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VIRTUAL SATELLITE NETWORK SIMULATOR (VSNES) - A SIMULATION ENGINE TO VIRTUALIZE NON-TERRESTRIAL NETWORKS

Abstract

The space has been populated by a wide range of satellite systems from governmental and private space entities. Monolithic satellites have been ruling the space, until novel user demands emerged requiring global coverage, low revisit time, and ubiquitous service. The possibility to integrate in-orbit infrastructure to support current mobile system is being discussed persistently in the last years. Specifically, the concept of deploying networks composed of aircraft and spacecraft as nodes, so-called Non-Terrestrial Networks, have emerged as a potential architecture to satisfy this new demand. This novel concept enabled to investigate with mobile technologies in space infrastructure. Among the different challenges, the integration of space systems to current 5G architecture is the most relevant. This integration may face the deployment of transparent or regenerative payloads, as presented in 3GPP standards. In the regenerative case, the deployment of Network Functions (NF) becomes thus a challenge to face if well-known and large deployed mechanisms are envisioned to use. From this premise, the Software Defined Satellite concept emerged as a satellite system managed as in-orbit infrastructure over which services or NF are deployed.

In this research domain, simulation engines are required to validate novel developments. This work presents the Virtual Satellite Network Simulator (VSNeS), a novel simulation engine capable to represent satellites and ground nodes as virtual machines and deploy a virtual network to represent the channel effects. Instead of using containers as in other solutions, this approach is based on virtual machines, which enables to directly represent satellite architectures (e.g. ARMv8) in a cloud environment. Although this solution is more resource demanding, this hardware representation enables to better simulate real scenarios.

The concept, requirements and design of the software is presented in this work, remarking each component and their functionalities. Additionally, the VSNeS is validated in different scenarios: (1) an scenario with a GEO satellite and two ground users, (2) in another scenario with a LEO satellite and two ground users, and (3) finally, an scenario with multiple LEO satellites and two ground users. Metrics like latency, throughput and packet error rate are collected to evaluate each scenario. Additionally, the scalability of the software is demonstrated by deploying up to 65 satellites in a standard laptop. The achieved results enables to demonstrate the features of the VSNeS and presents it as a potential open-source tool for future research. Note that the VSNeS is published in our repository center (https://github.com/Fundacio-i2CAT/vsnes).