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STUDY TO INTEGRATE DELAY-TOLERANT NETWORK PROTOCOLS IN IOT LEO CONSTELLATIONS FOR FLOOD PREVENTION

Abstract

In the era of the Internet of Things (IoT) the development of direct-to-satellite IoT applications are becoming increasingly relevant. These technologies enable IoT devices to communicate sensing nodes directly with satellites without depending on traditional terrestrial infrastructure. The utilization of Low Earth Orbit (LEO) satellites offers global and mass coverage, linking IoT devices even in remote locations. However, deploying larger constellations to achieve worldwide and ubiquitous coverage is challenging and economically difficult to justify as most IoT applications do not require real-time links. This configuration creates a communication architecture discontinuity that needs to be addressed as traditional terrestrial protocols are not designed to handle these interruptions in the flow of data.

The motivation of this work is to combine already space-proven Delay Tolerant Network (DTN) protocols into IoT communication for Non-Terrestrial Networks (NTN). Furthermore, this development will be tested in a simulated real-use case scenario.

The CCSDS Bundle Protocol (BP) is used for data transfer in dynamic space networks and it's the standard architecture for DTN space communications. It includes mechanisms for storing and forwarding bundles which make it suitable for this discontinuous scenario.

Direct-to-Satellite IoT can satisfy different application requirements such as geoinformation monitoring and disaster prevention. For instance, India has one of the more severe affectations due to flooding as they have limited capacity to recover from natural disasters. Additionally, some of its regions have limited terrestrial network coverage due to economical and topographical constraints. The proposed case study uses DTN Direct-to-Satellite IoT communications to deploy hundreds of sensing nodes to create an early warning flood detection system. The simulation results provide valuable insights into the capabilities of DTN Direct-to-Satellite IoT communications when faced with high-stress levels from hundreds of sensing nodes. The study provides a performance comparison between different sensing node configurations. It also highlights the importance of the orbital configuration for DTN store-and-forward communications.

In conclusion, this work presents a novel approach for use cases using IoT communication with LEO satellites. It contributes to (1) kickstarting discussions around the usability of DTN protocols for LEO IoT communications, (2) evaluating the proposed architecture in a real case located in India for flood prevention, and (3) discussing BP as a key component for DTN protocols in mass IoT device communications with LEO satellites.