AFF3CT: A Fast Forward Error Correction Toolbox

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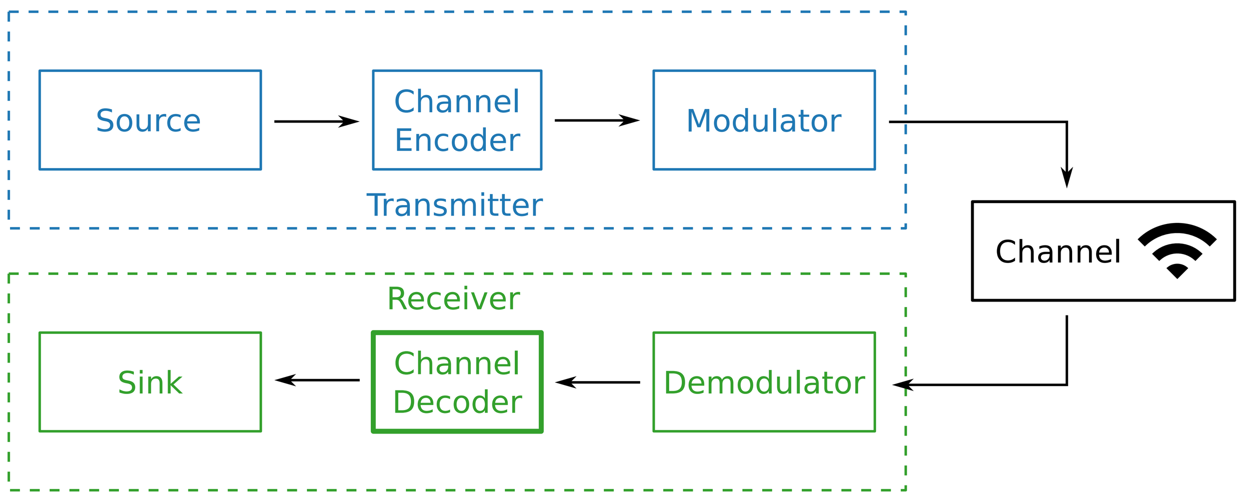
CONTEXT

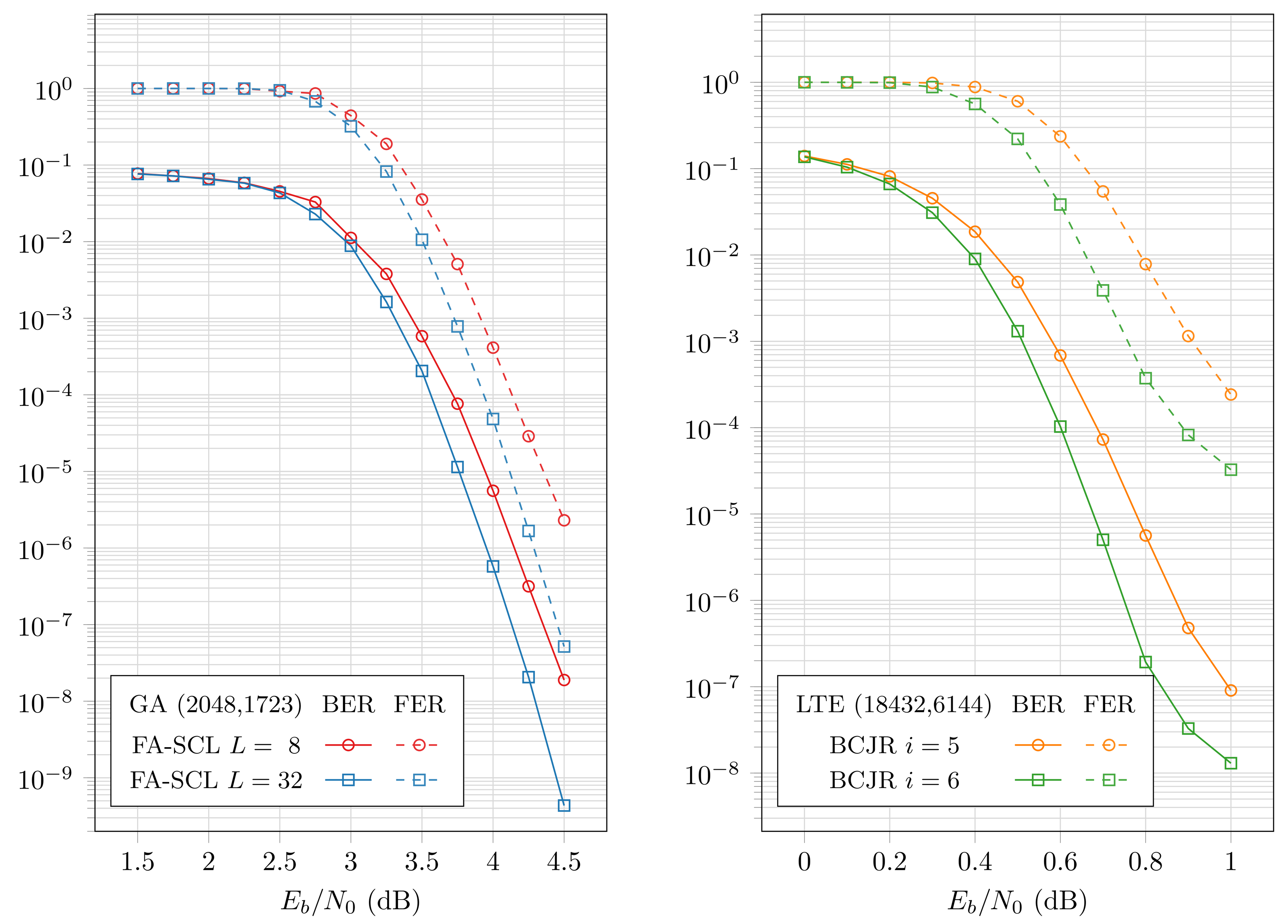


- Simulation of digital communications (5G, Wi-Fi, DVB-RCS, etc.)
  - Monte Carlo method: embarrassingly parallel problem
- Toolbox for Forward Error Correction (FEC) class of algorithms

MOTIVATIONS

1. **High throughput simulations**: optimized and parallel `C++` source code (SIMD, multi-threading, multi-node)
2. **Algorithmic heterogeneity**: codecs (polar, LDPC, turbo, BCH, RS, etc.), modems (PSK, QAM, CPM, SCMA, etc.), channels
3. **Reproducible science**: state-of-the-art simulation results, portable (Windows, macOS, Linux), open source (MIT license)

ALGORITHMIC HETEROGENEITY

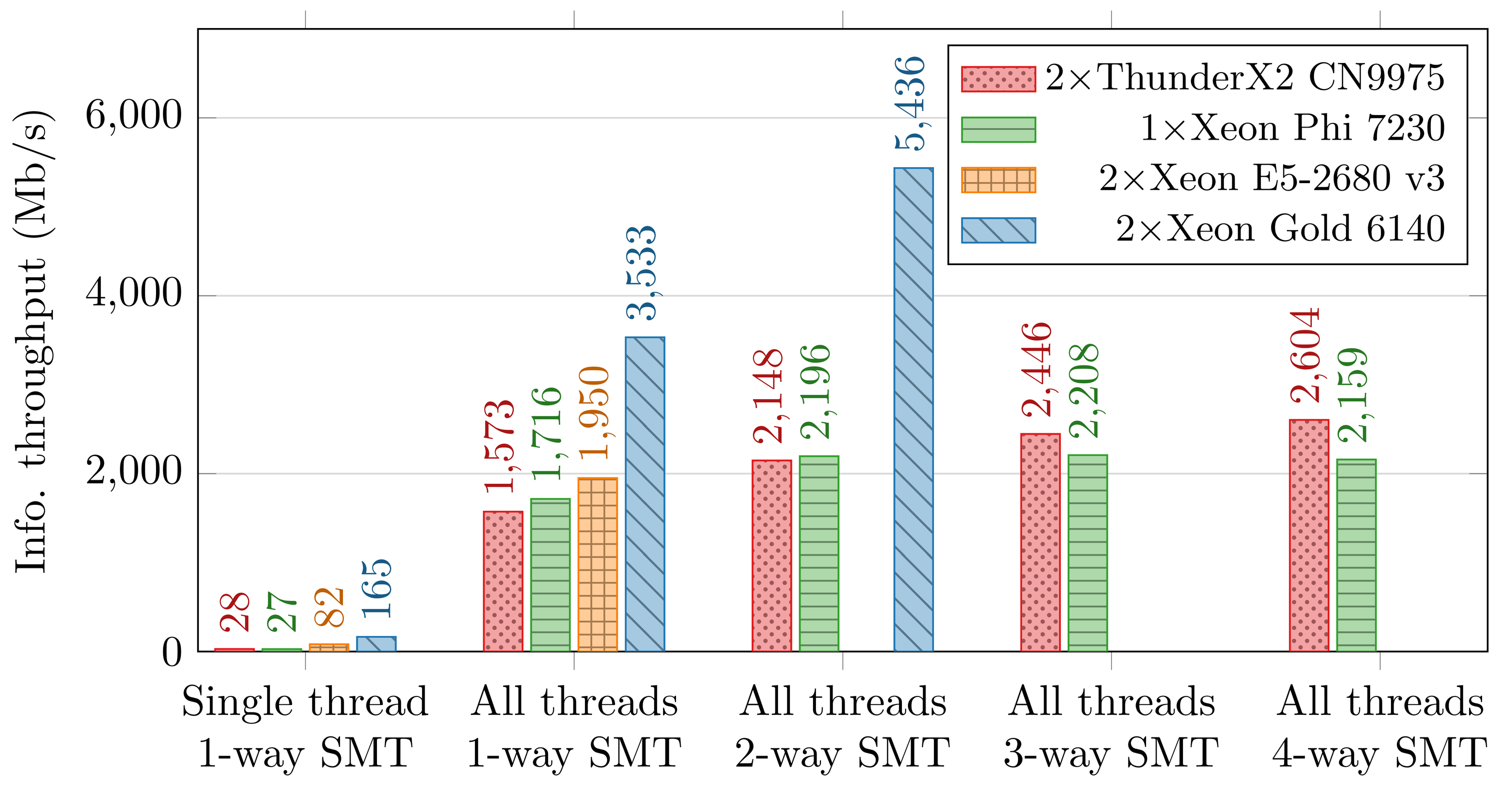


(a) : Polar code. (b) : Turbo code.

Bit/frame error rate decoding performances of polar [1] and turbo [2] codes depending on the Signal-to-Noise Ratio (SNR), lower is better.

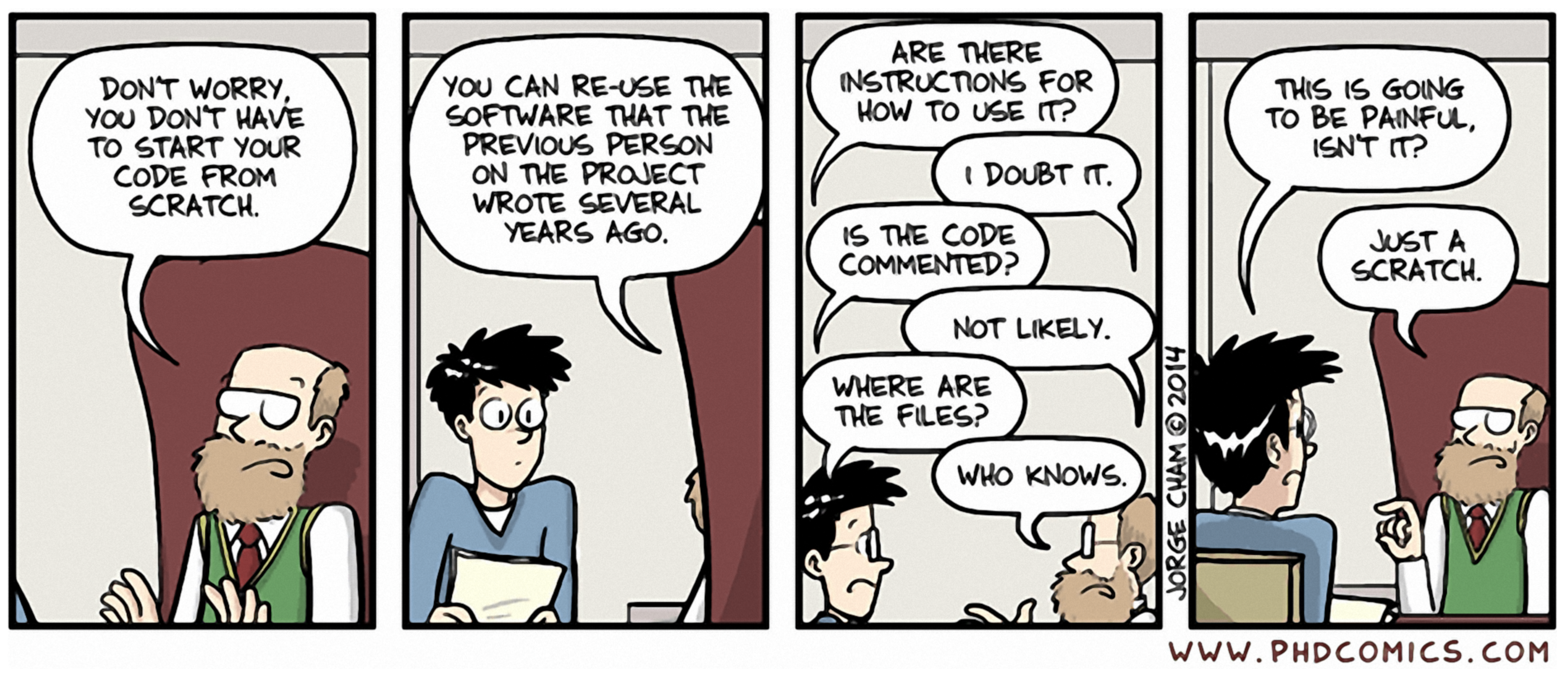
- **Many parameters can be evaluated** to explore new trade-offs

HIGH THROUGHPUT SIMULATIONS



A (2048,1723) **polar code is simulated** with a BPSK modem and over an AWGN channel (FA-SCL decoder, $L = 32$, BER @ 4.34e-10 [1]).

REPRODUCIBLE SCIENCE



- **Documentation** available online (installation + simulator usage)
- Come with a bank of **pre-simulated state-of-the-art references**
- Code validated over a complete **continuous integration** pipeline

RESEARCH RESULTS

- Generate **unrolled and highly optimized source code for polar decoders** targeting software-defined radio [3]
- **Adapt various channel decoding algorithms** for x86 targets and embedded low power ARM CPUs [2, 4, 5, 1]
- Propose an open source **portable wrapper for SIMD/vector instructions** (SSE, AVX, AVX-512 and NEON) [6]

CONTACT

COMMUNITY & COLLABORATIONS

open source initiative®

- Collaboration between Inria and IMS labs
- External academic contributors
- Industrial users and collaborators
  - Airbus
  - Schlumberger
  - TurboConcept
  - Thales
  - Huawei
  - Orange Labs
- FEC software decoders Hall of Fame (polar, LDPC and turbo)
- Source code on GitHub: `https://github.com/aff3ct`

REFERENCES

[1] M. Léonardon, A. Cassagne, C. Leroux, C. Jégo, L-P. Hamelin, and Y. Savaria. Fast and flexible software polar list decoders. *Springer JSPS*, January 2019.

[2] A. Cassagne, T. Tonnellier, C. Leroux, B. Le Gal, O. Aumage, and D. Barthou. Beyond Gbps turbo decoder on multi-core CPUs. In *ISTC*. IEEE, September 2016.

[3] A. Cassagne, B. Le Gal, C. Leroux, O. Aumage, and D. Barthou. An efficient, portable and generic library for successive cancellation decoding of polar codes. In *LCPC*. Springer, September 2015.

[4] A. Cassagne et al. Energy consumption analysis of software polar decoders on low power processors. In *EUSIPCO*. IEEE, August 2016.

[5] A. Ghaffari, M. Léonardon, A. Cassagne, C. Leroux, and Y. Savaria. Toward high performance implementation of 5G SCMA algorithms. *IEEE Access*, January 2019.

[6] A. Cassagne, O. Aumage, D. Barthou, C. Leroux, and C. Jégo. MIPP: A portable C++ SIMD wrapper and its use for error correction coding in 5G standard. In *WPMVP*. ACM, February 2018.