Contiki 6LoWPAN Quick Guide
Contiki on STM32 Nucleo plugged with Sub-1 GHz RF expansion board
(X-NUCLEO-IDS01A4, X-NUCLEO-IDS01A5)

Version 1.3 (Jan. 28, 2016)
Introduction

• Contiki (*) is an open source operating system (OS) for the Internet of Things (IoT)

• ST has developed a Contiki 3.x port for the STM32 Nucleo board (NUCLEO) plugged with the supported expansion boards (X-NUCLEO)

• The guide explains how to quickly get started with this platform

(*) Information on Contiki OS are available at www.contiki-os.org
ST port overview

• The ST port allows running the Contiki OS, 6LoWPAN protocol stack and related applications on an STM32 Nucleo board plugged with one sub-1 GHz RF expansion board and, optionally, one motion MEMS and environmental sensors expansion board.

• Software available for download from Contiki GitHub repository: https://github.com/contiki-os/contiki

• Boards supported:
  • NUCLEO-L152RE based on the STM32L152RET6 ultra-low power microcontroller
  • X-NUCLEO-IDS01A4 based on sub-1 GHz SPSGRF-868 SPIRIT1 module (operating at 868 MHz)
  • X-NUCLEO-IDS01A5 based on sub-1 GHz SPSGRF-915 SPIRIT1 module (operating at 915 MHz)
  • X-NUCLEO-IKS01A1 based on motion MEMS and environmental sensors (optional)

• License: BSD-3 (same as the Contiki distribution license)
STM32 Nucleo
Development Boards (NUCLEO)

• A comprehensive range of affordable development boards for the entire STM32 microcontroller series, with unlimited unified expansion capabilities and integrated debugger/programmer functionality.
Sub-1 GHz RF expansion boards

Overview

Description

• The X-NUCLEO-IDS01A4, X-NUCLEO-IDS01A5 are evaluation boards based on the SPIRIT1 RF modules SPSGRF-868 and SPSGRF-915

• The SPIRIT1 module communicates with the STM32 Nucleo board host microcontroller through an SPI link available on the Arduino UNO R3 connector.

Key products on board

SPSGRF
SPIRIT1 (Low data-rate, low-power sub-1GHz transceiver) module

M95640-RMC6TG
64-Kbit serial SPI bus EEPROM

Order code: X-NUCLEO-IDS01A4, X-NUCLEO-IDS01A5

(*) Identification of the operating frequency of the X-NUCLEO-IDS01Ax (x=4 or 5) is performed through two resistors (R14 and R15).
Motion MEMS and environmental sensor expansion board

Description

• The X-NUCLEO-IKS01A1 is a motion MEMS and environmental sensor evaluation board.

• It is compatible with the Arduino UNO R3 connector layout, and is designed around ST’s sensors.

Key products on board

**LSM6DS0**: MEMS 3D accelerometer (±2/±4/±8 g) + 3D gyroscope (±245/±500/±2000 dps)

**LIS3MDL**: MEMS 3D magnetometer (±4/±8/±12/16 gauss)

**LPS25HB**: MEMS pressure sensor, 260-1260 hPa absolute digital output barometer

**HTS221**: Capacitive digital relative humidity and temperature

**DIL 24-pin**: Socket available for additional MEMS adapters and other sensors (UV index)

Order code: X-NUCLEO-IKS01A1

**Connector for the STM32 Nucleo Board**
Setup & demo examples
Hardware prerequisites

- 1 x **NUCLEO-L152RE** (STM32 Nucleo board)

- 1 x **X-NUCLEO-IDS01A4** (Sub-1 GHz RF expansion board based on the SPSGRF-868 module) or 1 x **X-NUCLEO-IDS01A5** (Sub-1 GHz RF expansion board based on the SPSGRF-915 module)

- (OPTIONAL) 1 x **X-NUCLEO-IKS01A1** (Motion MEMS and environmental sensor expansion board)

- Laptop/PC with Windows 8/7 or Linux Ubuntu 15.4

- 1 x USB type A to Mini-B USB cable
The ST port is installed automatically when the Contiki and sub-module repositories are cloned.

The cloning can be done using the following command:

```
git clone --recursive https://github.com/contiki-os/contiki.git
```

Contiki Platform name for ST port: stm32nucleo-spirit1
Setup & demo examples
Software prerequisites (2/2)

• PC software
  • Windows PC:
    • Linux environment on Windows using Cygwin (Link)
    • GCC is provided in the System Workbench for STM32 (SW4STM32) (Link)
    • Git package for Cygwin or Git for Windows (Link)
    • WinPcaP (for demo purpose) (Link)
  • Linux PC:
    • GNU Tools for ARM Embedded Processors (Link)

• Firefox web browser (Link)

• Firefox Copper plug-in (only for CoAP demo purpose) (Link)
**Demo Overview**

CoAP REST Access to the Wireless Nodes Resources

IPv6/6LoWPAN Network

IPv6 Host PC

6LoWPAN Border Router

NUCLEO-L152RE

X-NUCLEO-IDS01A4/5 (sub-1 GHz)

Wireless Sensors Nodes

NUCLEO-L152RE

X-NUCLEO-IDS01A4/5 (sub-1 GHz)

X-NUCLEO-IKS01A1 (sensors) [optional]
Contiki on STM32 Nucleo in a few steps (1/2)

1. Clone the online repository
   
   ```
   git clone --recursive https://github.com/contiki-os/contiki.git
   cd contiki/
   ```

2. Compile the FW for a wireless node: REST example (using the standard Contiki provided "er-rest-example")
   
   ```
   cd examples/er-rest-example
   make TARGET=stm32nucleo-spirit1 BOARD=ids01a5
   arm-none-eabi-objcopy -O binary er-example-server.stm32nucleo-spirit1 er-example-server.bin
   ```

3. Connect the wireless sensor board to a PC USB slot and program the device
   
   Copy the "er-example-server.bin" file (e.g. drag & drop) to the USB mass storage corresponding to the STM32 Nucleo board
Contiki on STM32 Nucleo in a few steps (2/2)

4. Compile the FW for the Border Router node

```bash
cd examples/ipv6/rpl-border-router
make TARGET=stm32nucleo-spirit1 BOARD=ids01a5
arm-none-eabi-objcopy -O binary border-router.stm32nucleo-spirit1 br.bin
```

5. Connect the board to USB and program the device

Copy the “br.bin” file (e.g. drag & drop) to the USB mass storage corresponding to the STM32 Nucleo board
Contiki on STM32 Nucleo in a few steps

Windows PC setup (Win 7/8) using “wpcapslip6” utility

1. wpcapslip6 needs a working network adapter:
The Microsoft loopback adapter can be installed via “Add legacy hardware” in the Windows Device Manager (reboot is needed after installation of the loopback adapter)
2. Copy “cygwin1.dll” from “contiki/tools/cygwin” to wpcapslip6 folder
3. Install WinPcaP
4. run Cygwin as administrator

wpcapslip6 terminal window output

```
cd ./tools/stm32w/wpcapslip6
./wpcapslip6 –s /dev/ttyS21 –b aaaa::1/128 [addr]
```

Where [addr] is the MAC address of the local net adapter

Contiki server address (used in the next step)

Tunslip6 terminal window output

```
 cd ./tools
 make tunslip6
 sudo ./tunslip6 -s /dev/ttyACMO aaaa::1/64
```
Contiki on STM32 Nucleo in a few steps

7. Open a Web browser (Firefox) to access the Contiki server providing the RPL neighbors and routes information.

Contiki server address (see previous step) between brackets, e.g. [aaaa::800:f5ff:eb3a:14c5]

8. Ping the wireless Node to test the 6LoWPAN connectivity

ping6 aaaa::a00:f7ff:b9bc:4643

9. Install the “Copper” CoAP plugin for Firefox

Then access the CoAP Server on the wireless node by typing the URL with the node IP address

coop://[aaaa::a00:f7ff:b9bc:4643]:5683/
Contiki on STM32 Nucleo in a few steps

Example: “Hello World!” Resource Access using CoAP

(1) CoAP Resource Discovery

(2) CoAP GET Access to the “test/hello” resource

Firefox Browser window on Linux PC with “Copper” plugin (CoAP client)
Sensors Access using CoAP Demo

• This demo requires an **X-NUCLEO-IKS01A1** expansion board for STM32 Nucleo to be mounted on a wireless node
  • The X-NUCLEO-IKS01A1 should be plugged on top of X-NUCLEO-IDS01A4/5 and NUCLEO-L152RE

• To get the demo running, a modified version of the standard Contiki “er-rest-example” application needs to be used
  • The modification is needed to update the names of the sensors used in the “er-rest-example” application and match the names of the X-NUCLEO-IKS01A1 sensors
  • The modified application is available for download from the following GitHub repository: [https://github.com/STclab/stm32nucleo-spirit1-examples](https://github.com/STclab/stm32nucleo-spirit1-examples)
  • The step-by-step setup is identical to the one described in the previous “Hello World” demo, except for “step 2” in which the modified “sensor-er-rest-example” is used

• The next slide shows the result of a CoAP GET access to the “temperature” resource hosted by the CoAP server on the wireless node
Sensors Resource Access using CoAP

Example of temperature sensor reading

CoAP GET Access to the resource: “sensors/temperature”

CoAP Client

6LoWPAN

GET [addr]/sensors/temperature

ACK 2.05 Content “27.7”

CoAP Server

(*) Use of the X-NUCLEO-IKS01A1 sensors expansion board is required for this demo
www.st.com