PRESENTATION DOCUMENT

Mission Objectivies

This idea arise from the opportunity to "propose on board experiments to be put on nanosatellites (CubeSat family) orbiting the Earth, released by the International Space Station, or in extraterrestrial planetary orbits".

The aim of the experiment is to provide results useful for the implementation of a direct communication among satellites, without signal transferring through ground stations, using low-consumption technologies.

Our interest lies also in the development of transmission techniques among miniaturized satellites. Such satellites are attractive for universities and small / medium enterprises due to their reduced costs more affordable for the mentioned institutions. Moreover they can be used for different applications, one of the most interesting being the deployment as swarm around a central satellite used as center of the communication network or as hub for communications with other entities (ISS, Big telecom constellations, earth). We believe the results of our experiment could be immediately used for all these applications.

The first step of the experiment shall consists in the verification, through measurements, of the medium-range data transmissions signal quality in space. This parameter is regulated by known formulas whose validity limit shall be verified.

The second step shall consists in the measurement of the signal quality/distance ratio relevant to the transmission of signals in space. Two sub experiments are at the moment under evaluation: use of two different technologies and / or use of two transmission modes (i.e. different modulation techniques, different power levels for signals).

Finally , we know that the radiation present in space interferes both on the hardware and on the transceived signals. Proper shielding techniques shall be also investigated for the proposed experiments.

Experiment description

The hardware shall consist of three boards with CPUs and LoRa communication modules.

The experiment shall consist in the measurement of the signal quality in the bidirectional communication from ISS base station to satellites (case A) and from satellite to satellite (case B).

The measurement will allow to verify the influence of electromagnetic interference on the signal quality in different cases.

Proposed method

The method shall consists in sending data packets and verifying the echo as function of the distance between the stations and baud rate. Then, the resulting Bit Error Rate (BER) shall be measured counting the transmission errors based on the amount of data received.

The main hypothesis is therefore that the satellites are moving and /or can be moved each other. In addition, it must be said that the software installed on the mini-satellite allows a maximum separation distance which is: the maximum distance at which the data packets can be received, or the maximum allowed by the mission constraints (through protocols which we currently do not know).

Scientific/Technological Aspects

The main scientific interest consists in the identification of innovative and relatively low cost solutions, for the communication between different satellites without the use, as is currently the case, of a continuous rebound through the ground station.

The need arises from the growing need for data protection which are extremely vulnerable to intrusion during satellite-to-earth and then earth-to-satellite transfer. Conversely, intercepting data between satellites at altitude, involves the use of technologies that are not easily available. Furthermore, in this case the transmission of data to earth could take place, after the exchange between satellites of the same constellation, through a single channel that is more easily controlled in terms of safety. Finally, the possibility of transmitting sat-sat with the highest quality, can lead to a reduction of the satellite channels to and from the ground, the latter solution particularly attractive for small operators who cannot face the costs of accessing multi-channel satellites with high data-rate.

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On the basis of datasheets available from supplying companies, LoRa technology in ground applications reach a transmission distance of 20 km in specific conditions. With a first experiment we have reached only 500 m, in presence of various obstacles. It can be assumed that the absence of obstacles in space may favor the expansion of this transmission range, although there may be a significant interference due to Electromagnetic Field and other types of radiations.

Unlike what already developed and experimented on ground, the new LoRa modules developed for this space experiment, should contain CPU and other components specifically developed for the space industry. Such components are immune to the EM fields and have a high degree of radiation tolerance. In this regard, beyond the solutions we are investigating at the moment, worth to be mentioned that Microchip recently announced the industry's first space-qualified Ethernet transceiver - a radiation-resistant device based on a Commercial Off-the-Shelf (COTS) solution that offers reliable performance for applications ranging from launch systems to satellite constellations and space stations.

As far as concerns the implementation on the ISS, particular attention shall be put in avoiding interferences with the other circuits on board of the space station.

As for the protocols, we will certainly make available redundancy coding techniques for error correction. If the use of these techniques were to be decisive or relevant for the effectiveness of the transmissions, custom chips suitable for the purpose could be developed, perhaps by ourselves in the future, gained some experience with our start-up.

Finally, as for the power consumption, we expect to remain within the standards thanks to Low Power devices and to the absence of actuators in our experiment.

Mechanical configuration does not have any impact on the deployment due to the small dimensions of the antenna (only few cm) and its development along a single axis.

Other satellite equipment necessary for this experiment are relevant to :

- The energy endowments

- Heaters for low temperatures (cold start of the satellite)
- Aa small electric propulsion system for reorientation (attitude control) , even very slow

Conclusions

As mentioned, the proposed experiment aims at verifying the actual reachable communication distance between min-satellites orbiting the earth, so to implement an inter-satellite connection system consisting of a reduced number of LoRa repeaters.

The expectation consist in an effective transmission using low cost modules. This will allow small operators, small enterprises and universities to access experiment in space at an affordable cost.

The success of the proposed experiments would open the way to the development of low cost transmission modules for short / long term scenario.