Optimization of Energy Consumption for Narrowband Internet of Things (NB-IoT) Cellular Radio User Equipment (UE)

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Narrow-band Internet of Things (NB-IoT) is a cellular radio technology standard dedicated to IoT applications. NB-IoT is specified in the Release 13 of the 4th generation Long term evolution (LTE) standard and fulfill the requirements of the IoT use cases such as optimized through the network low data rate transfers, world-wide coverage, a large number of devices supported by single-cell and extended battery lifetime. To reduce the power consumption NB-IoT uses two new mechanisms – the Extended Discontinuous Reception (eDRX) and the Power Saving Mode (PSM) [1]. The traditional way for transferring data over LTE network is through the Internet Protocol (IP) over the network User Plane. The IP mechanism requires intensive signaling. Signaling messages need to activate the RF transmitter and use a consequent amount of energy. NB-IoT power consumption can be optimized by using non-IP transfer over the Control plane.

To test the different ways of optimizing the energy consumption of an NB-IoT device, a specialized measuring system was developed. The system block diagram is presented in Figure 1.a. The system allows us to configure the device and transfer a data block to a standard server or an echo server. For each mode, the power consumption is measured in real-time during the different stages of the transmission (connection establishment, data transfer, waiting for acknowledgment, connection release). Thus it is possible to measure the energy efficiency of the new NB-IoT specific configuration (PSM, eDRX) and data transfer modes (IP over User plane and non-IP over the Control plane).

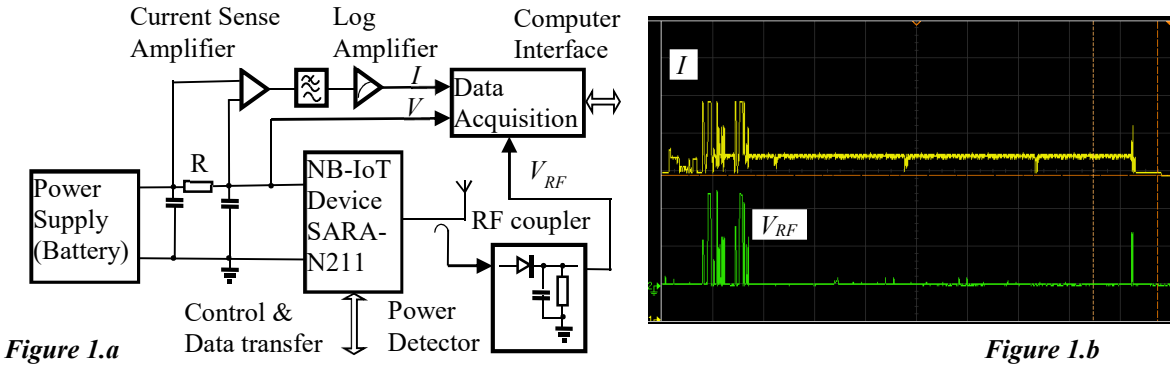

Figure 1.a *Figure 1.b*

Figure 1. NB-IoT power test system and record of real signals

Measurements were carried out on the 1NCE operator's network in Munich. Figure 1.b. shows a real record of the current consumption synchronously with the transmitted RF power. For a more detailed analysis, it is possible to record a log stream from the module.

In real propagation conditions, the energy used to transfer 128-byte blocks varies, depending on the configuration, between 700 µWh and 80 µWh. In particular, the use of the Release assistance feature has proven to be extremely effective in reducing energy consumption. The results of the measurements were compared with the available in the literature data for other proprietary systems dedicated to IoT communications. Power consumption measurements clearly show that NB-IoT is a suitable system for low power IoT applications and can provide 10 years of battery life for 100 bytes per day transfers.

References

[1] GSM Association, "NB-IoT Deployment Guide to Basic Feature set Requirements", Version 1.002, 2 August 2017, www.gsma.com/newsroom/wp-content/uploads/CLP.28-v1.0.pdf