.img
-rw-rw-r--.  1 mukund mukund  3932160 May  3 15:41 internal_storage_ubi.img
drwxrwxr-x. 15 mukund mukund     4096 May  3 15:41 obj
-rw-rw-r--.  1 mukund mukund       49 May  3 18:09 previous_build_config.mk
drwxrwxr-x.  8 mukund mukund     4096 May 10 15:57 root
drwxrwxr-x.  5 mukund mukund     4096 May  3 15:41 symbols
drwxrwxr-x. 10 mukund mukund     4096 May  3 15:24 system
-rw-------.  1 mukund mukund 80688960 May  3 15:41 system.img
-rw-rw-r--.  1 mukund mukund 57286656 May  3 15:41 system_ubifs.img
-rw-rw-r--.  1 mukund mukund 58720256 May  3 15:41 system_ubi.img
-rw-------.  1 mukund mukund  3691776 May  3 15:41 userdata.img
-rw-rw-r--.  1 mukund mukund  5677056 May  3 15:41 userdata_ubifs.img
-rw-rw-r--.  1 mukund mukund  6291456 May  3 15:41 userdata_ubi.img
drwxrwxr-x.  2 mukund mukund     4096 May  3 15:41 utilities
mukund@localhost:~/android_2.3.7/out/target/product/d2plug$
```

Fig. 17 build result

system.img :- It is a partition image that will be mounted as / and thus contains all system binaries.
userdata.img:- It is a partition image that can be mounted as /data and thus contains all application-specific and user-specific data.

➢ *To Build Single Module in Android Repo:*

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If you build some of the defined functions or module in part of the <android directory>.Use the 'mm' or 'mmm' commands to do this.
The 'mm' command makes stuff in the current directory.
<android directory> <module directory path > mm
The 'mmm' command, you specify a path of directory.
<android directory> mmm <module directory path>
The 'make snod' command is use to rebuild system images to changes with current binaries
<android directory> make snod
Advantage of 'make snod' command is to avoid the whole build process of latest system images with changes from android soruce code.

5) *Booting android from USB drive:*

- Setup USB drive with two Partitions using GParted, FDISK or any disk Partition utility.
- Partition1 is size of 100MB and remaining space for partition2.
- Format Partition1 as FAT32 and Partition2 as EXT4.
- copy ~/<kernel directory>/arm/arm/boot/uImage in partition1
- Copy ~/<android directory>/out/target/product/<platform>/root/*
  ~/<android directory>/out/target/product/<platform>/data and
  ~/<android directory>/out/target/product/<platform>/system folder in Partition2.

IV. CONCLUSION

In this paper explain easily android porting on any arm based platform .Here understood the kernel architecture and its most important files, set environment variables, compile the kernel ,add new arm based platform support in android, compiling the Android, booting from USB .

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