



nrfutil
User Guide v1.0

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Revision history

Table 1: Revision history

Date	Version	Description
September 2016	1.0	First release

Chapter 1

nrfutil

nrfutil is a Python package and command-line utility that supports Device Firmware Updates (DFU) and cryptographic functionality.

This user guide corresponds to nrfutil v1.5.0.

See the [DFU bootloader](#) and [BLE Secure DFU Bootloader example](#) in the SDK documentation for more information about Device Firmware Updates. The nrfutil application and its library offer the following features:

- DFU package generation
- Cryptographic key generation, management, and storage
- Bootloader settings generation
- DFU procedure over *Bluetooth*[®] low energy

There are two different and incompatible DFU package formats:

- Legacy: Uses a simple structure and no security.
- Modern: Uses Google's protocol buffers for serialization and can be cryptographically signed.

The DFU package format transitioned from legacy to modern in nRF5 SDK 12.0. Depending on the SDK version that you are using, select a compatible release of this tool:

- Version 0.5.2 generates legacy firmware packages compatible with nRF5 SDK 11.0 and earlier.
- Versions 1.5.0 and later generate modern firmware packages compatible with nRF5 SDK 12.0 and later.

1.1 Installing nrfutil

You can install nrfutil from the Python Package Index (PyPI) or you can run or install it from the sources.

In both cases, the following prerequisites must be installed:

- [Python 2.7](#) (2.7.6 or newer, but not Python 3)
- `pip` (see [Installing Python Modules](#))

1.1.1 Installing from PyPI

nrfutil is available as a package on the Python Package Index (PyPI) and can be downloaded and installed directly using the Python installer program `pip`.

Enter the following command to install the latest published version from PyPI:

```
pip install nrfutil
```

This command installs nrfutil and all required packages

If you are running nrfutil on Windows, the runtime libraries targeted when building the library must be present when running code using the library. The following errors indicate that the runtime libraries are not available:

- `Missing MSVC*120.DLL or MSVC*140.DLL`
- `RuntimeError: Could not load shared library <path>/pc_ble_driver_shared.dll : '[Error 193] %1 is not a valid Win32 application`

In this case, install the redistributable installer for [Visual Studio 2013](#) or [Visual Studio 2015](#), respectively. Make sure to install the version that corresponds to the architecture of your Python installation (x86 or x64).

1.1.2 Installing from sources

To be able to modify nrfutil, download the sources of the tool from GitHub and install it.

In addition to Python and `pip`, installing nrfutil from the sources requires the [Python setuptools](#). To upgrade to the latest version, run:

```
pip install -U setuptools
```

If you want to create an executable for nrfutil, install pyinstaller:

```
pip install pyinstaller
```

1. Clone the [nrfutil GitHub repository](#).
2. Open a command prompt in the folder into which you cloned the repository and run `pip install -r requirements.txt` to install all prerequisites.
3. Set up nrfutil in one of the following ways:
 - To run nrfutil from the sources without installation, enter the following command:

```
python nordicsemi/__main__.py
```

The following sections assume that you have installed the tool and can call it with `nrfutil`. If you choose to run it without installation, always replace the `nrfutil` command with `python nordicsemi/__main__.py` and add the required command-line options.

- To install the library to the local Python site-packages and script folder, enter the following command:

```
python setup.py install
```

- To generate a self-contained executable version of the utility, enter the following command:

```
pyinstaller nrfutil.spec
```

Important: Some anti-virus programs will stop `pyinstaller` from executing correctly when it modifies the executable file. In this case, configure your anti-virus program to ignore `pyinstaller`.

If you are running nrfutil on Windows, the runtime libraries targeted when building the library must be present when running code using the library. The following errors indicate that the runtime libraries are not available:

- Missing `MSVC*120.DLL` or `MSVC*140.DLL`
- `RuntimeError: Could not load shared library <path>/pc_ble_driver_shared.dll : '[Error 193] %1 is not a valid Win32 application`

In this case, install the redistributable installer for [Visual Studio 2013](#) or [Visual Studio 2015](#), respectively. Make sure to install the version that corresponds to the architecture of your Python installation (x86 or x64).

1.2 Displaying help

Add `--help` to any nrfutil command to display help about the command.

Help is context-sensitive. Enter `nrfutil --help` to get information about the general usage of nrfutil, or `nrfutil command --help` to display help for a specific *command*.

For example, enter the following command to display help about executing a DFU procedure over BLE:

```
nrfutil dfu ble --help
```

1.3 Generating DFU packages

The `pkg` command generates a package to use for a Device Firmware Update. The package contains the new firmware image, an init packet, and a manifest file that indicates the package format.

Run `nrfutil pkg generate` to generate a `.zip` file that you can later use with a mobile application or another tool to update the firmware of an nRF5 IC. The command takes several options that you can list by entering the following command:

```
nrfutil pkg generate --help
```

For example, enter the following command to generate a package named `app_dfu_package.zip` from the application file `app.hex` with application version 4 that requires hardware version 1 and SoftDevice S130 v2.0.0 (0x80) and is signed with the private key that is stored in `key.pem`:

```
nrfutil pkg generate --hw-version 1 --sd-req 0x80 --  
application-version 4 --application app.hex --key-file key.pem  
app_dfu_package.zip
```

Enter the following command to generate a debug package without version information from the application file `app.hex`, signed with the private key that is stored in `key.pem`:

```
nrfutil pkg generate --debug-mode --application app.hex --key-  
file key.pem app_dfu_package.zip
```

1.4 Performing a DFU

The `dfu` command performs a Device Firmware Update.

Use this command to perform the actual DFU, thus transfer a DFU package to the nRF5 IC. Several transports are available. You can list them by entering the following command:

```
nrfutil dfu --help
```

Important: Support for serial transport is currently disabled.

1.4.1 Performing a DFU over BLE

When performing a Device Firmware Update over a BLE connection, you use an nRF5 Development Kit board as connectivity IC.

Before performing a DFU over a BLE connection, you must set up your boards to be able to communicate with your computer (see [Hardware setup](#)).

1. Connect an nRF5 Development Kit board to your computer.
This board serves as connectivity IC to do the DFU on the DFU target.
2. Run `nrfutil dfu ble` to perform a full DFU procedure over a BLE connection.

The command takes several options that you can list by entering the following command:

```
nrfutil dfu ble --help
```

Most importantly, the `-f` instructs nrfutil to program the connectivity IC with the required connectivity software. If you specify this option, the contents of the board are overwritten.

For example, enter the following command to perform a DFU procedure of the file `app_dfu_package.zip` over BLE, using a connectivity IC connected to COM3, where the remote BLE device to be upgraded is called MyDevice:

```
nrfutil dfu ble -pkg app_dfu_package.zip -p COM3 -n "MyDevice" -f
```

1.4.2 Performing a DFU over a serial connection

Performing a Device Firmware Update over a serial (UART) connection is disabled in the current version of nrfutil.

Important: Support for serial transport is currently disabled. The following information is included for completeness only.

1. Connect the DFU target to your computer.
2. Run `nrfutil dfu serial` to perform a full DFU procedure over a serial (UART) connection.

The command takes several options that you can list by entering the following command:

```
nrfutil dfu serial --help
```

For example, enter the following command to perform a DFU procedure of the file `app_dfu_package.zip` over COM3 at 115200 bits per second:

```
nrfutil dfu serial -pkg app_dfu_package.zip -p COM3 -b 115200
```

1.5 Generating and displaying keys

The `keys` command can be used to generate and display cryptographic keys.

Cryptographic keys are required to sign and validate a Device Firmware Update package. See the [Cryptography library](#) in the SDK for more information about signing and cryptographic keys.

- Run `nrfutil keys generate` to generate a private (signing) key and store it in a file in PEM format.
- Run `nrfutil keys display` to display a private (signing) or public (verification) key from a PEM file.

The command takes several options that you can list by entering the following command:

```
nrfutil keys display --help
```

For example, enter the following command to generate a private key and store it in a file named `private.pem`:

```
nrfutil keys generate private.pem
```


Enter the following command to display a public key in code format from this key file:

```
nrfutil keys display --key pk --format code private.pem
```

1.6 Generating and displaying bootloader settings

The `settings` command can be used to generate and display a bootloader settings page.

A DFU bootloader requires a bootloader settings page that contains information about the current DFU process. In addition, it can contain information about the installed application and the firmware version.

- Run `nrfutil settings generate` to generate a bootloader settings page and store it in a HEX file.

The command takes several options that you can list by entering the following command:

```
nrfutil settings generate --help
```

- Run `nrfutil settings display` to display the contents of a bootloader settings page that is present in a HEX file.

To read the bootloader settings page from a programmed IC, use `nrfjprog` to dump the flash memory of the IC (where `HEX_file` is the name of the resulting HEX file):

```
nrfjprog --readcode HEX_file
```

After generating the bootloader settings page, you can use `mergehex` and `nrfjprog` to program it to the device. See the [nRF5x Command Line Tools](#) documentation for more information.

For example, enter the following command to generate a bootloader settings page for an nRF52 device with the application `app.hex` installed, with application version 3, bootloader version 2, and bootloader settings version 1 (for SDK v12.0.0), and store it in a file named `settings.hex`:

```
nrfutil settings generate --family NRF52 --application app.hex
--application-version 3 --bootloader-version 2 --bl-settings-
version 1 settings.hex
```

Enter the following command to display the contents of the generated HEX file:

```
nrfutil settings display settings.hex
```

1.7 Displaying version information

The `version` command can be used to display the version of the tool.

Different versions of `nrfutil` support different formats of the init packet that is part of the DFU package.

Therefore, you should always ensure to use the `nrfutil` version that corresponds to the DFU bootloader that is programmed on your device.

Enter the following command to display the `nrfutil` version:

```
nrfutil version
```

1.8 Customizing the init packet

If you have created a custom DFU bootloader that uses an init packet of a format different than the one used in the BLE Secure DFU Bootloader, you can customize nrfutil to use this different init packet format.

To customize the tool, you must have cloned the [nrfutil GitHub repository](#) (see [Installing from sources](#) on page 6).

The init packet is a packet that is sent before the actual firmware images in a Device Firmware Update. It contains metadata about the DFU, for example, the size and type of the image, version information, and compability requirements.

If you use the default packet format as described in the [BLE Secure DFU Bootloader example](#), you do not need to modify nrfutil. If you define a custom init packet format, however, you must modify both your DFU bootloader implementation and nrfutil to use this new format.

The format of the init packet is defined in a [Protocol buffers](#) (.proto) file. This file can be compiled into different formats. In this way, you can ensure that you use the same init packet format in you DFU bootloader implementation and in nrfutil.

1. Modify the protocol buffer file to suit your needs.

In the [nrfutil GitHub repository](#), the file is located at `nordicsemi/dfu/dfu-cc.proto`.

In the [BLE Secure DFU Bootloader example](#) in the nRF5 SDK, it is located at `examples/dfu/bootloader_secure/dfu-cc.proto`. Ensure that both files have the exact same content.

2. Download and install the [Protocol compiler](#) from Google.

3. Adapt nrfutil to use the new init packet format:

a) Compile the protocol buffer file to generate the corresponding Python file.

In the folder that contains your `dfu-cc.proto` file, enter the following command (where *dest_folder* is an empty folder where the protocol compiler will write its output):

```
protoc --python_out=dest_folder dfu-cc.proto
```

b) Copy or move the created file `dest_folder/dfu_cc_pb2.py` to `nordicsemi/dfu/`, overwriting the existing file.

c) If you added new information to the init packet: Adapt nrfutil to include command-line options for new fields and add the information provided through these options to the init packet.

To adapt the tool, you must edit the Python source files. The contents of the init packet are defined in the files `nordicsemi/dfu/init_packet_pb.py` and `nordicsemi/dfu/package.py`. The command-line options are defined in `nordicsemi/__main__.py`.

If you [installed nrfutil to the local Python site-packages and script folder](#) or [created a self-contained executable](#), you must repeat that procedure after editing the source files.

4. Adapt your DFU bootloader implementation to use the new init packet format:

a) Make sure that the `dfu-cc.proto` file in the folder of your DFU bootloader implementation (by default, this is the `examples/dfu/bootloader_secure/` folder in the SDK) is the same file that you used to adapt nrfutil.

b) In the DFU bootloader implementation folder, enter the following command:

```
protoc -odfu-cc.pb dfu-cc.proto
```

This command creates the file `dfu-cc.pb`.

c) If you are not working in the BLE Secure DFU Bootloader folder (`examples/dfu/bootloader_secure/`), copy the `dfu-cc.options` file from that folder to your implementation folder.

d) Run the `nanopb_generator.py` script (located in the `external\nano-pb\generator\` folder) to generate the required `dfu-cc.pb.c` and `dfu-cc.pb.h` files.

If you are working in `examples/dfu/bootloader_secure/`, enter the following command:

```
python ../../../../external/nano-pb/generator/nanopb_generator.py dfu-cc.pb -f dfu-cc.options
```

If you are working in a different folder, adapt the path to the script.

e) Compile your DFU bootloader.

For more information about this procedure, see the readme file in the BLE Secure DFU Bootloader folder in the SDK.

