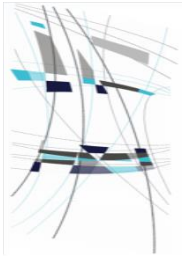
palmyre

Demonstration: Emulation environment of a DVB–S2 decoder

CNRS, UMR 6285, Lab-STICC
Centre de Recherche - BP 92116
F-56321 Lorient Cedex - FRANCE



MOTIVATION

- "Interaction Algorithm Architecture" team of Lab-STICC/pole CACS, develops jointly algorithm and associated architecture to optimize overall cost.
- For the physical layer, the quality is measured in term of Bit Error Rate (BER) and the complexity in terms of area, time to design and power dissipation.
- Optimization is a very complex task since:
  - Many parameters to optimize;
  - Evaluation of performance requires heavy Monte-Carlo simulations, for example, determining at which level of signal to noise ratio a LDPC decoder architecture is compliant with the DVB-S2 standard requires the simulation of more than 10 000 000 000 000 bits !

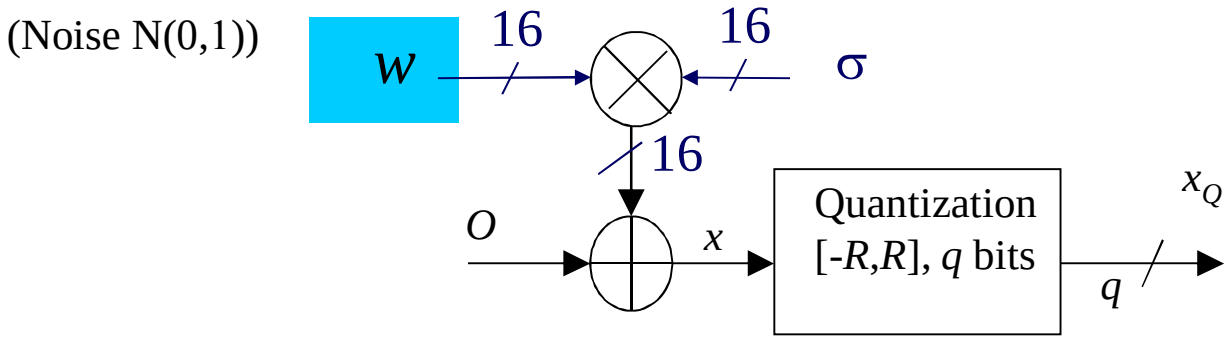
Solution developed in the Frame of PALMYRE II

- In order to reduce Monte-Carlo simulation, we can:
  - Exploit also the soft information of a Monte-Carlo simulation [1]
  - Reduce the number of Monte-Carlo simulation to be run [2]
  - Speed up the Monte-Carlo simulation, replacing CPU based simulation by FPGA based emulation.
- The last item required to emulate also the channel: Hardware Discrete Channel Emulator [3].

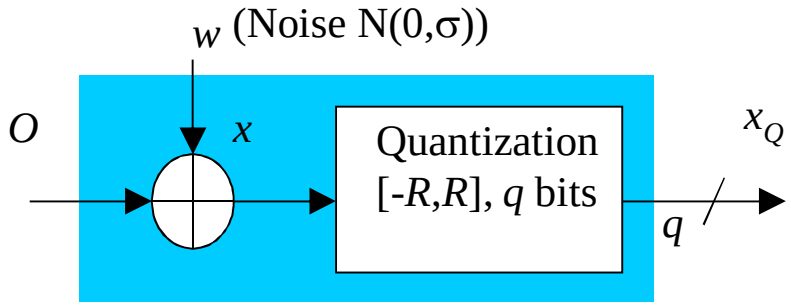
- [1] A. Singh, A. Al-Ghouwayel1, G. Masera, E. Boutillon, " A New Performance Evaluation Metric for Sub-Optimal Iterative Decoders", IEEE Communications letters, vol. 13, n°7, pp. 513-515, July 2009.
- [2] E. Boutillon, C. Douillard, G. Montorsi, " Iterative Decoding of Concatenated Convolutional Codes: Implementation Issues", Transactions of the IEEE, vol. 95, n°6, june 2007.
- [3] E. Boutillon, Y. Tang, C. Marchand, P. Bomel, "Hardware Discrete Channel Emulator", The 2010 International Conference on High Performance Computing & Simulation (HPCS 2010), pp 452-458, Caen, June 2010..

New idea

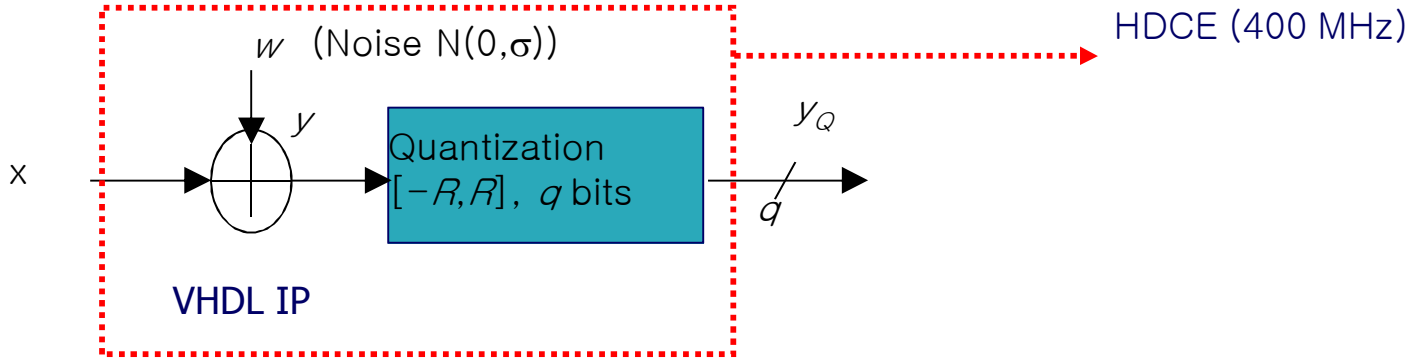
- Straigth method: Direct emulation of the AWGN channel.

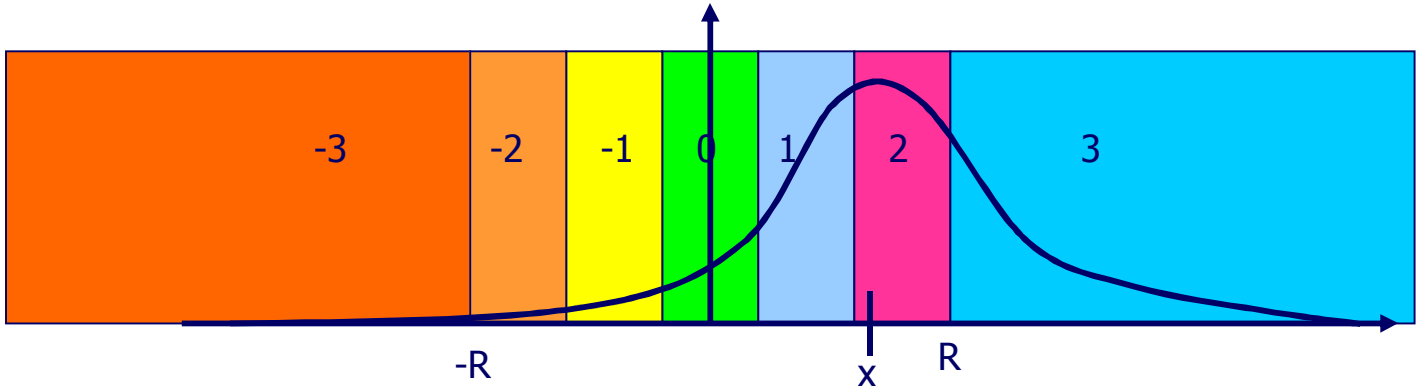


- New method: emulate channel + quantization.



DISCRETE HARDWARE CHANNEL EMULATOR

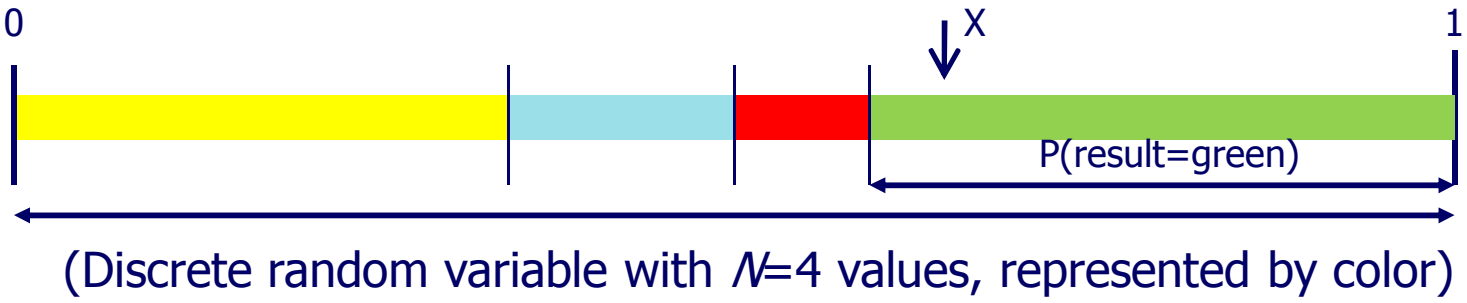




- **FOR A GIVEN *x*, σ and *R*, y_Q is EQUIVALENT TO A DISCRETE R.V.**

Principle of generation of a discrete random variable.

- 1D method
  - Draw a random number between [0,1] and see where it falls

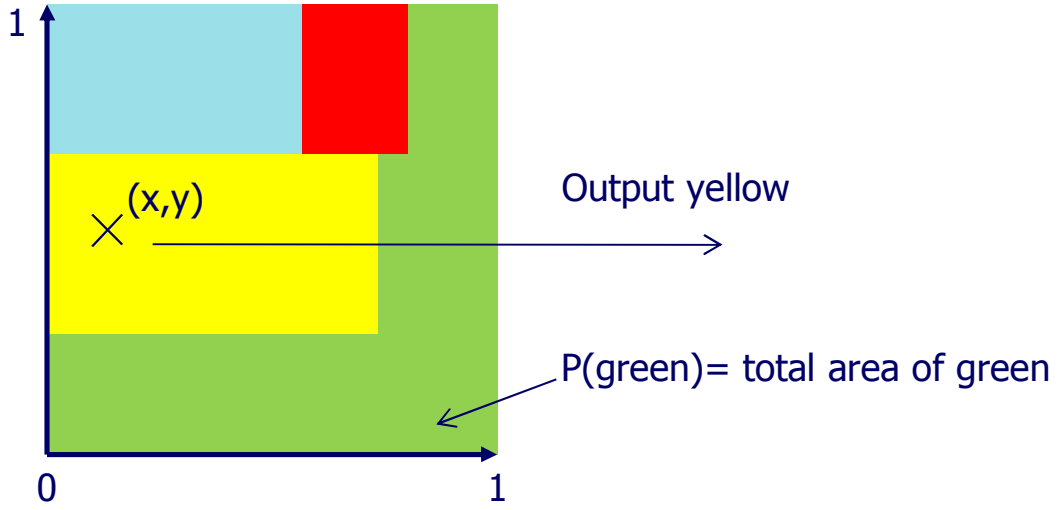


- Complex to implement: the value x needs to be compared to all the thresholds (*N*-1 comparizons).

- Solution : go toward 2D.

Principle of generation of a discrite random variable.

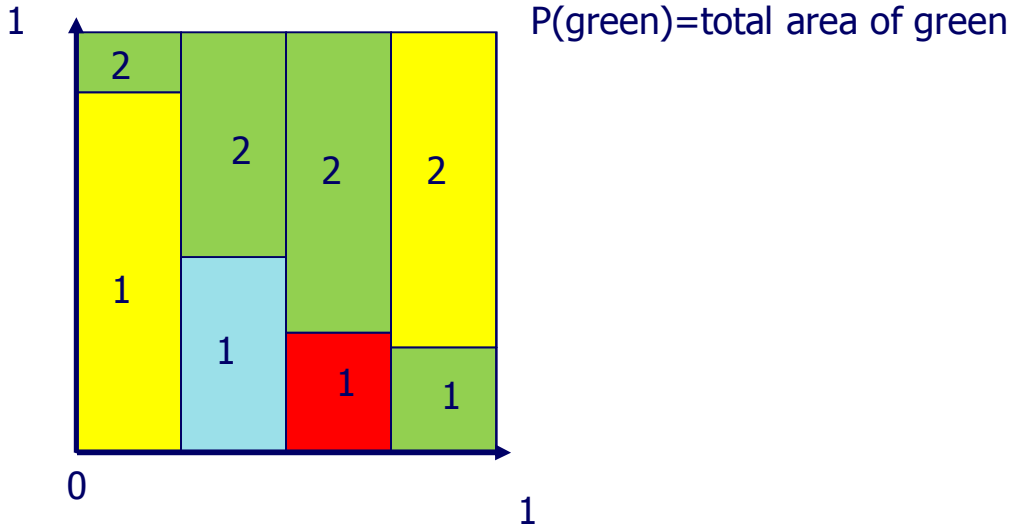
- 2D method
  - Principle: generate two random variables x,y between [0,1] and see where they fall.



  - No simplification => need a structure.

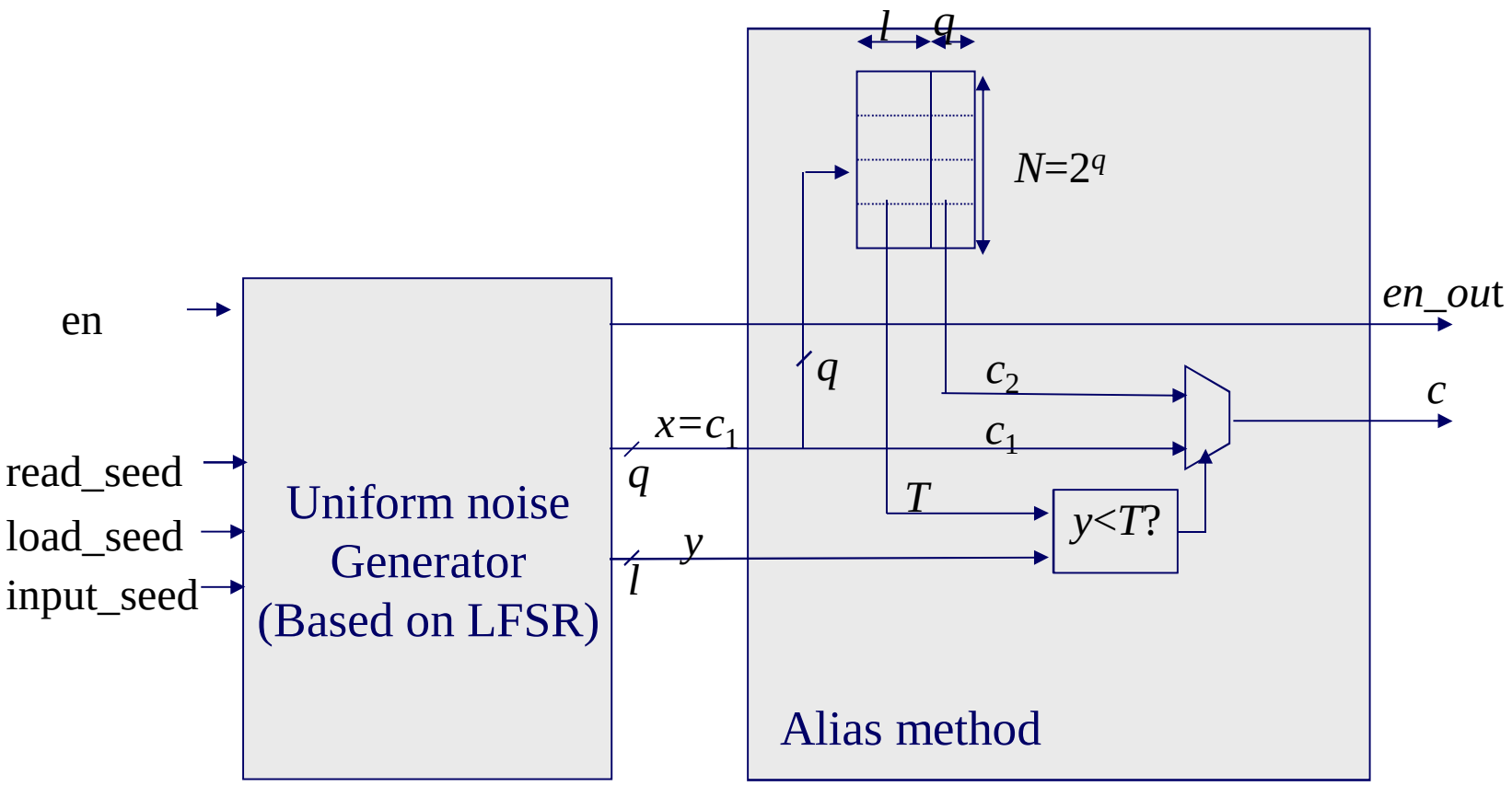
Principe of generation of a discrite random variable.

- 2D method: with x, select a column, with y, select color 1 or 2 in the column.

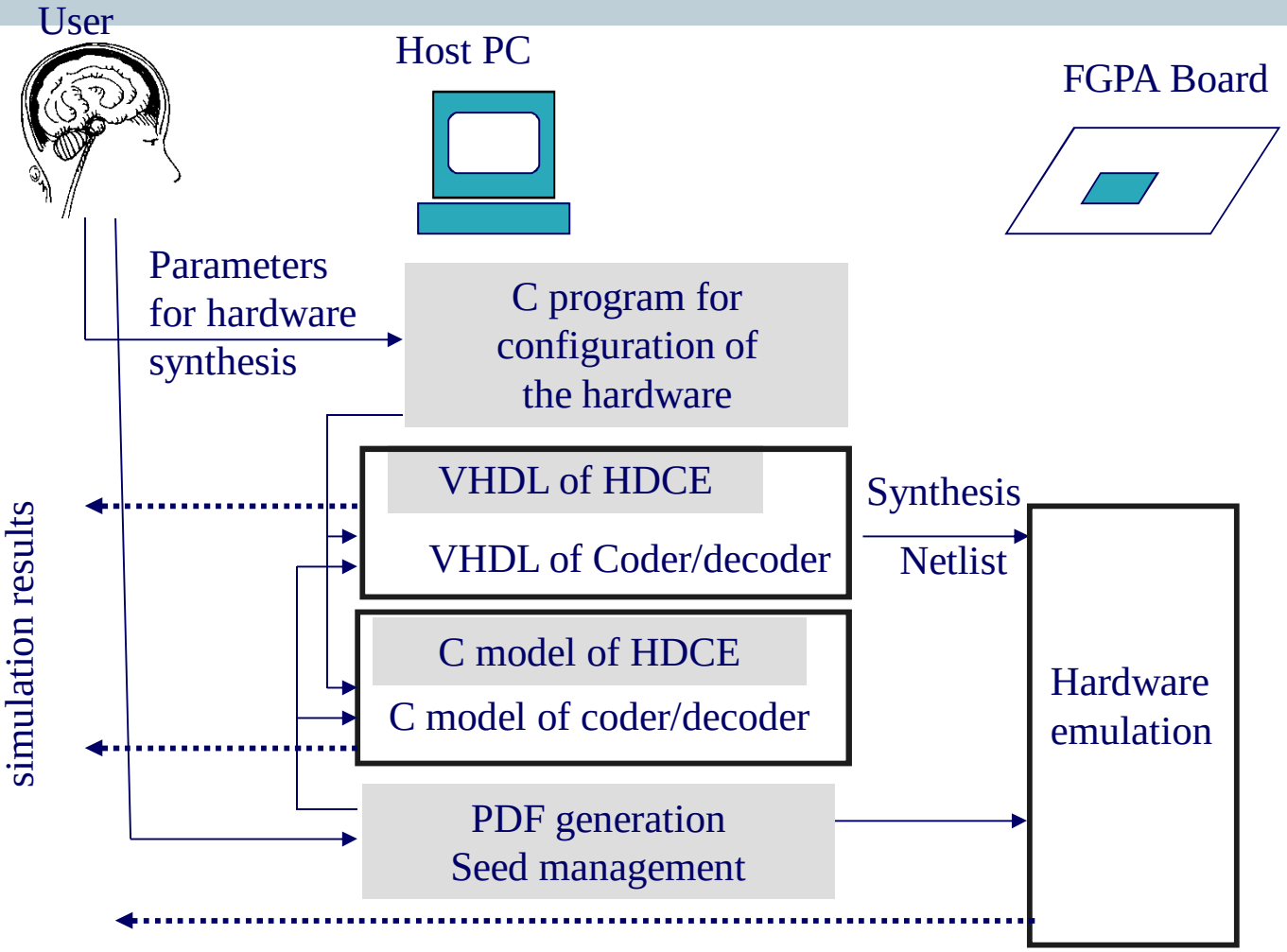


  - X: random number between 1 to N to select color 1 (c_1), then, read color 2 (c_2) and the threshold T in a memory and compare y to T to select c_1 or c_2.

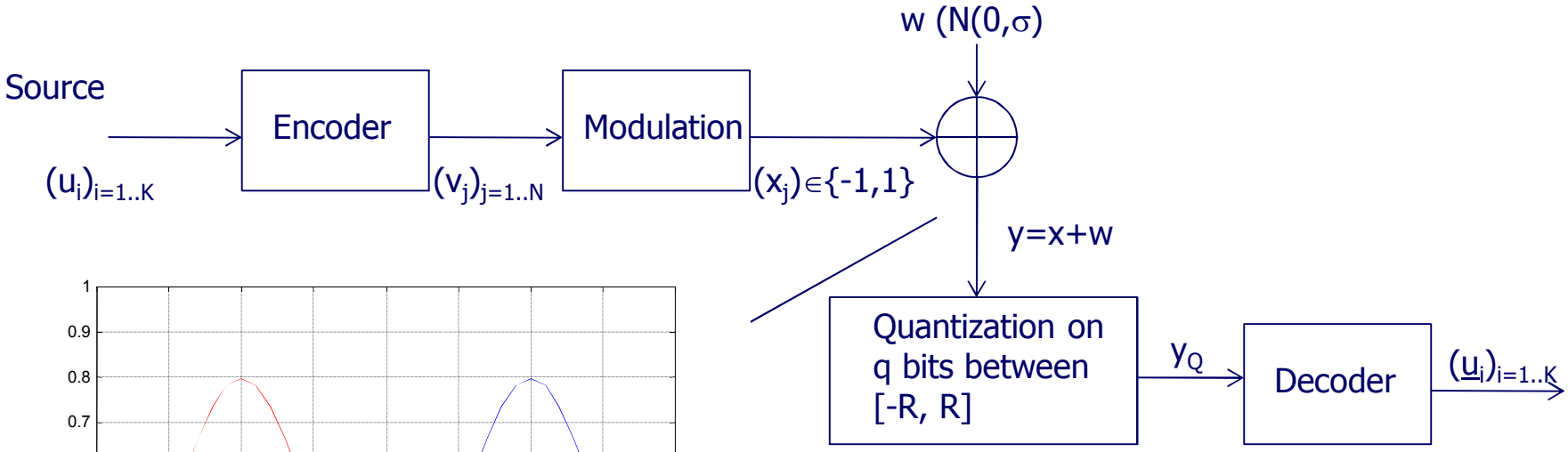
Hardware Discrete Channel Emulator.

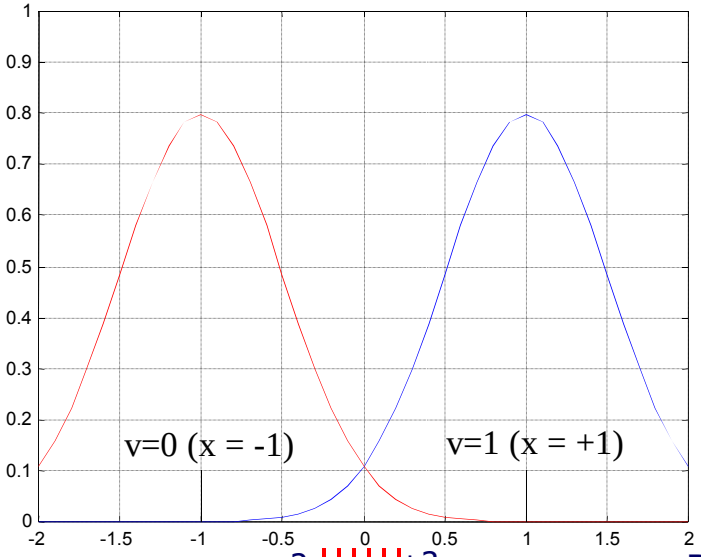


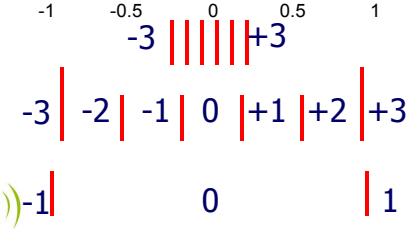
Coherent set of simulation/emulation



Application: range of quantization for a LDPC (DVB-S2) decoder







- Optimal value of R ?

R=0.25 => Saturates most of the time ⇔ hard decision

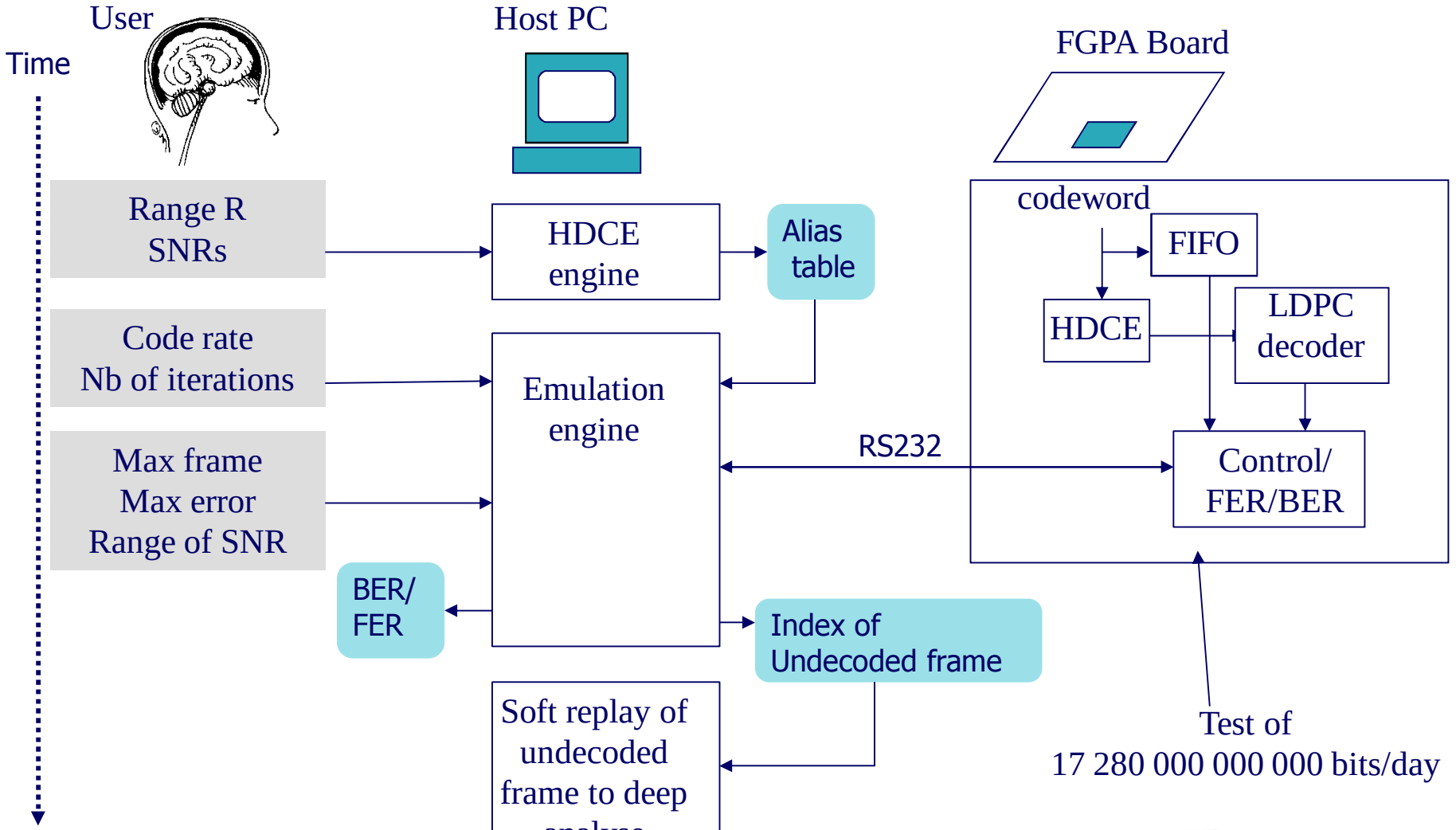
R=0.9 => Better match

R=5 => To much erasure...

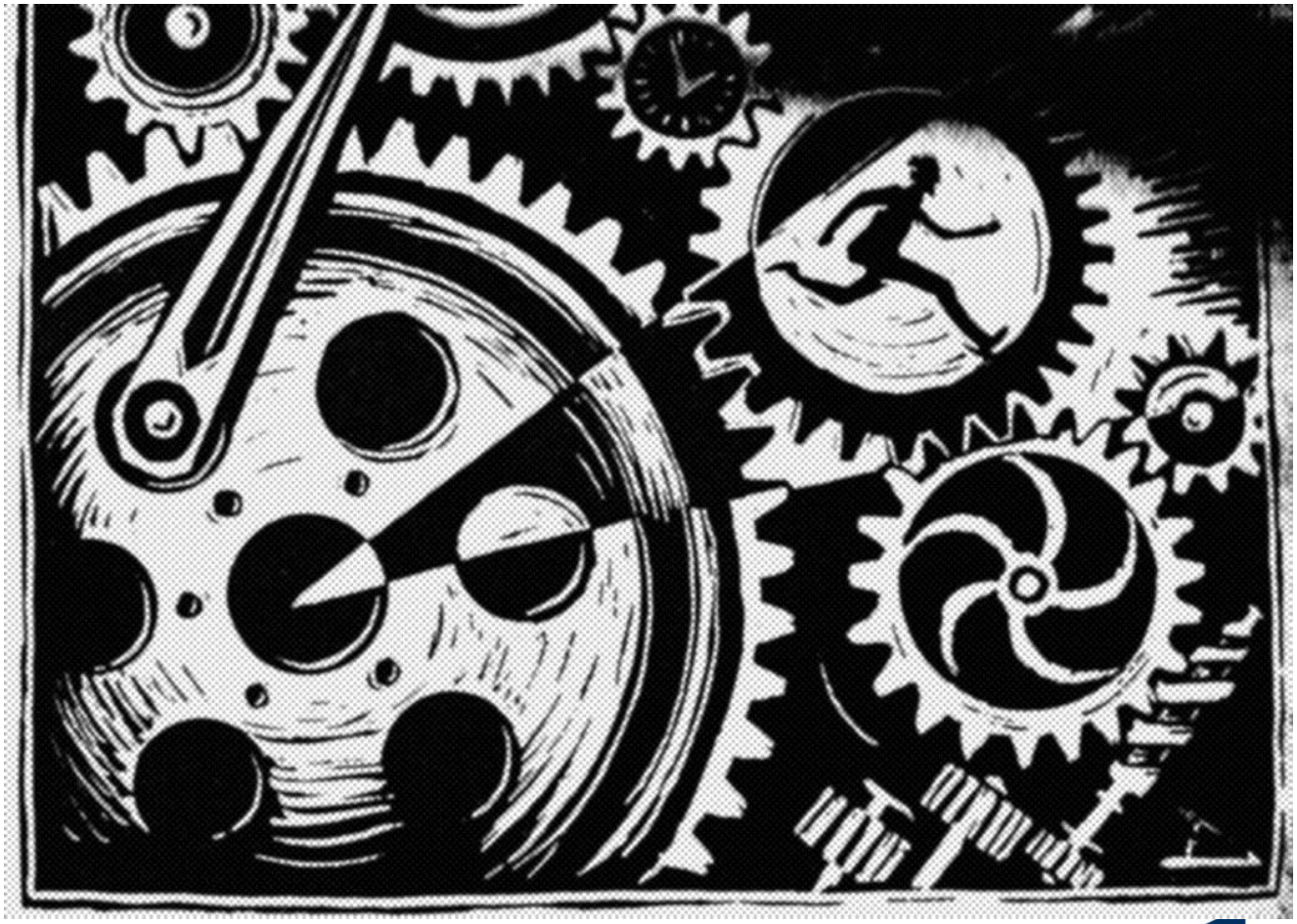
LDPC decoder

- June 2011-March 2012: Design of a DVB-S2 LDPC decoder for a Korean company (Private contract).
- Innovation: using “vertical scheduling” instead of “horizontal scheduling”.
- Size: 64 800 bits, rate ½ and 2/3 (proof of concept).
- Decoding throughput: 200 Mbit/s (information bit) with 36 decoding iterations on a Xilinx Virtex 5.

Scenario of emulation.



Demonstration…

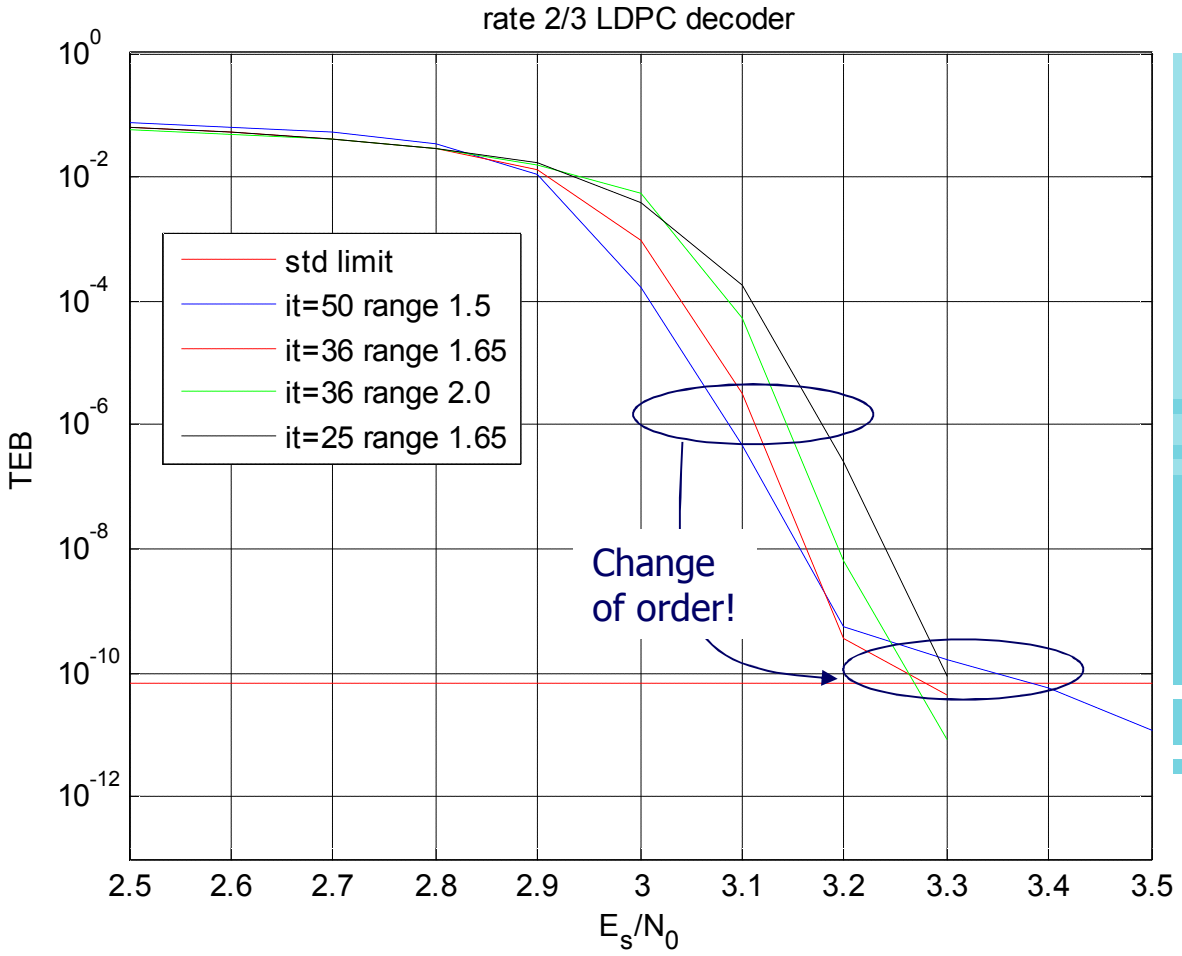


palmyre

Lab-STICC

cnrs

After few days of simulations…



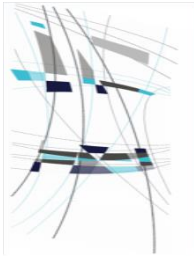
Range of BER that can be obtained by simulation in a reasonnable time

Range of BER that can be obtained by hard emulation in a reasonnable time

palmyre

Lab-STICC

cnrs



Conclusion

- Methods to optimized error control code architecture using both simulation and emulation.
- So far, methods applied for:
  - NXP (CIFRE): LDPC DVB-S2 (schedul. horizontal).
  - Orange Labs (private contract): Code cortex
  - ETRI (Private contract): LDPC DVB-S2 (schedul. Vertical)
  - DaVinci (FP7): LDPC Non Binaire.