课程目录

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STM32WL LoRa 例程介绍

David Liu

STM32

日程

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2. STM32WL 开发环境
3. LoRaWAN_End_Node例程
4. LoRaWAN_AT_Slave例程
5. SubGHz_Phy_PingPong例程
6. LocalNetwork例程

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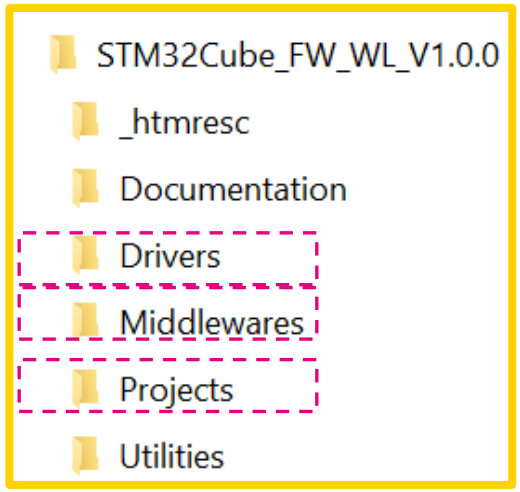
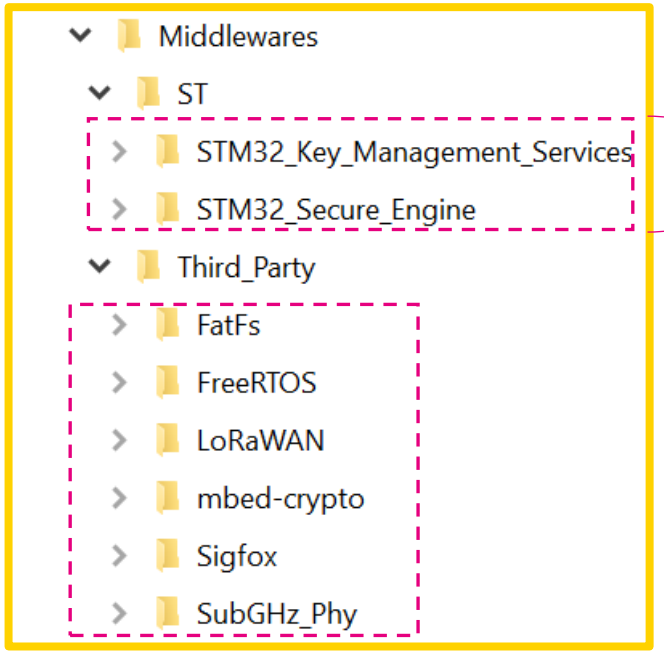
STM32WLCube 开发包

STM32

STM32Cube_FW_WL开发包目录



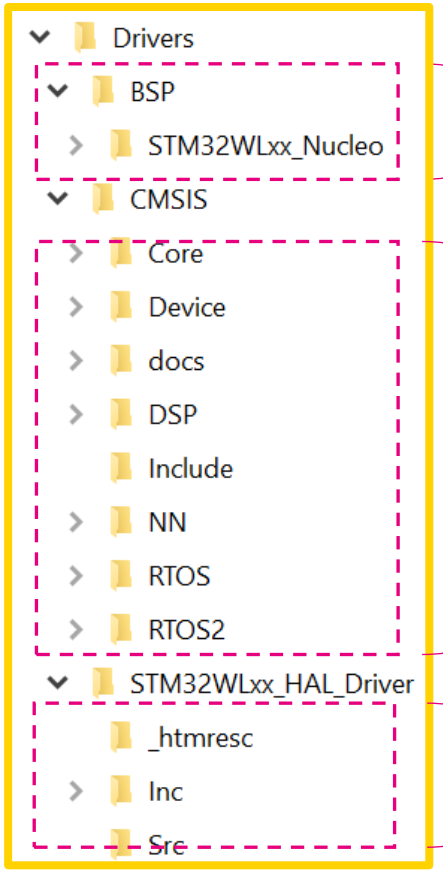
Middleware



Middleware
- KMS
- SE

Third party
- FreeRTOS
- FatFs
- LoRaWAN
- Mbed-crypto
- Sigfox
- SubGHz_Phy

Driver

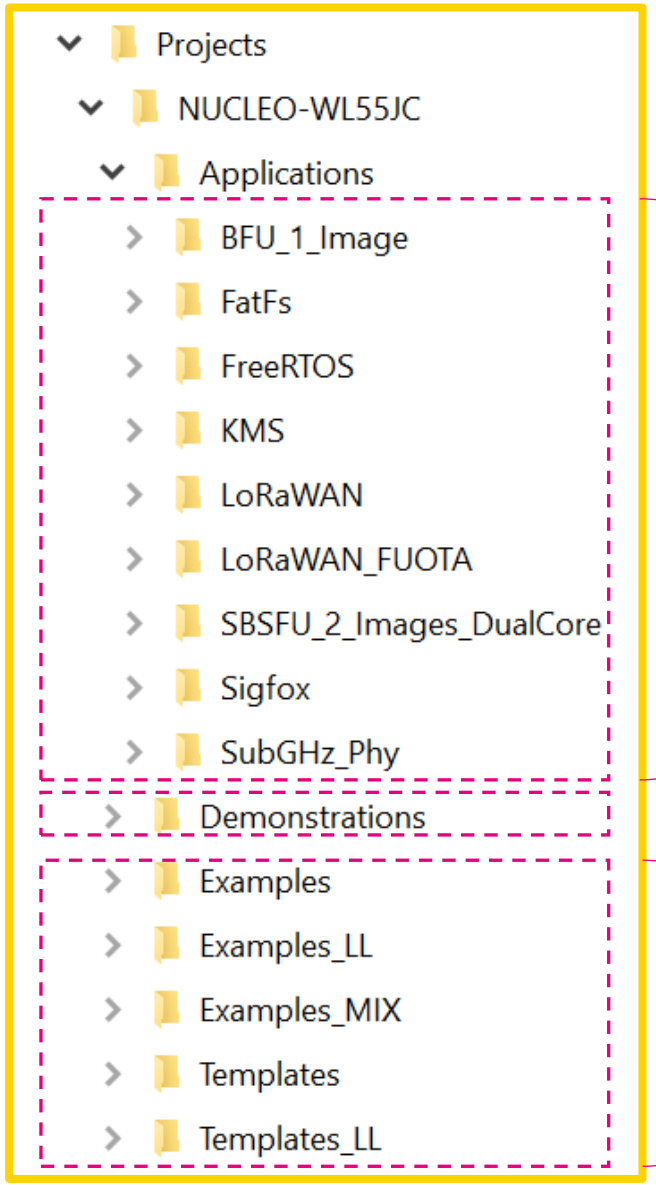


BSP

CMSIS

HAL Driver

Projects



STM32WL Application
- LoRa
- Sigfox
- SubGHz
- SBSFU
- KMS
- FUOTA
- FreeRTOS

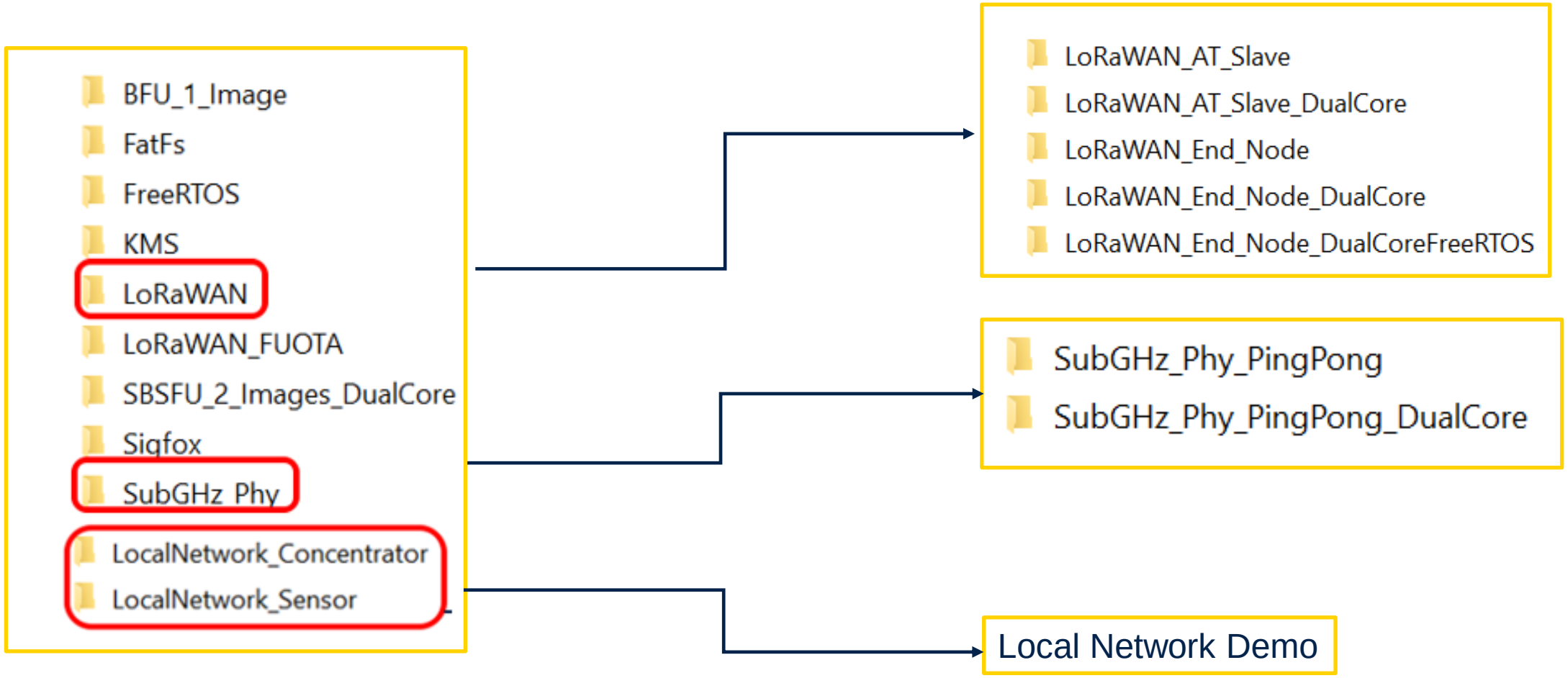
Local Network Demo

Peripheral Examples

下载链接：Here

STM32WL 例程

- STM32Cube_FW_WL_V1.0.0



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应用例程细节

- STM32WL Cube 开发包提供的4个 应用例程：
  - **LoRaWAN_AT_Slave**
    - 可以使用AT 指令和STM32WL 的LoRa 调制 通信
    - AN5481: LoRaWAN® AT commands for STM32CubeWL
  - **LoRaWAN_ End_Node**
    - STM32WL作为节点传输传感器数据到LoRaWAN 服务器
  - **SubGHz_Phy_PingPong**
    - STM32WL作为两个节点基于LoRa 调制进行点对点通信
  - **LocalNetwork**
    - STM32WL 基于LoRa调制搭建本地私有网络，一个STM32WL concentrator ， 多个STM32WL 节点 sensor

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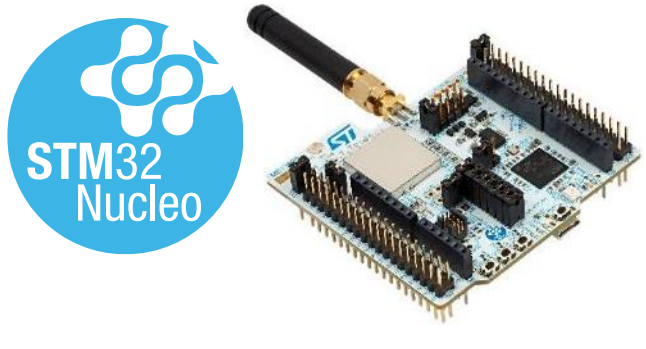
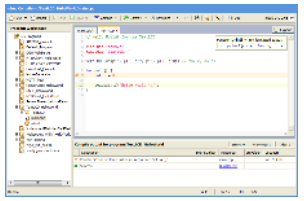
STM32WL 节点开发环境

STM32

STM32WL的生态系统

完全集成到经过市场验证的STM32丰富的生态系统中





STM32 Nucleo-64

开发非常容易的原型灵活硬件开发板:

NUCLEO-WL55JC1(High Band)

NUCLEO-WL55JC2(Low Band)

Dev tools

STM32CubeMX
STM32CubeWL
STM32CubeMonitor
STM32CubeProg
STM32CubeIDE + 合作伙伴IDE

Stacks

LoRaWAN (ST)

Sigfox (ST)

Wireless-MBUS (Stackforce)

ZETA (Zifisense)

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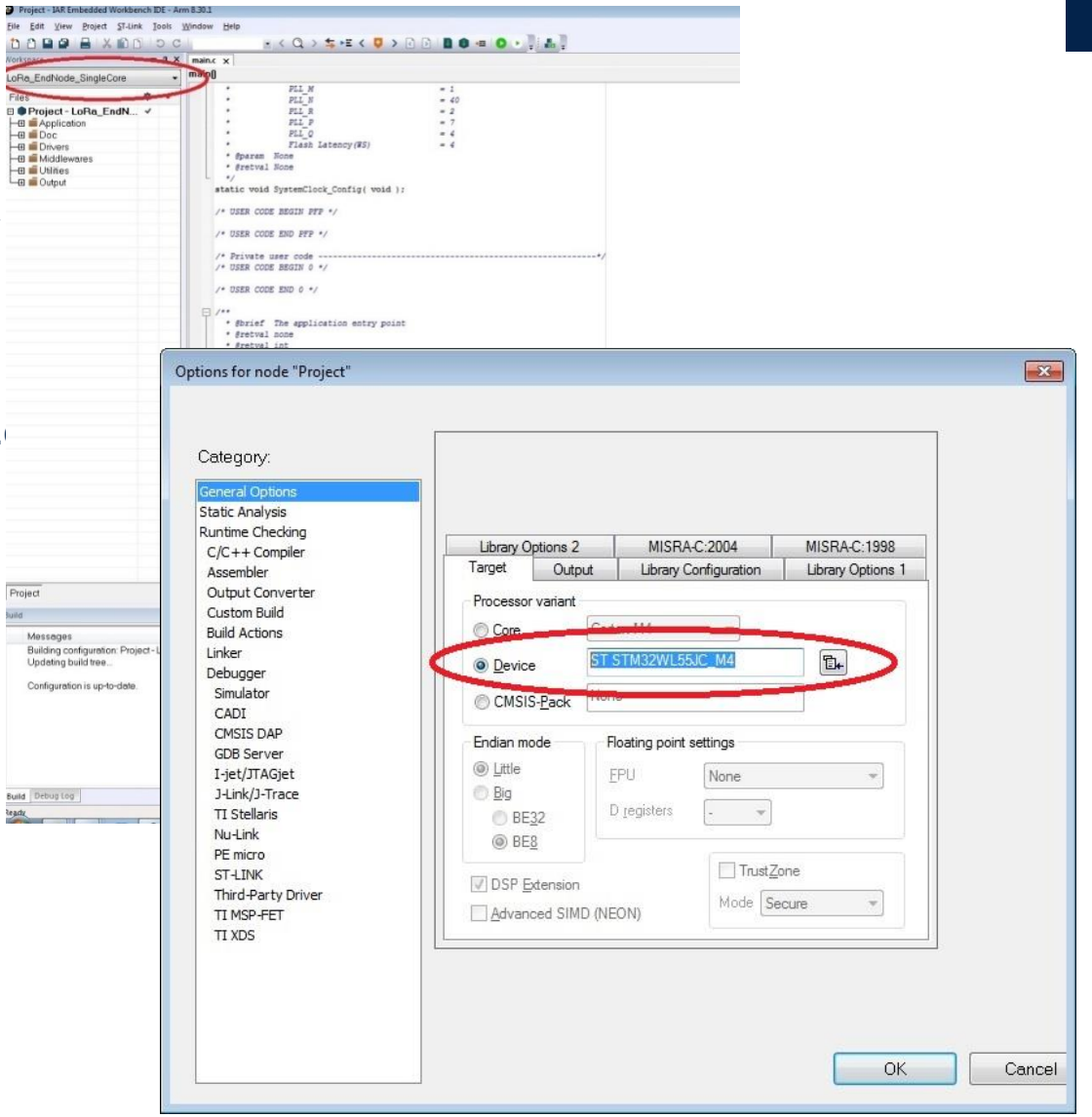
开发环境

- **硬件:**
  - STM32WLWL55JC Nucleo 板
    - NUCLEO-WL55JC1: 高频板，865 MHz - 930 MHz
    - NUCLEO-WL55JC2: 低频板，433MHz-520 MHz
- **软件**
  - STM32Cube_FW_WL_V1.0.0(STM32CubeWL)
  - **STM32CubeIDE**(1.5or later) /**IAR**(EWARM8 and laters)/**Keil** (MDK-ARM v5.25 or later installed)
  - EWARMv8_STM32WLxx_V4.6 补丁
    - 提取: STM32Cube_FW_WL_V0.2.0\Utilities\PC_Software
    - 运行EWARMv8_STM32WLxx_V4.6.exe， 默认安装路径是C:\Program Files\IAR Systems\Embedded Workbench \
  - Keil.STM32WLxx_DFP.1.0.7补丁
    - 提取: STM32Cube_FW_WL_V0.2.0\Utilities\PC_Software
    - 运行Keil.STM32WLxx_DFP.1.0.7.pack， 默认安装到keil 的安装路径
  - 串口工具：比如Tera Term

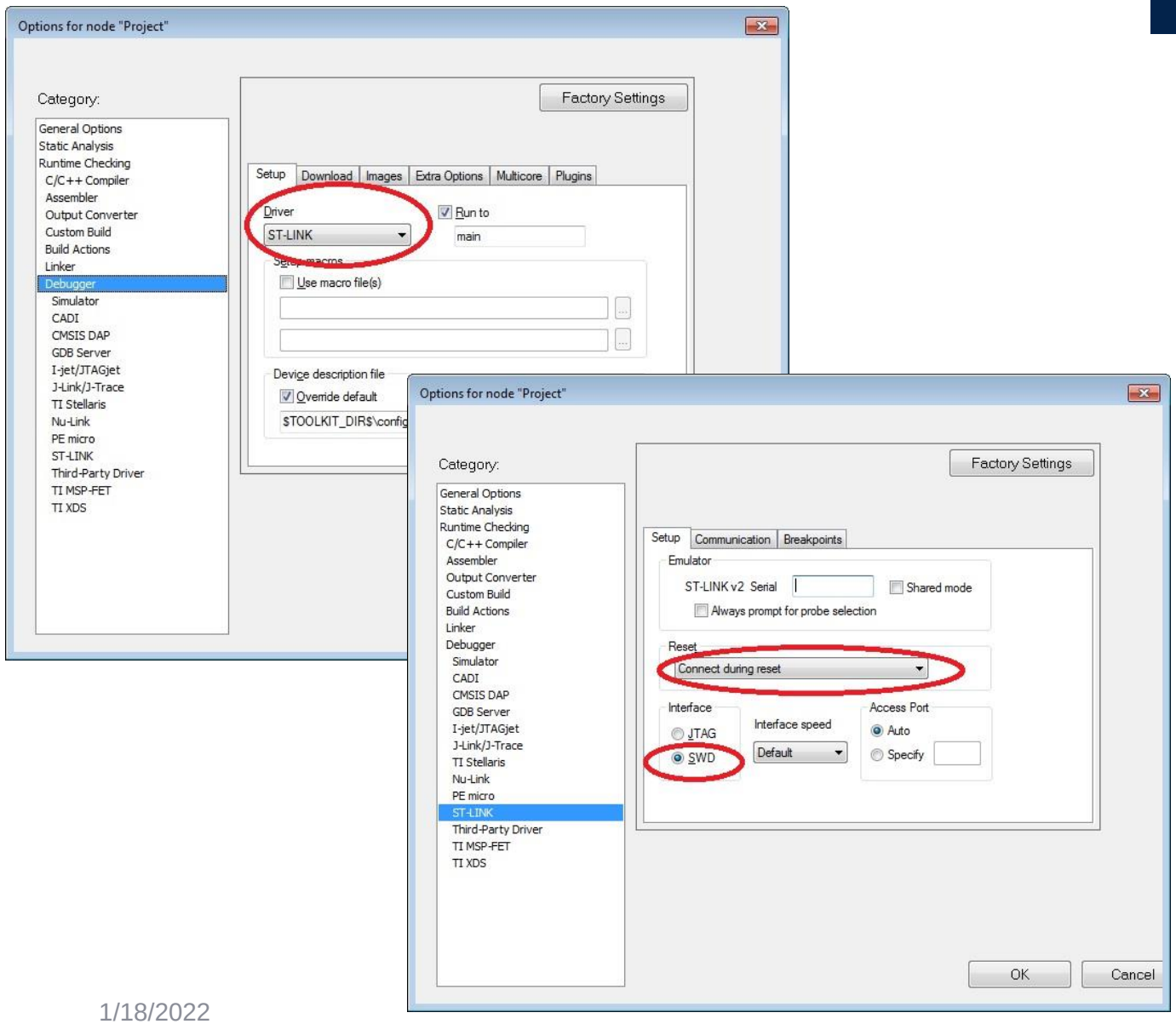
IAR 设置举例 (1/2)

- 打开 三个例程中的IAR工程:
  - STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN\LoRaWAN_End_Node\EWARM /Project.eww
  - STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN\LoRaWAN_AT_Slave\EWARM\Project.eww
  - STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\SubGHz_Phy\SubGHz_Phy_PingPong\EWARM\Project.
- 选择M4内核:
  - ST STM32WL55JC_M4



IAR 设置举例 (2/2)

- 检查是否使用ST-LINK调试
- 检查 ST-Link 配置
  - Connect during reset
  - Interface: SWD



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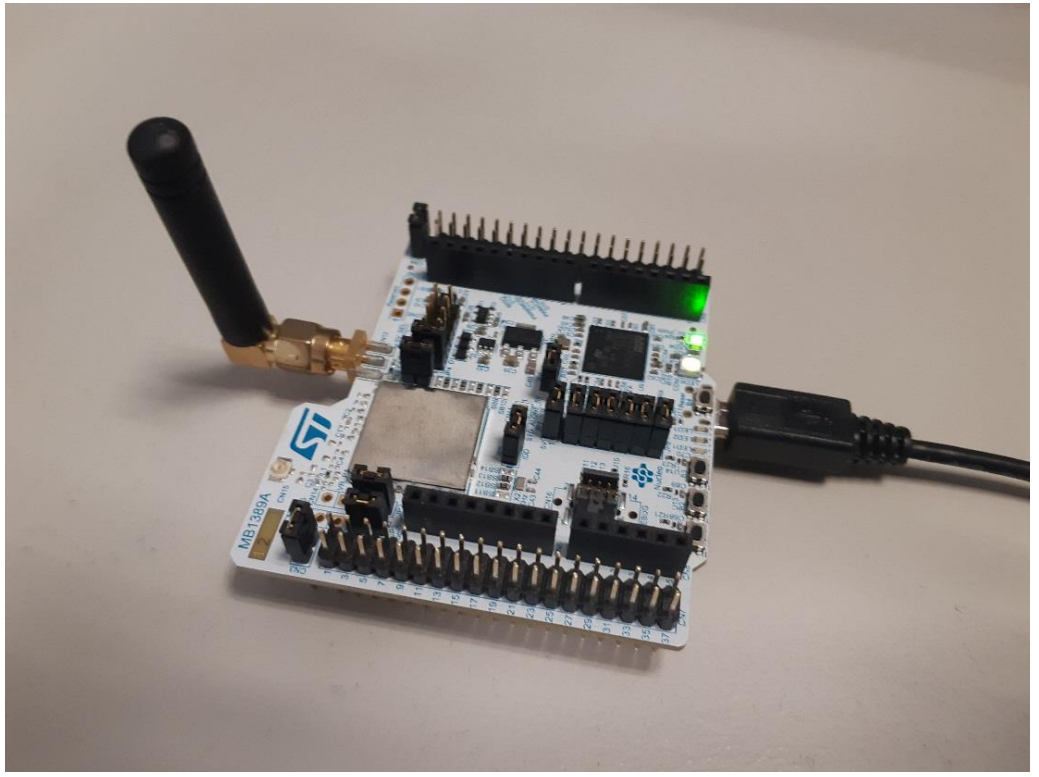
STM32WL Nucleo Board

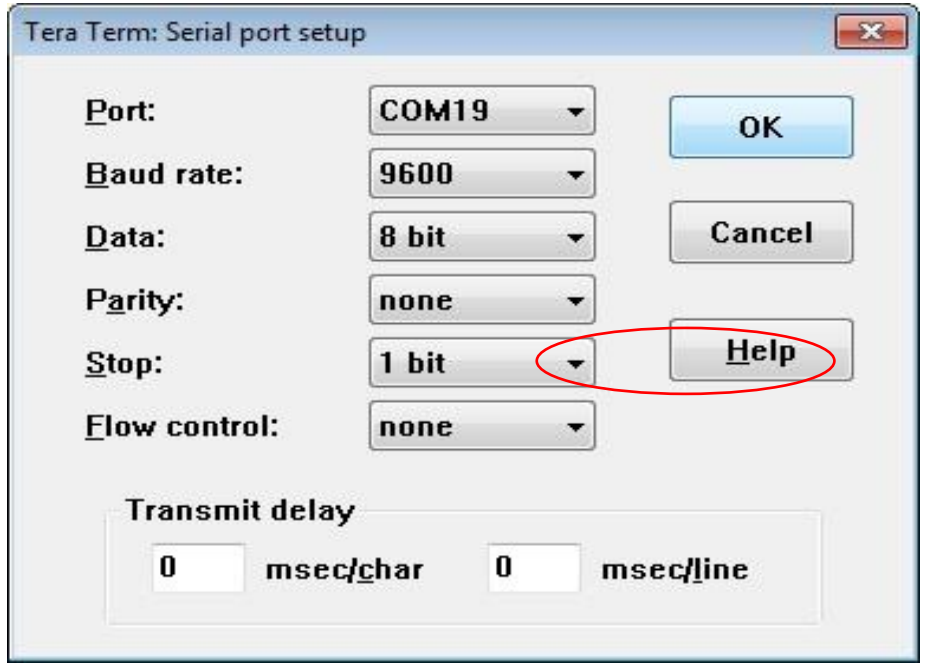
- 连接STM32WL Nucleo Board， 烧录软件
  - UM2592: STM32WL Nucleo-64 board (MB1389)

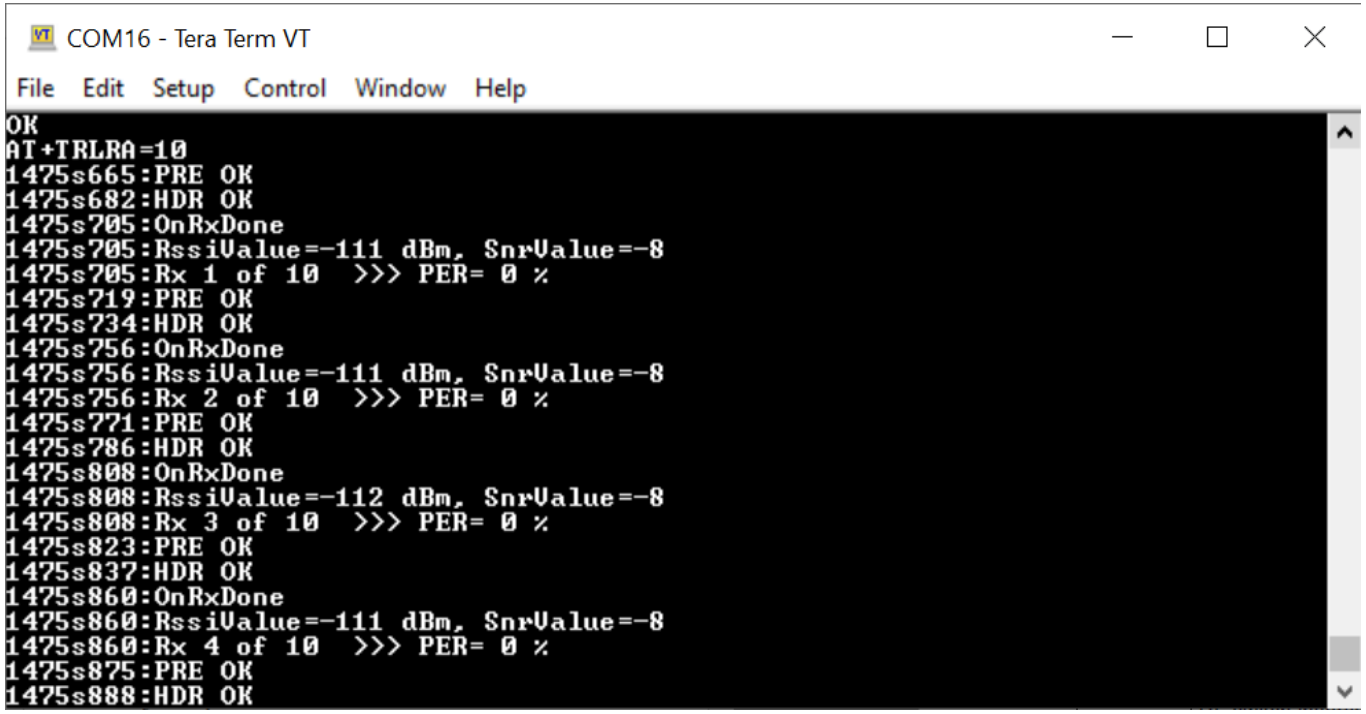


串口工具

- 打开串口工具 Tera Term监控
- 三个例程串口配置参考工程目录下对应的readme.txt
- 波特率

AT Slave	End Node	Ping Pong
9600	115200	115200





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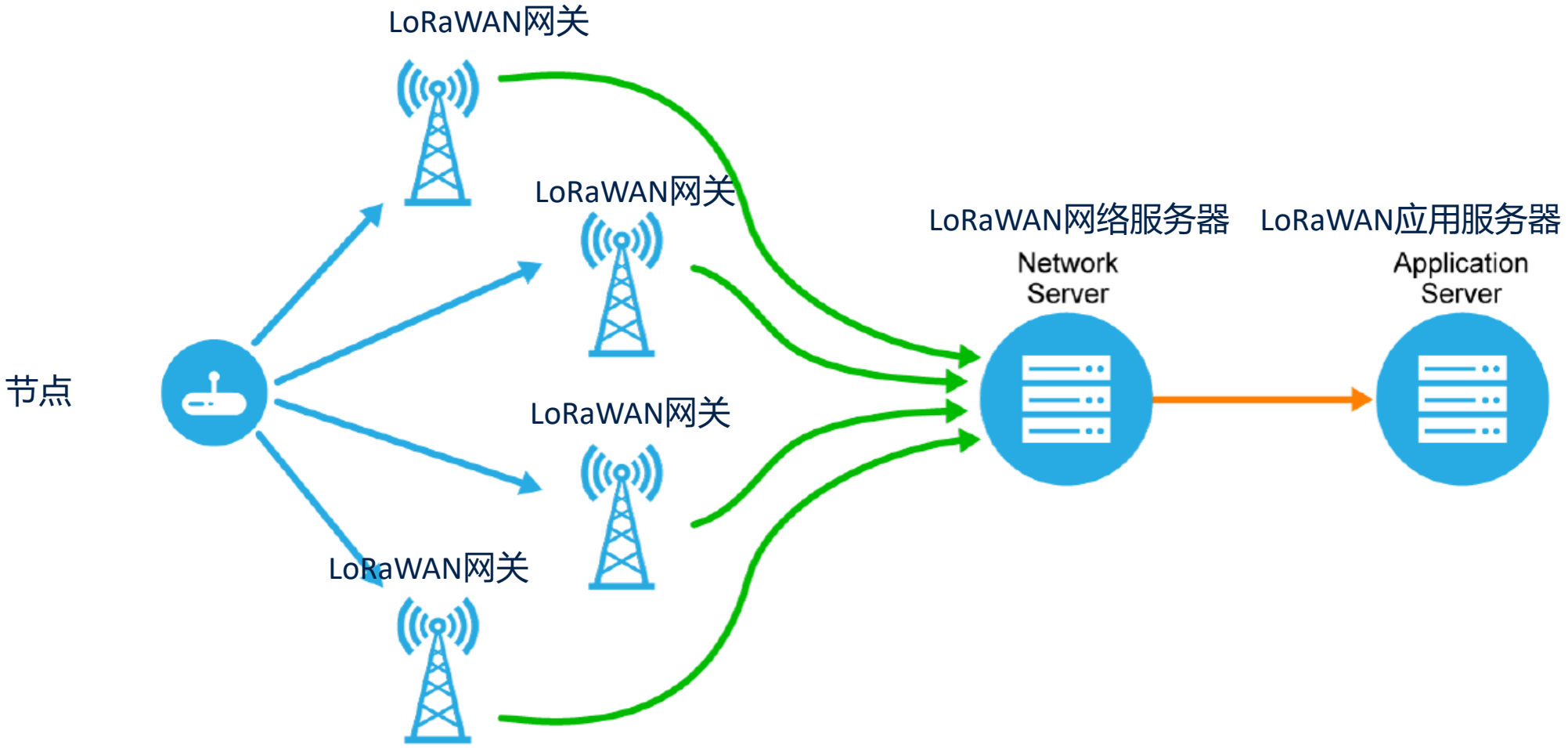
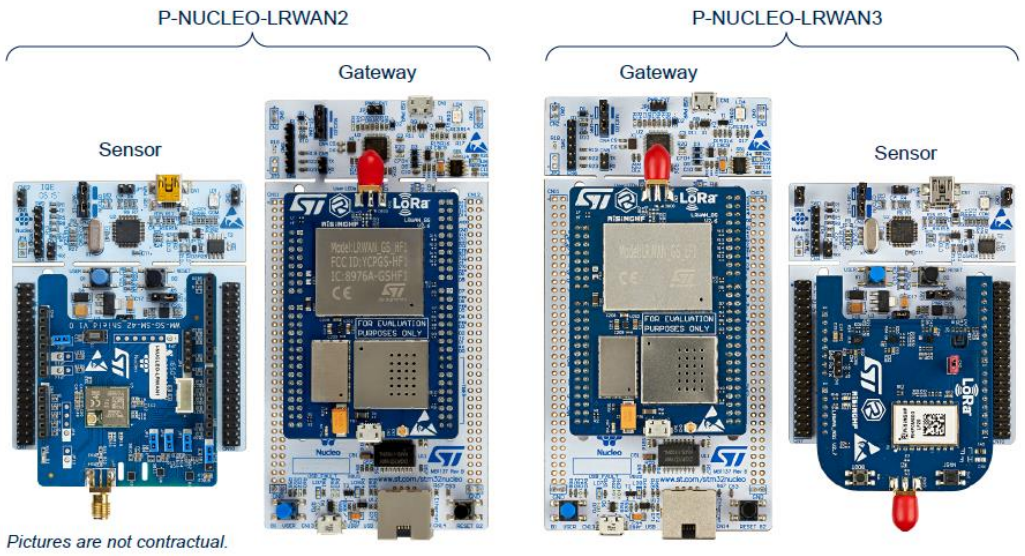
LoRaWAN 网关和网络服务器搭建

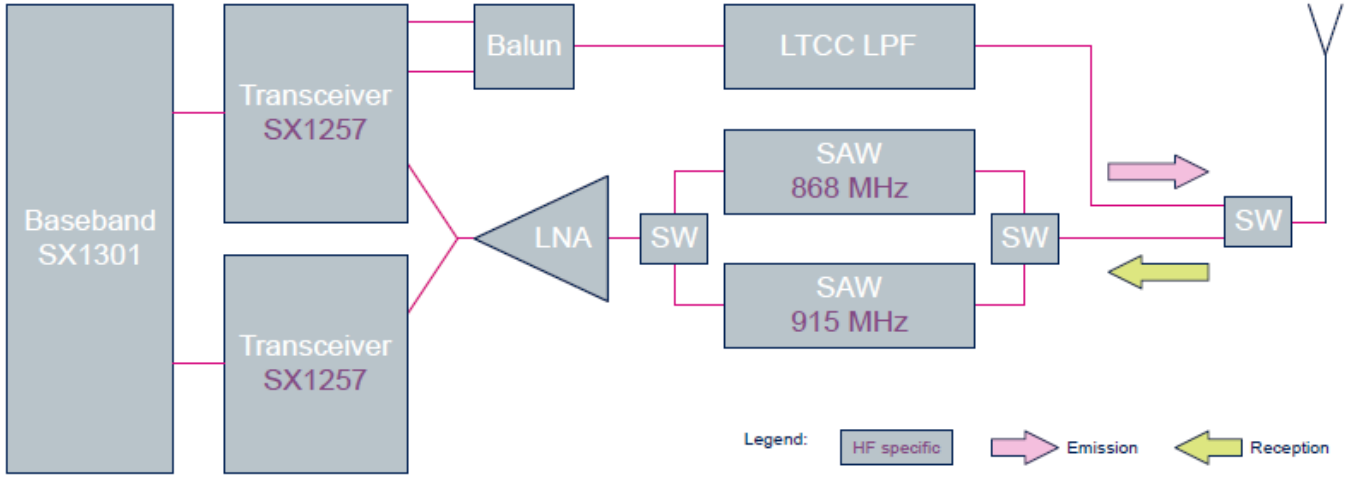
STM32

LoRaWAN 网络结构



P-NUCLEO-LRWAN 网关





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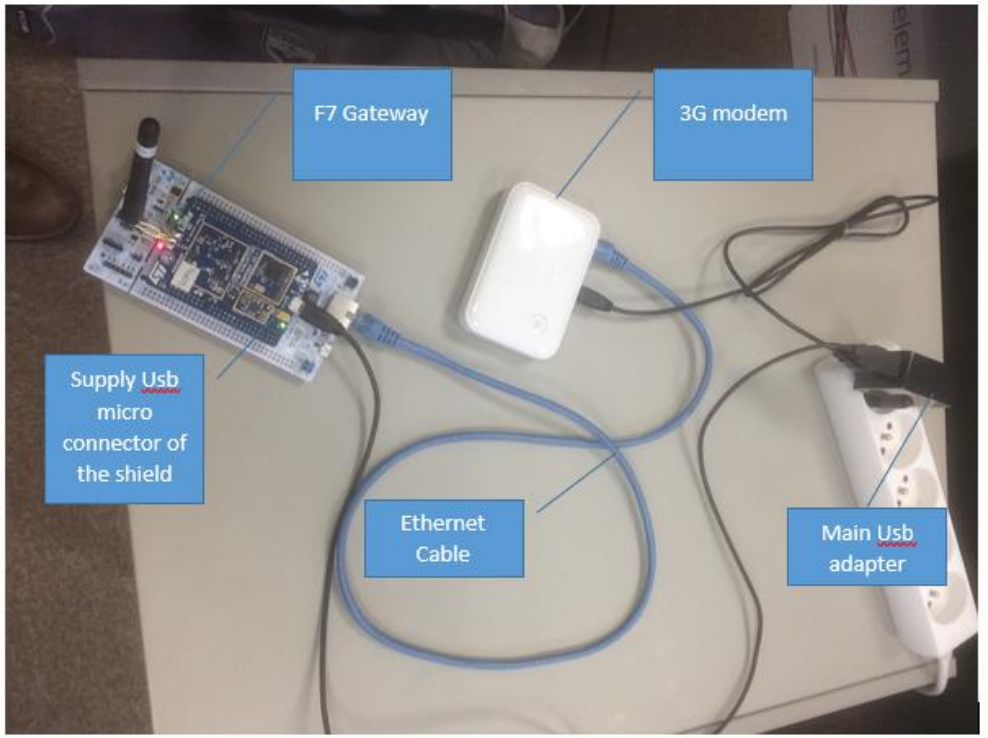
P-NUCLEO-LRWAN 网关配置

- 通过USB线给网关供电(如图示)

- 通过主板ST-Link连接串口
  - 通过串口使用AT 指令配置MAC 地址:
    - AT+MAC= 0800270DXXXX
  - 通过串口使用AT 指令配置LoRaWAN 网络服务器地址 和 端口
    - AT+PKTFWD: eu1.loriot.io, 1780, 1780

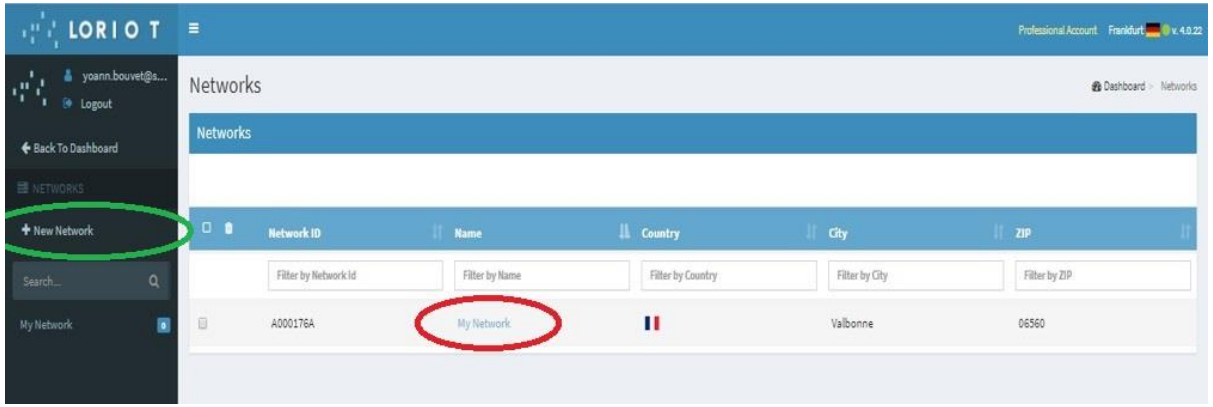
- 网关的网络通信
  - 无线热点 :
    - 网关通过网线连接热点上网
  - 有线网络



注册网关(1/2)

- 登入https://eu1.loriot.io
  - 建议使用Chrome 浏览器
- 注册账号
- 选择网络和网络名称

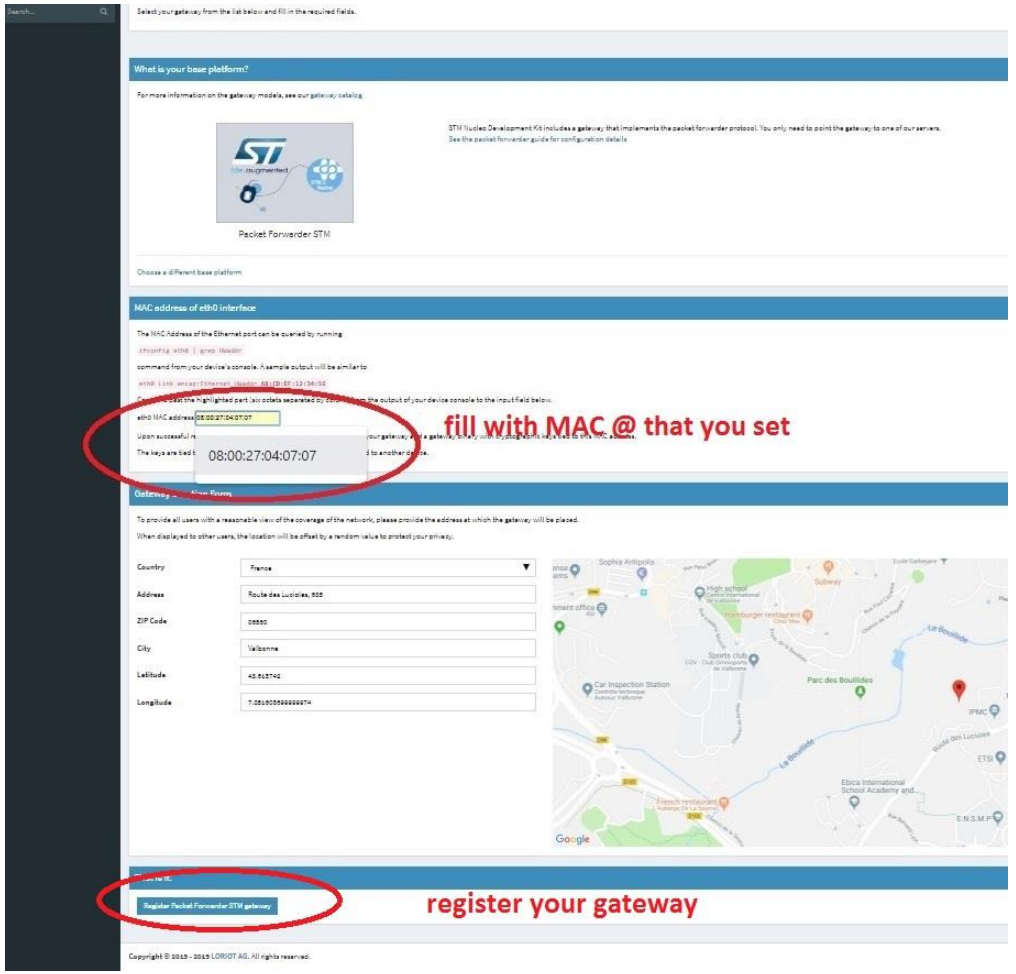
- 在网络服务器添加网关
  - 选择 ST packet Forwarder



注册网关(2/2)

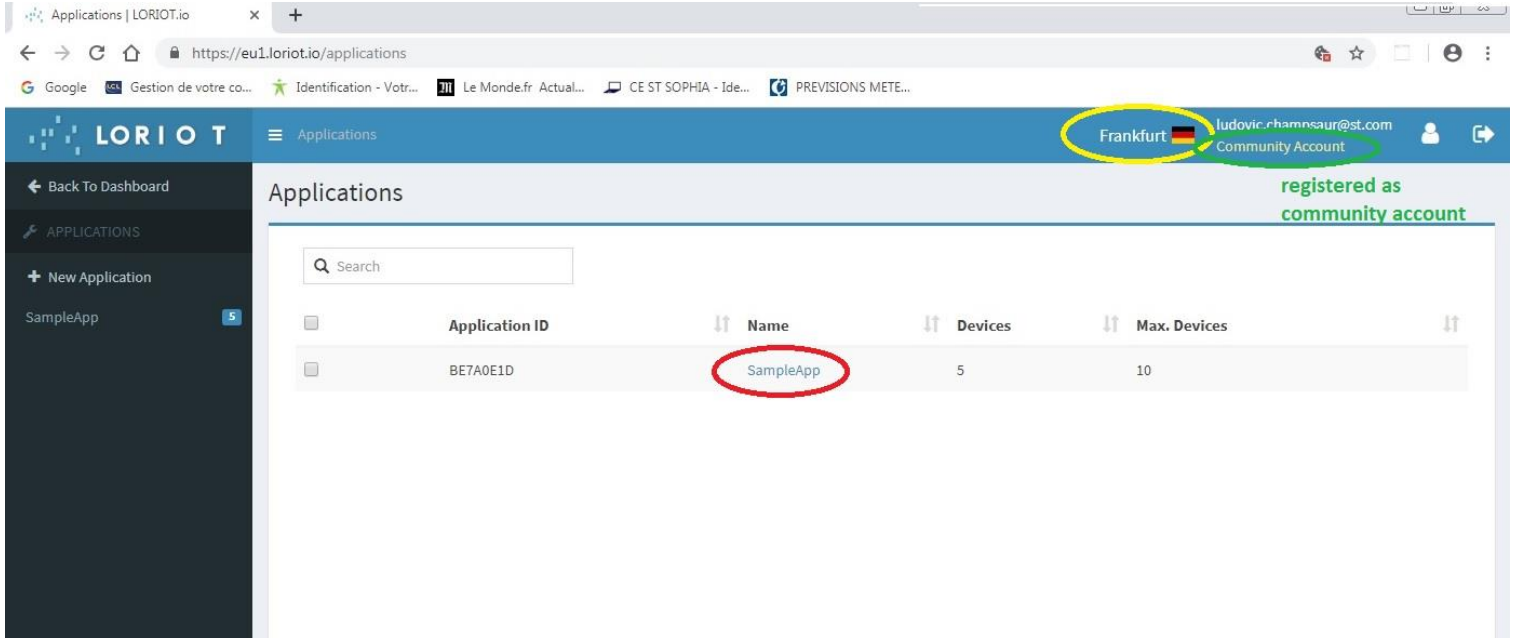
- 填入网关MAC地址
  - 通过串口读取MAC 地址或使用 AT+MAC修改
- 注册网关
  - 在网络服务器填入MAC地址，以及网关所在地理位置

```
          VERSION: 2.1.7, Nov 6 2018
              LOG: OFF
           AT ECHO: ON
         BAUDRATE: 115200bps
          MACADDR: xx:xx:xx:xx:xx:xx
         ETHERNET: DHCP
             DNS1: 114.114.114.114
             DNS2: 8.8.8.8
       NTP SERVER: 1.ubuntu.pool.ntp.org
      EUI PADDING: {3, FF}, {4, FF}
       GATEWAY ID: XXXXXXXXXXXXXXXX
          LORAWAN: Public
   LORAWAN SERVER: cn1.loriot.io
  UPLINK UDP PORT: 1780
DOWNLINK UDP PORT: 1780
          CHANNEL0: 471500000, A, SF7/SF12, BW125KHz   (LORA_MULTI_SF)
          CHANNEL1: 471700000, A, SF7/SF12, BW125KHz   (LORA_MULTI_SF)
          CHANNEL2: 471900000, A, SF7/SF12, BW125KHz   (LORA_MULTI_SF)
          CHANNEL3: 472100000, A, SF7/SF12, BW125KHz   (LORA_MULTI_SF)
          CHANNEL4: 472300000, A, SF7/SF12, BW125KHz   (LORA_MULTI_SF)
          CHANNEL5: 472500000, B, SF7/SF12, BW125KHz   (LORA_MULTI_SF)
          CHANNEL6: 472700000, B, SF7/SF12, BW125KHz   (LORA_MULTI_SF)
          CHANNEL7: 472900000, B, SF7/SF12, BW125KHz   (LORA_MULTI_SF)
          CHANNEL8: OFF                                (LORA_STANDARD)
          CHANNEL9: OFF                                (FSK)
```



添加应用

- 选择网关工作频段
- 使用 SampleApp application



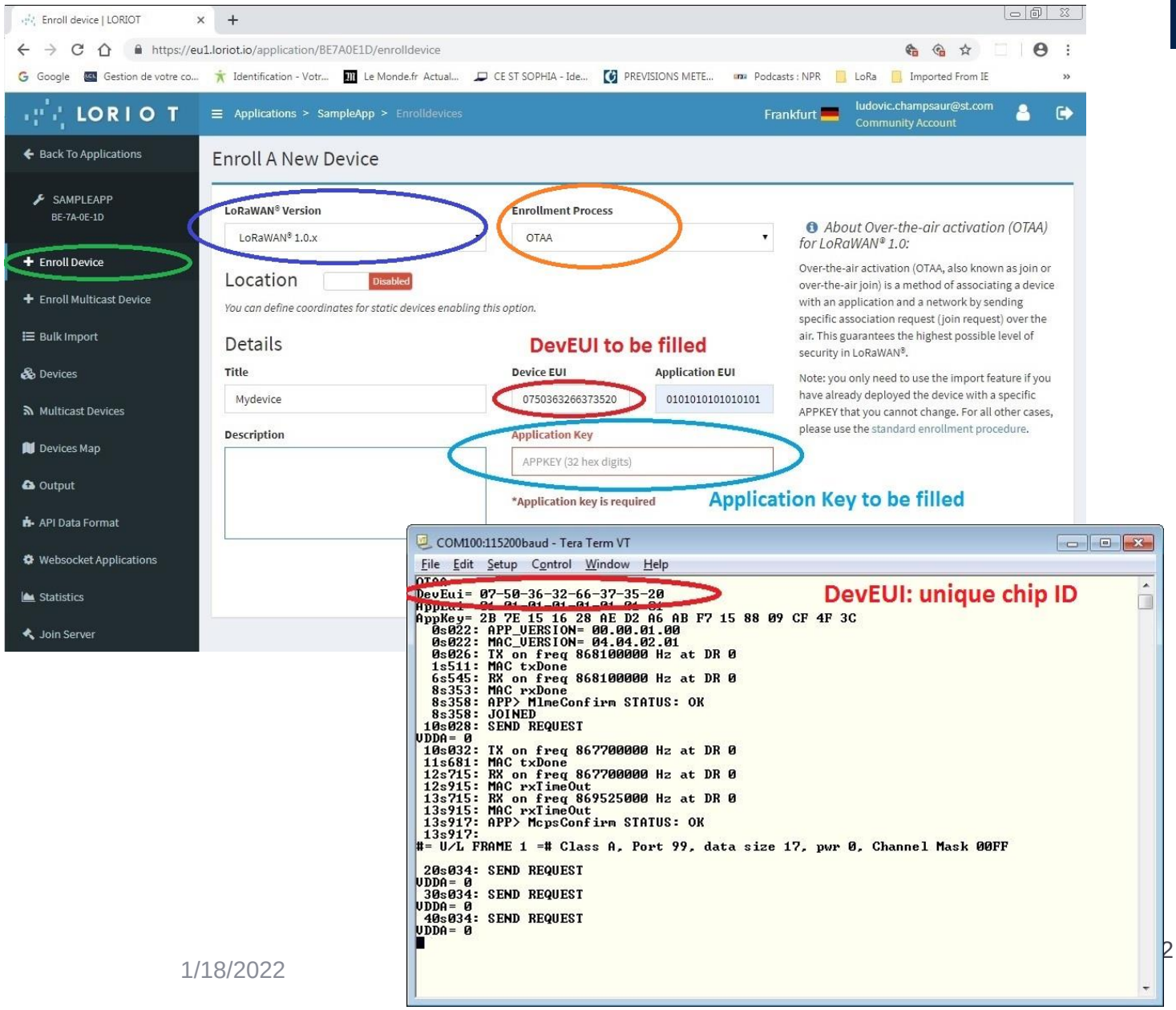
在应用添加节点

- 在 LoRiot 工具栏, 选择 “Enroll Device”
  - 检查LoraWAN version 1.0.x 版本
  - 检查入网方式，比如OTAA

- 填入配置好的节点参数(OTAA)(见下一章节点配置部分):
  - DevEUI :
  - Application Key
  - Application EUI:

- 本章节网关详细操作可参考UM2587

  UM2587 Getting started with the P-NUCLEO-LRWAN2 and P-NUCLEO-LRWAN3 starter packs 1.0



LoRaWAN_End_Node例程

LoRaWAN节点入网参数配置

1.在STM32Cube_FW_WL_V1.0.0 lora_app.h

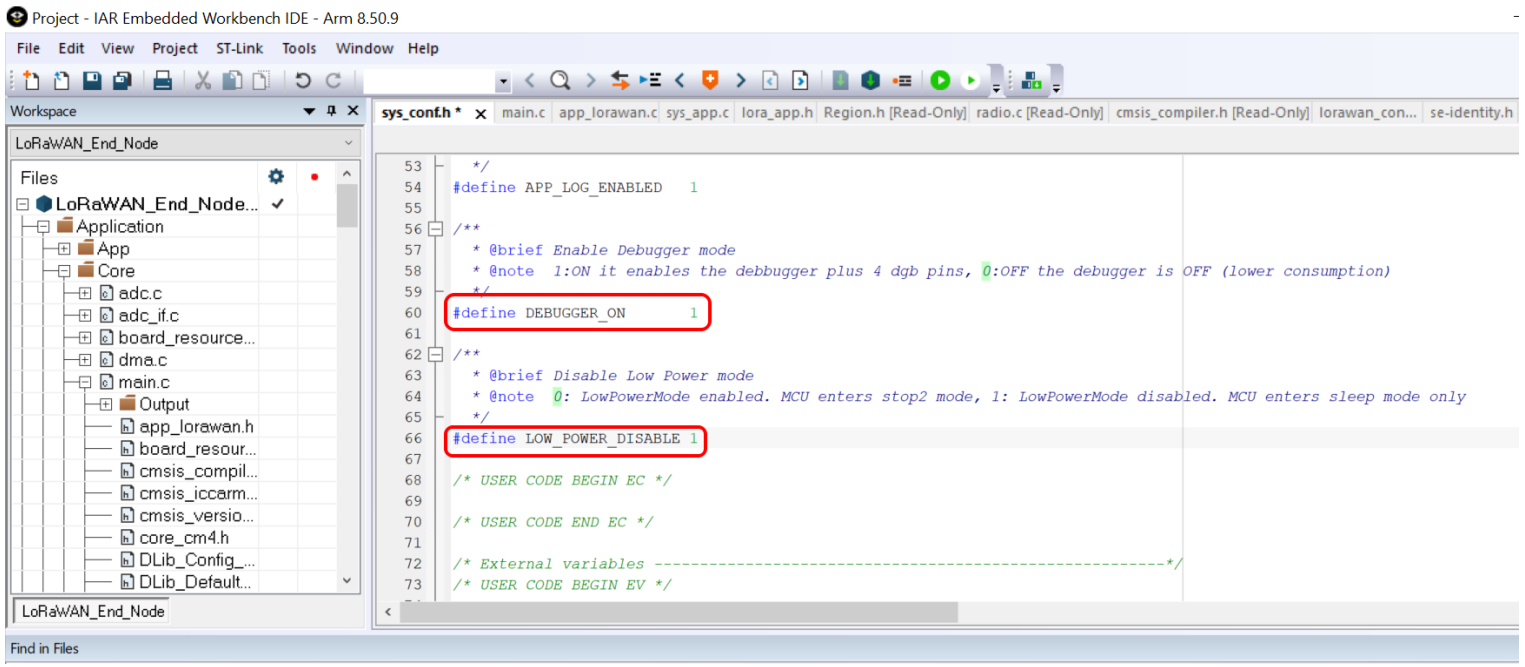
- 配置工作频段
  - #define ACTIVE_REGION LORAMAC_REGION_CN470,
- 配置入网方式 OTAA 或 APB
  - #define LORAWAN_DEFAULT_ACTIVATION_TYPE ACTIVATION_TYPE_OTAA (OTAA)
  - #define LORAWAN_DEFAULT_ACTIVATION_TYPE ACTIVATION_TYPE_ABP (ABP)

2.在STM32Cube_FW_WL_V1.0.0 se-identity.h 文件 配置LoRaWAN_End_Node入网参数

- 配置 DEVEUI
  - #define LORAWAN_DEVICE_EUI { 0x01, 0x01, 0x01, 0x01, 0x01, 0x01, 0x01, 0x01 }
  - #define STATIC_DEVICE_EUI 0
    - When set to 1 DevEui is LORAWAN_DEVICE_EUI
    - When set to 0 DevEui is automatically generated based on MCU ID
- OTAA参数
  - 配置LORAWAN_JOIN_EUI. 即 APPEUI
  - 配置 LORAWAN_APP_KEY. 即 APPKEY
- ABP参数
  - #define LORAWAN_DEVICE_ADDRESS (uint32_t)0x0100000A
  - #define LORAWAN_NWK_S_KEY 2B,7E,15,16,28,AE,D2,A6,AB,F7,15,88,09,CF,4F,3C
  - #define LORAWAN_APP_S_KEY 2B,7E,15,16,28,AE,D2,A6,AB,F7,15,88,09,CF,4F,3C

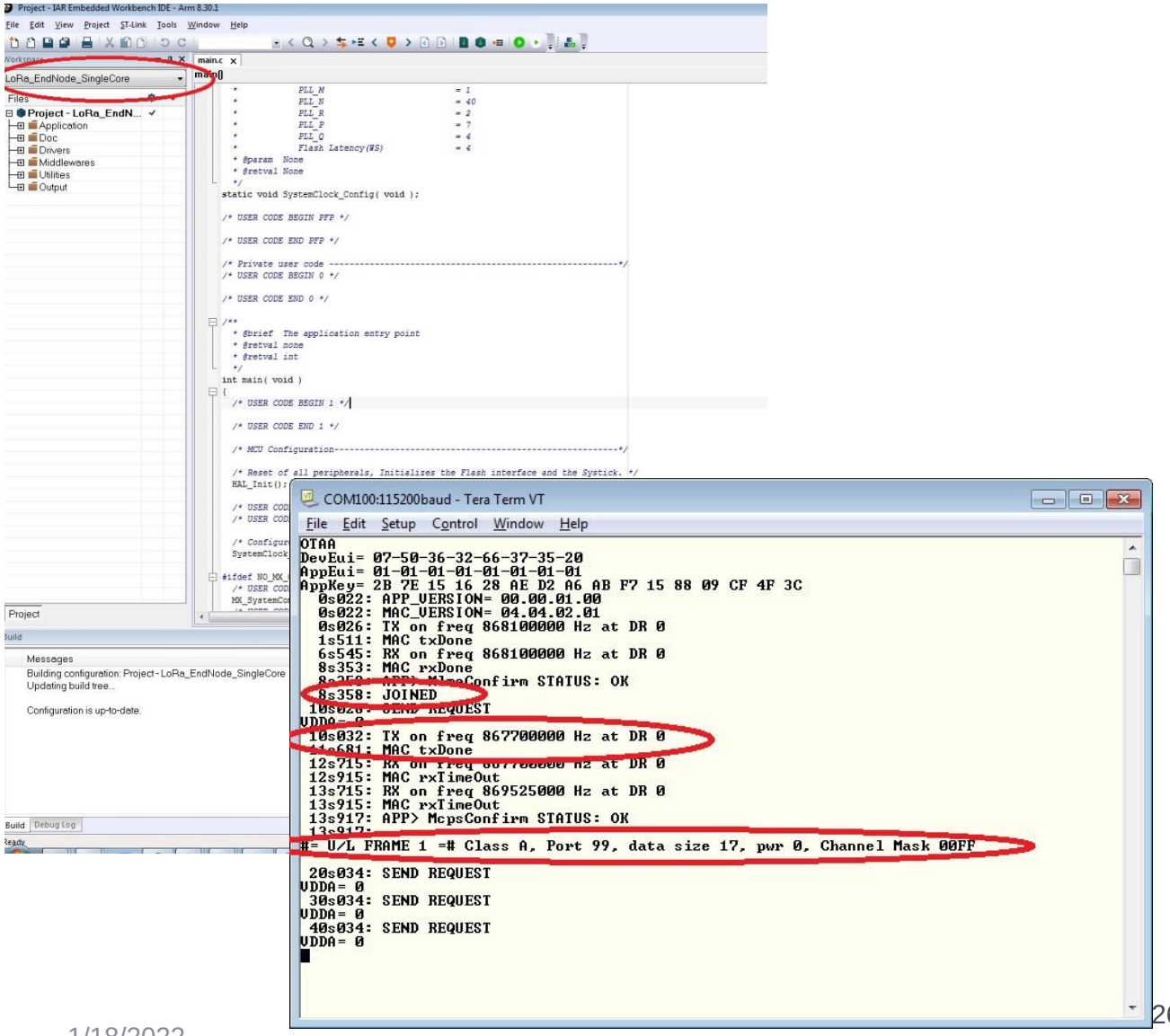
程序调试

- 在“sys_conf.h” 打开调试:
  - #define DEBUGGER_ON 1
- 在“sys_conf.h” 可关闭或打开低功耗模式:
  - #define LOW_POWER_DISABLE 0
- 使Nucleo 板上ST_LINK 进行调试



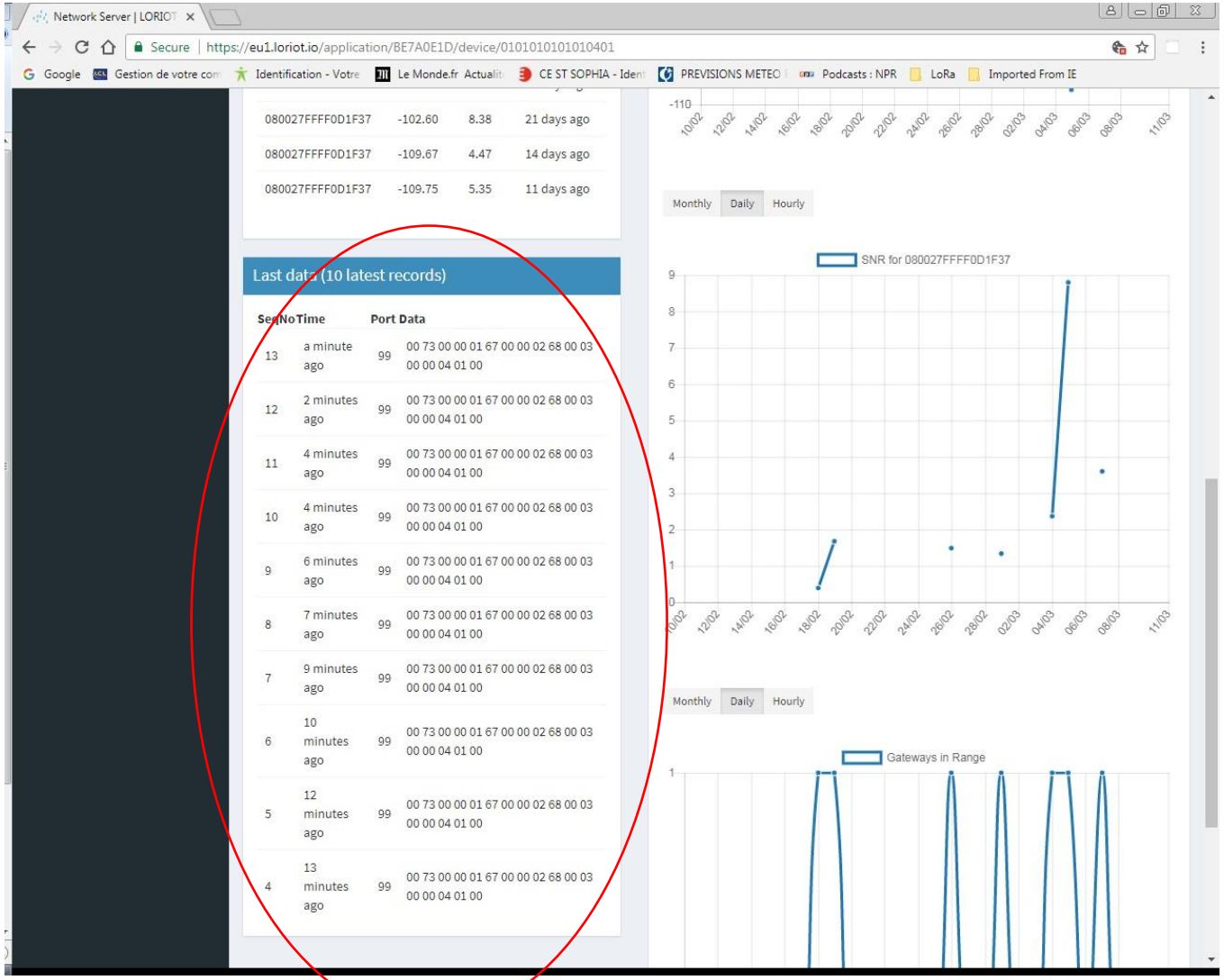
LoRaWAN_End_Node(1/2)

- 打开IAR 工程:
  - STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN\LoRaWAN_End_Node\EWARM \Project.eww
- 编译工程并烧写到STM32WL Nucleo 板上
- 通过串口可以观察工作状态信息:
  - “Joined”: devices joins Network
  - “MAC txDone”: Tx sent
  - “U/L Frame X”: Frame X sent & received



LoRaWAN_End_Node(2/2)

- 开启之前配置好的网关，打开网络服务器
- 节点配置完成，，节点就可以自动加入对应的网关，
- 网络节点将传感器信息传输到Loriot LoRaWAN 网络服务器

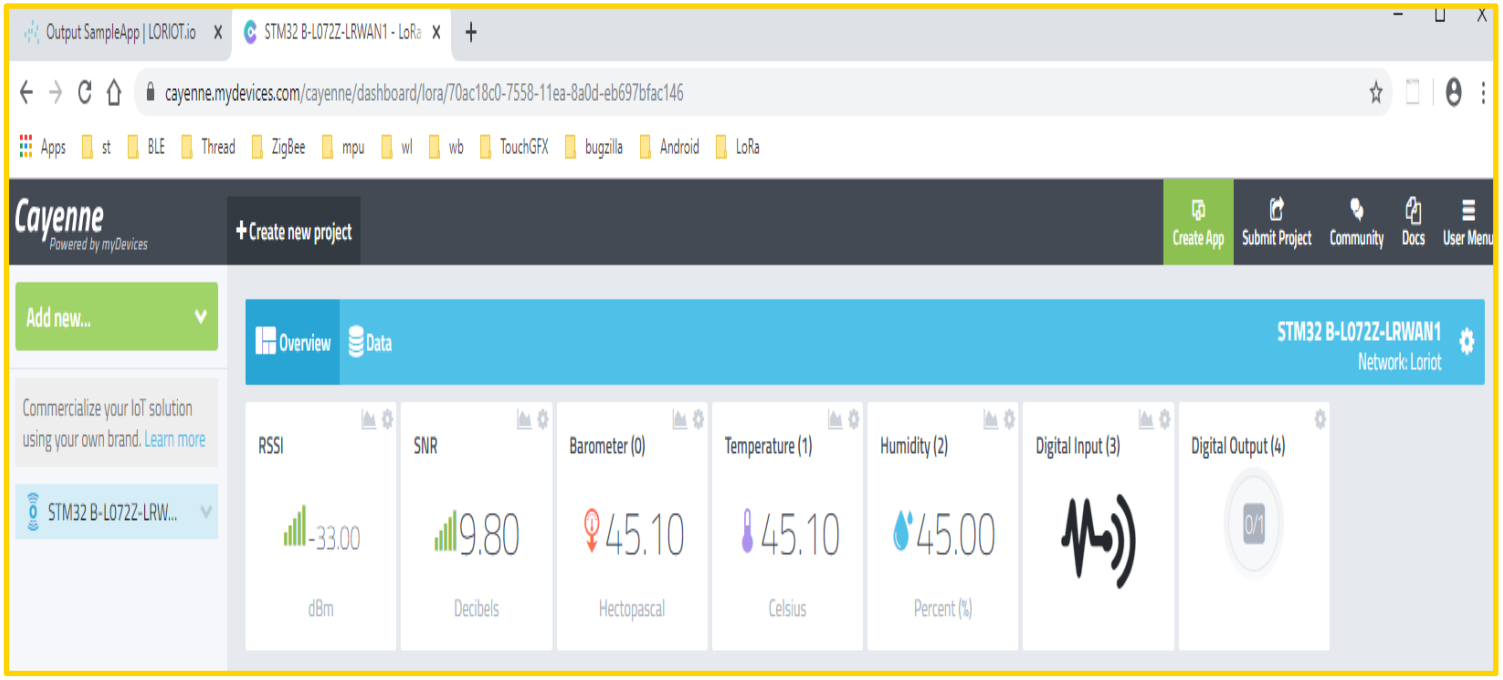


LoRaWAN_End_Node(2/2)

- LoRaWAN 网络服务器Loriot 收到数据后，还可以将网络服务器收到的数据转发给应用服务器Cayenne.

- 本章节详细操作可参考UM2587

  UM2587 Getting started with the P-NUCLEO-LRWAN2 and P-NUCLEO-LRWAN3 starter packs 1.0



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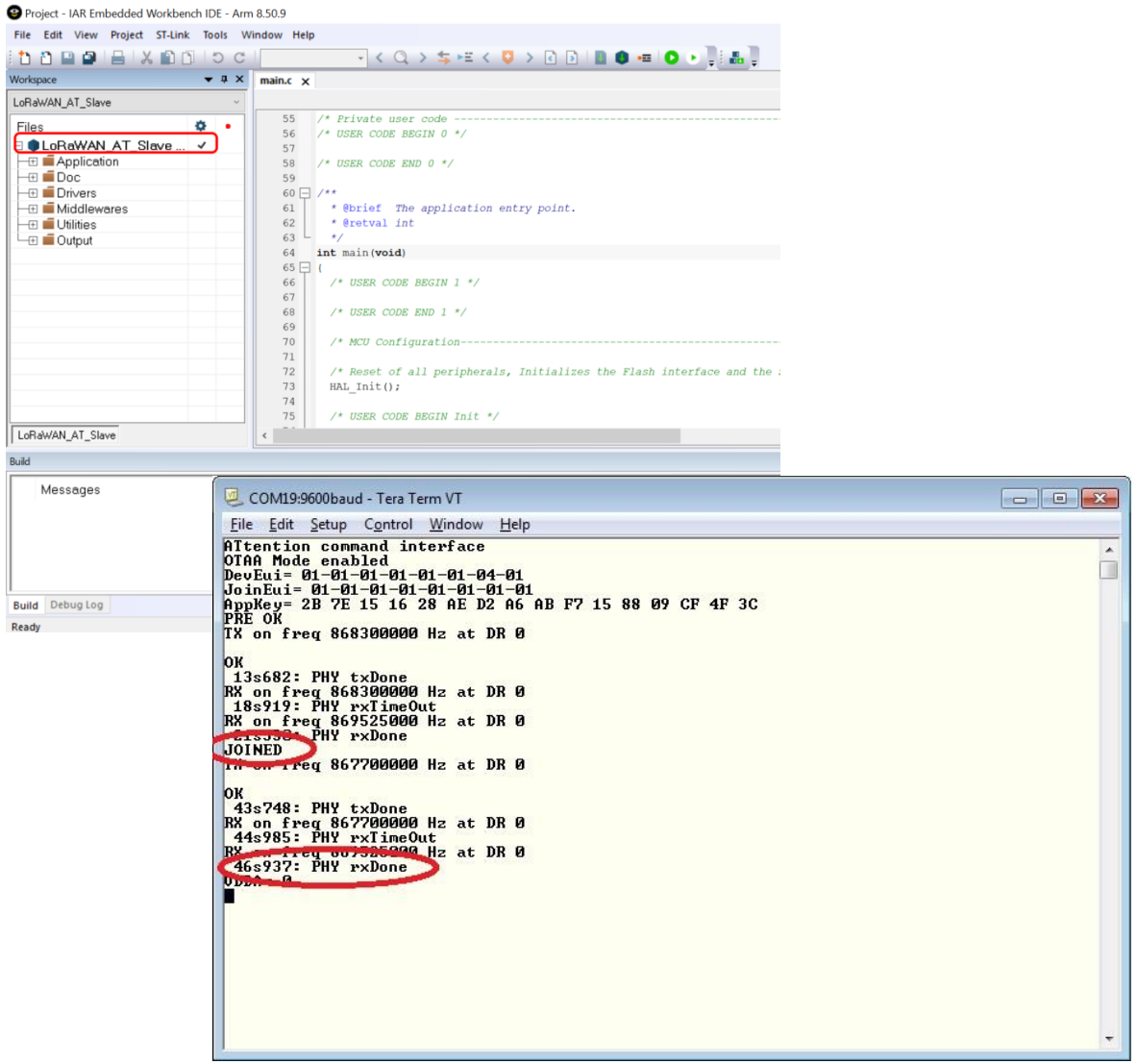
LoRaWAN_AT_Slave例程

STM32

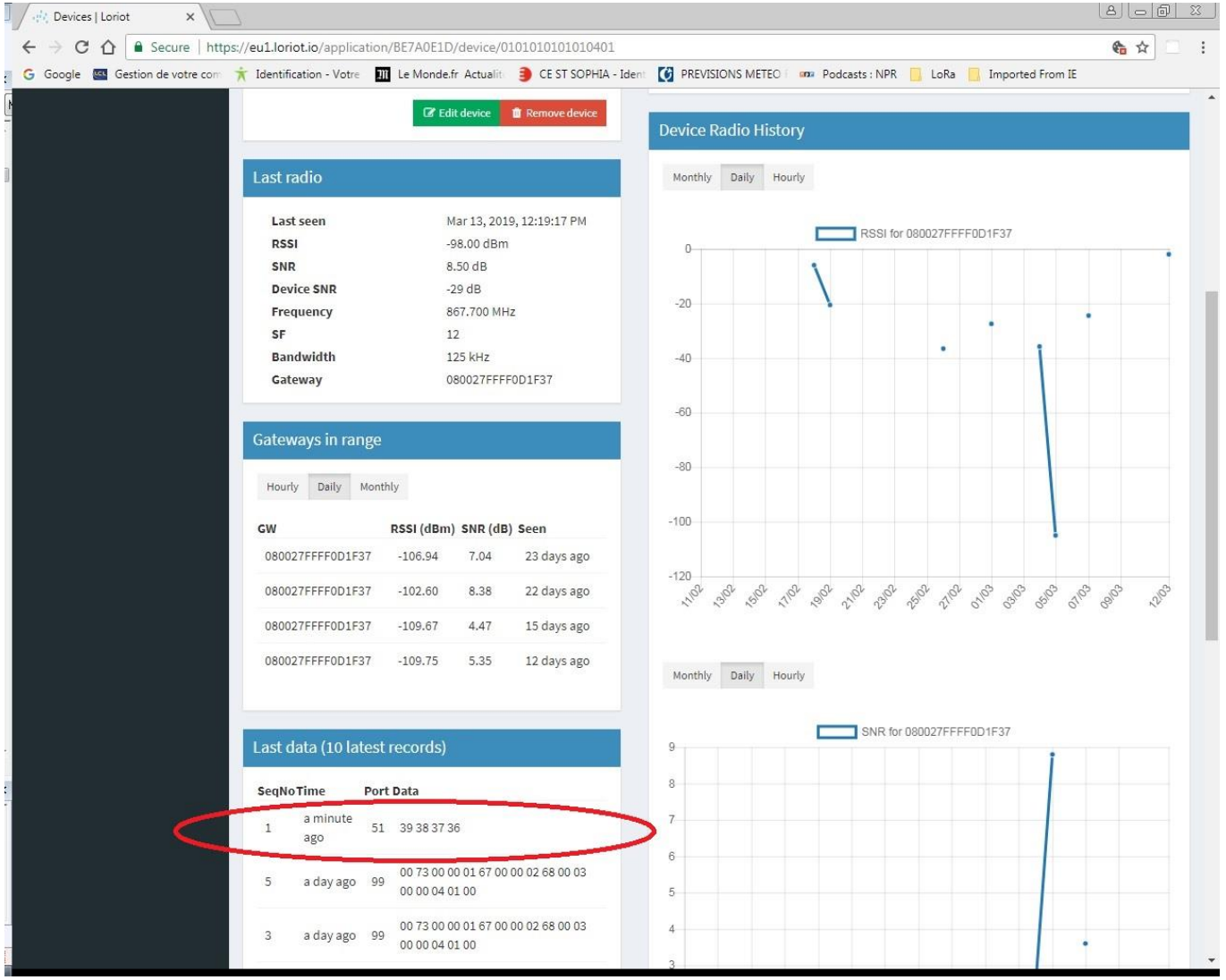
LoRaWAN_AT_Slave(1/3)

- 打开 IAR工程 :
  - STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\LoRaWAN\LoRaWAN_AT_Slave\EWARM\Project.eww
- 将编译好的软件烧写到STM32WL NUCLEO 板
- 打开串口工具,可使用AT指令对入网参数进行配：具体AT指令操作可以参考 AN5481: LoRaWAN® AT commands for STM32CubeWL
  - AT+APPEUI=<Param>
  - AT+APPKEY=<Param>
  - AT+DEUI=<Param>
  - AT+JOIN: Join the Network
  - AT+SEND=PortNb:my_value



LoRaWAN_AT_Slave(2/3)

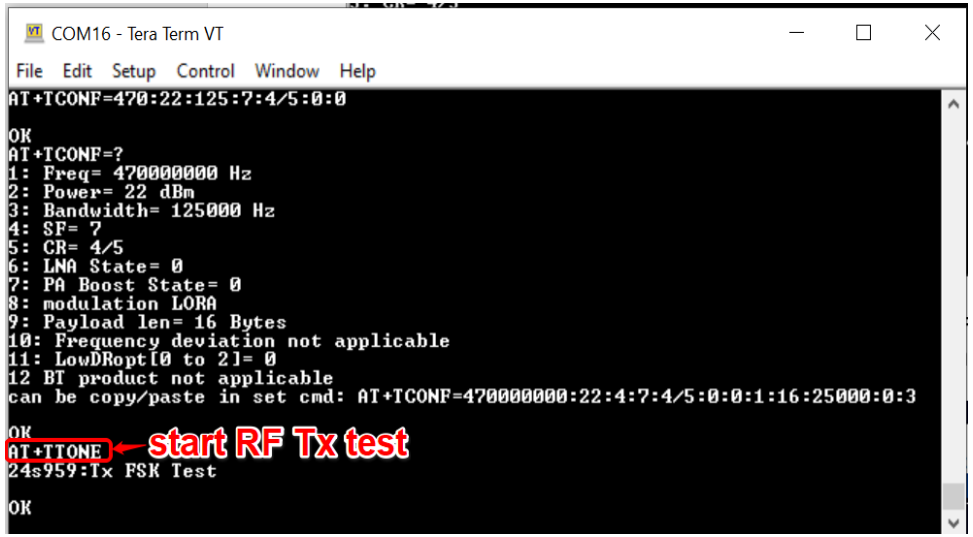
- 开启之前配置好的网关，打开网络服务器
- 节点配置完成，，节点就可以自动加入对应的网关，
- 网络节点将传感器信息传输到 Loriot LoRaWAN 网络服务器

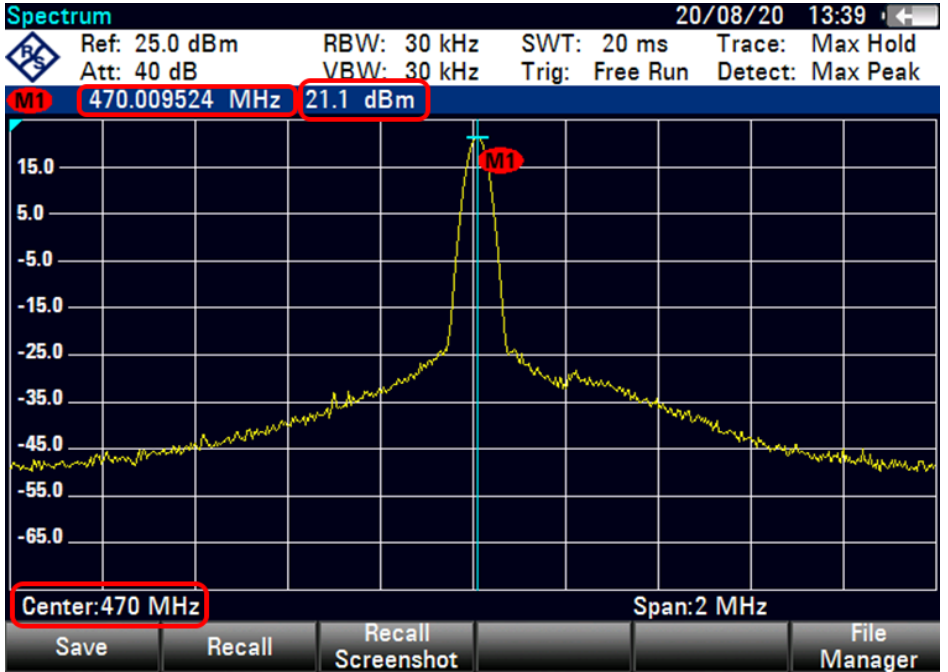


LoRaWAN_AT_Slave(3/3)

- 通过串口工具输入AT 指令也可以做LoRa RF 性能的测试

- 比如执行下面的指令测试RF Tx：
  - AT+TTONE



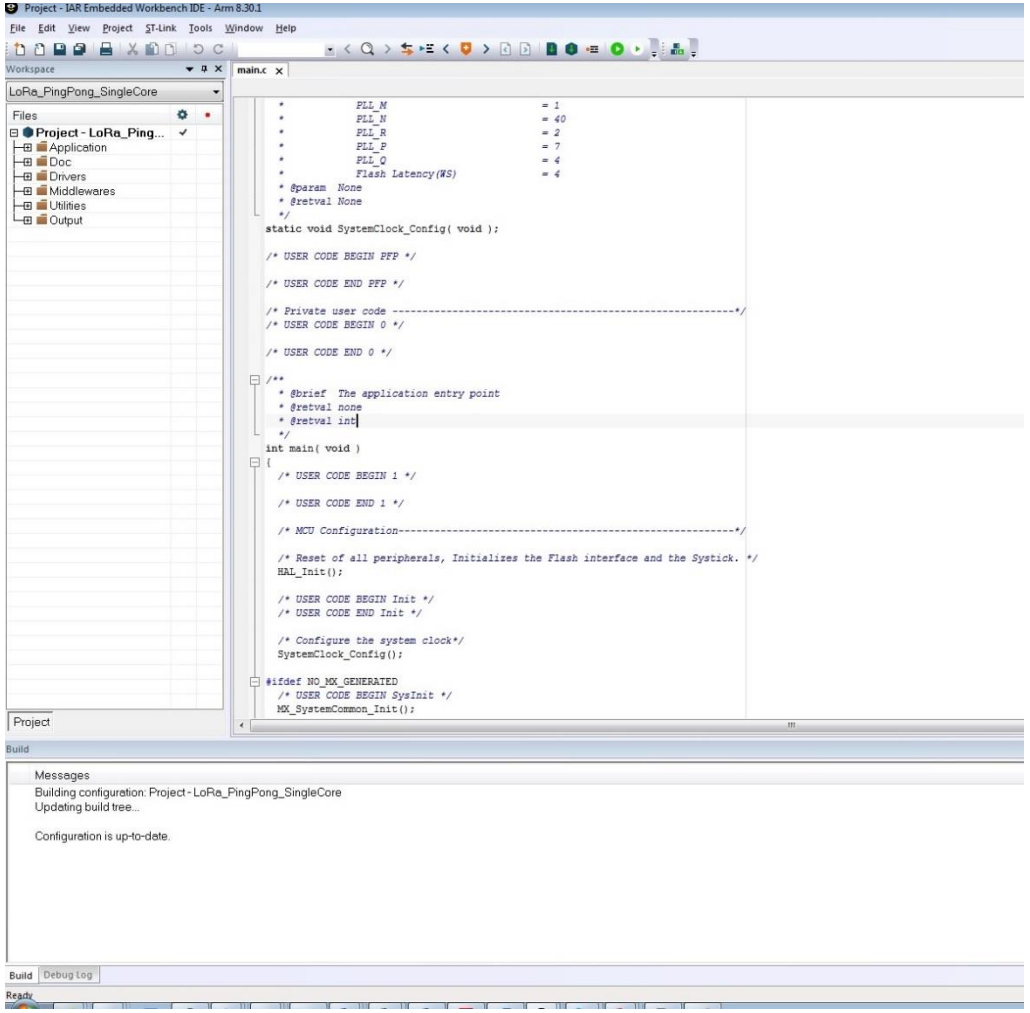


SubGHz_Phy_PingPong例程

Ping Pong (1/2)

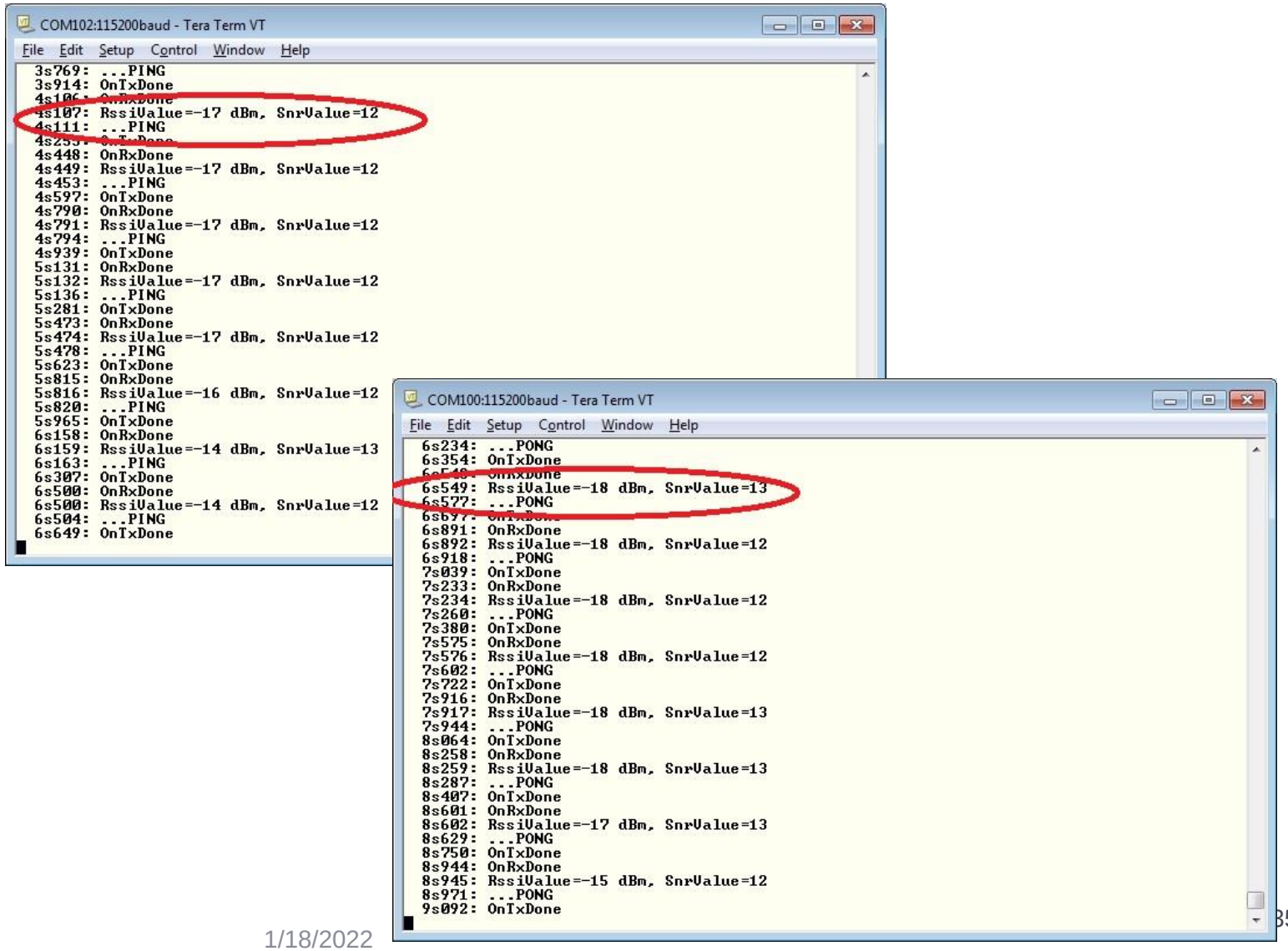
- 打开 IAR 工程编译:
  - STM32Cube_FW_WL_V1.0.0\Projects\NUCLEO-WL55JC\Applications\SubGHz_Phy\SubGHz_Phy_PingPong\EWARM\Project.eww

- 在两块STM32WL Nucleo 板上分别烧录软件
- 两块板中先上电的会做master发出PING 信息，另一块收到PING信息的板会做slave，并回一个PONG信息给master。
- 打开两个串口工具分别监控两块板的工作状态



Ping Pong (2/2)

- 做master的板串口显示如右上图:
- 做slave的板串口显示如右下图:
- 收到PONG消息时,红灯闪
- 收到PING消息时,蓝灯闪烁



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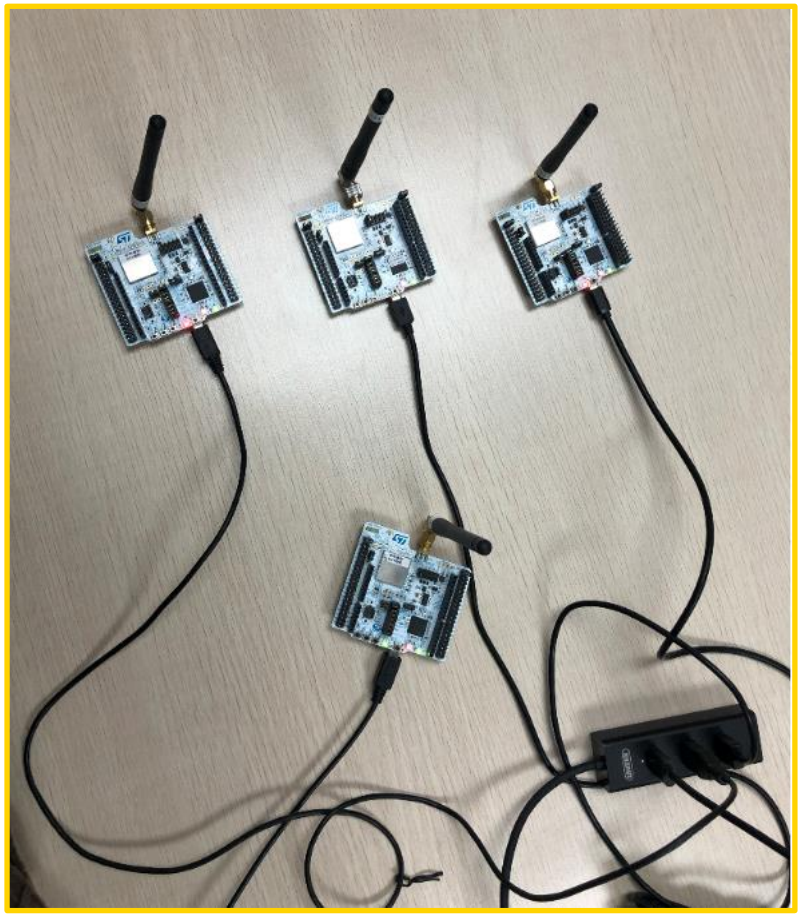
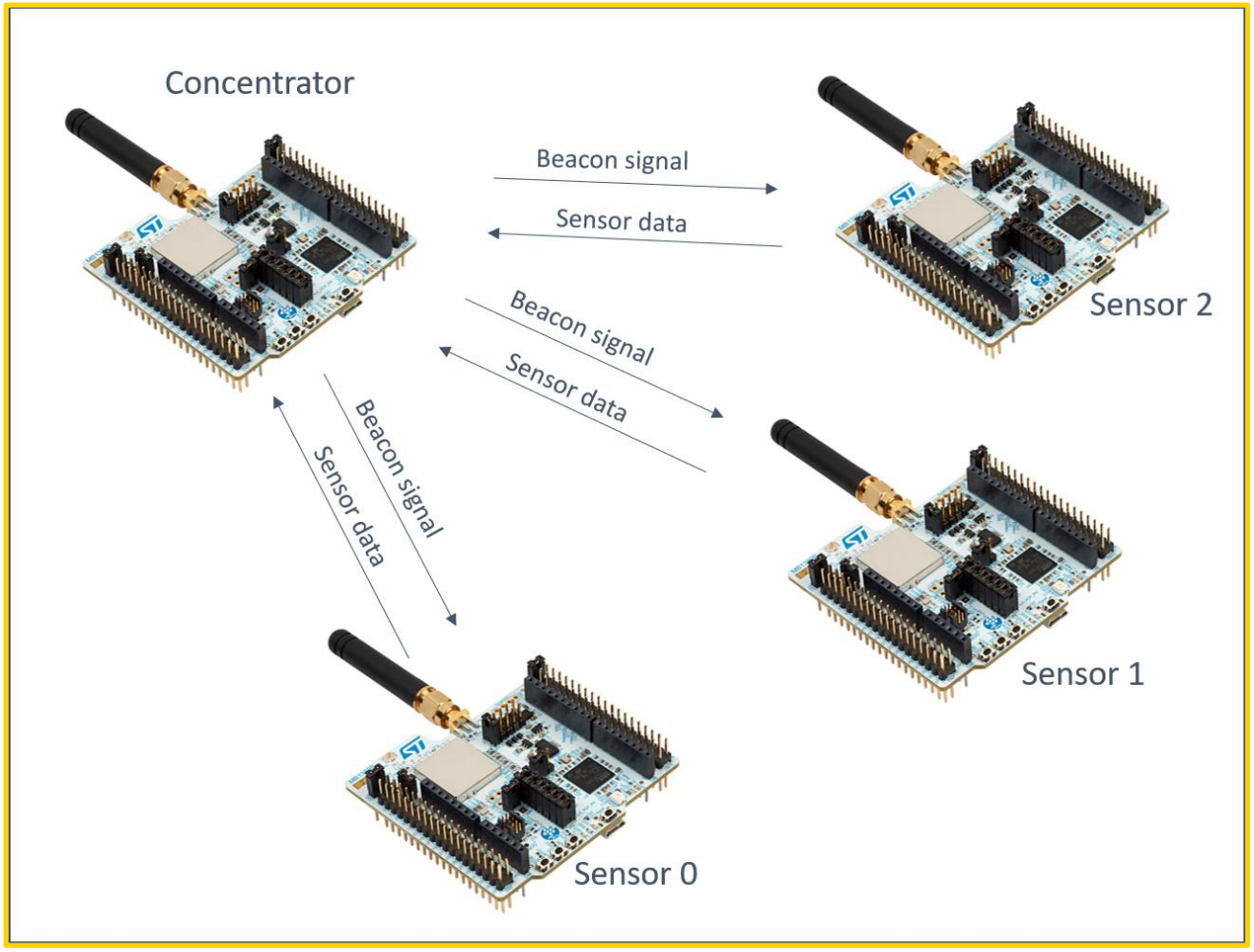
LocalNetwork例程

STM32

LocalNetwork(1/2)

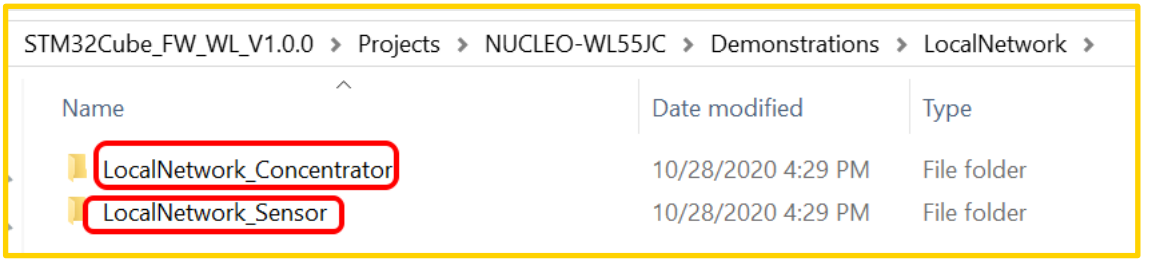
本例程可支持一个STM32WL concentrator，和14个STM32WL sensor组成的私有网络





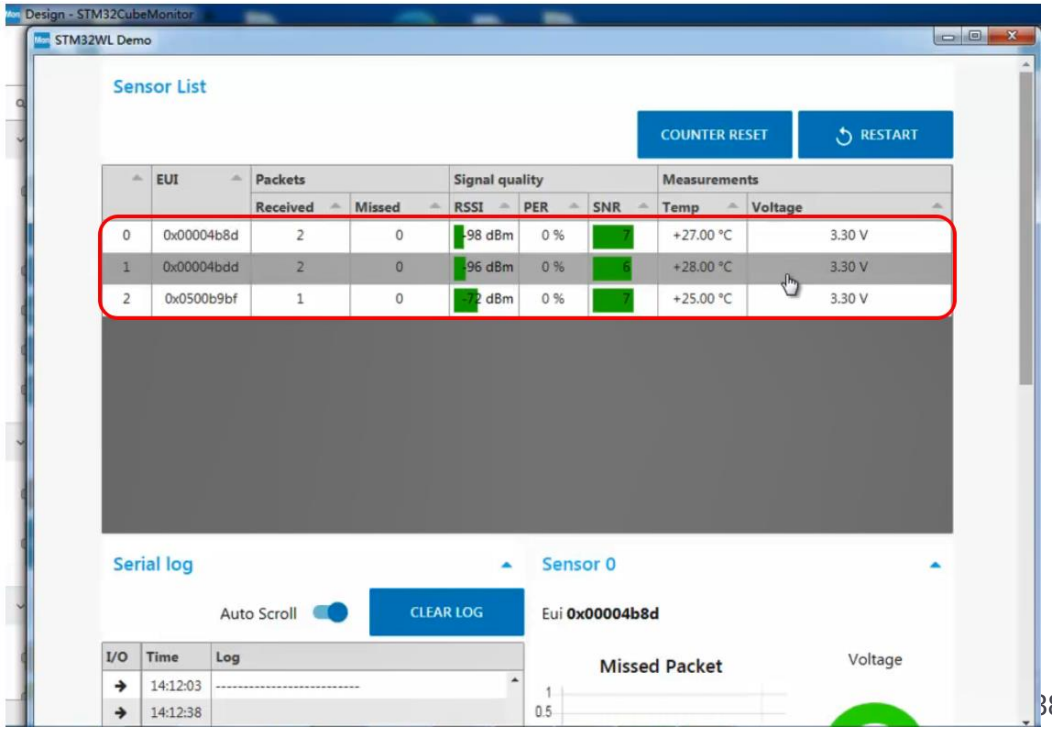
LocalNetwork(2/2)

- 比如，有四块STM32WL Nucelo 板，选其中一块作为Concentrator,烧写LocalNetwork_Concentrator 工程软件。其余3块烧写LocalNetwork Sensor 工程软件作为节点。



- 将四块STM32WL Nucleo 板分别上电，让节点加入concentrator

- 使用串口工具，或者STM32CubeMonitor1.1.0 监控节点传输传感器数据到Concentrator。



- 关于STM32CubeMonitor 详细操作请参考链接：
https://wiki.stmicroelectronics.cn/stm32mcu/wiki/STM32CubeMonitor:How_to_start_with_STM32_Wireless_Long_Range_demo

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课程回顾

1. 开发包
2. STM32WL 开发环境
3. LoRaWAN_End_Node例程
4. LoRaWAN_AT_Slave例程
5. SubGHz_Phy_PingPong例程
6. LocalNetwork例程

Thank you

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