使用ML51實現LoRa模組資料對傳

NuMicro® 8 位系列微控制器範例代碼介紹

文件資訊

代碼簡述	本範例代碼基於NuMicro ML51晶片中的SPI及GPIO功能，實現LoRa模組資料對傳
BSP 版本	ML51_BSP_Keil_C51_V1.0.0
開發平台	NT-ML51PC V1.1

1 功能介紹

1.1 簡介

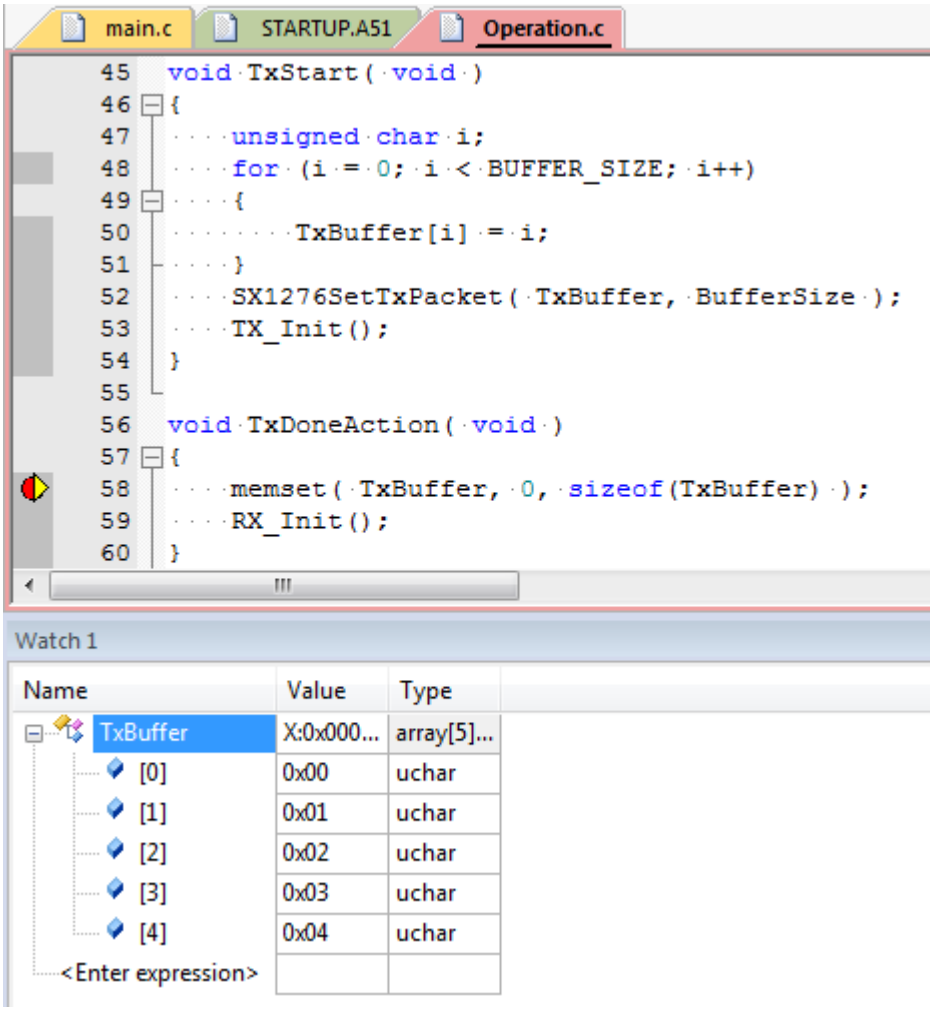
LoRa是LongRange的簡稱，應用於物聯網的低功耗廣域網路傳輸技術(Low Power Wide Area Network, LPWAN)。LoRa無線通訊技術由美商Semtech併購的法商Cycleo所開發，並與IBM合作制定規範，最後由Semtech、Cisco、IBM三大公司作為核心，組成LoRa聯盟推動相關發展，為現今最受產業支持的LPWAN技術。

LoRa的模式如Wi-Fi般，任何人都可以設置基地台來建置網路環境。其具有較高的傳輸頻寬，除了能進行單向傳輸的省電通訊外，也能夠進行數據交換，適合應用於一些較大型的智慧工廠中。除此之外，為了因應不同使用目的，LoRa有Class A, Class B, Class C 3個種類。Class A 做基本的定時傳輸用，強調省電、Class B 除基本傳輸功能外，還增加觸發性傳輸能力、Class C 則提供持續傳輸功能。

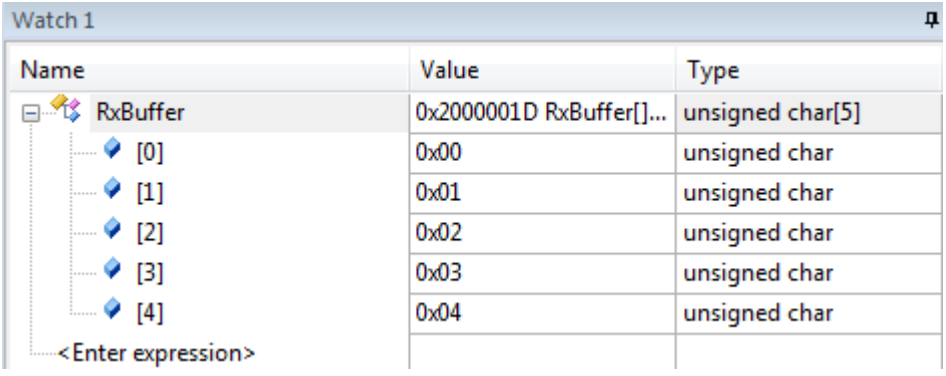
本範例代碼基於NuMicro ML51晶片中的SPI及GPIO功能，實現LoRa模組資料對傳。

1.2 執行結果

a. TX傳送0x00, 0x01, 0x02, 0x03, 0x04，如TxBuffer陣列中的資料



b. RX接收到0x00, 0x01, 0x02, 0x03, 0x04，如RxBuffer陣列中的資料



2 代碼介紹

設定#define TX 1，可以讓ML51控制LoRa模組作為TX傳送資料。

設定#define TX 0，可以讓ML51控制LoRa模組作為RX傳送資料。

範例中先呼叫BoardInit()與Radio_Init()進行GPIO與SPI等硬體的初始化，然後開始進行LoRa資料傳輸測試。

```
#include <stdio.h>
#include "platform.h"
#include "ML51.h"
#include "Operation.h"

/*---------------------------------------------------------------------------------------------------------*/
/*Define                                                                                                   */
/*---------------------------------------------------------------------------------------------------------*/
#define TX 1

/*---------------------------------------------------------------------------------------------------------*/
/*Global variables                                                                                         */
/*---------------------------------------------------------------------------------------------------------*/
extern unsigned char F_RxStart;
extern unsigned char F_TxStart;

/*---------------------------------------------------------------------------------------------------------*/
/* Functions.                                                                                              */
/*---------------------------------------------------------------------------------------------------------*/
int main(void)
{
   BoardInit();
   Radio_Init();

#if TX
    TxStart();
#else
    RX_Init();
#endif

    while (1)
    {
        if (F_RxStart)
        {
            F_RxStart = FALSE;
            RX_Done();
            RxDoneAction();
            RX_Init();
        }
        if (F_TxStart)
        {
            F_TxStart = FALSE;
            TX_Done();
            TxDoneAction();
            TxStart();
        }
    }
}
```

LoRa 接收通過GPIO中斷喚醒，模塊數據通過SPI進行，初始化步驟如下

```
void SX1276InitIo( void )
{
```

```
    /* SPI1 IO define */
    MFP_P32_SPI1_CLK;
    P32_PUSHPULL_MODE;
    MFP_P31_SPI1_MISO;
    P31_INPUT_MODE;
    P31_PULLUP_ENABLE;
    MFP_P30_SPI1_MOSI;
    P30_PUSHPULL_MODE;
    MFP_P33_GPIO;        /*setting SS use gpio mode */
    P33_PUSHPULL_MODE;

    /*Init DIO0 */
    MFP_P00_GPIO;
    P00_INPUT_MODE;
    P00_PULLDOWN_ENABLE;
    GPIO_EnableInt(PIT0, RISING, EDGE, Port0, 0); /*set DIO0 use pin interrupt */
```

```
void SpiInit( void )
{
    unsigned char u8MasterSlave = SPI_MASTER;
    unsigned char u8SPICLKDIV = 9;
    unsigned char u8SPIMode = SPI_MODE_0;
    unsigned char u8MSBLSB = MSB_FIRST;

    SX1276InitIo();
    set_SPI1SR_DISMODF;       /*Mode fault error detection disable*/
    clr_SPI1CR0_SSOE;         /*SS pin use as GPIO*/
    SFRS = 0;
    SPI1CR0 = 0;
    SPI1CR0 |= (u8MasterSlave << 4) | (u8SPICLKDIV & 0x03) | (u8SPIMode << 2) | (u8MSBLSB
<< 5);
    SPI1CR1 = 0 ;
    SPI1CR1 |= (u8SPICLKDIV & 0x0C) << 2;
    set_SPI1CR0_SPIEN;
```

LoRa模塊發送及接收buffer的動作如下

```
void SX1276WriteBuffer( unsigned char addr, unsigned char *buffer, unsigned char size_in )
{
    unsigned char i;

    SPI_SS0_PIN = 0;
    SpiInOut( addr | 0x80 );
    for ( i = 0; i < size_in; i++ )
    {
        SpiInOut( buffer[i] );
    }
    SPI_SS0_PIN = 1;
}

void SX1276ReadBuffer( unsigned char addr, unsigned char *buffer, unsigned char size_in )
{
    unsigned char i;

    SPI_SS0_PIN = 0;
    SpiInOut( addr & 0x7F );

    for ( i = 0; i < size_in; i++ )
    {
        buffer[i] = SpiInOut( 0 );
    }

    SPI_SS0_PIN = 1;
}
```

3 軟體與硬體環境

- 軟體環境
  - BSP 版本
    - ML51_BSP_Keil_C51_V1.0.0
  - IDE 版本
    - Keil uVersion 4.6 及 PK51 Development Kit V9.52
- 硬體環境
  - 硬體需求
    - NT-ML51PC V1.1 tiny board
    - SX1276 LoRa module board
  - 接線圖

NuTiny-SDK-ML51 V1.1		LoRa Module
VCC	↔	VCC
(GPIO INPUT)P00	↔	LORA_DIO0
(GPIO INPUT)P01	↔	LORA_DIO1
(GPIO INPUT)P02	↔	LORA_DIO2
(GPIO INPUT)P03	↔	LORA_DIO3
(GPIO INPUT)P14	↔	LORA_DIO4
(GPIO INPUT)P15	↔	LORA_DIO5
(GPIO OUTPUT)P33	↔	LORA_CS
(SPI CLK)P32	↔	LORA_CLK
(SPI MISO)P31	↔	LORA_MISO
(SPI MOSI)P30	↔	LORA_MOSI
GND	↔	GND

4 目錄資訊

- EC_ML51_LoRa_Control
  - Library: Sample code header and source files.
    - Device: ML51 device header files.
    - Startup: Keil51 startup files
    - StdDriver: All peripheral driver header and source files.
  - Sample_Code
    - Example: Source file of example code.
      - LoRa_Control LoRa module SX1276 TX/RX driver sample code

5 如何執行範例程式

1. 本專案支援Keil uVersion 4.6 及PK51 Development Kit V9.52 以上版本
2. 根據目錄資訊章節進入ExampleCode\LoRa_Control\KEIL資料夾，雙擊 LoRa_Control.uvproj開啟專案
3. 進入編譯模式介面
   a. 編譯
   b. 下載代碼至記憶體
   c. 進入 / 離開除錯模式
4. 進入除錯模式介面
   a. 執行代碼

6 修訂紀錄

日期	版本	描述
Oct. 24, 2019	1.00	1. 初始發布.

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