PROJECT PROPOSAL - N SAT CONSTELLATION DATAFLOW

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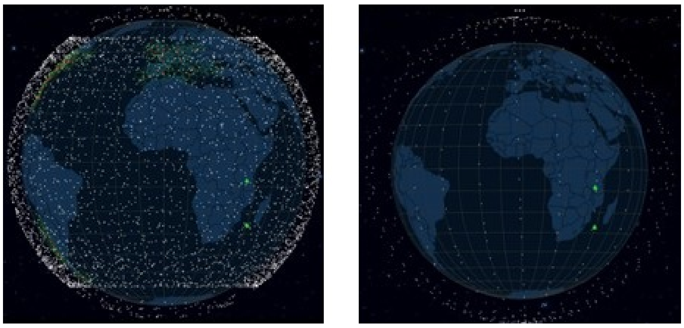
17/09/2024

1. INTRODUCTION

With the development of the internet by satellite with the new Low Earth Orbit (LEO) constellations, managing data transfer from ground to space and between satellites has become an emerging topic in the space sector.
Each constellation is different, for example, the two main constellations for the internet, Starlink (6 000 satellites in 2024) and OneWeb (634 operational satellites) have very different satellite network organization.
We can also differentiate constellations by their altitudes, between a geostationary constellation (36 000 km) which need at least 3 satellites to work but with a bigger latency, and a Low Earth Orbit constellation (like Starlink and Oneweb) which will need more satellites.

Figure 1. comparative visualization of oneweb and starlink



Source: satellitemap.space

2. SIMULATION COMPONENTS

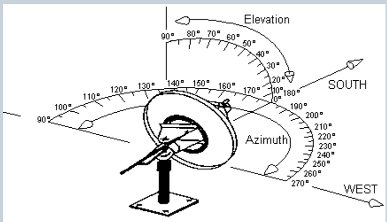
The goal of this project is to develop a simulator of a messaging system between multiple ground terminals through an N satellites constellation.
To do this, we will define the various components, and how they can interact with each other and behave during the simulation:

- **User terminal:**
  - Can send/receive a message to/from another terminal via the satellite constellation.
  - Can communicate with a satellite when it is in its reception cone defined by minimal elevation.
  - Has a planning system to know with which satellite and when it will be able to transfer the message.
- **Satellite:**
  - Can get a message from a user terminal to be handled in the constellation
  - Store the message until it reaches a satellite able to distribute it to the targeted receiving terminal or it is able to distribute the message itself
  - Once onboard, the message has a limited lifetime, if it is reached, the message is erased and a failed feedback should be send by the satellite to the terminal
- **Ground station:**
  - Used for synchronization of the network (satellites and terminal).
  - When a satellite is connected to the ground station, the onboard time and the orbital parameters of the satellites are updated.

simulation constraints

- Earth will be modeled as a sphere
- It is necessary to have a clear line of sight between the two elements (satellites, terminal, or ground station) without any obstacles to ensure proper signal transmission.
- An antenna of a user terminal has a minimal elevation to work well (usually 5°, can be modified to stress the simulation).

Figure 2. antenna parameters description



- Altitude and number of satellites can be modified to simulate different constellation scenarios.
- Each message has a specific size, and each satellite has limited onboard storage, which can lead to refusing an uplink from a station if storage is full.