

NTN early evaluation Getting Started Guide

v1.1

Contents

Rev	vision	history	2
1.	Intr	oduction	2
-	1.1.	Early release package content	2
2.	Inst	allation and programming	3
	2.1. 2.2.	Program MFW_nRF9151-NTN_v0.4.x Programming application MCU	3 4
2	2.3. 2.4.	SIM card	6
3.	Con	figure and use Skylo NTN	7
	3.1. 3.2. 3.2.1 3.3. 3.4.	Setting up an NTN connection (using externally acquired location) Setting up an NTN connection (using nRF9151 GPS) Acquiring new GPS location Send data over NTN Receiving data over NTN	8 9 .10 11 12
4.	Tro	ıble shooting	14
5.	Furt	her work	15
Lia	bility	disclaimer	16



Revision history

Date	Version	Description
9.6.2025	1.0	Initial release
9.7.2025	1.1	nRF9151 GPS usage and Data
		Socket WAITACK update



1. Introduction

Welcome to the early evaluation program of 3GPP Non-Terrestrial Networks (NTN) using the Nordic Semiconductor nRF9151 module.

IMPORTANT:

- 1. It is assumed that you already are familiar with nRF9151 and have the nRF connect for desktop and/or our tool chain/SDK installed.
- 2. If not follow the install instructions in this document closely.

If you don't have the nRF connect tool chain installed, please start with downloading the <u>nRF connect</u> <u>for desktop</u> PC application, the applications in this frame work will be key for your NTN evaluation.

Although not strictly necessary for the NTN evaluation, IF you also want to install the SW development tool chain (VS code) and our SDK to compile your own code for nRF9151, run the quick start found in nRF connect for desktop. This can wait until you have completed all the steps in this guide. Be aware of the following!

- Stop following the quick start when you get to testing the application examples, i.e. before you program the device with any code!
- If you do this step, you will erase anything you have programmed on the device before, like the NTN code you will program by following this getting started guide!
- Also note the quick start examples will **only** work in terrestrial networks. SIM cards for terrestrial operation are not included in the nRF9151 SMA DK you have received, and the DK as well as NTN FW is not yet certified for operation in terrestrial networks!

1.1. Early release package content

The content you will find in your early release package is:

- 1. MFW_nRF9151-NTN_v0.4.0 nRF9151 MFW/LTE stack with NTN support
- 2. SLM app FW Pre-compiled SLM example with and w/o modem trace enabled.
- 3. Modem trace data base needed for modem trace, see section 2.3.
- 4. MFW_nRF9151-NTN_AT_commands_v0.4 AT command reference guide
- 5. nRF9151_PS_v1.1A prerelease next version nRF9151 product spec.
- 6. nRF9151 SMA DK HW user guide Documentation of the development kit used for NTN
- 7. nRF9151_SMA_DK box access to 3D model files for plastic box fitting nRF9151 SMA DK.
- 8. nRF9151_SMA_DK antennas a selection of antennas that can be used for testing in live networks
- 9. NTN early evaluation getting started guide this Document

Further documentation that will get public release in June 2025:

1. Updated version of the nRF91 antenna design guide – adding NTN specific details



2. Installation and programming

To program the nRF9151 for the NTN evaluation, use the standard programmer app found in the <u>nRF</u> <u>connect for desktop</u>.

Open the framework, install if needed, and open the programmer application.

2.1. Program MFW_nRF9151-NTN_v0.4.x

To program the LTE modem with the new MFW, download the zip file found on the shared jfrog.io server.

Follow the steps below to program/flash the MFW_nRF9151-NTN_v0.4.0 on nRF9151. Do not open/unzip the MFW file; the programmer tool will automatically flash the zip file into the nRF9151 modem.

Install and open the nRF Connect for Desktop. In the main APPS page open the *Programmer* App (or install it if not installed yet). Next another window for the *Programmer* appears.



Note:

Engineering (first) nRF9151 SMA DK will show up in your connected devices list as a generic Jlink device, not as a Nordic DK, but nRF connect for desktop applications will still have full functionality.

Program the modem firmware.

- 1. Click *SELECT DEVICE* and a pull-down menu list of nRF kits connected to the PC will show up. For simplicity, you should only have a single Devkit attached to your PC.
- 2. Select the Devkit to be programmed (it shows either as J-Link or nRF9151).
- 3. Click *Add file* and use *Browse*.. to locate the modem firmware file unless it is already listed in the pull-down menu list you will be presented.



- 4. Select the firmware package zip file provided by Nordic. In this example it is named as *mfw_nrf9151-ntn_0.4.x-prealpha.zip*.
- 5. Click *Write* and you will get a pop-up window with a warning. Since the provided modem firmware is not yet a publicly released modem firmware by Nordic, you will get the warning from the *Programmer* APP when you click *Write*. Ignore this warning and proceed to the next step.
- 6. Click Write in the pop-up window. Programming the modem will take about ~30 seconds.

Programmer v4.50	- 0 x]	Programmer v4.6.0	0 X
J-Link PROGRAMMER ABOUT	89	Stank APROGRAMMER ADOUT	8
Production ACCCC Production ACCCCC Production ACCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC	0 0 0 0 10 0 10 <td< th=""><th>PORTALINE ADDR PORTALINE PORTALINE ADDR PORTAL</th><th>8</th></td<>	PORTALINE ADDR PORTALINE PORTALINE ADDR PORTAL	8
Finner No even Activity 213-etts,242-39-2	v MRX/20FEboc(*Jeoc*Alicy*ali v Open Carcel	152/2000 007 Genetic Is loaded and ready for further spension 122/2014 (split filter the region account to the Application are 122/2014) (split filter the region account to the Application are 122/2017) (filter was all models of the Application and the State	loctsvart9
traucou sur mexicuty residuals (protection institut to Application core completed 13:2359.000 toxics tak mexicuty and ready for further operation sciences for mexicuty and ready for further operation	AUTESCHOLLISS 👥 SECOLOS 🚺	12.26.25.36 - Working C. Scherzigkei (Scherzigkei) (Scherz	nas 🥌

2.2. Programming application MCU

For the early evaluation, please program the nRF9151 application core with the simple Serial LTE Modem (SLM) application, which will enable you to issue AT commands to the nRF9151 modem directly from a PC terminal.

In the release package you will find 2 pre-compiled Serial LTE Modem (SLM) examples for your early testing.

- 1. Serial_Ite_modem_mfw_trace_vXX SLM application with modem trace enabled, for debugging the operation and link.
- 2. Serial_Ite_modem_vXX SLM w/o trace, once you have a link up and running, you can use this example to look at link behavior and device power consumption during NTN operation without the additional power drawn by the trace functionality.

Programming the selected Application core firmware, the procedure is almost the same as for the modem firmware.



Protocologies (a) (b) (c) (c) (c) (c) (c) (c) (c) (c) (c) (c						
Lit 1) Add fin Biolog files Correct for the file of	001052042942	PROGRAMMER ABOUT Select a HEX / ZIP file				
Add the Copies in New Idage Copies Copies in New Idage Copies	1)		-			
Aligned Automotion Auto		← → ♥ · · · · · · · · · · · · · · · · · ·	плутхт > арр >	v o	Search app	ų
Broad field Constrained Data in Norme 2 Data in N	ADD THE	Organise - New folder			= -	
Case Test Vore Case Test Vore Case Test Vore Case Test Case Case Test Case Case Test Case Test Case Test Case Case Case Test Case Case Case Test Case Case Case Case Test Case Case Case Test Case Case Case Test Case Case Test Case Case Test Case	Reload files	> 🔁 Documents	Status Name 2)			-
Image: Series all image: Series	Clear files	> 🏂 MFW2.0	🗋 🧿 slm_master_nrf9151dk_	normal_no_cloud_ext_antenn	a_modem_hwfc_uart_trace	v67.hex
The set and the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea, uncdem, lock), and (user, VSB have the set of S13 decomed (ne., cloud, at unterea)). Is a S13 set of S13	1105	> 🚞 Microsoft Teams Chat Files	0 npg_mosh_dev_nrf9151	ldk_normal_protocol_tester_ir	t_antenna_modem_uart_tr	ace_v1120.he
Bit and and an anomaly and a state of the state of t		> Pictures	master_nrf9151dk_nom	nal_no_cloud_ext_antenna_m	odem_hwfc_uart_trace_v58	hex
Bits ak with Image: State and	 Erase all 	3)	🗋 🥥 npg_mosh_dev_nrf9151	Igoboard_normal_int_antenna	_modem_fido_trace_v1029	hex
Consistence Conseconcollectencollectence Conseconcollectencollectence	* Erase & write	Shared Documents - Aloo Team	🗋 🥥 npg_mosh_dev_nrf9151	lgoboard_normal_protocol_te	ster_int_antenna_modem_i	uart_trace_v9
Reat 		Shared Documents - NTN	🗋 🥥 npg_mosh_dev_nrf9131	Igoboard_normal_protocol_te	ster_int_antenna_modern_f	lido_trace_v9
With Image: Castory in Cas	Reset	Jan Shared Documents - Wilv	0 npg_mosh_dev_nrf9131	lgoboard_normal_int_antenni	_modem_fido_trace_v973J	hex
Read Image: Construction Intx SETTINGS File name: dim_mate_ref93316f_normat_nc_biox_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_interv_int_inc_cut_intervint_intervintervintervint_intervintervint_intervintervintint			0 npg_mosh_dev_nrf9151	ldk_normal_protocol_tester_in	t_antenna_modern_fido_tr	ace_v942.hes
LINE SETTINGS to read memory to read memory to read memory solution of setTing S aller MCLood 13.49.57.108 Modern OFU starts to write. 13.49.57.108 Modern OFU starts to write.	7 Read	Desktop *				
INCLETINGS to reset A US 001 SECTIONS alle MCCbool 13:40-57.108 Modem DFU starts to wite 13:40-57.108 Modem DFU starts to wite 13:40-57.108 Modem DFU starts to wite 13:40-57.108 Modem DFU starts to wite 13:40-57.109 Modem DFU starts to wite		File names sim_master	nrf9151dk_normal_no_cloud_ext_anten	na_modem_hwfc_uart_trace >	HEX / ZIP files (".hex;"	.iHec*zij ∽
or read many or read A Or read A Or read A De set strings de MO2.boot 13.49.57.108 Modem DFU starts to write 13.49.57.108 Modem DFU starts to write 13.49.57.109 Modem DFU starts to write 13.49.57.109 Modem DFU starts to write 13.49.57.109 Modem DFU starts to write 13.49.57.009 Modem DFU starts to wr	INK SETTINGS				Open	Cancel
Depert A Control Contr	to read memory					
UBDOT SETTINGS aller MC2.bool III.40-57.108 Modern DFU starts to write III.40-57.108 III.100-00000 III.40-57.108 III.100-00000 III.40-57.108 III.100000 III.100000 III.10000 III.10000 III.10000 III.10000 III.1000 III.1000 III.1000 III.1000 III.1000 III.1000 III.1000 III.1000 III.1000 III.100 IIIII.100 IIII.100 IIII.100 IIII.100 IIII.100 IIIIIIIII.100 IIIIIIIIII	to reset 🛦					
Bite MOxdoorf The second						
13.49.57.108 Modern OFU starts to write. 13.49.57.108 Vitting C.U.Bersylokin Datchive - Nordic Semiconductor Documents/firmware.certification_material/poducts/pr071 13.20.27.20 Vietom OFU completed successfullyi 13.20.48.209 Paring HEX file: C.U.Bersylokin Datchive - Nordic Semiconductor/Documents/firmware.certification_material/poducts/pr071 13.20.48.209 Paring HEX file: C.U.Bersylokin Datchive - Nordic Semiconductor/Bersylokin Datchive - Nordi	UBOOT SETTINGS					
13:49:57:108 Modern DFU starts to write 13:49:57:108 Writing c, Sutersfyleid Jonden Nordic Semiconductor/Documents/firmware_certification_material/products/ur971 13:30:20, 70 Modern DFU starts (FEC, Watersfyleid) Onderbre - Nordic Semiconductor/Documents/firmware_certification_material/produ 13:30:42.09 File was last condicided a 30:30:5275; 10:43:37						
13.49.57.108 Modern DFU starts to write 13.49.57.108 Witting C, Maeryloki O. Noethive - Nordic Semiconductor/Documents/firmware_certification_material/products/ur/97 13.902.87.20 Modern DFU completed successfully/ 13.504.8.00 Paring HZK / Ric C, Users J, Nota 37 13.504.8.00 Paring HZK / Ric C, Valers J, 10.4.37	uboot settings	·				
13.49-57.108 Modern 0FL starts to write. 13.49-57.108 Writing CLIVerer(lpic) (Intellive - Mordic Semiconductor(Documents/firmware_certification_material/products)re191 13.89.08.708 Mordom 0FL completed suscessfullyi 13.89.08.708 Mordom 0FL completed suscessfullyi 13.89.08.709 Preiming HEX file_C-Marcing/biol/0naDriteNordic Semiconductor/Documents/firmware_certification_material/products/se101 13.89.08.209 File misl etic modified at 30/05/5; D.63.37	able MCUboot	·				
13:49:57:108 Modern DFU starts to wite 13:49:57:108 Winting CJUserlykeit Ondere - Nordic Semiconductor/Documents/Immware_cettification_material/products/srd91 13:30:23:20 Paring HZX Rec Cyberrykeit Ondere - Nordic Semiconductor/Documents/Immware_cettification_material/products/srd91 13:30:42:30 Paring HZX Rec Cyberrykeit Ondere - Nordic Semiconductor/Documents/Immware_cettification_material/products/srd91 13:30:42:30 Paring HZX Rec Cyberrykeit Ondere - Nordic Semiconductor/Documents/Immware_cettification_material/products/srd91 13:30:42:30 Paring HZX Rec Cyberrykeit Ondere - Nordic Semiconductor/Documents/Immware_cettification_material/products/srd91	SUBOOT SETTINGS					
13:495-71 toe Moorem unu samt to minite 13:495-71 508 Writing (Subersylokio) binettive - Nordic Semiconductor/Documents/Immware_certification_material/products/unf91 13:50:28.736 Moorem DFU completed successfullyi 13:50:28.739 Parising FER (Loc Usubersylok) binoffine - Nordic Semiconductor/Documents/Immware_certification_material/produ 13:50:28.739 Parising FER (Loc Usubersylok) binoffine - Nordic Semiconductor/Documents/Immware_certification_material/produ 13:50:28.739 Parising FER (Loc Usubersylok) binoffine - Nordic Semiconductor/Documents/Immware_certification_material/product 13:50:28.739 Parising FER (Loc Usubersylok) binoffine - Nordic Semiconductor/Documents/Immware_certification_material/productor/Documents/Immware_certification_material/productor/Documents/Immware_certification_material/productor/Documents/Immware_certification_material/productor/Documents/Immware_certifi	UBOOT SETTINGS					
13:9028-776 Modem DFL completed successfully 13:9028 709 Parsing left for Clusters jeldo modifier. André Serniconductor/Documents/firmware_certification_material/produ 13:9048-209 File was last modified at 50/05/2025, 10:43:37	UBOOT SETTINGS					
13:50:48:209 Parsing HEX file: C:\Users\joko\OneDrive - Nordic Semiconductor\Documents\firmware_certification_materiaNprodu 13:50:48:209 File was last modified at \$00,05;2025, 10:43:37	UBOOT SETTINGS	13.49.57.108 Modern DFU starts to write 13.49.57.108 Writing C \liseratickolOn	re eDrive - Nordic Semiconductor\Do	cuments\firmware_certif	cation material\produ	cts\nrf91x
13:50:48:209 File was last modified at 30(05/2025, 10:43:37)	UBOOT SETTINGS	13:49:57:108 Modern DFU starts to writ 13:49:57:108 Writing C,SusersJoko Kon 13:50:287.56 Modern DFU completed a	re eDrive - Nordic Semiconductor\Do uccessfully!	cuments\firmware_certif	cation_material\produ	cts\nrf91x
LIA 20 40 ZOD UDDARE UPS REDODS ACCORDED TO ADDICATOL CARE	UBOOT SETTINGS Bile MCOlfoot	18.49.57.108 Modem DFU starts to wri 13.49.57.108 Writing C/Lisers/Jek/D0 13.922.87.5 Modem DFU completed 13.50.48.209 Parsing HEX file: C/Lisers	re EDrive - Nordic Semiconductor\Do uccessfully! Ajoko\DneBrive - Nordic Semicono	cuments\firmware_certif ductor\Documents\firmw	cation_material\produ are_certification_mater	cts\nrf91x ial\produc
	UBOOT SETTINGS élie MCUboot	13.49.57.108 Modern DFU starts to wri 13.46.57.108 Writing C.Usters Valence 13.50.81.200 Parming HCM, Mick, C.Warri 13.50.81.200 Parming HCM, Mick, C.Warri 13.50.84.200 Update files regions accurately files 13.50.84.200 Update files regions accurately files 13.50.84.200 Update files regions accurately files	te EDrive - Nordic Semiconductor\Do uccessfullyi Ajøko\OneDrive - Nordic Semicons 00/59/2025, 10:43:37 rding to Application core r file	cuments\firmware_certif ductor\Documents\firmw	cation_material\produ are_certification_mater	cts\nrf91x laî\produc

1) Click *Add file* and a file selector window will show up.

2) Locate the HEX file for SLM provided by Nordic.

3) Click *Erase & write*. The programming will take less than 10 seconds.

2.3. Modem trace and debug

If you run into any issues in your NTN testing and communication, all tech support requests will need to include a modem trace for us to help you debug. While tracing you can also see all the communication between the modem and the network using Wireshark.

NOTE:

For tracing of MFW you need to select a Trace Data Base file. Use the Trace DB file provided in the MFW catalog of the release package, as the cellular monitor will not be able to find it online.

Modem tracing is logging all commands, traffic and key events during modem operation, and is managed on the PC by the cellular monitor application found in nRF Connect for Desktop framework. Install and open Cellular monitor and follow the instructions to get tracing set up.



Member 1744	1 ¹⁾			5] 0	A
J-Link	DASHBOARD CERTIFICATE MANAGER AB	TUOE		/	1
				-	-
O Stop	Gapturing from Wpipetwreshark-iegamzmsh				- 0
	File Edit View Go Capture Analyze Sta	atistics Telephony Wireless Tools			
	Acoly a disolar filter _ <ct+></ct+>		(11)		E •
CTION STATUS	No. Time Source	Destination Protocol Lengt	info		
	29 14:19:41,146638	LTE RR 44	ULInformationTransfer, Cipher	ed message	
2	30 14:19:41,160859	LTE 88. 20	5 UEInformationRequest-r9		
	32 14:19:41,251802 fe80::1119:6-	fe80::594a:6501 ICMPv6 100	8 Router Advertisement		
	33 14:19:41,512422	AT 37	Revd AT Command: Dropped trac	es count: 294	
TION	34 14:19:41,547609 35 14:19:41,555513	LTE RR. 22	5 MeasurementReport 5 MeasurementReport		
	36 14:19:41,650636	LTE RR. 64	RRCConnectionReconfiguration		
	37 14:19:41,651307	LTE RR. 26	5 RRCConnectionReconfiguration	Complete	
ce database 9776/765da tar.gz	> AT Command: AT+cfun+41				
ce database 9796/10566 tar go v ce seriar port vesharik fresharik file to diak	AT Consult AT-claim41	sture in progresss	Packe	te: 37	Profile: Defaul
tabase 6/hb5da targe v serport vice and on start vice c diak Free	AT Consult, AT-claim41 AT Consult, AT-claim41 Orever, AT Provide September (Second Second Se	uture in progresso Ukanown Tilternom	Packa Sim	xe 37	Profile: Defau
se dda tar gz v lokt	AT Conserved (AT-c fuen-12 Or T () (pp/ scientum trajectorest) - ther op Or T () (pp/ scientum trajectorest) - ther op Orall VIII (Territorias Orall VIII (Territorias Orall VIII (Territorias	Stare in progress Unknown Utknown Titterown	Sim	te 37	Profile: Defaul
hase Toda targe v rport dion start free 1.78 TB	AT Conserved (AT+Char+E Conserved (AT	ture in progress) Ukanown Ukanown Liter ve	Sim	te 37	Profile Defaul
abase 47056a targe v ar port v ar port v ar on start c disk v 7ree 1.78 TB 1.78 TB 1.78 TB 1.78 TB 1.78 TB	AT Connect(AT-cfue+1 AT-cfue+1 Orientation injunctuals injunctuals injunctuals Orientation injunctuals Orientation Provid Event Viewer	tur is progress Universit Universit Thirtown Iter 4	Simi	te 37 Ilbinnen O SETTINGS LIVE	Prefile Defau
Sationse 2750/10545 terger V events port Vents for a first 1.778 TB The first The first first The first first The first first the first first first first first first first first first firs	AT Conserved (AT+Char+S AT+Char+S AT+CHAR+S	taré in progress Distribuin Distribuin Transmon Transmon Transmon Transmon Transmon Transmon Transmon Transmon Transmon Transmon Transmon Transmo Tran	∭ Pede € Smi	1637000. (1637000) 0 SETTINGS LIVE	Profile Defau
Plafradat segr Verfarbidat segr Verfarb	AT Consel(AT-Che+1 AT-Che+1 AT Consel(AT-Che+1 AT CONse(AT-Che+1 AT CONse(AT-	ture is propress Useroum Useroum Historum Historum	Poste Sim	e 37 • SETTINGS LIVE	Pedia Delar
Atloade Atloade targe and port and port an	AT Connect AT-cfuer41 AT-cfuer41 Oracle AT-cfuer41 Oracfuer41 Oracfuer41 Oracle AT-cf	Aur in progress Gradowin Hardowin Hardowin Hardowin	Pada Simi	n 37 I Second O SETTINGS LIVE	Polis Dela
Africista targer v Africista targer v Africon stant v Africon	AT Consel(AT-Che+1	thus is property Ukaroun Ukaroun Harown Hare e	@ Pede @ Sim	Ibbanet. O SETTINGS LIVE	Profile: Defail
database Print holds target v based on stort based on stort three to disk Pree 1.73 TB me fille site 1.75 KB or T1 hulls All site (port	AT Conset(AT-Char42 AT-Char42 AT-Char42 AT-Char43 AT-Char43 AT-Char44	Num in program Without M Without M History M H	€ Des	te 17 I Hennen O SETTINOS LIVE	Profile Edea
dddose 77df10604 krg/ v Xerdie start Artificijos et to disk Free Entrade Crited Crited Crites	AT Connect(AT-cfuer42	University progress University Un	e Sm	e 37 I bitwees o settiness Live 0.3	Profee Eduar
24 SED Set 1 24 SED SET 1 24 SED SET 1 24 SED SET 1 25 SED SET 1 2	AT Connect AT-char-1 AT Connect AT-char-1 Or T Stylep/calmbal-log/promoti-star-cop Connext, It provides Connext, It provides	Atur in program U totomin Historym Bietown Bie	e Dest	ikinon jkinon ¢stTikos Livi	Petite Detail
As diffuent as a star of the second s	AT Connect(AT-Cher+1 AT	Universe Uni	e Sm	e stTikos Live 9 stTikos Live 9 s	
Incl. difference of the second	AT Connect AT-char42 AT-char42 Oracle AT-char42 Oracle AT-char42 Oracle AT-char44 Oracle	Aturé la program Versionen Historium Historium 2003/024 Aturé program 2003/024 Aturé program 2003/024 Aturé program Aturé program	Device Device	e 37 Jedanen. • SETTINGS Link • S	Profile Defend
Tess dispersions La Contract on any contract La Contract on any contract Sector of the data Sector of	AT Connect(AT-cfuer42	Aller in progress - Unicom Transmit Transmit Construction	Pack Sm Transe y lakes if you an out our, by log by doing any out our out our, by log by doing any out our out our, by log	1934 vers e settinos Live 0.3 overs cycle the device and Verman cycle the device and	Prefix Defail

- 1) Click SELECT DEVICE and select nRF9151 (or J-Link if that is shown)
- 2) Click the Modem trace database pull-down menu and select *Select Trace DB*, and locate the database file provided by Nordic.
- 3) Select *Open in Wireshark* and *Save trace file to disk*. Wireshark is for your benefit to see cellular signaling and user traffic packet traces. For Nordic you need to provide the trace files saved during tracing.
- 4) Click Start to start tracing.
- 5) Wireshark should pop up and show what is happening in the modem.

Note: You may want to select *Deselect* in the *Terminal serial port* pull-down menu before step 4) if you are using external to Nordic serial terminal for your AT-commands. Otherwise, Cellular Monitor will reserve the COM-port.

2.4. SIM card

The RF9151 SMA DK is not shipped with any SIM cards, it is assumed you have a test SIM card for use with lab instruments or an NTN enabled SIM card from your chosen NTN connectivity provider.



3. Configure and use Skylo NTN

This section describes how you configure and run NTN communication, using MFW_nRF9151-NTN_v0.4.x and SLM in the Skylo NTN. If you want to test in the Myriota network, please contact Myriota on <u>support@myriota.com</u> to get needed application FW for their network.

Before you attempt connection to a live network, make sure that some of the more obvious conditions are met:

- 1. You have an NTN enabled SIM with data, including the default APN of that SIM provider.
- 2. The NTN provider you are testing with have landing rights (coverage) in your test area.
- 3. Your antenna has free line of sight to the satellites.
 - a. Avoid placement close to large walls and other obstacles that may create shadows in NTN coverage.
 - b. Note: Especially if you are testing at high latitudes and using GSO satellites orbiting in proximity of the equator, obstruction of the southern horizon can be an issue.

Communication over both NIDD and IP are supported, and the needed commands for each protocol are interleaved below.

The assumption is that the Initial ATTACH (default PDN) only is used, and the UE must define an APN for that using the APN configuration <u>defined by your SIM provider</u>.

The following AT commands will enable you to set up an NTN connection with test instruments or a live network in a static location, largely focusing on the connection/link behaviour. More advanced operation needed by applications/use cases where they UE is changing location between and during NTN operation will be covered later in the eval program.

Please refer to MFW_nRF9151-NTN AT command reference in the download directory for all ATcommands supported and <u>Serial LTE Modem Application AT-commands</u> for details on SLM AT commands for control from a PC terminal.

Note on product mobility:

If your final product (or test HW) is static in a location, you only need to input the location once, during the initial attach procedure as described in sec. 3.1 and 3.2.

If it is mobile, and moves more than ~400m between/during NTN connection(s) you will need to update the position to maintain NTN performance and eventually connection:

- If you use an external GNSS receiver you can input new location to NTN stack at any time using the **AT%LOCATION** command. This includes while the NTN stack is in an active connection with a satellite!
- If you use the internal GPS in nRF9151, you need to run the routine in chapter 3.1.1 prior to each connection. Acquiring new location updates during an active connection is not supported



3.1. Setting up an NTN connection (using externally acquired location)

Simple template for setting up NTN connection with band and EARFCN lock using serial LTE Modem Application (SLM).

; Modem off AT+CFUN=4

; Set modem system mode to NB-IoT IoT-NTN **AT%XSYSTEMMODE=0,0,0,0,1**

; Set a runtime bandlock. The list of bands a comma separated.

; In this example we have locks for bands 255 and 256.

AT%XBANDLOCK=2,,"255,256"

; Tell modem your GPS location: latitude, longitude, altitude

; Example here is the Nordic office in Espoo, Finland.

; Note: if you are testing in live network this position needs to be the actual position of your kit.

; syntax: %LOCATION= <operation>[,<latitude>,<longitude>,<altitude>,<accuracy>,<validity>]

AT%LOCATION=2,"60.21864797","24.81997709","0",0,0

; Create a PDN Connection for the initial ATTACH and Non-IP data (NIDD). AT+CGDCONT=0,"non-ip","*your-NIDD-enabled-APN-goes-here*"

; **Or** in case you want to use IPv4 (UDP) data replace the above with: **AT+CGDCONT=0,"ip","***your-IP-enabled-APN-goes-here*"

; Order some event notifications to see what modem is doing. Refer to MFW_nRF9151-NTN ATcommand reference manual for further command details.

; +CEREG to subscribe to unsolicited network status indications.

; +CNEC to subscribe to unsolicited reporting of error codes sent by the network

; +CDCON to subscribe unsolicited connection state indications

; %MDMEV to subscribe sending of modem domain events

AT+CEREG=5 AT+CNEC=24 AT+CSCON=3 AT%MDMEV=2



; Activate the modem AT+CFUN=1

; Place your data communication here. See examples below.

3.2. Setting up an NTN connection (using nRF9151 GPS)

Simple template for setting up NTN connection with band and EARFCN lock using serial LTE Modem Application (SLM) and GPS functionality in MFW_nRF9151-NTN_v0.x.x

To alternate between GNSS and NTN, keeping the NTN connection intact while getting the GPS fix, the application must set up a cellular profile for both access technologies.

Note, this example has the following assumptions:

- Single SIM for both NTN and TN
- Communication in TN network not tested, only acquiring the GNSS fix

; Acquire your initial GPS location: latitude, longitude, altitude

AT+CFUN=4 AT%XSYSTEMMODE=0,0,1,0,0 AT+CFUN=31 AT#XGPS=1,0,0,0

; expected output EXAMPLE! #XGPS: 1,1 #XGPS: 60.400130,20.178765,182.815308,66.373810,0.444368,0.000000,"2025-07-09 20:08:01" #XGPS: 1,4

NOTE! Cold start minimum TTFF is ~30 seconds in open sky conditions

; Shutdown GNSS stack **AT#XGPS=0**

; GNSS off AT+CFUN=30

; While modem is off, activate NTN system mode: **AT%XSYSTEMMODE=0,0,0,0,1**

; Set up appropriate band locks: AT%XBANDLOCK=2,,"23,255,256"

; Create cellular profiles for NTN and TN (will *only* be used for GNSS purposes):



AT%CELLULARPRFL=2,0,4,0 ;NTN AT%CELLULARPRFL =2,1,1,0 ;TN

; Create a PDN Connection for the initial ATTACH and Non-IP data (NIDD) on NTN . AT+CGDCONT=0,"non-ip","*your-NIDD-enabled-APN-goes-here*"

; **Or** in a case you want to use IPv4 (UDP) data replace the above with: **AT+CGDCONT=0, "ip", "***your-IP-enabled-APN-goes-here*"

; Input the acquired location to NTN stack: **AT%LOCATION=2**," 60.400130","20.178765","182.815308",0,0

; Order profile change notifications: AT%CELLULARPRFL=1

; Get NTN connection
AT+CFUN=1

; Do your NTN communication, see next sections

3.2.1. Acquiring new GPS location

; When new location fix is needed, put NTN into "flight mode". ; This preserves the PDN Connection previously set up! AT+CFUN=45

; Acquire your GPS location: latitude, longitude, altitude AT%XSYSTEMMODE=0,0,1,0,0 AT+CFUN=31 AT#XGPS=1,0,0,0

; expected output EXAMPLE #XGPS: 1,1 #XGPS: 60.400130,20.178765,182.815308,66.373810,0.444368,0.000000,"2025-07-09 20:08:01" #XGPS: 1,4

; Shutdown GNSS stack AT#XGPS=0

; GNSS off AT+CFUN=30

; Set modem system mode to IoT-NTN AT%XSYSTEMMODE=0,0,0,0,1



; Update NTN GPS location

; syntax: %LOCATION = <operation>[,<latitude>,<longitude>,<altitude>,<accuracy>,<validity>] ; copy the latitude, longitude, and altitude. (See XGPS output above)

AT%LOCATION=2," 60.400130","20.178765","182.815308",0,0

; Activate the modem AT+CFUN=1

; Run NTN communication

3.3. Send data over NTN

Simple template to create a socket and send either UDP/IP or NIDD data..

More information on the use of sockets in the SLM example available at:

https://docs.nordicsemi.com/bundle/ncslatest/page/nrf/applications/serial_lte_modem/doc/SOCKET_AT_commands.html

; Create a socket for UDP/IP. The CID is implicitly 0 here for the default PDN Connection ; Syntax: #XSOCKET=<op>[,<type>,<role>[,<cid>]] AT#XSOCKET=1,2,0

; **Or** in case of a NIDD PDN Connection create a socket for NIDD **AT#XSOCKET=1,3,0**

; Send a NIDD payload over the NIDD type PDN Connection ; Syntax: #XSEND[=<data>] AT#XSEND="Your Hello World(tm) payload"

; **Or** send with WAITACK Flag, i.e. send command doesn't return until uplink transmission has been acknowledged on the NTN NB-IOT radio level

AT#XSEND="Your Hello World(tm) payload",512

; Or alternatively UDP over the IPv4 type PDN Connection. at the

; same time set the destination IP address and the port number.

; Syntax: #XCONNECT=<url>,<port>

AT#XCONNECT="FQDN-or-IP-address-dotted-format-for-your-server",port-address-as-integer



AT#XSEND="Your Hello World(tm) payload"

; **Or** send with WAITACK Flag, i.e. send command doesn't return until uplink transmission has been acknowledged on the NTN NB-IoT radio level

AT#XCONNECT="FQDN-or-IP-address-dotted-format-for-your-server",port-address-as-integer AT#XSEND="Your Hello World(tm) payload",512

; Or UPD/IP alternative to #XCONNECT is to use #XSENDTO ; Syntax: #XSENDTO=<url>,<port>[,<data>] AT#XSENDTO="FQDN-or-IP-address-dotted-format-for-your-server",port-address-asinteger,"Your Hello World(tm) payload"

; **Or** send with WAITACK Flag, i.e. send command doesn't return until uplink transmission has been acknowledged on the NTN NB-IoT radio level

AT#XSENDTO="FQDN-or-IP-address-dotted-format-for-your-server",port-address-asinteger,"Your Hello World(tm) payload",512

; Close the latest opened socket in use ; Syntax: #XCSOCKET=0 AT#XCSOCKET=0

3.4. Receiving data over NTN

Simple template to create a socket and receive either UDP/IP or NIDD data with a timeout.

more information on use of the sockets available in the SLM example at: <u>https://docs.nordicsemi.com/bundle/ncs-</u> <u>latest/page/nrf/applications/serial_lte_modem/doc/SOCKET_AT_commands.html</u>

; Create a socket for UDP/IP. The CID is implicitly 0 here for the default PDN Connection **AT#XSOCKET=1,2,0**

; **Or** in case of a NIDD PDN create a socket for NIDD **AT#XSOCKET=1,3,0**

; Recv an NIDD payload over the NIDD type PDN Connection with 5 seconds timeout ; Syntax:

```
AT#XRECV=5
```

; **Or** alternatively UDP over the IPv4 type PDN Connection.. at the

; same UPD/IP payload with a 5 seconds timeout. Using #XCONNECT you can limit

; receiving packets only from a specific source IP address and port number. The use



; of AT#XCONNECT is optional ; Syntax: #XRECVFROM=<timeout>[,<flags>]

AT#XCONNECT="FQDN-or-IP-address-dotted-format-for-your-server",port-address-as-integer AT#XRECVFROM=5

; Close the latest opened socket in use **AT#XCSOCKET=0**



4. Trouble shooting

The AT+CGDCONT fails to configure the CID 0 with a new APN and/or PDN Type:

- This is a known issue with mfw_nrf9151-ntn_0.4.0-prealpha
- To resolve the issue, use the following command sequence:
 - AT+CFUN=0
 - AT%XFACTORYRESET=0
- The modem will lose all the existing configuration and for example, AT%LOCATION and other connection configurations must be given again.

The device stays in RRC CONNECTED mode for an extended time while using NTN connection:

- The satellite eNB did not release the RRC connection.
- The UE will do implicit RRC connection release after the network configured data inactivity time expires (this is typically around 80 seconds or more).
 - For cases where the network does not configure the data inactivity timer and does not release the UE, the UE stays in RRC CONNECTED over 4 minutes before implicitly doing the RRC release.

My RSRP, RSRQ and SNR values are very bad:

- Especially in the case of GEO, the above values are much worse than what one would typically expect from an NB-IOT (terrestrial) connection.
- RSRP average around –120dBm or a bit less is very good RSRP for GSO NTN.
- RSRQ average around –12dB is just fine.
- SNR average around 0dB or a few dB below zero is still fine.



5. Further work

Once you successfully have your NTN link up, you can continue your evaluation using the serial AT commands and our power profiler kit to look at timing and power consumption when using NTN, or indeed integrate them in a test application of your own.

If you don't already have our power profiler kit, please read more about it in the nRF9151 SMA DK suer guide or at <u>Power profiler kit v2</u>

We will continue our NTN development, so stay tuned for updates.

Further work



Liability disclaimer

Nordic Semiconductor ASA reserves the right to make changes without further notice to the product to improve reliability, function or design. Nordic Semiconductor ASA does not assume any liability arising out of the application or use of any product or circuits described herein.