LOW POWER WIDE AREA NETWORKS FOR THE INTERNET OF THINGS: FRAMEWORK, PERFORMANCE EVALUATION, AND CHALLENGES OF LORAWAN AND NB-IOT

Samer Lahoud
Saint Joseph University
Beirut, Lebanon
samer.lahoud@usj.edu.lb

Melhem El Helou
Saint Joseph University
Beirut, Lebanon
Melhem.helou@usj.edu.lb

ABSTRACT

Low-Power Wide Area Networks (LPWAN) have recently gained considerable attention in the Internet of Things (IoT). The key objective of these wireless technologies is to connect low-power devices over very large areas, with low data rates. LPWANs represent a novel wireless communication paradigm, which will complement traditional cellular and short-range wireless technologies in addressing diverse requirements of IoT applications. Machina Research (2016) expects 11 percent of IoT connections in 2025 to use LPWAN technologies.

In this tutorial, we present the recent advances of LPWAN technologies with focus on LoRaWAN and NB-IoT. We analyse the link level and system level design aspects. We further focus on link budget analysis and radio network dimensioning for both LoRaWAN and NB-IoT. Precisely, we present best practices in the network design and deployment of these technologies. Acquiring such best practices is of paramount importance for the optimization of LPWANs. We also provide a comparative performance evaluation of LoRaWAN and NB-IoT in terms of coverage and capacity.

Finally, we cover the research directions and scientific challenges in these technologies. Particularly, we present research directions for radio resource management in both LoRaWAN and NB-IoT.

The outline of the tutorial and the topics the speakers will cover are presented in the following:

- Services and applications that foster low power wide area networks
- Architecture and characteristics of low power wide area networks
- Optimized modulation and access method for low power consumption and large coverage in LoRaWAN
- Leveraging and adapting 3GPP LTE infrastructure and mechanisms for NB-IoT
- LoRaWAN specification: Radio interface, physical architecture, protocol architecture
- NB-IoT standard: Radio interface, physical architecture, protocol architecture
- Coverage performance and link budget analysis for LoRaWAN
- Coverage performance and link budget analysis for NB-IoT
- ALOHA based model dimensioning and capacity performance for LoRaWAN
- Bandwidth based dimensioning and capacity performance for NB-IoT
- Research directions for radio resource management in LoRaWAN and NB-IoT

This tutorial is of strong interest to professionals and scientists involved in performance evaluation of computer and telecommunication systems. First, professionals will benefit from an overview on the two major technologies in LPWAN, namely LoRaWAN and NB-IoT. They will acquire deep understanding of the major design choices of both technologies, and best practices for evaluating their performance in terms

of capacity and coverage. Second, academic scientists and industry researchers will benefit from a scientific overview on the state-of-the-art, and the promising research perspectives for radio resource management in LPWANs. Finally, graduate students will benefit from a technology overview on the radio interface, and the physical and protocol architectures for LoRaWAN and NB-IoT. This tutorial is accessible to a broad audience in the SPECTS community as it only requires familiarity with communication and networking concepts.

REFERENCES

Machina Research. 2016. “Global Internet of Things Market to Grow to 27 Billion Devices, Generating USD3 Trillion Revenue in 2025”. Machina Research Press Release, August 3, 2016. https://machinaresearch.com/news/press-release-global-internet-of-things-market-to-grow-to-27-billion-devices-generating-usd3-trillion-revenue-in-2025/.

AUTHOR BIOGRAPHIES

SAMER LAHOUD is an Associate Professor at the Saint-Joseph University of Beirut where he lectures computer networking courses at the Faculty of engineering (ESIB). His research activities focus on routing and resource allocation algorithms for wired and wireless communication networks. He has co-authored more than 80 papers published in international journals and conference proceedings. Mr. Lahoud received the Ph.D. degree in communication networks from Telecom Bretagne, Rennes, in 2006. After his Ph.D. degree, he spent one year at Alcatel-Lucent Bell Labs Europe. From 2007 to 2016, he was with the University of Rennes 1 and with IRISA Rennes as an Associate Professor.

MELHEM EL HELOU received the engineer's degree and master's degree in telecommunications and networking engineering from the Ecole Supérieure d’Ingénieurs de Beyrouth (ESIB), Faculty of Engineering at the Saint Joseph University of Beirut, Beirut, Lebanon, in 2009 and 2010, respectively and the Ph.D. degree in computer and telecommunications engineering from IRISA Research Institute, University of Rennes 1, Rennes, France and Saint Joseph University of Beirut, in 2014. He joined ESIB in September 2013 where he is currently an Assistant Professor (fr: Maître de conférences). His research interests include wireless networks, radio and energy resource management, Internet of Things, and quality of service.