

”Low Power Wide Area Networks: the LoRaWAN system” tutorial proposal for WPMC 2018

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1 Title of the tutorial

Low Power Wide Area Networks: the LoRaWAN system

2 Abstract, objectives and motivation

2.1 Abstract

The tutorial will start by quickly introducing the current broad landscape of the *wireless communication* technologies for the IoT and Smart Cities including those based on IEEE 802.15.4 (ZigBee, 6LoWPAN and Thread) and IEEE 802.11 (with some emphasis on 802.11ah) .

Then the tutorial will move forward to highlight the shortcomings of these technologies, having in mind the services which can be offered in Smart City, Home and industrial environments.

Afterwards, the major LPWA technologies will be shortly introduced, including NB-IoT and SigFox. The benefits and drawbacks of using such a kind of technologies will be examined in general.

The focus will move then more on the Lo-Ra and Lo-RaWAN systems, including the network architecture, the protocol stack, and the physical layer. This will constitute the core of the tutorial and the part where more specific technical details will be given.

2.2 Objectives

The tutorial aims at giving a *technical* overview of the LoRa/LoRaWAN system to enable

- the academic community to head start research on this topic and e.g., compare the LoRa/LoRaWAN system with other connectivity options for the Internet of Things

- the industrial community (including incumbent and perspective telecom operators, private telecom providers, and other application and infrastructure providers) to evaluate the possible application and the economic viability of LoRa/LoRaWAN system.

2.3 Motivations

Low Power Wide Area Networks is a game changing paradigm but yet there very little literature widely available which provides a systematic introduction, comparison and technical description of Low Power Wide Area Networks. So the author expect many people be interested in getting one of the first *technical* overview of the most prominent LPWAN technology, i.e. the Lo-Ra/LoRa-WAN system The topic is very hot on the marketing and business journals and magazines. Quoting Machina Research:

As recently as early 2013, the term "LPWA" did not even exist. The fact that the LPWA space has since then become one of the fastest developing aspects of the Internet of Things (IoT) market is testimony to the incredible potential for LPWA technologies. Machina Research forecasts that there will be 3.6bn LPWA connections by 2024, growing from today base that has numbers in the low 10s of millions. This extremely rapid growth rate is driven by a wide range of applications, each of which is the product of a rapidly evolving technological landscape.

3 Intended audience

The interest in Internet of Things is clear for a wide variety of people, both in the academic community and in the industrial community (including telecom operators, equipment manufacturers, solution providers).

4 Names, affiliations and short biography of speakers

4.1 Name and affiliation of the speaker

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4.2 Biography

Lorenzo Vangelista (IEEE SM'02) was born in Bassano del Grappa, Italy, in 1967. He received the Laurea degree from University of Padova, Padova, Italy, in 1992, and the Ph.D. degree in Electrical and Telecommunication Engineering from University of Padova, in 1995. He subsequently joined the Transmission and Optical Technology Department of CSELT, Torino, Italy. From December 1996 to January 2002, he was with Telit Mobile Terminals, Sgonico (TS), Italy and then, up to May 2003, with Microcell A/S, Copenhagen, Denmark. Until July 2006 he has been with the worldwide organization of Infineon Technologies, as program manager. Since October 2006 he is an Associate Professor of Telecommunication within the Department of Information Engineering of Padova University, Italy. His research interests include signal theory, multi-carrier modulation techniques, cellular networks, wireless sensors and actuators networks and smartgrid.

5 Outline of the Tutorial content and tentative schedule

5.1 Outline of the Tutorial content

The topic of Low Power Wide Area Networks (LPWA) is timely as we see the emergence of technologies like Lo-Ra, SigFox, Ingenu and others gaining more and more momentum and market acceptance all over the world. These technologies differs from the communication technologies usually employed in the Internet of Things space since their architecture is no longer based on short distance communications and mesh topologies but instead on long distance (up to 15 km) technologies, very low bit-rate, architecturally similar to the cellular technologies but operating in unlicensed spectrum.

More in detail, the tutorial will present

- 1) the emergency of the LPWAN paradigm in contrast to the classical "mesh networking" paradigm
- 2) the common architecture of the LPWAN networks
- 3) a review of the most prominent LPWAN technologies
- 4) the LoRaWAN architecture
- 5) the MAC protocol and system architecture, known as LoRaWAN, defined by the Lo-Ra Alliance
- 6) the application platforms commonly used for the LoRa systems

5.2 Schedule

Half-day tutorial, 4 hours with 20 minutes break (can be shrunk to 3 hours and 15 minutes break, depending on the tutorial program)

6 Relevant experience of the speaker in the topic

Lorenzo Vangelista has been CEO of Patavina Technologies s.r.l., a spinoff of Padova University, dealing with LoRa Network Servers, acquired in 2017 by the A2A group, listed in the Italian Stock Exchange.

Lorenzo Vangelista published several papers on the Internet of Things and Smart Cities, among which the most popular paper in IEEE Explore at the moment entitled "*Internet of Things for Smart Cities*," in IEEE Internet of Things Journal, vol. 1, no. 1, pp. 22-32, Feb. 2014, by A. Zanella, N. Bui, A. Castellani, L. Vangelista and M. Zorzi.

Lorenzo Vangelista is co-author of a several of journal and conference papers on Lo-Ra.

For the publications of Lorenzo Vangelista please refer to the profile https://scholar.google.it/citations?hl=it&user=A7QtWnMAAAAJ&view_op=list_works&sortby=pubdate

Lorenzo Vangelista is teaching the course of "Internet of Things and Smart Cities" (graduate level) at Padova University, Padova, Italy.

A similar tutorial (extended version, one full day) has been presented at IEEE CCNC 2018.