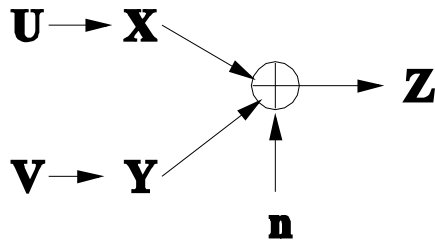

Correlated Sources over Gaussian Multiple Access Channels: Blind Cooperative Source Channel Coding

Arul D. Murugan and Hesham El Gamal

Gaussian Multiple Access Channel with Correlated Sources

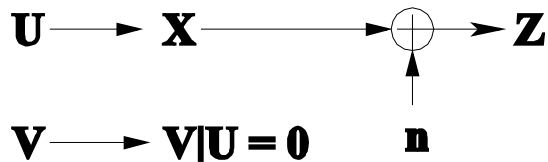


- U and V correlated sources.
- Encoder for U receives only U and not V , and vice versa

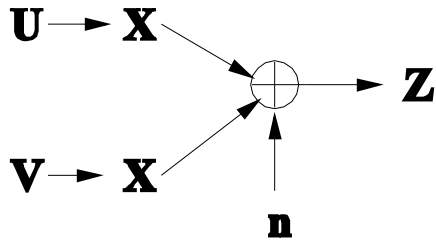
- **AWGN channel:**
 - *Capacity*: Known.
 - Capacity achieving codes (Irregular LDPC codes).
- **GMAC with independent sources:**
 - *Capacity region*: Known.
 - Capacity achieving codes available.
- **GMAC with correlated sources:**
 - *Capacity region*: Not known.
 - Present codes based on distributed compression, NOT optimal.

Example

- Consider $U=V$.
Distributed compression approach:



- A better way:**



For *identical* sources ($U=V$), the second approach gives a **3 dB** improvement from the first. (Beamforming gain).

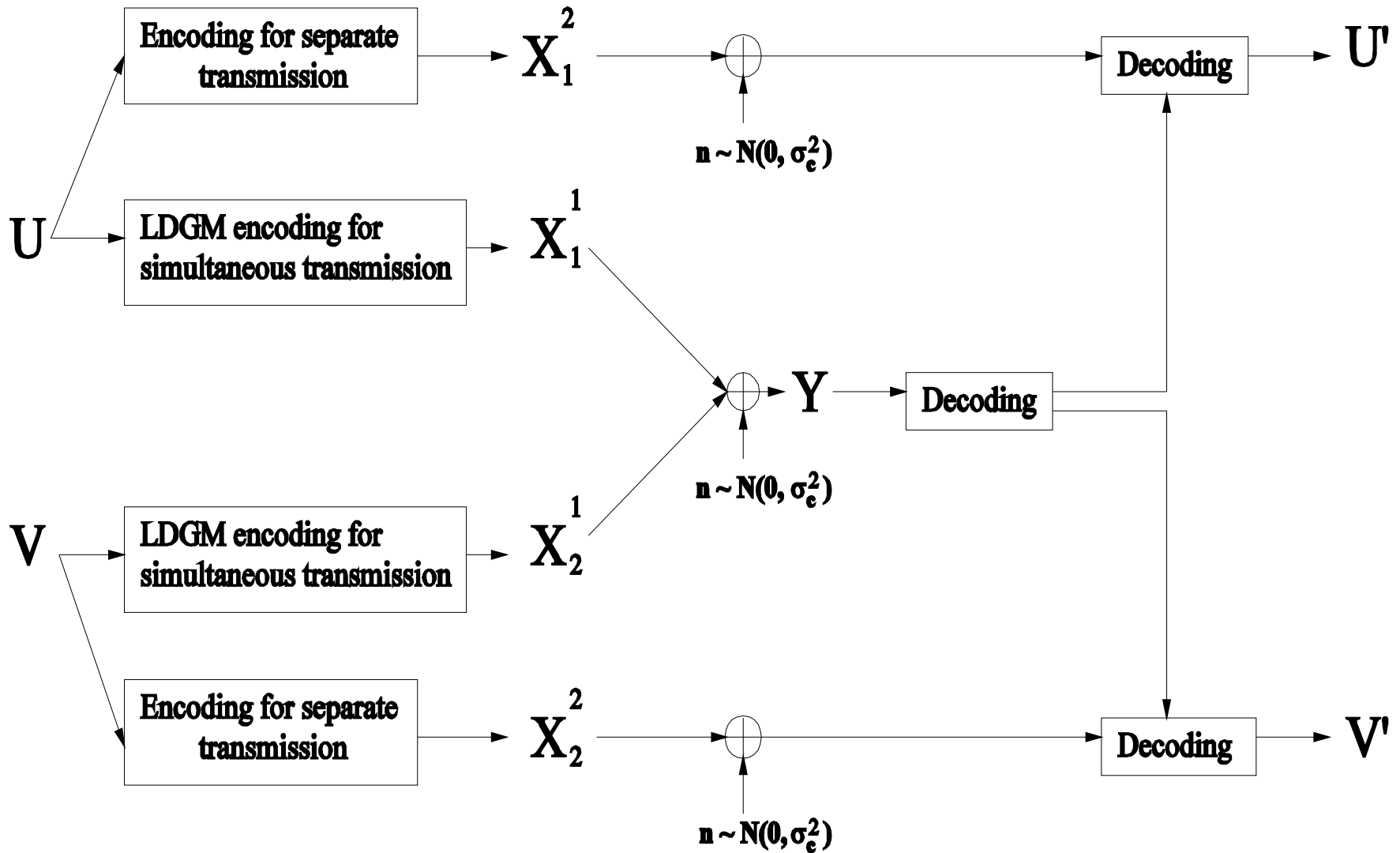
Low Density Generator Matrix Codes

- G for a systematic LDGM code:

$$G = \left(\begin{array}{c|c} \begin{matrix} 1 & & & \\ & \cdot & & \\ & & \cdot & \\ & & & 1 \end{matrix} & G' \end{array} \right)$$

- G' : sparse matrix, d_v ones in each row, and d_c ones in each column.
- The corresponding H matrix is also sparse, with (d_c+1) ones in each row.
- LDGM codes : Provide a good trade-off between error correction capability and correlation preservation.

Proposed Scheme



Simulation

- 2 sensor nodes.

- $k=9500, R = \frac{k}{N} = 0.2375.$

- Threshold defined by *Bit Error Rate* = 10^{-5} .

$$\frac{E_{so}}{N_0} = (1 + H(p)) \frac{P_{avg}}{4R'}, \text{ where } R' = (1 + H(p)) \frac{k}{N}$$

- Simulation done for $p=0.01$ and $p=0.025$.

Results

- $d_c=4$ provides the optimum trade-off for the range of parameters considered.
- $p=0.01$:

	d_v	m	$\frac{E_{so}}{N_0}$
Analysis	11	1.25	-5.99 dB
Simulation	8	1.25	-3.76 dB

- **Simulation threshold 2.23 dB away from the theoretical bound** obtained by analysis
- An **improvement of 2.26 dB** from the performance of the Joint source channel coding scheme proposed by Garcia-Frias *et al.*

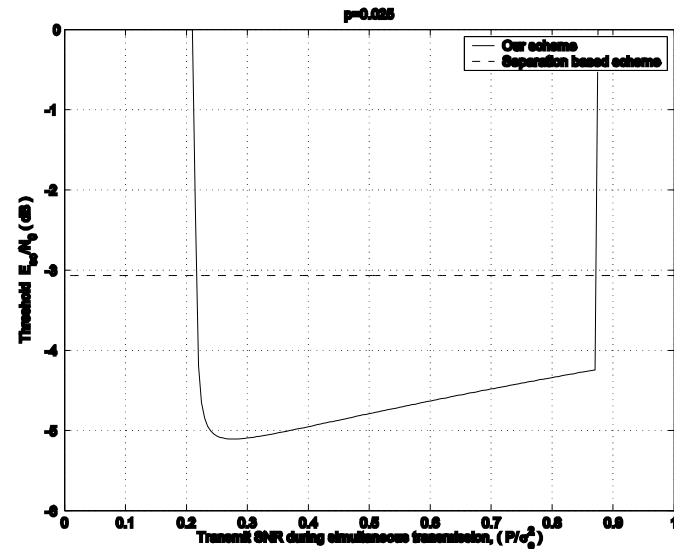
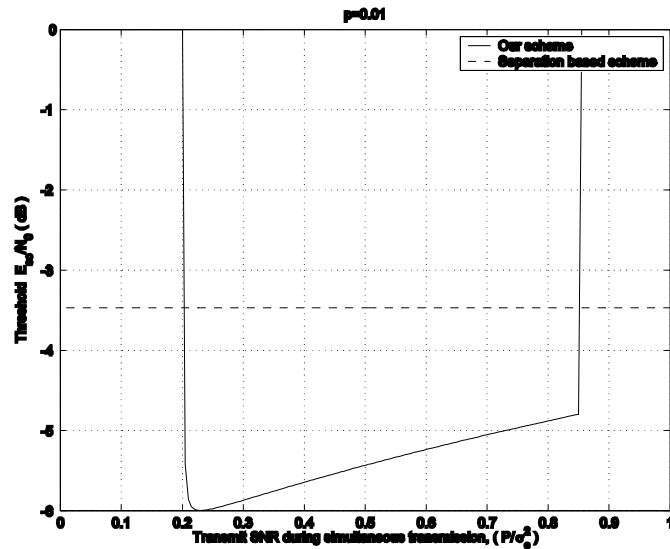
Results (contd.)

- $p=0.025$:

	d_v	m	$\frac{E_{so}}{N_0}$
Analysis	9	1.32	-5.10 dB
Simulation	8	1.15	-2.60 dB

- **Simulation threshold 2.5 dB away from the theoretical bound** obtained by analysis.
- **An improvement of 1.26 dB** from the performance of the Joint source channel coding scheme proposed by Garcia-Frias et al.

Theoretical Analysis Plots



- P_{avg} vs. P plot for $p=0.01$ and $p=0.025$.
- For a particular value of d_v, m , and P , P_{avg} is minimum. This is taken as performance bound.

Conclusion

- New statistical cooperative scheme for Gaussian Multiple Access Channel with Correlated Sources.
- Demonstrates inapplicability of source/channel separation principle in this scenario.
- Significant improvement over earlier schemes.