ETH

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High-Precision Timestamp Estimation from Satellite Communication Signals

Master thesis proposal (external thesis in collaboration with armasuisse)

Orbits in space have become much more crowded over recent years. Satellites have to avoid collisions with other satellites and space debris. For this, satellite operators rely on data sets from official sources as the ESA or the US Air Force's space surveillance network [1]. Verifying these data sets independently is often not possible due to the expensive equipment required.

In order to use well-known independent localization algorithms on such space communication, precise time stamps are required. Precise Time-of-Arrival (TOA) estimates of communication signals have been used in other domains, specifically in relation to aircraft and drones, for a wide set of applications including aircraft/drone tracking, air traffic data verification, or self-localization [2].

Your focus in this work is on building a TOA estimation system that can run on low-cost software-defined radio (SDR) receivers. The student will build on typical SDR hardware in conjunction with Raspberry Pi computers in order to create a cheap receiver that can tune into satellite streams in order to demodulate them and measure precise signal timestamps in analogy to existing work in the aviation domain [3].

Requirements

- Low-level knowledge of software-defined radio hard- and software (e.g., GNU Radio).

- Working understanding of radio frequency communication and necessary physical-layer concepts such as demodulation.

- Programming knowledge in languages necessary also on a lower level (e.g., C)

References

[1] The Cyber-ASAT: On the Impact of Cyber Weapons in Outer Space
James Pavur and Ivan Martinovic
In 11th International Conference on Cyber Conflict (CyCon), Tallinn, 2019.

[2] Nanosecond-precision Time-of-Arrival Estimation for Aircraft Signals with low-cost SDR Receivers
Roberto Calvo-Palomino, Fabio Ricciato, Blaz Repas, Domenico Giustiniano and Vincent Lenders. In ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN), Porto, Portugal, April 2018.

[3] dump1090-hptoa
Github: https://github.com/openskynetwork/dump1090-hptoa

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