

nRF Util for nRF5 SDK v1.0.0

User Guide

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Revision history

Date	Description
2022-11-07	Updated content for nRF Util v7.0.0 command nrf5sdk-tools v1.0.0: <ul style="list-style-type: none">• Introduction on page 5• Installing nRF Util for nRF5 SDK on page 6• Displaying help on page 7• Editorial changes• removed<ul style="list-style-type: none">• Displaying version information• Customizing the init packet
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March 2017	Updated for nrfutil v2.2.0: <ul style="list-style-type: none">• Added support for serial DFU (DFU over a serial UART connection on page 13)• Changed the location of the <code>dfu-cc.proto</code> file in the DFU bootloader implementation.

Date	Description
November 2016	Updated for nrfutil v2.0.0
September 2016	First release

Previous versions

PDF files for relevant previous versions are available here:

- [nRF Util User Guide v6.1.0](#) (corresponds to nRF Util PY (legacy) v6.1.0)
- [nRF Util PY \(Legacy\) User Guide v1.0](#) (corresponds to nRF Util PY (legacy) v1.5.0)

1 Introduction

nRF Util 7.0.0 and later supports *Device Firmware Update (DFU)* and cryptographic functionality, designed for nRF5 SDK, when the command `nrf5sdk-tools` is installed.

Note: If you plan to use nRF Utils with NCS or nRF5 SDK, for functionality other than *DFU* and cryptography, please refer to: [nRF Util](#).

The nRF Util for nRF5 SDK application has the following features:

- DFU package generation
- Cryptographic key generation, management, and storage
- Bootloader settings generation
- *DFU* procedure on the following protocols:
 - *Bluetooth*[®] Low Energy
 - Serial over UART
 - Serial over USB
 - Thread unicast
 - Thread multicast
 - Zigbee
 - ANT[™]

There are two different *DFU* package formats:

- Legacy – Uses a simple structure and has 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 v12.0.0. nRF Util for nRF5 SDK supports only modern firmware packages compatible with nRF5 SDK v15.3.0 and later. For support of earlier SDKs and the legacy firmware format, see the documentation for the legacy Python package: [nRF Util User Guide v6.1.0](#).

Note: By default, firmware images compatible with nRF SDK 15.3.0 and later are created. Firmware images compatible with nRF SDK 12.0 to nRF SDK 15.0 can be supported by using the `--no-backup` command when generating the *DFU* settings.

See the [DFU bootloader](#) and [BLE Secure DFU Bootloader example](#) in the nRF5 SDK documentation for more information about *DFU*.

2 Installing nRF Util for nRF5 SDK

nRF Util for nRF5 SDK is installed as a `nrf5sdk-tools` command in nRF Util version 7.0.0 or later

As a prerequisite, ensure the `nrfjprog` executable is installed and available in the system path. `nrfjprog` is part of nRF Command Line Tools. Download and installation information is available here: [Installing the nRF Command Line Tools](#)

Install nRF Util as follows:

1. Download the `nrfutil` executable file from [nRF Util](#).
2. Install nRF Util by doing one of the following:
 - Run `nrfutil` from the command line in the folder where it was downloaded.
 - Move it to a folder in the system path, to run it from anywhere on the system.
3. On macOS and Linux, give `nrfutil` execute permissions.

Do this by typing `chmod +x nrfutil` in a terminal or using a file browser (this is typically a checkbox found under file properties).

Next, to install the `nrf5sdk-tools` command:

4. Run `nrfutil install nrf5sdk-tools`.

When `nrf5sdk-tools` is installed, nRF Util behaves in the same way as nRF Util 6.1 and earlier.

The command package is installed to a sub folder under `{USER HOME DIRECTORY}/.nrfutil/`.

3 Displaying help

Add `--help` to any nRF Util for nRF5 SDK command to display help about the command.

Help is context sensitive.

1. To get information on general usage, enter `nrfutil nrf5sdk-tools --help`.
The command `nrf5sdk-tools` is optional, and omitted in the examples below.
2. To display help for a specific command, or protocol name, run `nrfutil command --help`.

For example, enter the following command to display help on the *DFU* over Bluetooth Low Energy procedure:

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

To display all available options for Zigbee, enter the following command:

```
nrfutil zigbee --help
```

4 Generating DFU packages

The `pkg` command generates a package to use for a *DFU*. The package contains the new firmware image, an init packet, and a manifest file that indicates the package format. The command can also be used to display the package contents.

Run `nrfutil pkg generate` to generate a zip file that you can use later with a mobile application or another tool to update the firmware of an nRF5 device. You can see available options by entering the following command:

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

Run `nrfutil pkg display` to display the contents of a package.

For example, enter the following command to generate an unsigned package called `app_dfu_package.zip` from the application file `app.hex`:

```
nrfutil pkg generate --application app.hex app_dfu_package.zip
```

Enter the following command to generate a package called `app_dfu_package.zip` from the application file `app.hex` with application version 4 that requires hardware version 51 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 51 --sd-req 0x80 --application-version 4 --application app.hex --key-file key.pem app_dfu_package.zip
```

Enter the following command to generate an unsigned debug package without version information from the application file `app.hex`:

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

Enter the following command to display the contents of the created package:

```
nrfutil pkg display app_dfu_package.zip
```

The `--hw-version` option must correspond to the nRF5 device used.

The `--sd-req` option must correspond to the firmware ID of the SoftDevice present on the target device. Refer to the list of SoftDevice firmware IDs (under `--sd-req`) displayed by the `nrfutil pkg generate --help` command.

Note: While Thread and Zigbee stacks do not use a SoftDevice, the `--sd-req` option is required for compatibility. Any value provided for this option is ignored during the *DFU*.

Not all combinations of Bootloader, SoftDevice, and Application are possible when generating a package. See [Table 1: Supported Bootloader, SoftDevice, and Application combinations](#) on page 9 for more information.

4.1 DFU package combinations

The following table lists the supported combinations when generating a *DFU* package.

Combination	Supported
Bootloader (BL)	Yes ¹
SoftDevice (SD)	Yes ²
Application (APP)	Yes
BL + SD	Yes
BL + APP	No ³
BL + SD + APP	Yes ⁴
SD + APP	Yes ^{2,4}

Table 1: Supported Bootloader, SoftDevice, and Application combinations

¹Update packages of external applications (for example, updates for third-party applications) are generated with the `--external-app` option. When this option is set, the receiving device stores the update but will not activate it. This functionality is experimental in the nRF5 SDK and is not used in any examples.

The `--zigbee` boolean option generates the Zigbee update file in addition to the zip package. For example:

```
nrfutil pkg generate --hw-version 52 --sd-req 0 --application-version 0x01020101
--application nrf52840_xxaa.hex --key-file ../priv.pem --app-boot-validation
VALIDATE_ECDSA_P256_SHA256 app_dfu_package.zip --zigbee-manufacturer-id 0xCAFE --zigbee-
image-type 0x1234 --zigbee-comment good_image --zigbee-ota-hw-version 52 --zigbee-ota-fw-
version 0x01020101 --zigbee-ota-min-hw-version 52 --zigbee-ota-max-hw-version 52 --zigbee
True
```

The `--zigbee-ota-hw-version` and `--zigbee-ota-fw-version` options refer to the generated image to be distributed to the Zigbee OTA Server and disseminated later into the network. The `--zigbee-ota-hw-version` and `--zigbee-ota-fw-version` options describe the hardware version and firmware version of the Zigbee OTA Server respectively. Each time the Zigbee OTA Server receives the image for the dissemination, its firmware version is updated. This is done to protect from a malicious attack, where an attacker could wear down the Server flash memory by repeatedly sending the full Zigbee image to be distributed. Thus, for the OTA Server to accept the image for dissemination, the value passed as a `--zigbee-ota-fw-version` must be incremented with every transfer of the image.

The `--zigbee-ota-min-hw-version` and `--zigbee-ota-max-hw-version` options refer to the fields in the Zigbee OTA header, which determine the range of the OTA Client's hardware version for which the image is suitable. Both `--zigbee-ota-min-hw-version` and `--zigbee-ota-max-hw-version` are optional and if used, both must be given.

²The SD must be of the same Major Version as the old BL may not be compatible with the new SD.

³Create two ZIP packages.

⁴The SD (+ BL) + APP update is done with two consecutive connections, unless a custom bootloader is used. First the SD (+ BL) is updated, then the bootloader will disconnect and the (new) BL will start advertising. Then the second connection to the bootloader will update the APP.

However, the two SDs may have different IDs. The first update requires `--sd-req` to be set to the ID of the old SD. The APP update requires the ID of the new SD. The new ID must be set using `--sd-id` parameter. This parameter was added in nRF Util v3.1.0 and is required since v3.2.0 in case the package should contain SD (+ BL) + APP. Also, the new ID is copied to `--sd-req` list so that in case of a link loss

during the APP update the *DFU* process can be restarted. In this case, the new SD would overwrite itself, so `--sd-req` must contain the ID of the new SD.

5 Performing a DFU

The `dfu` command transfers a *DFU* package to the nRF5 device.

There are several DFU transports available. Enter the following command to display a list of supported transports:

```
nrfutil dfu --help
```

Make sure that the transport you select matches the DFU bootloader that is installed on the DFU target device.

5.1 DFU over Bluetooth Low Energy

Use an nRF5 *Development Kit (DK)* as the connectivity device for the *DFU* over Bluetooth Low Energy procedure.

Complete the following steps to do the DFU:

1. Connect an nRF5 DK to your computer.

Note: In the `-ic` option, you must specify if the DK contains an nRF51 or nRF52 chip.

2. Run `nrfjprog --eraseall` to erase the contents of the DK.
3. Run `nrfutil dfu ble` to do a full DFU over Bluetooth Low Energy.

Use the `-f` option to program the DK with the required connectivity software. This option overwrites the contents of the DK.

Enter `nrfutil dfu ble --help` to see available options.

For example, to perform a DFU procedure using `app_dfu_package.zip` over Bluetooth Low Energy on an nRF52 device connected to COM3, where MyDevice is the remote Bluetooth Low Energy device being upgraded, enter the following command:

```
nrfutil dfu ble -pkg app_dfu_package.zip -ic NRF52 -p COM3 -n "MyDevice" -f
```

5.2 DFU over ANT

Use an ANT USB dongle (ANT USB-m for example) as the connectivity device for the *DFU* over ANT procedure.

Complete the following steps to perform the DFU:

1. Connect an ANT USB dongle to your computer.
2. Run `nrfutil dfu ant` to do a full DFU over ANT.

You can see available options by entering the following command:

```
nrfutil dfu ant --help
```

For example, enter the following command to perform a DFU procedure on the `app_dfu_package.zip` file:

```
nrfutil dfu ant -pkg app_dfu_package.zip
```

5.3 DFU over Thread

Use an nRF5 DK as the connectivity device for the *DFU* over Thread procedure.

For DFU over Thread, nRF Util for nRF5 SDK supports both unicast and multicast mode. In unicast mode, every DFU client requests consecutive blocks of firmware from nRF Util for nRF5 SDK individually. In multicast mode, nRF Util for nRF5 SDK sends consecutive blocks of firmware in multicast messages, and clients that are interested in a new firmware receive and process these messages.

The default mode is unicast mode. To select multicast mode, call nRF Util for nRF5 SDK with a multicast address as a destination address.

Complete the following steps to perform the DFU:

1. Connect an nRF5 DK to your computer.

This board serves as the Thread network co-processor (NCP) for performing the DFU on the target.

2. Run `nrfjprog --eraseall` to erase the contents of the DK.

3. Run `nrfutil dfu thread` to do a full DFU over a Thread.

Use the `-f` option to program the DK with the required connectivity software. This option overwrites the contents of the DK.

Enter `nrfutil dfu thread --help` to see available options.

For example, enter the following command to initiate a unicast DFU procedure for the file `app_dfu_package.zip` over Thread on channel 11 with PAN ID 0xABCD, using an nRF52840 NCP connected to COM3:

```
nrfutil dfu thread -f -pkg app_dfu_package.zip --channel 11 --panid 43981 -p COM3
```

Any remote Thread device can then request the firmware update.

Enter the following command to perform a multicast DFU procedure for the file `app_dfu_package.zip` over Thread on channel 11 with PAN ID 0xABCD to the multicast address FF03::1, using an nRF52840 NCP connected to COM3:

```
nrfutil dfu thread -f -pkg app_dfu_package.zip --channel 11 --panid 43981 -rs 5000 -a
FF03::1 -p COM3 -r 4
```

Any remote Thread device can then decide whether it wants to receive and process the firmware update messages.

5.4 DFU over Zigbee

Use an nRF5 DK as the connectivity device for the *DFU* over Zigbee procedure.

Before you begin, run the following command to generate a Zigbee-specific image from your own application:

```
nrfutil pkg generate --hw-version 52 --sd-req 0x00 --application-version 0x01020101
--application app.hex --key-file key.pem app_dfu_package.zip --zigbee True --zigbee-
manufacturer-id 123 --zigbee-image-type 321 --zigbee-comment good_image
```

The DFU over Zigbee procedure is performed by loading an upgrade image to the *Over-the-Air (OTA)* Server running on the DK.

Complete the following steps to perform the DFU:

1. Connect an nRF5 DK to your computer.

This board serves as the Zigbee OTA Server which distributes a Zigbee image in the network.

2. Run `nrfutil dfu zigbee` to start the Zigbee OTA Server which is going to distribute new firmware in the network.

Enter `nrfutil dfu zigbee --help` to see available options.

The DFU over Zigbee process ends immediately after loading the image, but the OTA Server is active until DK reset.

For example, enter the following command to start the Zigbee OTA Server that distributes the file `CAFE-1234-good_image.zigbee` on channel 20, using an nRF52840 DK with serial number 683604699:

```
nrfutil dfu zigbee -f CAFE-1234-good_image.zigbee -chan 20 -snr 683604699
```

5.4.1 Updating external applications

Packages for updating external applications can be generated by nRF Util for nRF5 SDK by setting the `--external-app` option.

This is only available for updates that contain an application and no SoftDevice or bootloader. Setting this option instructs the receiving device that the update should be stored, but not activated, and then passed on to a third party. The following command is an example for generating an external application update package:

```
nrfutil pkg generate --hw-version 52 --application-version 0x01020101 --application app.hex
--key-file key.pem app_dfu_package.zip --zigbee True --zigbee-manufacturer-id 123 --
zigbee-image-type 321 --zigbee-comment good-image --external-app --zigbee-ota-hw-version
231
```

Note: This functionality is experimental in the nRF5 SDK and not used in any current examples.

5.5 DFU over a serial UART connection

The nRF Util for nRF5 SDK tool supports *DFU* over a serial UART connection.

Complete the following steps to perform the DFU:

1. Connect the DFU target to your computer.

Most Nordic Semiconductor *DKs* have an interface MCU that serves as a virtual COM port and transparently maps the UART into a USB CDC ACM interface. See [Virtual COM port](#) for more information. If no interface MCU is available, use other options to connect the DFU target to your computer, such as a USB to TTL adapter or a serial cable with an RS-232 connector.

2. Run `nrfutil dfu serial` to do a full DFU over a serial UART connection.

You can see available options 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
```

5.6 DFU over a serial USB connection

The nRF Util for nRF5 SDK tool supports *DFUs* over a *USB Communications Device Class-Abstract Control Model (USB-CDC-ACM)* connection.

DFU over a serial USB connection is supported only for chips that have USB pins (for example, nRF52840).

Note: The USB port for the interface MCU is not connected to the USB pins on the chip. If you are using the interface MCU, you must perform a [DFU over a serial UART connection](#).

Complete the following steps to perform the *DFU*:

1. Connect the DFU target to your computer.

If your DFU target is an nRF52840 DK, use the USB port marked **nRF USB**.

2. Run `nrfutil dfu usb-serial` to do a full DFU procedure over a USB CDC ACM connection.

You can see available options by entering the following command:

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

6 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 *DFU* 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.

You can see available options 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
```

7 Generating and displaying bootloader settings

Use the **settings** command 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.

You can see available options 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 device, 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 [nRF Command Line Tools](#) documentation for more information.

For example, enter the following command to generate a bootloader settings page for an nRF52840 device with the application `app.hex` installed, with application version 3, bootloader version 2, and bootloader settings version 1 (for SDK v13.0.0), and store it in a file named `settings.hex`:

```
nrfutil settings generate --family NRF52840 --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
```

Each nRF device has a corresponding `--family` setting:

Family setting	nRF devices
NRF51	nRF51xxx
NRF52	nRF52832, nRF52833
NRF52QFAB	nRF52832-QFAB, nRF52820
NRF52810	nRF52810, nRF52811, nRF52805
NRF52840	nRF52840

Table 2: `--family` settings

The `--bl-settings-version` depends on the SDK version:

SDK version	BL settings version
<=12.0	1
>=15.3.0	2

Table 3: SDK and BL settings versions

The *DFU* bootloader settings version supported and used by your selected SDK is listed in the `nrf_dfu_types.h` file in the `bootloader` library. Even though bootloaders compiled from an nRF5 SDK 15.3.0 or later can only use version 2, they can be configured to support a version 1 settings page. When a new bootloader with a version 1 settings page boots, the bootloader translates the settings page to version 2 before booting. If a version 2 settings page is used, boot validation for SoftDevice and Application can be generated with the settings page using the `--sd-boot-validation` and `--app-boot-validation` commands.

8 Generating HEX files for Zigbee

Use the **zigbee production_config** command to generate production configuration HEX files for Zigbee devices.

Production configuration HEX files can be used to set the production configuration flash memory block in the Zigbee stack when working with the nRF5 SDK for Thread and Zigbee. See the [Zigbee production configuration section in nRF5 SDK for Thread and Zigbee](#) for more information.

1. Create a `yaml` input file that contains the list of required values that are used to generate the production configuration HEX file.

Enter the following command for an example of the `yaml` input and other available options:

```
nrfutil zigbee production_config --help
```

2. Run **nrfutil zigbee production_config** and provide input and output file names to generate a binary file in Intel HEX format.

For example, enter the following command to generate a production configuration `output.hex` file from the `input.yaml` file:

```
nrfutil zigbee production_config input.yaml output.hex
```

Glossary

Device Firmware Update (DFU)

A mechanism for upgrading the firmware of a device.

Development Kit (DK)

A hardware development platform used for application development.

Over-the-Air (OTA)

Refers to any type of wireless transmission.

USB Communications Device Class-Abstract Control Model (USB-CDC-ACM)

A vendor-independent publicly documented protocol that can be used for emulating serial ports over USB.

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