Exiting new features in nRF9160 Modem Firmware version v1.3.0

Nordic Tech Webinar

Martin Lesund / Technical Marketing Manager

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Today's host

Martin Lesund

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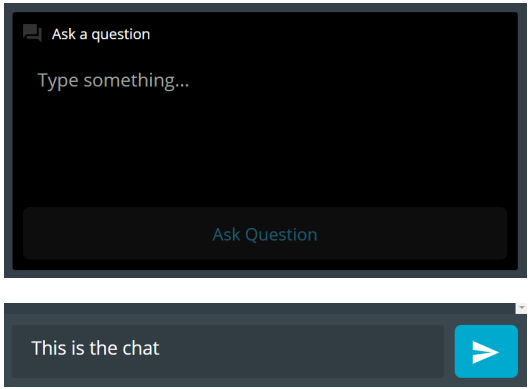
Cellular IoT

NORDIC SEMICONDUCTOR

Practicalities

- Duration: 45 min presentation + Q&A
- Questions are encouraged!
  - Please type questions in the top of the right sidebar
  - All questions are anonymous
  - Try to keep them relevant to the topic
  - We will answer them towards the end
- The chat is not anonymous, and should not be used for questions



- Go to DevZone if you have questions after the webinar
- A recording of the webinar will be available together with the presentation at webinars.nordicsemi.com

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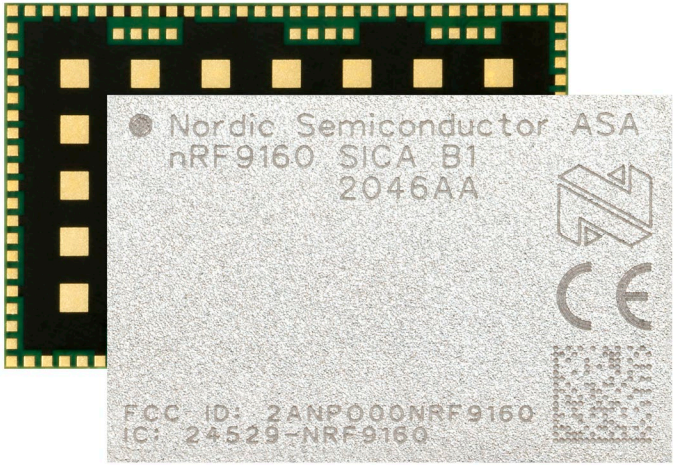
Agenda

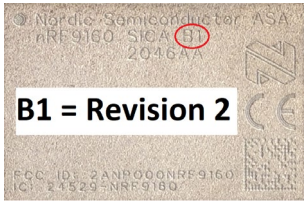
- Important note before use
- Power optimization features
- Cellular positioning and GPS features
- 3GPP Release 14 features
- Other new useful features
- Q&A



Important note before use

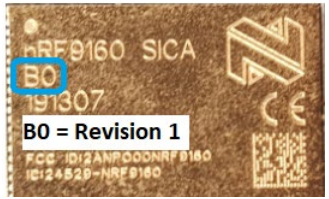
- The Modem Firmware v1.3.0 is targeted nRF9160 SiP revision 2 (*B1 marking*)
  - *How to check revision*: SiP marking or read out by AT command 'AT%HWVERSION'

Revision 2



- nRF9160 SiP revision 1 device (*B0 marking*)
  - Rev1 + mfw1.3.0 should only be used for testing and development

Revision 1



Important note before use

- nRF9160 SiP revision 1 **engineering** samples (*E2.x.y marking*)
  - Device will not boot

Engineering sample

- If you have older kits (**below v0.9.0**) you need to upgrade to test mfw v1.3.0

nRF9160-DK version below v0.9.0.

Found on the sticker on the back of nRF91DK

Thingy:91 version below v0.9.0.

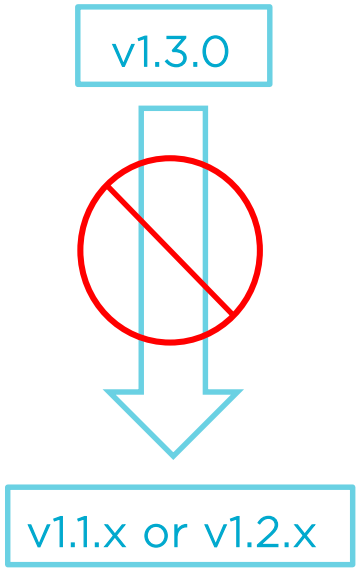
Found on the sticker on the front of Thingy:91

Downgrade limitation

- We do **not** recommend downgrading mfw v1.3.0 to v1.2.x or v1.1.x
  - The modem file system is not compatible with older modem firmware

- Downgrading can cause file system issues

-> losing certificates/keys



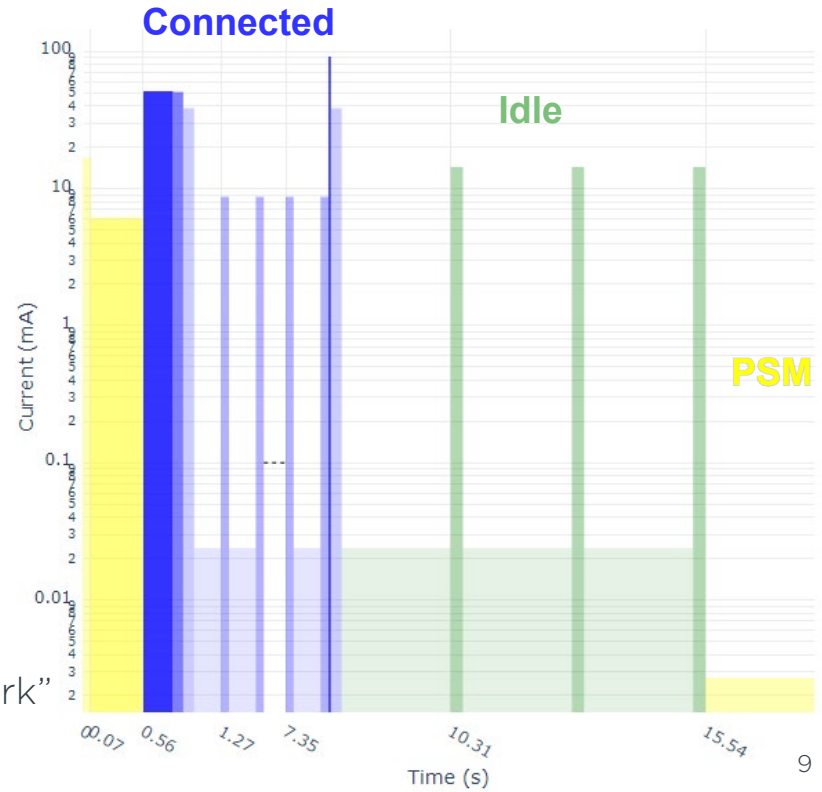
Carrier Support

- Target is to include all carriers in one modem firmware (*ongoing*)
  - For older versions you need a specific mfw version depending on the carrier certification
  - *Ref. Mobile network operator certifications)*

- This makes it much easier for customers since you avoid needing a specific mfw version for your carrier/location

Quick re-cap of the LTE modes

- RRC Connected mode
  - Data sent/received over network (RX/TX)
  - High power consumption
- RRC Idle mode
  - Listening to network in intervals (RX only)
  - Medium/low power consumption
- Power Saving Mode
  - Modem sleeps, but still “registered to network”
  - Ultra low power consumption (*avg. 2.7uA*)



Power Optimization Features

First LTE search optimization

- Speed up network selection when moving to a new area or first-time deployment
- Modem will go over to full searches if needed
- Store *Mobile Country Code, Bands, Radio Frequency Channel Number, LTE-M/NB-IoT* in a prioritized list
- AT Command : AT%COUNTRYDATA

Modem domain events

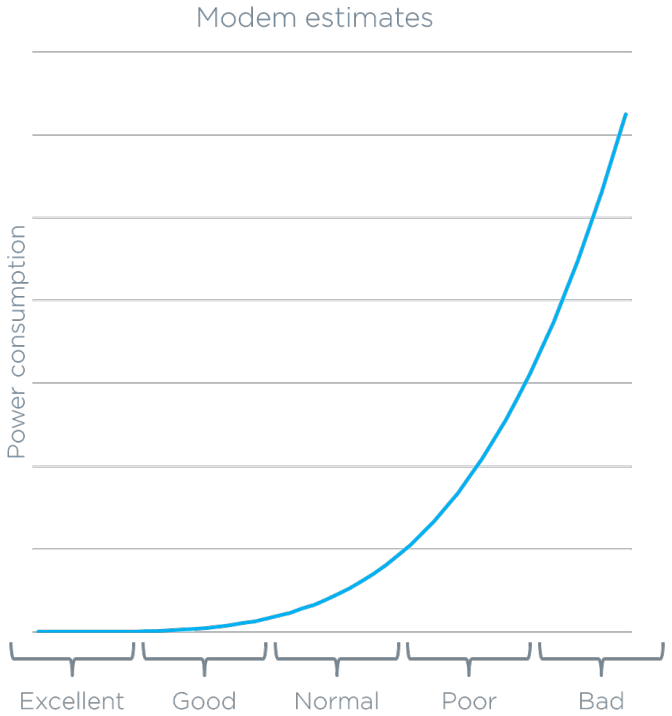
- Get notified of “SEARCH STATUS 1”, “SEARCH STATUS 2”, “RESET LOOP”, “ME OVERHEATED”, “ME BATTERY LOW”

- The search statuses are very helpful to decide to stop the LTE search to save power after a “Light search” (SEARCH STATUS 1)

- “Light search” is the most modems most intelligent guesses to select the network
- AT Command : AT%MDMEV

Pre-evaluation of a connection

- Evaluate the power consumption **before** connecting and sending data
- Returns both estimate category and raw parameters:
  - **Estimate categories:** Excellent, Good, Normal, Poor or Bad
  - **Raw parameters**: Radio link quality, RSRP, RSRQ, SNR, CE level, TX Power, repetitions, pathloss ++
- Perform a short measurement and analyze the radio environment on downlink on a cell
- AT Command : AT%CONEVAL



Non-IP Data Delivery (NIDD)

NB-IoT only

- Removes the IP (Internet Protocol) headers from the payload

Two possible methods:

- Mobile Network Operator (MNO) provided services, or MNO provides a SGi tunnel to an external solution. (*e.g. a device manufacturers own solutions*)
- "Service Capability Exposure Function" (SCEF) can provide additional services via REST APIs for IoT applications

- How to test:
  - Configure the Non-IP PDN connection via AT commands AT+CGDCONT
  - Use normal raw-socket interface and bind the raw-socket to the Non-IP PDN connection

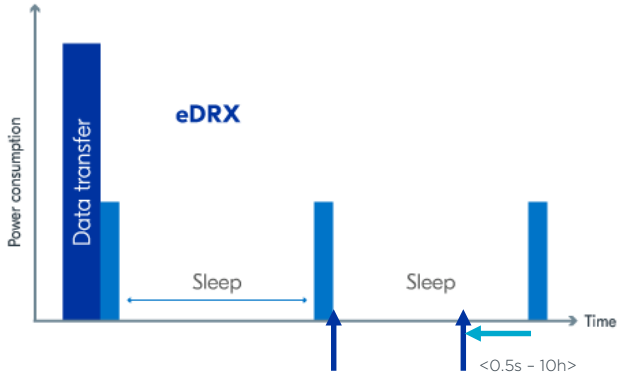
Modem Sleep notifications

- Get information about inactive periods in modem radio usage and get a pre-warning at a desired time before radio activity happens

- Notification just before modem wakes up
  - *E.g., Operator specific requests, SIM card request etc.*

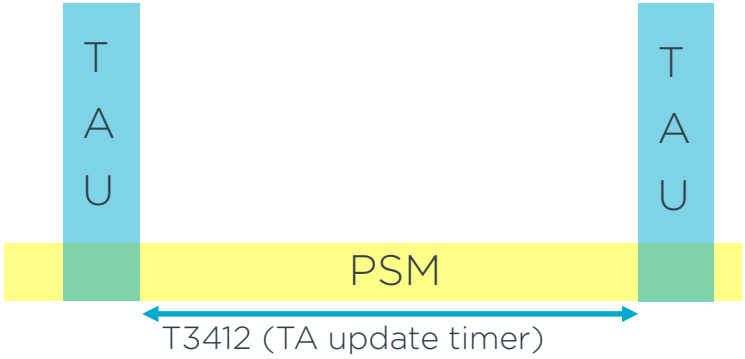
- Useful to sync. with external sensor reading/data sending
- Useful if you need to turn ON some HW components ON/Off depend on modem activity

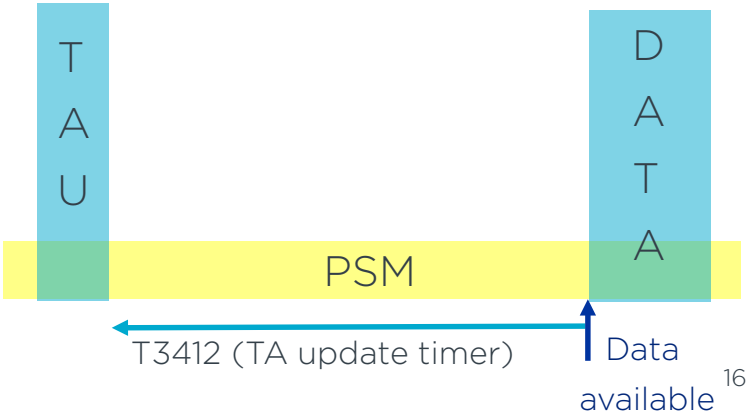
- AT Command: AT%XMODEMSLEEP



Periodic TAU notification

- Notification before and when it will end
- Very useful for synchronizing data send with the Periodic Tracking Update
- Periodic TAU can be avoided completely if data is sent
- AT Command: AT%XT3412





Modem performance improvements

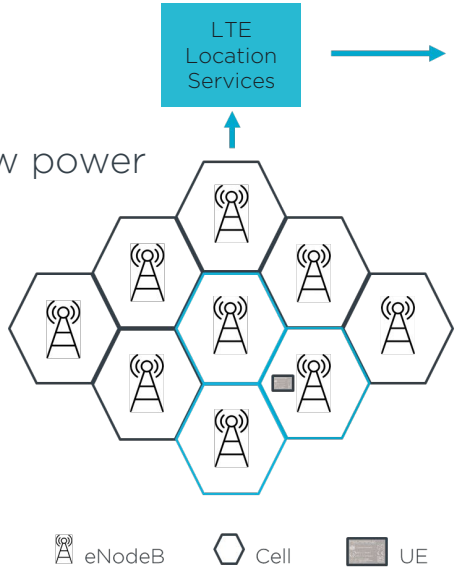
- Improved searching algorithm for better efficiency
- Improved behavior when device moves between countries
- Improved cell selection and reselection
  - Connections will more likely initiate on better cells compared to before
  - Connections established faster and regaining lost connections improved
- Improved Paging reception
  - Modem will stop monitoring page during occasions after decoding the first number of repetitions on the paging channel
- Dual search and automatic LTE system selection (*AT Command: AT%XSYSTEMMODE*)

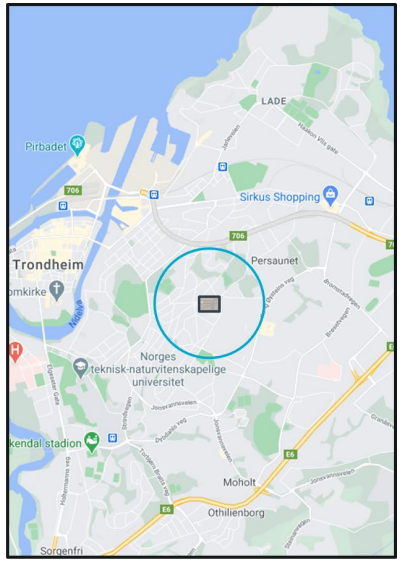
Cellular positioning and GPS

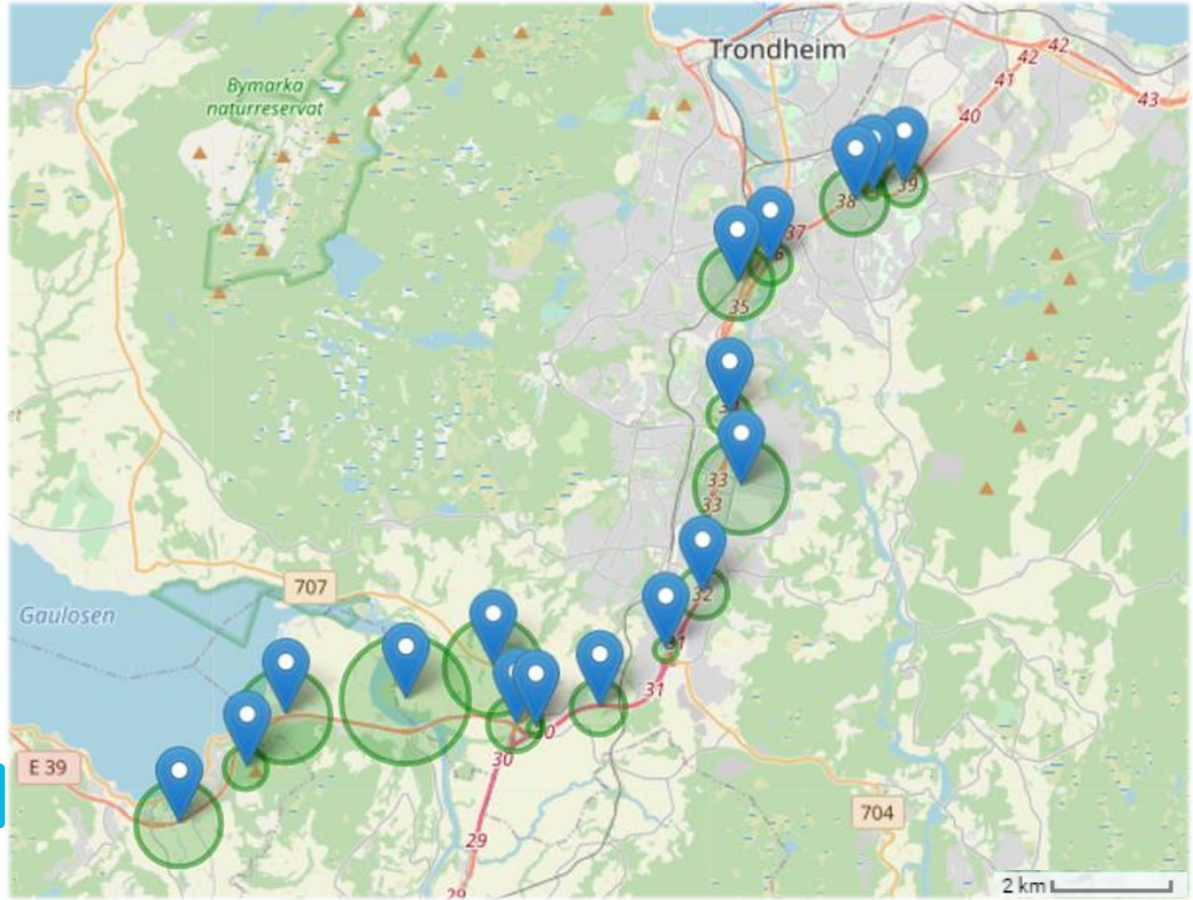
New features and improved performance

Neighbor cell measurements

- Provide current and neighbor cell information
  - To be used with LTE location services
- Very useful for asset tracking, indoor and low power
- Up to 17 neighbor cells in response
  - Max 6 from one frequency
  - Inter-frequency neighbors included only if configured by network
  - AT Command: AT%NCELLMEAS







Demo: ~17min car drive with Thingy:91 reporting NCM each minute

New GPS features

- QZSS L1C/A (Quasi-Zenith Satellite System)
  - 4 additional satellites that can be used as GPS satellites
  - Developed by and targeted for Japan, but useful in large parts of Asia, Australia, Oceania

- 1PPS on COEX pin
  - Time accurate programmable pulse train (interval 1-1800 seconds) or single pulse
  - Programmable trade-offs of accuracy vs. power consumption

- Optimized Tracking modes
  - General, stationary, pedestrian and vehicular
  - Continuous tracking only

- 3-satellite first fix and Re-acquisitions
  - In modem v1.2.2, was usable only in periodic tracking mode
  - Now all start modes are supported (excl. cold)
  - Activated by selecting “Relaxed accuracy” mode

QZSS extra satellites

GPS performance improvements

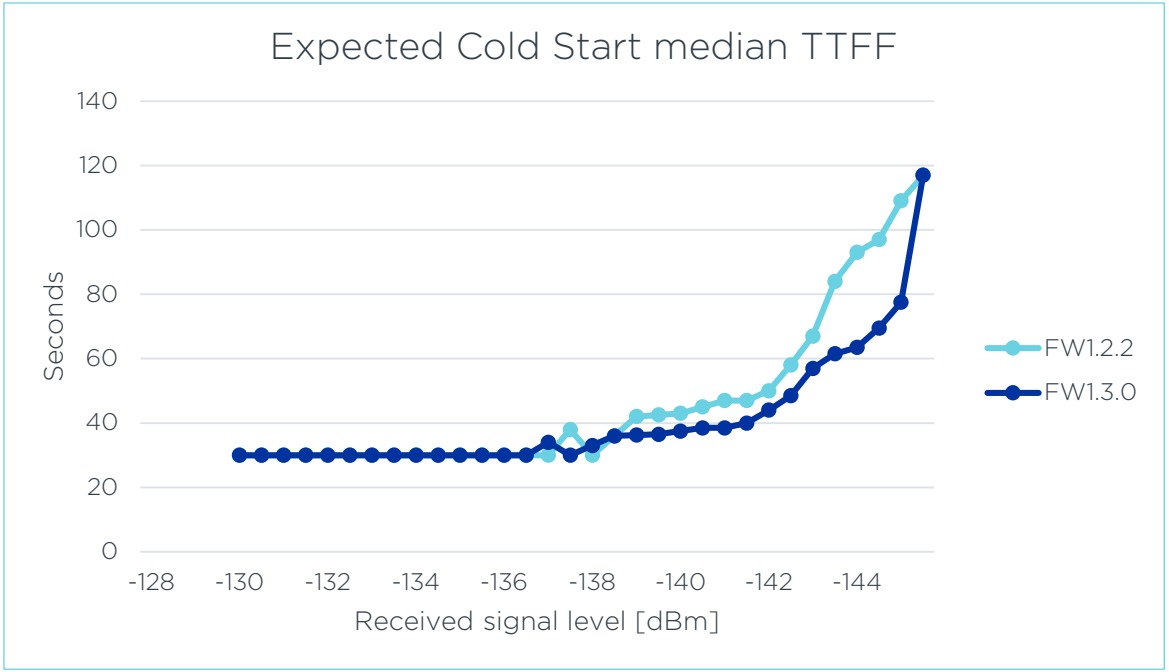
- 2x speedup of Satellite Search/Processing during Cold Start acquisition
  - Graph on next slide
- 2x speedup of Satellites Search/Processing during Hot/Warm/re-acquisition

GPS Hot Start	Severe conditions	
MFW 1.2.x	11s	
MFW v1.3.0	6s	-54%

- Assisted GPS start speed-up: avg. 3.6s TTFF reduction improvement in open sky
- DSP optimizations in the GPS:
  2 mA current consumption reduction during continuous tracking mode

GPS performance improvements

- 2x speedup of Satellite Search during Cold Start acquisition
  - Below a figure that describes the expected TTFF improvement



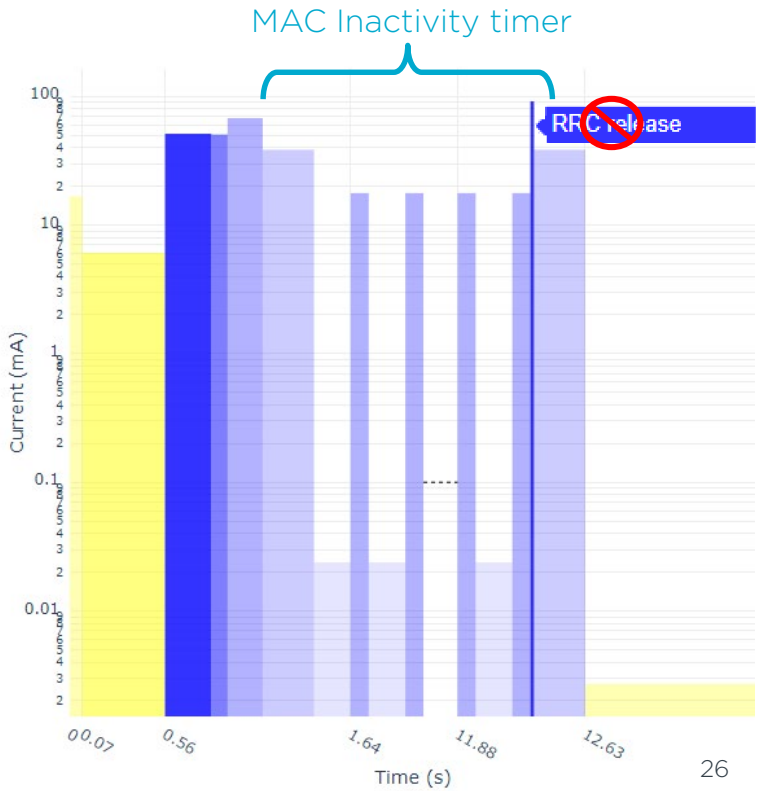
3GPP Release 14 features

3GPP Rel-14 features

- Rel-14 features are disabled by default
- Rel-14 specific features must be enabled via the AT command interface
- Certification issues with specific carriers combining Rel-13 baseline with cherry-picked Rel-14 features
- AT Command: AT%REL14FEAT

MAC Inactivity Monitoring

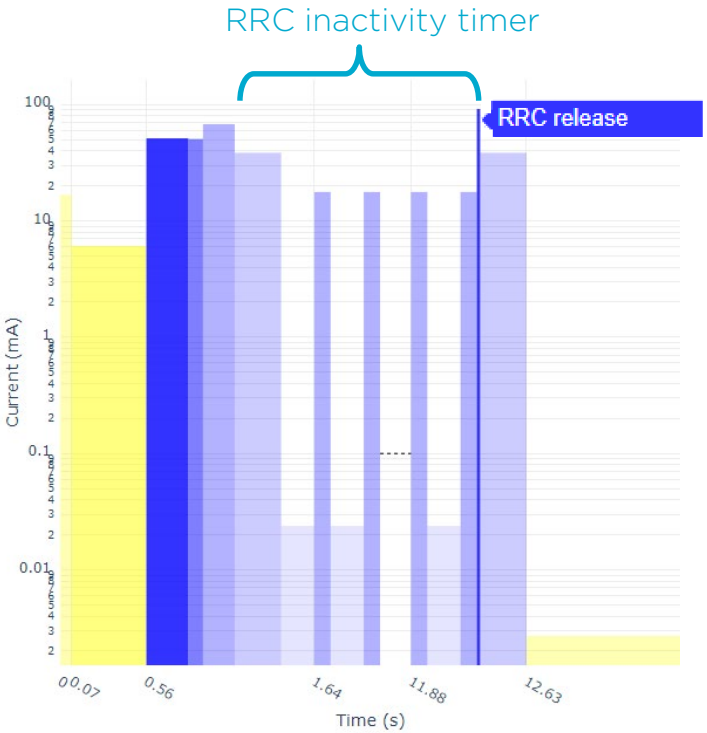
- A “safety net” if the network does not provide the expected RRC Release event
- Network will assign a MAC inactivity timer to the device under connection establishment
  - This timer is slightly longer than the RRC inactivity timer
- Handled automatically by the modem and you will avoid getting stuck in RRC Connected mode



3GPP Rel 14

AS Release Assistance Indication

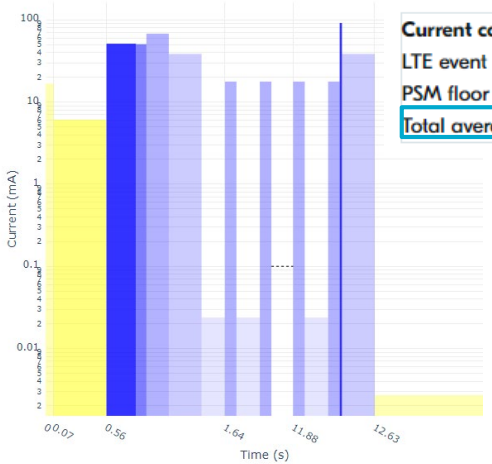
- Skip the network dependent “RRC inactivity timer”
- Switch quickly from RRC connected mode to IDLE/PSM if there is no more data to send or receive.
- A lot of power to be saved since radio needs to stay ON after each send/recv. in this RRC inactivity timer.
- AT Command : AT%RAI



AS Release Assistance Indication

- *Example*: Sending data UDP (1kB) each 30min, rest of time in PSM
- Using AS RAI, we see a 50% improvement = double the battery life!

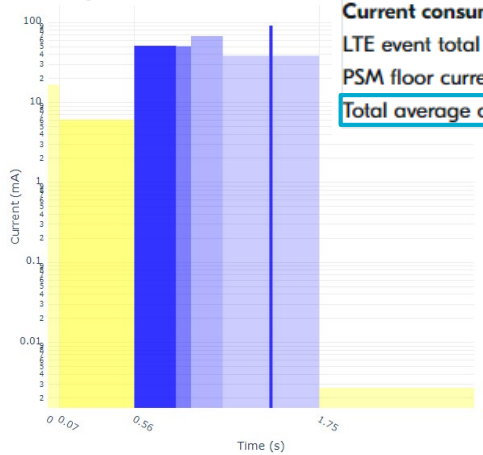
RRC Inactivity timer: 11 sec



Current consumption	
LTE event total charge	125.73 mC
PSM floor current	2.7 µA
Total average current	72.53 µA

2 years 1 month of battery life*

Using AS RAI



Current consumption	
LTE event total charge	61.83 mC
PSM floor current	2.7 µA
Total average current	37.05 µA

4 years 3 months of battery life*

*1400mAh battery based on estimates on the Online Power Profiler

Increased Data rates NB2

3GPP Rel 14

NB-IoT only

- **Dual HARQ** and **Max Transport Block Size** support
- **Increased** the maximum Downlink and Uplink **data rates** in good signal conditions

	NB-1 (Rel 13)	NB-2 (Rel 14)	Improvements
Uplink Max throughput *(peak rate, physical layer)*	62.5 kbit/s	169.1 kbits/s	+271%
Uplink Max TBS change on NPUSCH	1000 bits	2536 bits	+254%
Downlink Max throughput *(peak rate, physical layer)*	27.2 kbits/s	126.8 kbits/s	+466%
Downlink Max TBS change on NPDSCH	680 bits	2536 bits	+373%

Other new features

"But wait, there is more"

Key Generation and Key injection

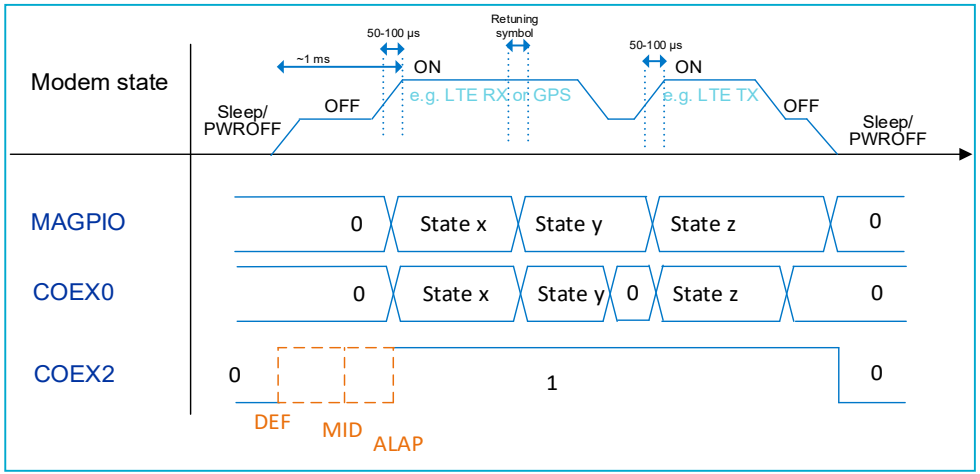
- Generate Keys for different purposes: AT%KEYGEN
  - Client private key and certificate signing request (CSR)
  - Client private key and public key
  - Device Endorsement key pair
- Key injections: AT%KEYINJECT
  - injects encrypted provisioning messages to the modem
- Generate JSON Web Tokens (JWT): AT%JWT

Configurable RX/TX indication on COEX2 pin

- COEX2 pin can be configured to toggle on RF usage with 3 different selections for anticipations

- Anticipation timings:
  - PIN toggled with 1 ms anticipation (default)
  - PIN toggled with ~400 µs anticipation
  - PIN toggled with 50 – 100µs

  - Useful to sync. radio activity with external devices



- AT command: AT%XCOEX2

New AT commands not yet mentioned

- Reset modem to factory settings: AT%XFACTORYRESET

- Request Attestation token: AT%ATTESTTOKEN

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Q&A