



High Throughput APSK demodulator on GPU for Satellite SDR Modem Application

About Celestia Antwerp

Celestia Antwerp is a leading company in Belgium, active in the field of satellite ground communication technology. It is part of the Celestia Technologies Group.

Celestia Antwerp's core business is in the delivery of satellite communication solutions for the ground segment extension with products and systems. Celestia Antwerp operates both on the commercial and institutional markets, supporting space agency programs, as well as industrial company projects worldwide. The company activities have been located in Antwerp since 1962, when it was founded as part of Bell Telephone.

Type and Description:

Type: Master Thesis

Abstract : The need for very high-speed transceivers keeps on growing in the satellite market which relates to science missions and earth observation. This is induced by the technology improvements done the past decade on high-resolution offered by the satellite payload observation instrument. The Ka-band is the band of choice for high speed Near Earth observation missions. As the Ka-band suffers more from attenuation due to precipitation and other meteorologic events, the need for an Adaptive Coding and Modulation (ACM) mechanism has also been identified. CCSDS (Consultative Committee for Space Data Systems) has addressed this market demand through the definition of a new standard, namely "Flexible and advanced coding and modulation scheme for high rate telemetry applications" ([CCSDS 131.2-B-2](#)). Today, the industry has implemented this standard with equipment based on Field Programmable Gates Array (FPGA). However, nowadays, Graphics Processing Units (GPU) are offering excellent throughput performance on vectorized mathematic operations through a high degree of parallel computations. Hence, the scope of this project will focus on the modulation subsystem of this new standard and develop a high-throughput APSK demodulator prototype, taking benefits of GPU processing power.

Activities The candidate will go through the following activities

- Study & Analysis :
 - Analysis & understanding of CCSDS (131.2-B-2) physical layer framing, baseband filtering, frame synchronization, pseudo-randomizer.

- State of the art analysis of APSK demodulator implementation
- Selection of target GPU with justification.
- Architectural Design :
 - GPU APSK demodulator architectural design including resampling, baseband filtering, carrier acquisition & tracking, frame synchronization, PL pseudo-randomizing, PL deframing.
 - Design trade-offs and rationale discussion.
- Software Development :
 - GPU implementation (Cuda or OpenCL) of the APSK demodulator.
 - Unit tests.
 - Code optimization.
 - Test-bed development (enabling encoder to decoder testing).
- Final Verification :
 - Performance characterization (BER, max throughput, Latency).
 - Functional verification.
- Project Closure :
 - Suggestion for further improvements.
 - Redaction & presentation of the final report.

Research Objective and Deliverables:

Objective: The research objective of this thesis consists the realization of a software defined APSK demodulator prototype following CCSDS 131.2-B-2 standard (released February 2023). The technical challenges of parallel processing for demodulation algorithms in software will be elaborated. He/She shall finish this activity with a presentation to a mixed audience of academical & industrial experts.

Expected deliverables: The following deliverables are expected:

- Documentation shall include state of the art analysis, software design architecture, test-bed user manual, final test results, final report.
- APSK demodulator (source code (commented)).
- Test-bench (executables, source code).
- Final Presentation.

Timetable:

Milestones: Indicative schedule proposal (to be agreed)

- By end of Oct 2024 : Study & Analysis.
- By end of Dec-2024 : Architectural Design.
- By end of April-2025 : Software Development
- By end of May-2025 : Final Verification.
- By end of June-2025: Project closure.

Evaluation Criteria:

Evaluation Criteria The following will be taken into account for the final evaluation.

- Demonstrated technical skills.
- Timeline of deliverables vs agreed plan.
- Quality of deliverable.
- Level of autonomy shown by the candidate.
- Motivation and initiatives taken.

Location

Roderveldlaan 1 (bus 3) – 2600 Berchem - Belgium

More Information about Celestia and other potential internship or open vacancies:

<https://www.celestia-antwerp.be/>

Contact information

Would you be interested in this internship or would you like to get more information about this internship, please take contact with hr@celestia-antwerp.be.