密级状态：绝密（　　）　秘密（　　）　内部（ ）　公开（√ ）

RK3368H_ANDROID7.1-MID-SDK_V1.00_20170406 发布说明

（技术部，第一系统产品部）

文件状态： [ ] 正在修改 [√] 正式发布	当前版本：	V1.00
	作　　者：	吴良清
	完成日期：	2017-04-06
	审　　核：	黄祖芳、刘益星
	完成日期：	2017-04-06

福州瑞芯微电子有限公司

Fuzhou Rockchips Semiconductor Co . , Ltd

版 本 历 史

版本号	作者	修改日期	修改说明	备注
V1.00	吴良清	2017.04.06	正式发布	
V1.01	张骏	201705.12	增加 HDMI 配置说明	

目 录

1 概述

本 SDK 是基于谷歌 Android7.1 系统，适配瑞芯微 RK3368H 芯片的软件包，适用于 RK3368H MID 开发板以及基于其上所有开发产品。

2 主要支持功能

参数	**模块名**
数据通信	Wi-Fi、USB 以太网卡、3G Dongle、USB、SDCARD
应用程序	图库、APK 安装器、浏览器、计算器、日历、相机、闹钟、下载、电子邮件、资源管理器、GMS 应用、音乐、录音、设置、视频播放器

3 SDK 获取说明

3.1 获取 SDK

SDK 通过瑞芯微代码服务器对外发布。其编译开发环境，参考附录 A 编译开发环境搭建。

客户向瑞芯微技术窗口申请 SDK，需同步提供 SSH 公钥进行服务器认证授权，获得授权后即可同步代码。关于瑞芯微代码服务器 SSH 公钥授权，请参考附录 B SSH 公钥操作说明。

RK3368H_ANDROID7.1_SDK 下载地址如下：

```
repo init
--repo-url=ssh://git@www.rockchip.com.cn:2222/repo-release/tools/repo.git
-u ssh://git@www.rockchip.com.cn:2222/rk3368h-n/manifests.git -m
RK3368H-n_Android7.1_sdk.xml
```

注，repo 是 google 用 Python 脚本写的调用 git 的一个脚本，主要是用来下载、管理 Android 项目的软件仓库，其下载地址如下：

```
git clone ssh://git@www.rockchip.com.cn/repo/rk/tools/repo
```

为方便客户快速获取 SDK 源码，瑞芯微技术窗口通常会提供对应版本的 SDK 初始压缩包。

以 Rk3368H_Android7.1_SDK.tar.gz 为例，拷贝到该初始化包后，通过如下命令可检出源码：

```
mkdir rk3368H
tar jxvf Rk3368H_Android7.1_SDK.tar.gz -C rk3368H
cd rk3368H
.repo/repo/repo sync –l
.repo/repo/repo sync
```

3.2 补充说明

1. Android7.1 SDK 已不再支持 UMS 功能，平台设备皆使用合并分区。
2. 关于 RK3368H 调试口，我们建议采用 uart3，早期的 3368 机器都是用 uart2，用 uart2 的话存在跟 sd 卡复用的问题。

   1）如果硬件采用 uart3 作为 debug 口，则 SDK 代码不需要做任何修改即可使用，代码默认使用 uart3 作为 debug 口；

   2）如果硬件采用 uart2 作为 debug 口，则 SDK 代码需要把 debug 口改成 uart2，包括 uboot 和 kernel，修改方法如下：

   uboot:

```
diff --git a/configs/rk3368_defconfig b/configs/rk3368_defconfig
index 35babef..0aaf9fa 100644
--- a/configs/rk3368_defconfig
+++ b/configs/rk3368_defconfig
@@ -1,4 +1,4 @@
-CONFIG_SYS_EXTRA_OPTIONS="RKCHIP_RK3368,PRODUCT_MID,NORMAL_WORLD,SECOND_LEVEL_BOOTLOADER,UART_NUM=UART_CH3"
+CONFIG_SYS_EXTRA_OPTIONS="RKCHIP_RK3368,PRODUCT_MID,NORMAL_WORLD,SECOND_LEVEL_BOOTLOADER"
 CONFIG_ARM=y
 CONFIG_ROCKCHIP_ARCH64=y
 CONFIG_PLAT_RK33XX=y
```

kernel:

```
--- a/arch/arm64/boot/dts/rockchip/rk3368-android.dtsi
+++ b/arch/arm64/boot/dts/rockchip/rk3368-android.dtsi
@@ -42,18 +42,18 @@

 / {
        chosen {
-               bootargs = "earlycon=uart8250,mmio32,0xff1b0000 swiotlb=1 f
irmware_class.path=/system/vendor/firmware";
+               bootargs = "earlycon=uart8250,mmio32,0xff690000 swiotlb=1
firmware_class.path=/system/vendor/firmware";
        };
        fiq_debugger: fiq-debugger {
                compatible = "rockchip,fiq-debugger";
-               rockchip,serial-id = <3>;
+               rockchip,serial-id = <2>;
                rockchip,signal-irq = <186>;
                rockchip,wake-irq = <0>;
                rockchip,irq-mode-enable = <1>;  /* If enable uart uses irq inst
ead of fiq */
                rockchip,baudrate = <115200>;  /* Only 115200 and 1500000
*/
                pinctrl-names = "default";
-               pinctrl-0 = <&uart3_xfer>;
+               pinctrl-0 = <&uart2_xfer>;
```

```
        };

        reserved-memory {
```

注意：由于 RK3368H　SD 卡与 uart2 复用了 pin 脚，这样修改以后会导致 sd 卡功能无法使用。调试阶段可以修改，产品化时请勿修改。

3. RK3368H Android7.1 SDK 默认配置支持 emmc，如果是 nand flash 则 dts 中需要修改为 nand 的配置。

例 rk3368-p9.dts 配置如下：

```
&nandc0 {
	status = "okay"; /* enable both for emmc and nand */
};

&emmc {
	bus-width = <8>;
	cap-mmc-highspeed;
	supports-emmc;
	disable-wp;
	non-removable;
	num-slots = <1>;
	pinctrl-names = "default";
	pinctrl-0 = <&emmc_clk &emmc_cmd &emmc_bus8>;
	status = "disabled";
};
```

4. RK3368H Android7.1 SDK 可配置支持 HDMI。

例 rk3368-p9.dts 配置如下：

Step1：移除原 codec sound 节点（如 es8316）,配置 hdmi_analog

注意 rockchip,codec = <&es8316>, <&hdmi>；把 es8316 声卡导入

```
-	es8316-sound {
-		compatible = "simple-audio-card";
-		simple-audio-card,format = "i2s";
-		simple-audio-card,name = "rockchip,es8316-codec";
```

```
-                 simple-audio-card,mclk-fs = <256>;
-                 simple-audio-card,widgets =
-                         "Microphone", "Mic Jack",
-                         "Headphone", "Headphone Jack";
-                 simple-audio-card,routing =
-                         "Mic Jack", "MICBIAS1",
-                         "IN1P", "Mic Jack",
-                         "Headphone Jack", "HPOL",
-                         "Headphone Jack", "HPOR";
-                 simple-audio-card,cpu {
-                         sound-dai = <&i2s_8ch>;
-                 };
-                 simple-audio-card,codec {
-                         sound-dai = <&es8316>;
-                 };
+         hdmi_analog: hdmi-analog {
+                 status = "okay";
+                 compatible = "rockchip,rk3368-hdmi-analog";
+                 rockchip,cpu = <&i2s_8ch>;
+                 rockchip,codec = <&es8316>, <&hdmi>;
+                 rockchip,widgets = "Microphone", "Mic Jack",
+                                    "Headphone", "Headphone Jack";
+                 rockchip,routing = "Mic Jack", "micbias",
+                                    "Headphone Jack", "HPOL",
+                                    "Headphone Jack", "HPOR";
          };
```

Step2： 配置&hdmi 节点

```
+&hdmi {
+           #address-cells = <1>;
+           #size-cells = <0>;
+           #sound-dai-cells = <0>;
+           status = "okay";
+};
+
 &i2s_8ch {
         status = "okay";
         rockchip,i2s-broken-burst-len;
```

Step3：配置显示相关

```
         sdio_pwrseq: sdio-pwrseq {
@@ -328,6 +319,8 @@
                 vcc7-supply = <&vcc_sys>;
                 vcc8-supply = <&vcc_sys>;
                 vcc9-supply = <&vcc_io>;
+                boost-supply = <&vcc_sys>;
+                h_5v-supply = <&boost_otg>;

                 regulators {
                         vdd_logic: DCDC_REG1 {
@@ -503,6 +496,15 @@
                                 regulator-suspend-microvolt =
<5000000>;
```

```
                                        };
                                };
+
+                               hdmi_5v: HDMI_SWITCH {
+                                       regulator-name = "hdmi_5v";
+                                       regulator-always-on;
+                                       regulator-boot-on;
+                                       regulator-state-mem {
+                                               regulator-on-in-suspend;
+                                       };
+                               };
                        };
```

Step4：目录 hardware/rockchip/audio/tinyalsa_hal/codec_config/

文件 hdmi_analog_config.h 中根据实际 codec 按需修改 route 表实现互斥

如不维护 HDMI 和 CODEC 同时输出声音

例如：codec es8316

hdmi 播放时"DAC Playback Volume"设为 0，MUTE 平板上的输出

```
+const struct config_control hdmi_analog_hdmi_normal_controls[] = {
+       {
+               .ctl_name = "DAC Playback Volume",
+               .int_val = {0, 0},
+       },
 };
```

切换到喇叭或者耳机时恢复"DAC Playback Volume"

```
 const struct config_control hdmi_analog_speaker_normal_controls[] = {
```

```
+         {
+                  .ctl_name = "DAC Playback Volume",
+                  .int_val = {192, 192},
+         },
 };
```

4 SDK 编译说明

4.1 JDK 安装

Android7.1 系统编译依赖于 JAVA 8。编译之前需安装 OpenJDK。

安装命令如下。

```
sudo apt-get install openjdk-8-jdk
```

配置 JAVA 环境变量，例如，安装路径为/usr/lib/jvm/java-8-openjdk-amd64，可在终端执行如下命令配置环境变量。

```
export JAVA_HOME=/usr/lib/jvm/java-8-openjdk-amd64
export PATH=$JAVA_HOME/bin:$PATH
export CLASSPATH=.:$JAVA_HOME/lib:$JAVA_HOME/lib/tools.jar
```

4.2 编译模式

SDK 默认以 userdebug 模式编译。

使用 adb 时，需要先执行 adb root ，adb disable-verity 关闭 system 分区的 verity 特性，重启后再执行 adb root, adb remount，进而进行 push 操作来 debug。

4.3 代码编译

4.3.1 uboot 编译步骤

Uboot 编译，执行如下命令，详见《RockChip_Uboot 开发文档 V3.3》。

```
make rk3368h_defconfig
make ARCHV=aarch64
```

编译完，会生成 rk3368_loader_v2.00.256.bin, uboot.img，trsut.img, 三个镜像。

其中，rk3368_loader_v2.00.256.bin, uboot.img，分别为一级、二级引导 loader，trust.img 用于芯片 MCU、电源管理、多核及安全相关模块配置。

4.3.2 kernel 编译步骤

SDK 默认支持 SDK 板及 P9 样机，其配置与编译如下：

```
make ARCH=arm64   rockchip_defconfig   (P9 样机)
make ARCH=arm64   rk3368-p9.img   (P9 样机)
```

```
make ARCH=arm64   rockchip_defconfig   (SDK 板)
make ARCH=arm64   rk3368-sheep.img   (SDK 板)
```

编译完成后，kernel 根目录，生成 kernel.img，resource.img 两个镜像文件。

4.3.3 Android 编译步骤

客户按实际编译环境配置好 JDK 环境变量后，按照以下步骤配置完后，执行 make 即可。

$ source build/envsetup.sh

$ lunch

选择 rk3368H_64-userdebug

$ make -j4

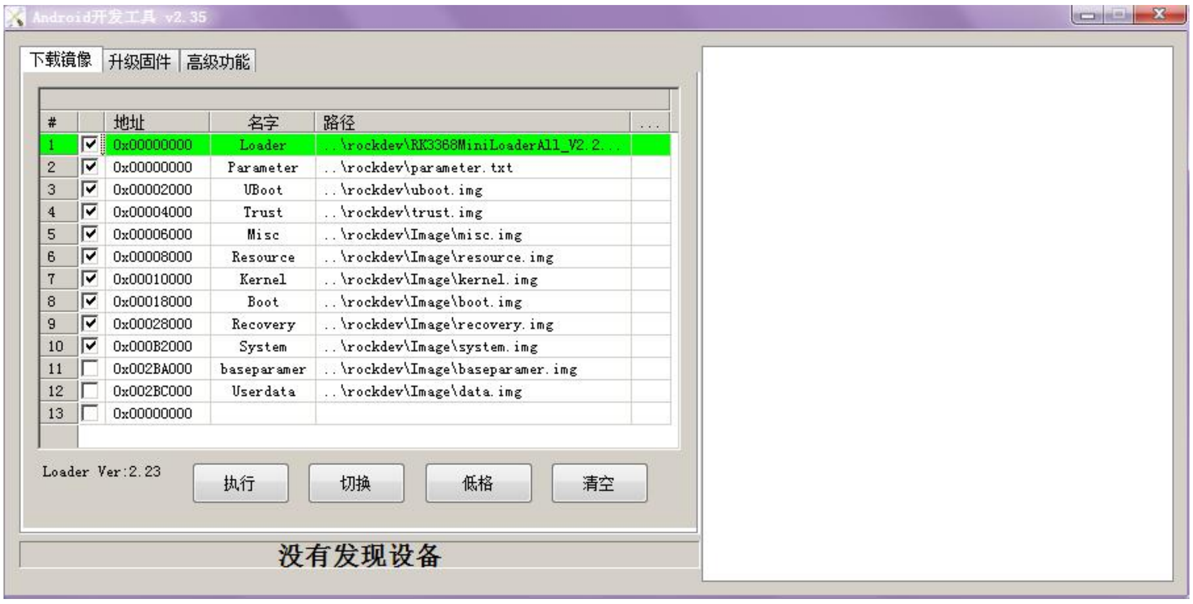
完成编译后，执行 SDK 根目录下的 mkimage.sh 脚本生成固件，位于 rockdev/Image-rk3368H_64 目录。

5 刷机说明

SDK 提供烧写工具，如下图所示。编译生成相应的固件后，进入 loader 模式，即可进行刷机。对于已烧过其它固件的机器，请选择低格设备，擦除 idb，然后进行刷机。

注意，Trust.img 用于芯片 MCU、电源管理、多核及安全相关模块配置，baseparameter.img

用于配置 BOX/MID 产品的显示参数，客户均不用改动。



#		地址	名字	路径	...
1	✓	0x00000000	Loader	..\rockdev\RK3368MiniLoaderAll_V2.2...	
2	✓	0x00000000	Parameter	..\rockdev\parameter.txt	
3	✓	0x00002000	UBoot	..\rockdev\uboot.img	
4	✓	0x00004000	Trust	..\rockdev\trust.img	
5	✓	0x00006000	Misc	..\rockdev\Image\misc.img	
6	✓	0x00008000	Resource	..\rockdev\Image\resource.img	
7	✓	0x00010000	Kernel	..\rockdev\Image\kernel.img	
8	✓	0x00018000	Boot	..\rockdev\Image\boot.img	
9	✓	0x00028000	Recovery	..\rockdev\Image\recovery.img	
10	✓	0x000B2000	System	..\rockdev\Image\system.img	
11		0x002BA000	baseparamer	..\rockdev\Image\baseparamer.img	
12		0x002BC000	Userdata	..\rockdev\Image\data.img	
13		0x00000000			

Loader Ver:2.23

没有发现设备

附录 A 编译开发环境搭建

1. Initializing a Build Environment

This section describes how to set up your local work environment to build the Android source files. You will need to use Linux or Mac OS. Building under Windows is not currently supported.

Note: The source download is approximately 35GB in size. You will need over 45GB free to complete a single build, and up to 100GB (or more) for a full set of builds.

For an overview of the entire code-review and code-update process, see Life of a Patch.

2. Choosing a Branch

Some of the requirements for your build environment are determined by which version of the source code you plan to compile. See Build Numbers for a full listing of branches you may choose from. You may also choose to download and build the latest source code (called "master"), in which case you will simply omit the branch specification when you initialize the repository.

Once you have selected a branch, follow the appropriate instructions below to set up your build environment.

3. Setting up a Linux build environment

These instructions apply to all branches, including master.

The Android build is routinely tested in house on recent versions of Ubuntu LTS (10.04), but most distributions should have the required build tools available. Reports of successes or failures on other distributions are welcome.

For Gingerbread (2.3.x) and newer versions, including the master branch, a 64-bit environment is required. Older versions can be compiled on 32-bit systems.

Note: It is also possible to build Android in a virtual machine. If you are running Linux in a virtual machine, you will need at least 16GB of RAM/swap and 30GB or *more of disk space in order to build the Android tree.*

Detailed instructions for Ubuntu and MacOS follow. In general you will need:

A. Python 2.6 -- 2.7, which you can download from python.org.

B. GNU Make 3.81 -- 3.82, which you can download from gnu.org,

C. JDK 6 if you wish to build Gingerbread or newer; JDK 5 for Froyo or older. You can download both fromjava.sun.com.

D. Git 1.7 or newer. You can find it at git-scm.com.

4. Installing the JDK

The master branch of Android in the Android Open Source Project (AOSP) requires Java 7. On Ubuntu, use OpenJDK.Java 7: For the latest version of Android

```
$ sudo apt-get update
$ sudo apt-get install openjdk-7-jdk
```

Optionally, update the default Java version by running:

```
$ sudo update-alternatives --config java
$ sudo update-alternatives --config javac
```

If you encounter version errors for Java, set its path as described in the Wrong Java Version section.

To develop older versions of Android, download and install the corresponding version of the Java JDK:

Java 6: for Gingerbread through KitKat

Java 5: for Cupcake through Froyo

5. Installing required packages (Ubuntu 12.04)

You will need a 64-bit version of Ubuntu. Ubuntu 12.04 is recommended. Building using an older version of Ubuntu is not supported on master or recent releases.

```
$ sudo apt-get install git gnupg flex bison gperf build-essential \
  zip curl libc6-dev libncurses5-dev:i386 x11proto-core-dev \
  libx11-dev:i386 libreadline6-dev:i386 libgl1-mesa-glx:i386 \
  libgl1-mesa-dev g++-multilib mingw32 tofrodos \
  python-markdown libxml2-utils xsltproc zlib1g-dev:i386
$ sudo ln -s /usr/lib/i386-linux-gnu/mesa/libGL.so.1 /usr/lib/i386-linux-gnu/libGL.so
```

6. Installing required packages (Ubuntu 10.04 -- 11.10)

Building on Ubuntu 10.04-11.10 is no longer supported, but may be useful for building older releases of AOSP.

```
$ sudo apt-get install git-core gnupg flex bison gperf build-essential \
  zip curl zlib1g-dev libc6-dev lib32ncurses5-dev ia32-libs \
  x11proto-core-dev libx11-dev lib32readline5-dev lib32z-dev \
  libgl1-mesa-dev g++-multilib mingw32 tofrodos python-markdown \
  libxml2-utils xsltproc
```

On Ubuntu 10.10:

```
$ sudo ln -s /usr/lib32/mesa/libGL.so.1 /usr/lib32/mesa/libGL.so
```

On Ubuntu 11.10:

```
$ sudo apt-get install libx11-dev:i386
```

7. Configuring USB Access

Under GNU/linux systems (and specifically under Ubuntu systems), regular users can't directly access USB devices by default. The system needs to be configured to allow such access.

The recommended approach is to create a file /etc/udev/rules.d/51-android.rules (as the root user) and to copy the following lines in it. <username> must be replaced by the actual username of the user who is authorized to access the phones over USB.

```
# adb protocol on passion (Rockchip products)
SUBSYSTEM=="usb", ATTR{idVendor}=="2207", ATTR{idProduct}=="0010", MODE="0600", OWNER="<username>"
```

Those new rules take effect the next time a device is plugged in. It might therefore be necessary to unplug the device and plug it back into the computer.

This is known to work on both Ubuntu Hardy Heron (8.04.x LTS) and Lucid Lynx (10.04.x LTS). Other versions of Ubuntu or other variants of GNU/linux might require different configurations.

References : http://source.android.com/source/initializing.html

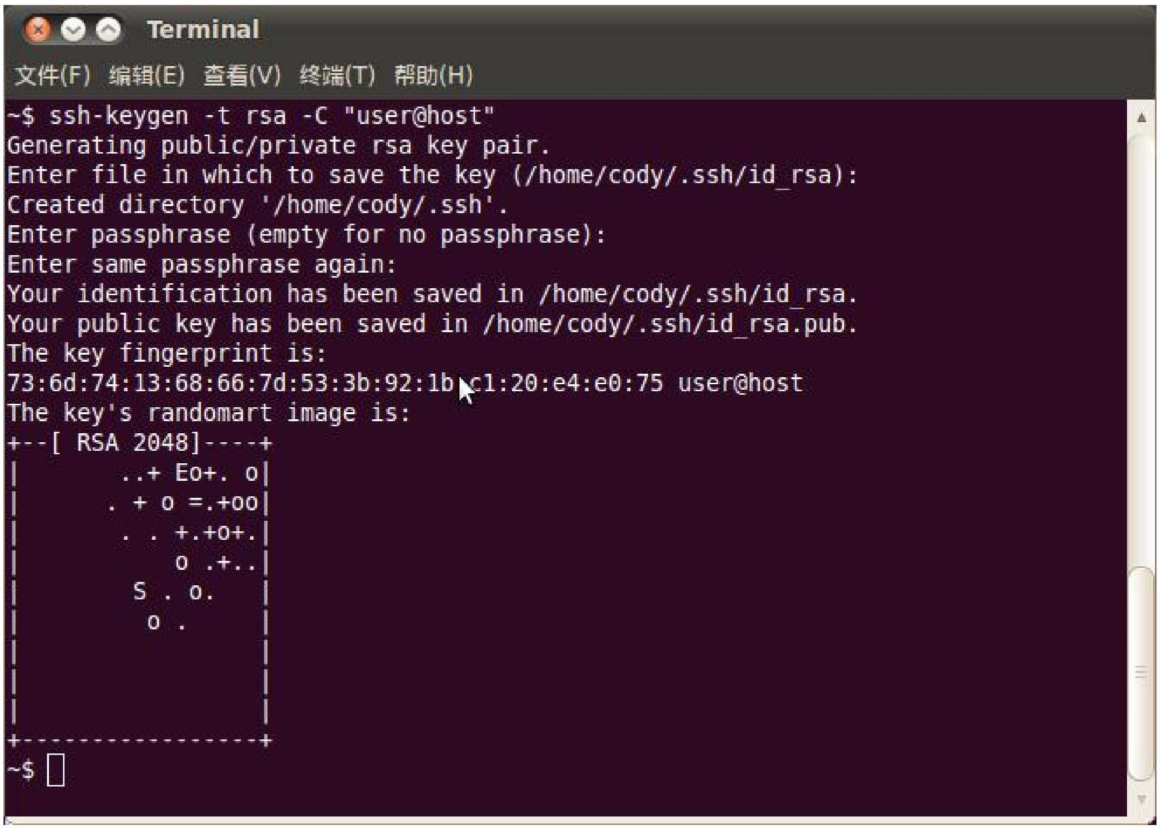
附录 B SSH 公钥操作说明

附录 B-1 SSH 公钥生成

使用如下命令生成：

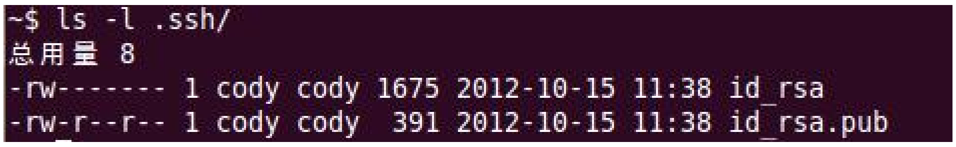
```
ssh-keygen -t rsa -C "user@host"
```

请将 user@host 替换成您的邮箱地址。



```
~$ ssh-keygen -t rsa -C "user@host"
Generating public/private rsa key pair.
Enter file in which to save the key (/home/cody/.ssh/id_rsa):
Created directory '/home/cody/.ssh'.
Enter passphrase (empty for no passphrase):
Enter same passphrase again:
Your identification has been saved in /home/cody/.ssh/id_rsa.
Your public key has been saved in /home/cody/.ssh/id_rsa.pub.
The key fingerprint is:
73:6d:74:13:68:66:7d:53:3b:92:1b:c1:20:e4:e0:75 user@host
The key's randomart image is:
+--[ RSA 2048]----+
|        ..+ Eo+. o|
|       . + o =.+oo|
|        . . +.+o+.|
|            o .+..|
|         S . o.   |
|          o .     |
|                  |
|                  |
|                  |
+-----------------+
~$ 
```

命令运行完成会在你的目录下生成 key 文件。



```
~$ ls -l .ssh/
总用量 8
-rw------- 1 cody cody 1675 2012-10-15 11:38 id_rsa
-rw-r--r-- 1 cody cody  391 2012-10-15 11:38 id_rsa.pub
```

请妥善保存生成的私钥文件 id_rsa 和密码，并将 id_rsa.pub 发邮件给 SDK 发布服务器的管理员。

附录 B-2　使用 key-chain 管理密钥

推荐您使用比较简易的工具 keychain 管理密钥，使用此方法即可不用下面 3.3/3.4 的方法。

具体使用方法如下：

1. 安装 keychain 软件包：

```
$sudo aptitude install keychain
```

2. 配置使用密钥：

```
$vim ~/.bashrc
```

增加下面这行：

```
eval `keychain --eval ~/.ssh/id_rsa`
```

其中，id_rsa 是私钥文件名称。

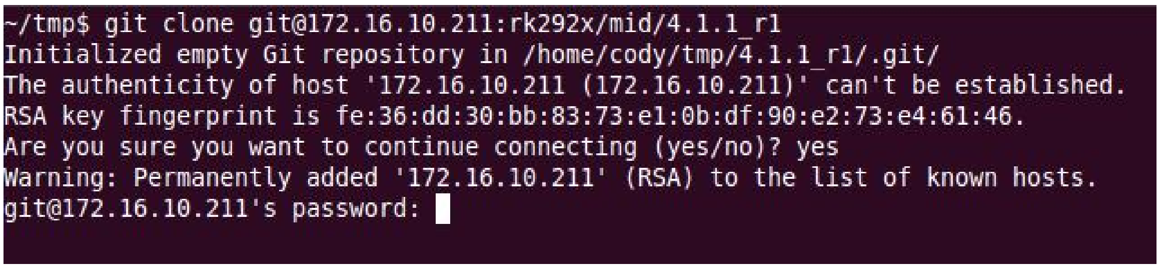
以上配置以后，重新登录控制台，会提示输入密码，只需输入生成密钥时使用的密码即可，若无密码可不输入。

另外，请尽量不要使用 sudo 或 root 用户，除非您知道如何处理，否则将导致权限以及密钥管理混乱。

附录 B-3　多台机器使用相同 ssh 公钥

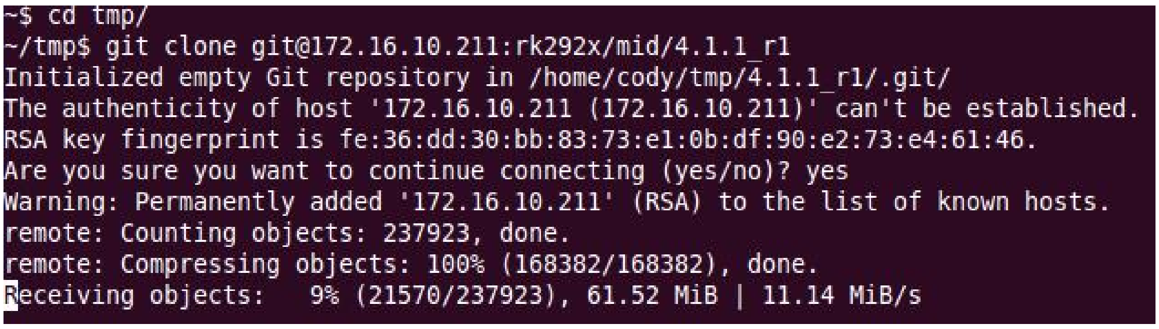
在不同机器使用，可以将你的 ssh 私钥文件 id_rsa 拷贝到要使用的机器的“~/.ssh/id_rsa”即可。

在使用错误的私钥会出现如下提示，请注意替换成正确的私钥。



```
~/tmp$ git clone git@172.16.10.211:rk292x/mid/4.1.1_r1
Initialized empty Git repository in /home/cody/tmp/4.1.1_r1/.git/
The authenticity of host '172.16.10.211 (172.16.10.211)' can't be established.
RSA key fingerprint is fe:36:dd:30:bb:83:73:e1:0b:df:90:e2:73:e4:61:46.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '172.16.10.211' (RSA) to the list of known hosts.
git@172.16.10.211's password: 
```

添加正确的私钥后，就可以使用 git 克隆代码，如下图。



```
~$ cd tmp/
~/tmp$ git clone git@172.16.10.211:rk292x/mid/4.1.1_r1
Initialized empty Git repository in /home/cody/tmp/4.1.1_r1/.git/
The authenticity of host '172.16.10.211 (172.16.10.211)' can't be established.
RSA key fingerprint is fe:36:dd:30:bb:83:73:e1:0b:df:90:e2:73:e4:61:46.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '172.16.10.211' (RSA) to the list of known hosts.
remote: Counting objects: 237923, done.
remote: Compressing objects: 100% (168382/168382), done.
Receiving objects:   9% (21570/237923), 61.52 MiB | 11.14 MiB/s
```

添加 ssh 私钥可能出现如下提示错误。

```
Agent admitted failture to sign using the key
```

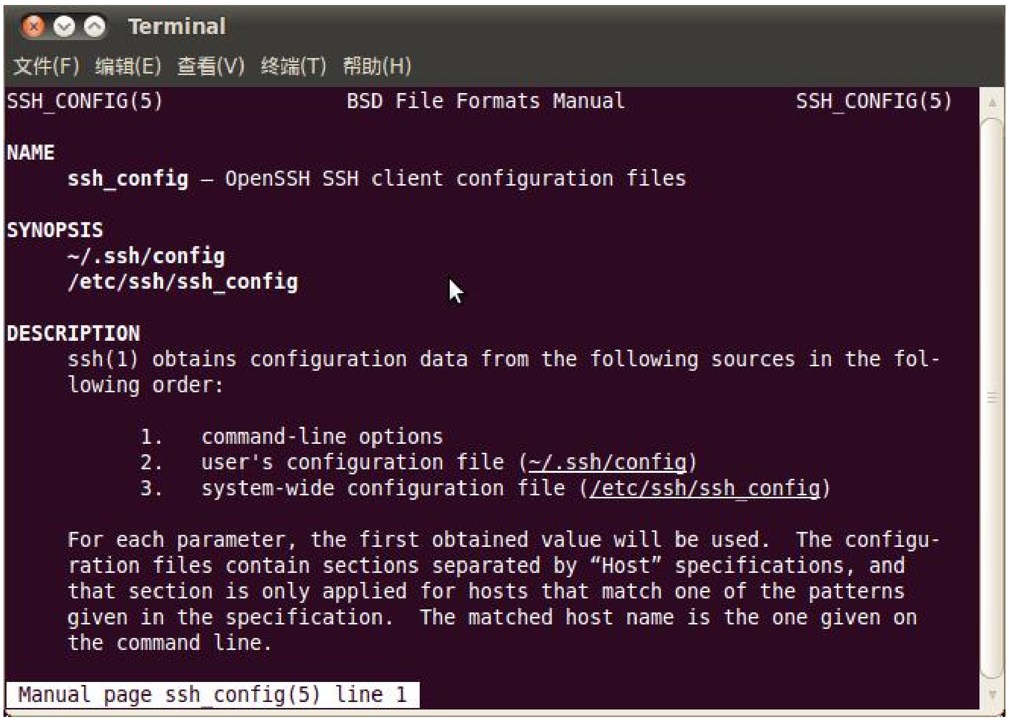
在 console 输入如下命令即可解决。

```
ssh-add ~/.ssh/id_rsa
```

附录 B-4 一台机器切换不同 ssh 公钥

可以参考 ssh_config 文档配置 ssh。

```
~$ man ssh_config
```



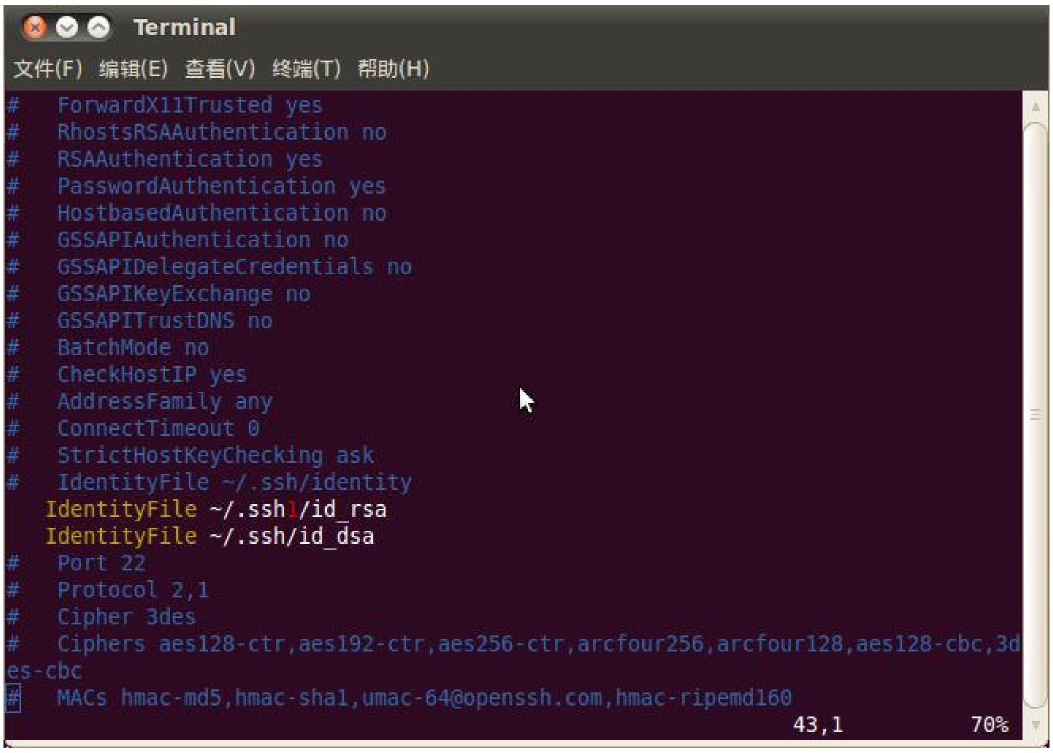
```
SSH_CONFIG(5)              BSD File Formats Manual             SSH_CONFIG(5)

NAME
     ssh_config — OpenSSH SSH client configuration files

SYNOPSIS
     ~/.ssh/config
     /etc/ssh/ssh_config

DESCRIPTION
     ssh(1) obtains configuration data from the following sources in the fol-
     lowing order:

           1.   command-line options
           2.   user's configuration file (~/.ssh/config)
           3.   system-wide configuration file (/etc/ssh/ssh_config)

     For each parameter, the first obtained value will be used.  The configu-
     ration files contain sections separated by “Host” specifications, and
     that section is only applied for hosts that match one of the patterns
     given in the specification.  The matched host name is the one given on
     the command line.

 Manual page ssh_config(5) line 1
```

通过如下命令，配置当前用户的 ssh 配置。

```
~$ cp /etc/ssh/ssh_config ~/.ssh/config
```

```
~$ vi .ssh/config
```

如图，将 ssh 使用另一个目录的文件 “~/.ssh1/id_rsa” 作为认证私钥。通过这种方法，可以切换不同的的密钥。



```
#   ForwardX11Trusted yes
#   RhostsRSAAuthentication no
#   RSAAuthentication yes
#   PasswordAuthentication yes
#   HostbasedAuthentication no
#   GSSAPIAuthentication no
#   GSSAPIDelegateCredentials no
#   GSSAPIKeyExchange no
#   GSSAPITrustDNS no
#   BatchMode no
#   CheckHostIP yes
#   AddressFamily any
#   ConnectTimeout 0
#   StrictHostKeyChecking ask
#   IdentityFile ~/.ssh/identity
   IdentityFile ~/.ssh1/id_rsa
   IdentityFile ~/.ssh/id_dsa
#   Port 22
#   Protocol 2,1
#   Cipher 3des
#   Ciphers aes128-ctr,aes192-ctr,aes256-ctr,arcfour256,arcfour128,aes128-cbc,3d
es-cbc
#   MACs hmac-md5,hmac-sha1,umac-64@openssh.com,hmac-ripemd160
                                                                43,1          70%
```

附录 B-5　密钥权限管理

服务器可以实时监控某个 key 的下载次数、IP 等信息，如果发现异常将禁用相应的 key 的下载权限。

请妥善保管私钥文件。并不要二次授权与第三方使用。

附录 B-6　Git 权限申请说明

参考上述章节，生成公钥文件，发邮件至 fae@rock-chips.com，申请开通 SDK 代码下载权限。