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END-TO-END 3GPP NB-IOT NTN RELEASE 17 TESTBED FOR A LOW-DENSITY LEO CUBESAT
CONSTELLATION WITH REGENERATIVE PAYLOAD

Abstract

5G NB-IoT is the LPWAN technology standard developed by the 3GPP to fulfill the challenging massive IoT application requirements in terms of low-power consumption and low-complexity at the User Equipment (UE) side. While initially conceived for terrestrial network deployments, efforts have been directed to improve the NB-IoT protocol with satellite access features. These are meant to obtain the potential benefits of currently unserved use cases in areas where terrestrial coverage is limited or non-existent. In this direction, a first specification of the NB-IoT Non-Terrestrial Network (NTN) protocol has been delivered with 3GPP Release 17 and further enhancements and new capabilities are under work with Release 18 and Release 19. This paper will describe the set-up and testing results conducted over a laboratory testbed for a complete NB-IoT NTN system which includes a regenerative payload Engineering Model (EM) for a Cubesat form factor at its core. The deployed testbed acts as a validation platform for in-orbit tests which will be reproduced during flight for the verification of the NB-IoT NTN system in an operational environment. The provided results are intended to validate the end-to-end operation of the NB-IoT NTN architecture for a low-density LEO constellation scenario, which is identified as one of the most cost-effective approaches to serve delay-tolerant applications in remote locations. In addition, the test results are meant to prove the technical feasibility of the key parts of the proposed solution for delay-tolerant NB-IoT NTN services, including an Store Forward mechanism and an splitted Evolved Packet Core (EPC) architecture required to successfully cope with Service and Feeder Link discontinuity. Among others, demonstrations will include the network registering process by completing the authentication of an Attach Procedure, as well as the exchanging of data back and forth with a User Datagram Protocol (UDP) echo test by sending Mobile Originating (MO) and receiving Mobile Terminating (MT) messages. These functionalities are tested under different scenarios defined by the location of the Home Subscriber Server (HSS) in the end-to-end architecture. The tests start with the authentication data onboard of the satellite payload, and conclude with the setup of a Visiting Public Land Mobile Network (VPLMN) accessing the HSS located on the Home Public Land Mobile Network (HPLMN) of a 3rd party Mobile Network Operator (MNO) via 3GPP/GSMA standard roaming interface.