MT8788 Customization sensor SOP

Version: 1.0

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Specifications are subject to change without notice.

Document Revision History

Revision	Date	Description
1.0	2019-03-18	Initial Draft

Table of Contents

1 Introduction

☞ [Random filler text. Not intended for actual reading.] Must keep the chapter even it have empty content.

1.1 Purpose

The following topics are included in the documentation.

- MTK sensor architecture
- Porting guide
- API interface
- Build option
- Debug method

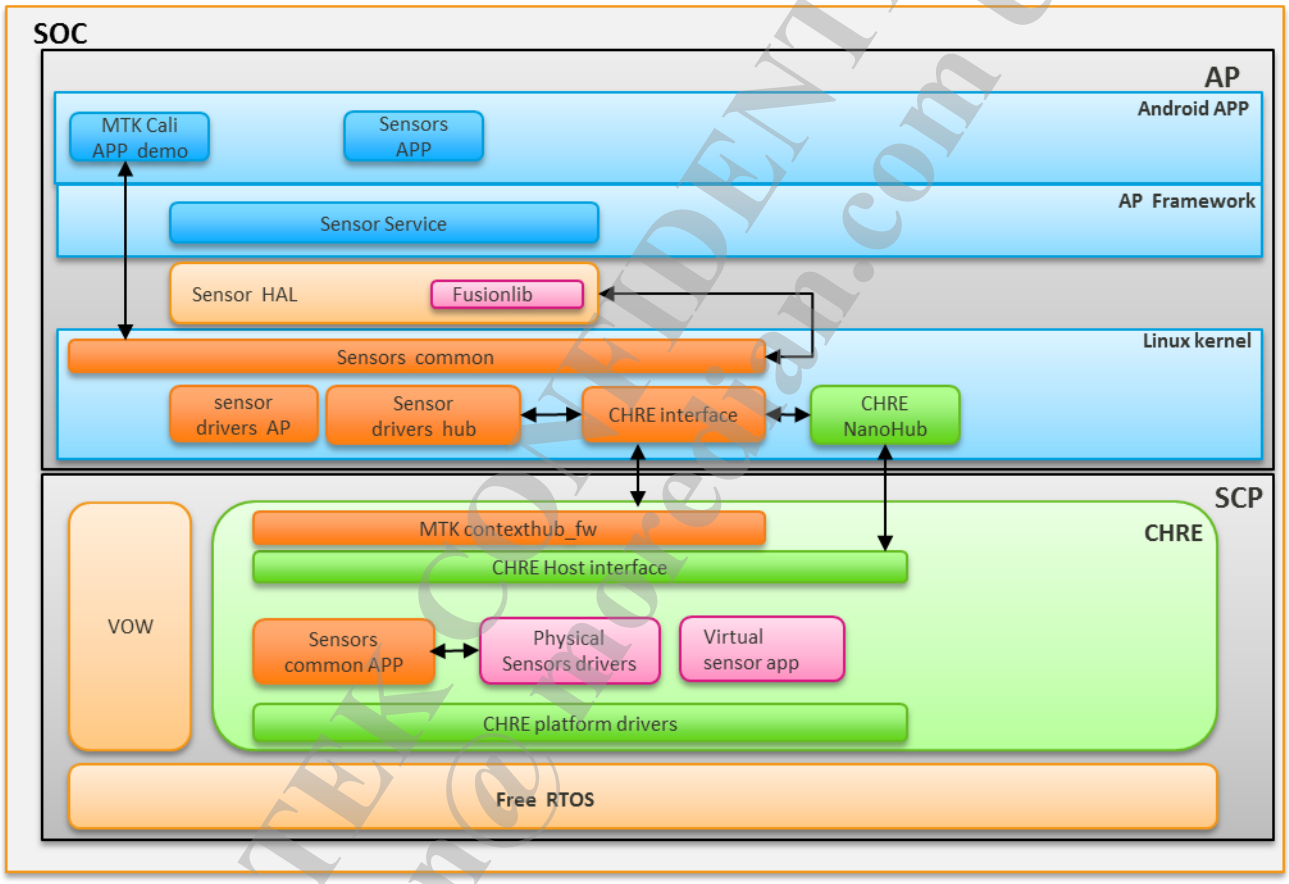
The Introductions are from AP side and from SCP side.
This doc is based on MTK 6762 platform

1.2 Overview

This chapter first gives a brief description of the modules of the system and the relationship of the modules.

1.3 Architecture

Note:
Orange: MTK maintain
Purple: MTK or 3rd party
Blue: Google default
Green: Google CRHE AOSP
CHRE: Open source



MTK Sensor can be divided into two parts: AP(ca5x, CA7x seires main processor), SCP(CM4 coprocessor) . They work together to deal with sensor data.
Another scheme is to use AP only without SCP to implement sensor function

1.4 Source Code Organization

Sensor Hub

- alps/vendor/mediatek/proprietary/tinysys/freertos/source

Kernel code

- alps/kernel-3.18/drivers/misc/mediatek/sensors-1.0/
- alps/kernel-4.4/drivers/misc/mediatek/sensors-1.0/
- alps/device/mediatek/common/kernel-headers/linux/hwmsensor.h
- kernel-4.9/drivers/staging/nanohub

HAL code

- alps/vendor/mediatek/proprietary/hardware/sensor
- alps/vendor/mediatek/proprietary/hardware/libsensor (third party library)
- alps/device/mediatek/MTxxxx/device.mk
- alps/device/mediatek/MTxxxx/manifest.xml
- alps/device/mediatek/MTxxxx/init.sensors_1_0.rc
- alps/device/mediatek/common/kernel-header/linux/hwmsensor.h
- alps/hardware/interface/sensors/
- alps/device/mediatek/sepolicy/basic/non-plat/

Figure 1-1. Source Code Directory Structure

2 AP Side introduction

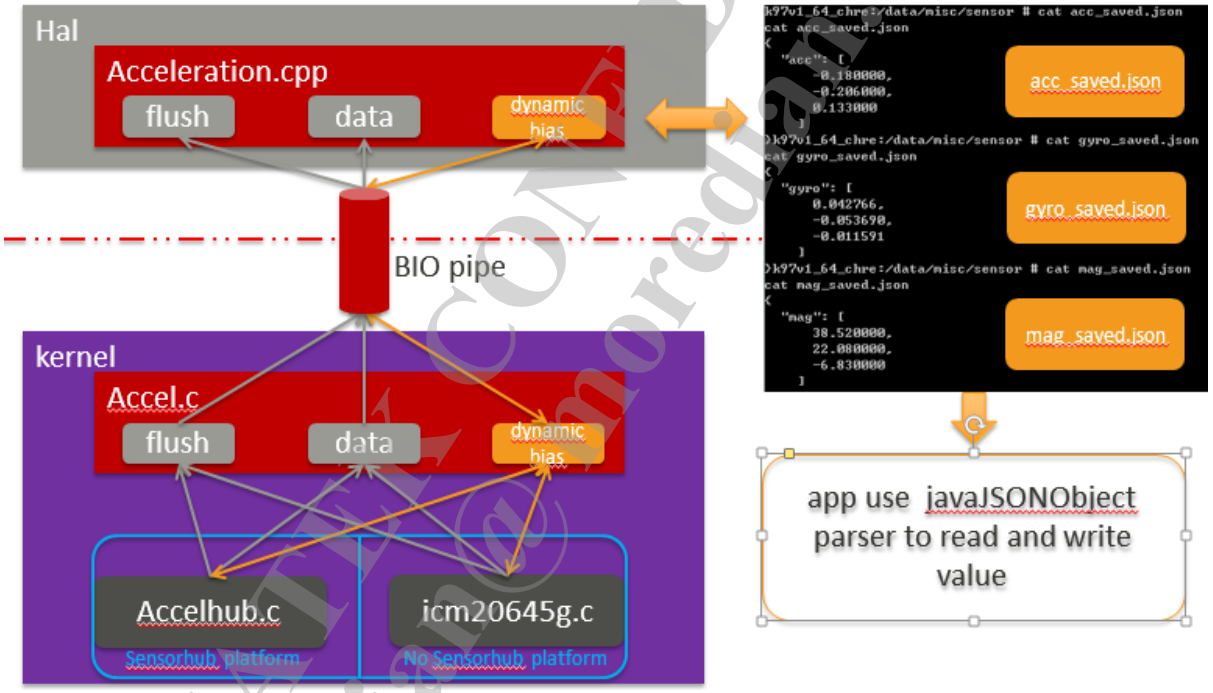
This section specifies sensor architecture in AP part which include: kernel driver and interface, HAL Layer and porting guide.

2.1 Linux sensors drivers interface

This section introduces MTK kernel common sensor Interface，and porting guide.

2.1.1 MTK sensor common layer introduction

The purpose of common layer is to simplify porting work.
On the other hand, the communications between common layer and MTK HAL is using MTK exclusive interface (BIO pipe) which is much more efficient than input event.



2.1.2 Common layer API Introduction

The next part introduces how to use common API and accelerometer is used as an example.
APIs are provided by two header files.

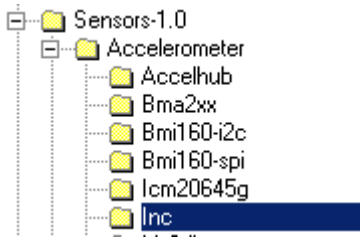
1. **Accel.h**, provide data flow and control flow API to Android layer.
2. **Acc_factory.h** provide data flow and control flow 的 API to MTK factory mode.

Accel.h imlements API as following. It provides data report patch to Android layer:

API Name	Parameter description
acc_driver_add(struct acc_init_info* obj)	acc_init_info includes sensor related information. Sensor auto detect can be implements by registering this structure to common driver.

acc_register_data_path(struct acc_data_path *data)	acc_data_path includes a function to get sensor data and two parameters to normalize sensor raw data from different vendor. These two parameters are registered to common sensor driver architecture to get sensor data for MTK architecture.
acc_register_control_path(struct acc_control_path *ctl)	acc_control_path includes 3 functions and a boolean parameter to control sensor to enable/disable, setDelay and so on.
acc_data_report()	Report data
Acc_flush_report()	Report flush

The structure to pass to the API could be referred to an already implemented driver.



2.1.3 Step counter access

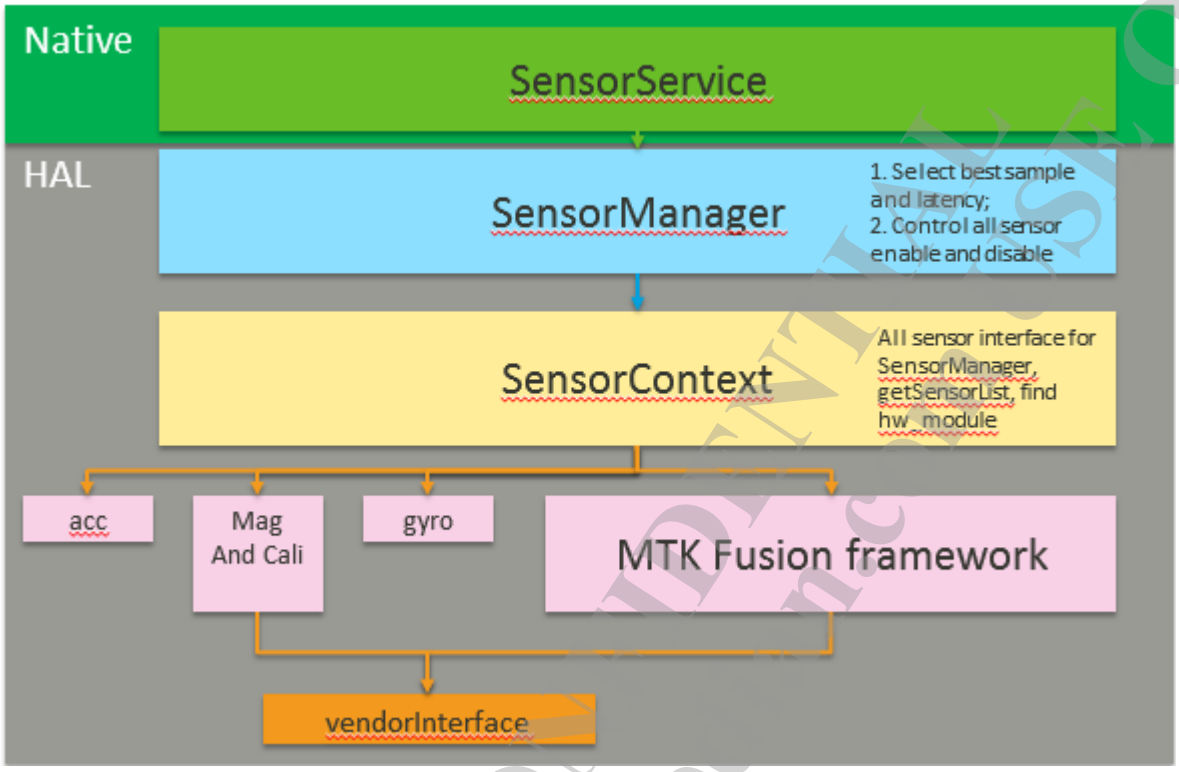
This section introduces, based on accelerometer which comes with acc, how to access step counter data. The interface in the following folder could be referred and is similar to the acc common interface as introduced before.

2.2 Msensor lib porting guide

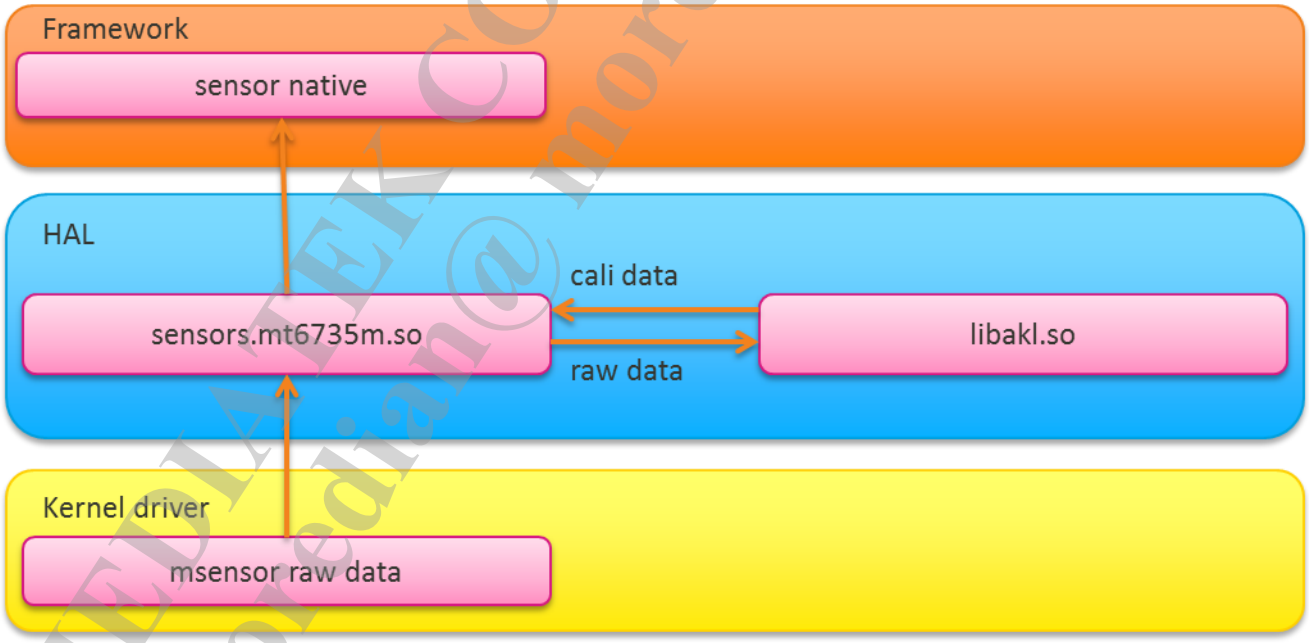
2.2.1 Archetecture

MTK HAL provides third-party algorithm interface according to different needs from customers. Customers may want to implement a series of algorithm such as fusion, virtual gyro and so on in native layer.

MTK HAL architecture is as following：



Msensor lib communicate with MTK lib as following:



2.2.2 Mag lib interface introduction

vendor/mediatek/proprietary/hardware/sensor/sensors-1.0/include/mag_calibtation_lib.h

```
struct magCaliDataOutPut {
    int64_t timeStamp;
    float x, y, z;
    float x_bias, y_bias, z_bias;
    int8_t status;
};
struct magCaliDataInPut {
    int64_t timeStamp;
    float x, y, z;
    int32_t status;
};
struct magChipInfo {
    int32_t layout;
    int32_t deviceid;
    int8_t hwGyro;
};
struct mag_lib_interface_t {
    const char *module;
    int (*initLib)(struct magChipInfo *info);
    int (*enableLib)(int en);
    int (*caliApiGetOffset)(float offset[3]);
    int (*caliApiSetOffset)(float offset[3]);
    int (*caliApiSetGyroData)(struct magCaliDataInPut *inputData);
    int (*caliApiSetAccData)(struct magCaliDataInPut *inputData);
    int (*caliApiSetMagData)(struct magCaliDataInPut *inputData);
    int (*doCaliApi)(struct magCaliDataInPut *inputData,
        struct magCaliDataOutPut *outputData);
    int (*getGravity)(struct magCaliDataOutPut *outputData);
    int (*getRotationVector)(struct magCaliDataOutPut *outputData);
    int (*getOrientation)(struct magCaliDataOutPut *outputData);
    int (*getLinearaccel)(struct magCaliDataOutPut *outputData);
    int (*getGameRotationVector)(struct magCaliDataOutPut *outputData);
    int (*getGeoMagnetic)(struct magCaliDataOutPut *outputData);
    int (*getVirtualGyro)(struct magCaliDataOutPut *outputData);
};
```

int (*initLib)(struct magChipInfo *info);

- ✓ Be called after hal init
- ✓ return value is 0 or others，0 means success or others means fail
- ✓ parameter ：hwGyro，0：no hw gyro

  1：have hw gyro

int (*enableLib)(int en);

- ✓ every time enable and disable mag need to call this api
- ✓ return value is 0 or others，0 means success or others means fail
- ✓ 传入参数：en，0：close mag，close lib，pelase clean some info in the library if no need.

  1: open mag，open lib

int (*doCaliApi)(struct magCaliDataInPut *inputData,
struct magCaliDataOutPut *outputData);

- ✓ Send mag data to the lib，and do calibration
- ✓ return value is 0 or others，0 means success or others means fail
- ✓ input parameter ：timestamp，data（uncali data）
- ✓ output parameter：timestamp(don't change data timestamp in your lib），data（after cali），bias，status（accuracy）

- ✓ data unit：data: ut, timestamp: ns

  int (*caliApiGetOffset)(float offset[3]);

- ✓ if status changed from **doCaliApi**，please call **caliApiGetOffset**， read bias and saved it at storage
- ✓ return value is 0 or others，0 means success or others means fail
- ✓ output parameter：bias

  int (*caliApiSetOffset)(float offset[3]);

- ✓ call **caliApiSetOffset** to reload bias to library
- ✓ return value is 0 or others，0 means success or others means fail
- ✓ input parameter：last bias before reboot，defualt is 0

  int (*caliApiSetGyroData)(struct magCaliDataInPut *inputData);
  int (*caliApiSetAccData)(struct magCaliDataInPut *inputData);
  int (*caliApiSetMagData)(struct magCaliDataInPut *inputData);

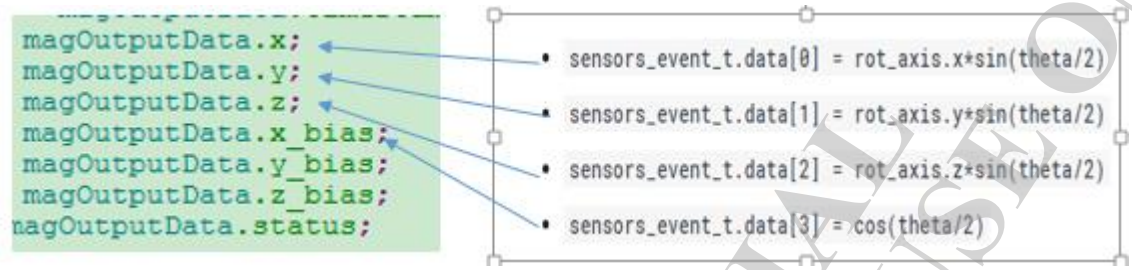
- ✓ libsend acc，gyro，mag to lib (after doCaliApi)
- ✓ return value is 0 or others，0 means success or others means fail
- ✓ input parameter：timestamp，data，status（accuracy）
- ✓ data unit acc ：m/s^2，mag：ut，gyro：radians/second

  int (*getGravity)(struct magCaliDataOutPut *outputData);
  int (*getRotationVector)(struct magCaliDataOutPut *outputData);
  int (*getOrientation)(struct magCaliDataOutPut *outputData);
  int (*getLinearaccel)(struct magCaliDataOutPut *outputData);
  int (*getGameRotationVector)(struct magCaliDataOutPut *outputData);
  int (*getGeoMagnetic)(struct magCaliDataOutPut *outputData);
  int (*getVirtualGyro)(struct magCaliDataOutPut *outputData);

- ✓ get fusion data from lib
- ✓ return value is 0 or others，0 means success or others means fail
- ✓ output parameter：timestamp(**please follow acc timestamp**)，data，status（accuracy）
- ✓ data unit，align goolge sensor unit

  Some tips：

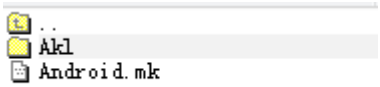
- like type rotation vector will generate 3 or 4 datas ，you only need assign the value to x,y,z,x_bias successively，but sensor accuracy still need to assign to status.



- If you want to save some parameter , you can write it to mnt/vendor/nvcfg/sensor/xxx , when phone reboot ,you also can read param from the file you saved
- For example , /mnt/vendor/nvcfg/sensor/yamaha.txt

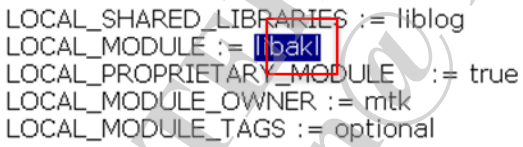
2.2.3 Porting Guid

1. Put msensor souce and lib at following folder
   vendor/mediatek/proprietary/hardware/libsensor

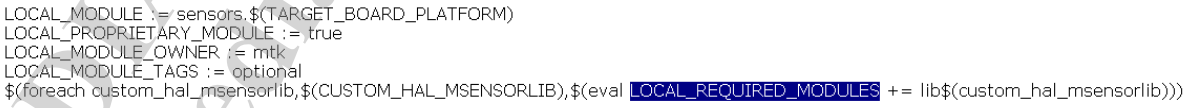


2. device/mediatekprojects/&project/ProjectConfig.mk
   Or device/mediateksample/&project/ProjectConfig.mk

3. vendor/mediatek/proprietary/hardware/libsensor/akl/Android.mk



4. vendor/mediatek/proprietary/hardware/sensor/sensors-1.0/Android.mk



   Build sensors.&project.so auto link libakl.so

5. vendor/mediatek/proprietary/hardware/sensor/sensors-1.0/VendorInterface.cpp

```
#ifndef CUSTOM_KERNEL_SENSORHUB
    char libinfos[64] = {"/sys/class/sensor/m_mag_misc/maglibinfo"};
    char buf[20] = {0};
    char strbuf[64] = {0};
    int len = 0;
    fd = open(libinfos, O_RDWR);
    if (fd >= 0) {
        len = read(fd, buf, sizeof(buf) - 1);
        if (len <= 0) {
            ALOGD("read libinfo err, len = %d", len);
        }
        close(fd);
    } else
        ALOGE("open vendor libinfo fail\r\n");

    strcpy(strbuf, "lib");
    strcat(strbuf, buf);
    strcat(strbuf, ".so");
    //ALOGE("yue strbuf=%s\r\n", strbuf);

    //void *handle = dlopen("libcalmodule_akm.so", RTLD_NOW);
    void *handle = dlopen(strbuf, RTLD_NOW);
    if (!handle) {
        ALOGE("dlopen fail\n");
        return;
    }
```

Read "/sys/class/sensor/m_mag_misc/maglibinfo" string from kernel driver

String = libakl.so

6. Lib interface, path:

vendor/mediatek/proprietary/hardware/sensor/sensors-1.0/include/mag_calibtation_lib.h

```
struct magCaliDataOutPut {
    int64_t timeStamp;
    float x, y, z;
    float x_bias, y_bias, z_bias;
    int8_t status;
};
struct magCaliDataInPut {
    int64_t timeStamp;
    float x, y, z;
    int32_t status;
};
struct magChipInfo {
    int32_t layout;
    int32_t deviceid;
};
struct mag_lib_interface_t {
    const char *module;
    int (*initLib)(struct magChipInfo *info);
    int (*caliApiGetOffset)(float offset[3]);
    int (*caliApiSetOffset)(float offset[3]);
    int (*caliApiSetGyroData)(struct magCaliDataInPut *inputData);
    int (*caliApiSetAccData)(struct magCaliDataInPut *inputData);
    int (*caliApiSetMagData)(struct magCaliDataInPut *inputData);
    int (*doCaliApi)(struct magCaliDataInPut *inputData,
        struct magCaliDataOutPut *outputData);
    int (*getGravity)(struct magCaliDataOutPut *outputData);
    int (*getRotationVector)(struct magCaliDataOutPut *outputData);
    int (*getOrientation)(struct magCaliDataOutPut *outputData);
    int (*getLinearaccel)(struct magCaliDataOutPut *outputData);
    int (*getGameRotationVector)(struct magCaliDataOutPut *outputData);
    int (*getGeoMagnetic)(struct magCaliDataOutPut *outputData);
    int (*getVirtualGyro)(struct magCaliDataOutPut *outputData);
};
```

Interface implementation in your libxxx.so, path:vendor/mediatek/proprietary/hardware/libsensor/xxx

```
const struct mag_lib_interface_t MAG_LIB_API_INTERFACE = {
    .module = "libakl",
    .initLib = AKMInitLib,
    .caliApiGetOffset = AKMCaliApiGetOffset,
    .caliApiSetOffset = AKMCaliApiSetOffset,
#if 0
    .caliApiSetGyroData = AKMCaliApiSetGyroData,
    .caliApiSetAccData = AKMCaliApiSetAccData,
#endif
    .doCaliApi = AKMDoCaliApi,
};
```

This can't be changed

7. Set follow macro in
vendor/mediatek/proprietary/custom/{project}/hal/sensors/sensor/hwmsen_custom.h

- MAG_CALIBRATION_IN_SENSORHUB // need define if do mag cali in sensor hub
- MAG_CALIBRATION_FAST // if use acc and gyro do mag cali need define this
- FUSION_ALGORITHM_IN_SENSORHUB // if implement fusion lib in sensor hub ,need define
- FUSION_SUPPORT_9D_ALGORITHM //open it if AP fusion use gyro , beside acc and mag
- VIRTUAL_GYROSCOPE_ALGORITHM // if support Virtual gyro we need define this
- ACC_GYRO_CALIBRATION_IN_SENSORHUB // no need define if no sensor hub
- ACC_GYRO_CALIBRATION_SUPPORT // no need define

8. If you use android P please do some change
   1) Change akm09918 driver, use akm as library name

```
strncpy(mTask.mag_dev_info.libname, "akm", sizeof(mTask.mag_dev_info.libname));
```

   2) Update vendor/mediatek/proprietary/custom/$project/hal/sensors/sensor/hwmsen_custom.c

```
static struct sensor_t dynamicSensorList[] = {
    {
        .name       = MAGNETOMETER,
        .vendor     = "akm",
        .version    = MAGNETOMETER_VERSION,
        .handle     = ID_MAGNETIC + ID_OFFSET,
        .type       = SENSOR_TYPE_MAGNETIC_FIELD,
        .maxRange   = MAGNETOMETER_RANGE,
        .resolution = MAGNETOMETER_RESOLUTION,
        .power      = MAGNETOMETER_POWER,
        .minDelay   = MAGNETOMETER_MINDELAY,
        .fifoReservedEventCount = MAGNETOMETER_FIFO_RESERVE_COUNT,
        .fifoMaxEventCount = MAGNETOMETER_FIFO_MAX_COUNT,
        .stringType = SENSOR_STRING_TYPE_MAGNETIC_FIELD,
        .maxDelay   = MAGNETOMETER_MAXDELAY,
        .flags      = MAGNETOMETER_FLAGS,
        .reserved   = {}
    },
```

   3) Update device/Huawei/$project/ProjectConfig.mk

```
CUSTOM_HAL_MSENSORLIB = akl akm
```

2.3 Sensors Calibration Interface

MTK provides Calibration interface that can be used by Android APP. Now it supports ACC and Gyro zero calibration, and Proximity threshold calibration. MTK provides engineer mode APK as an example to use these APIs.

2.3.1 Debug Command

Using adb cmd to do accel and gyroscope calibration(the calibration is done in adb command window):

1、adb root

2、adb shell

3、Case Accel calibration ：cd sys/bus/platform/drivers/gsensor

Case Gyro calibration ：cd sys/bus/platform/drivers/gyroscope

4、Do Calibration. Put the phone flat, and DO NOT HAVE any even slight movement： echo 1 > test_cali

```
k71v1_64_bsp:/vendor/nvcfg/sensor #
```

If on Android P the cali data saved at **mnt/vendor/nvcfg/sensor/**

5. Check calibration result：

```
1|k71v1_64_bsp:/vendor/nvcfg/sensor # cat *
{
  "acc_bias": [
      0.187000,
      -0.459000,
      0.008000
    ]
}{
  "acc_cali": [
      185,
      -460,
      10
    ]
}k71v1_64_bsp:/vendor/nvcfg/sensor # cd ..
```

2.3.2 Accel & Gyro Zero Calibration Interface

Native API Path：vendor\mediatek\proprietary\external\sensor-tools\include\libhwm.h

Notice : call these API need android boot up

Accel Calibration API

Int gsensor_start_static_calibration(void);

- ✓ Return zero or non-zero. If zero: success; if non-zero: failure.

Int gsensor_get_static_calibration(sensorData *sensorDat);

- ✓ Return zero or non-zero. If zero: success; if non-zero: failure.

  Passed parameter is used to send back the calibration data to be displayed on the UI.,x=sensorDat->data[0], y=sensorDat->data[1], z=sensorDat->data[2]
- ✓ Only when gsensor_start_static_calibration returns true, this api can be used to get static calibration data.

Gyroscope Calibration API

Int gyroscope_start_static_calibration (void);

- ✓ Return zero or non-zero. If zero: success; if non-zero: failure.

Int gyroscope_get_static_calibration (sensorData *sensorDat);

- ✓ Return zero or non-zero. If zero: success; if non-zero: failure.
- ✓ Passed parameter is used to send back the calibration data to be displayed on the UI,x=sensorDat->data[0], y=sensorDat->data[1], z=sensorDat->data[2]
- ✓ Only when gyroscope_start_static_calibration, this api can be used to get static calibration data.

2.3.3 Proximity Threshold Calibration Interface

Proximity threshold calibration API locates in the same place as Accel and Gyro.

Demo：Enter Engineer Mode: Phone Call Display + “*#*#3646633#*#*” to enter Engineer Mode

Ehen encountering proximity issue, the first interface is used to do calibration and the second one is used to set threshold manually.

Native API Path：vendor\mediatek\proprietary\external\sensor-tools\include\libhwm.h

int get_psensor_data(void)

- ✓ Return psensor raw data

Int set_psensor_threshold(int high, int low)

- ✓ High and low two data are stored in the nvram and can be passed to bottom driver.
- ✓ For example in 36658.c

  When phone power on to home screen, the scp dirver will received the Cali data you reserved at last calibration.

```
/* ps cali state */
sensorFsmCmd(STATE_PS_CALI, CHIP_PS_CALI_DONE, cm36558_ps_cali),
/* ps cfg state */
sensorFsmCmd(STATE_PS_CFG, CHIP_PS_CFG_DONE, cm36558_ps_cfg),
```

2.3.4 Ligth calibration interface

Int als_start_static_calibration(void);

- ✓ Call this native API , SCP driver will received the Cali cmd
- ✓ For example 36658 driver ‘s function cm36658_als_cali will be called

```
/* als cali state */
sensorFsmCmd(STATE_ALS_CALI, CHIP_ALS_CALI_DONE, cm36558_als_cali),
```

You can implement your cali algo in the below function cm36558_als_cali(), this is a demo function , you need to do the cali function by your self

```
static int cm36558_als_cali(I2cCallbackF i2cCallBack, SpiCbkF spiCallBack, void *next state,
                            void *inBuf, uint8_t inSize, uint8_t elemInSize,
                            void *outBuf, uint8_t *outSize, uint8_t *elemOutSize)
{
    //sensorFsmEnqueueFakeI2cEvt(i2cCallBack, next_state, SUCCESS_EVT);
    int32_t alsCali[2];
    float   alsCali_mi;

    alsCali_mi = 0.345;
    alsCali[0] = alsCali_mi * ALS_INCREASE_NUM_AP;
    alsCali[1] = 0;

    sendAlsPsCalibrationResult(SENS_TYPE_ALS, alsCali);
    sensorFsmEnqueueFakeI2cEvt(i2cCallBack, next_state, SUCCESS_EVT);
    return 0;
}
```

After calibration, when power on you can get the cali value in cm36558_als_cfg()

```
static int cm36558_als_cfg(I2cCallbackF i2cCallBack, SpiCbkF spiCallBack, void *next state,
                           void *inBuf, uint8_t inSize, uint8_t elemInSize,
                           void *outBuf, uint8_t *outSize, uint8_t *elemOutSize)
{
    int ret = 0;
    struct alspsCaliCfgPacket caliCfgPacket;
    double  alsCali_mi;

    ret = rxCaliCfgInfo(&caliCfgPacket, inBuf, inSize, elemInSize, outBuf, outSize, elemOutSize);

    if (ret < 0) {
        sensorFsmEnqueueFakeI2cEvt(i2cCallBack, next_state, ERROR_EVT);
        osLog(LOG_ERROR, "cm36558_als_cfg, rx inSize and elemSize error\n");
        return -1;
    }
    alsCali_mi = (double)((float)caliCfgPacket.caliCfgData[0] / ALS_INCREASE_NUM_AP);
    osLog(LOG_INFO, "cm36558_als_cfg: [%f]\n", alsCali_mi);
    mTask.alsCali = caliCfgPacket.caliCfgData[0];
    sensorFsmEnqueueFakeI2cEvt(i2cCallBack, next_state, SUCCESS_EVT);
    return 0;
} ? end cm36558_als_cfg ?
```

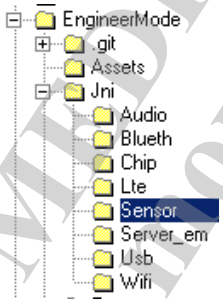
Int als_get_static_calibration(void);

You can call this function to show the cali value

```
struct caliData caliData;
int ret = als_get_static_calibration (&caliData)
```

2.3.5 Engineer mode Demo code example（*#*#3646633#*#*）

- Native Layer interface using example : JIN encapsulates API to be used by APP.




```
static jint calculatePsensorMaxValue(JNIEnv *, jclass) {
    ALOGD("Enter calculatePsensorMaxValue()\n");
    int ret = calculate_psensor_max_value();
    ALOGD("calculatePsensorMaxValue() returned %d\n", ret);

    return ret;
}
```

Reference Path：vendor\mediatek\proprietary\external\apps\engineerMode

2.4 Self Test interface

Path: vendor/mediatek/proprietary/external/sensor-tools/libhwm.so

1. **Native API : gsensor_do_selftest, gyroscope_do_selftest, msensor_do_selftest**

```
int gsensor_do_selftest(int fd)
{
    int err, flags = 1;
    if (fd < 0) {
        HWMLOGE("invalid file handle %d\n", fd);
        return -EINVAL;
    }
    if (0 != (err = ioctl(fd, GSENSOR_IOCTL_SELF_TEST, &flags))) {
        HWMLOGE("self_test err: %d\n", err);
        return err;
    }
    return 0;
}
```

2. **Kernel API:**

   maghub_factory_do_self_test() in sensors-1.0/magnetometer/maghub/maghub.c

   gsensor_factory_do_self_test() in sensors-1.0/magnetometer/maghub/acchub.c

   gyrohub_factory_do_self_test() in sensors-1.0/magnetometer/maghub/gyrohub.c

3. **SCP interface**

Example[demo in SCP] : you need implement the self test function according to the vendor datatsheet .

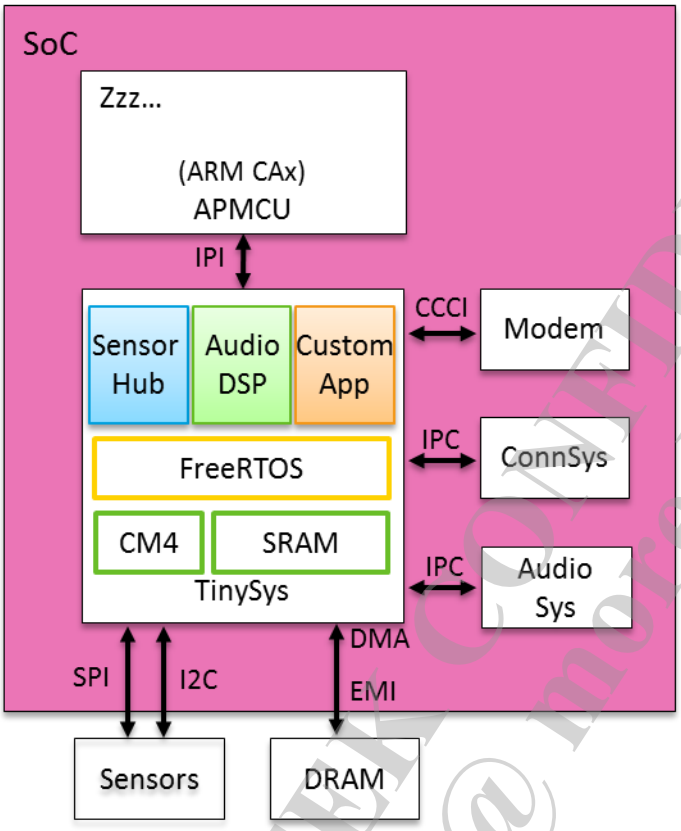
If est pass sensor 1 to AP , fail send 0 to SCP

```
sensorFsmCmd(STATE_ACC_SELF_TEST, STATE_ACC_SELF_TEST_DONE, lis2hh12AccSelfTest),

static int lis2hh12AccSelfTest(I2cCallbackF i2cCallBack, SpiCbkF spiCallBack, void *next_state,
                               void *inBuf, uint8_t inSize, uint8_t elemInSize,
                               void *outBuf, uint8_t *outSize, uint8_t *elemOutSize)
{
    accGyroSendTestResult(SENS_TYPE_ACCEL, 1); /* 0 fail, 1 success, and you could define by yourself */
    sensorFsmEnqueueFakeSpiEvt(spiCallBack, next_state, SUCCESS_EVT);
    return 0;
}
```

3 SCP Introduction

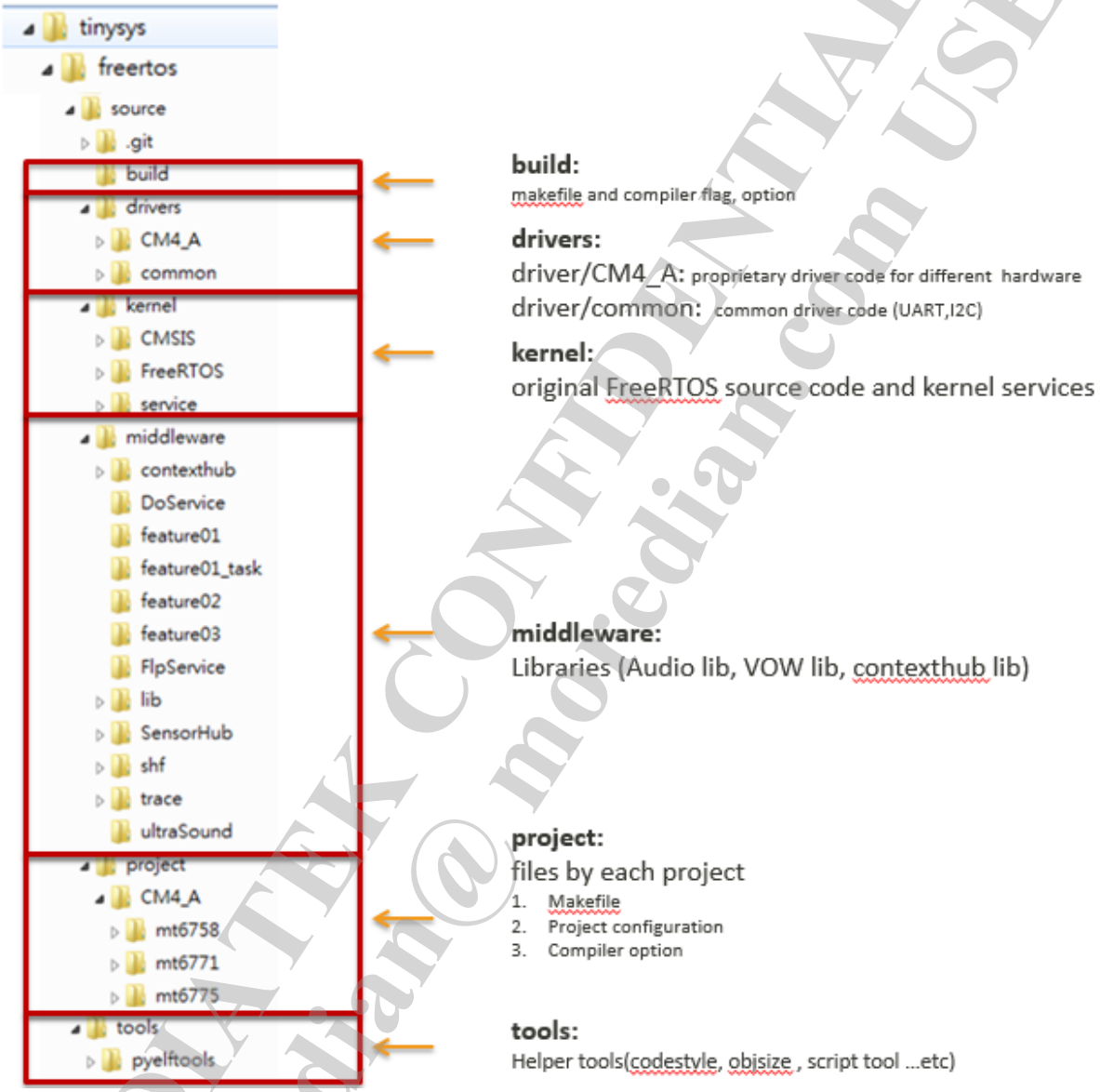
SCP （Tinysys）co-processor is in charge of sensor and audio related features and other customized feature.

MTK SCP chooses FreeRTOS as os and CHRE is a specialized Task to deal with Sensor related data in FreeRTOS. Audio feature is developed on FreeRTOS directly.



3.1 Tinysys introduction

3.1.1 Folder Structure



3.1.2 Configuration files

1. **Platform Configuration file**

   Required LDFLAGS, headers or C files of the platform

   Default configurations of the platform

   Path：project/$(PROCESSOR)/$(PLATFORM)/platform/platform.mk

   As following：

```
################################################################
# Mandatory platform-specific resources
################################################################
INCLUDES += \
  $(PLATFORM_DIR)/inc \
  $(SOURCE_DIR)/kernel/service/common/include \
  $(SOURCE_DIR)/kernel/CMSIS/Device/MTK/$(PLATFORM)/Include \
  $(SOURCE_DIR)/middleware/SensorHub \
  $(DRIVERS_PLATFORM_DIR)/feature_manager/inc

C_FILES += \
  $(PLATFORM_DIR)/src/main.c \
  $(PLATFORM_DIR)/src/platform.c \
  $(PLATFORM_DIR)/src/interrupt.c \
  $(SOURCE_DIR)/kernel/service/common/src/mtk_printf.c \
  $(SOURCE_DIR)/kernel/service/common/src/wakelock.c \
  $(PLATFORM_DIR)/src/scp_it.c \
  $(DRIVERS_PLATFORM_DIR)/feature_manager/src/feature_manager.c
```

2. **Project Configuration file**

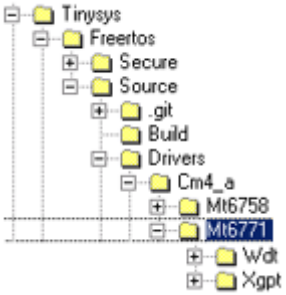
ProjectConfig.mk will **overwriting** options in platform.mk

```
CFG_MTK_VOW_SUPPORT = no

CFG_CHRE_SUPPORT = yes
CFG_CONTEXTHUB_FW_SUPPORT = yes
CFG_ACCGYRO_SUPPORT = yes
CFG_LSM6DSM_SUPPORT = yes
CFG_ALSPS_SUPPORT = yes
CFG_CM36558_SUPPORT = yes
CFG_MAGNETOMETER_SUPPORT = yes
```

3.1.3 How to add freeRTOS driver under Tinysys

1 put the code in the appropriate folder
For driver code, put your file at following path:
drivers/$(PROCESSOR)/$(PLATFORM)/(New_Driver_Folder)

- Example: drivers/CM4_A/mt6771/XGPT



2. add a new compiler option in platform.mk
project/$(PROCESSOR)/$(PLATFORM)/platform/platform.mk

- example：project/mt6771/platform/platform.mk

```
ifeq ($(CFG_XGPT_SUPPORT),yes)
INCLUDES += $(DRIVERS_PLATFORM_DIR)/xgpt/inc/
C_FILES  += $(DRIVERS_PLATFORM_DIR)/xgpt/src/xgpt.c
C_FILES  += $(SOURCE_DIR)/kernel/service/common/src/utils.c
endif
```

3. add a new configuration in platform.mk or ProjectConfig.mk

- project/$(PROCESSOR)/$(PLATFORM)/platform/platform.mk
- project/$(PROCESSOR)/$(PLATFORM)/$(PROJECT)/ProjectConfig.mk
- example：project/mt6771/platform/platform.mk

```
##################################################
# SCP internal feature options
##################################################
CFG_TESTSUITE_SUPPORT = no
CFG_MODULE_INIT_SUPPORT = yes
CFG_XGPT_SUPPORT = yes
CFG_UART_SUPPORT = no
CFG_MTK_SCPUART_SUPPORT = yes
```

3.1.4 SCP code size limitation mechanism

1. memoryReport.py is a script which use to limit code size at the build time.
   If code size over your settings, it will cause build errors.
   (script: vendor/mediatek/proprietary/tinysys/freertos/source/tools/**memoryReport.py**)
2. This script is hooked by tinysys scp make file:

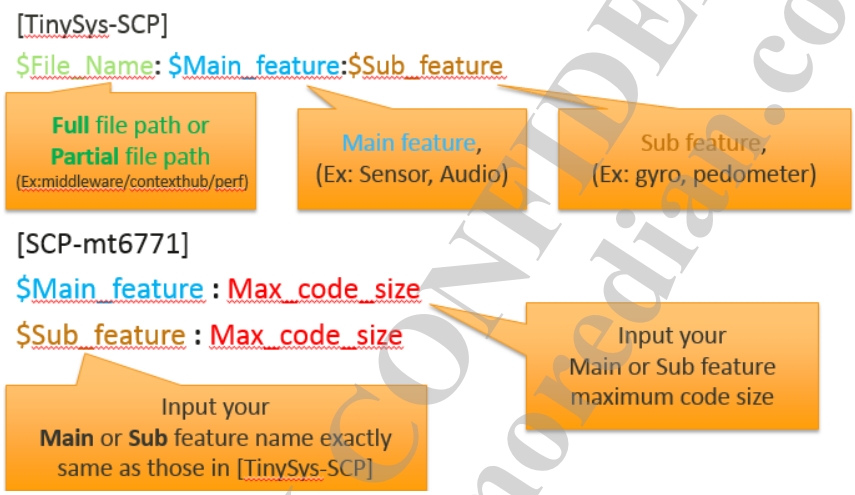
vendor/mediatek/proprietary/tinysys/freertos/source/build/**config.mk**

```
-180,8 +180,8 @@ $($(PROCESSOR).ELF_FILE): $(MY_LIBFLAGS_SEARCH_FILE)
$(PROCESSOR).ELF_FILE): $(DEPS)
    @echo '$(TINYSYS_SCP): ELF      $@'
    $(hide)$(CC) $(PRIVATE_LDFLAGS) $(PRIVATE_OBJS) -Wl,-Map=$(PRIVATE_MAP_FILE) -o
    @echo '$(TINYSYS_SCP): Memory Check'
    $(hide)PLATFORM=$(PLATFORM) $(MCHECK) SCP $(SETTING) $(PRIVATE_MAP_FILE)
```

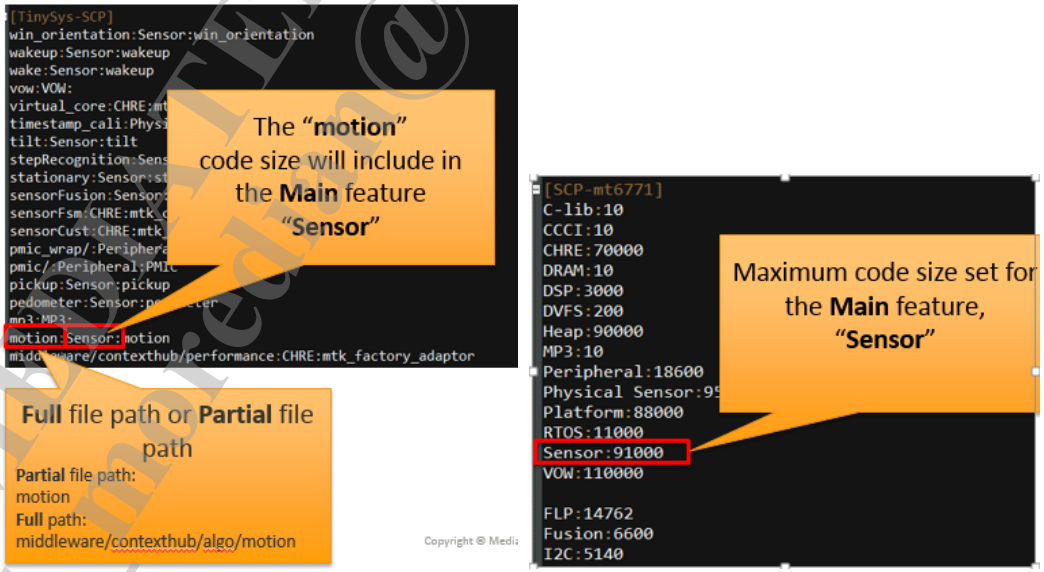
3. Configuration file at following path :

   vendor/mediatek/proprietary/tinysys/freertos/source/project/CM4_A/**$PLATFORM**/platform/**Setting.ini**

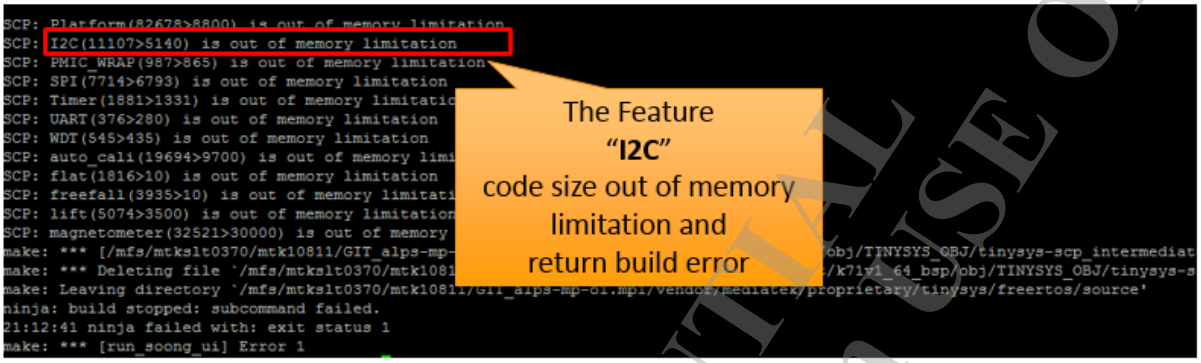
4. **Setting.ini format**



Example :



If code size exceeds limit, there will be build error warning as following :



4 CHRE sensors introduction

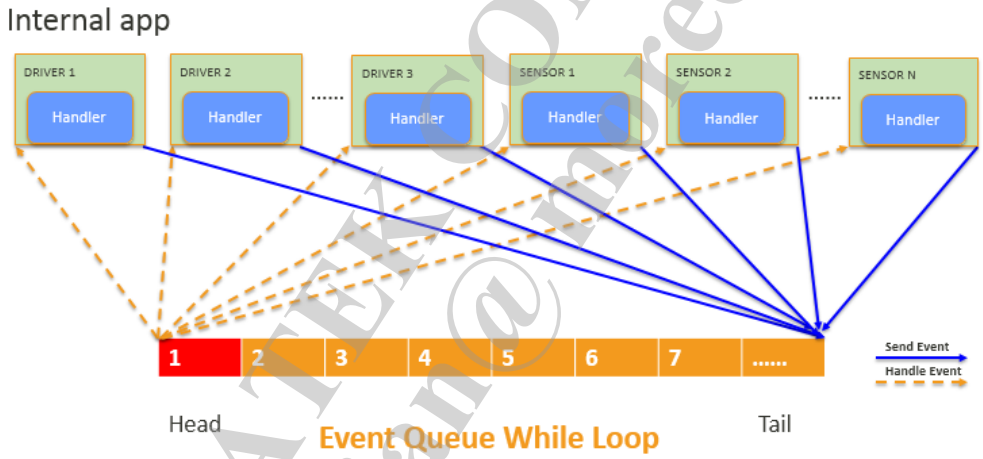
4.1 CHRE Introduction

Under SCP，MTK sensor hub feature is developed on Google CHRE architecture.
CHRE (Context Hub Runtime Environment) is an event-driven architecture，and can also be treated as an OS。

The yellow part is the Event Queue. CHRE only has a while loop to handle the head event in the event queue. One task in the queue cannot be invoked by the CHRE if a previous invocation hasn't completed. So there's no concept of priority and the current event queue processing can only be interrupted by interrupts. CHRE supports maximum 512 events in Event Queue in default.
The purpose of CHRE is to be real-time and lightweight, so all tasks invoked in Event Queue must run quickly.

The driver implementation in CHRE is called nano hub app. The following section will explain how to implement a nano hub app in detail.

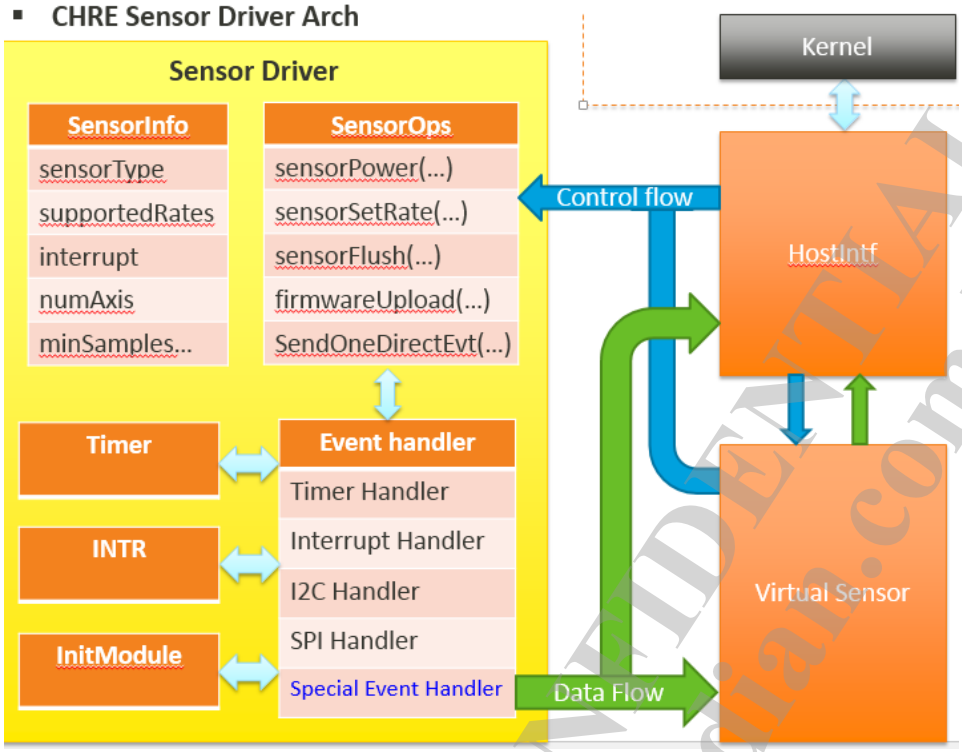
CHRE message mechanism is briefly shown in the figure.



4.2 MTK CHRE Sensors Common Layer

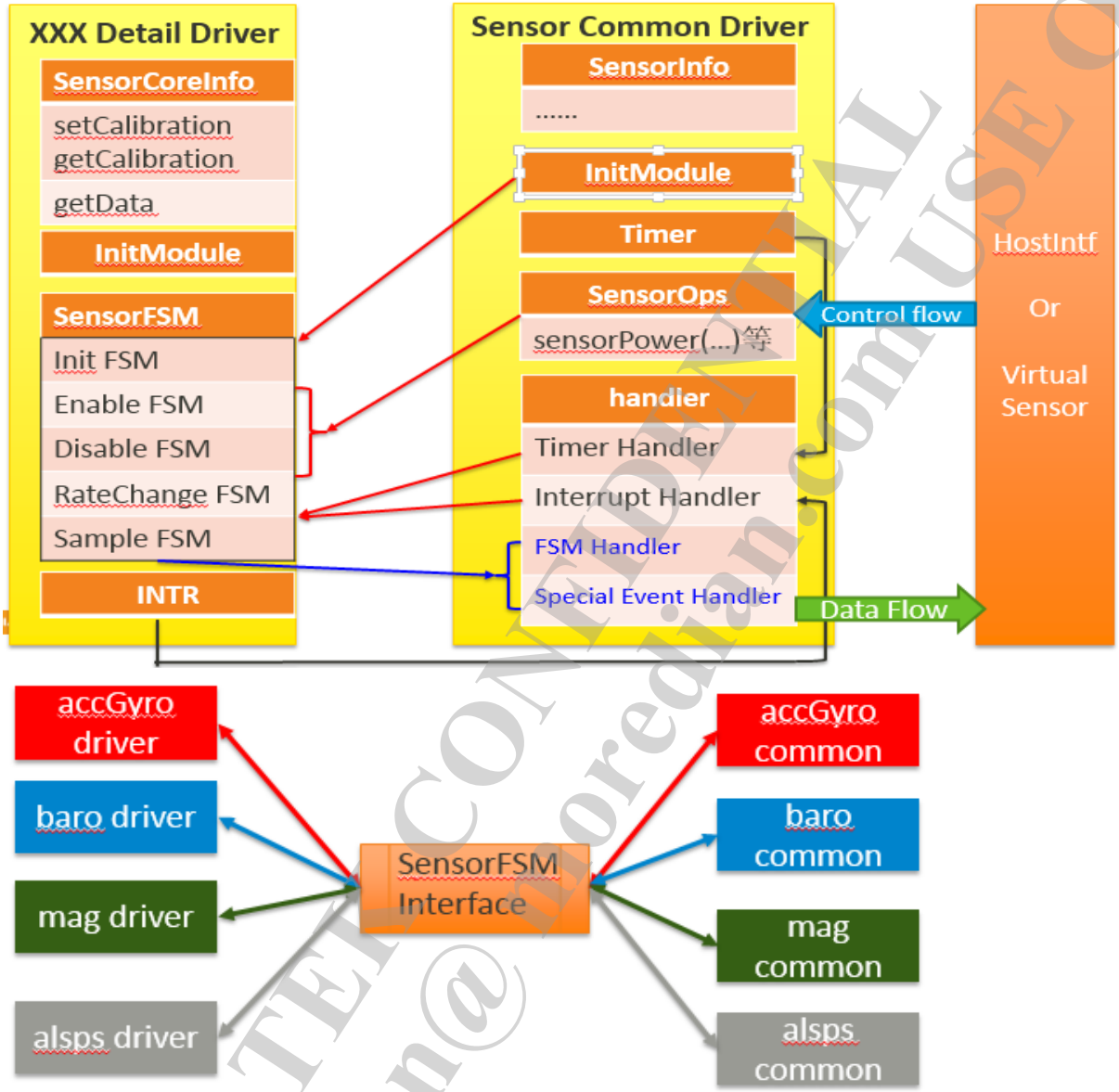
Because of the event-driven mechanism in CHRE, it is quite complex to implement an app. The native CHRE app architecture is as following:

- CHRE Sensor Driver Arch



App needs to implements hostintf (hostintf provide functions which are similar to SensorManager, SensorService and HAL layer interface as well in AP side) to perform control/data flow as shown in the figure. Programmers are required to be familiar with hostintf internal flow.

To avoid too much effort to do porting and bug hunting, MTK separates physical sensor logical part as a single layer called sensorFSM. Hardware related part is in other files and evoked by sensorFSM. The architecture is as following:



After seperating common layer , what customers need to implement are:

- Init flow (load customization, auto detect…)
- Implement finite sensor FSM
- Implement sensorCoreInfo

4.3 How to implement a CHRE APP

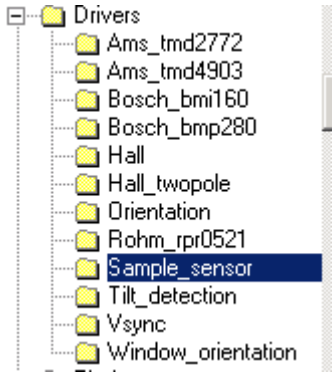
MTK virtual sensor is implemented following CHRE APP standardization. Customers could implement their own virtual sensors or other sensor related APP. The following part introduces an example to show how to implement a CHRE APP.

This example implements a custom sensor typle flat. This sensor type is used to check whether the phone is horizontal placement.

4.3.1 Copy a demo driver to implement CHRE APP architecture

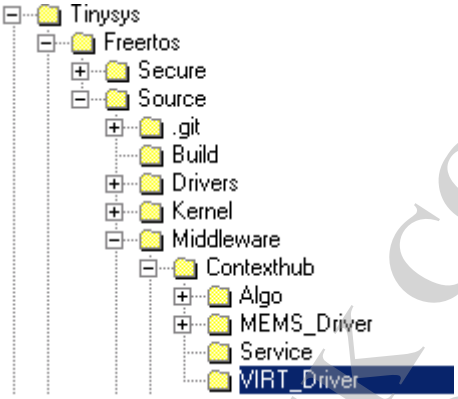
路径：

vendor\mediatek\proprietary\hardware\contexthub\firmware\src\drivers\sample_sensor\sample_sensor.cpp



Copy to the following path：

vendor\mediatek\proprietary\tinysis\freertos\souce\middleware\virt_driver\



4.3.2 Add compile options

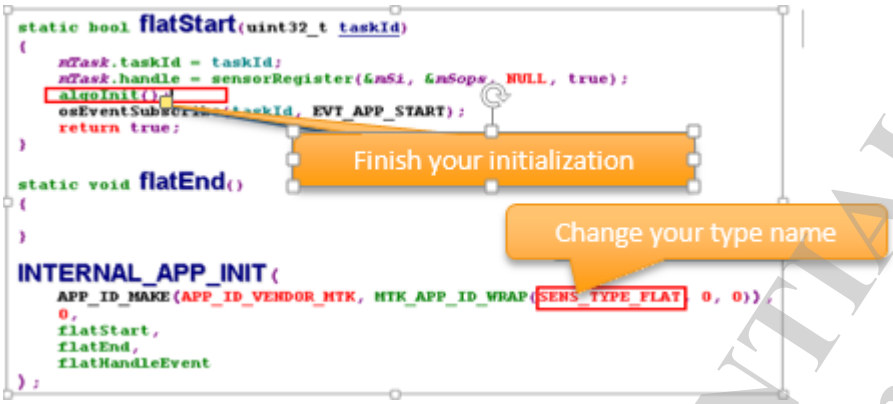
project/CM4_a/mt6771/platform/feature_config/chre.mk

```
######### flat #########
ifeq ($(CFG_FLAT_SUPPORT),yes)
INCLUDES += -I$(SOURCE_DIR)/middleware/contexthub/algo/common
C_FILES  += $(SOURCE_DIR)/middleware/contexthub/VIRT_Driver/flat.c
C_FILES  += $(SOURCE_DIR)/middleware/contexthub/VIRT_Driver/algoDataResample.c
LIBFLAGS += -L$(SOURCE_DIR)/middleware/contexthub/algo/common -lmath
endif
```

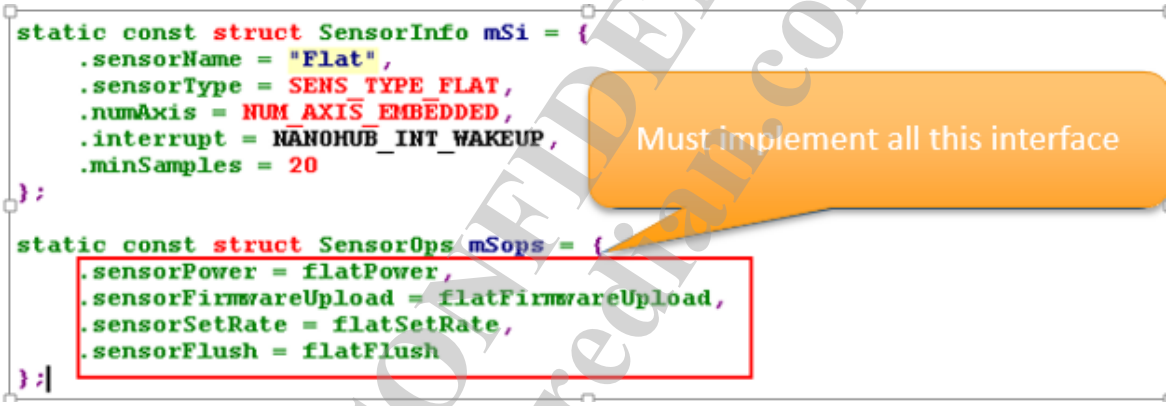
4.3.3 APP modification tips

Do the following modification:

1. Initialization, start the CHRE APP.



2. Implement a global structure in APP and register a sensor type

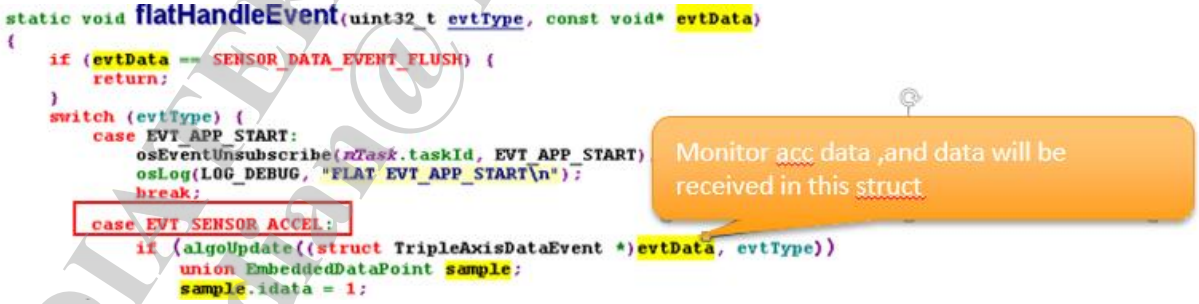


3. Subscribe events

   Flat needs to subscribe ACC raw date to implement its own algorithm.

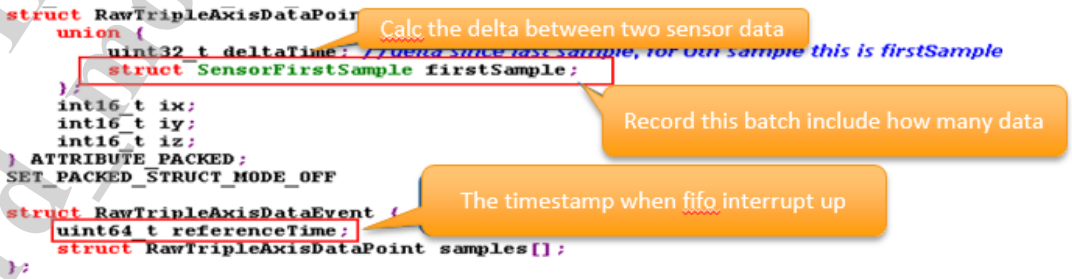
```
osEventSubscribe(mTask.taskId, EVT_SENSOR_ACCEL);
```

4. Handle subscribed events



5. CHRE sensor data structure introduction ：

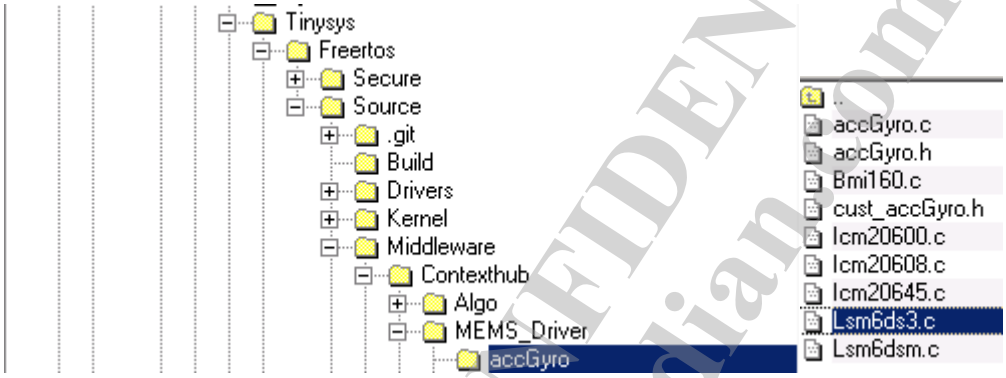
   Path ：vendor\mediatek\proprietary\hardware\contexthub\firmware\inc\sensors.h



4.4 A+G driver porting guide

4.4.1 A+G initialization

Here a ST driver is employed as an example:
Copy an implemented driver to do modification. Please copy from the same series to save effort to do modification.

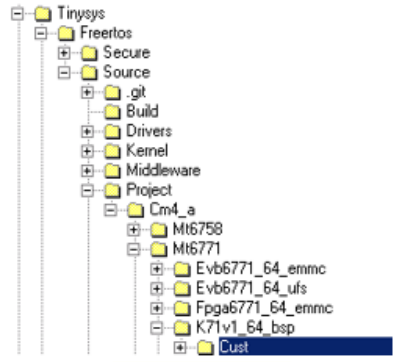



```
int lsm6ds3Init(void)
{
    int ret = 0;
    enum SensorIndex i;

    insertMagicNum(&mTask.accGyroPacket);
    mTask.hw = get_cust_accGyro("lsm6ds3");

    if (NULL == mTask.hw) {
        osLog(LOG_ERROR, "get_cust_acc_hw fail\n");
        return 0;
    }

    osLog(LOG_INFO, "acc spi_num: %d\n", mTask.hw->i2c_num);

    if (0 != (ret = sensorDriverGetConvert(mTask.hw->direction, &mTask.cvt))) {
        osLog(LOG_ERROR, "invalid direction: %d\n", mTask.hw->direction);
    }
    osLog(LOG_ERROR, "acc map[0]:%d, map[1]:%d, map[2]:%d, sign[0]:%d, sign[1]:%d, sign[2]:%d\n\r",
        mTask.cvt.map[AXIS_X], mTask.cvt.map[AXIS_Y], mTask.cvt.map[AXIS_Z],
        mTask.cvt.sign[AXIS_X], mTask.cvt.sign[AXIS_Y], mTask.cvt.sign[AXIS_Z]);

    mTask.sensors[ACC].sensitivity = 65536 / (8 * 2);
    mTask.sensors[GYR].sensitivity = 1000 / 70;
```

Get customize info

Change sensitivity

Custom info location:




```
#include "cust_accGyro.h"

struct accGyro_hw cust_accGyro_hw[] __attribute__((section(".cust_accGyro"))) = {
#ifdef CFG_LSM6DSM_SUPPORT
        {
            .name = "lsm6dsm",
            .i2c_num = 0,
            .direction = 7,
            .i2c_addr = {0, 0},
            .eint_num = 10,
        },
#endif
};
```

Configure customize info here

If use SPI，we still need to add SPI bus info to i2c_num section, we reuse this item

1. SensorFSM array

Definition： head-tail event

Head event，such as STAT_ENABLE，STAT_SAMPLE

Tail event，the last event to execute after finishing a specific action，such as ENABLE_DONE，DISABLE_DONE，RATECHG_DONE, SAMPLE_DONE and so on. These events usually come along with interaction with top layer.

Events betewen head and tail, it defined by demand according to specific hw spec. Ususally, one i2c/SPI transfer is corresponded to one state.

To implement a new driver，customer just need to finish the FMS array

This is a typical example:

```
static struct sensorFsm lsm6dsmFsm[] = {
    sensorFsmCmd(STATE_SW_RESET, STATE_INIT_REG, lsm6dsmSwReset),
    sensorFsmCmd(STATE_INIT_REG, STATE_SENSOR_REGISTRATION, lsm6dsmInitReg),
    sensorFsmCmd(STATE_SENSOR_REGISTRATION, STATE_EINT_REGISTRATION, lsm6dsmSensorRegistration),
    sensorFsmCmd(STATE_EINT_REGISTRATION, STATE_INIT_DONE, lsm6dsmEintRegistration),

    sensorFsmCmd(STATE_ACC_ENABLE, STATE_ACC_ENABLE_DONE, lsm6dsmAccPowerOn),
    sensorFsmCmd(STATE_ACC_DISABLE, STATE_ACC_DISABLE_DONE, lsm6dsmAccPowerOff),

    sensorFsmCmd(STATE_ACC_RATECHG, STATE_ACC_RATECHG_DONE, lsm6dsmAccRate),

    sensorFsmCmd(STATE_GYRO_ENABLE, STATE_GYRO_ENABLE_DONE, lsm6dsmGyroPowerOn),
    sensorFsmCmd(STATE_GYRO_DISABLE, STATE_GYRO_DISABLE_DONE, lsm6dsmGyroPowerOff),

    sensorFsmCmd(STATE_GYRO_RATECHG, STATE_GYRO_RATECHG, lsm6dsmGyroRate),

    sensorFsmCmd(STATE_HW_INT_STATUS_CHECK, STATE_HW_INT_HANDLING, lsm6dsmIntStatusCheck),
    sensorFsmCmd(STATE_HW_INT_HANDLING, STATE_HW_INT_HANDLING_DONE, lsm6dsmIntHandling),

    sensorFsmCmd(STATE_SAMPLE, STATE_FIFO, lsm6dsmSample),
    sensorFsmCmd(STATE_FIFO, STATE_CONVERT, lsm6dsmReadFifo),
    sensorFsmCmd(STATE_CONVERT, STATE_SAMPLE_DONE, lsm6dsmConvert),

    /* For Anymotion */
    sensorFsmCmd(STATE_ANYMO_ENABLE, STATE_ANYMO_ENABLE_DONE, anyMotionPowerOn),
    sensorFsmCmd(STATE_ANYMO_DISABLE, STATE_ANYMO_DISABLE_DONE, anyMotionPowerOff),
};
```

initialization

Enable disable

Rate change

Handle interrupt

Sample data

```
enum LSM6DSMState {
    STATE_SAMPLE = CHIP_SAMPLING,
    STATE_FIFO = CHIP_FIFO,
    STATE_CONVERT = CHIP_CONVERT,
    STATE_SAMPLE_DONE = CHIP_SAMPLING_DONE,
    STATE_ACC_ENABLE = CHIP_ACC_ENABLE,
    STATE_ACC_ENABLE_DONE = CHIP_ACC_ENABLE_DONE,
    STATE_ACC_DISABLE = CHIP_ACC_DISABLE,
    STATE_ACC_DISABLE_DONE = CHIP_ACC_DISABLE_DONE,
    STATE_ACC_RATECHG = CHIP_ACC_RATECHG,
    STATE_ACC_RATECHG_DONE = CHIP_ACC_RATECHG_DONE,
    STATE_GYRO_ENABLE = CHIP_GYRO_ENABLE,
    STATE_GYRO_ENABLE_DONE = CHIP_GYRO_ENABLE_DONE,
    STATE_GYRO_DISABLE = CHIP_GYRO_DISABLE,
    STATE_GYRO_DISABLE_DONE = CHIP_GYRO_DISABLE_DONE,
    STATE_GYRO_RATECHG = CHIP_GYRO_RATECHG,
    STATE_GYRO_RATECHG_DONE = CHIP_GYRO_RATECHG_DONE,

    STATE_ANYMO_ENABLE = CHIP_ANYMO_ENABLE,
    STATE_ANYMO_ENABLE_DONE = CHIP_ANYMO_ENABLE_DONE,
    STATE_ANYMO_DISABLE = CHIP_ANYMO_DISABLE,
    STATE_ANYMO_DISABLE_DONE = CHIP_ANYMO_DISABLE_DONE,

    STATE_HW_INT_STATUS_CHECK = CHIP_HW_INT_STATUS_CHECK,
    STATE_HW_INT_HANDLING = CHIP_HW_INT_HANDLING,
    STATE_HW_INT_HANDLING_DONE = CHIP_HW_INT_HANDLING_DONE,

    STATE_INIT_DONE = CHIP_INIT_DONE,
    STATE_IDLE = CHIP_IDLE,
    STATE_SW_RESET = CHIP_RESET,
    STATE_INIT_REG,
    STATE_SENSOR_REGISTRATION,
    STATE_EINT_REGISTRATION,
};
```

Note: In the driver, head-tail MUST be defined first.

Head-tail events are already defined in the common header file which can be used directly. But these must be put in front.

Your own definitions at the end

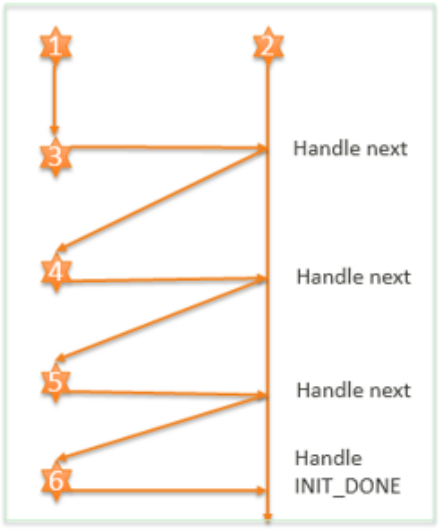
The following is the introduction of an init flow.

FSM Mechanism introduction :

Then **accGyro** app receive event and handle it

```
static void handleEvent(uint32_t evtType, const void* evtData)
{
    struct transferDataInfo dataInfo;
    const struct sensorFsm *cmd;

    switch (evtType) {
        case EVT_APP_START: {
            if (mTask.fsm.mSensorFsm != NULL) {
                osLog(LOG_INFO, "accGyro: app start\n");
                /* Reset chip */
                dataInfo.inBuf = NULL;
                dataInfo.inSize = 0;
                dataInfo.elemInSize = 0;
                dataInfo.outBuf = NULL;
                dataInfo.outSize = NULL;
                dataInfo.elemOutSize = NULL;
                sensorFsmRunState(&dataInfo, &mTask.fsm, (const void *)CHIP_RESET,
            } else
                osLog(LOG_INFO, "accGyro: wait for auto detect\n");
            break;
        }
        case EVT_SENSOR_EVENT: {
            handleSensorEvent(evtData);
            break;
        }
```

```
sensorFsmCmd(STATE_SW_RESET, STATE_INIT_REG, lsm6dsmSwReset),
sensorFsmCmd(STATE_INIT_REG, STATE_SENSOR_REGISTRATION, lsm6dsmInitReg),
sensorFsmCmd(STATE_SENSOR_REGISTRATION, STATE_EINT_REGISTRATION, lsm6dsmSensorRegistration),
sensorFsmCmd(STATE_EINT_REGISTRATION, STATE_INIT_DONE, lsm6dsmEintRegistration),
```



4.4.2 Enable/Disable

```
sensorFsmCmd(STATE_ACC_ENABLE, STATE_ACC_ENABLE_DONE, lsm6dsmAccPowerOn),
sensorFsmCmd(STATE_ACC_DISABLE, STATE_ACC_DISABLE_DONE, lsm6dsmAccPowerOff),
```

```
sensorFsmCmd(STATE_GYRO_ENABLE, STATE_GYRO_ENABLE_DONE, lsm6dsmGyroPowerOn),
sensorFsmCmd(STATE_GYRO_DISABLE, STATE_GYRO_DISABLE_DONE, lsm6dsmGyroPowerOff),
```

Note: if there's FIFO open/close operation, the following function should be called immediately after FIFO opened. This function will calibrate FIFO data timestamps.

```
registerAccGyroFifoInfo((mTask.sensors[ACC].hwRate == 0) ? 0 : 1024000000000 / mTask.sensors[ACC].hwRate,
    (mTask.sensors[GYR].hwRate == 0) ? 0 : 1024000000000 / mTask.sensors[GYR].hwRate);
```

Implement the function according to the vendor's data sheet.

4.4.3 Report rate

In A+G two in one driver, rate setting needs to pay attention. If both Acc and Gyro are enabled, the rates should be kept in consistent. The reason could be referred to FIFO setting section.

```
static int lsm6dsmAccRate(I2cCallbackF i2cCallBack, SpiCbkF spiCallBack, void *next_state,
                          void *inBuf, uint8_t inSize, uint8_t elemInSize,
                          void *outBuf, uint8_t *outSize, uint8_t *elemOutSize)
{
    odr = lsm6dsmCalcuOdr(&mTask.sensors[ACC].rate, &sampleRate);

    if (odr < 0) {
        sensorFsmEnqueueFakeSpiEvt(spiCallBack, next_state, ERROR_EVT);
        osLog(LOG_ERROR, "lsm6dsmAccRate, calcu odr error\n");
        return -1;
    }

    if (odr < 2)
        sampleRate = SENSOR_HZ(26.0f / 2.0f);
    mTask.sensors[ACC].preRealRate = sampleRate;
```

Convert the input rate to a closest hardware-supported report rate.

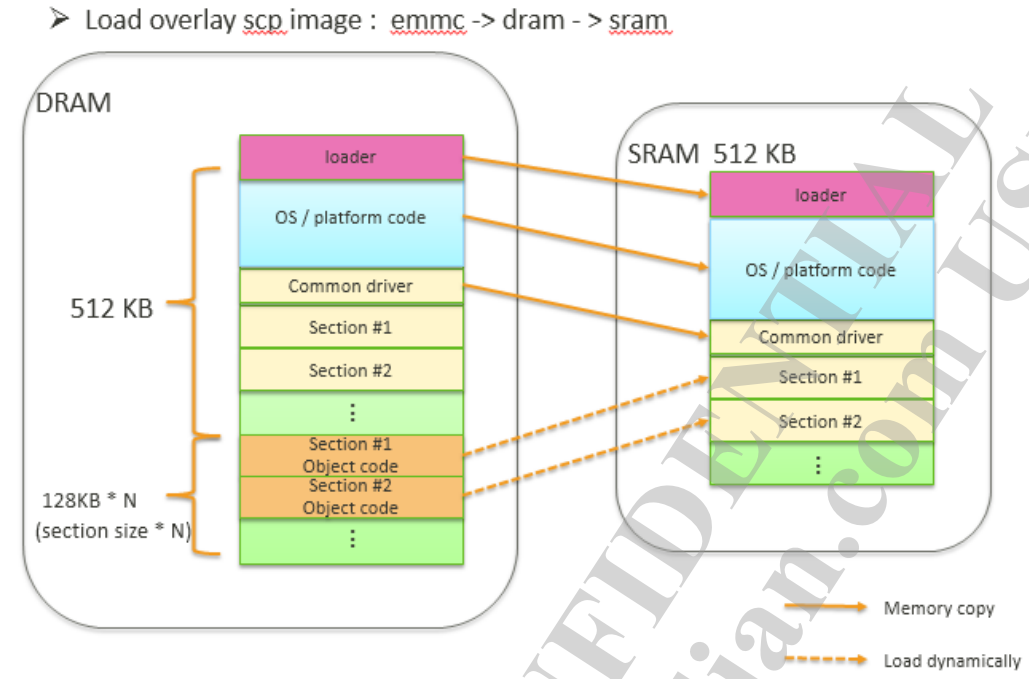
Record the report rate temporarily and the final rate still needs to be calculated. Ex. is the acc is already enabled? ????? acc or gyro?

```
if (mTask.sensors[GYR].configed) {
    maxRate = max(sampleRate, mTask.sensors[GYR].preRealRate);  //choose with preRealRate
    if ((maxRate != mTask.sensors[ACC].hwRate) || (maxRate != mTask.sensors[GYR].hwRate)) {
        mTask.sensors[ACC].hwRate = maxRate;
        mTask.sensors[GYR].hwRate = maxRate;

        odr = lsm6dsmCalcuOdr(&maxRate, &sampleRate);
        if (odr < 0) {
            sensorFsmEnqueueFakeSpiEvt(spiCallBack, next_state, ERROR_EVT);
            osLog(LOG_ERROR, "lsm6dsmAccRate, calcu odr error\n");
            return -1;
        }

        regValue = LSM6DSMImuRatesRegValue[odr];

        //delay = LSM6DSMGyroRatesSamplesToDiscard[odr] * (1024000000 / maxRate);
        mTask.sensors[ACC].samplesToDiscard = LSM6DSMAccelRatesSamplesToDiscard[odr];
        mTask.sensors[GYR].samplesToDiscard = LSM6DSMGyroRatesSamplesToDiscard[odr];

        SPI_WRITE(LSM6DSM_CTRL1_XL_ADDR, LSM6DSM_CTRL1_XL_BASE | regValue, 30);
        SPI_WRITE(LSM6DSM_CTRL2_G_ADDR, LSM6DSM_CTRL2_G_BASE | regValue, 30);
        accelOdrChanged = true;
    } ? end if (maxRate! =mTask.senso... ?  else {
        accelOdrChanged = false;
    }
} ? end if mTask.sensors[GYR].co... ?  else {
    if ((sampleRate != mTask.sensors[ACC].hwRate)) {
        mTask.sensors[ACC].hwRate = sampleRate;
        regValue = LSM6DSMImuRatesRegValue[odr];

        //delay = LSM6DSMAccelRatesSamplesToDiscard[odr] * (1024000000 / maxRate);
        mTask.sensors[ACC].samplesToDiscard = LSM6DSMAccelRatesSamplesToDiscard[odr];

        SPI_WRITE(LSM6DSM_CTRL1_XL_ADDR, LSM6DSM_CTRL1_XL_BASE | regValue, 30);
        accelOdrChanged = true;
    } else {
        accelOdrChanged = false;
    }
}
```

HW ODR needs to be reset if ACC retae is not equal to the current one.

4.5 Sensor driver overlay

Purpose: customers need two materials. One type sensor may come from two different vendor. If putting these two drivers in SCP SRAM to do auto detect, it consumes SRAM. So MTK solution locates two drivers in the DRAM and one driver is loaded when SCP boots.

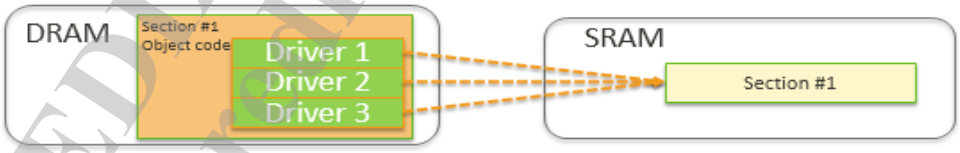


Overlay load flow

1) Memory copy loader code from dram to SRAM, then SCP run loader

2) SCP loader copy Tinysys common code from dram to SRAM, os run and sensor driver init

3) OverlayRemap copy sensor driver 1 to sram section and hw verify , if fail ,copy driver 2 and verify , if success , remap next sensor type



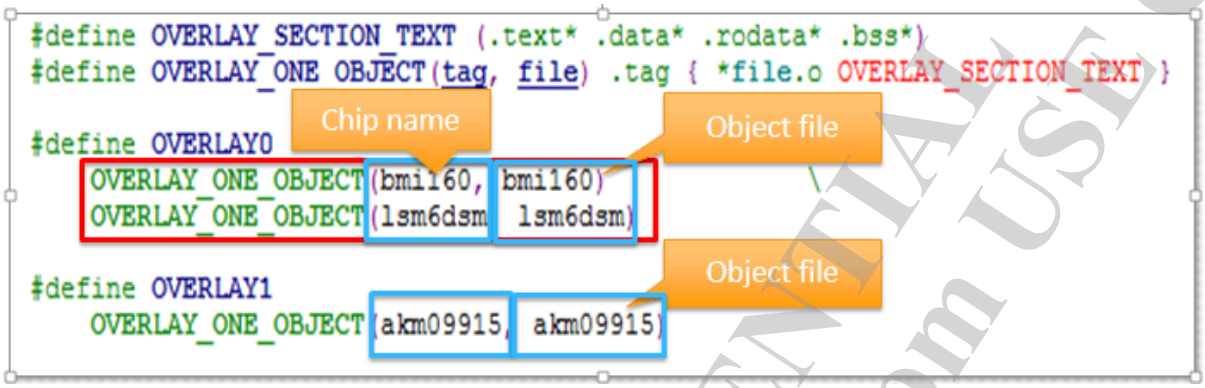
One section represent one sensor type ,may have multiple drivers (object code)

4.5.1 How to add overlay driver

1) ADD object in linker script

vendor\mediatek\proprietary\tinysys\freertos\source\project\CM4_A\#PLATFORM\$PROJECT\inc\overlay_sensor.h

For A+G sensor type , may have bmi160 chip and lsm6dsm chip, add driver object file in overlay scp image, and for mag sensor type ,may have akm09915 chip.

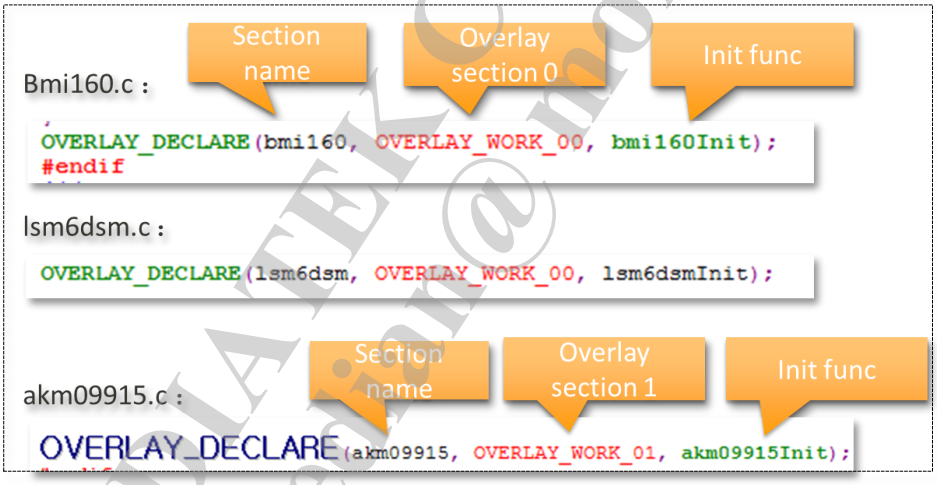



```
#define OVERLAY_SECTION_TEXT (.text* .data* .rodata* .bss*)
#define OVERLAY_ONE_OBJECT(tag, file) .tag { *file.o OVERLAY_SECTION_TEXT }

#define OVERLAY0
    OVERLAY_ONE_OBJECT(bmi160, bmi160)
    OVERLAY_ONE_OBJECT(lsm6dsm  lsm6dsm)

#define OVERLAY1
    OVERLAY_ONE_OBJECT(akm09915, akm09915)
```

For mag sensor type , there are several library file

```
#define OVERLAY_FIVE_OBJECT(tag, file1, file2, file3, file4, file5) \
    .tag { *file1.o OVERLAY_SECTION_TEXT } \
    .tag { *file2.o OVERLAY_SECTION_TEXT } \
    .tag { *file3.o OVERLAY_SECTION_TEXT } \
    .tag { *file4.o OVERLAY_SECTION_TEXT } \
    .tag { *file5.o OVERLAY_SECTION_TEXT }

#define OVERLAY1
    OVERLAY_FIVE_OBJECT(akm09915, akm09915, AkmApi, ParameterIO, Measure, Libakm09912)
```

2) ADD overlay declare in your overlay object (This is added in the specific driver)



3) In the driver, synchronized spi or i2c API is used in senor init flow.

vendor\mediatek\proprietary\tinysys\freertos\source\middleware\contexthub\MEMS_Driver\

```
static int bmi160Init(void)
{
    // read the device ID for bmi160
    txData[0] = BMI160_REG_ID | 0x80;
    ret = spiMasterRxTxSync(T(spiDev), rxData, txData, 2);

    if (ret < 0 || (rxData[1] != BMI160_ID)) {
        ERROR_PRINT("failed id match: %02x, ret: %d\n", rxData[1], ret);
        spiMasterRelease(T(spiDev));
        goto err_out;
    }
    osLog(LOG_ERROR, "success id match: %02x\n", rxData[1]);
    SET_STATE(SENSOR_INITIALIZING);
    mTask.init_state = RESET_BMI160;
    registerAccGyroInterruptMode(ACC_GYRO_FIFO_INTERRUPTIBLE);
    registerAccGyroDriverFsm(bmi160Fsm, ARRAY_SIZE(bmi160Fsm));
err_out:
    return ret;
}
```

使用同步 API

4) ADD overlay remap for load and init in overlay.c

vendor\mediatek\proprietary\tinysys\freertos\source\project\CM4_A\$PLATFORM\$PROJECT\cust\overlay\

```
void accGyroOverlayRemap(void)
{
ACC_GYRO_OVERLAY_REMAP_START
    ACC_GYRO_OVERLAY_REMAP(bmi160);
    ACC_GYRO_OVERLAY_REMAP(lsm6dsm);
ACC_GYRO_OVERLAY_REMAP_END

    return;
}
```

Load to sram and init, if success , goto return directly

```
void magOverlayRemap(void)
{
MAG_OVERLAY_REMAP_START
    MAG_OVERLAY_REMAP(akm09915);
MAG_OVERLAY_REMAP_END

    return;
}
```

Section name

5) Enable overlay feature

vendor\mediatek\proprietary\tinysys\freertos\source\project\CM4_A\$PLATFORM\$PROJECT\Projectconfig.mk

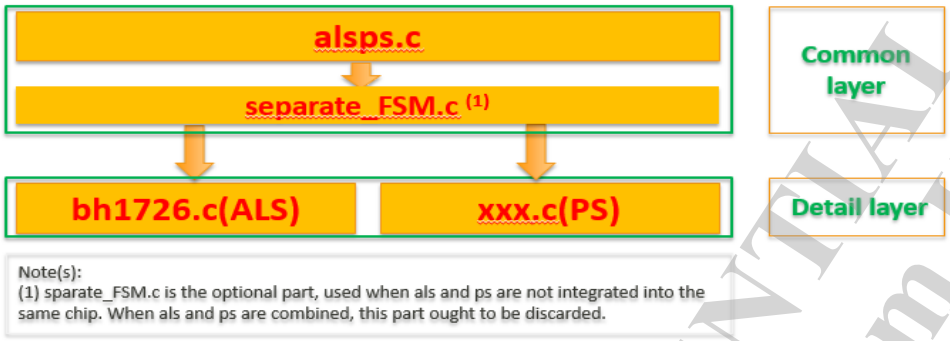
```
CFG_OVERLAY_INIT_SUPPORT = yes
CFG_OVERLAY_DEBUG_SUPPORT = yes
```

4.6 ALS and PS driver porting guide

Driver ARCH

In order to reduce the cost of porting and maintenance of software to customers, MTK design a sensorHub that splits each sensor's driver into two layers by logically: common layer & detail layer. Among them, the common layer is independ on the sensor vendor, and there is almost no change in

driver porting. And the detail layer is the focus of porting issue, which is operating the sensor register directly. The architecture is shown in following Figure

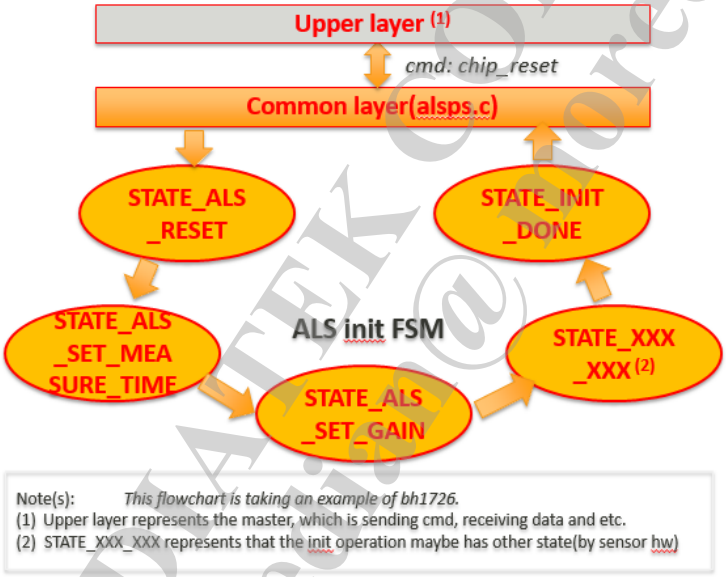


4.6.1 ALS porting guide

Sensor FSM (Finite State Machine)

For further customer maintenance costs, MTK splits each operation of the sensor into different states, and the different states constitute sensorFSM. The main job of Driver Porting is to implement the corresponding operations of each state. And the FSM also is the core of sensor work.

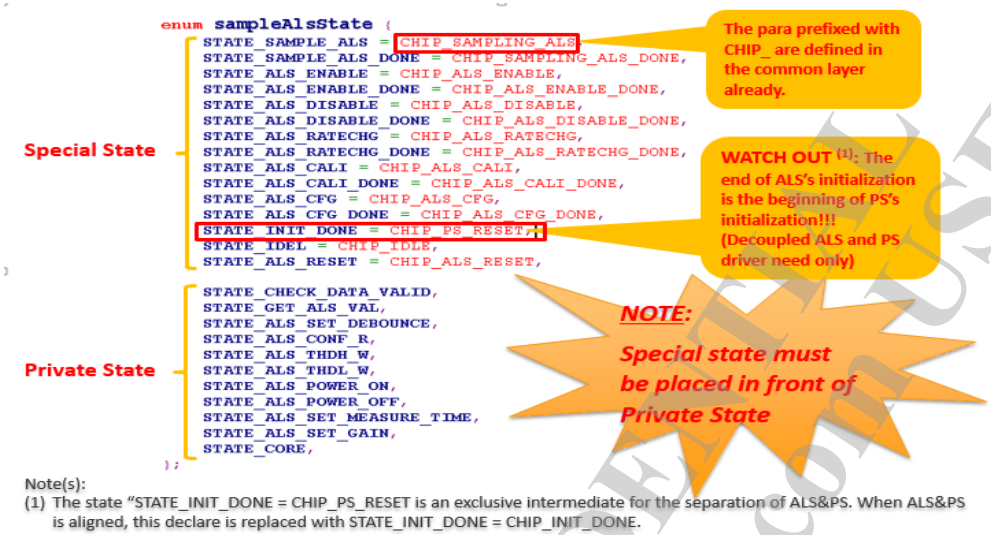
The ALS's initialization FSM is shown as following figure



In the figure, We are splitting ALS's initialization FSM into 5 states, which is representing 5 CHRE event. And later you will know that the splitting principle of these states is based on I2C transmission

Detail steps :

1. **Taking the existing sensorfsm as the demo code, defining enum struct to declare sensor work states, which is containing two part: head & tail state and middle state. As shown figure below**

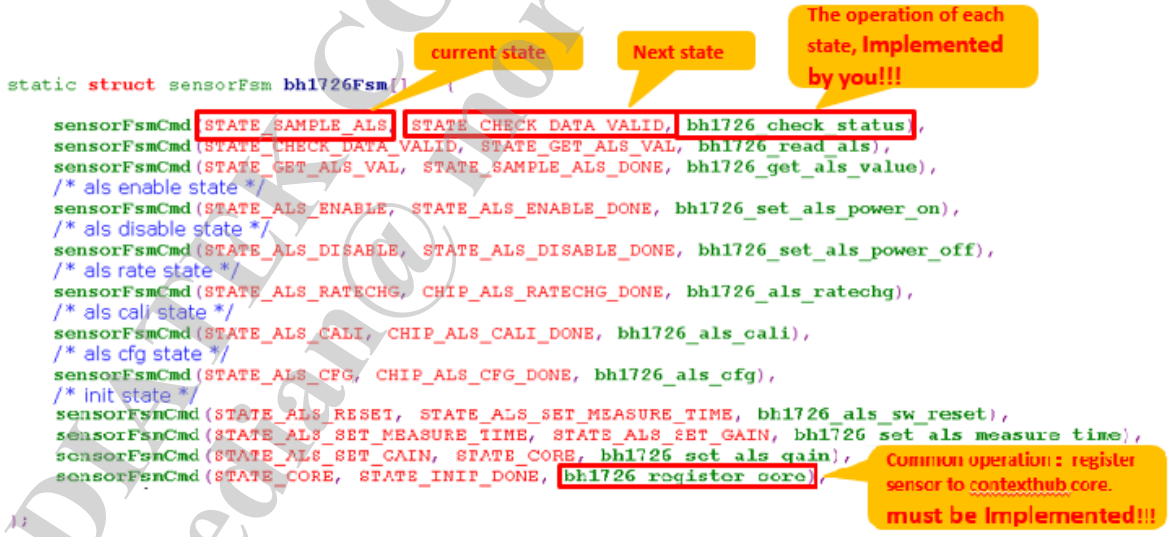


Note(s):
(1) The state "STATE_INIT_DONE = CHIP_PS_RESET is an exclusive intermediate for the separation of ALS&PS. When ALS&PS is aligned, this declare is replaced with STATE_INIT_DONE = CHIP_INIT_DONE.

2. Instantiate each FSM

As mentioned earlier, MTK splits each operation of the Sensor into one FSM, and different FSMs make up the SensorFSM. Usually, SensorFSM includes Initialization FSM, Enable FSM、Disable FSM、Sample FSM、 Rate change FSM &Calibration FSM etc.

And the SensorFSM of ALS (bh1726) is shown as Figure 4 below. And the FSM's work flow is the same way as other sensors



The end state of init FSM is STATE_CORE, must be implemented at each sensor. The main task of this operation is to register the sensor to the core and provide the operation interface in the factory mode, such as sensor Calibration, get data etc.

ALS's (bh1726) "rgister_core" as below

```
static int bh1726_register_core(I2cCallbackF i2cCallBack, SpiCbkF spiCallBack, void *next
                                void *inBuf, uint8_t inSize, uint8_t elemInSize,
                                void *outBuf, uint8_t *outSize, uint8_t *elemOutSize)
{
    struct sensorCoreInfo mInfo;
    memset(&mInfo, 0x00, sizeof(struct sensorCoreInfo));
    /* Register sensor Core */
    mInfo.sensType = SENS_TYPE_ALS;
    mInfo.getData = alsGetData;
    mInfo.getSensorInfo = alsGetSensorInfo;
    sensorCoreRegister(&mInfo);

    sensorFsmEnqueueFakeI2cEvt(i2cCallBack, next_state, SUCCESS_EVT);
    return 0;
}
```

At sample state

The FSM's task is sending the data to upper layer, which is the basis for getting data from chip.

```
static int bh1726_get_als_value(I2cCallbackF i2cCallBack, SpiCbkF spiCallBack, void *next :
                                void *inBuf, uint8_t inSize, uint8_t elemInSize,
                                void *outBuf, uint8_t *outSize, uint8_t *elemOutSize)
{
    mTask.rawData[DATA0] = ((mTask.rxBuf[1] << 8) | mTask.rxBuf[0]);
    mTask.rawData[DATA1] = ((mTask.rxBuf[3] << 8) | mTask.rxBuf[2]);
    osLog(LOG_INFO, "RawData0=0x%x, RawData1=0x%x\n", mTask.rawData[DATA0], mTask.rawData[DATA1]
    mTask.data.als_data = (int)getLuxFromData(); //aal mapping value
    mTask.data.sensType = SENS_TYPE_ALS;
    osLog(LOG_INFO, "mTask.data.als_data = %d\n", mTask.data.als_data);
    txTransferDataInfo(&mTask.dataInfo, 1, &mTask.data);
    sensorFsmEnqueueFakeI2cEvt(i2cCallBack, next_state, SUCCESS_EVT);
    return 0;
}
```

The interface of transfer data to the common layer. **Must be implemented!!!**

Rate change

In general, the rate of ALS's data reporting mode is on-changed, and the data report rate does not need to be changed. The default setting is 5Hz or 10Hz unless the customer has special requirements.

The ALS is set to the timer polling mode, and the rate of data reporting is determined by the timer. And need to cater to the measurement time of the HW. Therefore, it is necessary to set timer period and HW sampling time accordingly. The setting detail as follows:

(1) Support rate setting (alsps.c):

```
static const uint32_t alsSupportedRates[] = {
    SENSOR_HZ(10),
    SENSOR_RATE_ONCHANGE,
    0
};
static const uint64_t rateTimerValsAls[] = {
//should match "supported rates in length" and be the
    1000000000ULL / 10,
    1000000000ULL / 10,
};
```

(2) HW measure time setting (bh1726.c): (by chip)

```
static int bh1726_set_als_measure_time(I2cCallbackF i2cCallBack, SpiCbkF spiCallBack,
                                       void *inBuf, uint8_t inSize, uint8_t elemInSize,
                                       void *outBuf, uint8_t *outSize, uint8_t *elemOutSize)
{
    mTask.txBuf[0] = BH1726_REG_TIMING;
    mTask.txBuf[1] = 0xE3;
    return i2cMasterTx(mTask.hw->i2c_num, mTask.i2c_addr, mTask.txBuf, 2,
                       i2cCallBack, next_state);
}
```

Calibration FSM

ALS's data calibration is the interface reserved for the factory mode, and the specific implementation is added according to customer needs.

Bh1726's data cali is empty operation as follows:

```
static int bh1726_als_cali(I2cCallbackF i2cCallBack, SpiCbkF spiCallBack, void *next_state,
                           void *inBuf, uint8_t inSize, uint8_t elemInSize,
                           void *outBuf, uint8_t *outSize, uint8_t *elemOutSize)
{
/*temp set the cali value = 0, if enable the feature, please rewrite here*/
    int32_t alsCali[2] = {0, 0};
    alsPsSendCalibrationResult(SENS_TYPE_ALS, alsCali);
    sensorFsmEnqueueFakeI2cEvt(i2cCallBack, next_state, SUCCESS_EVT);
    return 0;
}
```

3. ALS module Init:

Get HW info:

Getting the hw information by the API get_cust_alsps("xxx"), the demo is as follows,

```
mTask.hw = get_cust_alsps("bh1726");
if (NULL == mTask.hw) {
    osLog(LOG_ERROR, "get_cust_acc_hw fail\n");
    return 0;
}
```

The information of ALS's hw is setting in the file of "cust_alsps.c". The specific settings will be explained in the settings section of the next section.

Register the sensor info & FSM:

Register the ALS sensor info to CHRE via the API alsSensorRegister().

Register the ALS's SensorFSM into CHRE via the API registerAlsSeparateFSM() when the ALS&PS are decoupled. And register the ALS&PS's(ALS&PS coupled) SensorFSM via the API registerAlsPsDriverFSM() when the ALS&PS coupled.

The demo code is as follows:

(1) ALS&PS decoupled (ALS part):

```
osLog(LOG_INFO, "bh1726: auto detect success:0x%x\n", mTask.deviceId);
alsSensorRegister();
registerAlsSeparateFsm(bh1726Fsm, ARRAY_SIZE(bh1726Fsm));
```

(2) ALS&PS coupled:

```
success_out:
    alsSensorRegister();
    psSensorRegister();
    registerAlsPsDriverFsm(cm36558Fsm, ARRAY_SIZE(cm36558Fsm));
```

Configure Setting

1. HW relative setting：

Add your own sensor to cust_alsps.c in the following format, including iic_address, polling or interrupt mode of operation, etc.

```
#ifdef CFG_BH1726_SUPPORT
    {
        .name = "bh1726",
        .i2c_num = 0,
        .i2c_addr = {0x39, 0},
        .polling_mode_als = 1,
        .eint_num = 6,
    },
#endif
```

file: Cust_alsps.c

path：

\vendor\mediatek\proprietary\tinysys\freertos\source\project\cm4_a\$PLATFORM\$PROJECT\cust\alsps

2. Compile setting：

Open the configuration.

```
CFG_CHRE_SUPPORT = yes
CFG_CONTEXTHUB_FW_SUPPORT = yes
CFG_ALSPS_SUPPORT = yes
CFG_BH1726_SUPPORT = yes
CFG_TMD2702_SUPPORT = no
CFG_TMD3702_SUPPORT = yes
CFG_CM36558_SUPPORT = no
```

File：projectConfig.mk

Path：

\vendor\mediatek\proprietary\tinysys\freertos\source\project\cm4_a\$PLATFORM\$PROJECT\

Add your sensor driver to the system compilation.

```
######## alsps support ########
ifeq ($(CFG_ALSPS_SUPPORT),yes)
INCLUDES += -I$(SOURCE_DIR)/drivers/common/cache/v01/inc
INCLUDES += -I$(SENDRV_DIR)/alsps
C_FILES  += $(SENDRV_DIR)/alsps/alsps.c
C_FILES  += $(SENDRV_DIR)/alsps/alsps_separate.c
C_FILES  += $(SENCUST_DIR)/alsps/cust_alsps.c
ifeq ($(CFG_CM36558_SUPPORT),yes)
C_FILES  += $(SENDRV_DIR)/alsps/cm36558.c
endif
ifeq ($(CFG_BH1726_SUPPORT),yes)
C_FILES  += $(SENDRV_DIR)/alsps/bh1726.c
endif
```

File：chre.mk 中

Path：\vendor\mediatek\proprietary\tinysys\freertos\source\project\cm4_a\$PLATFORM\platform\feature_config

Overlay setting：

Add you sensor driver to the overlay system.

```
void alspsOverlayRemap(void)
{
ALSPS_OVERLAY_REMAP_START
    ALSPS_OVERLAY_REMAP(bh1726);
    //ALSPS_OVERLAY_REMAP(cm36558);
ALSPS_OVERLAY_REMAP_END

    return;
}
```

File：Overlay_sensor.h

Path：

\vendor\mediatek\proprietary\tinysys\freertos\source\project\cm4_a\$PLATFORM\$PROJECT\inc

Overlay setting cont'.

```
#define OVERLAY2                                    \
    OVERLAY_ONE_OBJECT(bh1726, bh1726)
```

File：Overlay_sensor.h

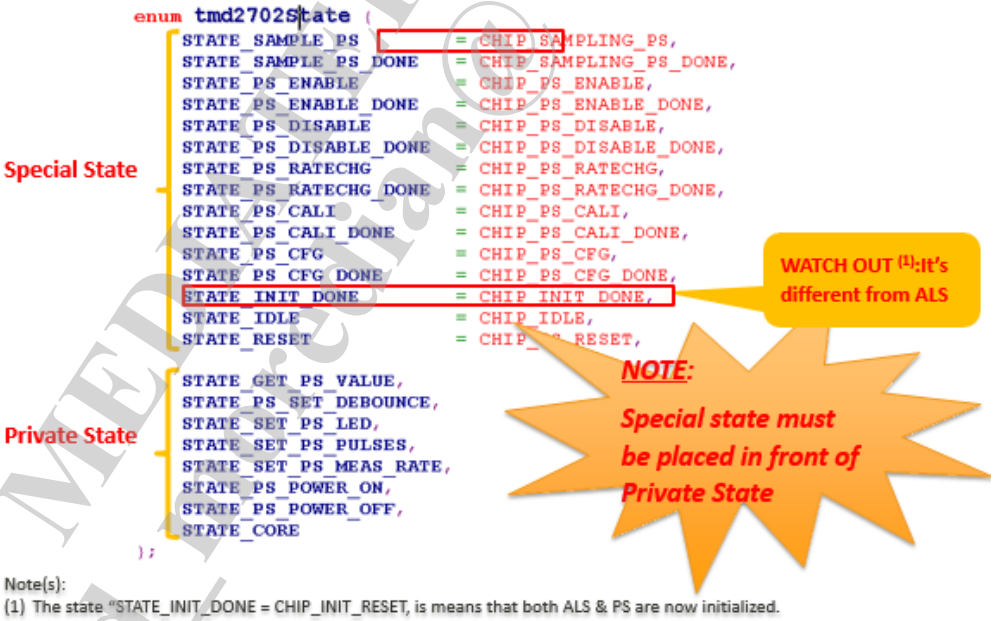
Path：

\vendor\mediatek\proprietary\tinysys\freertos\source\project\cm4_a\$PLATFORM\$PROJECT\inc

4.6.2 PS porting guide

1. Define SensorFSM State

Similar to ALS, Taking the existing sensorFsm as the demo code, defining enum struct to declare sensor work states, which is containing two part: head & tail state and middle state. As shown Figure below.



Note(s):
(1) The state "STATE_INIT_DONE = CHIP_INIT_RESET, is means that both ALS & PS are now initialized.

2. Instantiate each FSM

Similar to ALS, PS also needs to define and implement a structure of sensorFsm. And the structure includes Initialization FSM, Enable FSM、Disable FSM、Sample FSM、 Rate change FSM &Configure FSM etc.

The SensorFSM of PS (tmd2702) is shown as Figure 2 below. And the FSM's work flow is the same way as other sensors.

```
static struct sensorFsm tmd2702Fsm[] = {
    /* sample ps */
    sensorFsmCmd(STATE_SAMPLE_PS, STATE_GET_PS_VALUE, tmd2702_read_ps_raw_data),
    sensorFsmCmd(STATE_GET_PS_VALUE, STATE_SAMPLE_PS_DONE, tmd2702_get_ps_status),
    /* ps enable state */
    sensorFsmCmd(STATE_PS_ENABLE, STATE_PS_POWER_ON, tmd2702_get_ps_conf),
    sensorFsmCmd(STATE_PS_POWER_ON, STATE_PS_SET_DEBOUNCE, tmd2702_set_ps_power_on),
    sensorFsmCmd(STATE_PS_SET_DEBOUNCE, STATE_PS_ENABLE_DONE, tmd2702_set_ps_debounce_on),
    /* ps disable state */
    sensorFsmCmd(STATE_PS_DISABLE, STATE_PS_POWER_OFF, tmd2702_get_ps_conf),
    sensorFsmCmd(STATE_PS_POWER_OFF, STATE_PS_DISABLE_DONE, tmd2702_set_ps_power_off),
    /* ps rate change */
    sensorFsmCmd(STATE_PS_RATECHG, STATE_PS_RATECHG_DONE, tmd2702_ps_ratechg),
    /*ps cali*/
    sensorFsmCmd(STATE_PS_CALI, STATE_PS_CALI_DONE, tmd2702_ps_cali),
    /*ps cali*/
    sensorFsmCmd(STATE_PS_CFG, STATE_PS_CFG_DONE, tmd2702_ps_cfg),
    /* init state */
    sensorFsmCmd(STATE_RESET, STATE_SET_PS_LED, tmd2702_set_main_ctrl),
    sensorFsmCmd(STATE_SET_PS_LED, STATE_SET_PS_PULSES, tmd2702_set_ps_led),
    sensorFsmCmd(STATE_SET_PS_PULSES, STATE_SET_PS_MEAS_RATE, tmd2702_set_ps_pulses),
    sensorFsmCmd(STATE_SET_PS_MEAS_RATE, STATE_CORE, tmd2702_set_ps_meas_rate),
    sensorFsmCmd(STATE_CORE, STATE_INIT_DONE, tmd2702_register_core),
};
```

For each specific implementation of B, refer to ALS, and I won't go into details here.

3. PS module Init(main part):

Get HW info:

Getting the hw information by the API get_cust_alsps("xxx"), the demo is as follows,

```
mTask.hw = get_cust_alsps("tmd2702");
if (NULL == mTask.hw) {
    ret = -1;
    goto err_out;
}
```

The information of PS's hw is setting in the file of "cust_alsps.c". The specific settings will be explained in the settings section of the next section.

Register the sensor info & FSM:

Register the ALS sensor info to CHRE via the API alsSensorRegister().

Register the ALS's SensorFSM into CHRE via the API registerAlsSeparateFSM() when the ALS&PS are decoupled. And register the ALS&PS's(ALS&PS coupled) SensorFSM via the API registerAlsPsDriverFSM() when the ALS&PS coupled.

The demo code is as follows:

(1) ALS&PS decoupled (PS part):

```
psSensorRegister();
registerPsSeparateFsm(tmd2702Fsm, ARRAY_SIZE(tmd2702Fsm));
```

(2) ALS&PS coupled:

```
success_out:
    alsSensorRegister();
    psSensorRegister();
    registerAlsPsDriverFsm(cm36558Fsm, ARRAY_SIZE(cm36558Fsm));
```

Register the sensor work mode(polling or interrupt):

Registering the working mode flag of PS via the function registerPsInterruptMode(), this flag will be reported to the common layer to assign the appropriate processing method.

(1) Polling mode

The macro definition for POLLING and INTERRUPT mode have been defined in the upper layer, as shown below. Can be used directly.

```
#define PS_INTERRUPT_MODE    0
#define PS_POLLING_MODE      1

registerPsInterruptMode(PS_POLLING_MODE); /*using polling mode*/
```

(2) Interrupt mode

Define an interrupt working mode through the following configuration.

```
registerPsInterruptMode(PS_INTERRUPT_MODE); /*using interrupt mode*/
```

In summary, through the above two APIs, the common layer can be notified to perform corresponding processing. Such as, if polling mode is selected, the timer will be started.

Configure Setting

HW relative setting：

Add your own sensor to cust_alsps.c in the following format, including iic_address, polling or interrupt mode of operation, etc.

- ps: tmd2702

```
#ifdef CFG_TMD2702_SUPPORT
    {
        .name = "tmd2702",
        .i2c_num = 0,
        .i2c_addr = {0x49, 0},
        .polling_mode_ps = 1,
        .ps_threshold_high = 4000,
        .ps_threshold_low = 2000,
        //.eint_num = 0,
    },
#endif
```

[Note] The high and low thresholds of the PS customization information setting are temporary settings (the value in the picture is setting when the chip is exposed), and need to be modified during actual installation and debugging.

file: Cust_alsps.c

path：

\vendor\mediatek\proprietary\tinysys\freertos\source\project\cm4_a\$PLATFORM\$PROJECT\cust\alsps

[Note] The $PLATFORM included in the path refers to the MTK SOC platform code, such as mt6765; $PROJECT is the project code, such as k62v1_64_bsp

1. Compile setting：

- enable the als & ps configuration (Union with ALS).

```
CFG_ALSPS_SUPPORT = yes
CFG_CM36558_SUPPORT = no
CFG_BH1726_SUPPORT = yes
CFG_TMD2702_SUPPORT = yes
CFG_TMD3702_SUPPORT = no
```

File：projectConfig.mk

Path：

\vendor\mediatek\proprietary\tinysys\freertos\source\project\cm4_a\$PLATFORM\$PROJECT\

Add your sensor driver to the system compilation(Union with ALS).

```
######## alsps support ########
ifeq ($(CFG_ALSPS_SUPPORT),yes)
INCLUDES += -I$(SOURCE_DIR)/drivers/common/cache/v01/inc
INCLUDES += -I$(SENDRV_DIR)/alsps
C_FILES  += $(SENDRV_DIR)/alsps/alsps.c
C_FILES  += $(SENDRV_DIR)/alsps/alsps_separate.c
C_FILES  += $(SENCUST_DIR)/alsps/cust_alsps.c
ifeq ($(CFG_CM36558_SUPPORT),yes)
C_FILES  += $(SENDRV_DIR)/alsps/cm36558.c
endif
ifeq ($(CFG_BH1726_SUPPORT),yes)
C_FILES  += $(SENDRV_DIR)/alsps/bh1726.c
endif
ifeq ($(CFG_TMD2702_SUPPORT),yes)
C_FILES  += $(SENDRV_DIR)/alsps/tmd2702.c
endif
ifeq ($(CFG_TMD3702_SUPPORT),yes)
C_FILES  += $(SENDRV_DIR)/alsps/tmd3702.c
endif
```

File：chre.mk

Path：\vendor\mediatek\proprietary\tinysys\freertos\source\project\cm4_a\$PLATFORM\platform\feature_config

Overlay setting：

Add you sensor driver to the overlay system (Union with ALS).

```
void alspsOverlayRemap(void)
{
ALSPS_OVERLAY_REMAP_START
    ALSPS_OVERLAY_REMAP(bh1726);
ALSPS_OVERLAY_REMAP_END

    return;
}


void alspsSecondaryOverlayRemap(void)
{
ALSPS_SECONDARY_OVERLAY_REMAP_START
    ALSPS_SECONDARY_OVERLAY_REMAP(tmd2702);
ALSPS_SECONDARY_OVERLAY_REMAP_END
    return;
}
```

File：Overlay.c

Path：
\vendor\mediatek\proprietary\tinysys\freertos\source\project\cm4_a\$PLATFORM\$PROJECT\cust\overlay

Overlay.c (y:\casws_mtk15712\alps-mp-p0_mp1-of_p7_b\vendor\mediatek\proprietary\tinysys\freertos\source\project\cm4_a\mt6765\k62v1_64_mexico\cust\overlay) 6806

Overlay setting cont'(Union with ALS).

```
#define OVERLAY_SECTION_ALSPS                    \
    OVERLAY_ONE_OBJECT(bh1726, bh1726)

#define OVERLAY_SECTION_BARO                     \
    OVERLAY_ONE_OBJECT(bmp280, bmp280)

#define OVERLAY_SECTION_ALSPS_SECONDARY          \
    OVERLAY_ONE_OBJECT(tmd2702, tmd2702)
```

File：
Overlay_sensor.h
Path：
\vendor\mediatek\proprietary\tinysys\freertos\source\project\cm4_a\$PLATFORM\$PROJECT\inc

4.7 CHRE Physical driver porting notice

1. **If you use CHRE I2C Async API , you must use globle buffer to do the i2c read**

Right coding:

```
static int cm36558_get_ps_conf(I2cCallbackF i2cCallBack, SpiCbkF spiCallBack, void *next_state,
                               void *inBuf, uint8_t inSize, uint8_t elemInSize,
                               void *outBuf, uint8_t *outSize, uint8_t *elemOutSize)
{
    mTask.txBuf[0] = CM36558_REG_PS_CONF1_2;
    return i2cMasterTxRx(mTask.hw->i2c_num, mTask.i2c_addr, mTask.txBuf, 1,
                         mTask.rxBuf, 2, i2cCallBack,
                         next_state);
}
```

Error coding:

```
static int mmc3630Sample(I2cCallbackF i2cCallBack, SpiCbkF spiCallBack, void *next_state,
                         void *inBuf, uint8_t inSize, uint8_t elemInSize,
                         void *outBuf, uint8_t *outSize, uint8_t *elemOutSize)
{

    osLog(LOG_ERROR, "%s Enter\n",__func__);
    static int read_idx = 0;
  unsigned char buf[2]={0,};
  unsigned char rbuf = 0;

    mTask.txBuf[0] = MMC3630_REG_DATA;
    i2cMasterTxRxSync(mTask.hw->i2c_num, mTask.i2c_addr, mTask.txBuf, 1, mTask.rxBuf, 6, NULL, NULL);
    read_idx++;

    if(!(read_idx % SET_INTV))
    {
    buf[0] = 0x0F;
    buf[1] = 0xE1;
    i2cMasterTx(mTask.hw->i2c_num, mTask.i2c_addr, buf, 2,NULL,NULL);

    buf[0]=0x20;
    i2cMasterTxRx(mTask.hw->i2c_num, mTask.i2c_addr, buf, 1,&rbuf,1,NULL,NULL);

    buf[1] = rbuf & 0xE7;
    buf[0] = 0x20;
```

2. **You must use memset before call sensorCoreRegister() API , otherwise SCP will random exception and it will be hard to debug**

```
682     /* Register sensor Core */
683     memset(&mInfo, 0x00, sizeof(struct sensorCoreInfo));
684     mInfo.sensType = SENS_TYPE_ALS;
685     mInfo.getData = alsGetData;
686     mInfo.getSensorInfo = alsGetSensorInfo;
687     sensorCoreRegister(&mInfo);
```

3. **You must implement psGetSensorInfo() ,or accGetSensorInfo() ..... when you porting physical driver**

```
665 static void psGetSensorInfo(struct sensorInfo_t *data)
666 {
667     strncpy(data->name, PS_NAME, sizeof(data->name));
668 }
669
670 static void alsGetSensorInfo(struct sensorInfo_t *data)
671 {
672     strncpy(data->name, ALS_NAME, sizeof(data->name));
673 }
674
```

```
31
32 #define ALS_NAME      "ltr578_l"
33 #define PS_NAME       "ltr578_p"
```

4. **When initial driver, we need retry the chip ID for unexpected error**

```
779     for (uint8_t i = 0; i < 3; i++) {
780         ret = i2cMasterTxRxSync(mTask.hw->i2c_num, mTask.i2c_addr, mTask.txBuf, 1,
781             &mTask.deviceId, 1, NULL, NULL);
782
783         if (ret >= 0 && mTask.deviceId == 0x58) {
784             osLog(LOG_INFO, "ltr578 auto detect success %x\n", mTask.deviceId);
785             goto success_out;
786         } else
787             ret = -1;
788     }
789
790     if (ret < 0) {
791         ret = -1;
792         sendSensorErrToAp(ERR_SENSOR_ALS_PS, ERR_CASE_ALS_PS_INIT, ALS_NAME);
793         sendSensorErrToAp(ERR_SENSOR_ALS_PS, ERR_CASE_ALS_PS_INIT, PS_NAME);
794         osLog(LOG_INFO, "ltr578 id fail: %x\n", mTask.deviceId);
795         i2cMasterRelease(mTask.hw->i2c_num);
796         goto err_out;
797     }
798
799 success_out:
800     alsSensorRegister();
801     psSensorRegister();
802     registerAlsPsDriverFsm(ltr578Fsm, ARRAY_SIZE(ltr578Fsm));
803 err_out:
804     return ret;
805 }
```

5. **Must add overlay code**

```
807 #ifndef CFG_OVERLAY_INIT_SUPPORT
808 MODULE_DECLARE(ltr578, SENS_TYPE_ALS, ltr578Init);
809 #else
810 #include "mtk_overlay_init.h"
811 OVERLAY_DECLARE(ltr578, OVERLAY_ID_ALSPS, ltr578Init);
812 #endif
```

6. **Add error info**

If you have error wanted to update to AP , you need call the sensorSensorErrToAP()

```
    if (ret < 0) {
        ret = -1;
        sendSensorErrToAp(ERR_SENSOR_ALS_PS, ERR_CASE_ALS_PS_INIT, ALS_NAME);
        sendSensorErrToAp(ERR_SENSOR_ALS_PS, ERR_CASE_ALS_PS_INIT, PS_NAME);
        osLog(LOG_INFO, "ltr578 id fail: %x\n", mTask.deviceId);
        i2cMasterRelease(mTask.hw->i2c_num);
        goto err_out;
    }
```

7. **SensorFsm array optimization**

We must locate interrup handle Fsm at first line in Fsm array for beter performance

```
static struct sensorFsm bmi160Fsm[] = {
    sensorFsmCmd(CHIP_SAMPLING, STATE_CONVERT, bmi160Sample),
    sensorFsmCmd(STATE_CONVERT, CHIP_SAMPLING_DONE, bmi160Convert),
    /* acc enable state */
    sensorFsmCmd(CHIP_ACC_ENABLE, CHIP_ACC_ENABLE_DONE, accPowerOn),
    /* acc disable state */
    sensorFsmCmd(CHIP_ACC_DISABLE, STATE_UNMASK_EINT, accPowerOff),
    /* acc disable unmask eint state */
    sensorFsmCmd(STATE_UNMASK_EINT, CHIP_ACC_DISABLE_DONE, accGyroUnmaskEint),
    /* acc rate state */
    sensorFsmCmd(CHIP_ACC_RATECHG, CHIP_ACC_RATECHG_DONE, accSetRate),
                                        ... skipped 25 common lines ...
    sensorFsmCmd(CHIP_RESET, STATE_RESET_BMI160, sensorInit),
    sensorFsmCmd(STATE_RESET_BMI160, STATE_INIT_BMI160, sensorInit),
    sensorFsmCmd(STATE_INIT_BMI160, STATE_INIT_ON_CHANGE_SENSORS, sensorInit),
    sensorFsmCmd(STATE_INIT_ON_CHANGE_SENSORS, CHIP_INIT_DONE, sensorInit),
    /* For Anymotion */
    sensorFsmCmd(CHIP_ANYMO_ENABLE, CHIP_ANYMO_ENABLE_DONE, anyMotionPowerOn),
    sensorFsmCmd(CHIP_ANYMO_DISABLE, CHIP_ANYMO_DISABLE_DONE, anyMotionPowerOff),
    /* For Nomotion */
    sensorFsmCmd(CHIP_NOMO_ENABLE, CHIP_NOMO_ENABLE_DONE, noMotionPowerOn),
    sensorFsmCmd(CHIP_NOMO_DISABLE, CHIP_NOMO_DISABLE_DONE, noMotionPowerOff),
    /* Int Status Check */
    sensorFsmCmd(CHIP_HW_INT_STATUS_CHECK, CHIP_HW_INT_HANDLING, hwIntStatusCheck),
    sensorFsmCmd(CHIP_HW_INT_HANDLING, CHIP_HW_INT_HANDLING_DONE, hwIntHandling),
```

```
static struct sensorFsm bmi160Fsm[] = {
    /* Int Status Check */
    sensorFsmCmd(CHIP_HW_INT_STATUS_CHECK, CHIP_HW_INT_HANDLING, hwIntStatusCheck),
    sensorFsmCmd(CHIP_HW_INT_HANDLING, CHIP_HW_INT_HANDLING_DONE, hwIntHandling),
    /* smple */
    sensorFsmCmd(CHIP_SAMPLING, STATE_CONVERT, bmi160Sample),
    sensorFsmCmd(STATE_CONVERT, CHIP_SAMPLING_DONE, bmi160Convert),
    /* acc enable state */
    sensorFsmCmd(CHIP_ACC_ENABLE, CHIP_ACC_ENABLE_DONE, accPowerOn),
    /* acc disable state */
    sensorFsmCmd(CHIP_ACC_DISABLE, STATE_UNMASK_EINT, accPowerOff),
    /* acc disable unmask eint state */
    sensorFsmCmd(STATE_UNMASK_EINT, CHIP_ACC_DISABLE_DONE, accGyroUnmaskEint),
    /* acc rate state */
    sensorFsmCmd(CHIP_ACC_RATECHG, CHIP_ACC_RATECHG_DONE, accSetRate),
                                        ... skipped 25 common lines ...
    sensorFsmCmd(CHIP_RESET, STATE_RESET_BMI160, sensorInit),
    sensorFsmCmd(STATE_RESET_BMI160, STATE_INIT_BMI160, sensorInit),
    sensorFsmCmd(STATE_INIT_BMI160, STATE_INIT_ON_CHANGE_SENSORS, sensorInit),
    sensorFsmCmd(STATE_INIT_ON_CHANGE_SENSORS, CHIP_INIT_DONE, sensorInit),
    /* For Anymotion */
    sensorFsmCmd(CHIP_ANYMO_ENABLE, CHIP_ANYMO_ENABLE_DONE, anyMotionPowerOn),
    sensorFsmCmd(CHIP_ANYMO_DISABLE, CHIP_ANYMO_DISABLE_DONE, anyMotionPowerOff),
    /* For Nomotion */
    sensorFsmCmd(CHIP_NOMO_ENABLE, CHIP_NOMO_ENABLE_DONE, noMotionPowerOn),
    sensorFsmCmd(CHIP_NOMO_DISABLE, CHIP_NOMO_DISABLE_DONE, noMotionPowerOff),
```

4.8 CHRE I2C & SPI API

4.8.1 I2C API

1） Standard API

request i2c. Before Calingl I2C transfer API, call this API firstly. This API is usually only used in user init function.

```
int i2cMasterRequest(uint32_t busId, uint32_t speedInHz);
```

release i2c

```
int i2cMasterRelease(uint32_t busId);
```

I2C Write

```
static inline int i2cMasterTx(uint32_t busId, uint32_t addr,
        const void *txBuf, size_t txSize, I2cCallbackF callback, void *cookie)
```

I2C Read

```
static inline int i2cMasterRx(uint32_t busId, uint32_t addr,
        void *rxBuf, size_t rxSize, I2cCallbackF callback, void *cookie)
```

I2C write and read

```
int i2cMasterTxRx(uint32_t busId, uint32_t addr, const void *txBuf, size_t txSize,
        void *rxBuf, size_t rxSize, I2cCallbackF callback, void *cookie);
```

2） MTK custom serial API

Int is used for sensor overlay

4.8.2 SPI API

Initialization

```
struct BMI160Task {
    uint32_t tid;
    struct BMI160Sensor sensors[NUM_OF_SENSOR];
    struct BMI160Sensor sensors_handle[NUM_OF_HANDLE];

    // time keeping.
    uint64_t last_sensortime;
    uint64_t frame_sensortime;
    uint64_t prev_frame_time[3];
    uint64_t time_delta[3];
    uint64_t next_delta[3];
    uint64_t tempTime;

    // spi and interrupt
    spi_cs_t cs;
    struct SpiMode mode;
    struct SpiPacket packets[SPI_PACKET_SIZE];
    struct SpiDevice *spiDev;
    time_sync_t gSensorTime2RTC;
```

定义 SPI 用的结构体类型

```
T(mode).speed = 8000000;     //8Mhz
T(mode).bitsPerWord = 8;
T(mode).cpol = SPI_CPOL_IDLE_LO;
T(mode).cpha = SPI_CPHA_LEADING_EDGE;
T(mode).nssChange = true;
T(mode).format = SPI_FORMAT_MSB_FIRST;
```

设置 mode，CS，速率

```
spiMasterRequest(T(hw)->i2c_num, &T(spiDev));
```

申请 SPI 使用权限

Synchronized SPI AP（only used in sensor initialization）

```
// read the device ID for bmi160
txData[0] = BMI160_REG_ID | 0x80;
ret = spiMasterRxTxSync(T(spiDev), rxData, txData, 2);

if (ret < 0 || (rxData[1] != BMI160_ID)) {
    ERROR_PRINT("failed id match: %02x, ret: %d\n", rxData[1], ret);
    ret = -1;
    spiMasterRelease(T(spiDev));
    goto err_out;
}
osLog(LOG_ERROR, "success id match: %02x\n", rxData[1]);
```

You can set delay here, 2 means 2us

CHRE API

```
// perform soft reset and wait for 100ms
SPI_WRITE(BMI160_REG_CMD, 0xb6, 100000);
// dummy reads after soft reset, wait 100us
SPI_READ(BMI160_REG_MAGIC, 1, &mTask.dataBuffer, 100);
```

```
spiBatchTxRx(&mTask.mode, sensorSpiCallback, &mTask, "sensorInit RESET" );
```

5 Build and Debug

5.1 Source Code Structure & File Description

Kernel code

- alps/kernel-3.18/drivers/misc/mediatek/sensors-1.0/
- alps/kernel-4.4/drivers/misc/mediatek/sensors-1.0/
- alps/device/mediatek/common/kernel-headers/linux/hwmsensor.h

HAL code

- alps/vendor/mediatek/proprietary/hardware/sensor
- alps/vendor/mediatek/proprietary/hardware/libsensor (第三方算法库)
- alps/device/mediatek/MTxxxx/device.mk
- alps/device/mediatek/MTxxxx/manifest.xml
- alps/device/mediatek/MTxxxx/init.sensors_1_0.rc

5.2 How to build SCP

Build with Android environment

Before building with Android environment, initialization is required (except a standalone build without Android):

1. *$. build/envsetup.sh*
2. *$ lunch full_<PROJECT>-eng*

Step #1 is needed only once.

If you wish to change your project, re-run step #2 and replace <PROJECT> accordingly.

Full Android Build

$ mosesq make -j24

Module Build

*$ mosesq make **tinysys-scp** -j24*

Faster Module Build

$ vendor/mediatek/proprietary/tinysys/freertos/source/tools/build_tinysys.sh -j24

Built binary: **out/target/product/<PROJECT>/obj/TINYSYS_OBJ/tinysys-scp_intermediates/freertos/source/tinysys-scp.bin**
Check the built time of the binary if you wanna make sure the binary is updated:

5.3 How to build a sensor driver to binary

5.3.1 AccGyro

vendor/mediatek/proprietary/tinysys/freertos/source/project/CM4_A/mt6758/platform/feature_config/chre.mk

```
ifeq ($(CFG_ACCGYRO_SUPPORT),yes)
INCLUDES += -I$(SENDRV_DIR)/accGyro/
INCLUDES += -I$(SOURCE_DIR)/middleware/contexthub/algo/auto_cali
INCLUDES += -I$(SOURCE_DIR)/middleware/contexthub/algo/timestamp_cali
C_FILES  += $(SENDRV_DIR)/accGyro/accGyro.c
C_FILES  += $(SENCUST_DIR)/accGyro/cust_accGyro.c
LIBFLAGS += -L$(SOURCE_DIR)/middleware/contexthub/algo/auto_cali -lksensor
LIBFLAGS += -L$(SOURCE_DIR)/middleware/contexthub/algo/timestamp_cali -lktimestamp
ifeq ($(CFG_BMI160_SUPPORT),yes)
C_FILES  += $(SENDRV_DIR)/accGyro/bmi160.c
endif
endif
```

vendor/mediatek/proprietary/tinysys/freertos/source/project/CM4_A/mt6758/{PROJECT}/cust/accGyro/cust_accGyro.c

```
#include "cust_accGyro.h"

struct accGyro_hw cust_accGyro_hw[] __attribute__((section(".cust_accGyro"))) = {
#ifdef CFG_BMI160_SUPPORT
    {
        .name = "bmi160",
        .i2c_num = 1,
        .direction = 4,
        .i2c_addr = {0x68, 0},
        .eint_num = 7,
    },
#endif
};
```

5.3.2 Barometer

vendor/mediatek/proprietary/tinysys/freertos/source/project/CM4_A/mt6758/platform/feature_config/chre.mk

```
ifeq ($(CFG_BAROMETER_SUPPORT),yes)
INCLUDES += -I$(SENDRV_DIR)/barometer
C_FILES  += $(SENDRV_DIR)/barometer/barometer.c
C_FILES  += $(SENCUST_DIR)/barometer/cust_baro.c
ifeq ($(CFG_BMP280_SUPPORT),yes)
C_FILES  += $(SENDRV_DIR)/barometer/bosch_bmp280.c
endif
endif
```

vendor/mediatek/proprietary/tinysys/freertos/source/project/CM4_A/mt6758/{PROJECT}/cust/barometer/cust_baro.c

```
struct baro_hw cust_baro_hw[] __attribute__((section(".cust_baro"))) = {
#ifdef CFG_BMP280_SUPPORT
    {
        .name = "bmp280",
        .i2c_num = 1,
        .direction = 0,
        .i2c_addr = {0x77, 0},
    },
#endif
};
```

5.3.3 Magnetometer

vendor/mediatek/proprietary/tinysys/freertos/source/project/CM4_A/mt6758/platform/feature_config/chre.mk

```
ifeq ($(CFG_MAGNETOMETER_SUPPORT),yes)
INCLUDES += -I$(SENDRV_DIR)/magnetometer
C_FILES  += $(SENDRV_DIR)/magnetometer/magnetometer.c
C_FILES  += $(SENCUST_DIR)/magnetometer/cust_mag.c
ifeq ($(CFG_AKM09915_SUPPORT),yes)
C_FILES  += $(SENDRV_DIR)/magnetometer/akm09915.c
INCLUDES += -I$(SENLIB_DIR)/akm09912/
INCLUDES += -I$(SENLIB_DIR)/akm09912/include/
C_FILES  += $(SENLIB_DIR)/akm09912/AkmApi.c
C_FILES  += $(SENLIB_DIR)/akm09912/ParameterIO.c
C_FILES  += $(SENLIB_DIR)/akm09912/Measure.c
LIBFLAGS += -L$(SENLIB_DIR)/akm09912/include -lakm09912
```

vendor/mediatek/proprietary/tinysys/freertos/source/project/CM4_A/mt6758/{PROJECT}/cust/alsps/cust_mag.c

```
struct mag_hw cust_mag_hw[] __attribute__((section(".cust_mag"))) = {
#ifdef CFG_AKM09915_SUPPORT
    {
        .name = "akm09915",
        .i2c_num = 1,
        .direction = 4,
        .i2c_addr = {0x0c, 0},
    }
#endif
};
```

5.4 Build Option

5.4.1 Common build option

1. **Device config**

   Patch: /device/mediatekprojects/$project/ProjectConfig.mk

   MTK_TINYSYS_SCP_SUPPORT=yes
   MTK_SENSOR_SUPPORT =yes

CUSTOM_KERNEL_SENSORHUB=yes

MTK_SENSORS_1_0=yes

2. **Kernel config**

Path:

/kernel-4.4/arch/$TARGET_ARCH/configs/$project_defconfig

/kernel-4.4/arch/$TARGET_ARCH/configs/$project_debug_defconfig

CONFIG_MTK_TINYSYS_SCP_SUPPORT=y
CONFIG_MTK_HWMON=y
CONFIG_MTK_SENSOR_SUPPORT=y

CONFIG_CUSTOM_KERNEL_SENSORHUB=y

CONFIG_NANOHUB_MTK_IPI=y
CONFIG_MTK_SENSORS_1_0=y
CONFIG_NANOHUB=y
CONFIG_IIO=y

3. **SCP config**

Patch: /vendor/mediatek/proprietary/tinysys/freertos/source/Project/cm4_a/mt6758/工程名/projectconfig.mk

CFG_CHRE_SUPPORT =yes

CFG_CONTEXTHUB_FW_SUPPORT =yes

4. **LK config**

Path: /vendor/mediatek/proprietary/bootable/bootloader/lk/project/$(project)

MTK_TINYSYS_SCP_SUPPORT=no

MTK_TINYSYS_SCP_SUPPORT=yes

5.4.2 Physical sensor build option

1. **Device config**

Patch: /device/mediatek/$project/ProjectConfig.mk

ALS/PS	CUSTOM_KERNEL_ALSPS=yes
ACCELEROMETER	CUSTOM_KERNEL_ACCELEROMETER=yes
MAGNETIC_FIELD	CUSTOM_KERNEL_MAGNETOMETER=yes
GYROSCOPE	CUSTOM_KERNEL_GYROSCOPE=yes
BAROMETER	CUSTOM_KERNEL_BAROMETER=yes

2. **Kernel config**

Path:

/kernel-4.4/arch/$TARGET_ARCH/configs/$project_defconfig

/kernel-4.4/arch/$TARGET_ARCH/configs/$project_debug_defconfig

ALS/PS	CONFIG_CUSTOM_KERNEL_ALSPS=y CONFIG_MTK_ALSPSHUB=y
ACCELEROMETER	CONFIG_CUSTOM_KERNEL_ACCELEROMETER=y CONFIG_MTK_ACCELHUB=y
MAGNETIC_FIELD	CONFIG_CUSTOM_KERNEL_MAGNETOMETER=y CONFIG_MTK_MAGHUB=y
GYROSCOPE	CONFIG_CUSTOM_KERNEL_GYROSCOPE=y CONFIG_MTK_GYROHUB=y
BAROMETER	CONFIG_CUSTOM_KERNEL_BAROMETER=y CONFIG_MTK_BAROHUB=y

3. **SCP config**

Patch: /vendor/mediatek/proprietary/tinysys/freertos/source/Project/cm4_a/mt6758/工程名/projectconfig.mk

ALS/PS	CFG_ALSPS_SUPPORT =yes CFG_CM36558_SUPPORT =yes
ACCELEROMETER	CFG_ACCGYRO_SUPPORT =yes CFG_BMI160_SUPPORT =yes
MAGNETIC_FIELD	CFG_MAGNETOMETER_SUPPORT =yes CFG_AKM09915_SUPPORT=yes
GYROSCOPE	same as acc
BAROMETER	CFG_BAROMETER_SUPPORT =yes CFG_BMP280_SUPPORT =yes

5.4.3 Fusion sensors build option

1. **Device config**

Patch: /device/mediatek/$project/ProjectConfig.mk

ORIENTATION	CUSTOM_KERNEL_ORIENTATION_SENSOR=yes
GRAVITY	CUSTOM_KERNEL_GRAVITY_SENSOR=yes
LINEAR_ACCELERATION	CUSTOM_KERNEL_LINEARACCEL_SENSOR=yes
ROTATION_VECTOR	CUSTOM_KERNEL_RV_SENSOR=yes
MAGNETIC_FIELD_UNCALIBRATED	CUSTOM_KERNEL_UNCALI_MAG_SENSOR=yes
GAME_ROTATION_VECTOR	CUSTOM_KERNEL_GRV_SENSOR=yes
GYROSCOPE_UNCALIBRATED	CUSTOM_KERNEL_UNCALI_GYRO_SENSOR=yes
GEOMAGNETIC_ROTATION_VECTOR	CUSTOM_KERNEL_GMRV_SENSOR=yes

2. **Kernel config**

Path:

/kernel-4.4/arch/$TARGET_ARCH/configs/$project_defconfig

/kernel-4.4/arch/$TARGET_ARCH/configs/$project_debug_defconfig

ORIENTATION	CONFIG_MTK_ORIENTHUB=y
GRAVITY	CONFIG_CUSTOM_KERNEL_GRAVITY_SENSOR=y CONFIG_MTK_GRAVITYHUB=y
LINEAR_ACCELERATION	CONFIG_CUSTOM_KERNEL_LINEARACCEL_SENSOR=y CONFIG_MTK_LINEARACCHUB=y
ROTATION_VECTOR	CONFIG_CUSTOM_KERNEL_RV_SENSOR=y CONFIG_MTK_ROTATVECHUB=y
MAGNETIC_FIELD_UNCALIBRATED	CONFIG_CUSTOM_KERNEL_UNCALI_MAG_SENSOR=y CONFIG_MTK_UNCALI_MAGHUB=y
GAME_ROTATION_VECTOR	CONFIG_CUSTOM_KERNEL_GRV_SENSOR=y CONFIG_MTK_GAMEROTVECHUB=y
GYROSCOPE_UNCALIBRATED	CONFIG_CUSTOM_KERNEL_UNCALI_GYRO_SENSOR=y CONFIG_MTK_UNCALI_GYROHUB=y
GEOMAGNETIC_ROTATION_VECTOR	CONFIG_CUSTOM_KERNEL_GMRV_SENSOR=y CONFIG_MTK_GMAGROTVECHUB=y

3. **SCP config**

Patch: /vendor/mediatek/proprietary/tinysys/freertos/source/Project/cm4_a/mt6758/

工程名/projectconfig.mk

CFG_FUSION_SUPPORT=yes

5.4.4 Pedometer build option

1. **Device config**

Patch: /device/mediatek/$project/ProjectConfig.mk

SIGNIFICANT_MOTION	CUSTOM_KERNEL_SIGNIFICANT_MOTION_SENSOR=yes
STEP_DETECTOR STEP_COUNTER	CUSTOM_KERNEL_STEP_COUNTER=yes

2. **Kernel config**

Path:

/kernel-4.4/arch/$TARGET_ARCH/configs/$project_defconfig

/kernel-4.4/arch/$TARGET_ARCH/configs/$project_debug_defconfig

SIGNIFICANT_MOTION STEP_DETECTOR STEP_COUNTER	CONFIG_CUSTOM_KERNEL_STEP_COUNTER=y CONFIG_MTK_STEPSIGNHUB=y

3. **SCP config**

Patch: /vendor/mediatek/proprietary/tinysys/freertos/source/Project/cm4_a/mt6758/

工程名/projectconfig.mk

SIGNIFICANT_MOTION	CFG_SIGNIFICANT_MOTION_SUPPORT=yes
STEP_DETECTOR	CFG_STEP_COUNTER_SUPPORT=yes
STEP_COUNTER	CFG_STEP_DETECTOR_SUPPORT=yes

5.4.5 Situation & Gesture build option

1. **Device config**

   Patch: /device/mediatek/$project/ProjectConfig.mk

TILT_DETECTOR	CUSTOM_KERNEL_TILT_DETECTOR_SENSOR=yes
WAKE_GESTURE	CUSTOM_KERNEL_WAKE_GESTURE_SENSOR=yes
GLANCE_GESTURE	CUSTOM_KERNEL_GLANCE_GESTURE_SENSOR=yes
PICK_UP_GESTURE	CUSTOM_KERNEL_PICK_UP_SENSOR=yes
DEVICE_ORIENTATION	CUSTOM_KERNEL_DEVICE_ORIENTATION=yes
STATIONARY_DETECT	CUSTOM_KERNEL_STATIONARY_SENSOR=yes
ANSWERCALL	CUSTOM_KERNEL_ANSWER_CALL_SENSOR=yes
MOTION_DETECT	CUSTOM_KERNEL_MOTION_DETECT=yes

2. **Kernel config**

   Path:

   /kernel-4.4/arch/$TARGET_ARCH/configs/$project_defconfig

   /kernel-4.4/arch/$TARGET_ARCH/configs/$project_debug_defconfig

TILT_DETECTOR	CONFIG_MTK_TILTDETECTHUB=y
WAKE_GESTURE	CONFIG_MTK_WAKEHUB=y
GLANCE_GESTURE	CONFIG_MTK_GLGHUB=y
PICK_UP_GESTURE	CONFIG_MTK_PICKUPHUB=y
DEVICE_ORIENTATION	CONFIG_MTK_DEVICE_ORIENTATION_HUB=y
STATIONARY_DETECT	CONFIG_MTK_STATHUB=y
ANSWERCALL	CONFIG_MTK_ANSWER_CALL_HUB=y
MOTION_DETECT	CONFIG_MTK_MOTION_DETECT_HUB=y

3. **SCP config**

   Patch: /vendor/mediatek/proprietary/tinysys/freertos/source/Project/cm4_a/mt6758/工程名/projectconfig.mk

TILT_DETECTOR	CFG_TILT_SUPPORT=yes
WAKE_GESTURE	CFG_WAKEUP_SUPPORT=yes
GLANCE_GESTURE	CFG_SNAPSHOT_SUPPORT=yes
PICK_UP_GESTURE	CFG_PICKUP_SUPPORT=yes
DEVICE_ORIENTATION	CFG_WIN_ORIENTATION_SUPPORT=yes
STATIONARY_DETECT	CFG_STATIONARY_SUPPORT=yes
ANSWERCALL	CFG_ANSWERCALL_SUPPORT=yes

MOTION_DETECT	CFG_MOTION_SUPPORT=yes
Floor count	CFG_FLOOR_COUNT_SUPPORT=yes
Lift to wake	CFG_LIFT_SUPPORT =yes

5.4.6 Activity build option

1. **Device config**

   Patch: /device/mediatek/$project/ProjectConfig.mk

   CUSTOM_KERNEL_ACTIVITY_SENSOR=yes

2. **Kernel config**

   Path:

   /kernel-4.4/arch/$TARGET_ARCH/configs/$project_defconfig

   /kernel-4.4/arch/$TARGET_ARCH/configs/$project_debug_defconfig

   CONFIG_CUSTOM_KERNEL_ACTIVITY_SENSOR=y

   CONFIG_MTK_ACTIVITYHUB=y

3. **SCP config**

   Patch: /vendor/mediatek/proprietary/tinysys/freertos/source/Project/cm4_a/mt6758/

   工程名/projectconfig.mk

   CFG_ACTIVITY_NO_BARO_SUPPORT=yes

   CFG_ACTIVITY_BARO_SUPPORT=yes

5.4.7 Enable SCP virtual gyro(based on AKM M-sensor)

SCP config

Patch: /vendor/mediatek/proprietary/tinysys/freertos/source/Project/cm4_a/mt67xx/

工程名/projectconfig.mk

```
CFG_VIRTUAL_GYRO_SUPPORT = yes
CFG_AKM_FUSION_SUPPORT = yes
CFG_FUSION_SUPPORT = no   // closeMTK自己的fusion算法，virtual gyro 配套AKMfusion
CFG_FAST_CALIBRATION_SUPPORT = no   // 没有gyro，AKM不支持快速校准
```

5.4.8 Enable SCP MTK fusion algorithm (need physical gyro)

Patch: /vendor/mediatek/proprietary/tinysys/freertos/source/Project/cm4_a/mt67xx/

工程名/projectconfig.mk

```
CFG_VIRTUAL_GYRO_SUPPORT = no
CFG_AKM_FUSION_SUPPORT = no
CFG_FUSION_SUPPORT = yes   // enable MTK fusion algorithm
CFG_FAST_CALIBRATION_SUPPORT = yes  // AKM 的磁力方案，可以尝试开快速校准
```

5.5 SCP Log

5.5.1 Mobile log

5.5.2 How to enable SCP Uart

vendor/mediatek/proprietary/tinysys/freertos/source/project/CM4_A/mt67xx/platform/platform.mk

```
CFG_UART_SUPPORT = yes
```

Attention: uart DO NEED to be disabled during QA test, otherwise there will be performance issue.

5.5.3 SCP uart reuses AP uart

Enable by modify config
project/CM4_A/mt6771/platform/platform.mk

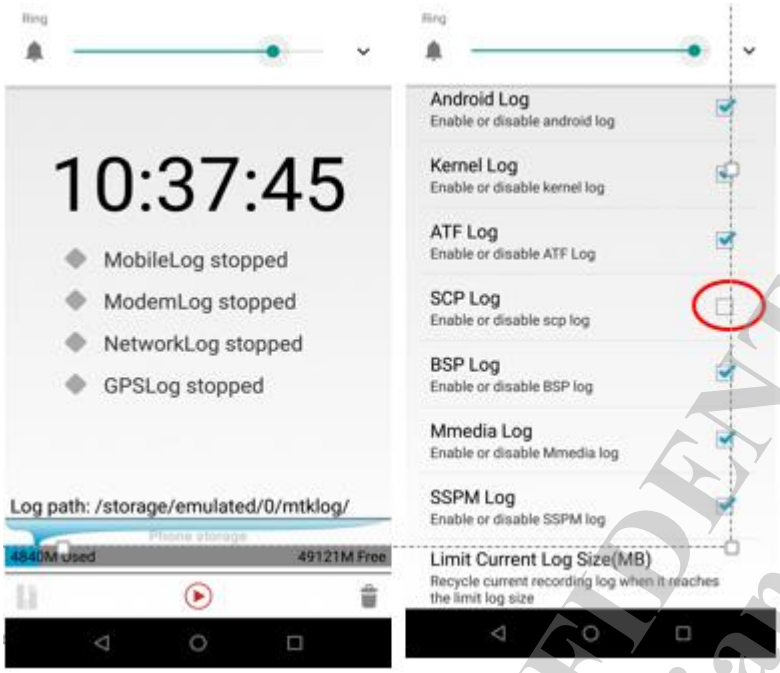
- Warning
  - DO NOT apply this change to ENG build, because AP and SCP log will mix together and hard to recognize.
  - DO NOT use this when measure suspend power, it keeps infra always on.

CFG_UART_SUPPORT = yes
CFG_MTK_SCPUART_SUPPORT = no
CFG_SCP_UART1_SUPPORT = no
CFG_MTK_APUART_SURPPOT = yes

- Notice
  - Mixed messages with the AP's in the output log, you can use follow cmd to reduce kernel log
    - echo 0 > proc/sys/kernel/printk
  - Increase power consumption by keeping infra bus always on.

5.5.4 usb outputs SCP log directly

1. Make sure mobile log (SCP part) is disabled
   1) All mobile log disable
   2) Or Disable SCP log



2. Enter adb shell and then type the following cmd
    1) echo 1 > /sys/class/misc/scp/scp_mobile_log
    2) while true; do cat /dev/scp;done

```
C:\Users\MTK11261>adb shell
k71v1_64_bsp:/ # echo 1 > /sys/class/misc/scp/scp_mobile_log
k71v1_64_bsp:/ # while true; do cat /dev/scp;done
103284, ap:39031836157017, ap_raw:39031836071402
raw_offset:2290053733, timestamp_offset_to_ap:2290053733
sync time counter_elapse:1126, ipi_transfer_time:86615
sync time scp:39039562168462, ap:39041852222325, ap_raw:39041852135710
raw_offset:2290053863, timestamp_offset_to_ap:2290053863
No sleep reasons: tmr=0, build=0, sema=0, lock=0, ipi=0, flag=4, slpbusy=0
sync time counter_elapse:1129, ipi_transfer_time:86846
sync time scp:39049578174332, ap:39051868228172, ap_raw:39051868141326
raw_offset:2290053840, timestamp_offset_to_ap:2290053840
sync time counter_elapse:1130, ipi_transfer_time:86923
sync time scp:39059594165433, ap:39061884219173, ap_raw:39061884132250
raw_offset:2290053740, timestamp_offset_to_ap:2290053740
sync time counter_elapse:1111, ipi_transfer_time:85461
sync time scp:39069610088456, ap:39071900142173, ap_raw:39071900056712
raw_offset:2290053717, timestamp_offset_to_ap:2290053717
No sleep reasons: tmr=0, build=0, sema=0, lock=0, ipi=0, flag=3, slpbusy=0
log en=1,update=1
sync time counter_elapse:1208, ipi_transfer_time:92923
sync time scp:39079626695403, ap:39081916749174, ap_raw:39081916656251
raw_offset:2290053771, timestamp_offset_to_ap:2290053771
^C
```

5.5.5 Dynamic AP/SCP UART Switch

- Default enable AP uart support, switch with Fastboot cmd line
- Warning!! Limitation & side effect
    - extra code size require(+560 bytes)
    - Must disable AP uart log self
    - Timing impact, for debug only, can not use it on stress test
    - Power impact

(DO NOT apply this change to ENG build, because AP and SCP log will mix together and hard to recognize)

(DO NOT use this when measure suspend power, it keeps infra always on

1. How to use:
   Set CFG_MTK_DYNAMIC_AP_UART_SWITCH = yes
   (@ project/CM4_A/mt6771/platform/platform.mk)

```
################################################################################
# When the option CFG_MTK_DYNAMIC_AP_UART_SWITCH is set to "yes", the code
# of UART will be built into the SCP image. This leads to a larger image.
# Set this option to "yes" only when you really know what you are doing.
# Otherwise, set it to "no".
################################################################################
CFG_MTK_DYNAMIC_AP_UART_SWITCH = yes
ifeq ($(CFG_MTK_DYNAMIC_AP_UART_SWITCH), yes)
CFG_UART_SUPPORT = yes
CFG_MTK_SCPUART_SUPPORT = no
CFG_MTK_APUART_SUPPORT = yes
endif
```

2. How to dynamic switch
   1) enter lk fastboot
      - use adb reboot bootloader (@adb shell)
      - or booting menu (Power key + Volume- boot up) -> fastboot
   2) switch with fastboot cmd
      - enable: fastboot oem scp_log_thru_ap_uart 1
      - disable: fastboot oem scp_log_thru_ap_uart 0

```
D:\>fastboot oem scp_log_thru_ap_uart 1
...
(bootloader) SCP log thru AP UART: on
(bootloader) Please reboot to apply the change.
OKAY [  0.010s]
finished. total time: 0.011s
```

   3) reboot (remember disable AP uart)

5.6 SCP open EE DB mechanism

- 1 .ensure AEE mechanism is enabled
  - Execute adb shell “aee -m 3”。Through adb shell “getprop persist.mtk.aee.mode”, check whether the return value is 3. If 3, the execution is successful.
- 2.ensure SCP db can dump info
  - Do adb command:
  - 1) adb shell cat /sys/class/misc/scp/scp_A_db_test (會看到返回 dumping SCP A db)
  - 2）find the db in the following path

sdcard/mtklog/aee_exp/data/aee_exp/

5.6.1 SCP reboot correlates AP reboot

Function：Force enable KE when SCP EE occur

- Default Status: DISABLE
  - How to switch: write the control node to turn on/off
    - How to use explain in next page
- When Enable:
  - Reset scope: Whole system (KE)
  - Debug info: Full RAM Dump (takes a long time) and mobile log
    - db = db.xx.EE & db.fatal.xx.KE
- When Disable:
  - Reset scope: SCP only (EE)
  - Debug info: SCP db and mobile log
    - db = db.xx.EE

1. Control node:
   - Path: /sys/class/misc/scp/scp_ee_force_ke
   - Enable
     - echo 1 > /sys/class/misc/scp/scp_ee_force_ke
   - Disable
     - echo 0 > /sys/class/misc/scp/scp_ee_force_ke
2. Selinux permission settings

Must allow to access the path: /sys/class/misc/scp/scp_ee_force_ke

Ex： to enable eng_app access sysfs_scp should do the following

Under device/mediatek/sepolicy/basic/non_plat/eng_app.te

add your own file xxx.te, the eng_app in this example.

The content is as the following:

```
# Purpose: Allow eng_ap read /sys/class/misc/scp/scp_ee_force_ke
allow eng_ap sysfs_scp:dir r_dir_perms;
allow eng_ap sysfs_scp:file r_file_perms;
```

3. Property settings

device/mediatek/mt6771/init.mt6771.rc add contents as following：

```
# Add by MTK
  # SCP log
  ...
  chmod 0664 /sys/class/misc/scp/scp_ee_force_ke
  chown root system /sys/class/misc/scp/scp_ee_force_ke
```

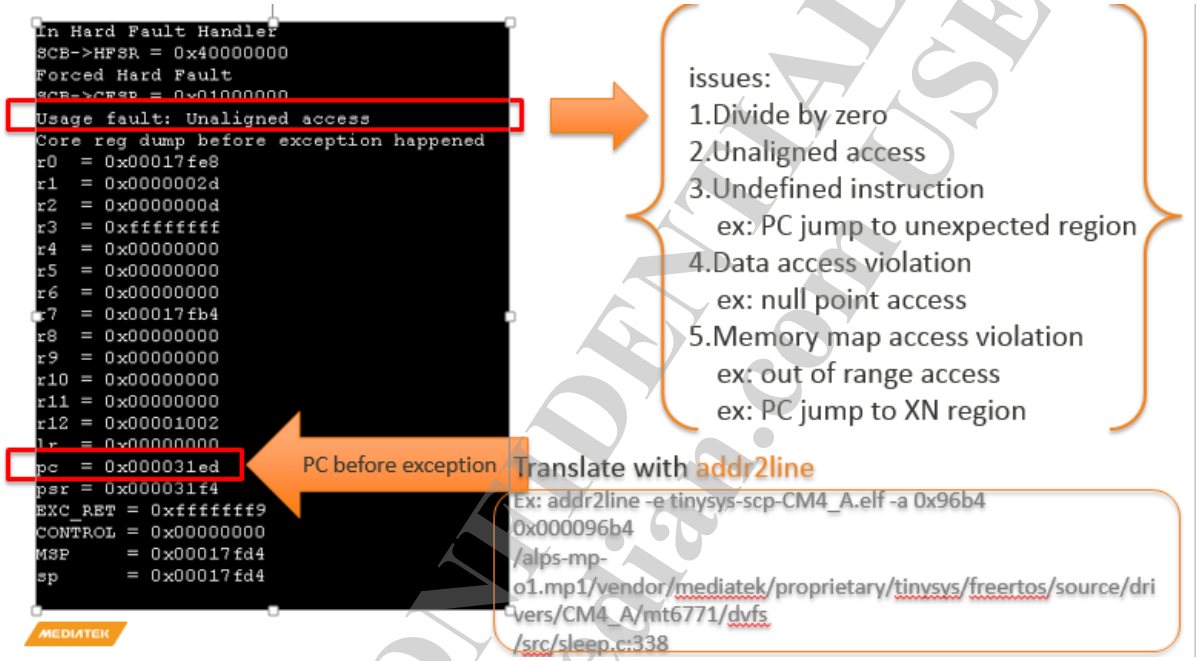
5.6.2 SCP Exception debug

1. **How to get exception log**
   1) From uart/mobile log
   2) From db

i. Extract SCP EE DB, it can see SYS_SCP_DUMP

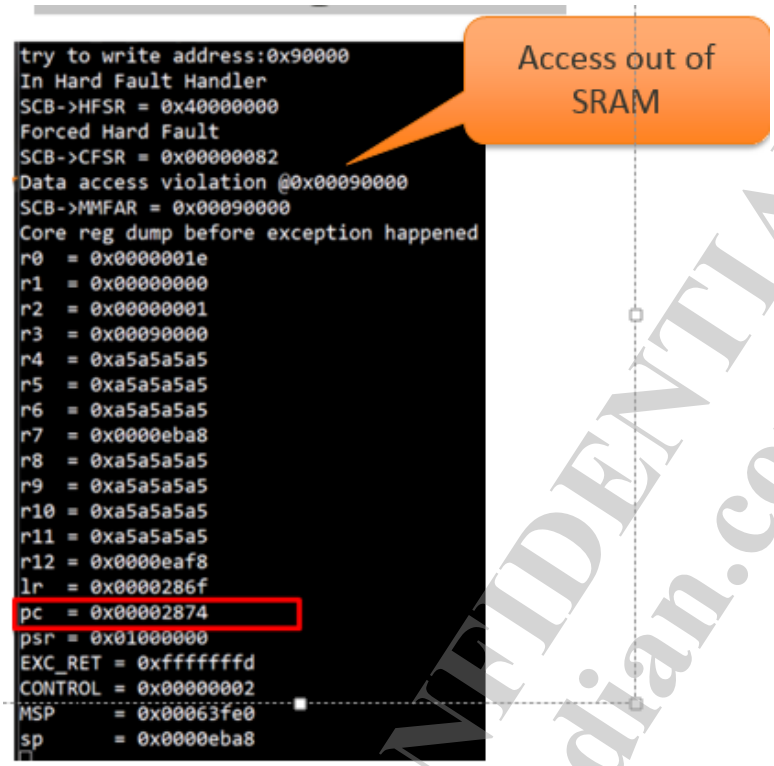
2. **Exception category introduction**

If get exception log already

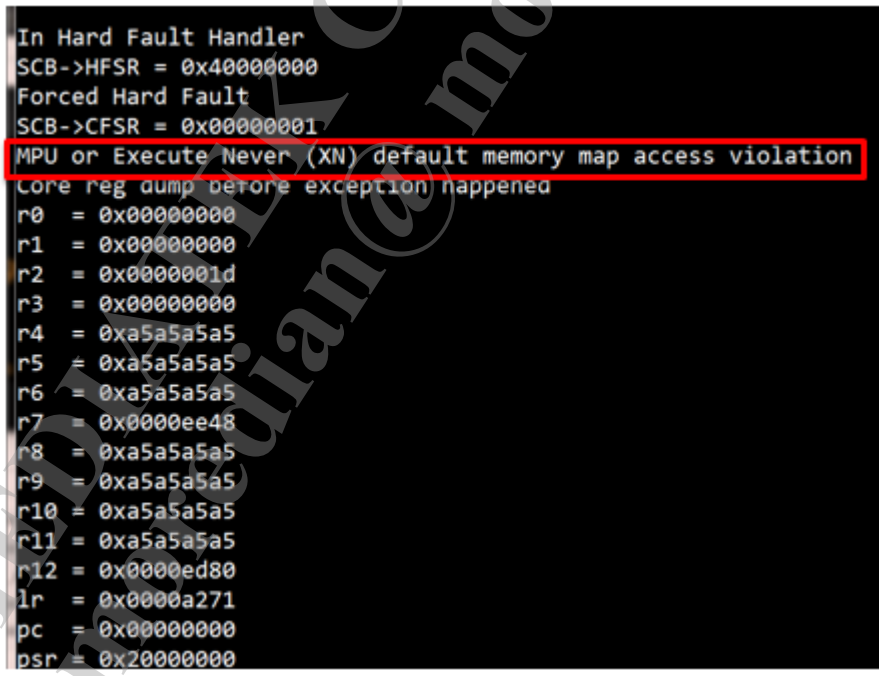


1) Divde by zero

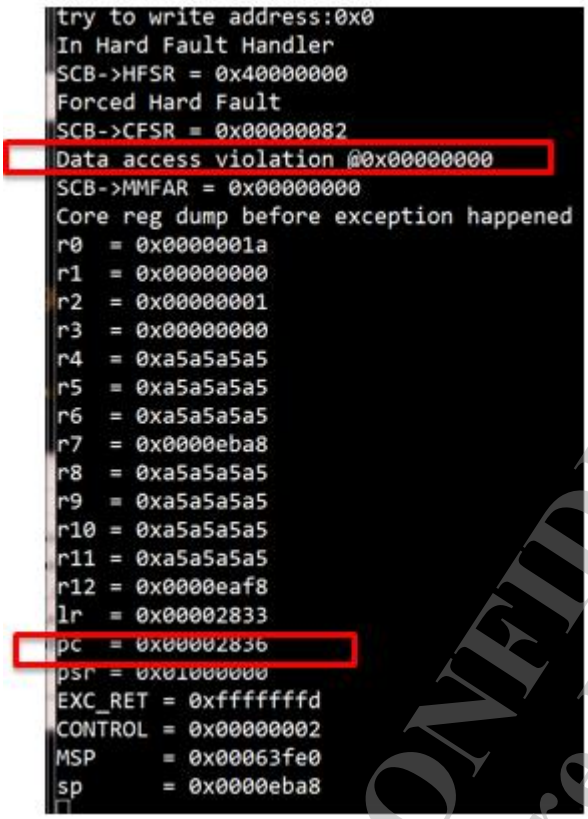
2) Out of range access



3) Jump to XN region



4) Null pointer access

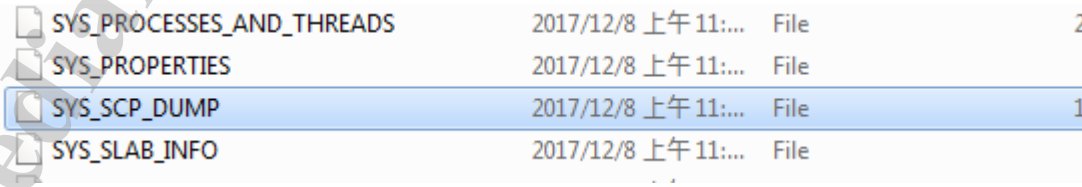


3. **Debug ram dump with gdb**

GDB download

- Get android ndk
  - https://developer.android.com/ndk/downloads/index.html
- You can find it in prebuild folder
  - Ex: prebuild/linux-x86_64/bin/gdb

1) Get ramdump
   i. Get SCP EE DB and extract it, it can see SYS_SCP_DUMP
   ii. If size of SYS_SCP_DUMP is 0, this issue is probably not an SCP issue

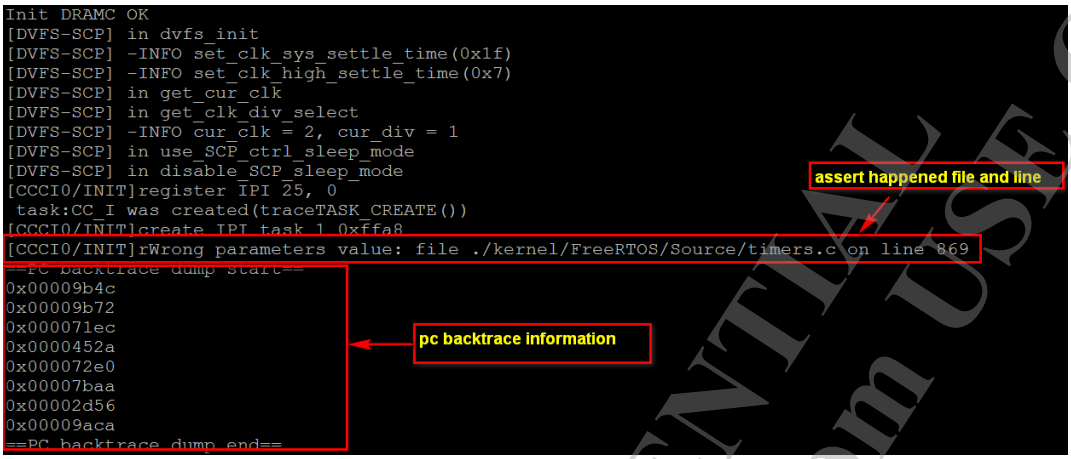


2) See last log

Run command, strings, to parse the ram dump:

```
strings SYS_SCP_DUMP | less
```

In this case, it shows “assert” in kernel/FreeRTOS/Source/timers.c:869.
We can know the failed point. The PC backtrace is also helpful. You can use addr2line to lo locate the problem



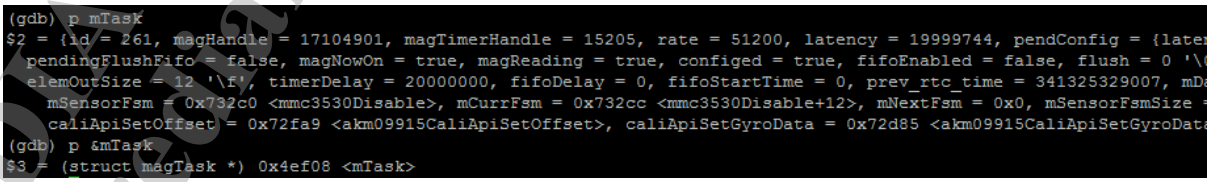
3) **Debug ram dump with gdb**

[Shell]$ ./gdb tinysys-scp-CM4_A.elf SYS_SCP_DUMP

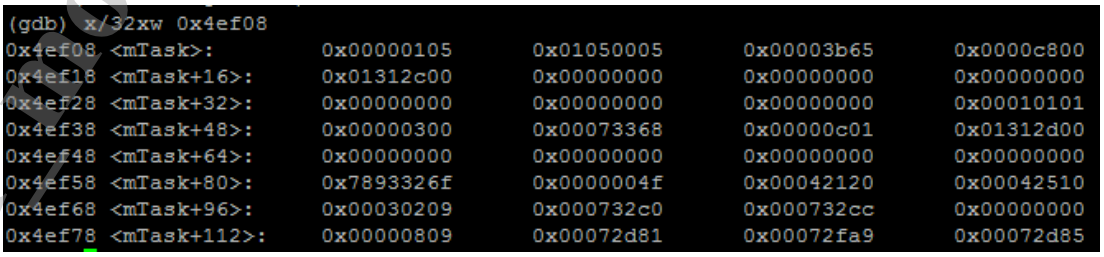
Further cmds please reference GDB guide

Back trace: bt

GDB Basic cmds: p variable



Dump memory : x/FMT address



5.7 Sensor driver debug trace

5.7.1 SPI driver debug trace

Because CHRE SPI is not like i2c， use SPI dump register need to follow the already existed sensor flow

Example ：

In a power on flow to judge debug trace（debug trace can define such as, 0x1,0x2 ……）, after debug trace was set , you can use synchronization SPI api to dump register,

```
static int lsm6dsmAccPowerOn(I2cCallbackF i2cCallBack, SpiCbkF spiCallBack, void *next state,
                             void *inBuf, uint8_t inSize, uint8_t elemInSize,
                             void *outBuf, uint8_t *outSize, uint8_t *elemOutSize)
{
    osLog(LOG_INFO, "lsm6dsmAccPowerOn\n");
    int ret = 0;
    uint8_t txData[2] = {0}, rxData[2] = {0};
    if(mTask.debug_trace == 0x1)
    {
       //dump register
        osLog(LOG_ERROR, "lsm6dsm: fwq dump reg\n");

        txData[0] = LSM6DSM_WAI_ADDR | 0x80;
        ret = spiMasterRxTxSync(mTask.spiDev, rxData, txData, 2);
        osLog(LOG_ERROR, "lsm6dsm: device id: %02x , %d\n", rxData[1],ret);
      return 0;
    }
```

adb cmd：

```
/sys/bus/platform/drivers/gsensor # echo 0x1 > trace
```

Note ： after dump must you must return 0, and then sensor cannot work, you must restart the phone

5.7.2 I2c driver debut trace

You can call i2c synchronization API in the debug trace call back function

```
static void ltr578SetDebugTrace(int32_t trace) {
    int ret = 0;
    mTask.debug_trace = trace;
    osLog(LOG_ERROR, "%s ==> trace:%d\n", __func__, mTask.debug_trace);
    // can use i2cMasterTxRxSync API dump register whitch you wanted
     ret = i2cMasterTxRxSync(mTask.hw->i2c_num, mTask.i2c_addr, mTask.txBuf, 1,
       &mTask.deviceId, 1, NULL, NULL);
    if (ret < 0) {
        osLog(LOG_ERROR, "bmp280 i2cMasterTxRxSync fail!!!\n");
        ret = -1;
        i2cMasterRelease(mTask.hw->i2c_num);
        goto err_out;
    }
}
```

5.7.3 Sensor driver device node

```
generic_arm64_a:/sys/class/sensor $ ls
ls
m_acc_misc m_baro_misc    m_gyro_misc m_ps_misc    m_step_c_misc
m_als_misc m_fusion_misc m_mag_misc   m_situ_misc
```

5.8 Tools for checking SCP SRAM size

Can be used at Android P version

Method 1:

(platform supposed is mt6765)

1. cd to the folder, /vendor/mediatek/proprietary/tinysys/freertos/source
2. PLATFORM=mt6765 tools/memoryReport.py SCP project/CM4_A/mt6765/platform/Setting.ini tinysys-scp_out/freertos/source/CM4_A/tinysys-scp-CM4_A.map > memory_report.txt

You would have the memory report in file, memory_report.txt

Method 2:

Check & Build environment at first time

1. please make sure that customer have the latest patch for updated tool.
2. cd ~ (your home)
3. mkdir .pip & vim .pip/pip.conf with the following content

   [global]

   index-url = http://172.21.69.138/pypi/simple

   [install]

   trusted-host = 172.21.69.138
4. virtualenv-p python MyVirtualenv
5. source MyVirtualenv/bin/activate
6. pip install openpyxl
7. deactivate

Usage:

1. source MyVirtualenv/bin/activate
2. PLATFORM=mt6765 tools/memoryReport.py SCP-d-e project/CM4_A/mt6765/platform/Setting.ini tinysys-scp_out/freertos/source/CM4_A/tinysys-scp-CM4_A.map
3. deactivate

You would have the report excel file, memory_report.xlsx, in the current folder