High Throughput Serial Concatenated Convolutional Code (SCCC) 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 error correction codes are widely used in digital communication systems to correct the transmission errors. The space industry, following CCSDS & ECSS standard recommendations, makes use of the SCCC (Serial Concatenated Convolutional code) en/decoding scheme to improve robustness against errors in some specific high-throughput mission scenarios (e.g. Earth Observations). Typically, this algorithm is mostly implemented with Field Programmable Gates Array (FPGA) for very high-speed transceivers. 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 is to develop and characterize a high-throughput SCCC codec (Coder / Decoder) prototype, taking benefits of GPU processing power.

Activities   The candidate will go through the following activities

- Study & Analysis :
  - Analysis & understanding of CCSDS SCCC Scheme (131.2-B-2).
  - State of the art analysis of SCCC implementation.
  - Selection of target GPU with justification.
- Architectural Design :
  - GPU codec Software architectural design.
  - Design trade-offs and rationale discussion.
- Software Development :

- GPU implementation (Cuda or OpenCL) of the SCCC codec.
    - 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 in the software development and its characterization of a SCCC codec prototype running on a GPU and following CCSDS 131.2-B-2 standard (released February 2023). 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.
- SCCC codec (executables and source code (commented)).
- Testing tools (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.