

MTC2-N9151 NTN Experimentation

Quick Start with the LooUQ MTC2-N9151

The MTC2-N9151 is LooUQ's third-generation embedded modem, built around the Nordic Semiconductor nRF9151 System-in-Package (SiP). It pairs an Arm Cortex-M33 application MCU with an integrated cellular/GNSS modem and is one of the first commercially available carrier boards for the nRF9151's emerging **Non-Terrestrial Network (NTN)** capability — direct device-to-satellite NB-IoT connectivity.

This guide walks through getting a development environment running and pointed at NTN specifically. NTN support on the nRF9151 works now via Skylo — official Skylo certification is currently underway and covers the **MTC2-N9151 paired with the Taoglas FXUB64 Cyclone antenna** as a combination, not the module alone. Once certified, leveraging LooUQ's certification in your product requires using both the MTC2-N9151 and the Taoglas Cyclone together — swapping in a different antenna would fall outside the certified configuration. Treat this as functional for experimentation while formal certification catches up — always cross-check against LooUQ's current docs before you start.

The fastest way to get started with everything you need already in hand is LooUQ's **UXplor QuickStart (MTC2-N9151)** kit, available now from the LooUQ webstore. It bundles the MTC2-N9151, the UXplor carrier/breakout board, and the Taoglas antennas together, and comes **pre-flashed and ready to go** — so you can skip individually sourcing hardware and building firmware and go straight to the walkthrough below.



The UXplor QuickStart (MTC2-N9151) kit: MTC2-N9151 mounted on the UXplor carrier board, wired to the Taoglas GNSS antenna (left) and Cyclone NTN antenna (top).

What “NTN” Means Here

- NTN = 3GPP IoT-NTN, based on a modified Cat-NB1/NB2 physical layer, letting the nRF9151 talk directly to satellites instead of a terrestrial cell tower.
- It requires a **specialized modem firmware image** (*mfw_nrf9151-ntn*), distinct from the standard terrestrial LTE-M/NB-IoT modem firmware. You cannot run both at once — you flash one or the other.
- Satellite links come in two flavors:
 - **GEO** (geostationary, ~35,786 km) — e.g., Skylo, Myriota HyperPulse
 - **LEO** (low earth orbit, ~500–2000 km) — e.g., Sateliot
- NTN via Skylo works on the MTC2-N9151 now for experimentation and development. Official Skylo certification covers the MTC2-N9151 + Taoglas FXUB64 Cyclone antenna as a pair and is currently underway — treat it as pre-certification/experimental status until that completes, and note that once certified, both components must be used together to claim the certification. Firmware and tooling are still young, so version numbers below are a snapshot; check LooUQ’s and Nordic’s current docs before you start.

Hardware You Will Need

LooUQ recommends you consider the ***UXplor QuickStart (MTC2-N9151) for TN/NTN*** available for purchase from the LooUQ web store. It allows you to unbox, get connected, and start learning about how NTN could be a part of your product design rapidly.

Kit includes:

- MTC2-N9151 modem
- MTC2-N9151-UXP
- Monogoto Starter SIM
- Antennas: Taoglas Cyclone (TN/NTN) and FXP612 (GNSS)
- UXP development board and antenna assembly base
- Cables (power, serial-UART)

Item	Purpose
LooUQ MTC2-N9151 module	The modem/MCU itself
LooUQ UXplor or Breakout board	Carrier board exposing GPIO, power, and SWD headers
Segger J-Link (any model, incl. J-Link EDU Mini) or a Nordic DK	Flashing/debugging via SWD
GNSS antenna (passive or active)	Required for NTN — the modem needs a location fix to compute Doppler/timing pre-compensation for the satellite link. The GNSS antenna in the Quick Start from LooUQ is a Taoglas FXP612 <u>passive</u> antenna.
Satellite-capable antenna	LooUQ offers the MTC2-N9151 paired with a Taoglas Cyclone antenna as a ready-to-go bundle for experimentation — start there rather than sourcing a generic

Item	Purpose
	cellular antenna, which may not have adequate gain/pattern for satellite links
USB-C cable	Power + serial console via UXplor
A satellite-enabled SIM/eSIM	From Skylo, or a Skylo-network reseller (Monogoto, etc. — see “NTN service provider: Skylo” below)

Important gotcha: If you’re flashing with a Nordic DK instead of a standalone J-Link, the DK’s SWD I/O voltage must match the MTC2-N9151’s VDD-GPIO level. Nordic’s nRF91-series DKs default to 1.8V, which can cause silent flashing failures. Use the Board Configurator app in nRF Connect for Desktop to check/set this, and note that nRF9160/nRF9151 DKs have had reported issues acting as an external SWD host for this board — nRF5340 and nRF54L15 DKs have been confirmed to work.

Software Toolchain

If you are using the **UXplor QuickStart (MTC2-N9151) for TN/NTN** your firmware is preloaded for TN or NTN based on your store selection. If you need to change your firmware or are ready to start experimenting further, take note of the sections below.

1. **Install nRF Connect SDK (NCS)** via the nRF Connect for Desktop “Toolchain Manager,” or the VS Code extension “nRF Connect for VS Code.” Use a recent NCS release (3.4.0 is current as of July-2026) — NTN support landed around **NCS 3.2.0**.
2. Recommended (highly) get the [nRF Connect for Desktop](#) from Nordic: Programmer, Serial Terminal, Cellular Monitor, Board Configurator.
3. **Clone LooUQ’s board support repo:** [LooUQ/LooUQ-MTC2-SW](#) on GitHub. It contains out-of-tree board definitions, devicetree overlays, and default Kconfig fragments for the MTC2-N9151.
 - LooUQ’s own convention: install NCS at `C:\NCS` and place this repo at `C:\NCS\LooUQ` (short paths matter — Zephyr/NCS tooling can hit Windows path-length limits).
 - Because it’s out-of-tree, you must register the board root in VS Code settings so the nRF Connect extension can find it (the repo README documents the exact setting).
4. **Segger J-Link software** (if using a standalone J-Link) or the drivers bundled with nRF Connect for Desktop.

If you’re new to NCS/Zephyr generally, Nordic’s DevAcademy “NCS Fundamentals” and “Intermediate” courses are a reasonable investment before diving into NTN specifically.

Build and Flash a Baseline Application

1. In nRF Connect for VS Code, create a new build configuration and select your LooUQ MTC2-N9151 board target (added via the out-of-tree board repo).

2. Build *ncs-serial-modem* — Nordic’s serial modem application, distributed as an NCS add-on rather than bundled in the SDK itself (*nrfconnect/ncs-serial-modem* on GitHub). It exposes a plain AT pass-through interface over serial and is the application firmware the AT-command walkthrough below assumes. You can build it yourself from source, or use LooUQ’s pre-built binary (available [here](#)).
3. Build and flash over SWD. Confirm you get a console (USB CDC-ACM or UART, depending on your board overlay) and that *AT* returns *OK* in Serial Terminal before going further.

Alternative: LooUQ also provides a purpose-built application firmware package that automates Skylo + TagoIO UDP testing end-to-end (GNSS fix, NTN attach, and UDP payload push in one flow), instead of driving the sequence by hand over AT commands. It’s available on LooUQ’s GitHub: [Skylo-NTN-FieldTesting](#). Worth using once you’ve done the manual walkthrough once and understand what’s going on under the hood.

NTN-Specific Firmware and Documentation

From Nordic’s nRF9151 SMA DK resource page (the reference hardware Nordic uses for NTN bring-up — useful even though you’re on LooUQ hardware, since the modem firmware is the same nRF9151 SiP part):

- **NTN modem firmware:** *mfw_nrf9151-ntn_1.0.0.zip* — is the current release of the NTN firmware. Note: current release of the TN modem firmware is *mfw_nrf91x_2.0.4.zip*.
- **NTN AT command reference:** the *nRF91x1 NTN AT Commands* document/PDF, covering NTN-specific commands like *%XSYSTEMMODE* (select NTN system mode), *%XBANDLOCK* (lock to satellite bands), and *%LOCATION* (feed the modem a GNSS fix).
- **Documentation package** with full install/evaluation instructions for NTN bring-up.

Feeding the Modem a Location

NTN requires user-equipment (UE) to supply its location so the modem can pre-compensate timing advance and Doppler shift for the satellite. Via AT command:

```
AT%LOCATION=2, "60.171000", "24.941000", "30.0", 100, 3600
```

(latitude, longitude, altitude, accuracy in meters, validity in seconds)

Internal GNSS and NTN NB-IoT can’t run simultaneously in the same system mode — get your fix with GNSS first, then disable GNSS and enable NTN NB-IoT, or feed location from an external GNSS receiver over UART if your application needs both concurrently.

NTN Service Provider – Skylo

This guide targets **Skylo**, a GEO satellite network — LooUQ specifically markets MTC2-N9151/Skylo compatibility, and it’s the provider covered in Nordic’s bundled NTN documentation package. The

LooUQ *UXplor QuickStart (MTC2-N9151) for TN/NTN* kit comes with a Monogoto starter SIM that works with Skylo.

(Nordic and others also document Sateliot (LEO) and Myriota HyperPulse (GEO) against the nRF9151, in case you want to evaluate alternatives later — but this guide is scoped to Skylo.)

Where to Test

Before worrying about precise orientation or look angles, get the basic environment right — NTN, like GNSS, needs a clear view of the sky.

- **Outside, generally, is the answer.** Roofs, ceilings, and most building materials attenuate or block satellite signals enough to prevent a reliable link. Plan on testing outdoors rather than at your desk.
- **In the northern hemisphere:** Clear line-of-sight facing south is generally best.
- **No overhead obstructions in the relevant direction.** You need clear line-of-sight not straight up, but toward wherever the satellite actually sits in the sky for your location — tree canopy, roof overhangs, power lines, and nearby buildings can all block it even if you're technically outside.
- **An open window or window sill can work, conditionally.** If you can't get outside, a window facing the satellite's direction, with no obstruction and minimal signal-blocking material (avoid low-E/metallic coated glass, which can significantly attenuate RF and GNSS signals), may pass a link — but treat it as a fallback to validate against an outdoor test, not a substitute for one. If a window test fails, that alone doesn't tell you whether the problem is the glass, the angle, or something else — retest outdoors before troubleshooting further.
- **Avoid dense urban canyons and heavy tree cover.** Tall buildings and foliage both degrade GNSS and satellite-NTN links through multipath and attenuation, similarly to how they affect GPS reception.
- **Elevated, open ground beats flat ground surrounded by obstructions.** A rooftop, hilltop, or open field will generally outperform a spot at ground level between buildings or trees, even if both are nominally "outdoors."

Antenna Orientation for a GEO Satellite Link

Skylo's satellites sit in **geostationary orbit** (~35,786 km up), meaning each one holds a fixed position in the sky relative to a given point on Earth. Unlike LEO NTN, there's no satellite pass to wait for or track — the satellite is always in the same spot, so getting a link is a matter of orientation and line-of-sight, not timing.

It's a fixed-position link, not a tracking one — but orientation still matters. The Taoglas Cyclone (FXUB64) that ships in LooUQ's bundle is a flexible antenna with no motor or aiming mechanism. That doesn't mean orientation is irrelevant, though — its radiation pattern isn't uniform in all directions, and performance toward the satellite depends on how the antenna is mounted and oriented relative to the sky.

Good Orientation



Standing on edge, panel vertical, coil facing out toward the horizon

Not So Good Orientation



Lying flat, coil facing straight up (zenith)

The base for the *UXplor QuickStart (MTC2-N9151) for TN/NTN* kit assists here when the assembly is laying flat on a horizontal surface. Both the NTN and the GNSS antennas are oriented for best performance under typical conditions.

The loop antenna's radiation pattern favors energy out along the plane of the coil, with a null through its face. Mounted **vertically on edge**, that favored direction points out toward the horizon — where a GEO satellite actually sits at a low-to-moderate elevation angle. Laid **flat with the coil facing up**, the favored direction points at the zenith instead, which is a poor match for a satellite that isn't directly overhead. Orient the antenna so its edge, not its face, points toward the satellite's compass bearing and elevation. - **Keep clearance from metal.** Taoglas recommends at least 10 mm clearance from metal surfaces or components, and ideally 20 mm, to avoid detuning the antenna and losing efficiency. **Line-of-sight matters as much as orientation.** A building, hillside, or even your own test fixture sitting between the antenna and the satellite's direction in the sky will hurt you as much as a poorly oriented antenna will — both need to be right.

Orient consistently between antenna and GNSS. Since you need a GNSS fix before attaching (see below), and GNSS wants open sky overhead while the satellite link wants open sky toward a specific compass bearing, plan your test setup so neither antenna is shadowed by the other, your enclosure, or nearby structures. - **Expect real-world variation.** Skylo's own materials note that actual performance depends on environment, device, and device orientation relative to the satellite — treat your first link attempt as a baseline to characterize, not a guaranteed pass/fail on the first try.

GNSS Considerations for Geostationary NTN

The MTC2-N9151 needs a valid GNSS fix before it can attach to NTN — this isn't optional for GEO the way it might seem like it could be for a “the satellite never moves” link.

Here's why, and what it means practically:

- **What the fix is for.** For a GEO satellite, Doppler shift from satellite motion is negligible (it isn't moving relative to Earth), but the **propagation delay is enormous** — a round trip to a satellite 35,786 km away and back is on the order of 240+ ms one-way link distance, versus

microseconds for a terrestrial cell. The modem uses your GNSS-derived position, together with network-provided satellite ephemeris, to pre-compute timing advance so its transmissions land in the right slot at the satellite. Without a valid fix, the modem has no basis for this calculation and won't attach.

- **GNSS and NTN can't run at the same time.** The MTC2-N9151's GNSS receiver and cellular/NTN transceiver are time-multiplexed, not concurrent — this is why the walkthrough above has you get a fix first (`AT%XSYSTEMMODE=0,0,1,0,0` → GNSS-only), then explicitly switch modes into NTN (`AT%XSYSTEMMODE=0,0,0,0,1`) afterward.
- **Fix accuracy needed is modest.** The `AT%LOCATION` accuracy parameter used in the walkthrough (100 m) is well within what a standard GNSS fix delivers — Nordic's published GNSS accuracy figures for the nRF9151 are in the single-digit-meters range under open sky, so a normal cold or hot fix is more than sufficient; you don't need survey-grade positioning.
- **Fix validity expires.** The `AT%LOCATION` validity parameter tells the modem how long to trust the injected position before it's considered stale. For a stationary test setup this can be set generously; for anything that moves, keep it short enough that timing-advance calculations stay accurate, and re-inject a fresh fix on a schedule that matches your mobility.
- **Open-sky matters for GNSS specifically, and independently from the satellite link.** GNSS signals don't penetrate roofs or walls well, and multipath in urban environments or near tall structures degrades fix quality — this is a separate line-of-sight requirement from the NTN antenna's need to "see" toward the satellite's compass bearing. Outdoors, flat, open ground works best for both.
- **External GNSS is an option if your enclosure doesn't allow open sky for the onboard antenna.** The MTC2-N9151 supports both remote GNSS (active) antennas and feeding location from an external GNSS module over UART/NMEA if your mechanical design makes a compact antenna solution impractical.

Now... AT-Command Walkthrough for Skylo (GEO)

This is a field-tested, step-by-step AT command sequence for bringing an MTC2-N9151 onto the Skylo GEO network from a cold start. It's written against Nordic's `ncs-serial-modem` application firmware, which exposes a plain AT pass-through interface over serial — this is the correct target for this walkthrough. It assumes `mfw_nrf9151-ntn_1.0.0` is already flashed as the modem firmware (see "Get NTN-specific firmware and docs" above).

Prefer not to drive this by hand? LooUQ's automated Skylo/TagoIO test firmware (see "Build and flash a baseline app" above) runs this same GNSS-fix → NTN-attach → UDP-push sequence automatically. The manual version below is still worth doing at least once so you understand what's happening at each step.

Get the application firmware one of two ways: - **Build it yourself** from `nrfconnect/ncs-serial-modem`, targeting the MTC2-N9151 board. - **Use LooUQ's pre-built binary** — LooUQ provides a ready-to-flash `.hex` for the MTC2-N9151: [\[PLACEHOLDER – LooUQ ncs-serial-modem .hex download link\]](#).

Test station location (fill in for your setup — used as the GNSS reference in the location-injection step below):

Field	Value
Latitude	<your location>
Longitude	<your location>
Altitude	<your location>

Prerequisites — Confirm the Device is Alive and Sane

Command	Purpose
<code>AT+CFUN=1</code>	Turn RF on
<code>AT+CPIN?</code>	Verify SIM is ready
<code>AT+CGMR</code>	Confirm modem firmware version — expect <code>mfw_nrf9151-ntn_1.0.0</code>
<code>AT%HWVERSION</code>	Confirm hardware — expect <code>nRF9151 LACA A1A</code> (the <code>A1A</code> suffix is the key thing to check; other SiP variants don't support NTN)
<code>AT+CIMI</code>	Read IMSI (from SIM)
<code>AT%XICCID</code>	Read ICCID (from SIM)
<code>AT+CGSN</code>	Read IMEI (from nRF9151 module)

Get a Location Fix

NTN needs a GNSS fix before it can attach — the modem uses it to pre-compensate Doppler shift and timing advance for the satellite pass.

Command	Purpose
<code>AT+CFUN=4</code>	Turn off LTE (flight-mode-like state, keeps modem addressable)
<code>AT%XSYSTEMMODE=0,0,1,0,0</code>	Set system mode to GNSS-only
<code>AT%XCOEX0=1,1,1570,1580</code>	* Configure COEX0 to activate when GNSS turns on — this switches the N9151's onboard GNSS LNA
<code>AT+CFUN=31</code>	Activate GNSS without disturbing the LTE configuration set above
<code>AT#XGNSS=1,0,0,0</code>	Start acquiring a GNSS fix — expect 30–180 seconds for first fix outdoors with clear sky view

* The MTC2-N9151 incorporates both an internal LNA/noise filter passive GNSS antennas and a power injection circuit for active GNSS antennas (containing an LNA). The NTN firmware does not automatically switch the coexistence-0 signal when GNSS is activated; we have to configured this manually.

Attach to NTN

Command	Purpose
<i>AT+CFUN=0</i>	Turn LTE back off before reconfiguring system mode
<i>AT%SYSTEMMODE=0,0,0,0,1</i>	Set system mode to NTN
<i>AT%XBANDLOCK=2,, "23,255,256"</i>	Lock to Skylo's satellite bands (23, 255, 256)
<i>AT%LOCATION=2, "<lat>", "<lon>", "<alt>", 100, 0</i>	Inject the GNSS fix — parameters are lat, lon, altitude, accuracy (m), validity
<i>AT%LOCATION?</i>	Read back and confirm the modem accepted the location
<i>AT+CGDCONT=0, "IP", "data.mono"</i>	Monogoto — Skylo IP/UDP

Subscribe to status/URC reporting — either as four separate commands or chained in one line:

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

—or—

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

Then bring the connection up and verify:

Command	Purpose
<i>AT+CFUN=1</i>	Initiate the connection attempt
<i>AT+CGDCONT?</i>	Confirm an IP address was assigned against your chosen APN

Send a Test UDP Payload (TagoIO “TiP” endpoint)

For this exercise, we are going to use Tago.IO and their TiP UDP endpoint with no encryption. TagoIO offers a Free plan that includes 5 devices, 5 dashboards, and all the key features — free forever, with no credit card required. Once you set up an account, you need to perform a couple of tasks to get test ready.

1. Create the device — In your TagoIO account, go to Devices → Add Device, and set it up with the TagoTiP network/connector (choosing UDP, TCP, MQTT, or HTTP as your transport).
2. Generate the token — Go to that device's Authorization (or General) tab and click Generate.

3. Pick the token format — Choose the TagoTiP(s) token format.
4. Save the Token/Authorization Hash — It is a 16-char hex string (e.g. *4deedd7bab8817ec*). That's your hash.

Region	Host	IP	Ports
US-East-1	udp.tip.us-e1.tago.io	166.117.107.129	5683 / 5684

Quick usage notes

- Port 5683 — plain TagoTiP frames (no encryption)
- Port 5684 — TagoTiP(s), the AEAD-encrypted variant, useful when TLS isn't practical (LoRa, NB-IoT, raw UDP)
- Each UDP datagram carries exactly one frame, and you get one datagram back (e.g. ACK|OK|1)
- Keep datagrams under ~1,400 bytes to avoid IP fragmentation

The four steps below show how to open a UDP socket, send a packet, receive a response, then close the socket. A nice tidy task. The *hash* and *deviceId* values are obtained from your Tago.IO console.

Command

```
AT#XSOCKET=1,2,0
```

```
AT#XSENDTO=0,0,0,"166.117.107.129",5683,"PUSH\|<hash>\|<deviceId>\|[/temperature:=59#F;conditions=overcast]"
```

```
AT#XRECVFROM=0,1,0,5
```

Expected like response:

```
#XRECVFROM: 0,1,8,"166.117.107.129",5683
```

```
41434b7c4f4b7c32
```

```
OK
```

"41434b7c4f4b7c32" translates to "ACK|OK|2"

<https://www.rapidtables.com/convert/number/hex-to-ascii.html>

```
AT#XSOCKET=0
```

Check the TagoIO TiP dashboard to confirm the payload arrived — this closes the loop on ground-to-satellite-to-cloud.

Known Rough Edges to Budget Time For

- **Firmware pairing:** not a concern if you stick with LooUQ's UXplor QuickStart (MTC2-N9151) kit as-is — it ships pre-flashed with a correctly matched firmware set. It becomes relevant if you reflash, build your own firmware, or mix components from outside the kit:

NTN modem firmware, application firmware, and NCS version all need to line up; check the changelog rather than assuming forward/backward compatibility.

- **SWD host voltage mismatches** when using a Nordic DK as your flashing host (see “Hardware you’ll need” above).
- **GNSS/NTN mutual exclusion** in a single system mode — plan your application’s state machine around this.
- **Antenna suitability** — largely a non-issue if you use LooUQ’s MTC2-N9151 + Taoglas Cyclone bundle (see “Hardware you’ll need” above); if you source your own antenna instead, confirm its frequency bands and gain pattern match Skylo’s requirements, since this is different from terrestrial cellular antenna selection.

Key Reference Links

- LooUQ MTC2-N9151 product page: <https://www.loouq.com/mtc2-n9151>
- LooUQ MTC2-SW board support repo: <https://github.com/LooUQ/LooUQ-MTC2-SW>
- LooUQ automated Skylo/TagoIO UDP test firmware repo: <https://github.com/LooUQ/Skylo-NTN-FieldTesting>
- Nordic nRF9151 SMA DK (NTN reference hardware/docs):
<https://www.nordicsemi.com/Products/Development-hardware/nRF9151-SMA-DK>
- NTN library docs (NCS): search “nRF Connect SDK NTN library” on docs.nordicsemi.com
- nRF91x1 NTN AT Commands reference: docs.nordicsemi.com
 - (bundle: [ref_at_commands_nrf91x1_ntn](#))
- LooUQ contact for current NTN firmware availability: answers@loouq.com