

Android Porting
移植 Android 至 PXA270

Mask (鍾文昌)

cycdisk@gmail.com

http://www.mask.org.tw



作者簡介

http://www.mask.org.tw

鍾文昌 Mask <cycdisk@gmail.com>

- 數年 Linux 及 Embedded Linux 相關開發經驗，開發產品包含 Set-Top-Box、手機及快速開機軟體等相關產品，接觸過 x86、MIPS 及 ARM platform，對 Linux kernel、Linux device driver、Shared Library、Application 等皆有所涉獵。
- 在 IC 廠完全沒有支援 Android 的情況下，獨立移植 Android 至 PXA270、OMAP3530 等硬體平台。
- 豐富的 Android Porting 授課經驗。



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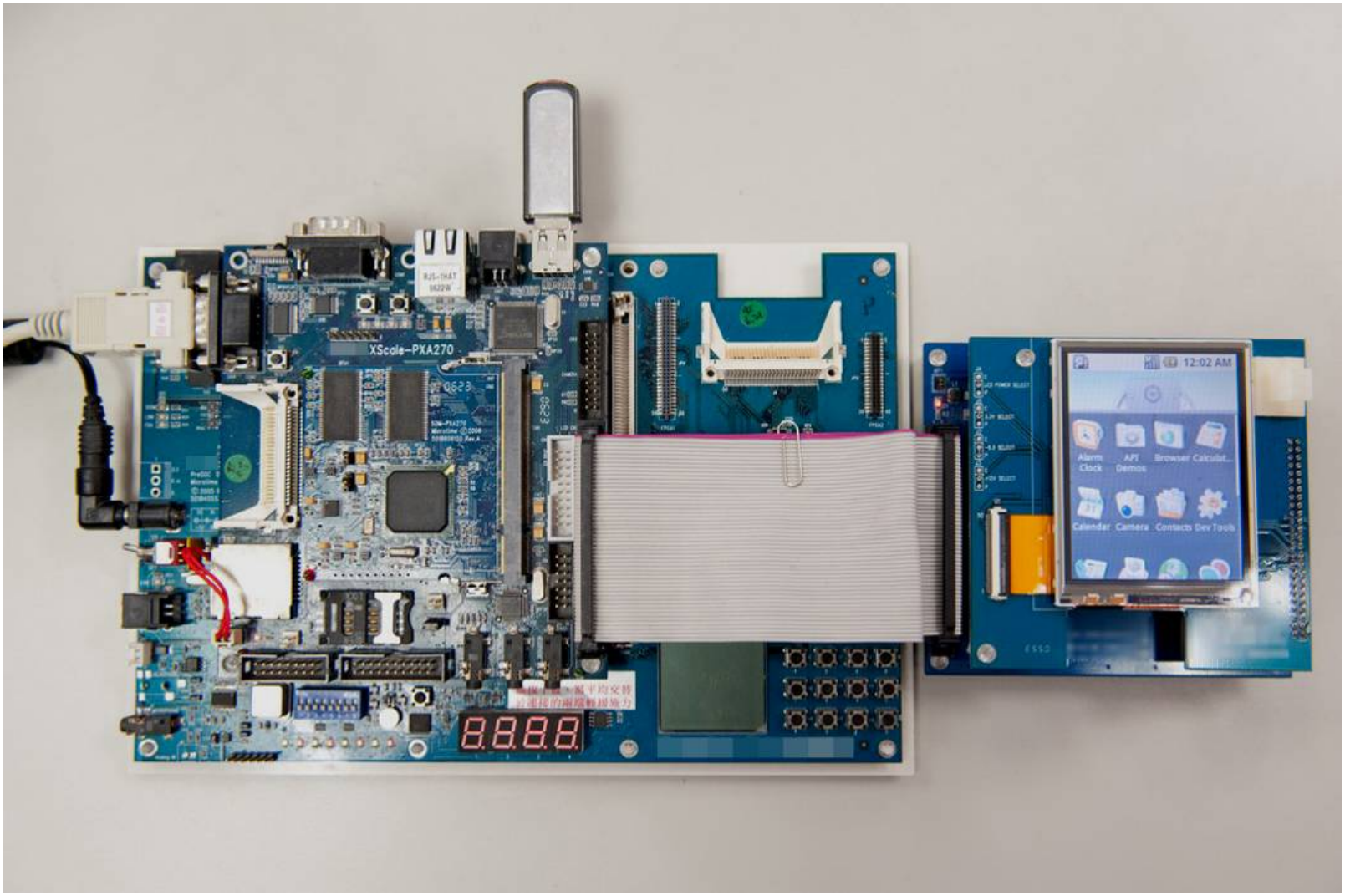
Android 1.0 on PXA270



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Outline

- Introduction
- Motivation
- Porting Procedure
- Building Environment
- Conclusion

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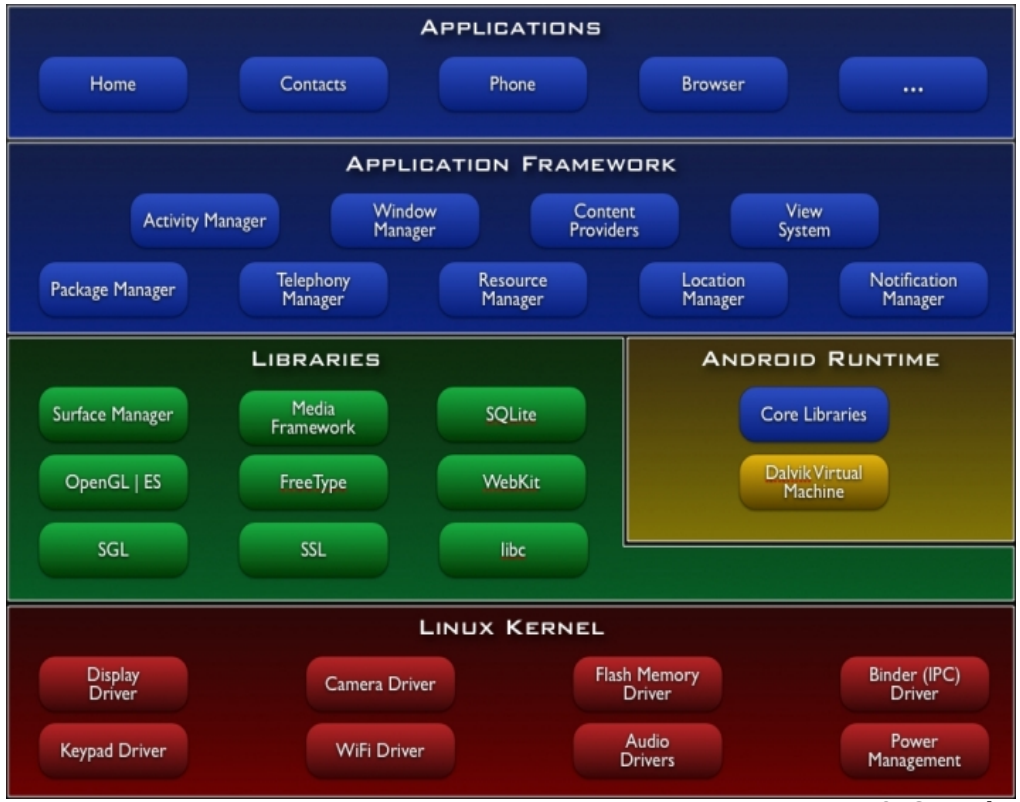
What Is Android

- Android is a software stack for mobile devices that includes an operating system, middleware and key applications



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Android Features

- Bionic libc
- Multimedia
- 2D, 3D graphics
- FreeType
- SQLite
- Application framework
- Dalvik virtual machine
- Network
- Rich development environment

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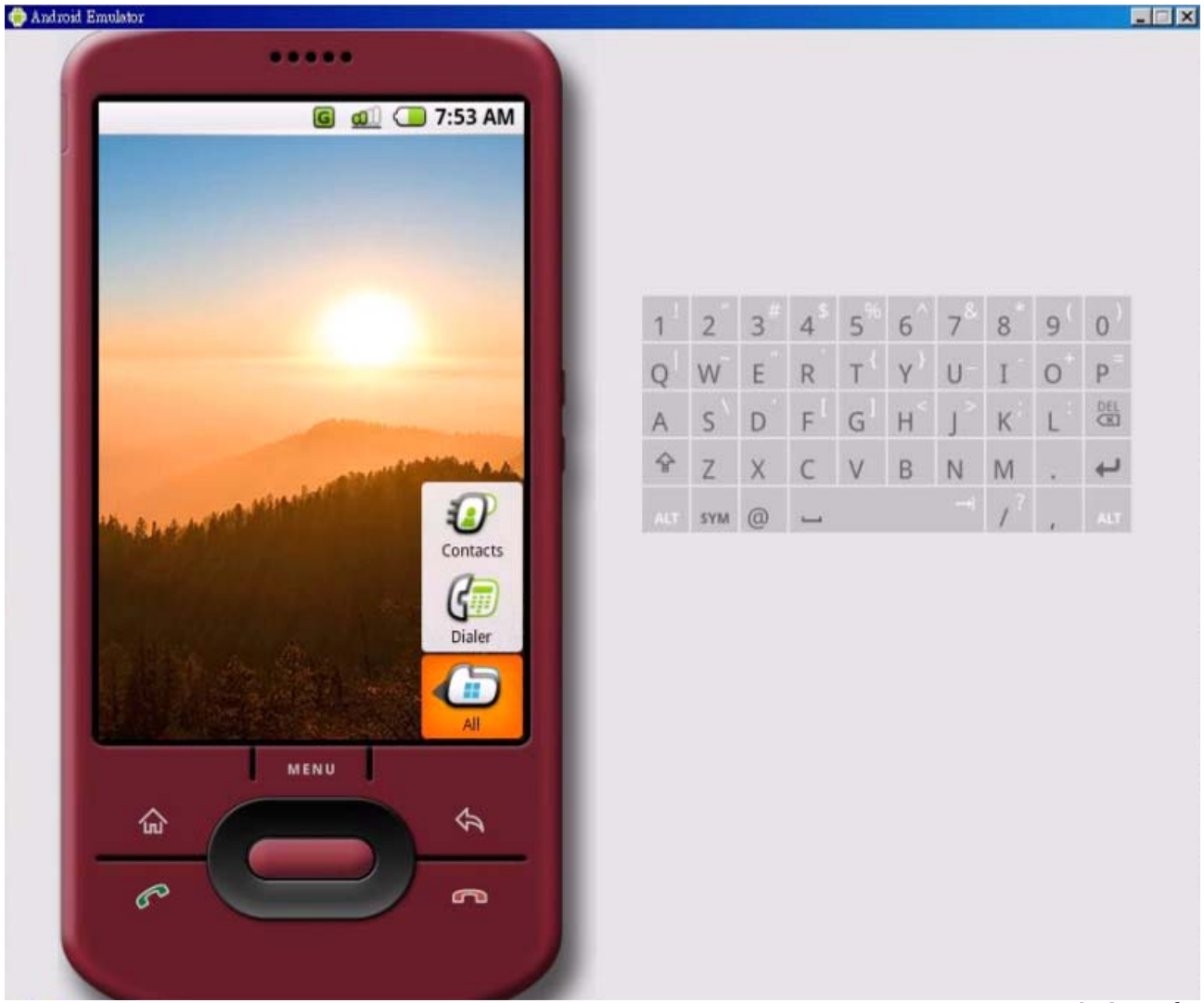
Android Emulator



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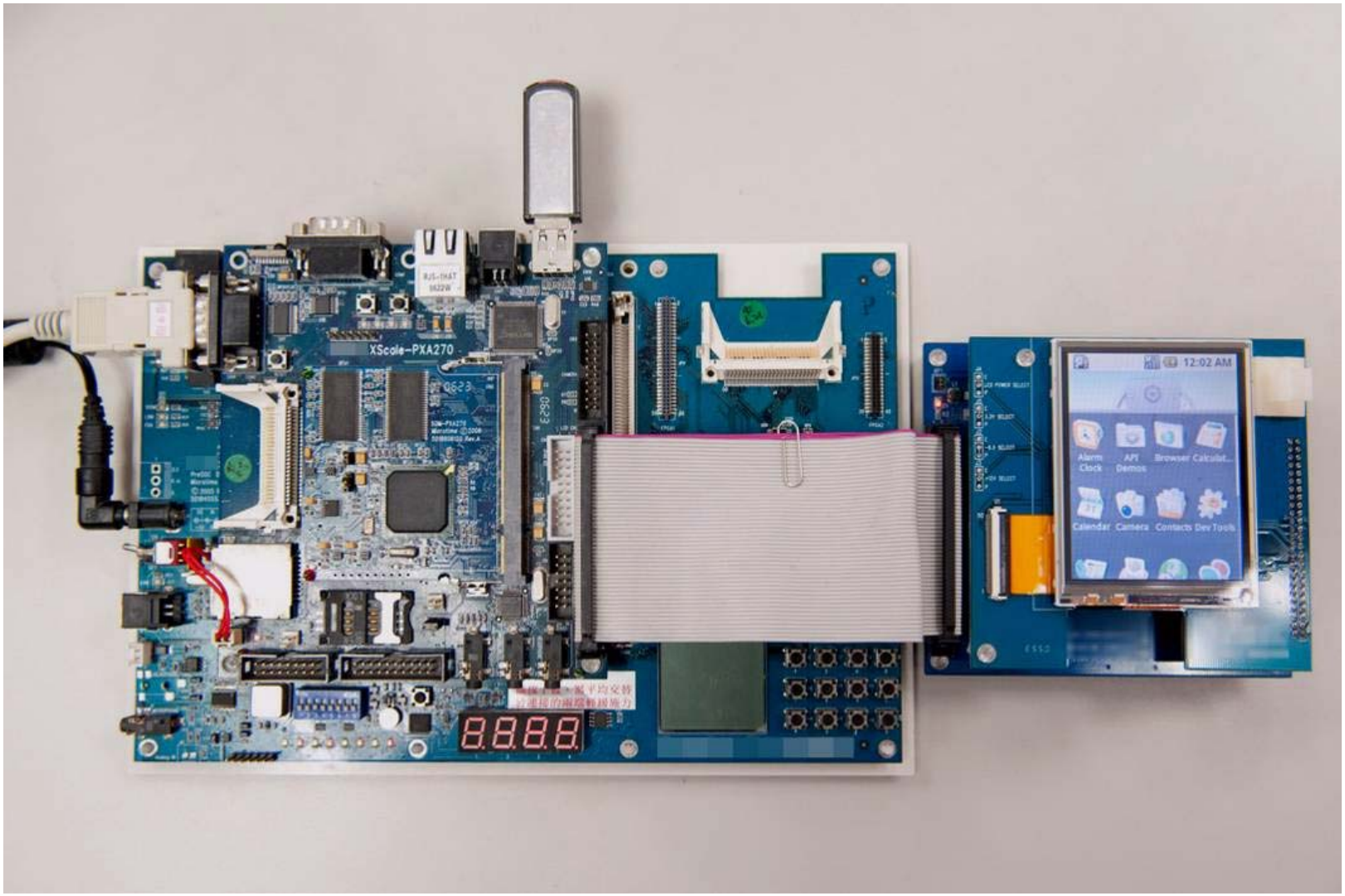
Experimental Android



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Recommended Minimum Device Requirements on ARM Platform

	Official	Our
CPU	ARM-based	●ARM9 at least (Goldfish use ARM926) ●ARMv5
RAM	128MB	128MB up
Flash	256MB	128MB up

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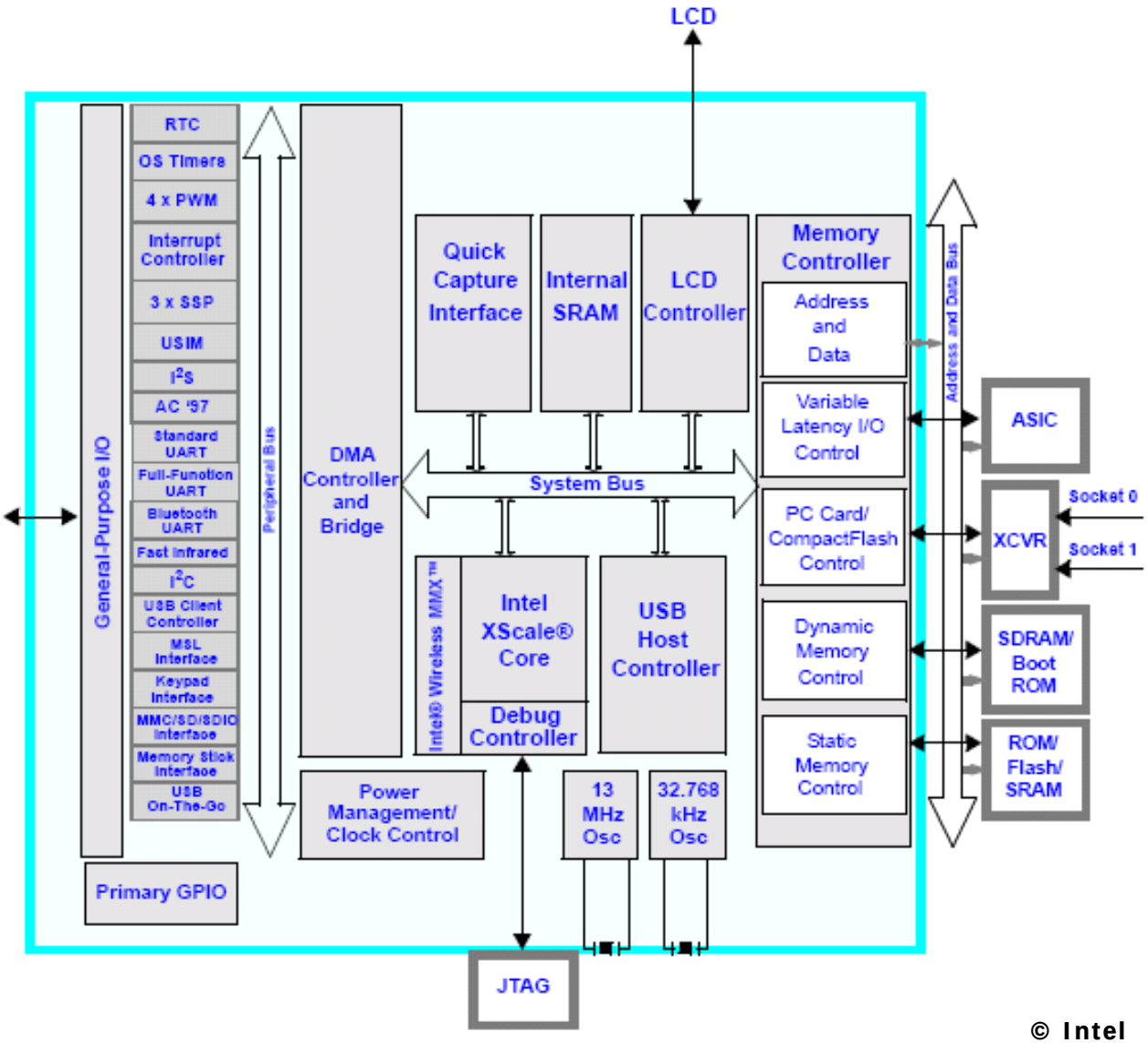
PXA27x Processor Block Diagram



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Our PXA270 Hardware Brief

CPU	Intel XScale PXA270 520MHz	
Flash ROM	32M Bytes	
SDRAM	64M Bytes	
Keypad	4x4 matrix	
Touch	UCB1400	
LCD Module(LCM)	LCD Panel	TOPPOLY TD035STEB1
	Display Area	53.64mm(H) x 71.52mm(V)
	Drive System	TFT active matrix
	Display Colors	262144 colors
	Number of Pixels	240 x RGB(H) x 320(V)
	Pixel Arrangement	RGB Vertical stripe
	Signal System	6-bit digital signals for each RGB
UART		
Ethernet	10/100 Mbps	
USB		
Audio	UCB1400	

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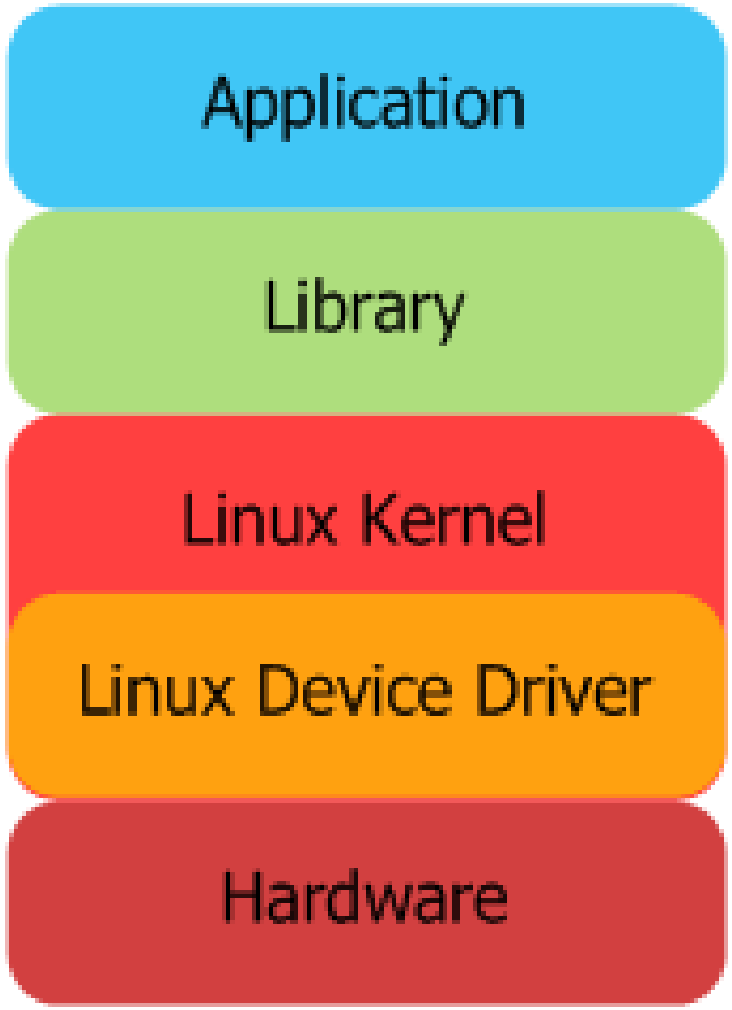
Embedded Linux System Architecture



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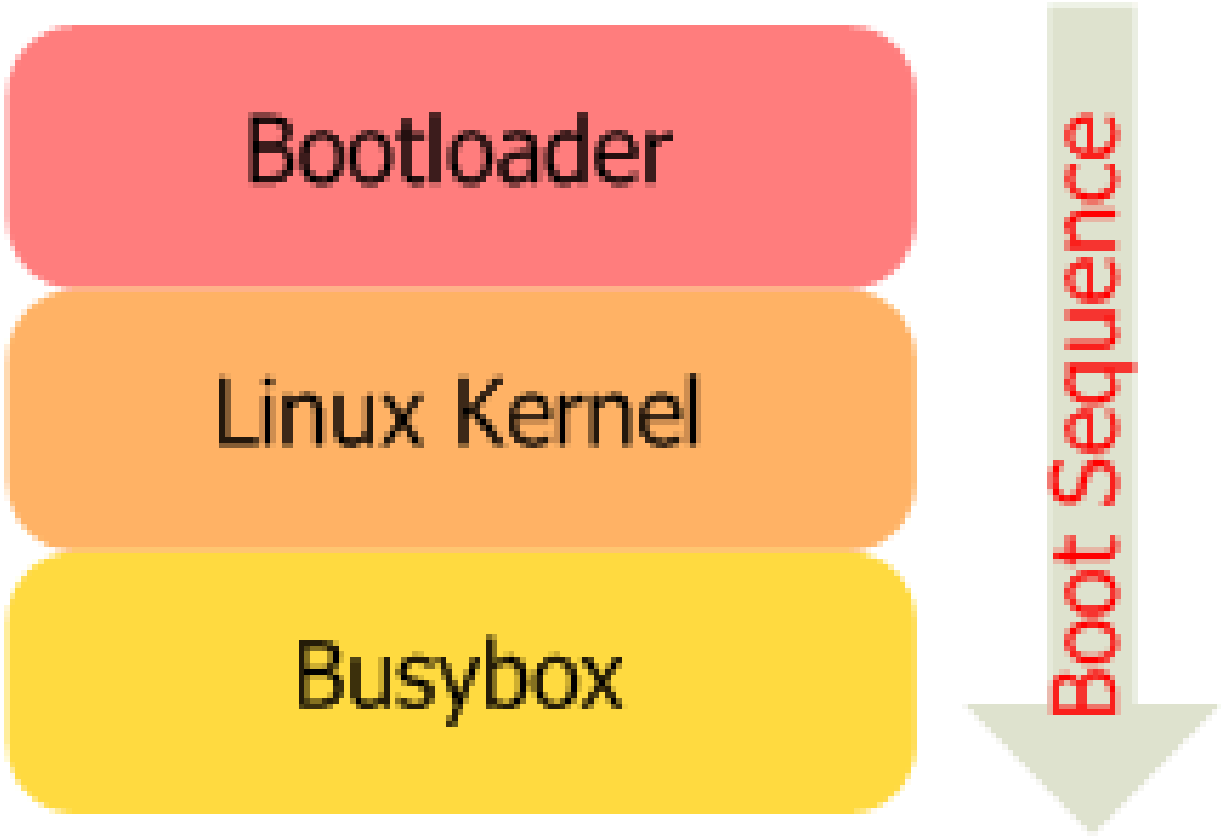
Embedded Linux System Boot Sequence



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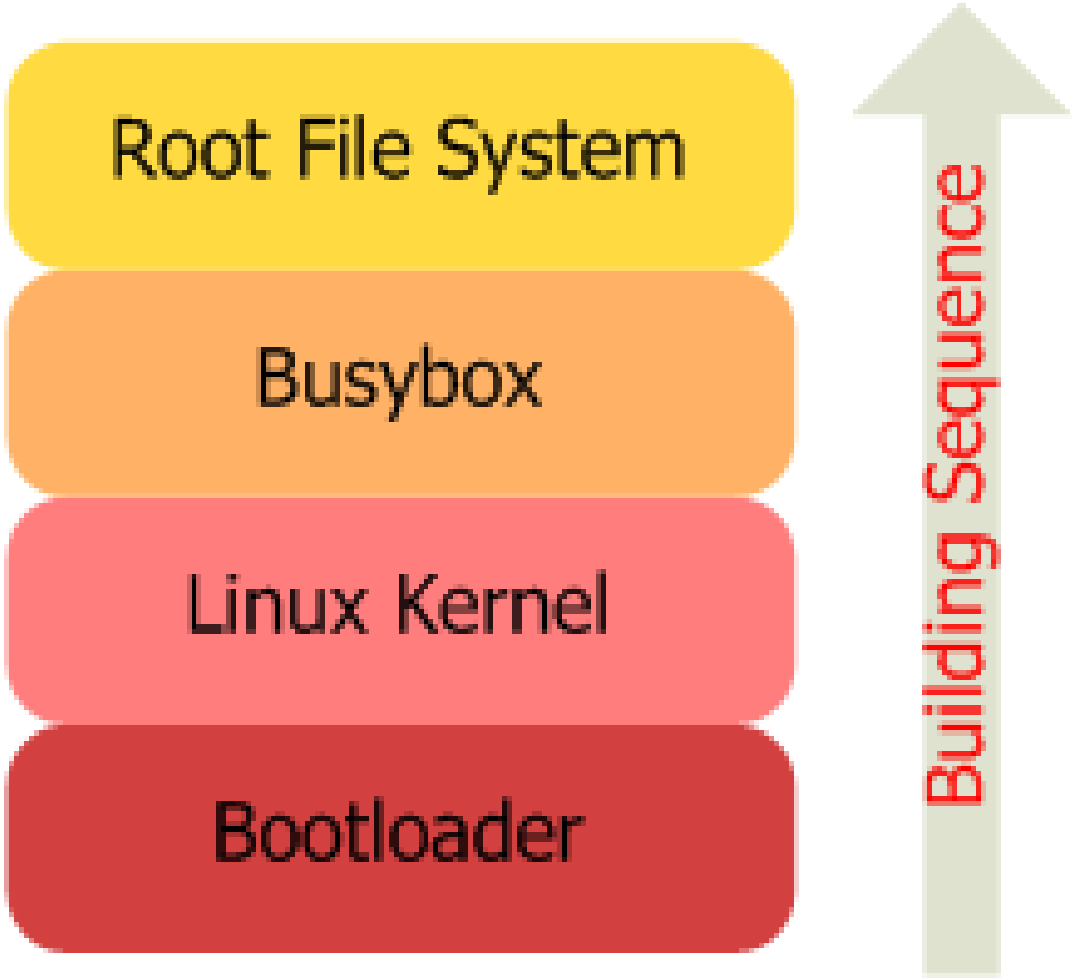
How to Build An Embedded Linux System



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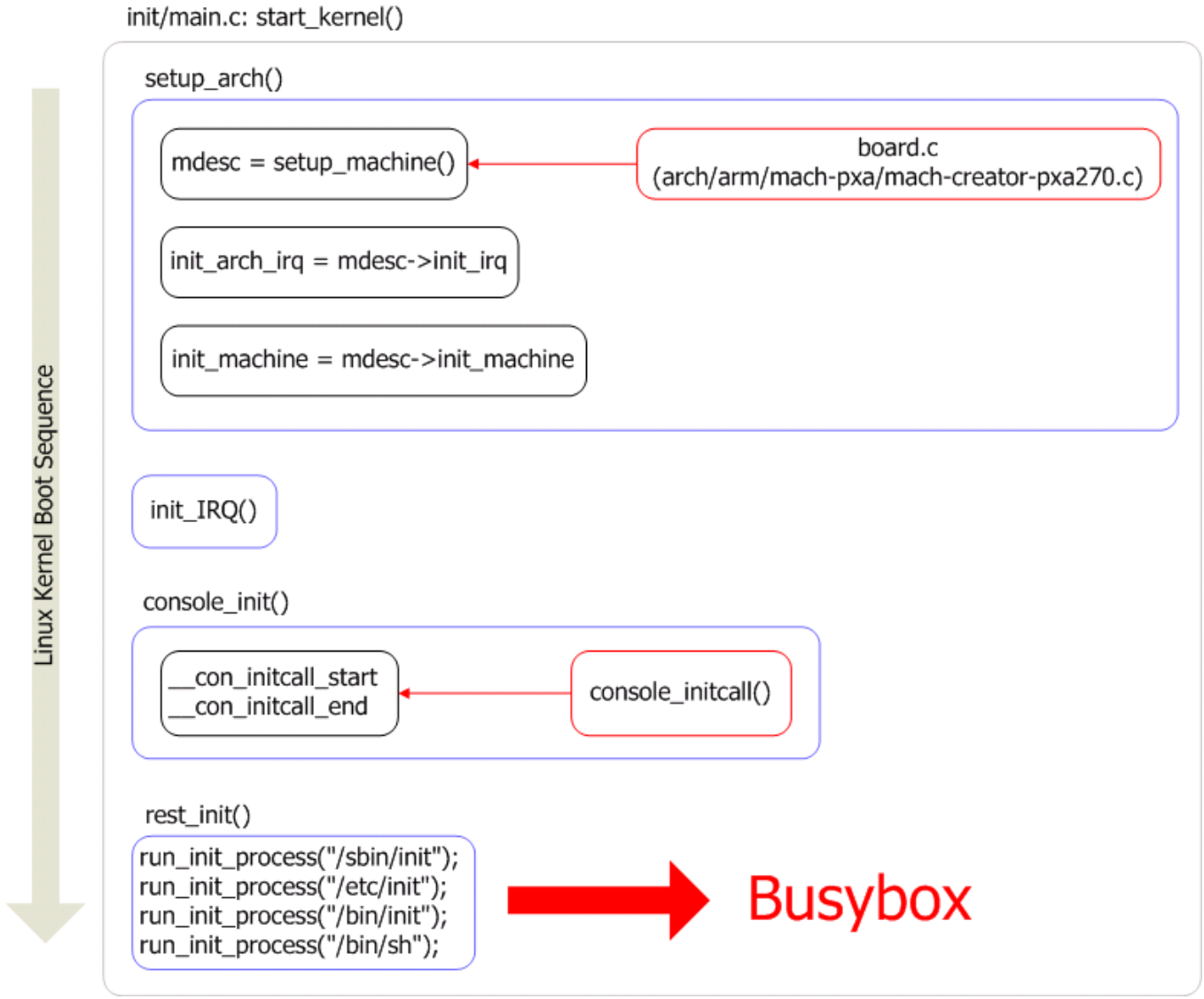
Linux Kernel Boot Sequence



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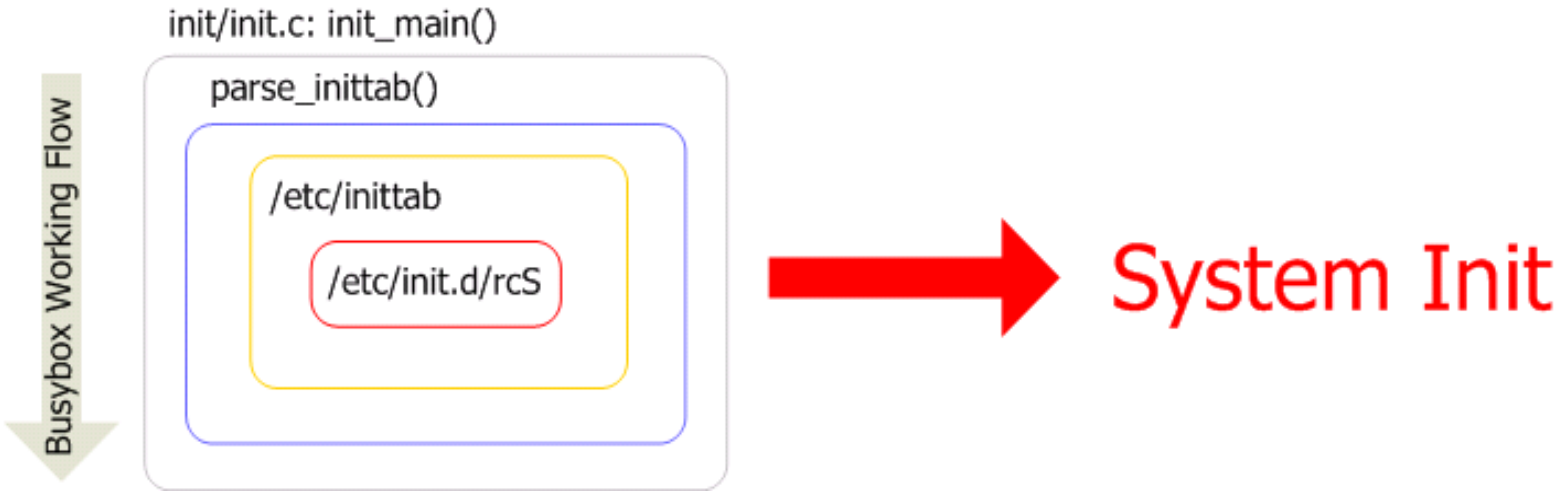
Busybox Working Flow



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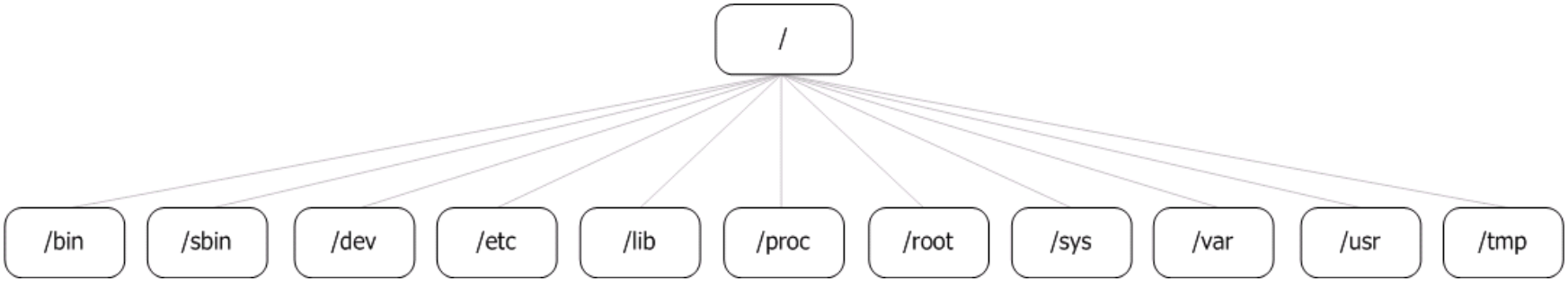
Embedded Linux System Directories



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Embedded Linux System Directories (cont)

- /bin, /sbin
  - Utilities
- /dev
  - Device nodes
- /etc
  - Configurations
  - Init scripts
- /lib
  - Kernel modules (device driver)
- /proc
  - Process information

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Embedded Linux System Directories (cont)

- /root
  - Specific utilities
- /sys
  - An interface for user accessing kernel information
  - Representation of hardware architecture
- /var
  - Logs
- /tmp
  - Memory space

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Motivation

- Build a new experimental Android platform
- Study how Linux device drivers cooperate with Android applications
- Open Source
- Share Android Porting experience
- Prove Android could run on PXA270

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Key Points of Building An Android Run-time System

- Carefulness
- Luckiness
- Experience

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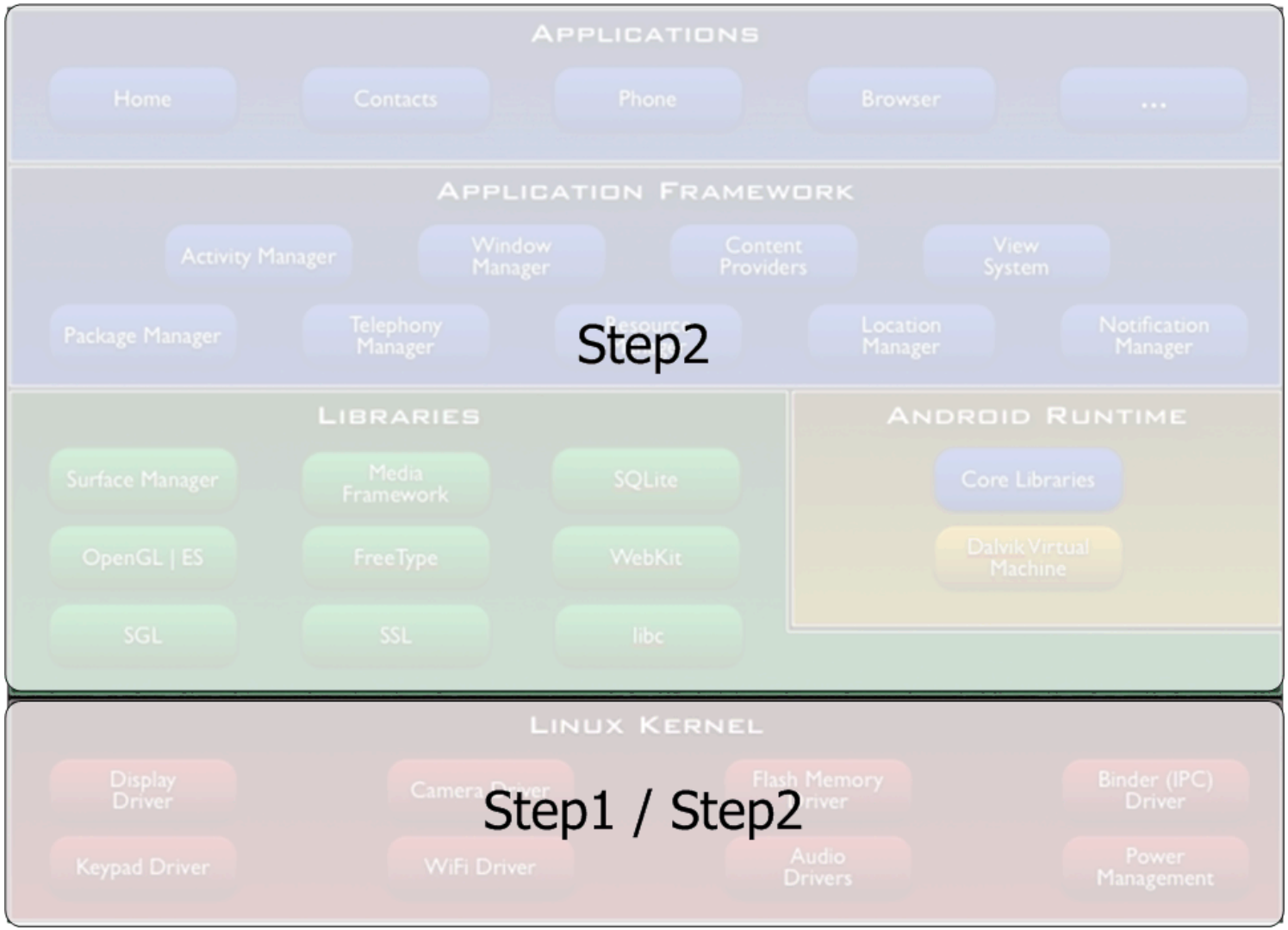
Porting Steps



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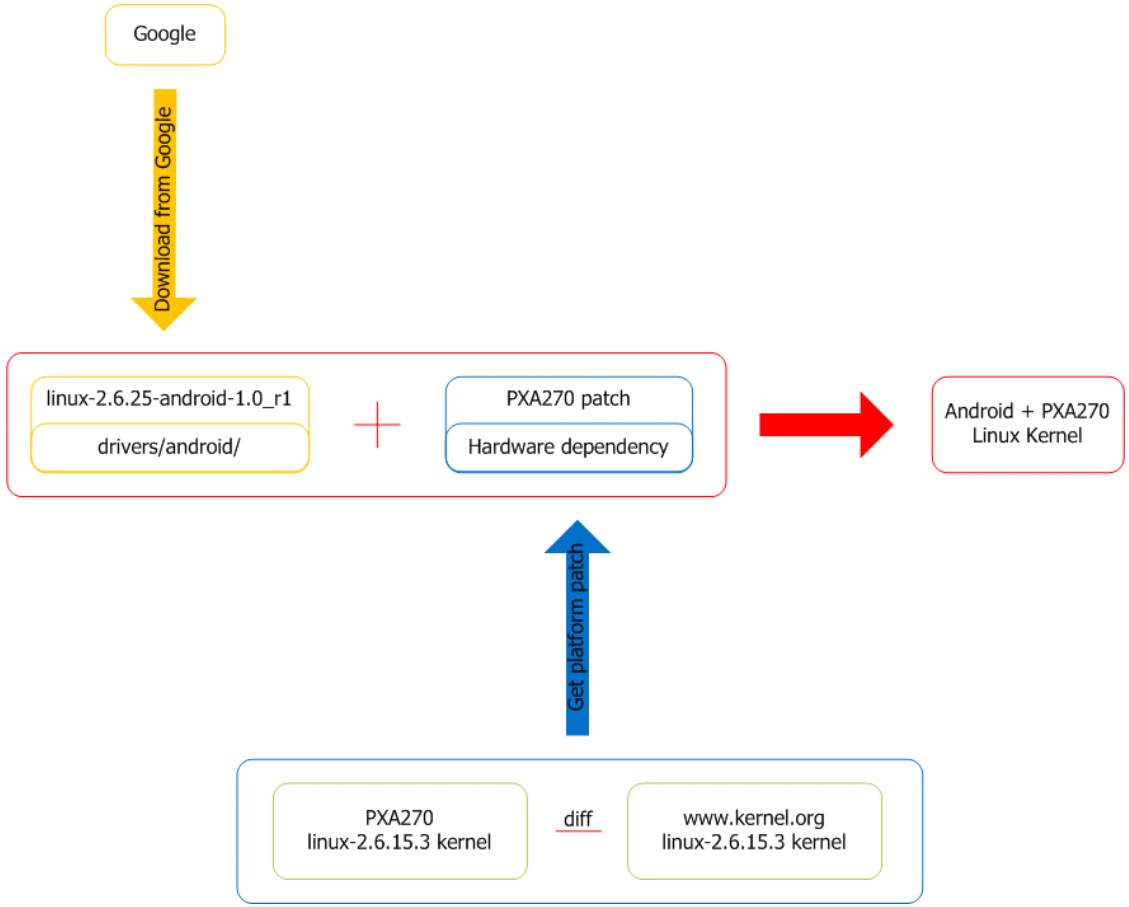
How to Construct Linux Kernel with Android Patch

- There are different ways to patch Linux kernel depending on different situations



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Use Which Tools to Patch Linux Kernel

- Linux platform
  - Meld
- Windows platform
  - WinMerge

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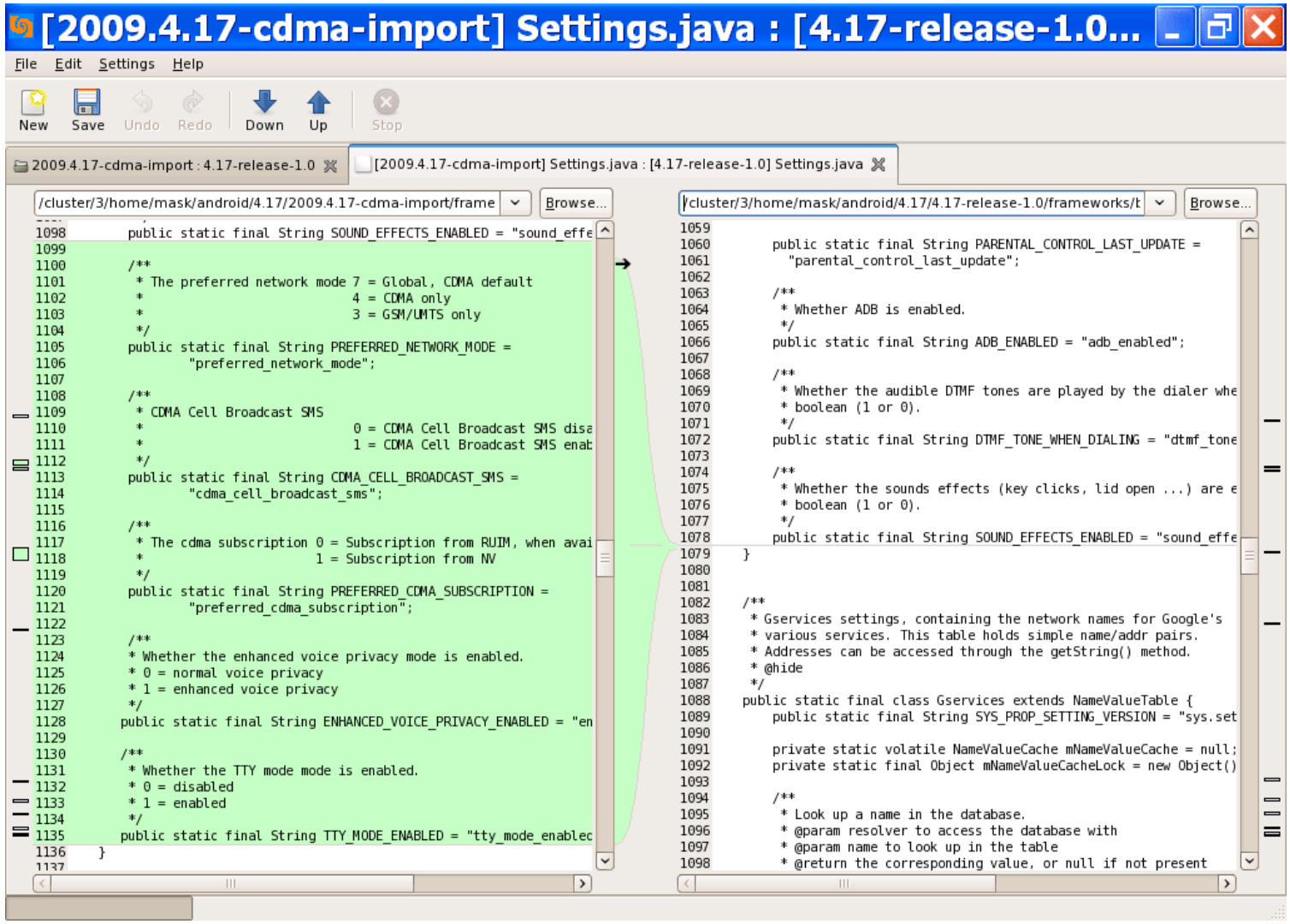
Meld



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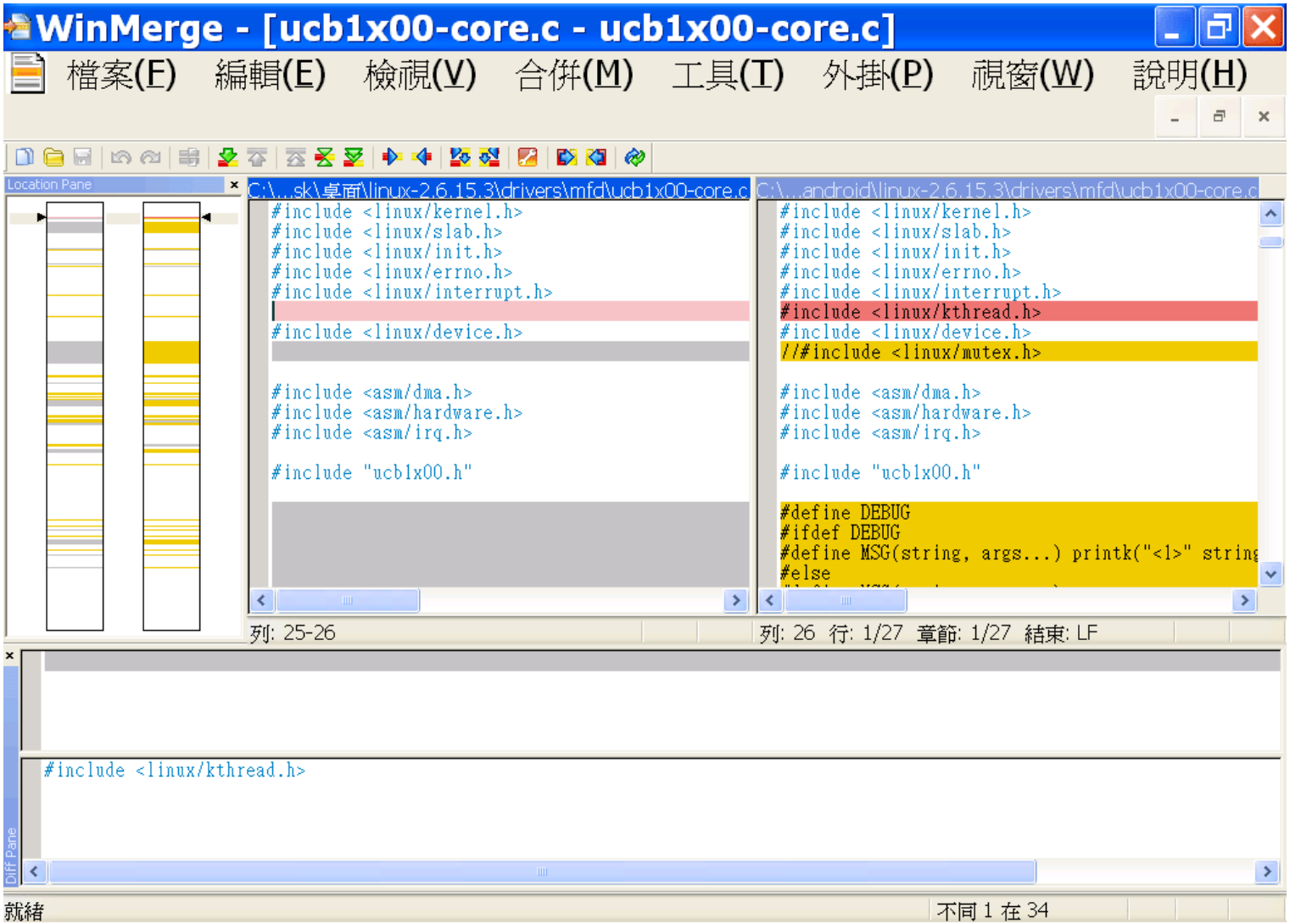
WinMerge



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Potential Problems on Patching Linux Kernel

- Data structure
  - Reference similar platforms
- Init section
  - Reference successfully compiled drivers
- Source dispersed
  - Only consider the BSP changed from the official Linux Kernel
- File name changed
  - Same as the previous item
- Kernel configuration
  - 1st stage
    - make oldconfig
    - make platform_old_defconfig
  - 2nd stage
    - Depend on your requirements to adjust

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How to Fix Compiling Problems

- Refer to kernel source of similar platforms
  - Mainstone (PXA270)
- Refer to the workable BSP from vendor
  - 2.6.15.3 from vendor

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Use Easy Ways to Debug Linux Kernel

- Enable options in the kernel configuration
  - CONFIG_DEBUG_KERNEL
- If you want to get more debug informations
  - CONFIG_DEBUG_DRIVER
  - CONFIG_DEBUG_DEVRES
- make V=1
  - Get detail information during compiling process

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Which Drivers May Need to Modify

- Serial
- NIC
- Framebuffer
- USB
- Touch
- Keypad
- Etc.

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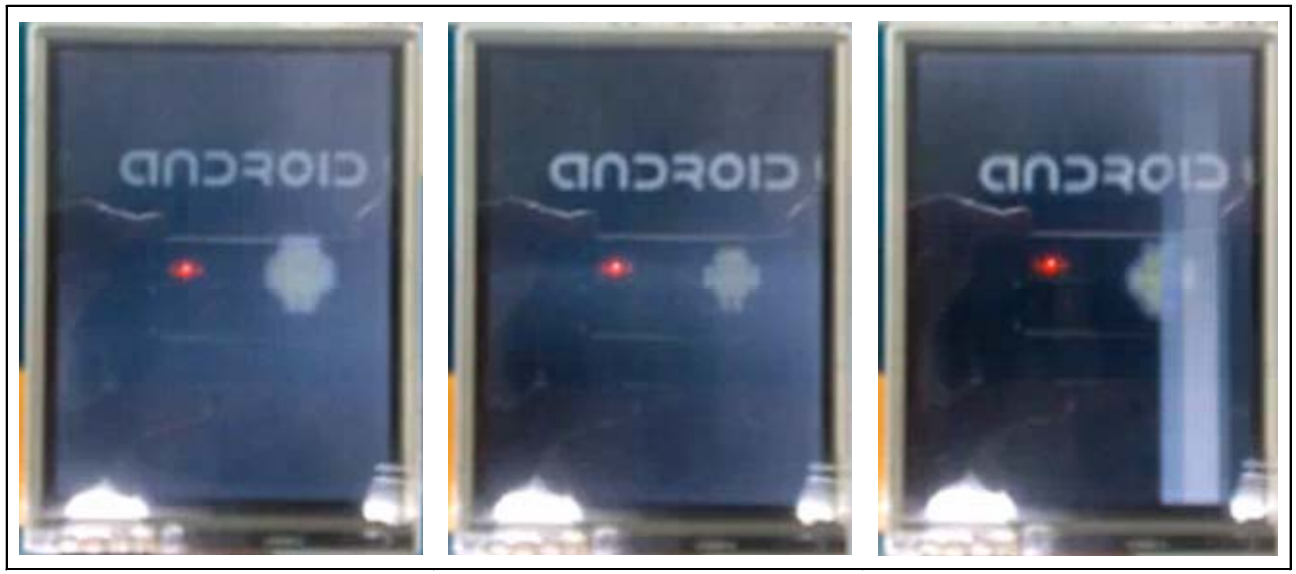
LCD Flickering Problem (linux/drivers/video/pxafb.c)

- Problem
  - LCD Screen Flicker



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LCD Flickering Problem (cont)

- Cause
  - LCD controller is enabled and then disabled repeatedly
  - It’s cause by the register LCCR0 is not properly synchronized in pxafb.c, which then falsely switches the status of LCD
- Solution
  - Add fb_pan_display() to change LCD states accordingly

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Keypad Driver (linux/drivers/input/keyboard/android_keypad.c)

- Problem
  - Only 16 keys
  - The keypad device doesn’t use IRQ
- Solution
  - Composed key
    - KEY_MENU
    - KEY_BACK
    - …
  - kthread
  - Polling
  - Idle algorithm
    - Incrementally double the idle time until reaching the maximum idle time

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Touch Panel Driver (linux/drivers/input/touchscreen/ucb1400_ts.c)

- Modification
  - Assign IRQ number to 161
  - Connected to input subsystem
  - Calibrate (x,y) position
  - Adjust touch sensitive

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How to Trace Android Source Code

- ctags --C++-kinds=+p -R

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It Seems Android Gets Wrong (x,y) Positions from Touch Driver

- Problem
  - The touch driver gets the (x,y) position successfully but Android always reports the (0,0) to applications
- Analysis
  - Did (x,y) report to the user space correctly?
  - Did Android get the correct (x,y)?
  - Did Android modify the (x,y) somewhere?
  - Why Android modify the (x,y)?
- Cause
  - The reporting (x,y) relates to the LCD status
  - The LCD status relates to the power status

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Android Gets The Touch Device

```
E/EventHub( 1589): could not get driver version for /dev/input/mouse0
I/EventHub( 1589): New device: path=/dev/input/event0 name=android-ke
I/SystemServer( 1589): Starting Bluetooth Service.
I/EventHub( 1589): New keyboard: publicID=65537 device->id=65537 devn
I/SystemServer( 1589): Starting Status Bar Service.
E/EventHub( 1589): could not get driver version for /dev/input/mice,
I/KeyInputQueue( 1589): Device added: id=0x0, name=android-keypad, cl
I/KeyInputQueue( 1589): Device added: id=0x10000, name=null, classes=
I/KeyInputQueue( 1589):   X: min=0 max=920 flat=0 fuzz=0
I/KeyInputQueue( 1589):   Y: min=0 max=950 flat=0 fuzz=0
I/KeyInputQueue( 1589):   Pressure: min=0 max=1 flat=0 fuzz=0
I/KeyInputQueue( 1589):   Size: unknown values
I/KeyInputQueue( 1589): absX=com.android.server.InputDevice$AbsoluteI
I/KeyInputQueue( 1589): absY=com.android.server.InputDevice$AbsoluteI
I/KeyInputQueue( 1589): absPressure=com.android.server.InputDevice$Ab
I/KeyInputQueue( 1589): absSize=null
I/foo     ( 1589): ***** HAVE TOUCHSCREEN!
I/WindowManager( 1589): Input configuration changed: { scale=1.0 imsi
D/dalvikvm( 1589): GC freed 11328 objects / 708880 bytes in 162ms
I/SystemServer( 1589): Starting Hardware Service.
I/SystemServer( 1589): Starting NetStat Service.
I/SystemServer( 1589): Starting Connectivity Service.
```


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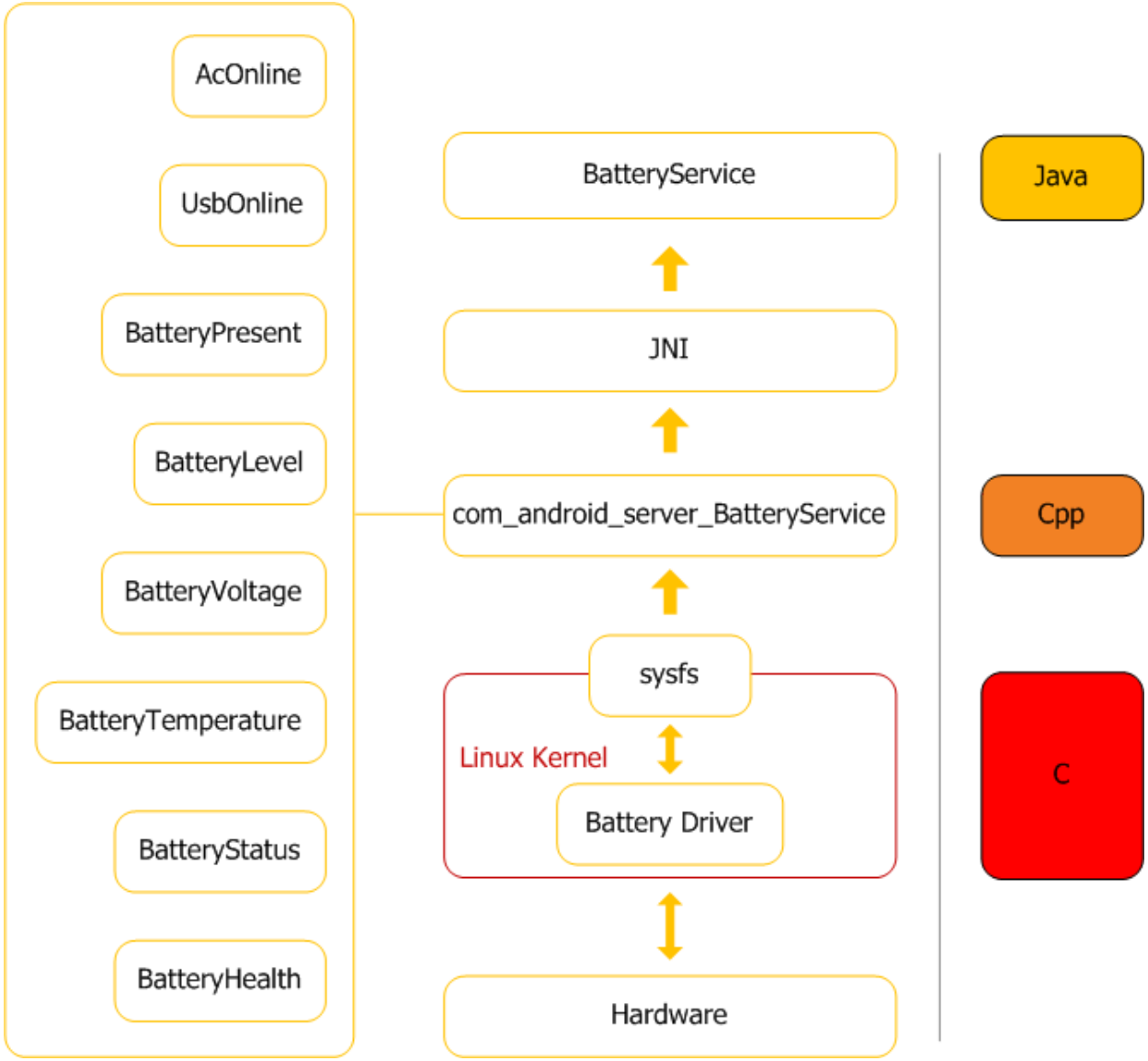
Android BatteryService Workflow



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Battery Driver

- Battery Driver creates the following sysfs entries
  - /sys/class/power_supply/ac/online
  - /sys/class/power_supply/usb/online
  - /sys/class/power_supply/battery/status
  - /sys/class/power_supply/battery/health
  - /sys/class/power_supply/battery/present
  - /sys/class/power_supply/battery/capacity
  - /sys/class/power_supply/battery/batt_vol
  - /sys/class/power_supply/battery/batt_temp
  - /sys/class/power_supply/battery/technology

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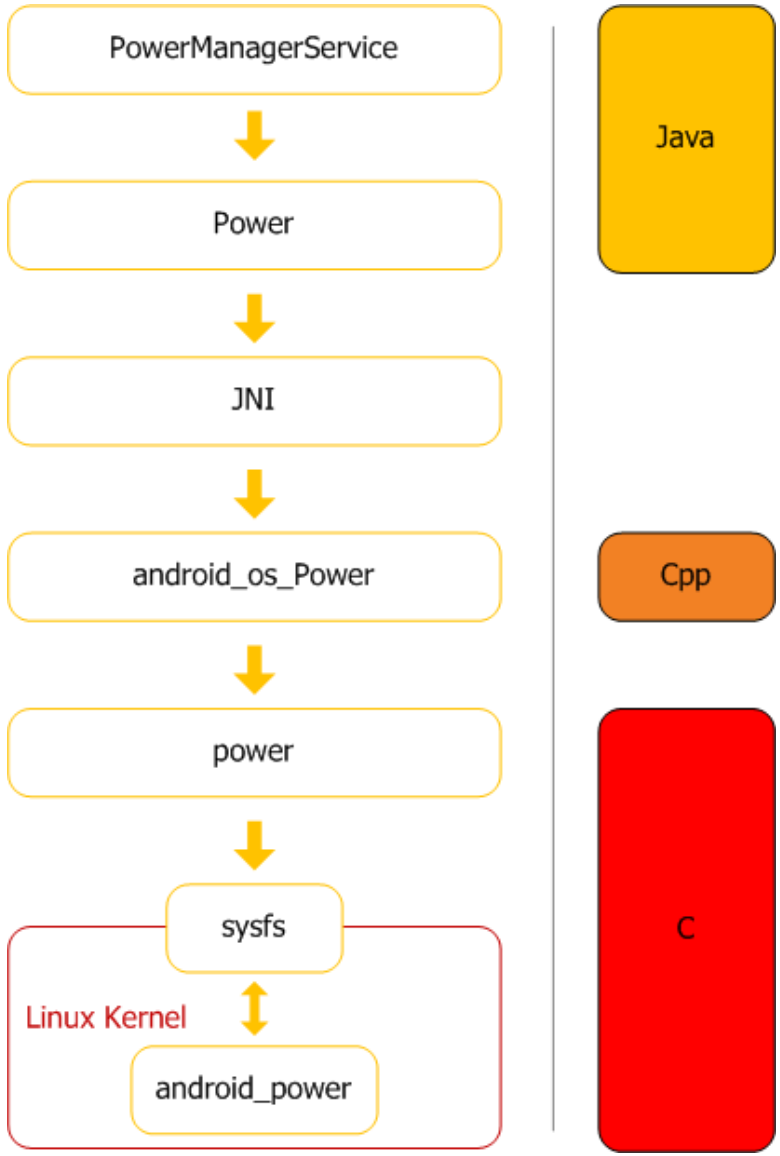
Android PowerManagerService Workflow



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Android Power Driver

- Android Power Driver creates the following sysfs entries
  - /sys/android_power/acquire_partial_wake_lock
  - /sys/android_power/acquire_full_wake_lock
  - /sys/android_power/release_wake_lock
  - /sys/android_power/request_state
  - /sys/android_power/auto_off_timeout
- Currently, we only use:
  - /sys/android_power/request_state
    - Turn on LCD

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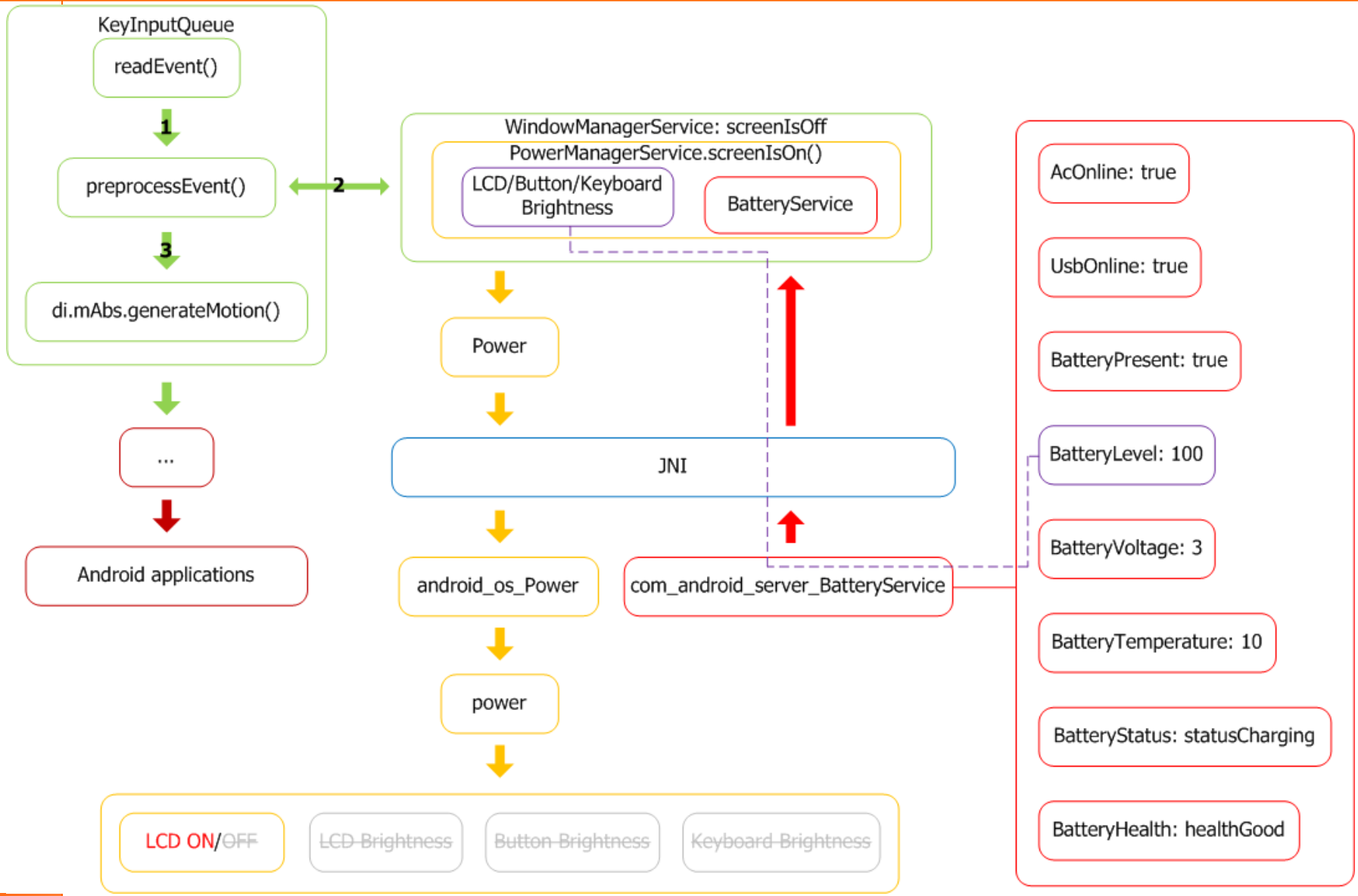
Relationship between Input Keys and Android Services



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Why We Need A Building Environment

- Just type "make" to build a whole Android run-time system
- Speeding up development
- Complete system integration

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Our Building Environment

- A new building environment
- Avoid recursive make
- Reduce variable declaration in Makefile
- Structural building system
  - Component based building
  - Easy to add components through adding new Makefile in the mkfile directory
- Support parallel make as much as we could
  - Reduce dependency
  - Distributed make process

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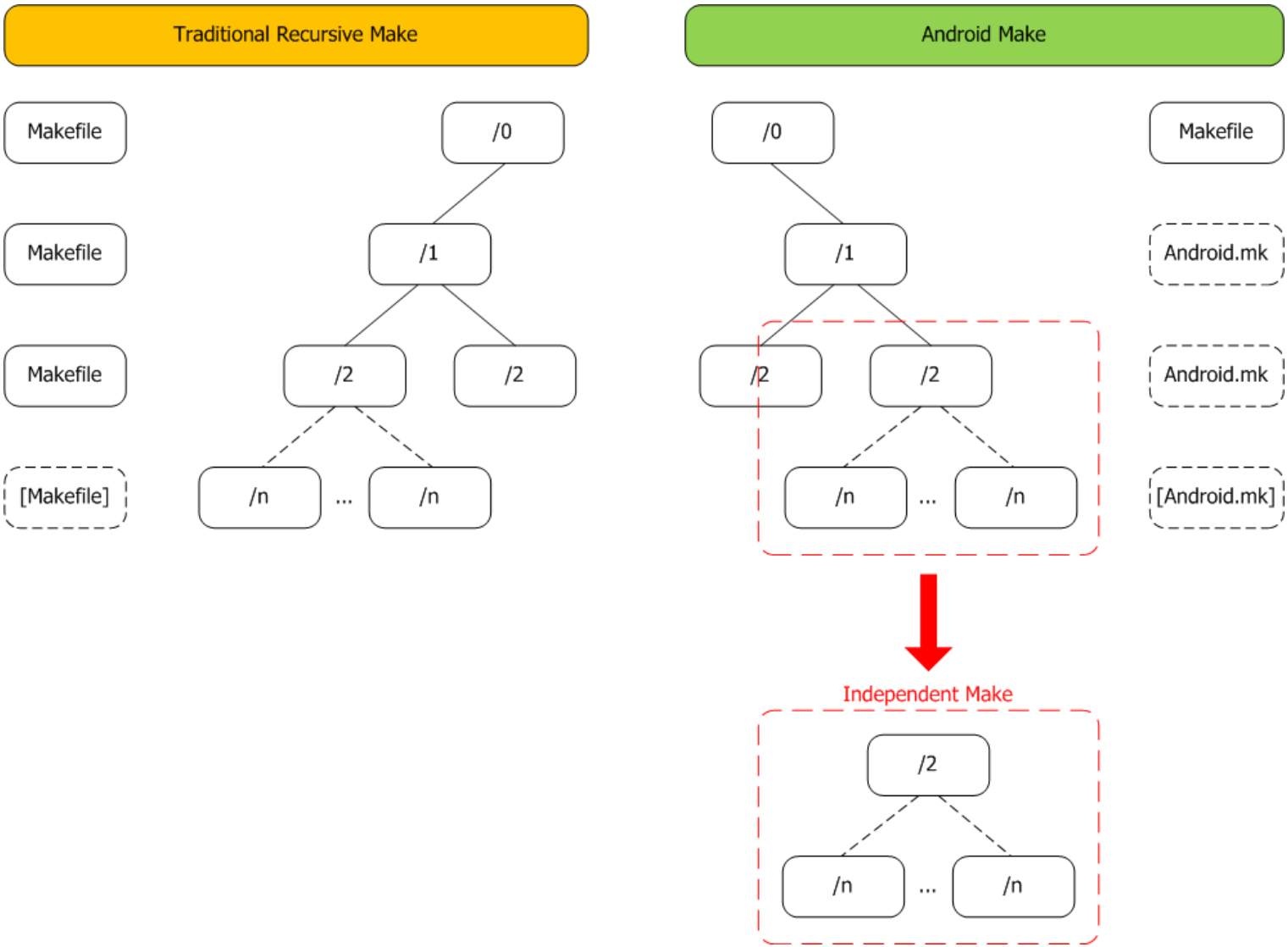
Recursive Make vs. Independent Make



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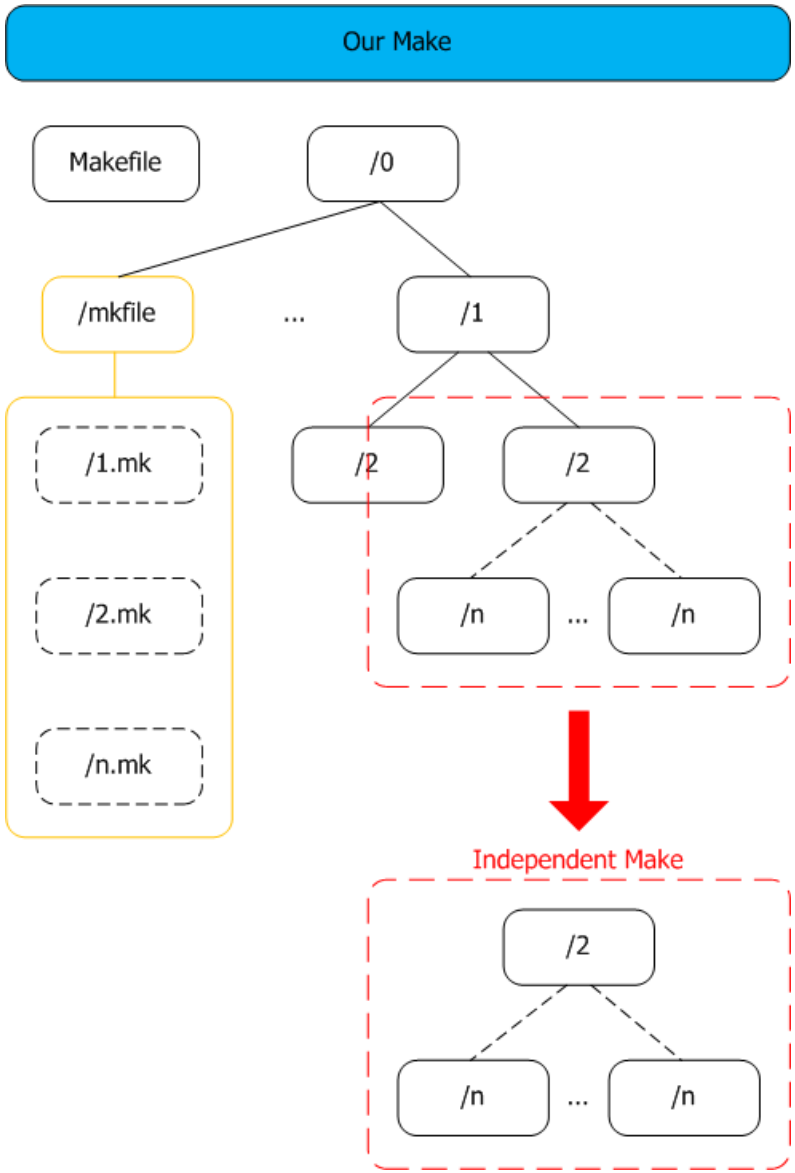
Our Building Environment



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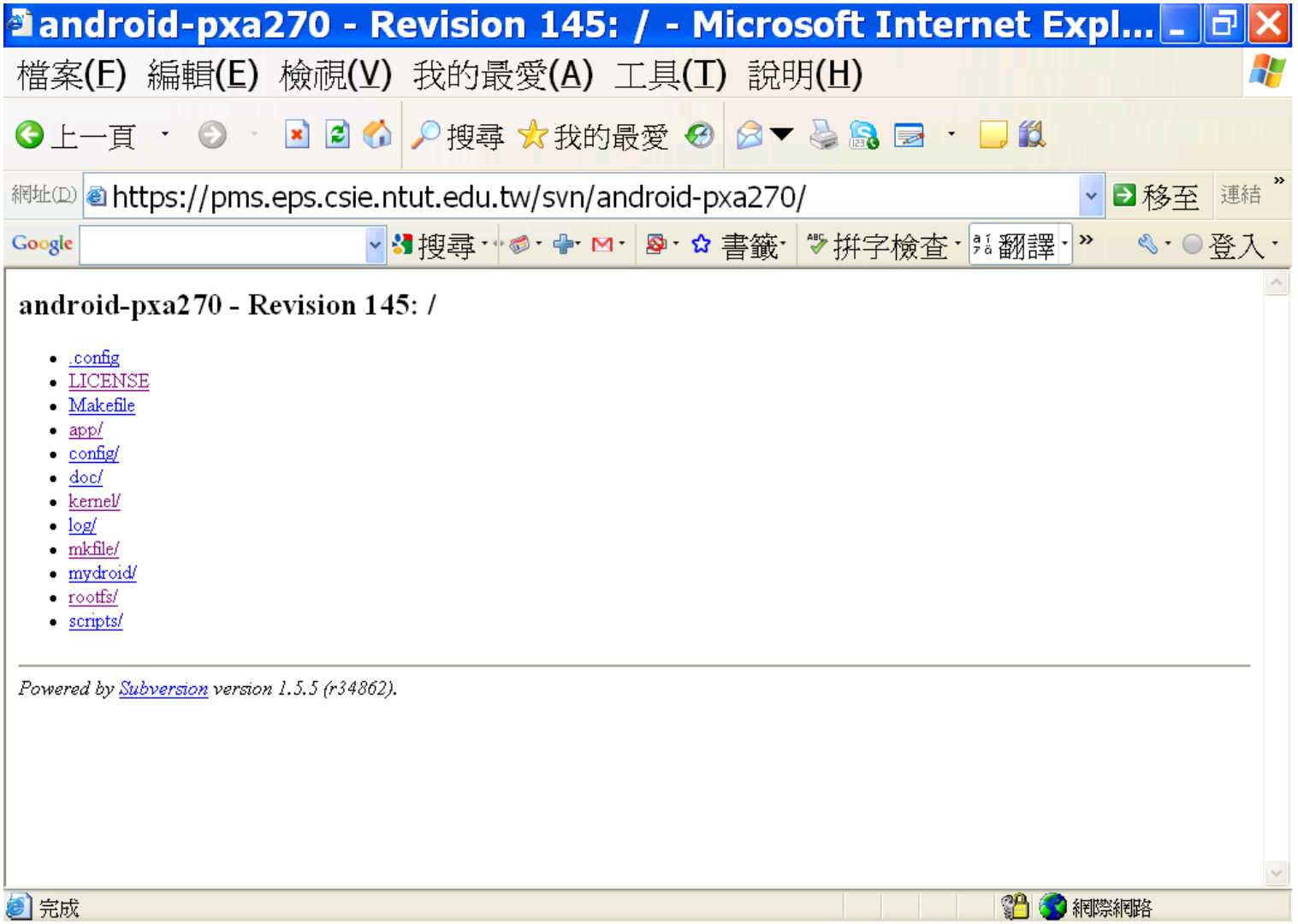
How to Use Our Building Environment



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make menuconfig

mask@eps:~/android-pxa270

```
                    EPS Android Configuration
  Arrow keys navigate the menu.  <Enter> selects submenus --->.  Highlighted
  letters are hotkeys.  Pressing <Y> selectes a feature, while <N> will exclude a
  feature.  Press <Esc><Esc> to exit, <?> for Help, </> for Search.  Legend: [*]
  feature is selected  [ ] feature is excluded

                  Toolchain  --->
                  Linux Kernel  --->
                  BusyBox  --->
                  Root File System  --->
                ---
                Load an Alternate Configuration File
                Save Configuration to an Alternate File

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


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Choose Toolchain

mask@eps:~/android-pxa270

Toolchain

Arrow keys navigate the menu. <Enter> selects submenus --->. Highlighted letters are hotkeys. Pressing <Y> selectes a feature, while <N> will exclude a feature. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] feature is selected [ ] feature is excluded

(arm-2008q3-41-arm-none-linux-gnueabi-i686-pc-linux-gnu.tar.bz2) Using which too

<Select> < Exit > < Help >

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Choose Linux Kernel

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Linux Kernel

Arrow keys navigate the menu. <Enter> selects submenus --->. Highlighted letters are hotkeys. Pressing <Y> selectes a feature, while <N> will exclude a feature. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] feature is selected [ ] feature is excluded

(linux-2.6.25-android-1.0_r1) Android 1.0 SDK, Release 1

<Select> < Exit > < Help >

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Choose Busybox

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BusyBox

Arrow keys navigate the menu. <Enter> selects submenus --->. Highlighted letters are hotkeys. Pressing <Y> selectes a feature, while <N> will exclude a feature. Press <Esc><Esc> to exit, <?> for Help, </> for Search. Legend: [*] feature is selected [ ] feature is excluded

(busybox-1.13.2) BusyBox 1.13.2

<Select> < Exit > < Help >

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Choose Root File System

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```
                        Root File System
  Arrow keys navigate the menu.  <Enter> selects submenus --->.  Highlighted
  letters are hotkeys.  Pressing <Y> selectes a feature, while <N> will exclude a
  feature.  Press <Esc><Esc> to exit, <?> for Help, </> for Search.  Legend: [*]
  feature is selected  [ ] feature is excluded

                  (tiny_rootfs.tgz) Base Root File System
                  [*] Enable Android  --->
                  [*] Using JFFS2 Root File System
                  [ ] Using YAFFS2 Root File System

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


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We Need More Powerful Developing Environment

- SVN
- SVN backup
- More powerful CPU
  - May need more than 1~2 hours to build our whole android run-time system at first time
- More large disk space
  - More than 6GB disk space

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Statistics of Compiling Time

	CentOS release 5.3 (Final) / Red Hat Enterprise Linux Server release 5 (Tikanga)	Fedora release 7 (Moonshine)	Ubuntu 8.04.2
Kernel	2.6.18-128.1.10.el5，x86_64	2.6.23.17-88.fc7	2.6.24-23-generic
CPU	4x Intel(R) Xeon(TM) MP CPU 3.16GHz	2x Intel(R) Core(TM)2 CPU 6320 @ 1.86GHz	AMD Athlon(tm) 64 Processor 3000+
DRAM	4GB	1GB	2GB
make	1：28：39	1：47：01	1：18：57
make -j	53：48	FAIL	1：28：14
make –j4	47：37	N/A	N/A

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Our Developing Environment



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Outline

- Introduction
- Motivation
- Porting Procedure
- Building Environment
- Conclusion

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Contributions

- Port Android to a real PXA270 target
- Open porting procedure
- Modify device drivers and whole Android system to make them cooperate with each other
- Open Source
- Build a new, simple, smart, component based building environment for developers co-work to each other

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Contributions (cont)



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Future Works

- Enable peripherals
  - Audio
  - Wireless
  - …
- Low power
- Benchmarks
- Android applications

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Q & A

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