OpenThread 1.2 Reference Release Quick Start Guide

Scope

This document introduces how to get started to run the certification tests supported in Thread 1.2 Test Harness with OpenThread 1.2 Reference Release.

Currently OpenThread1.2 reference release covers Low Power, Multicast across Thread Networks and Domain Unicast Address features defined in Thread 1.2 Specification.

Directory introductions

- otbr_stretch20190410.zip
  The Raspibian (2019-04-08-raspbian-stretch) with OTBR1.2 setup

- otbr_host_pkg/
  The compiled binaries and relative services/configurations. The `install.sh` script would help the dispatch them into proper directories and set up the service.

- fw_dongle
  The NCP and CLI firmware for nRF52840 USB dongle.

- fw_dk
  The NCP and CLI firmware for nRF52840 DK.

- thci
  OpenThread.py and OpenThread_Wpanctl.py are included to make OTBR1.2 or OT1.2 devices controlled by Test harness.

- burn_tool_dongle
  The script `nrf_burn.py` would help to flash a batch of nRF52840 USB dongle and verify the firmware version.

Prerequisites

Hardware

The reference hardwares for OpenThread 1.2 are

- Raspberry Pi 3 Model B or B+ with SD card >= 4G
- Nordic nRF52840 USB Dongle

Nordic nRF52840 DK is also supported for now, but not recommended any more.

Software

For OpenThread Border Router 1.2 (OTBR1.2 in short) host setup, currently there are two available options

- Raspbian image with OTBR1.2 setup
  (Based on 2019-04-08-raspbian-stretch-lite.zip)

- OTBR1.2 binary package
  (Compiled binaries on 2019-04-08-raspbian-stretch-lite.zip raspbian)

For the nRF52840 USB Dongle, here are two binaries for NCP device and CLI device respectively.

- ot-ncp-ftd-*.zip
  nRF52840 USB dongle, installed with NCP firmware, works with the Raspberry Pi with OTBR1.2 host setup as one OTBR1.2. (could act as PBBR and SBBR role during cert).

- ot-cli-ftd-*.zip
  nRF52840 USB dongle, installed with CLI firmware, works as a general Thread 1.2 device.

Additionally, before got confirmed from Thread Group that all relevant people has nRF52840 USB dongle, the firmware for `legacy` reference board nRF52840 DK would be provided during the transition.

Setup

OTBR1.2 Host Setup - (Option 1) OTBR 1.2 Host Raspbian

It is the easiest way to set up OTBR1.2 host - just install the Raspibian image `otbr_stretch20190410.zip` by flash the image to SD card via Etcher tool according to raspbian installation.

By default, this Raspbian has console serial and ssh enabled, and the OS would expand to the whole SD card at first bringup after flashed.

OTBR1.2 Host Setup - (Option 2) OTBR1.2 binary package

Assumes you have one Raspberry Pi newly installed with general Raspbian image (only tested on Raspbian Stretch Lite), or you have one Raspberry Pi already had once setup previous OTBR1.2 host, you could use the compiled binary package to install/upgrade the host.

1. Upload the `otbr_host_pkg/` to the Raspberry Pi.

There are various options to copy the files to the Raspberry Pi. Here provides one `scp` approach, assuming your PC laptop and Raspberry Pi is in the same LAN.

```
# 0) Get the IP address of the Raspberry Pi.
If you could access the Raspberry Pi via either serial port or ssh, you
could know the IP address by by `ifconfig` command

$ifconfig
eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 172.23.1.111  netmask 255.255.255.0  ...

Or via `ping` command on your laptop.

$ping raspberrypi
PING raspberrypi.lan (172.23.1.111): 56 data bytes
64 bytes from 172.23.1.111: icmp_seq=0 ttl=64 time=3.645 ms
```

```
# 1) copy the directory to the Raspberry Pi with `scp`
Open one terminal of laptop, or the PowerShell if on windows (win10)

$ scp -r otbr_host_pkg pi@172.23.1.111:/home/pi
pi@172.23.1.111's password: <--input passwd <raspberry> by default
```

2. Install/Update

```
# (on Raspberry Pi)

$cd otbr_host_pkg
$sudo chmod a+x ./install.sh
$sudo ./install.sh
```

install.sh will reboot Raspberry Pi automatically when it finishes.
Note: it may take several minutes for a fresh installation on a new Raspberry Pi.

Flash nRF52840 USB dongle

1. Install nrfutil

```
$python3 -m pip install --ignore-installed six nrfutil==6.0.1
```

2. Flash one nRF52840 USB dongle

```
# trigger DFU Bootloader Mode and download firmware
# nrfutil dfu serial -pkg <*.zip> -p <serial port>

# general thread 1.2 device
$nrfutil dfu serial -pkg ot-cli-ftd-20190519-gb9caedb-dongle.hex.zip -p
/dev/tty.usbmodem14112

# radio adapter (NCP device) for OTBR1.2
$nrfutil dfu serial -pkg ot-ncp-ftd-20190519-gb9caedb-dongle.hex.zip -p
/dev/tty.usbmodem14132
```

3. Flash a batch of nRF52840 USB dongle

burn_tool_dongle/nrf_burn.py is a script to flash and verify the firmware version of nRF52840 USB dongle in batch.

```
$./nrf_burn.py -h
usage: nrf_burn.py [-h] (-d DEVICE [DEVICE ...] | -f DEVICE_FILE)
                   [-i IMAGE_FILE] [-v VALID_VERSION] [-t {cli,ncp}]
                   [-r RETRIES]

program/verify a group of nRF52840-Dongles

optional arguments:
  -h, --help            show this help message and exit
  -d DEVICE [DEVICE ...]
                        devices (e.g. COMx, /dev/tty.usbxxx) for
                        programming/verifying
  -f DEVICE_FILE        devices from a file (one device per line) for
                        programming/verifying
  -i IMAGE_FILE         image file for programming
  -v VALID_VERSION      validate if devices' version contains
valid_version
  -t {cli,ncp}          image type: cli or ncp (associate with -v)
  -r RETRIES            retry times if failed
```

Here are some sample usage.

```
# program two dongles with cli firmware via port COM1&COM2 and retry 2
times if failed

$./nrf_burn.py -i ot-cli-ftd-20190519-gb9caedb-dongle.hex.zip -d COM1
COM2
```

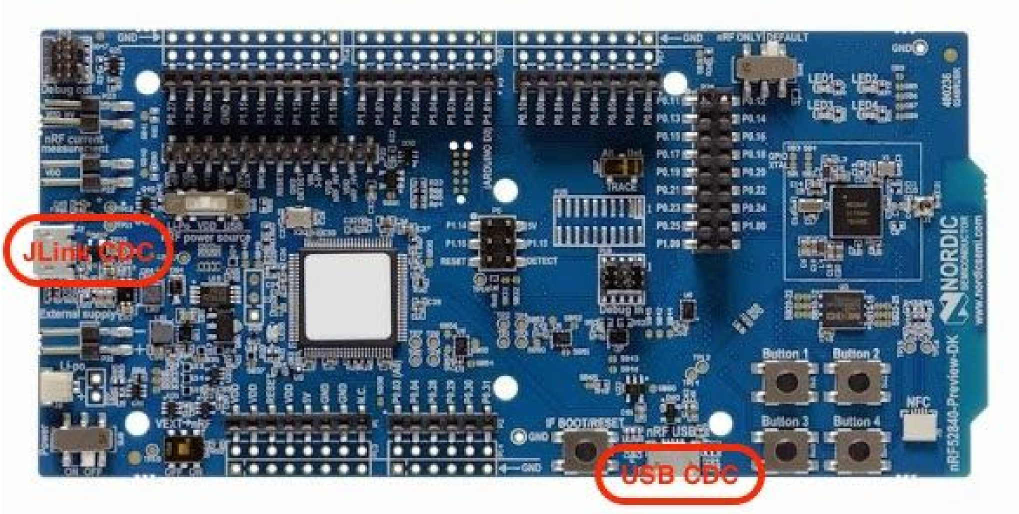
```
# verify if the version of a group of cli devices in device_file
contains version (sub)string via cli command

$ ./nrf_burn.py -f device_file -v b9caedb -t cli
```

```
# program a group of devices with ncp firmware check if version
(sub)string matches via spinel-cli

$./nrf_burn.py -f device_file -i
ot-ncp-ftd-20190519-gb9caedb-dongle.hex.zip -v 20190519-gb9caedb -t ncp
```

NOTE: *ncp firmware version verification only supports Linux & macOS.*

Flash nRF52840 DK with on-board Segger

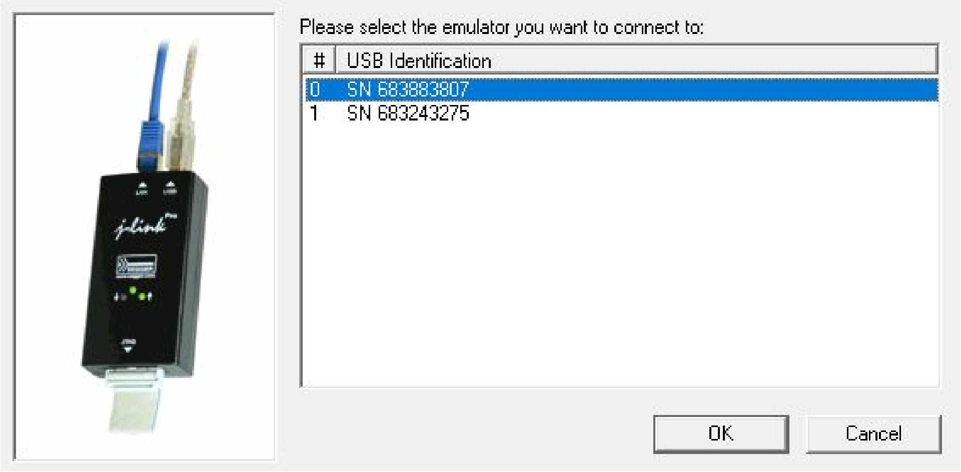
1. Install nRF5x-Command-Line-Tools
2. Flash nRF52840 DK
   1) Let's take a look at the DK board. There are two micro USB port as shown in the picture, one is the JLink CDC and the other is USB CDC.



   2) Disable MSD of JLink CDC.
    As the firmware is built without enable USB CDC, the micro USB port for JLink CDC would be used to connect with the windows laptop or the Raspberry Pi's USB Hub.

   In order to make JLink CDC works stable, better to **Disable MSD** via JLink Commander which is a command line based utility that comes along with Segger J-Link Software.

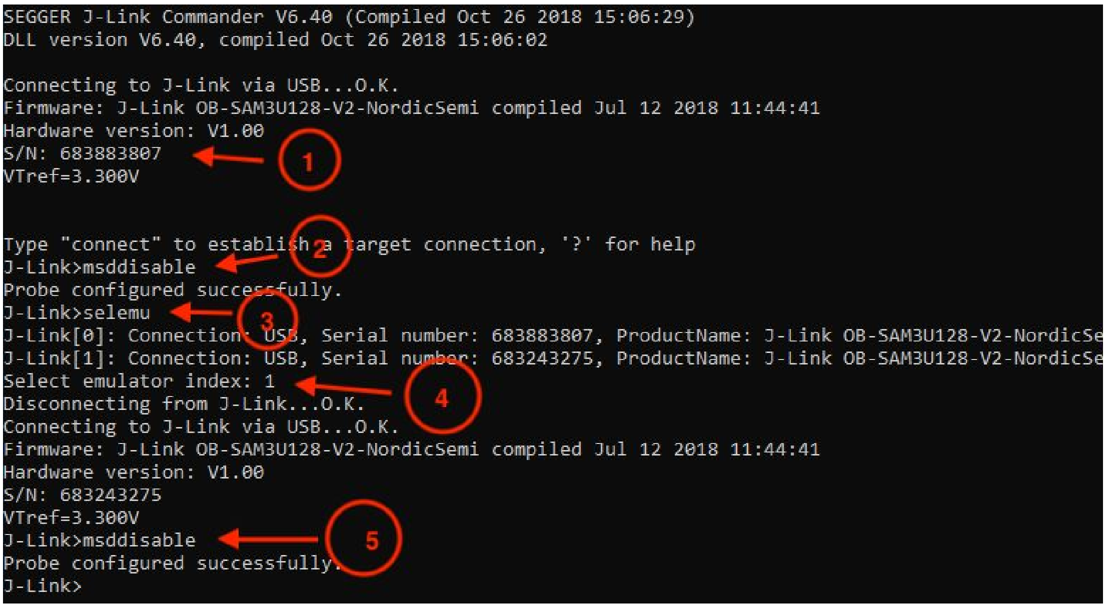
   Open JLink Commander terminal, and if more than one DK board are connected, it will prompt to ask which one to connect as below picture



Please select the emulator you want to connect to:

#	USB Identification
0	SN 683883807
1	SN 683243275

A. Here we choose ‘0’, we can see the serial number (S/N) is exactly the one chosen in below picture.
B. Execute ‘msddisable’ and the first one is ok now.
C. Execute ‘Selemu’ which will list all the serial numbers of JLink connected, now we input index ‘1’ and connect to the next JLink
D. Exectute ‘msddisable’ and the second one is ok.
E. Loop C) and D) if there are more J-Link (DK boards) connected.



```
SEGGER J-Link Commander V6.40 (Compiled Oct 26 2018 15:06:29)
DLL version V6.40, compiled Oct 26 2018 15:06:02

Connecting to J-Link via USB...O.K.
Firmware: J-Link OB-SAM3U128-V2-NordicSemi compiled Jul 12 2018 11:44:41
Hardware version: V1.00
S/N: 683883807
VTref=3.300V


Type "connect" to establish a target connection, '?' for help
J-Link>msddisable
Probe configured successfully.
J-Link>selemu
J-Link[0]: Connection: USB, Serial number: 683883807, ProductName: J-Link OB-SAM3U128-V2-NordicSe
J-Link[1]: Connection: USB, Serial number: 683243275, ProductName: J-Link OB-SAM3U128-V2-NordicSe
Select emulator index: 1
Disconnecting from J-Link...O.K.
Connecting to J-Link via USB...O.K.
Firmware: J-Link OB-SAM3U128-V2-NordicSemi compiled Jul 12 2018 11:44:41
Hardware version: V1.00
S/N: 683243275
VTref=3.300V
J-Link>msddisable
Probe configured successfully.
J-Link>
```

3) Burn the board over JLink CDC.

```
# board flashed with CLI firmware, acting as general thread device
sudo ./nrfjprog -f nrf52 --chiperase --program
ot-cli-ftd-20190519-gb9caedb-dk.hex --reset

# board flashed with NCP firmware, which would be plugged into
Raspberry Pi and act as radio adapter
sudo ./nrfjprog -f nrf52 --chiperase --program
ot-ncp-ftd-20190519-gb9caedb-dk.hex --reset
```

4) Connect the JLink CDC of Nordic nRF52840 DK (with cli firmware installed) to your laptop for general Thread 1.2 device.
Connect the JLink CDC of Nordic nRF52840 DK (with ncp firmware installed) to Raspberry Pi’s USB Hub to act as the OTBR1.2.

Test Harness Environment setup

1) Update THCI

```
a) copy OpenThread.py to C:\GRL\Thread1.2\Thread_Harness\THCI\
b) copy OpenThread_WpanCtl.py to
C:\GRL\Thread1.2\Thread_Harness\THCI\
c) copy ot-comm directory to C:\GRL\Thread1.2\ThirdParty\
d) modify C:\GRL\Thread1.2\Thread Harness.bat: append
%systemdrive%/GRL/Thread1.2/ThirdParty/ot-comm; at the end of
PYTHONPATH
```

2) To take advantage of the auto discovery feature of Test Harness, please add VID/PID of the JLink of Nordic to C:\GRL\Thread1.2\Config\configure.ini

```
GoldenDeviceHardwareIds = {'NXP':
['VID:PID=1FC9:0300','VID:PID=15A2:0300','VID:PID=1366:1015','VID:P
ID=0D28:0204'], 'SiLabs': 'VID:PID=10C4:8A5E',
'SiLabsBR':['VID:PID=0403:6001','VID:PID=067B:2303'], 'ARM':
'VID:PID=0D28:0204','OpenThread':['VID:PID=10C4:EA60','VID:PID=1915
:CAFE','VID:PID=1366:0105'],'Kirale':
'VID:PID=2DEF:0102','OpenThread_WpanCtl':['VID:PID=10C4:EA60','VID:
PID=0403:6001','VID:PID=067B:2303']}
```

References

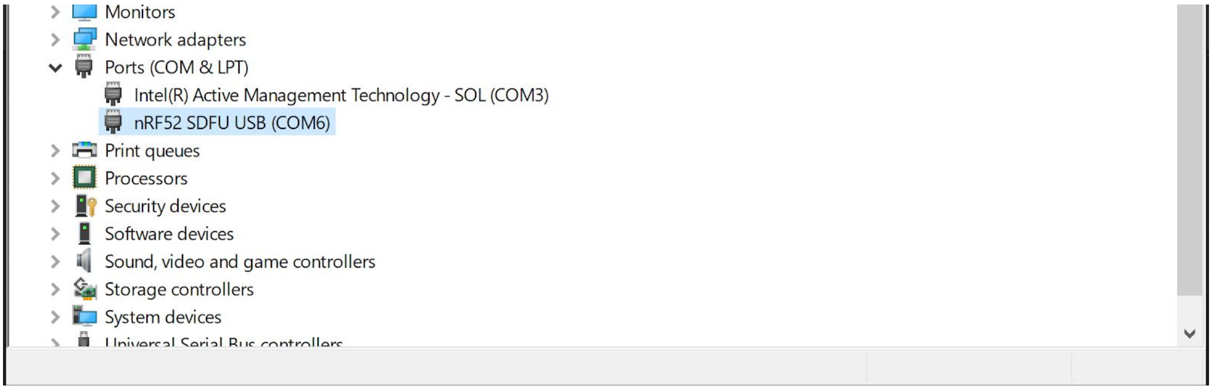
Use fresh nRF52840 USB dongle on windows

The instructions mentioned here are verified on win10 laptop. For every fresh nRF52840 USB dongle, it is required to do the driver update process per dongle after firstly flash OpenThread reference firmware.

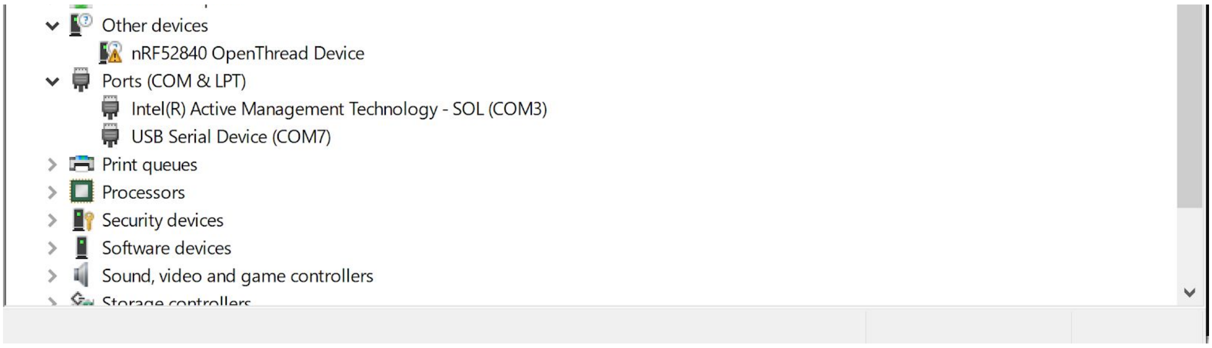
For win7 user, I don't have the chance to validate above process as I don't have one. Please download nRF52840 Win7 usb_drivers.zip Tom uploaded. Please report back to us if you have any issues when using the dongle on win7, and it is highly appreciated if you could contribute the driver update process on win7 if there are any differences.

Background

When a fresh nRF52840 USB dongle is plugged to Windows laptop, it would be recognized as `nRF52 SDFU USB` in Device Manager as below picture and LD2 on the dongle would be red, indicating the device is in DFU bootloader mode, ready to be flashed by nrfutil tool.



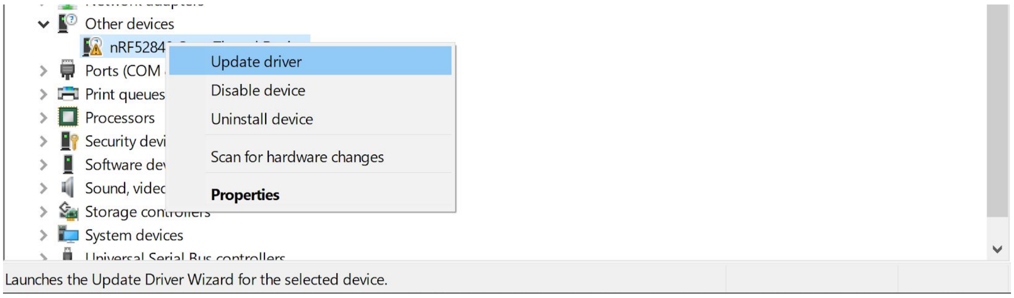
After flashed with the reference firmware provided in the release package first time, you will notice the change in the port number in `Ports (COM & LPT) section` in Device Manager and a new `nRF52840 OpenThread Device` with yellow triangle mark appeared in the 'Other devices' section, representing you need to update the Nordic DFU driver manually so that the device could be triggered by nrfutil to enter DFU bootloader mode next time, otherwise the device could not be flashed next time.



- Other devices
  - nRF52840 OpenThread Device
- Ports (COM & LPT)
  - Intel(R) Active Management Technology - SOL (COM3)
  - USB Serial Device (COM7)
- Print queues
- Processors
- Security devices
- Software devices
- Sound, video and game controllers
- Storage controllers

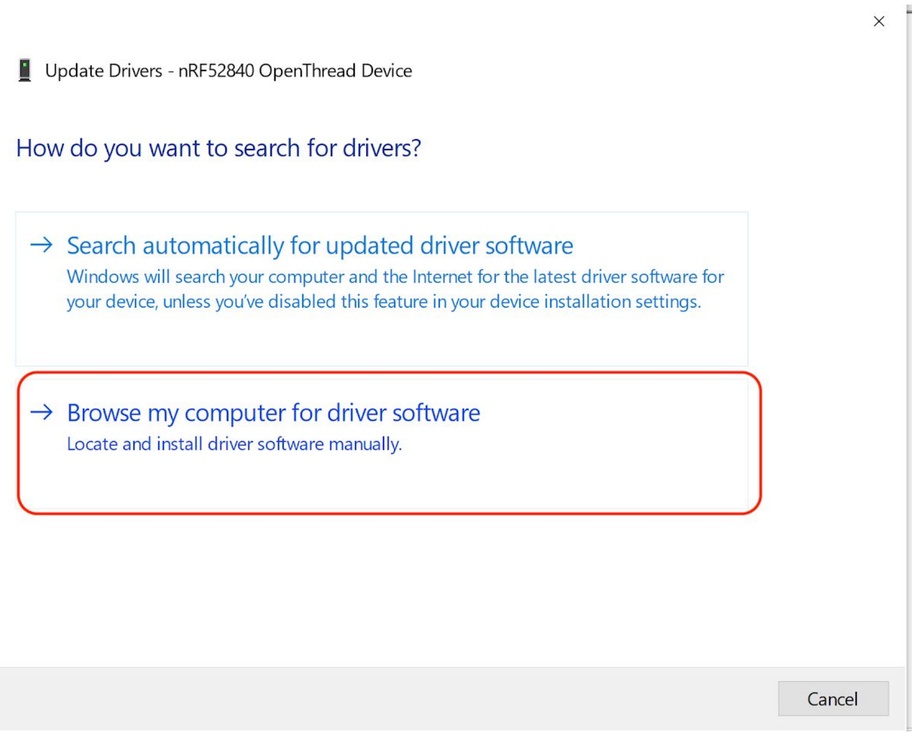
Update Nordic DFU driver on windows

1) Download nRFConnect for Desktop and install it following the wizard instructions.
2) Update driver manually according to below instructions
    a) Right-click the `nRF52840 OpenThread Device` and choose `Update Driver`



Launches the Update Driver Wizard for the selected device.

    b) Choose `Browse my computer for driver software`



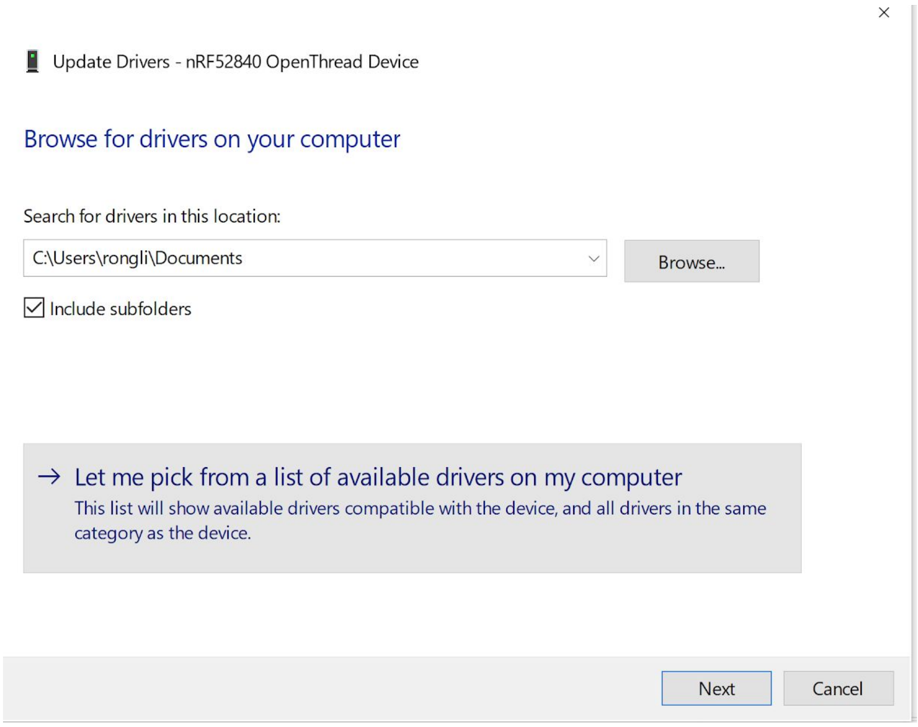
Update Drivers - nRF52840 OpenThread Device

How do you want to search for drivers?

→ Search automatically for updated driver software
Windows will search your computer and the Internet for the latest driver software for your device, unless you've disabled this feature in your device installation settings.

→ Browse my computer for driver software
Locate and install driver software manually.

    c) Choose `Let me pick from a list of available drivers on my computer`



Update Drivers - nRF52840 OpenThread Device

Browse for drivers on your computer

Search for drivers in this location:

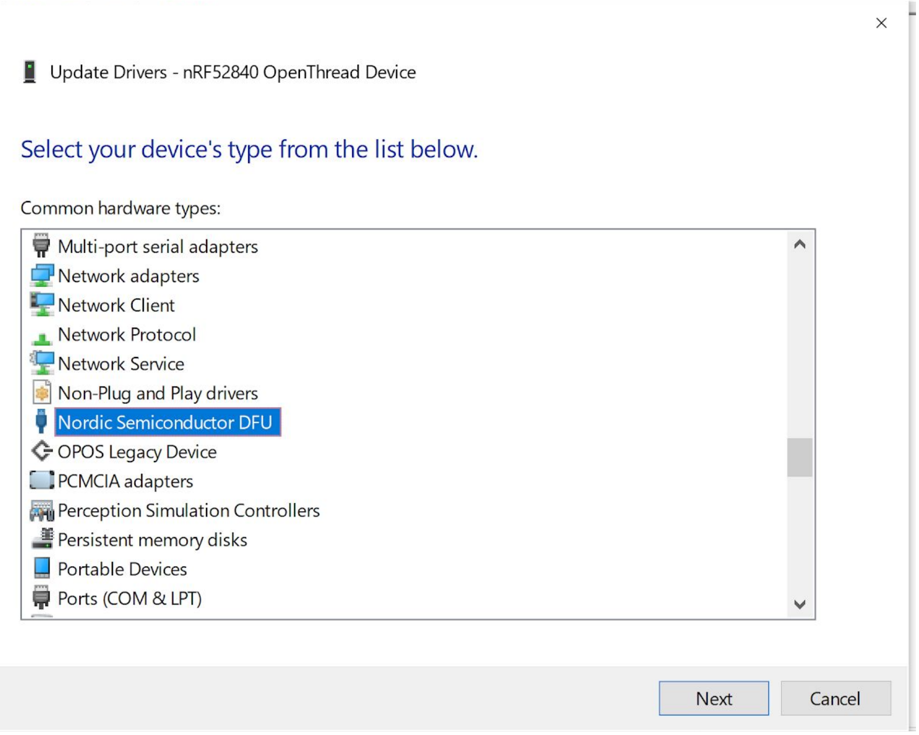
C:\Users\rongli\Documents

☑ Include subfolders

→ Let me pick from a list of available drivers on my computer

This list will show available drivers compatible with the device, and all drivers in the same category as the device.

d) Scroll the bar and choose `Nordic Semiconductor DFU` and click `Next`



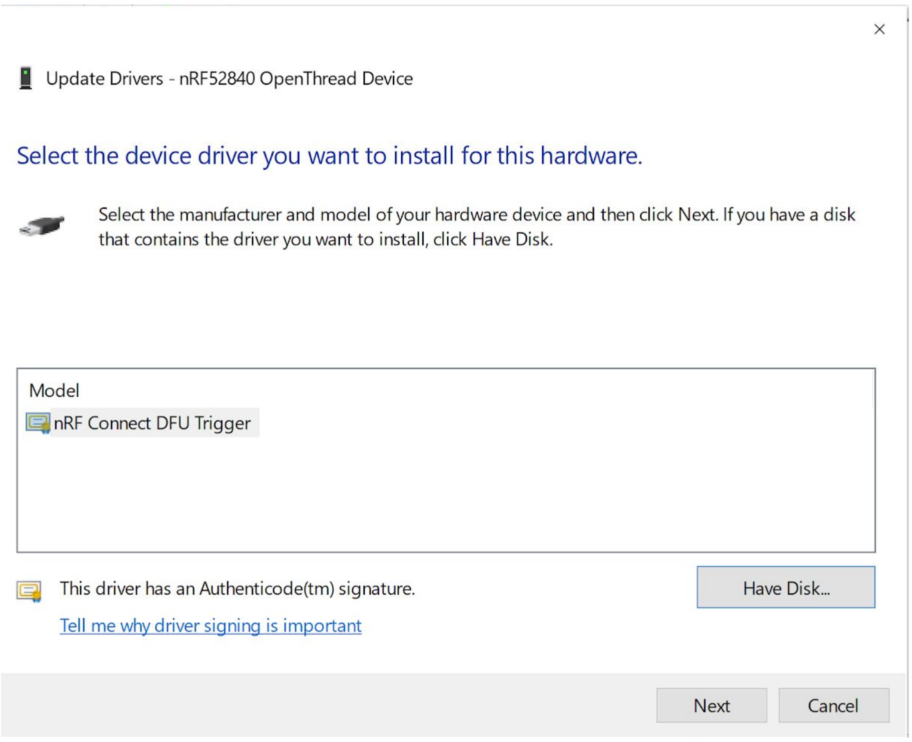
Update Drivers - nRF52840 OpenThread Device

Select your device's type from the list below.

Common hardware types:

- Multi-port serial adapters
- Network adapters
- Network Client
- Network Protocol
- Network Service
- Non-Plug and Play drivers
- Nordic Semiconductor DFU
- OPOS Legacy Device
- PCMCIA adapters
- Perception Simulation Controllers
- Persistent memory disks
- Portable Devices
- Ports (COM & LPT)

e) Choose `nRF Connect DFU Trigger` and click `Next`



Update Drivers - nRF52840 OpenThread Device

Select the device driver you want to install for this hardware.

Select the manufacturer and model of your hardware device and then click Next. If you have a disk that contains the driver you want to install, click Have Disk.

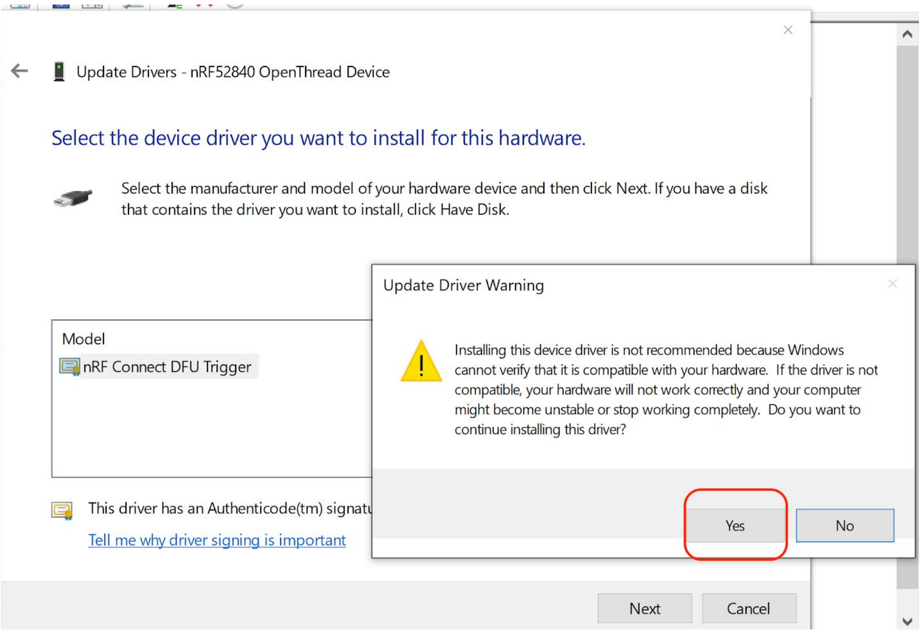
Model

nRF Connect DFU Trigger

This driver has an Authenticode(tm) signature.

Tell me why driver signing is important

f) Click `Yes` on the popup windows



Update Drivers - nRF52840 OpenThread Device

Select the device driver you want to install for this hardware.

Select the manufacturer and model of your hardware device and then click Next. If you have a disk that contains the driver you want to install, click Have Disk.

Model

nRF Connect DFU Trigger

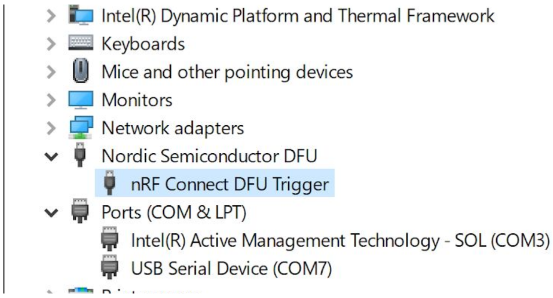
This driver has an Authenticode(tm) signatu

Tell me why driver signing is important

Update Driver Warning

Installing this device driver is not recommended because Windows cannot verify that it is compatible with your hardware. If the driver is not compatible, your hardware will not work correctly and your computer might become unstable or stop working completely. Do you want to continue installing this driver?

g) When it finishes, the yellow triangle will disappear, and you will see `nRF Connect DFU Trigger` as picture below, then you could continue to reflash the dongle or the update its firmware.



Intel(R) Dynamic Platform and Thermal Framework

Keyboards

Mice and other pointing devices

Monitors

Network adapters

Nordic Semiconductor DFU

nRF Connect DFU Trigger

Ports (COM & LPT)

Intel(R) Active Management Technology - SOL (COM3)

USB Serial Device (COM7)

Enable console serial or ssh

The OTBR1.2 host raspbian image has already had console serial and ssh set up. However if you have one Raspberry Pi newly installed with the raspbian from its official website, you need to enable the console serial or ssh. Here provides two options to achieve this.

If you have Monitor, HDMI and keyboard, you could use raspi-config to setup.

```
# enable serial
sudo raspi-config
5 Interface Options |
                    | P6 Serial Enable/Disable shell and kernel…
                            <Yes> <Ok>

# enable ssh
5 Interface Options |
                    | P2 Serial Enable/Disable remote command...
                            <Yes> <Ok>
```

Otherwise, you could do some modifications on the /boot/

> On MacOS or Win10, after flashed raspbian image, unplug and replug the SD card reader, there would be one `boot’ drive.
> On Linux, you could mount the boot partition.

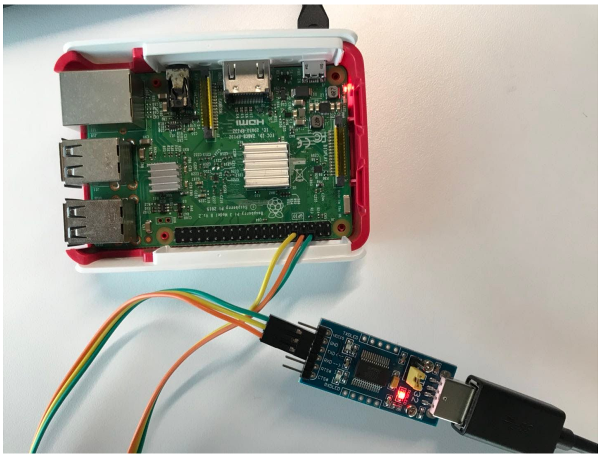
```
# append below two lines to boot/config.txt

enable_uart=1
dtoverlay=pi3-disable-bt

# create one empty file named as ssh. E.g. on Mac
touch boot/ssh
```

In the end, disable bluetooth relative service to ensure stable console serial port.

```
$sudo systemctl disable hciuart.service
$sudo systemctl disable bluealsa.service
$sudo systemctl disable bluetooth.service
```

Console serial connection

Any UART2USB adapter, e.g. FT232 adapter



Pin(RPi)	Pin(FT232)	Dupont Line
Pin6	GND	GREEN
Pin8	RXD	ORANGE
Pin10	TXD	YELLOW
Vcc Jump 3.3V		

Code base per package

	Repo	Thread 1.2 Development Branch
OT1.2	https://github.com/openthread/openthread-1.2	master-1.2
OTBR1.2	https://github.com/openthread/ot-br-posix-1.2	master-1.2

package	OT 1.2	OTBR1.2 host	Thread Features
ot-20190825-v1_2.zip	RC3	RC3	LP+MA+DUA
ot-20190520-v1_2.zip	b9caedb	PR1_Base	LP+MA+DUA
ot-201904-v1_2.zip	RC2 branch	RC2 branch	LP+MA+DUA
ot-commercial-201810.zip	IOP7 branch	IOP7 branch	MA+DUA
ot-commercial-201808.zip	RC1 branch	RC1 branch	MA+DUA

Revision History

Date	Author	Descriptions
Jan 23	Simon Lin	Update for RC5 - Add OT-Commissioner into otbr_host_pkg/ - Update THCI to support OT-Commissioner - Use Python3 to install nrfutil 6.0.1
Aug 25	Rongli Sun	Add new THCI APIs
May 31	Rongli Sun	Add Instructions to update Nordic DFU Trigger Driver for windows laptop users when using fresh nRF52840 USB dongle for the first time. Correct one typo (from \`-t\` to \`-p\`) when flash nRF52840 USB dongle via nrfutil tool.
May 20, 2019	Rongli Sun	Refine and Restructure the Quick Start Guide
April 11, 2019	Rongli Sun	Add introduction about how to disable MSD
April 2, 2019	Rongli Sun	Add introduction for otbr update Add nRF52840 USB dongle support
Oct 25, 2018	Rongli Sun	Add code repo introduction for each package delivered Add 'Build from source' section
Oct 20, 2018	Rongli Sun	Update for IOP7 - Support DomainPrefix in Thread Network Data(BHC-212) - Still keep reregistrationDelay 4 bytes - Support new BBR properties - Update THCI to support stable connection - Update burn_tool.py - Fix error when no USB CDC is specified - Add '-i' option to list JLink Serial Number of connected SEGGER - Add notes & tips section
Aug 13, 2018	Rongli Sun	Initial release