Satellite Communication Laboratory

Possible project for winter term 2018/2019

3. Implementation of a software satellite communication channel simulator

Problem description:

When developing and building satellite communication systems it is very important to thoroughly test the whole communication system before launch as any unnoticed issue might lead to a lack of communication with the system and thus failure of the entire mission.

The main challenges a satellite communication system has to overcome are attenuation, noise, delay and Doppler shift.

Due to the vast distances between the transmitter and receiver in satellite communication the signal will travel a very long distance. Together with only a coarse knowledge of the exact satellite position this leads to a long, but unknown delay of the signal. In addition, due to the free space loss, the signal will be received with very strong attenuation. In order to detect and sample the signal it needs to be amplified in the receiver which will add thermal noise onto the signal, leading to a decreased signal to noise ratio.

In order to improve the signal to noise ratio in the receiver, only the spectrum close to the central frequency of the signal is collected. Spectral bands further away from the central frequency are blocked by a band pass filter to suppress the noise energy present in these bands. However, due to relative movement between the satellite and the ground station the received central frequency may differ significantly from the central frequency transmitted by the satellite. This will lead to an attenuation of the actual signal by the filter if the system is not designed well.

Having an easy method to simulate these impairments -especially in a realistic joint simulation- will greatly simplify the development and testing of future satellite communication systems.

Your task in the SatComLab:

Within this lab course a GNURadio block shall be developed that will simulate the satellite communication channel effects mentioned above based on a coarse satellite orbit description. This includes the computation of the magnitude of these effects based on the given satellite orbit and the simulation of the effects based on clean input samples.

Expected results:

By the end of the lab a working implementation of the channel simulator is expected to be integrated into our existing receiver software. The source code of the implementation shall be according to the GNURadio programming baselines, well documented and inserted into our software version control system. The correct functionality of your implementation is demonstrated by meaningful tests and their results are documented in the final report.

Requirements:

- Good knowledge of signal processing
- Satellite orbits
- Experience in C++ and python programming or comparable languages (The signal processing has to be programmed in C++ and the unit tests will be written in python, however neither tasks requires specific knowledge about these specific two programming languages)

Topics discussed during this lab:

- Channel simulation
- Orbit propagation
- Doppler shift
- Software defined radios, USRP & GNURadio
- Testing with a real satellite