Demo: LoRa Mesh network experimentation in a city-wide testbed

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ABSTRACT

LoRa is a low-power long-range Internet of Things (IoT) standard that offers remarkable performance, especially in remote rural areas. However the single-hop nature of current LoRa networks, poses significant challenges for urban setups and complex network environments, where several gateways with network access need to be deployed to offer the required connectivity. Towards overcoming the connectivity inefficiency of LoRa in relevant environments, the application of mesh networking has been identified as a candidate solution with rich potential. In this work, we present a LoRa based mesh-networking tool for LoRa mesh experimentation. that is currently applied in testbed of 10 LoRa mesh capable devices across the city area of Volos, Greece.

KEYWORDS

LoRa Technology, Testbed Experimentation, LoRa Performance Evaluation, Multi-hop Network

1 INTRODUCTION

In recent years, *Low-Power Wide-Area Networks* (*LPWANs*) have gathered a lot of interest in both academic studies and industrial developments. LoRa [1] is a prominent technology of this type, employing a specific radio layer based on the *Chirp Spread Spectrum* (*CSS*s) modulation. Despite the remarkable performance of the LoRa specification in rural environments, its biggest disadvantage is the single-hop nature that results in low coverage, especially in urban areas where line of sight links are degraded mainly due to big obstacles (e.g. buildings, walls, floors). The ability of LoRa nodes to perform direct *Device-to-Device* (*D2D*) communications lead to the ability to create LoRa mesh networks, where relay nodes forward packets to the destination gateway. Several works, study the performance of LoRa mesh networking in urban and rural environments [2–4] and some others in theoretical basis [5], providing some first results in the behavior of this technology.

Over the past decades, significant research efforts have focused on routing for multi-hop wireless networks, and specifically for networks with dynamic topology, such as *IoT* networks. Mobile ad-hoc routing protocols are divided into three main categories, proactive, reactive and hybrid protocols, based on the information that they use for the route discovery procedure. A detailed analysis of representative protocols per category is presented in [6].

The specific characteristics of LoRa technology, along with the well-defined restrictions, such as the 1% duty cycle limitation, constitute a complex setup where network performance highly depends on the employed multi-hop routing protocol. Considering LoRa bandwidth limitations, it is made clear that proactive protocols are not well-suited for relevant deployments, due the continuous exchange of information for discovering and maintaining the network routes. On the other hand, reactive protocols require topology information only when a new route is required or when a route fails, consisting them ideal candidates for a LoRa mesh networking. In [2], the Ad-hoc On-Demand Distance Vector Routing (AODV) , which is probably the best-known reactive routing protocol for MANETs, and the Hybrid Wireless Mesh Protocol (HWMP) used in 802.11s mesh networks, are presented as the ideal routing protocols for LoRa mesh applications.

In this work, we present a LoRa wireless mesh networking set of tools, offering a wide range of experimentation options and performance evaluation tools that have been specifically designed for analyzing the performance of LoRa mesh networking in urban setups. The tool is directly deployed on a city-scale testbed presented in our previous works [7, 8].

The research leading to these results has received funding by GSRT, under the act of "HELIX-National Infrastructures for Research", MIS No 5002781.

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WiNTECH'19, October 25, 2019, Los Cabos, Mexico
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ACM ISBN 978-1-4503-6931-2/19/10.
https://doi.org/10.1145/3349623.3355479