# Best practices for cellular IoT development

Nordic Tech Webinar

*Bjørn Kvaale / Product Marketing Engineer*

*June 2022*

# Today's hosts

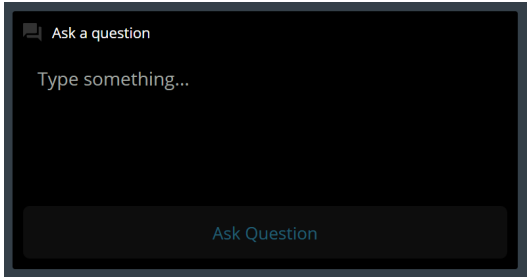
Bjørn Kvaale

Product Marketing Engineer

NORDIC SEMICONDUCTOR

# Practicalities

- Duration: 45 min presentation, 15 min 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 more questions
- A recording of the webinar will be available together with the presentation at webinars.nordicsemi.com/on-demand





{ DevZone

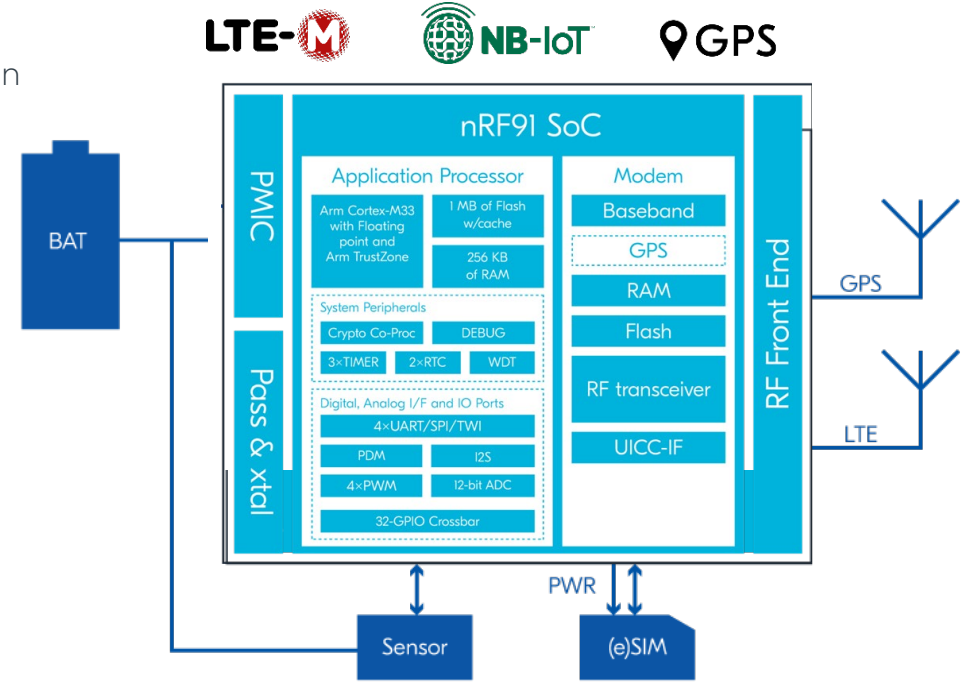
# Agenda

- 1: Hardware Architecture
- 2: Low-power application design through radio focus
- 3: LTE technology
- 4: Network coverage and SIM cards
- 5: IP transport options
- 6: Security protocols
- 12: Antenna design

- Best Practices for Cellular IoT white paper (nWP044) for Chapters 7-11

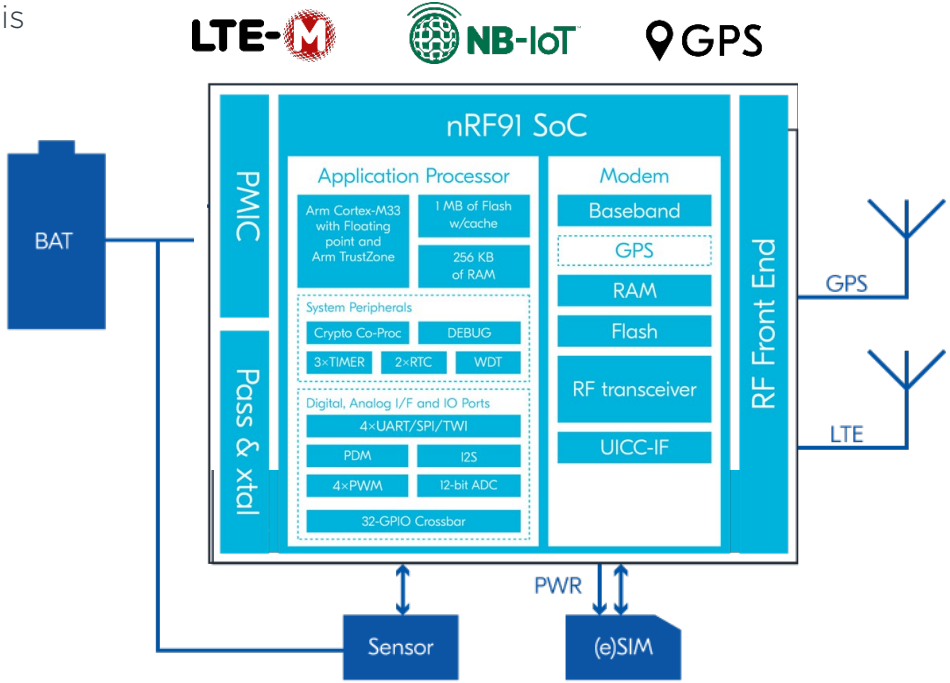
# 2: Hardware Architecture

- Based on **Nordic Dual Core SoC**:
  - **Arm® Cortex® M33 processor** for the application
  - Multiband **LTE-M/NB-IoT** modem with GNSS
  - **Small** form factor - includes PMIC, RF FEM, passives and crystals
  - Multiband support for global coverage
  - **Pre-certified** System-in-Package (SiP)
    - More information on our website



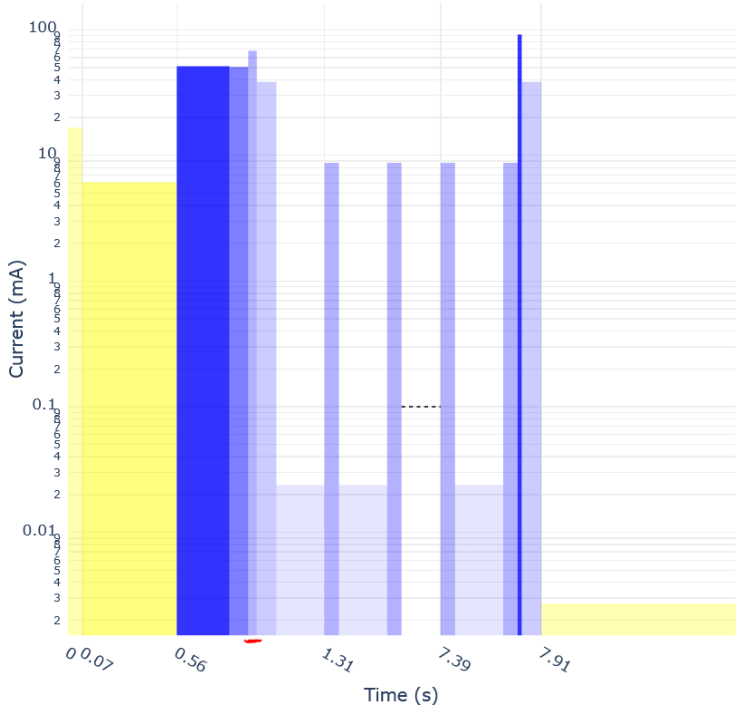
# 2: Hardware Architecture

- Better technical support since the entire module is provided by one vendor
  - Nordic DevZone
- Can use the nRF9160 SiP in a single-chip implementation or as a serial modem
- Serial LTE modem application
  - Quickly transition from 2G or 3G to LTE-M/NB-IoT



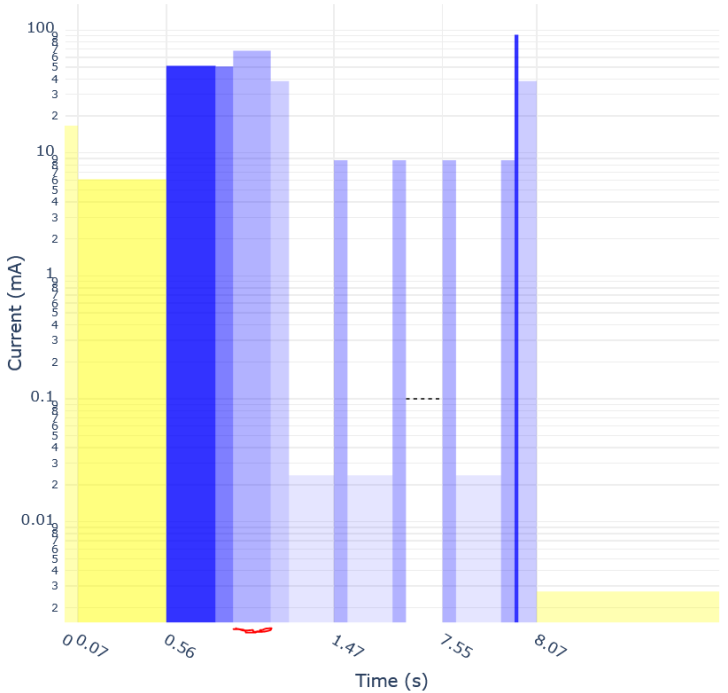
# 3: Low-power app design through radio focus

- LTE-M or NB-IoT, transport and application protocols, data transfer frequency and payload size influence power consumption
- Overhead for each cloud connection
  - Starting modem, connecting to network, app protocol headers, etc
- Online power profiler



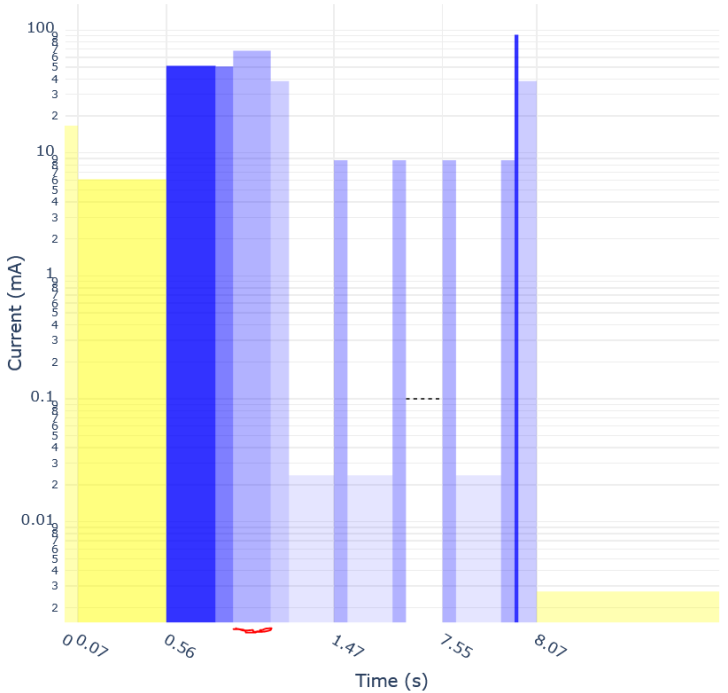
# 3: Low-power app design through radio focus

- Value the data you send vs the cost of sending it!
- Local processing on nRF9160 SiP
  - Only transfer important information to the cloud
  - Bulk data transfer up to AI or ML (Edge Impulse with Thingy:91)



# Sending 100 bytes vs 1000 bytes (bulk transfer)

- Value/cost=bytes sent/overhead charge (I*t)
- Sending 1000 bytes vs 100 bytes in one interval provides 10x the value/cost
- Key points
  - Only turn on the radio when necessary
  - Send time-critical data immediately
  - Send deferrable data in bulk transfers

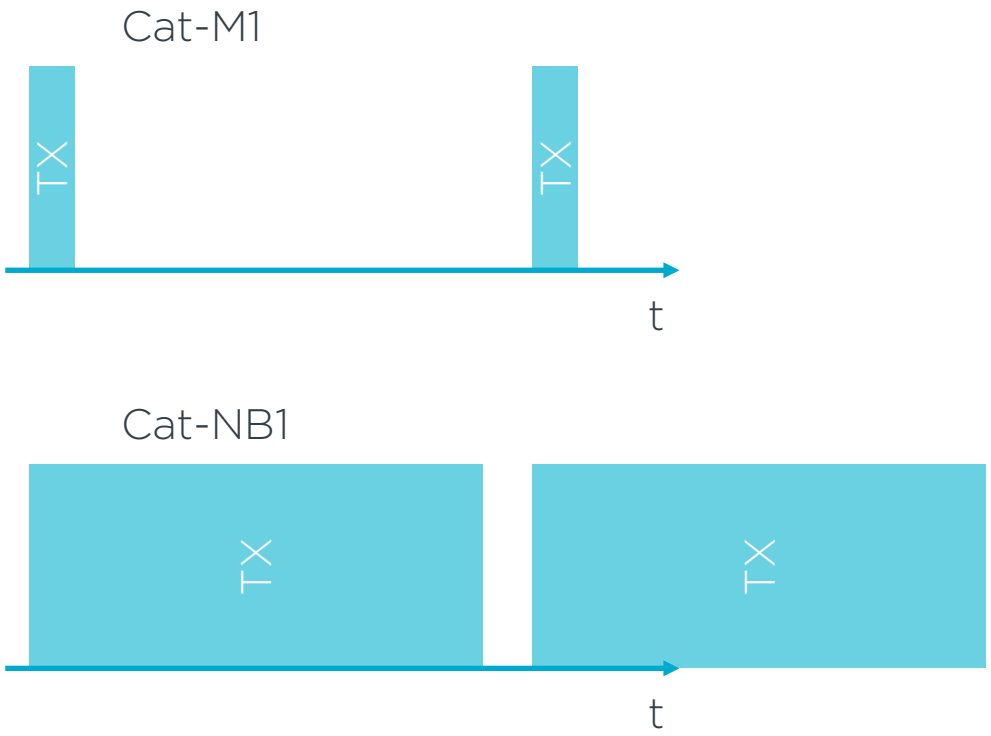


# 4: LTE technology

| Features | LTE-M | NB-IoT | |
|---|---|---|---|
| Also known as | LTE CAT-M1, *Enhanced Machine Type Communication (eMTC)* | LTE Cat-NB1 (3GPP rel 13) | LTE Cat-NB2 (3GPP rel 14) |
| Bandwidth | 1.4 MHz | 200 kHz | 200 kHz |
| Max throughput (DL/UL) | 300/375 kbps | 30/60 kbps | 127/169 kbps |
| Latency | 50-100ms | 1.5-10s | |
| Typical range | <11 km | <15 km | <15 km |
| Mobility/cell reselection | Yes | No | Limited |
| Roaming | Yes | Limited | Limited |
| Deployment density | Up to 50 000 per cell | Up to 50 000 per cell | Up to 50 000 per cell |
| Battery lifetime | Up to 12 years[1] | | |

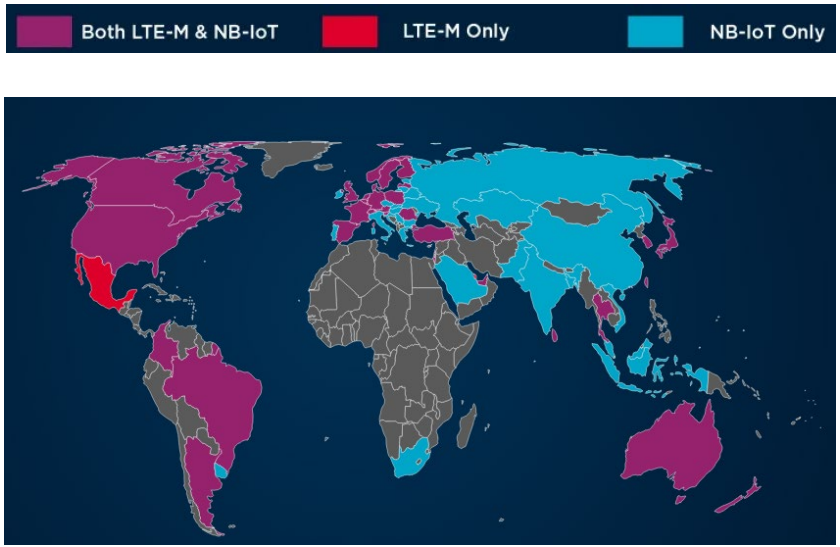
# 4: LTE technology

- Peak current Cat-M1 (TX, 23 dBm): 255-290 mA
- Peak current Cat-NB1 (TX, 23 dBm): 230-275 mA
- An nRF9160-based design using Cat-M1 uses less power than Cat-NB1 (good to reasonable radio conditions)



# 4: LTE technology

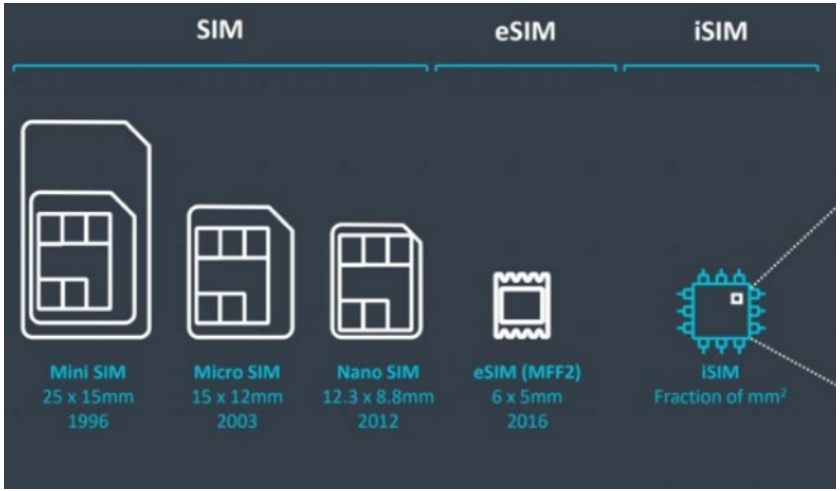
- Most operators support both Cat-M1 and Cat-NB1
  - Not the case in all countries though
- nRF9160 SiP SICA variant most popular
- Cat-M1 > Cat-NB1 unless you need high penetration or lower data throughput




GSMA Mobile IoT Deployment Map

# 5: Network coverage and SIM cards

- Is your product global or regional?
- You need an LPWAN SIM, not a regular 2G-4G SIM
- If deploying in multiple countries, a roaming SIM may be useful (Cellular Connectivity Partners)
- Roaming SIMs can be used on multiple networks where contracts have been negotiated



# 5: Network coverage and SIM cards

- Local SIMs may only work in specific regions
  - Can sign contracts with multiple operators, but this can be time-intensive
- Most local SIMs have eDRX/PSM features

- Roaming SIMs may be easier to use in global operation
- Roaming SIMs may not have eDRX/PSM features
  - Arkessa and iBasis have these features

# 6: IP transport options

| Option | Advantages | Disadvantages |
|---|---|---|
| TCP/IP | Data retransmissions<br>Congestion control<br>In-order delivery<br>Error detection | Slow handshake<br>Larger overhead<br>Repetition if data is not received<br>Not suited for NB-IoT |
| UDP/IP | No handshake needed<br>Better suited for low-power devices | Not guaranteed delivery<br>Not all major cloud vendors support UDP yet |
| NIDD | Removes the IP overhead<br>Network optimized | Not many networks support it<br>Only supported on NB-IoT<br>Not many cloud vendors support it |

# 6: IP transport options

- Is ultra-low power and data cost a high priority in your design?
- Do you know which IP protocol your cloud service supports?

# 7: Security protocols

- TLS for TCP, DTLS for UDP on transport layer in modem firmware
- Adding TLS/DTLS increases data overhead
- Data authentication via a pre-shared key (PSK)
  - Less overhead than TLS/DTLS
- Trusted Firmware-M implements Platform Security Architecture (PSA)

# 7: Security protocols

- ARM® TrustZone®, ARM® TrustZone® CryptoCell®
- FOTA: sign firmware images before going to production
  - FOTA supported in nRF Cloud
- Considerations
  - Is ultra-low power and data cost high priority in your design?
  - Will you store keys on your device?

# 12: Antenna design recommendations

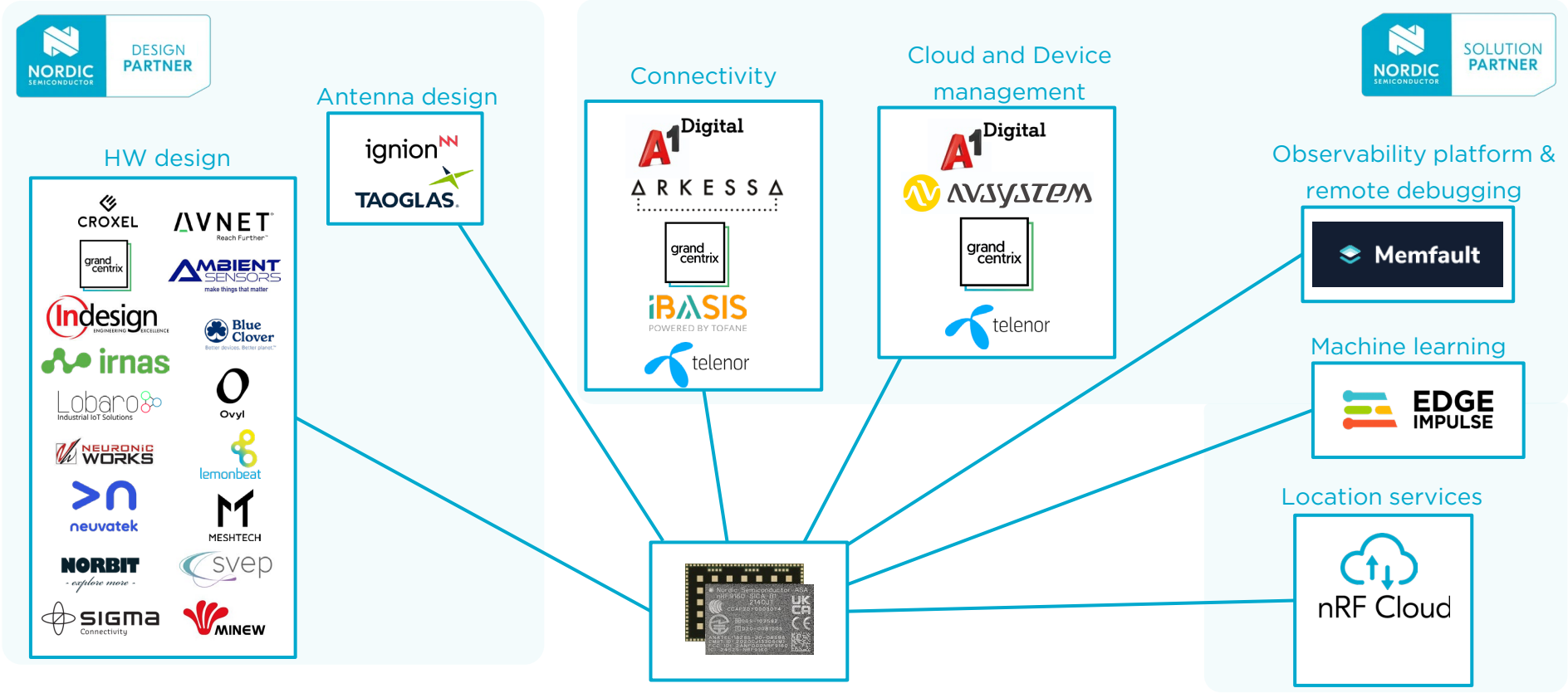
- Start antenna design ASAP! May be costly otherwise when you go to certify
  - Especially if you use LTE and GNSS
- nWP033 – nRF9160 Antenna and RF Interface Guidelines
- Hardware files (layout and BOM) for nRF9160 DK and Thingy:91 available
- Design partners (Taoglas, Ignion)


# Key takeaways

- Read the nWP044 white paper thoroughly!
- Data value versus data cost
- Plan well, it will lead to less issues later
- Antenna design very important
- Use Nordic DevZone

# Nordic Partner Program

## Simplify cellular with solutions optimized for Nordic technlogies



# Want to learn more?

- 8: Application protocols
- 9: Cloud services and connections
- 10: Local application processing
- 12: Certifications

Please check out the
«Best practices guide for Cellular IoT development»
(nWP044) white paper for more details

NORDIC SEMICONDUCTOR

# Get on it

#1 Sign up for more webinars at **webinars.nordicsemi.com**

#2 Get tech support and join our community at **devzone.nordicsemi.com**

#3 Find out more about our products and services at **nordicsemi.com**

NORDIC SEMICONDUCTOR

# Q&A