IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Interactive Presentations - IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (IP)

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SYSTEM LEVEL PERFORMANCE ANALYSIS FOR 3GPP NB-IOT NTN SOLUTIONS WITH SMALL SATELLITES AND SPARSE LEO CONSTELLATIONS

Abstract

Complementing and extending the coverage reach of terrestrial networks with satellite access is one of the new connectivity frontiers being addressed on the path to beyond 5G/6G systems. In particular, the realization of almost ubiquitous connectivity in a seamless and cost-affordable manner to power-constrained devices is key to unleash the potential of the massive IoT market, where the lack of global coverage and international roaming are currently standing as main limiting factors for market growth. To harness this potential, the 3rd Generation Partnership Project (3GPP), the standard development organization in charge of the mobile system specifications, is expected to be finalizing by June 2022 a first adaptation of the NB-IoT protocol for non-terrestrial networks (NB-IoT NTN), paving the way for integrated terrestrial-satellite connectivity solutions that could leverage and help further boost the large and growing 3GPP device and IoT application ecosystem. The NB-IoT NTN protocol is being designed to support different types of satellite deployments, including GEO, MEO and LEO constellations, single-beam and multi-beam satellite platforms and Earth-moving and Earth-fixed satellite cells. In this context, this paper will present a system level performance analysis of a NB-IoT NTN deployment solution using nanosats in sparse LEO constellations, which is one of the most challenging scenarios in terms of achievable coverage footprint and satellite capacity due to the power and size constraints in the satellite platform. A method to properly model such scenarios will be described in the paper and estimations of system performance indicators such as number of connections that can be handled simultaneously, effective satellite footprint coverage area and supported device density (UEs/km2) will be provided for different representative operational configurations (e.g. single and multi-tone transmissions modes, multi-carrier configurations with anchor and non-anchor carriers) and traffic characteristics (e.g. application payload sizes, signaling overhead) Our results demonstrate the feasibility of such a system and illustrate

some of the relevant trade-offs between the system configurations and communication performance.