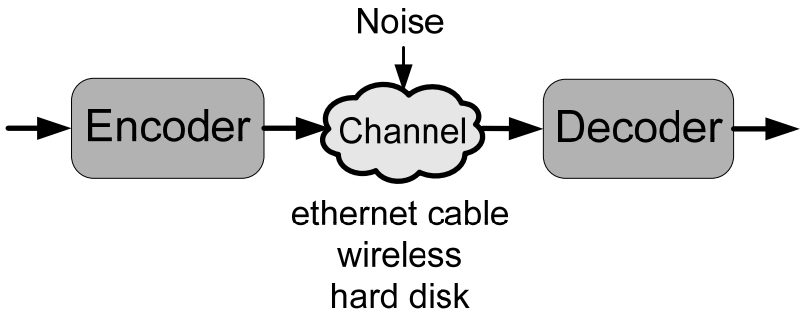
An 18 Gbps 2048-bit 10GBASE-T Ethernet LDPC Decoder

- Tinoosh Mohsenin
- Electrical & Computer Engineering, UC Davis
- tmohsenin@ucdavis.edu

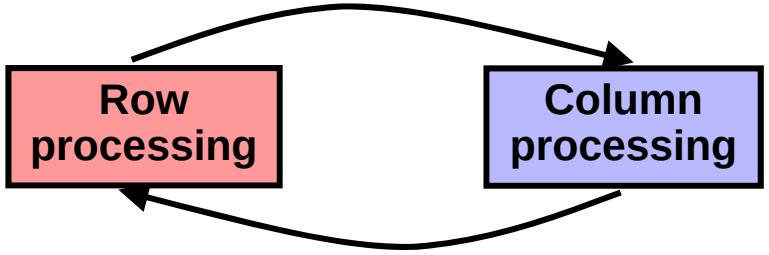
- PhD, graduation date: 2008
- Adviser: Professor Bevan Baas
- Research areas
  - Energy efficient and high performance signal processing and error correction architectures
  - Multi-gigabit full-parallel LDPC decoders
  - Many-core processor architecture design

- UC Davis
- BS from Sharif University
- MS from Rice University

Research Overview



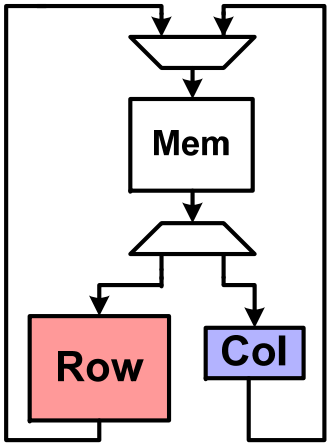
$$H=\begin{bmatrix} 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

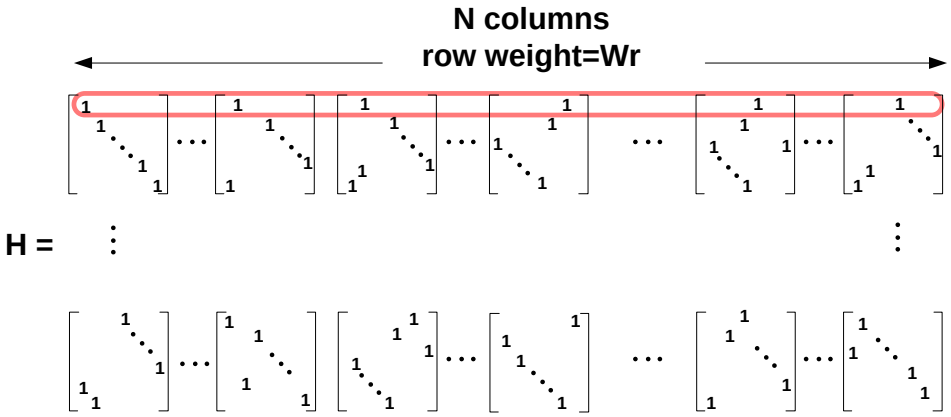


- Low Density Parity Check (LDPC) decoders
  - Algorithms
  - Architecture
  - High energy efficiency
  - High throughput
- LDPC codes applications
  - 10 Gigabit Ethernet (10GBASE-T)
  - WiMAX
  - Digital Video Broadcasting (DVB-S2)
- T. Mohsenin et al., *ICCD*, Oct 2006
- T. Mohsenin et al., *ICASSP*, Apr 2007
- A. Blanksby et al., *JSSC*, Mar 2002

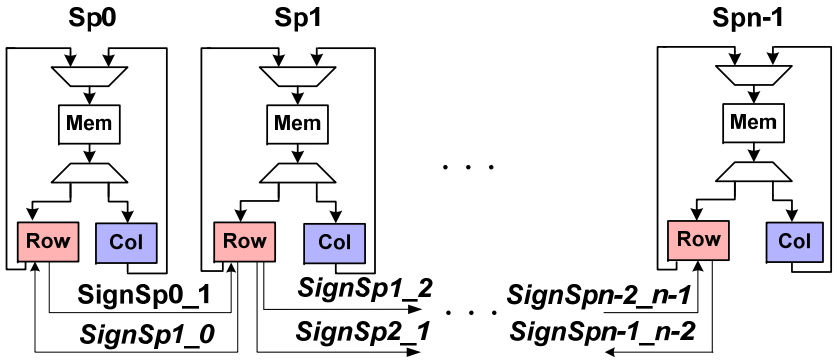
Multi-Split-Row vs. Standard Decoder

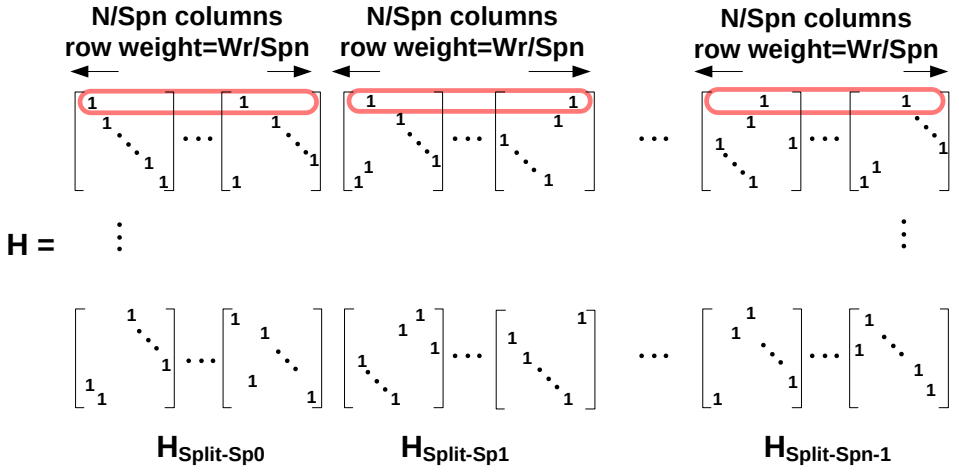
Standard decoder



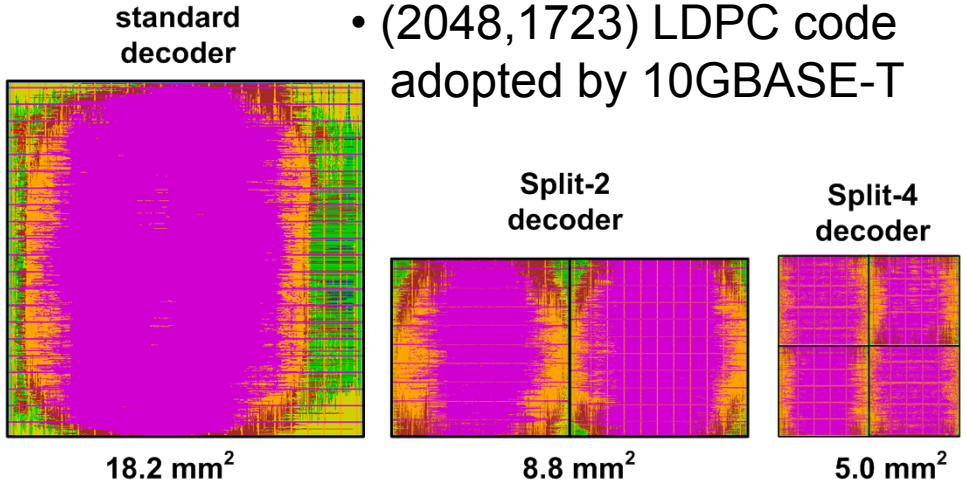


Multi-Split-Row decoder

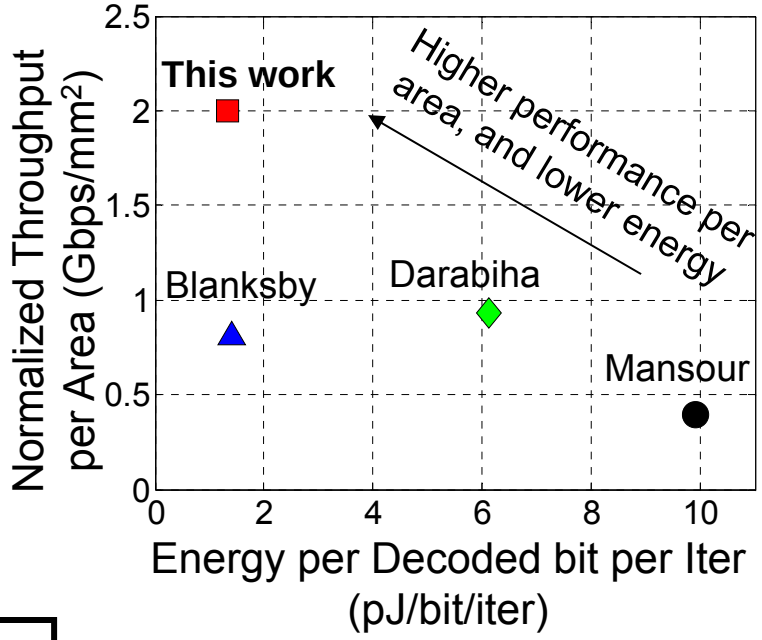




Decoder Implementation Results



- (2048,1723) LDPC code adopted by 10GBASE-T



10GBASE-T Code 65 nm, 1.3 V	Standard	Split-2	Split-4	Split-4 Improve.
Area Utilization	25%	50%	90%	3.6x
Avg. Wire length (μm)	175.2	115.5	73.8	2.4x
Speed (MHz)	12.5	45	**133**	**10.6x**
Throughput (Gbps)	1.7	6.1	**18.2**	**10.6x**
Energy per bit (pJ/bit)	141	79	**46**	**3.1x**

In the plot:

- 65 nm, 0.85 V
- Throughput normalized to 15 iterations
- Area: quadratically scaled with feature size, adjusted with row and column weights
- Speed: linearly scaled with feature size
- Energy: linearly scaled with feature size, quadratically scaled with voltage

[1] A. Blanksby et al., *JSSC*, Mar 2002
[2] M. Mansour et al., *JSSC*, Mar 2006
[3] A. Darabiha et al., *CICC*, Sep 2007