



Introduction to Ameba SDK



Content

- **Introduction to SDK**
- Network Stack and OS
- API of Components
- IDE Tool Demo
- MP Related



Software Features

- Operation System
 - FreeRTOS
- Wlan Security
 - Open/WEP/TKIP/AES PSK
- Architecture
 - STA mode
 - AP mode
 - STA+AP mode
 - Promiscuous mode
 - P2P GO
- Device Simple Config
 - SoftAP mode config
 - WPS
 - Realtek simple config
 - Customizable Promiscuous Mode
- Network Stack
 - LW/IP
 - mDNS
 - MQTT
 - HTTP Server/HTTP Client
 - WebSocket
- Secure Sockets Layer
 - Polar SSL (Ref: AN0012)
- Peripheral operation example
 - adc, crpto, efuse, ethernet, flash, dma, gpio, gsapi, gtimer, rtc, i2c, i2s, uart, log_uart, nfc, power save, pwm, spi, watchdog
- Application example
 - Jason, http_client, multicast, mdns, mqtt, rtsp, socket_select, ssl_download, wifi_manager, wifi_mac_monitor, xml



Software Features

- Multimedia
 - Video RTSP Server
 - Audio RTSP Server
 - Audio RTSP client
 - G711 encoder/decoder
 - Video/Audio Muxer

- File system
 - FatFs
 - File system over SD storage

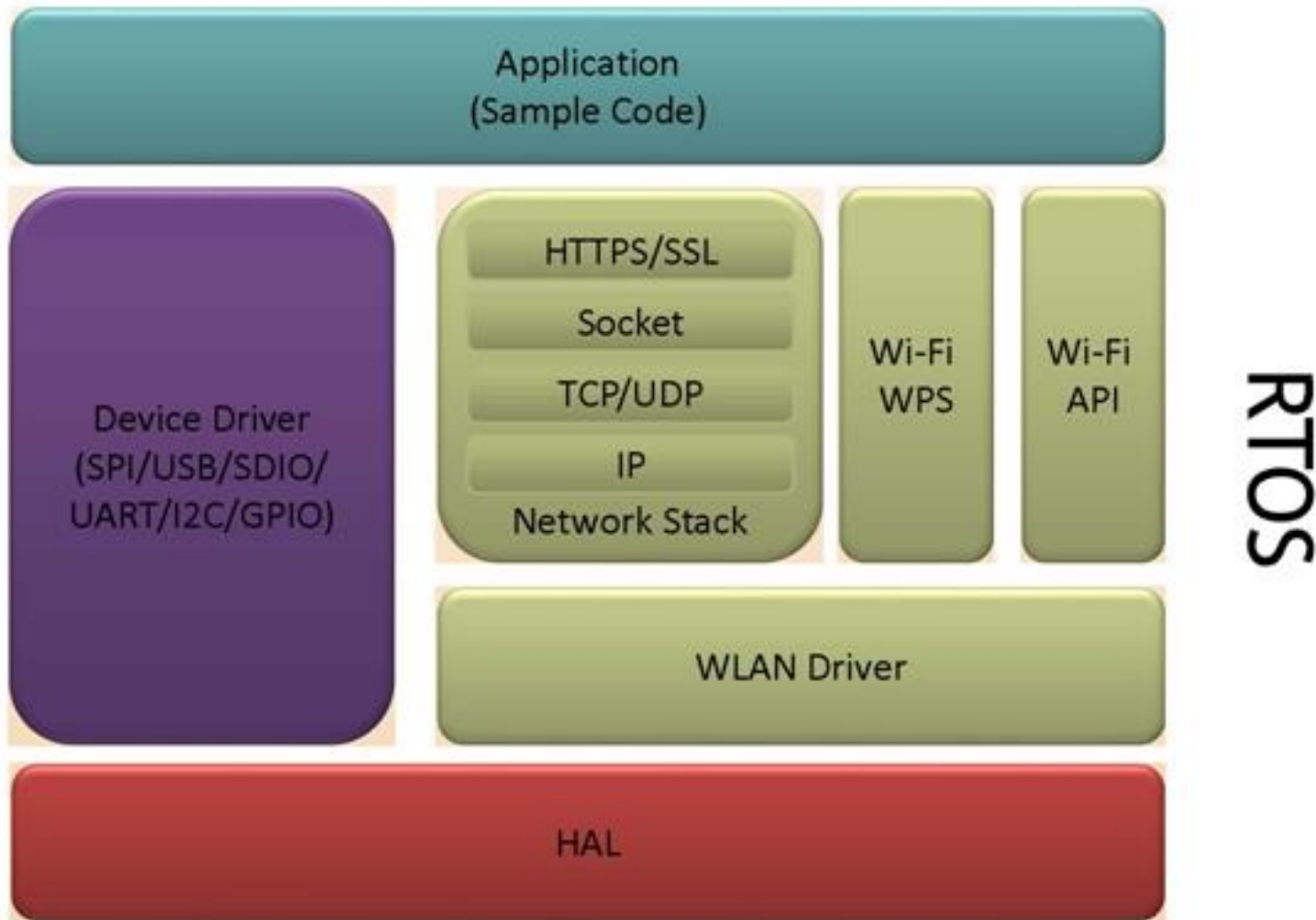
- Update Firmware
 - OTA update (Ref: AN0033)
 - UART update (Ref: AN0060)

- Cloud stack
 - Airkiss
 - Alink
 - Amazon AWS IoT
 - Google Nest(Ref: AN0038)
 - Jdsmart
 - Homekit (Ref: AN0040)
 - QQLink
 - Wechat

- Application
 - Wi-Fi RS 232 (Ref: AN0046)
 - Sensor Control (Ref: AN0049)
 - USB camera (Ref: AN0050)

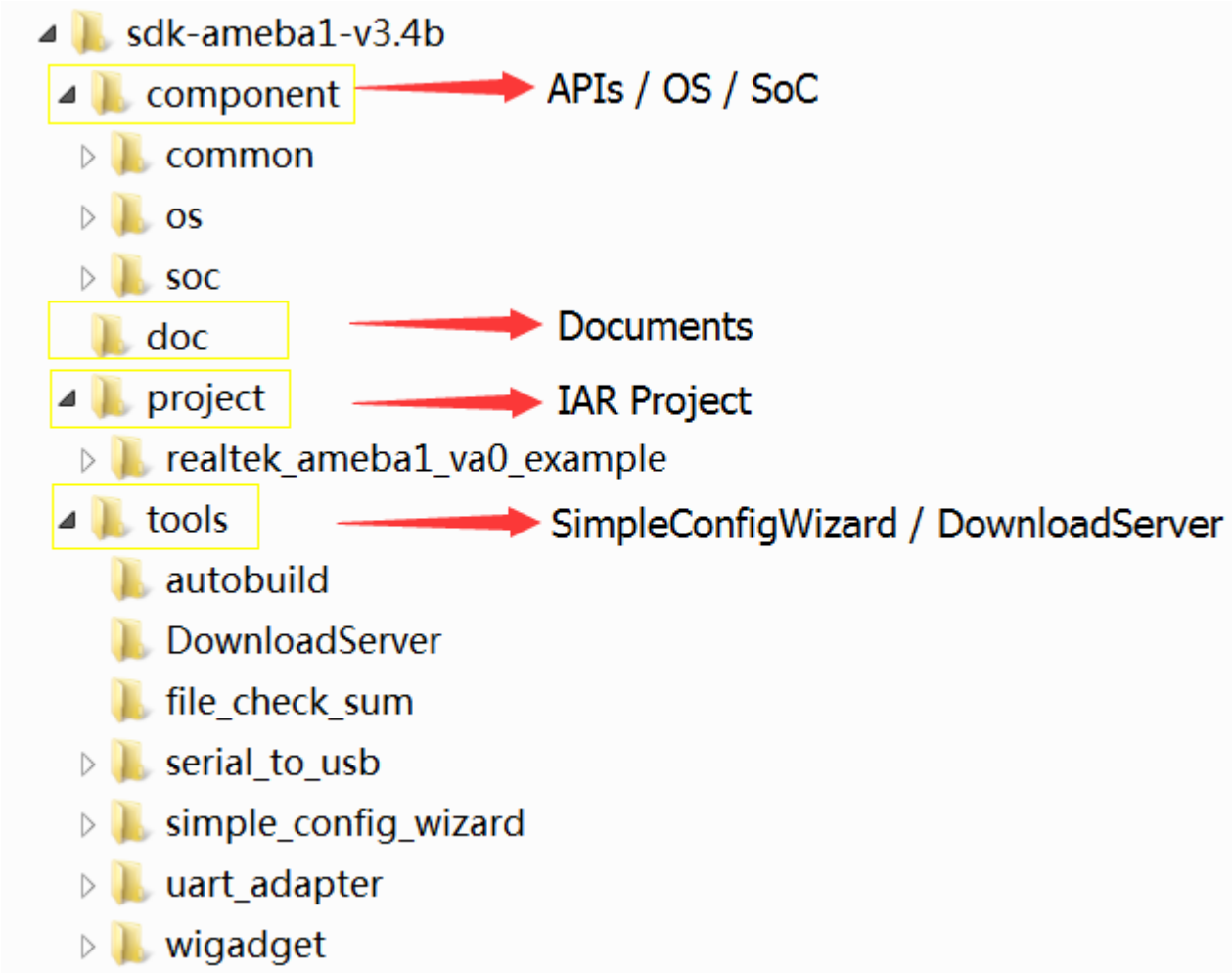


SDK Software Stack





Directory Structure





Component/common

- └─ common
 - ├─ api → ATCMDs and WiFi APIs
 - ├─ application → Apple/Homekit/UartAdapter...
 - ├─ drivers
 - ├─ usb_class
 - ├─ wlan → WiFi Driver
 - ├─ example → FastConnect/Multicast/mDNS...
 - ├─ mbed → mbed APIs
 - ├─ api
 - ├─ common
 - ├─ hal
 - ├─ hal_ext
 - ├─ targets
 - ├─ media
 - ├─ codec
 - ├─ network → LWIP / PolarSSL
 - ├─ test
 - ├─ utilities → OTA/Tcptest/UartSocket
 - ├─ video



Applications and Examples

- ▲ application → Airkiss/Gitwits/JDsmart/*QQLink
 - ▷ apple
 - google
 - iotdemokit
 - uart_adapter
 - wigadget
 - ▷ drivers
- ▲ example
 - cJSON
 - googlenest
 - mcast
 - mdns
 - socket_select
 - ssl_download
 - uart_firmware_update
 - uvc
 - wlan_fast_connect
 - xml



Peripheral example sources

- └─ realtek_ameba1_va0_example
 - └─ EWARM-RELEASE
 - └─ example_sources
 - └─ analogin_voltage
 - └─ crypto
 - └─ efuse_user
 - └─ flash
 - └─ gdma
 - └─ gpio
 - └─ gpio_irq
 - └─ gpio_jtag
 - └─ gpio_level_irq
 - └─ gpio_port
 - └─ gtimer
 - └─ gtimer_rtc
 - └─ i2c
 - └─ i2c_epl2197_heartrate
 - └─ i2c_epl2590_light
 - └─ i2c_epl2590_proximity
 - └─ i2c_LPS25HB_pressure
 - └─ i2c-shtc1
 - └─ i2s
 - └─ i2s_bypass
 - └─ i2s_tx_and_rx_only
 - └─ nfc
 - └─ pm_deepsleep
 - └─ pm_deepstandby
 - └─ pm_sleep
 - └─ pm_tickless
 - └─ pwm
 - └─ pwm-buzzer
 - └─ rtc
 - └─ spi
 - └─ spi_pl7223
 - └─ spi_stream_twoboard
 - └─ spi_twoboard
 - └─ uart
 - └─ uart_clock
 - └─ uart_irq
 - └─ uart_stream_dma
 - └─ uart_stream_irq
 - └─ uart_stream_rx_timeout_by_semaphore
 - └─ watchdog
 - └─ wlan



Getting Start (Ref: AN0025)

- Check AP setting

- Enter command to connect with AP
 - ATW0=ssid
 - ATW1=password
 - ATWC

- Enter command to show wifi info
 - ATW?

- Ping *.*.*.*
 - ATWI=192.168.1.1



Simple Config (Ref: AN0011)

- How to get IoT device link to AP
 - AP mode -> STA mode
 - Most reliable but more complicated
 - User experience is more complicated for iPhone user
 - WPS
 - Easy
 - Has more interoperability issue, but user may have enough WPS experience
 - Simple Connection
 - Easiest way
 - Realtek provide Android/iPhone API
 - Average configure time less than 10 seconds
 - Customizable Promiscuous Mode
 - Design individual algorithm



Network Stack

- Device Discovery and Bound
 - mDNS (ref:AN0043)
 - LWIP-UDP

- Instant message protocol
 - MQTT

- Remote control and OTA
 - Polar SSL (ref: AN0012)

- Local control
 - LWIP-TCP
 - Protected by WiFi security



Application

- Wi-Fi RS 232 (ref: AN0046)
- Sensor Control (ref: AN0049)
- Multi-media frame work (ref: UM0097)



Ameba Memory Layout (Ref: UM0034)

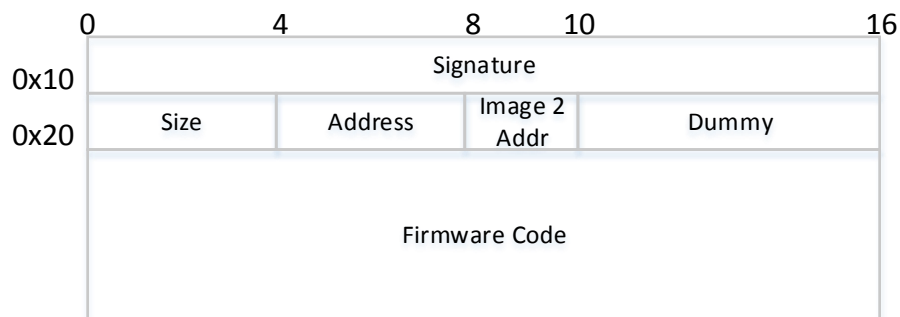
Feature	RTL8195AM	RTL8711AM	RTL8711AF
Package	TFBGA98	QFN56	QFN48
Package Dimension	6x6mm	7x7mm	6x6mm
CPU	ARM Cortex M3 166MHz		
ROM	1MB	1MB	1MB
Flash	selectable	selectable	1MB
RAM	2MB + 512KB	2MB + 512KB	512KB



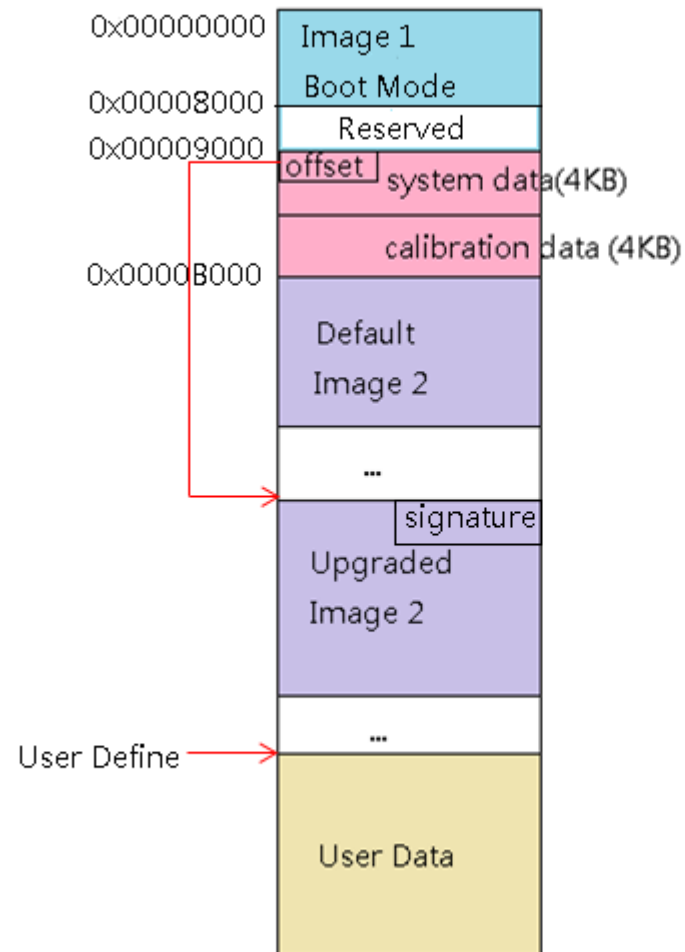
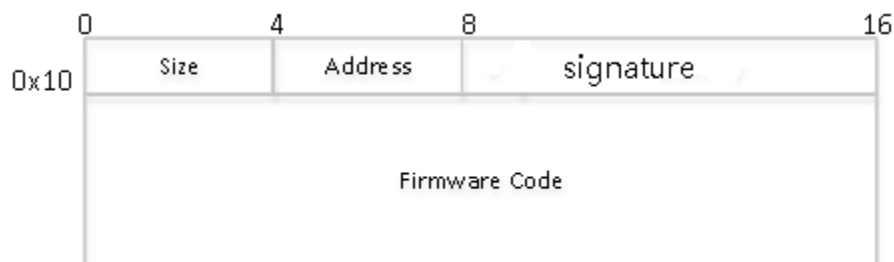
Ameba Flash Layout (Ref: UM0034)

Bootloader

- Hardware initialization
- Image 2 loading



Upgraded Image 2





Ameba Crypto Engine (UM0027)

- Polar SSL can be used with crypto engine.
- Crypto engine is the hardware which can help CPU to do the encryption, decryption and authentication.
- Authentication
 - Md5
 - Sha1
 - Sha2
 - suggests keep using software authentication
- Encryption and Decryption
 - AES (cbc, ecb, ctr)
 - DES (cbc, ecb)
 - 3DES (cbc, ecb).



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- IDE Tool Demo
- MP Related



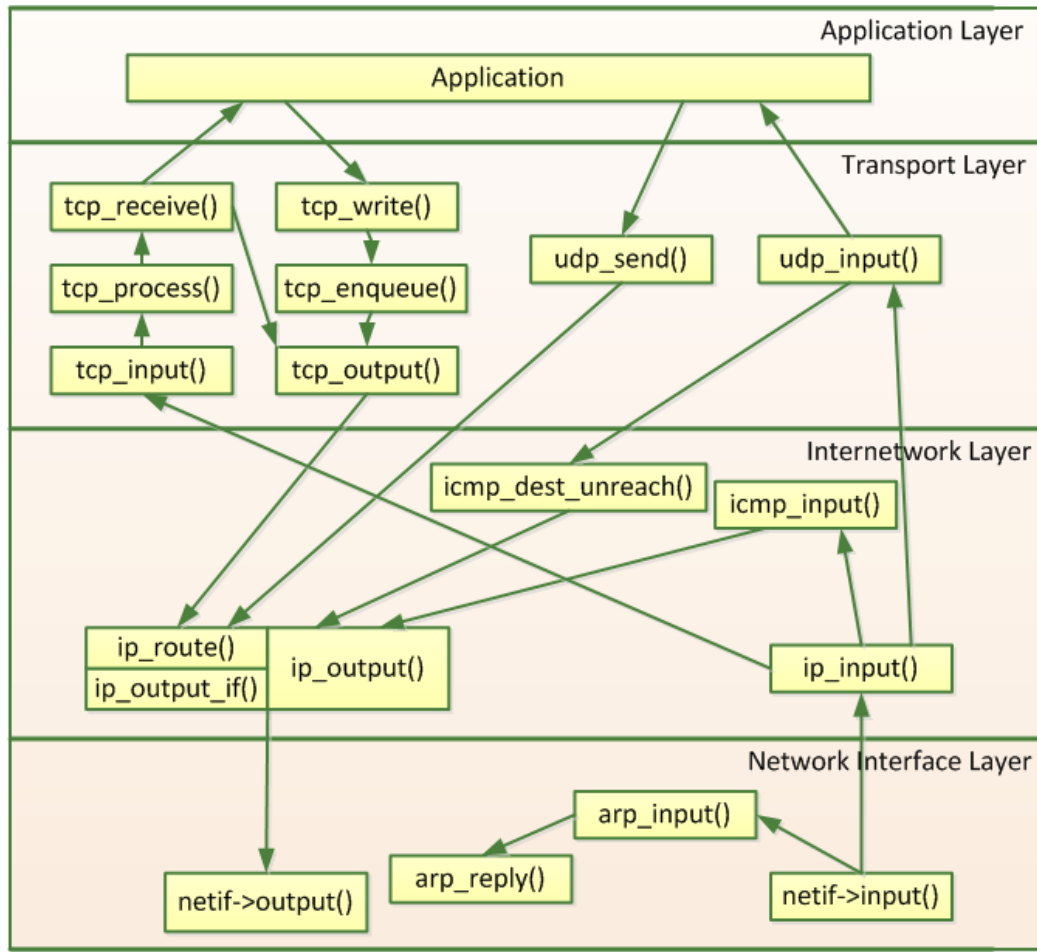
Introduction to LWIP

- Lightweight and open source TCP/IP stack
- Provide basic features of TCP Protocol with decreased system occupation
- Fit for small embedded applications , requires only 20K RAM and 40K ROM
- Support protocols
 - IP protocol
 - ARP protocol
 - ICMP protocol
 - UDP protocol
 - TCP protocol including Congestion Control, RTT Estimation and Fast Recovery/Fast Retransmit



LWIP

- Implemented based on 4 layer TCP/IP Model
- Design with scalability, ARP/IP/ICMP/UDP/TCP /OS API/Memory Management/Socket APIs are supported
- Implement the communications between protocols by memory share

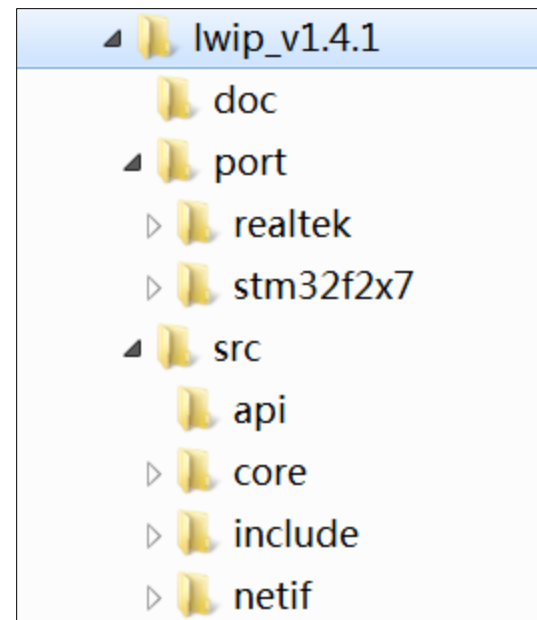




LWIP

■ Source Code Directory

- Port
 - Adapt different platform
- Api
 - BSD and RAW API
- Core
 - Implementation of ICMP/IP/UDP/TCP etc
- Include
 - header files
- Netif
 - Template of ARP and LwIP net device drivers



■ Reference

- LwIP Official Website: <http://www.nongnu.org/lwip/>
- LwIP Official Documentation: <http://www.nongnu.org/lwip/main.html>



Introduction to Freertos

- Is known to be reliable.
- Is undergoing continuous active development.
- Has a minimal ROM, RAM and processing overhead.
 - Typically an RTOS kernel binary image will be in the region of 4K to 9K bytes.
 - The core of the FreeRTOS kernel is contained in only 4 C files.
- Is very scalable, simple and easy to use.
- Is well established with a large and ever growing user base.
- FreeRTOS offers a smaller and easier real time processing alternative for applications.



Freertos

■ C Files

- Tasks.c
- Queue.c
- Heap_5.c
- Timer.c

■ Reference

- <http://www.FreeRTOS.org> - Documentation, books, training, latest versions, license and Real Time Engineers Ltd.



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AT Command (Ref: AN0025)

- 'AT??' Print Log History
- 'AT--' Exit Log Service
- 'ATW0' Wlan Set Network SSID
- 'ATW1' Wlan set Network Passphrase
- 'ATW2' Wlan Set Key ID
- 'ATWC' Wlan Join a Network
- 'ATWD' Wlan Disconnect from Network
- 'ATW3' Wlan Set Access Point SSID
- 'ATW4' Wlan Set Access Point Security Key
- 'ATW5' Wlan Set Access Point Channel
- 'ATWA' Wlan Activate Access Point
- 'ATWB' Wlan Activate Access Point mode and Station mode
- 'ATW?' Wlan Show WiFi information
- 'ATWS' Wlan Scan for Network Access Point
- 'ATWR' Wlan Get RSSI of Associated Network Access Point
- 'ATWM' Wlan Wi-Fi promisc
- 'ATWE' Wlan Start Web Server
- 'ATWQ' Wlan Wi-Fi Simple Config
- 'ATWP' Wlan Power on/off wifi module
- 'ATWI' Wlan ping test
- 'ATWO' Wlan OTA update
- 'ATWT' Wlan TCP throughput test
- 'ATWU' Wlan UDP test
- 'ATWL' Wlan SSL client
- 'ATWW' Wlan Wi-Fi Protected Setup
- 'ATWZ' Wlan IWPRIV

```
$sdk\component\common\api\at_cmd\atcmd_wifi.c
```





WiFi common API (Ref:UM0006)

- Wifi enable/disable
 - wifi_on
 - wifi_off
 - wifi_is_up
 - wifi_is_ready_to_transceive
- Station Mode Connection
 - wifi_connect
 - wifi_disconnect
- AP Mode Startup
 - wifi_start_ap
 - wifi_restart_ap
 - wifi_get_ap_info
 - wifi_get_associated_client_list
- AP+STA Concurrent Mode
 - wifi_start_ap
 - wifi_connect
- Wifi Scan
 - wifi_scan_networks
 - wifi_set_pscan_chan
- Wlan Driver Indication
 - wifi_indication
- Wifi Promiscuous Mode
 - wifi_enter_promisc_mode
 - wifi_set_promisc
 - wifi_init_packet_filter
 - wifi_add_packet_filter
 - wifi_enable_packet_filter
 - wifi_disable_packet_filter
 - wifi_remove_packet_filter
- Wifi Setting Information
 - wifi_get_setting
 - wifi_show_setting



WiFi common API

- Wifi Mac Address
 - wifi_set_mac_address
 - wifi_get_mac_address
- Wifi Power save
 - wifi_enable_powersave
 - wifi_disable_powersave
- Wifi Tx Power
 - wifi_set_txpower
 - wifi_get_txpower
- Wifi Channel
 - wifi_set_channel
 - wifi_get_channel
- Wifi Multicast Address
 - wifi_register_multicast_address
 - wifi_unregister_multicast_address
- Wifi RF Control
 - wifi_rf_on
 - wifi_rf_off
- Wifi Auto Reconnection
 - wifi_set_autoreconnect
 - wifi_get_autoreconnect
- Wifi Custom IE
 - wifi_add_custom_ie
 - wifi_update_custom_ie
 - wifi_del_custom_ie
- Wifi RSSI Information
 - wifi_get_rssi
- Country Code Setup
 - wifi_set_country
- Network Mode Setup
 - wifi_set_network_mode

```
$sdk\component\common\api\wifi\wifi_conf.c
```



Mbed peripheral API

■ Flash

- flash_init
- flash_lock
- flash_unlock
- flash_write_protect
- flash_erase_sector
- flash_read_word
- flash_write_word
- flash_stream_read
- flash_stream_write

■ GPIO

- gpio_init
- gpio_set
- gpio_mode
- gpio_dir
- gpio_write
- gpio_read

■ I2C

- i2c_init
- i2c_frequency
- i2c_start
- i2c_stop
- i2c_read
- i2c_write
- i2c_byte_read
- i2c_byte_write
- i2c_reset
- i2c_slave_address
- i2c_slave_mode
- i2c_slave_receive
- i2c_slave_read
- i2c_slave_write



Mbed peripheral API

■ Serial

- serial_init
- serial_free
- serial_baud
- serial_format
- serial_irq_handler
- serial_irq_set
- serial_getc
- serial_putc
- serial_readable
- serial_writable
- serial_clear
- serial_pinout_tx
- serial_break_set
- serial_break_clear

■ SPI

- spi_init
- spi_free
- spi_format
- spi_frequency
- spi_master_write
- spi_slave_receive
- spi_slave_read
- spi_slave_write
- spi_busy
- spi_slave_receive_interrupt
- spi_master_write_interrupt



LWIP API

- Socket
- Shutdown
- Bind
- Listen
- Accept
- Connect
- Recv
- Recvfrom
- Send
- Sendto
- Select
- Ioctlsocket
- Read
- Write
- Close
- tcp_new
- tcp_accept
- tcp_recv
- tcp_sent
- tcp_poll
- tcp_recved
- tcp_bind
- tcp_connect
- tcp_listen
- tcp_abort
- tcp_close
- tcp_write
- udp_new
- udp_remove
- udp_bind
- udp_connect
- udp_recv
- udp_send

```
$sdk\component\common\network\lwip\lwip_v1.3.2\src\api\sockets.c
```





Freertos API

- RtlZmalloc
 - RtlMALLOC
 - RtlMfree

 - RtlEnterCritical
 - RtlExitCritical
 - RtlInitSema
 - RtlFreeSema
 - RtlUpSema
 - RtlUpSemaFromISR
 - RtlDownSema
 - RtlDownSemaWithTimeout

 - RtlSystemtime2Ms
 - RtlMs2Systemtime
- `$sdk\component\os\os_dep\osdep_api.c`
- RtlMsleepOS
 - RtlUsleepOS
 - RtlMdelayOS
 - RtlUdelayOS

 - RTL_ATOMIC_SET
 - RTL_ATOMIC_READ
 - RTL_ATOMIC_ADD
 - RTL_ATOMIC_SUB
 - RTL_ATOMIC_INC
 - RTL_ATOMIC_DEC

 - RtlTimerCreate
 - RtlTimerDelete
 - RtlTimerStart
 - RtlTimerStop
 - RtlTimerReset
 - RtlTimerChangePeriod



Development Guideline

- Develop cross-platform api in common\api
- Develop driver (ex, sensor driver) in common\driver
- Develop application code in common\application
- Develop general network stack in common\network
- Keep platform dependent project as simple as possible



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- Introduction to Ameba SDK
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- **IDE Introduction**
- MP Related



IDE Tool Introduction (Ref: UM0023)

- IDE Tool
 - IAR

- Get Started
 - Build code
 - Load code
 - Debug



EVB Board

- 8195AM 3V0 Evaluation Board (ref UM0048)
- 8711AM 2V0
 - 8195AM 3V0 is mainstream EVB. It is suggested to use 8195AM 3V0
- 8711AF DEV01_1V0



Trouble shooting

- Project build fail
 - Check if RAM is enough.
- Uart log fail
 - Check Pin assignment
 - Check baud rate
- WLAN connect fail
 - Check log for connection status
 - Check security correctness
 - Check sniffer log
- Hardfault
 - If 8711AF, check if SDRAM run code.



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- Introduction to Ameba SDK
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MP related documentation

- Wi-Fi MP command (ref:AN0004)
 - Wi-Fi RF performance evaluation
 - Command and Operation for wi-fi related mass production

- Calibration data specification (ref:AN0057)
 - Specification for *system* and *wi-fi* board level parameter and calibration data.

- System Mass Production (ref: AN0058)
 - System level mass production flow introduction
 - Command for system level mass production



MP tools

- MP tool (Ref: UM0059)
- Image Generator / Flash Downloader (Ref: UM0066)
- 1 to 10 DAP Firmware Downloader (Ref: UM0063)



MP tool

The screenshot shows the 'UI_mptool' application window with the following sections:

- Main** (selected), PSD, Efuse, Reg
- Control**:
 - Initialize button
 - Initialize with Pidx in EEPROM
 - TX Power Tracking Start
 - MAC Address input field
 - Wlan Mode dropdown menu
 - Testing Item dropdown menu
 - Start and Stop buttons
- TX Setting**:
 - RX Setting**:
 - Ant TX and Ant RX dropdown menus
 - Data Channel dropdown menu
 - Data Rate dropdown menu
 - A, B, C, D dropdown menus
 - TX Power Index dropdown menu
 - Preamble dropdown menu
 - Bandwidth dropdown menu
 - Limit CH by BW
 - Xtal.cap dropdown menu

- TX Packet Setup**:
- Pattern dropdown menu
- Count input field
- Length input field
- Interval input field
- Packet Counter**:
- TX OK, RX OK, RX ERR input fields
- Reset button
- Advanced**:
 - TX Dest Set button
 - Empty input field
- View Window**: A large yellow rectangular area.



Image generator

Ameba Image Tool

Download Generate

Default image
File name: **D:\TCP_ram_all.bin** (1) Browse

Upgraded image
File name: **D:\MP_ota.bin** (2) Browse
Image offset: 0x4D000

User image
File name: Browse
Image offset:

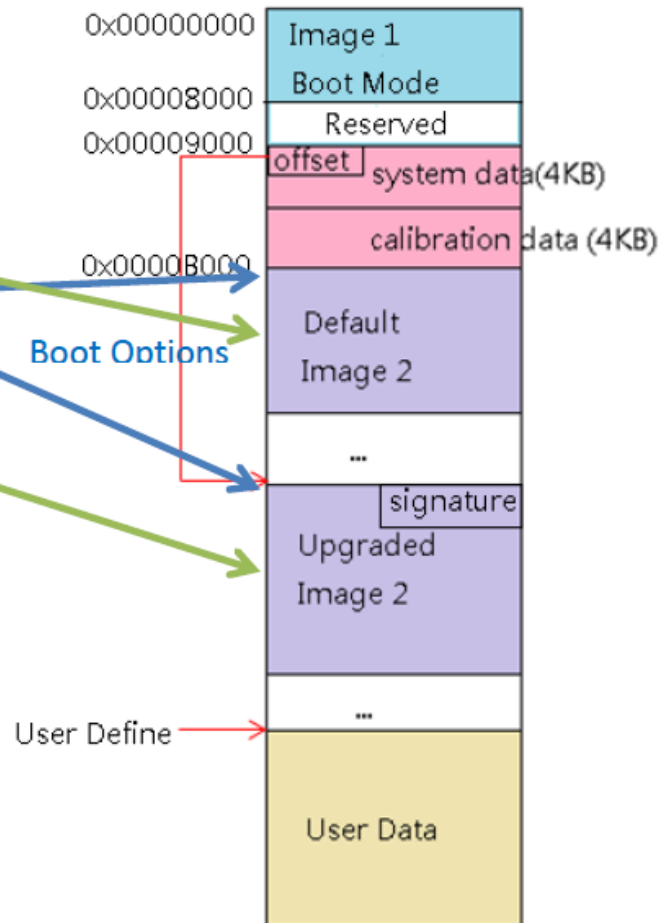
Output image
File name: **\SDK_3p4b_TCP.bi** (3) Browse

System Data (5)
Default Image trigger
Trigger: GPIO_A 0 Low
Trigger: GPIO_A 0 Low
Options: Boot from: Default
Flash: Size: 1 MB
Load System Data
Edit System Data

Image Info (4)

Default	0x0000	0x4C770
Upgraded	0x4D000	0x8C8C0
User		

Generate (6)





Flash Downloader for RD

Ameba Image Tool

Download | Generate

Boot image
File name: image1.p.bin [Browse] [Erase] [Download] [Clear] Adv. mode
Image offset: 0 verify

Firmware 1 image
File name: ota.bin [Browse] [Erase] [Download] default firmware verify

Firmware 2 image
File name: ota.bin [Browse] [Erase] [Download] default firmware verify

Customized image
File name: user.bin [Browse] [Erase] [Download] keep calibration verify

Image Info
 Boot
 Firmware1
 Firmware2
 User

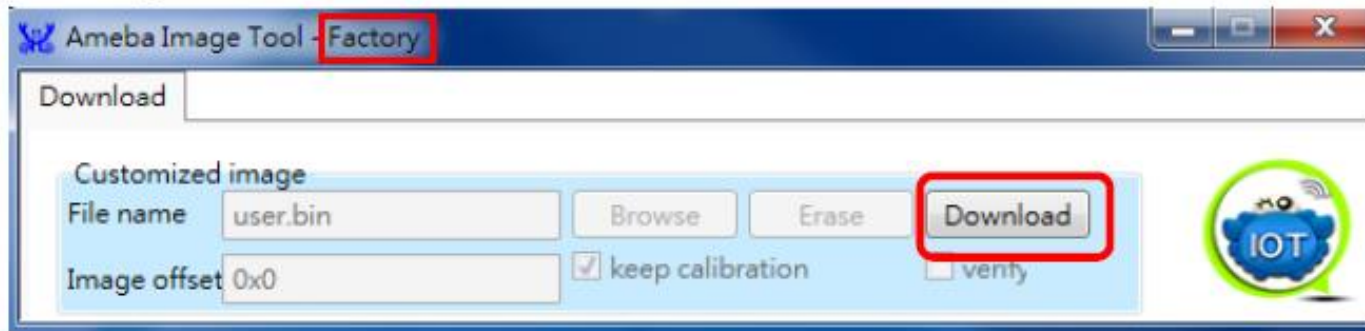
System Data
Default Image trigger
 Trigger: [] [] []
 Trigger: [] [] []

Flash Options
Size: 1 MB
Erase: chip w/o calibrator
Range: [] [] [Erase]

[Load Config] [Save Config]
[Edit System Data] [View Calibration]
[Factory Mode]



Flash Downloader for Factory





1 to 10 DAP Firmware Downloader

Ameba 1 to 10 Image Writer

Source Image
File Name: D:\ram_all.bin [Browse]

Destination Drive
Detected Drive: F:\ [Detect] [Execute]

Progress

1. F:\	<div style="width: 30%; background-color: green; border: 2px solid red;"></div>
2.	<div style="width: 0%; background-color: gray;"></div>
3.	<div style="width: 0%; background-color: gray;"></div>
4.	<div style="width: 0%; background-color: gray;"></div>
5.	<div style="width: 0%; background-color: gray;"></div>
6.	<div style="width: 0%; background-color: gray;"></div>
7.	<div style="width: 0%; background-color: gray;"></div>
8.	<div style="width: 0%; background-color: gray;"></div>
9.	<div style="width: 0%; background-color: gray;"></div>
10.	<div style="width: 0%; background-color: gray;"></div>

Output Message



Thank you!