LTE / NB-IoT Networks

Some Lobaro devices do support mobile connections like NB-IoT or LTE-Cat-M1. This page contains background information and technical details related to the mobile connections.

> **Configuration of Lobaro Devices**
>
> See: LTE Network Config

Content

LTE Signal strength

The signal strength of the LTE-M1 or NB-IoT network can be derived from the **RSRP and RSRQ** dimensionless values.

- RSRP - 140 = dBm
- RSRQ / 2 - 19.5 = dB

Coverage	LTE RSRP	LTERSRP (dBm)	RSRQ	RSRQ (dB)
	Average power received	Average power received (dBm)	Average receive quality	Average receive quality (dB)
Excellent (4/4)	**80 - 97**	-60 to -44	28 - 34	-5.5 to -3
Good (3/4)	**60 - 79**	-80 to -61	21 - 27	-9 to -6
Mid Cell (2/4)	**40 - 59**	-100 to -81	14 - 20	-12.5 to -9.5
Cell Edge (1/4)	**20 - 39**	-120 to -101	7 - 13	-16 to -13
Unstable (0/4)	**0 - 20**	-140 to -121	0 - 7	-19.5 to -16.5

The actual value of your devices connection statistics is shown in the Lobaro platform under "Device Properties".

⚠ For **"unstable" network coverage** Lobaro can not guarantee the correct function of the cellular uplinks and battery runtimes under all conditions. Please consider a different location for the particular device.

Source: https://infocenter.nordicsemi.com/index.jsp?topic=%2Fref_at_commands%2FREF%2Fat_commands%2Fmob_termination_ctrl_status%2Fproc_cesq_set.html

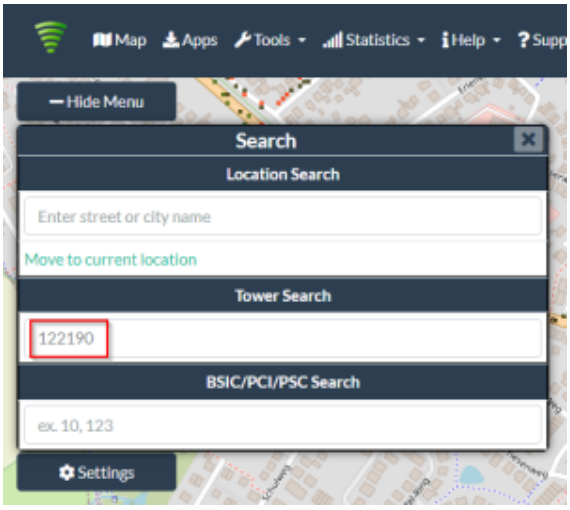
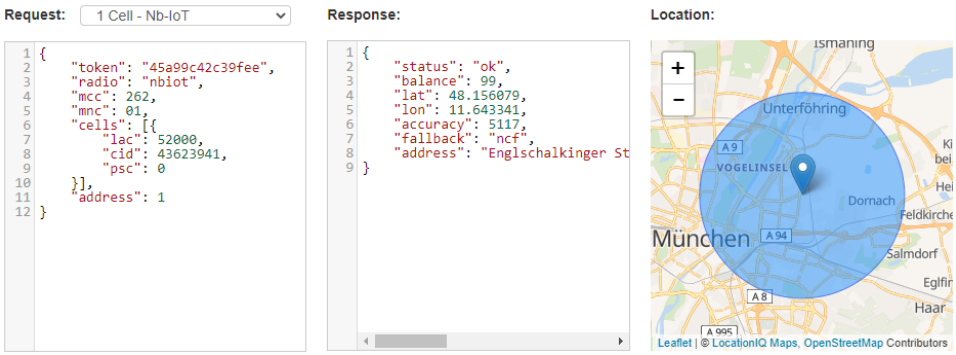
Geo Location Lookup

There are multiple ways to trace where a mobile device is.

In General the following information is required and transmitted in the device status packets:

- TAC lac (dezimal), 0xcb20 = 52000
  - Tracking Area Code (TAC) sometimes called Location Area Code (LAC)
- CI cid (dezimal), 0x299A605 = 43623941
  - Cell ID (CID / CID)

Here are some resources to use:

Resource	Description	
https://www.cellmapper.net/	Lookup Cells	⚠ Account needed - not for commercial use platform.eNodeB.towerID (based on CI) var ci = parseInt("01DD4E02",16); var towerID =parseInt(ci/256,10); z.B. 122190 
https://my.unwiredlabs.com/dashboard/login	LTE Location API Account required	

LTE network error codes

Newer firmware of Lobaro products report potential ESM (EPS Session Management) and EMM (EPS Mobility Management) errors in their status uploads.

EMM Error codes

Source: ETSI TS 124 301 V14.5.0 - Table 9.9.3.9.1: ESM cause information element

Table 9.9.3.9.1: EMM cause information element

Cause value (octet 2)

Bits

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	1	0	IMSI unknown in HSS
0	0	0	0	0	0	1	1	Illegal UE
0	0	0	0	0	1	0	1	IMEI not accepted
0	0	0	0	0	1	1	0	Illegal ME
0	0	0	0	0	1	1	1	EPS services not allowed
0	0	0	0	1	0	0	0	EPS services and non-EPS services not allowed
0	0	0	0	1	0	0	1	UE identity cannot be derived by the network
0	0	0	0	1	0	1	0	Implicitly detached
0	0	0	0	1	0	1	1	PLMN not allowed
0	0	0	0	1	1	0	0	Tracking Area not allowed
0	0	0	0	1	1	0	1	Roaming not allowed in this tracking area
0	0	0	0	1	1	1	0	EPS services not allowed in this PLMN
0	0	0	0	1	1	1	1	No Suitable Cells In tracking area
0	0	0	1	0	0	0	0	MSC temporarily not reachable
0	0	0	1	0	0	0	1	Network failure
0	0	0	1	0	0	1	0	CS domain not available
0	0	0	1	0	0	1	1	ESM failure
0	0	0	1	0	1	0	0	MAC failure
0	0	0	1	0	1	0	1	Synch failure
0	0	0	1	0	1	1	0	Congestion
0	0	0	1	0	1	1	1	UE security capabilities mismatch
0	0	0	1	1	0	0	0	Security mode rejected, unspecified
0	0	0	1	1	0	0	1	Not authorized for this CSG
0	0	0	1	1	0	1	0	Non-EPS authentication unacceptable
0	0	1	0	0	0	1	1	Requested service option not authorized in this PLMN
0	0	1	0	0	1	1	1	CS service temporarily not available
0	0	1	0	1	0	0	0	No EPS bearer context activated
0	0	1	0	1	0	1	0	Severe network failure
0	1	0	1	1	1	1	1	Semantically incorrect message
0	1	1	0	0	0	0	0	Invalid mandatory information
0	1	1	0	0	0	0	1	Message type non-existent or not implemented
0	1	1	0	0	0	1	0	Message type not compatible with the protocol state
0	1	1	0	0	0	1	1	Information element non-existent or not implemented
0	1	1	0	0	1	0	0	Conditional IE error
0	1	1	0	0	1	0	1	Message not compatible with the protocol state
0	1	1	0	1	1	1	1	Protocol error, unspecified

Any other value received by the mobile station shall be treated as 0110 1111, "protocol error, unspecified". Any other value received by the network shall be treated as 0110 1111, "protocol error, unspecified".

E.g.: +CNEC_EMM: 19 is error code 19 which is 0b10011 which corresponds to ESM failure (see table below)

ESM Error codes

Source: ETSI TS 124 301 V14.5.0 - Table 9.9.4.4.1: ESM cause information element

Table 9.9.4.4.1: ESM cause information element

Cause value (octet 2)

Bits

8	7	6	5	4	3	2	1	
0	0	0	0	1	0	0	0	Operator Determined Barring
0	0	0	1	1	0	1	0	Insufficient resources
0	0	0	1	1	0	1	1	Missing or unknown APN
0	0	0	1	1	1	0	0	Unknown PDN type
0	0	0	1	1	1	0	1	User authentication failed
0	0	0	1	1	1	1	0	Request rejected by Serving GW or PDN GW
0	0	0	1	1	1	1	1	Request rejected, unspecified
0	0	1	0	0	0	0	0	Service option not supported
0	0	1	0	0	0	0	1	Requested service option not subscribed
0	0	1	0	0	0	1	0	Service option temporarily out of order
0	0	1	0	0	0	1	1	PTI already in use
0	0	1	0	0	1	0	0	Regular deactivation
0	0	1	0	0	1	0	1	EPS QoS not accepted
0	0	1	0	0	1	1	0	Network failure
0	0	1	0	0	1	1	1	Reactivation requested
0	0	1	0	1	0	0	1	Semantic error in the TFT operation
0	0	1	0	1	0	1	0	Syntactical error in the TFT operation
0	0	1	0	1	0	1	1	Invalid EPS bearer identity
0	0	1	0	1	1	0	0	Semantic errors in packet filter(s)
0	0	1	0	1	1	0	1	Syntactical errors in packet filter(s)
0	0	1	0	1	1	1	0	Unused (see NOTE 2)
0	0	1	0	1	1	1	1	PTI mismatch
0	0	1	1	0	0	0	1	Last PDN disconnection not allowed
0	0	1	1	0	0	1	0	PDN type IPv4 only allowed
0	0	1	1	0	0	1	1	PDN type IPv6 only allowed
0	0	1	1	1	0	0	1	PDN type IPv4v6 only allowed
0	0	1	1	1	0	1	0	PDN type non IP only allowed
0	0	1	1	0	1	0	0	Single address bearers only allowed
0	0	1	1	0	1	0	1	ESM information not received
0	0	1	1	0	1	1	0	PDN connection does not exist
0	0	1	1	0	1	1	1	Multiple PDN connections for a given APN not allowed
0	0	1	1	1	0	0	0	Collision with network initiated request
0	0	1	1	1	0	1	1	Unsupported QCI value
0	0	1	1	1	1	0	0	Bearer handling not supported
0	1	0	0	0	0	0	1	Maximum number of EPS bearers reached
0	1	0	0	0	0	1	0	Requested APN not supported in current RAT and PLMN combination
0	1	0	1	0	0	0	1	Invalid PTI value
0	1	0	1	1	1	1	1	Semantically incorrect message
0	1	1	0	0	0	0	0	Invalid mandatory information
0	1	1	0	0	0	0	1	Message type non-existent or not implemented
0	1	1	0	0	0	1	0	Message type not compatible with the protocol state
0	1	1	0	0	0	1	1	Information element non-existent or not implemented
0	1	1	0	0	1	0	0	Conditional IE error
0	1	1	0	0	1	0	1	Message not compatible with the protocol state
0	1	1	0	1	1	1	1	Protocol error, unspecified
0	1	1	1	0	0	0	0	APN restriction value incompatible with active EPS bearer context
0	1	1	1	0	0	0	1	Multiple accesses to a PDN connection not allowed

Any other value received by the UE shall be treated as 0010 0010, "service option temporarily out of order". Any other value received by the network shall be treated as 0110 1111, "protocol error, unspecified".

NOTE 1: The listed cause values are defined in annex B.
NOTE 2: This value was allocated in earlier versions of this protocol, but there is no situation where this value can be used. If received by the network, it shall be treated as 0110 1111, "protocol error, unspecified".

CNEC_ESM: 27,0 is error code 27 with cid 0, and 27 is binary 1b11011 which corresponds to Missing or unknown APN

NB-IoT network coverage

Please see: https://iotcreators.com/network/?#G

For testing the coverage you can use our hardware with our USB Config Adapter and the Lobaro Maintenance Tool to observe the log during connection.

Or test yourself using a professional 3rd party network tester e.g. from ENQT.

Modem specifics (nRF9160)

Today Lobaro is using the Nordic nRF9160 in most of it's products. Beside that Lobaro Firmware the Modem Firmware from Nordic is running on a separate core.

Modem Parameter

Parameter	Beschreibung	Values
conMode		
reg	Registration	• 1 = Home Network • 5 = Roaming
tac	Tracking Area Code	
ci	Cell ID	
psm	PSM Activity Timer (T3324)	See for info: • https://docs.iotcreators.com/docs/nb-iot-network-information • https://www.soracom.io/psm-calculation-tool/
tau	Long-Periodic TAU Timer (Extended T3412)	
SNR	Signal to Noise Ratio	

Known issues

Remote Update for Modem Firmware not possible (relevant until today)

The Lobaro Hardware does not support remote Modem Firmware updates. This might change in future but brings additional hardware requirements like external memory.

Modem Firmware < 1.3.0 does not support LTE-M and NB-IoT at the same time (relevant until 10/2022)

When enabling both LTE-M and NB-IoT in a Lobaro Firmware that runs with Modem Firmware < 1.3.0 the Modem can not do a fallback to LTE-M when NB-IoT is not available and thus the firmware only uses NB-IoT in that case.

With Modem Firmware >= 1.3.0 a proper fallback is implemented.

nrf9160 SICA vs. SIBA (no LTE-M) (relevant until ~12/2021)

The nrf9160 SIBA only supports NB-IoT but not LTE-M. Since late 2021 Lobaro only uses the nrf9160 SICA which supports both NB-IoT and LTE-M.