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IMPLEMENTATION OF A PROTOCOL STACK WITH DTN PROTOCOLS FOR IOT SERVICES DEPLOYED FROM NON-TERRESTRIAL NETWORKS

Abstract

The Internet of Things (IoT) is defined as a key service in the 5th Generation (5G) and has established itself as a wide-spread technology of importance in future networks (e.g: 6G). Massive Machine Type Communications (mMTC) is the technological approach engaging the challenges posed by the data exchange needs of the ever increasing number of IoT devices. Many relevant IoT use cases are located in rural and remote areas where deploying the needed infrastructure is costly and inefficient. The growth of the nano-satellite sector and the deployment of LEO constellations, raise Non-Terrestrial Networks (NTN) as an alternative to provide coverage for these use cases. Its main tradeoffs are the increased delays, and the intermittent unreliable space links. Delay Tolerant Network (DTN) technology focuses on solving these challenges for discontinuous connectivity scenarios. For this reason, its application in IoT use cases is a current field of research, as studied in [1].

This work presents the development of a mixed protocol stack for IoT terminals to send data to a remote core network through a LEO constellation. Classic IP suite protocols are combined with CCSDS standard DTN protocols, such as Bundle Protocol v7 (BP). The stack implemented in this work handles their integration by tunneling the IoT packets through BP and its underlying protocols. This DTN encapsulation provides a reliable link over a disrupted communications channel. In addition, the store and forward capabilities of BP are a benefit for NTN and its intermittent links and delays.

The implementation of this protocol stack is a C-code software capable of seamlessly integrating the heterogeneous protocols employed. It allows Linux platforms to act as a satellite or ground bundle agent node in IoT NTN scenarios. The software also includes the basic functionalities for user and core network nodes. To validate the proposed stack and its implementation, a testbed setup is composed of two RaspberryPi 4 and virtual machines are employed.

With the validation of this implementation, this work (1) demonstrates the feasibility of implementing functional mixed IoT-DTN protocol stacks, (2) opens the discussion for DTN and IoT integration in mMTC-NTN scenarios and (3) provides a working implementation of an IoT-DTN stack for further testing and validation of the concept.

[1] M. Marin-de-Yzaguirre, et al. “Study to integrate Delay-Tolerant Network Protocols in IoT LEO constellations for Flood Prevention”. Abstract submitted for IAC2023