Rockchip

WIFI/BT 开发指南

发布版本:**0.01**

日期:**2018.05**

前言

概述

本文档主要介绍基于 Rockchip 平台的 WIFI、BT 的内核配置、相关功能的开发等等；

产品版本

芯片名称	内核版本
RK303X	4.0

读者对象

本文档（本指南）主要适用于以下工程师：

- 技术支持工程师
- 软件开发工程师

修订记录

日期	版本	作者	修改说明
2018/05/02	0.01	XY	初始版本

Copyright 2016 @Fuzhou Rockchip Electronics Co., Ltd.

目录

目录

1 WIFI/BT 内核配置

1.1 DTS

注意如下 pinctrl 的配置，其中 sdio-pwrseq 是 WIFI_REG_ON 管脚

```
wireless-wlan {
    compatible = "wlan-platdata";
    rockchip,grf = <&grf>;
    wifi_chip_type = "ap6255";
    WIFI,host_wake_irq = <&gpio0 RK_PA0 GPIO_ACTIVE_HIGH>; // WIFI_WAKE_HOST
    status = "okay";
};

wireless-bluetooth {
    compatible = "bluetooth-platdata";
    uart_rts_gpios = <&gpio4 RK_PA7 GPIO_ACTIVE_LOW>;
    pinctrl-names = "default", "rts_gpio";
    pinctrl-0 = <&uart4_rts>;
    pinctrl-1 = <&uart4_rts_gpio>;
    BT,power_gpio     = <&gpio4 RK_PB3 GPIO_ACTIVE_HIGH>; // BT_REG_ON
    BT,wake_host_irq = <&gpio4 RK_PB4 GPIO_ACTIVE_HIGH>; // BT_WAKE_HOST
    status = "okay";
};

&pinctrl {
    sdio-pwrseq {
        wifi_enable_h: wifi-enable-h {
            rockchip,pins =
                <0 RK_PA2 RK_FUNC_GPIO &pcfg_pull_none>; // WIFI_REG_ON
        };
    };
};
```

1.2 内核

```
CONFIG_WL_ROCKCHIP:

Enable compatible Wifi drivers for Rockchip platform.

Symbol: WL_ROCKCHIP [=y]
Type  : boolean
Prompt: Rockchip Wireless LAN support
  Location:
    -> Device Drivers
      -> Network device support (NETDEVICES [=y])
        -> Wireless LAN (WLAN [=y])
  Defined at drivers/net/wireless/rockchip_wlan/Kconfig:2
  Depends on: NETDEVICES [=y] && WLAN [=y]
  Selects: WIRELESS_EXT [=y] && WEXT_PRIV [=y] && CFG80211 [=y] && MAC80211 [=y]
```

Copyright 2016 @Fuzhou Rockchip Electronics Co., Ltd.

```
-*- Rockchip Wireless LAN support
[ ]   build wifi ko modules
[*]   Wifi load driver when kernel bootup
< >   ap6xxx wireless sdio cards support
<*>     Cypress wireless sdio cards support
[ ]   Realtek Wireless Device Driver Support  ----
< >   Realtek 8723B SDIO or SPI WiFi
< >   Realtek 8723C SDIO or SPI WiFi
< >   Realtek 8723D SDIO or SPI WiFi
< >   Marvell 88W8977 SDIO WiFi
```

2 配网开发

2.1 命令行配网：

根据对应 WiFi 选择相应配置：

```
There is no help available for this option.
Prompt: wifi chip support
  Location:
    -> Target packages
      -> rockchip BSP packages (BR2_PACKAGE_ROCKCHIP [=y])
        -> rkwifibt (BR2_PACKAGE_RKWIFIBT [=y])
  Defined at package/rockchip/rkwifibt/Config.in:5
  Depends on: BR2_PACKAGE_ROCKCHIP [=y] && BR2_PACKAGE_RKWIFIBT [=y]
  Selected by: BR2_PACKAGE_ROCKCHIP [=y] && BR2_PACKAGE_RKWIFIBT [=y] && m
```

```
wifi chip support
Use the arrow keys to navigate this window or press the
hotkey of the item you wish to select followed by the <SPACE
BAR>. Press <?> for additional information about this
( ) AP6255
( ) AP6212A1
( ) AW-CM256
(X) AW-NAB197
<Select>    < Help >
```

首先确保 WiFi 的服务进程启动： ps | grep wpa_supplicant，如果没启动请手动启动：

wpa_supplicant -B -i wlan0 -c /data/cfg/wpa_supplicant.conf

修改如下文件：

/ # vi /data/cfg/wpa_supplicant.conf

```
ctrl_interface=/var/run/wpa_supplicant
ap_scan=1
#添加如下配置项
network={
        ssid="WiFi-AP"          // WiFi 名字
        psk="12345678"          // WiFi 密码
        key_mgmt=WPA-PSK        // 加密方式
        # key_mgmt=NONE         // 不加密
}
```

重新读取上述配置：wpa_cli reconfigure

并重新连接：wpa_cli reconnect

2.2 手机配网：

2.2.1 Softap 配网

简介：SDK 板的 WiFi 起一个 AP 热点，然后手机端去连接该 AP 热点，然后通过手机端 apk 会获取 SDK 板的当前扫描到的热点列表，然后手机端填入要连接 AP 的密码，apk 会把 AP 的 ssid 和密码发到 SDK 端，最后 SDK 端会根据收到的信息去连接 WiFi。

Buildroot 配置：

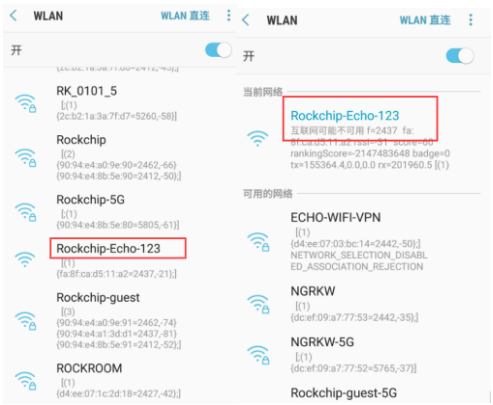
```
There is no help available for this option.
Symbol: BR2_PACKAGE_SOFTAPSERVER [=y]
Type  : boolean
Prompt: socket server based on softap
  Location:
    -> Target packages
      -> rockchip BSP packages (BR2_PACKAGE_ROCKCHIP [=y])
  Defined at package/rockchip/softapServer/Config.in:1
  Depends on: BR2_PACKAGE_ROCKCHIP [=y]
  Selects: BR2_PACKAGE_SOFTAP [=y]
```

源码开发目录：
/external/softapServer/ -- WIFI 与 APK 端相关操作
/external/softapDemo/ -- WiFi 相关操作
准备手机安装 apk：
确保 wifi server 进程启动
wpa_supplicant -B -i wlan0 -c /data/cfg/wpa_supplicant.conf

第一步：板子的命令行执行：
softapServer Rockchip-Echo-123 (wifi 热点的名字，前缀必须为 Rockchip-Echo-xxx)

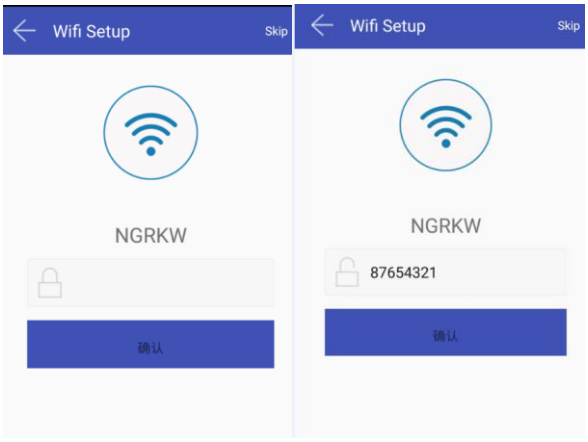
```
/ # softapServer Rockchip-Echo-123
DEBUG 263: check_wifi_chip_type_string: AP6255DEBUG 274:
wifi type: AP6255
DEBUG 297: start softap with name: Rockchip-Echo-123---DEBUG 30: cmdline = killall dnsmasq
killall: dnsmasq: no process killed
DEBUG 30: cmdline = killall hostapd
killall: hostapd: no process killed
DEBUG 30: cmdline = ifconfig wlan1 down
DEBUG 30: cmdline = rm -rf /data/bin/wlan1
DEBUG 30: cmdline = iw dev wlan1 del
DEBUG 30: cmdline = ifconfig wlan0 up
DEBUG 30: cmdline = iw phy0 interface add wlan1 type managed
```

第二步：打开手机的 wifi setting 界面：
找到 Rockchip-Echo-123，点击连接；



第三步：打开手机 apk：

打开 apk，点击 wifi setup->CONFIRM->确认->wifi 列表->点击你要连接的网络名字->输入密码->点击确认



板子串口端显示：

```
[Server]: accept a new client, ip:10.201.126.89, port:59446
[Server]: Come wifi setUp requeset from client.
[Server]: consule_run: wpa_cli -iwlan0 add_network
wpa_cli -iwlan0 set_network 1 ssid \"NGRKW\"
[Server]: consule_run: wpa_cli -iwlan0 set_network 1 ssid \"NGRKW\"
wpa_cli -iwlan0 set_network 1 psk \"87654321\"
[Server]: consule_run: wpa_cli -iwlan0 set_network 1 psk \"87654321\"
wpa_cli -iwlan0 select_network 1
[Server]: consule_run: wpa_cli -iwlan0 select_network 1
[Server]: Close client sockfd.

[Server]: consule_run: udhcpc -n -t 10 -i wlan0
udhcpc: started, v1.27.2
udhcpc: sending discover
udhcpc: sending discover
udhcpc: sending discover
udhcpc: sending discover
udhcpc: sending select for 192.168.1.16
udhcpc: lease of 192.168.1.16 obtained, lease time 86400
[Server]: consule_run: wpa_cli -iwlan0 status
[Server]: Congratulation: wifi connected.
[Server]: getpid cmdResult:30840 30543
. self:30840.
DEBUG 263: check_wifi_chip_type_string: AP6255DEBUG 274:
wifi type: AP6255
DEBUG 286: -stop softap-
DEBUG 58: --- hostapd pid = 30605 ---
DEBUG 30: cmdline = kill 30605
wlan1: interface state ENABLED->DISABLED
wlan1: AP-STA-DISCONNECTED a0:cc:2b:cb:90:f5
DEBUG 30: cmdline = killall dnsmasq
ERROR Resource not found. for file:///data/mode_sound/wifi_connected.mp3
ERROR debug information: gstfilesrc.c(535): gst_file_src_start (): /GstPlayBin:playbin/GstURIDecodeBin:uridecodebin0/GstFileSrc:s
No such file "/data/mode_sound/wifi_connected.mp3"
DEBUG 30: cmdline = ifconfig wlan1 down
wlan1: AP-DISABLED
nl80211: deinit ifname=wlan1 disabled_11b_rates=0
DEBUG 30: cmdline = rm -rf /data/bin/wlan1
[Server]: Application exit.[Server]: accept error:Bad file descriptor
/ #
```

可以看到你输入名字和密码

获取到ip地址

自动退出程序

检查网络是否连通：

/ # echo nameserver 8.8.8.8 > etc/resolv.conf // 添加 dns 域名解析
/ # ping www.baidu.com //看下是否 ping 通

注意要点：
1、softspServer Rockchip-Echo-123 执行后命令行是无法退出的，直到配网完成；
2、名字千万不要写错，否则 apk 无法进入确认界面（Rockchip-Echo-xxx）

2.2.2 蓝牙配网

仅支持海华模组，下个版本提供 demo；

3 蓝牙开发

3.1.1 海华模组

Buildroot 配置：

```
BR2_PACKAGE_CYPRESS_BSA:

broadcom bsa server and app

Symbol: BR2_PACKAGE_CYPRESS_BSA [=y]
Type  : boolean
Prompt: broadcom(cypress) bsa server and app
  Location:
    -> Target packages
      -> rockchip BSP packages (BR2_PACKAGE_ROCKCHIP [=y])
  Defined at package/rockchip/cypress_bsa/Config.in:1
  Depends on: BR2_PACKAGE_ROCKCHIP [=y]
```

相关开发文件源码目录：external/bluetooth_bsa
App 介绍目录：external /release_notes/bsa_examples

基于 broadcom 的海华模组支持 BSA 协议栈，而 BSA 协议栈是 broadcom 公司开发的蓝牙协议栈，类似 BLUEZ，开发人员可以基于它开发各种蓝牙 APP，并且提供丰富的 app demo：

*Application Demo List

release_notes/bsa_examples/Release_app_xx.txt
app_hh -- HH (HID Host): Used to connect to HID Devices (Mouse, Keyboard, Remote Control,)
app_hd -- HD(HID Device): To act HID device
app_av -- AV (Audio/Video): Used to stream audio to stereo headset
app_avk -- AVK (Audio/Video Sink): To act like a stereo headset
app_ag -- HS/HF –AG (Audio Gateway): Used in a phone or device connected to network
app_hs -- HS/HF –HS (HeadSet/HandsFree): To act like a mono headset (used by cellular)
app_fts -- FTP Server -- FTS (File Transfer Server): Used by remote devices (cellular, PC) to access files/folders.
app_ftc -- FTP Client
app_ops -- OPP Server -- OPS Object Push Server : Used by remote devices to push/pull files (e.g. business card)
app_opc -- OPP Client
app_pbs -- PBS (Phone Book Server): Used by remote devices to access local phone book.

app_pbc -- Phone Book Profile Client
app_pam -- Personal Area Networking Profile (PAN)
app_hl -- HDP (Health Device Profile): Used for exchange of medical device data
app_mce – MAP(Message Access Profile) client
app_3d – 3D Synchronization Profile
app_tm – Test Mode, for RF test
app_dg -- SPP (Serial Port Profile): Used for wireless replacement of serial cable
app_ble -- GATT
app_ble_cscc – BLE CSC(Cycling speed and cadence) controller
app_ble_hrc -- BLE Heart Rate Controller
app_ble_pm -- BLE Proximity Monitor
app_ble_rscc -- BLE RSC(Running speed and cadence) controller
app_hogp -- HOGP host

首先上电：

```
echo 0 > /sys/class/rfkill/rfkill0/state
echo 1 > /sys/class/rfkill/rfkill0/state
```

启动 server 进程：注意所有的蓝牙相关的进程都要在同一个可写目录执行（cd rw-dir/）

```
bsa_server -r 12 -p /system/etc/firmware/BCM4345C0.hcd -d /dev/ttyS4 -b
/data/btsnoop.log > /data/bsa_log &
```

启动管理进程：

```
app_manager &
```

启动你想要运行的客户端：

```
app_xxxx
```

举个 a2dp source 的例子：

1. AV -- connect stereo headset and play music

A. First pair and play:

Preparatory work:

a. put music to Music folder path: ./test_files/av **(服务端和客户端运行的目录)**

b. Open Headset, entry Bluetooth pair mode.

Start:

a. Run ./bsa_server -d /dev/btusb0 -p patchram.hcd

b. When bsa_server started successfully, run ./app_manager, ./app_av in sequence.

c. app_av menu: input **2** (Start Discovery)

```
2
Start Regular Discovery
BSA_trace 23@ 01/01 10h:11m:24s:460ms: BSA_DiscStartInit
BSA_trace 24@ 01/01 10h:11m:24s:460ms: BSA_DiscStart

Bluetooth AV Main menu
  AV Point To Point menu:
    1 => Abort Discovery
    2 => Start Discovery
    3 => Display local source points
    4 => AV Register (Create local source point)
    5 => AV DeRegister (Remove local source point)
    6 => AV Open (Connect)
    7 => AV Close (Disconnect)
    8 => AV Play Tone
    9 => AV Toggle Tone
    10 => AV Play File
    11 => AV Start Playlist
    12 => AV Play Microphone
    13 => AV Stop
    14 => AV Pause
    15 => AV Resume
    16 => AV Send RC Command (Inc Volume)
    17 => AV Send RC Command (Dec Volume)
    18 => AV Close RC
    19 => AV Send Absolute Vol RC Command
    20 => AV Configure UIPC
    21 => AV Change Content Protection (Currently:NONE)
    98 => AV Set Tone sampling frequency
    22 => AV Test SEC codec
    23 => AV Change busy level(1-5)
    99 => Quit
Select action => New Discovered device:0
        Bdaddr:00:24:1c:d9:e0:28
        Name:Motorola Elite Flip
        ClassOfDevice:24:04:04 => Audio/Video
        Services:0x00000000 ()
        Rssi:-68
BSA_trace 25@ 01/01 10h:11m:29s:587ms: COMPLETE_LOCAL_NAME_TYPE:
BSA_trace 26@ 01/01 10h:11m:29s:587ms:     0000: 4d 6f 74 6f 72 6f 6c 61 20 45 6c 69 74 65 20 46   Motorola Elite F
BSA_trace 27@ 01/01 10h:11m:29s:587ms:     0010: 6c 69 70                                          lip
BSA_trace 28@ 01/01 10h:11m:29s:587ms: COMPLETE_16BITS_UUID_TYPE:
BSA_trace 29@ 01/01 10h:11m:29s:587ms:     0000: 08 11 1e 11 0b 11 0e 11 01 11                     ..........
        inq_result_type:1 ble_addr_type:0 device_type:1
Discovery complete
```

d. input **6** (start connect)

```
6
Bluetooth AV Open menu:
    0 Device from XML database (already paired)
    1 Device found in last discovery
```

e. input **1**

```
Select source => 1
Dev:0
        Bdaddr:00:24:1c:d9:e0:28
        Name:Motorola Elite Flip
        ClassOfDevice:24:04:04 => Audio/Video
        Rssi:-68 _
```

f. input **0**

```
Select device => 0
Connecting to AV device
BSA_trace 30@ 01/01 10h:21m:33s:997ms: BSA_AvOpenInit
BSA_trace 31@ 01/01 10h:21m:33s:997ms: BSA_AvOpen
```

g. app_manager input **10** (accept pair)

```
Select action => BSA_trace 18@ 01/01 10h:21m:35s:914ms: bsa_sec_event_hdlr event:0
DEBUG: app_mgr_security_callback: event:0
DEBUG: app_mgr_security_callback: BSA_SEC_LINK_UP_EVT bd_addr: 00:24:1c:d9:e0:28
DEBUG: app_mgr_security_callback: ClassOfDevice:24:04:04 => Audio/Video
BSA_trace 19@ 01/01 10h:21m:36s:091ms: bsa_sec_event_hdlr event:6
DEBUG: app_mgr_security_callback: event:6
DEBUG: app_mgr_security_callback: BSA_SEC_SP_CFM_REQ_EVT
DEBUG: app_mgr_security_callback:     Remote device:Motorola Elite Flip
DEBUG: app_mgr_security_callback:     bd_addr: 00:24:1c:d9:e0:28
DEBUG: app_mgr_security_callback:     ClassOfDevice:24:04:04 => Audio/Video
DEBUG: app_mgr_security_callback:     Just Work:TRUE
DEBUG: app_mgr_security_callback:     Numeric Value:661430
DEBUG: app_mgr_security_callback:     You must accept or refuse using menu (10) or (11)
10
```

h. you can hear the headset hint connected, and find:

app_manager:

```
DEBUG: app_mgr_sp_cfm_reply:
BSA_trace 18@ 01/01 10h:28m:27s:013ms: BSA_SecSpCfmReplyInit
BSA_trace 19@ 01/01 10h:28m:27s:013ms: BSA_SecSpCfmReply
Bluetooth Application Manager Main menu:
        1 => Abort Discovery
        2 => Discovery
        3 => Discovery test
        4 => Bonding
        5 => Cancel Bonding
        6 => Services Discovery (all services)
        7 => Device Id Discovery
        8 => Stop Bluetooth
        9 => Restart Bluetooth
        10 => Accept Simple Pairing
        11 => Refuse Simple Pairing
        12 => Read Device configuration
        13 => Set device discoverable
        14 => Set device non discoverable
        15 => Set device BLE visibility
        16 => Set AFH Configuration
        17 => Set Tx Power Class2 (specific FW needed)
        18 => Set Tx Power Class1.5 (specific FW needed)
        19 => Change Dual Stack Mode (currently:DUAL_STACK_MODE_BSA)
        96 => Kill BSA server
        97 => Connect to BSA server
        98 => Disconnect from BSA server
        99 => Quit
Select action => BSA_trace 20@ 01/01 10h:28m:27s:043ms: bsa_sec_event_hdlr event:3
DEBUG: app_mgr_security_callback: event:3
DEBUG: app_mgr_security_callback: BSA_SEC_AUTH_CMPL_EVT (name=Motorola Elite Flip,success=1)
DEBUG: app_mgr_security_callback:     bd_addr:00:24:1c:d9:e0:28
DEBUG: app_mgr_security_callback:     LinkKey:97:55:75:16:da:83:e4:32:8e:e1:30:7a:27:91:48:eb
ERROR: app_xml_read_db: open(./bt_devices.xml) failed
ERROR: app_mgr_read_remote_devices: app_xml_read_db failed:-1
Update name with Motorola Elite Flip
Update link key
DEBUG: app_mgr_write_remote_devices: app_xml_write_db ok
```

app_av:

```
Connecting to AV device
BSA_trace 28@ 01/01 10h:28m:20s:550ms: BSA_AvOpenInit
BSA_trace 29@ 01/01 10h:28m:20s:550ms: BSA_AvOpen

Bluetooth AV Main menu
  AV Point To Point menu:
    1 => Abort Discovery
    2 => Start Discovery
    3 => Display local source points
    4 => AV Register (Create local source point)
    5 => AV DeRegister (Remove local source point)
    6 => AV Open (Connect)
    7 => AV Close (Disconnect)
    8 => AV Play Tone
    9 => AV Toggle Tone
    10 => AV Play File
    11 => AV Start Playlist
    12 => AV Play Microphone
    13 => AV Stop
    14 => AV Pause
    15 => AV Resume
    16 => AV Send RC Command (Inc Volume)
    17 => AV Send RC Command (Dec Volume)
    18 => AV Close RC
    19 => AV Send Absolute Vol RC Command
    20 => AV Configure UIPC
    21 => AV Change Content Protection (Currently:NONE)
    98 => AV Set Tone sampling frequency
    22 => AV Test SEC codec
    23 => AV Change busy level(1-5)
    99 => Quit
Select action => BSA_trace 30@ 01/01 10h:28m:27s:100ms: bsa_cl_av_event_hdlr event:0
BSA_AV_OPEN_EVT status:0 handle:65 cp:0 aptx:0 sec:0
DEBUG: app_read_xml_remote_devices: read(./bt_devices.xml): OK
Added trusted services
Update name with Motorola Elite Flip
        ClassOfDevice:24:04:04 => Audio/Video
Update class-of-device [0x24-0x04-0x04]
DEBUG: app_write_xml_remote_devices: write(./bt_devices.xml): OK
BSA_trace 31@ 01/01 10h:28m:27s:125ms: bsa_cl_av_event_hdlr event:4
DEBUG: app_av_cback: BSA_AV_RC_OPEN_EVT status:0 handle:0
```

i. Play File

input **10** to play specified music **OR** input **11** to play music list in folder.

If input **10**, and then select specified music, as below:

```
    38 : test_files/av/test3-48k-joint.wav
        codec(apt-X) ch(2) bits(16) rate(48000)
Select file => 31
31 :test_files/av/48k8bpsStereo.wav
    codec(PCM) ch(2) bits(8) rate(48000)
BSA_trace 25@ 01/01 10h:45m:45s:870ms: BSA_AvStartInit
BSA_trace 26@ 01/01 10h:45m:45s:870ms: BSA_AvStart
Waiting for AV connection to start
BSA_trace 27@ 01/01 10h:45m:45s:929ms: bsa_cl_av_event_hdlr event:2
BSA_AV_START_EVT status:0 channel:40 UIPC:5 SCMS:0,2
    Start PCM feeding: freq=48000 / channels=2 / bits=8
    SCMS-T: cp_enabled = FALSE, cp_flag = 2
DEBUG: app_dm_get_dual_stack_mode: Get DualStackMode
```

```
Select action => BSA_trace 28@ 01/01 10h:45m:45s:929ms: BSA_DmGetConfigInit
BSA_trace 29@ 01/01 10h:45m:45s:929ms: BSA_DmGetConfig
DEBUG: app_av_compute_uipc_param: app_av_compute_uipc_param
DEBUG: app_av_compute_uipc_param: UIPC is in blocking mode, no need to compute UIPC params length=512
BSA_trace 30@ 01/01 10h:45m:45s:929ms: UIPC_Ioctl ChId:5 Request:UIPC_WRITE_BLOCK (3)
DEBUG: app_uipc_tx_thread: Play started
DEBUG: app_uipc_tx_thread: Playing file test_files/av/48k8bpsStereo.wav
DEBUG: app_uipc_tx_thread: Playing file successfully
DEBUG: app_uipc_tx_thread: Streaming for 1 secs
DEBUG: app_uipc_tx_thread: Streaming for 2 secs
DEBUG: app_uipc_tx_thread: Streaming for 3 secs
DEBUG: app_uipc_tx_thread: Streaming for 4 secs
DEBUG: app_uipc_tx_thread: Streaming for 5 secs
DEBUG: app_uipc_tx_thread: No more samples -> stopping current
BSA_trace 31@ 01/01 10h:45m:50s:561ms: BSA_AvStopInit
BSA_trace 32@ 01/01 10h:45m:50s:561ms: BSA_AvStop
DEBUG: app_uipc_tx_thread: Streaming stopped
BSA_trace 33@ 01/01 10h:45m:50s:629ms: bsa_cl_av_event_hdlr event:3
DEBUG: app_av_cback: BSA_AV_STOP_EVT pause:0 Channel:64 UIPC:5
DEBUG: app_dm_get_dual_stack_mode: Get DualStackMode
BSA_trace 34@ 01/01 10h:45m:50s:629ms: BSA_DmGetConfigInit
BSA_trace 35@ 01/01 10h:45m:50s:629ms: BSA_DmGetConfig
DEBUG: app_uipc_tx_thread: Waiting for play start
```

注意：如果连接之后没有声音，请检查声卡的配置。

3.1.2 Realtek 模组

使用开源的 bluez + plusaudio

4 支持 WiFi 列表：

海华(Broadcom):

AW-CW256S: 802.11a/b/g/n/ac Wi-Fi with Bluetooth 4.2 1x1 (SDIO 3.0)

AW-NB197SM: 802.11 b/g/n Wi-Fi with Bluetooth 4.1 1x1 (SDIO 2.0)

后续支持：

REALTEK：RTL8723DS