# Crosslayer Cooperative Broadcast Communication Via Dualized Erasure Correction Codes

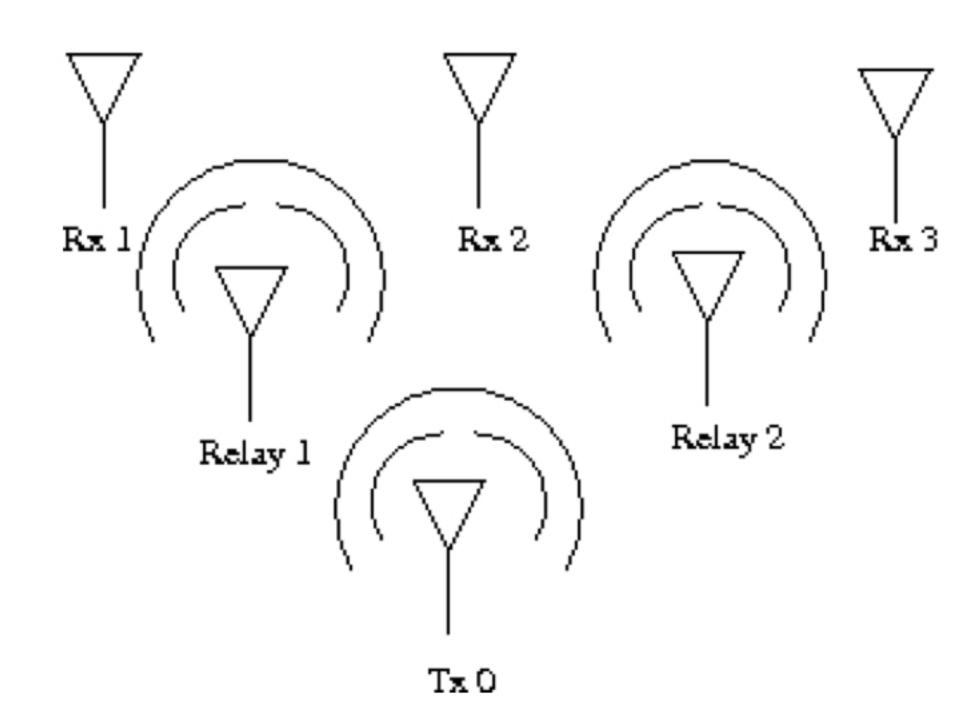
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## INTRODUCTION

- •Major issue in wireless networks: interference.
- •High level: noise well understood
- •Many network designs suppress interference by orthogonalization and successive cancellation.



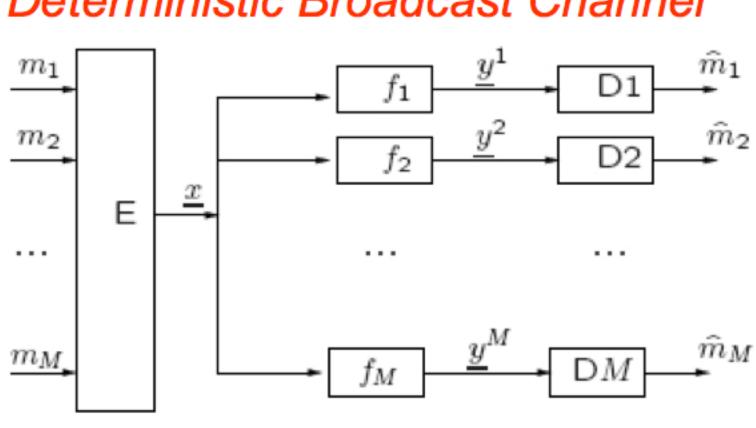
How to model such scenarios to understand effects of interference and develop efficient communication schemes?

- One approach: a *Gaussian BC model* with perfect Tx CSI.
- For such models, the capacity region [1] is obtained using Costa's dirty paper coding [2] approach.
- Unfortunately, perfect Tx, Rx CSI can be unrealistic.
- Thus dirty paper coding for non-coherent communication or distributed Tx cooperation relay networks might not be applicable.
- Even with perfect CSI, no practical coding scheme is known to achieve capacity. Best known dirty paper coding system is a couple of dB from capacity [3] (could mean a lot at low SNR).
- •If cooperation is enabled, interference can provide benefits.
- •Allow noise to be managed by physical layer, interference info exposed to application layer for management.
- •Interference carries information

# **OUR MODEL**

- •Rx1 only hears Rel1
- •Rx3 only hears Rel2
- •Rx2 hears both Rel1 and Rel2

# Deterministic Broadcast Channel

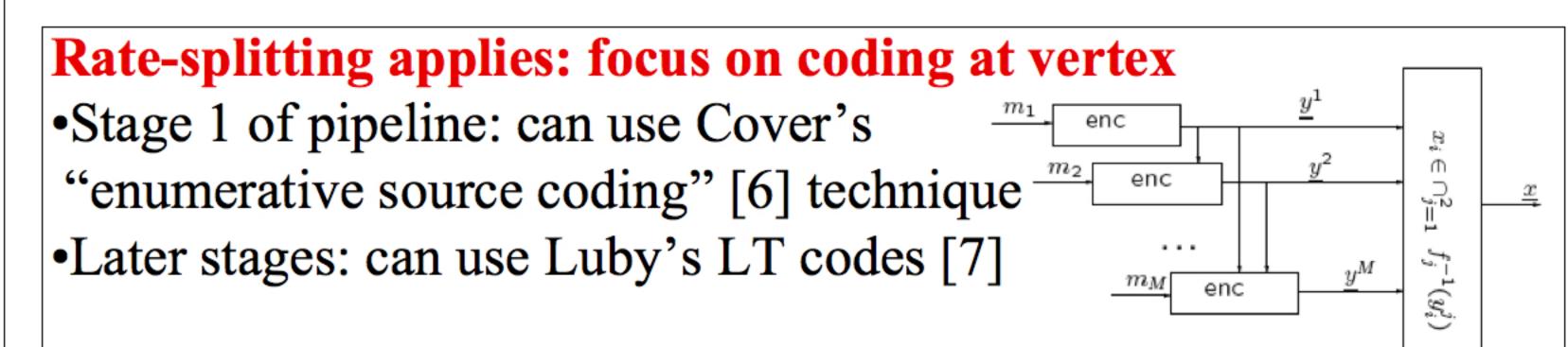


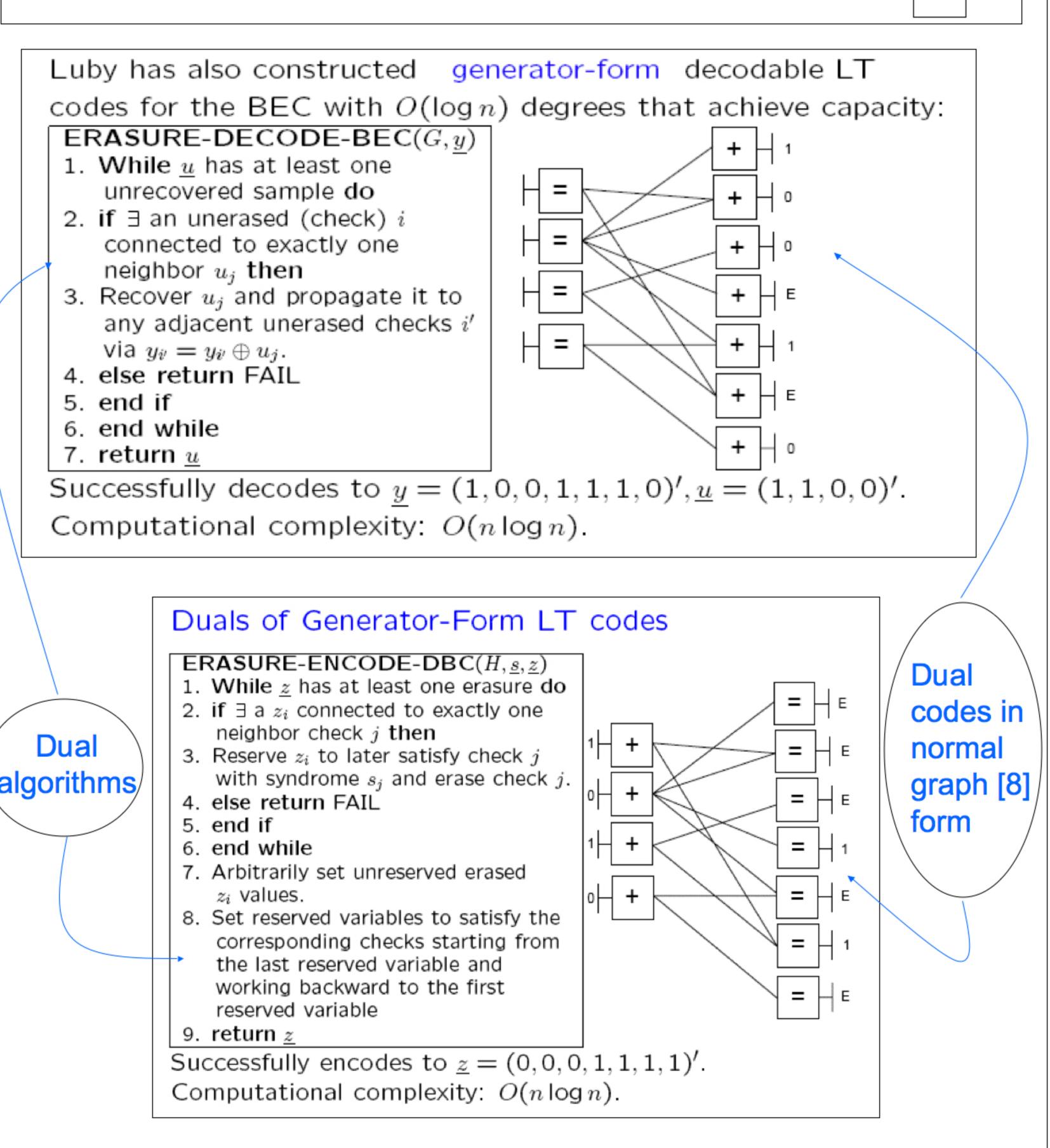
(Rel1,Rel2)	Rx1	Rx2	Rx3
(-1,-1)	-1	-1	-1
(-1,1)	-1	*	1
(1,-1)	1	*	-1
(1,1)	1	1	1

### Physical scenarios:

- BPSK with additive combining
- Non-coherent modulation with FSK (Each relay sends on f0 or f1. If Rel1 = Rel2, all Rx's see signal on freq f and decode correctly.
- Otherwise, Rx2 sees signals on both freqs: an erasure)

- $R_2$  $H(Y^2)$ Slepian-Wolf Deterministic Data Compression Broadcast Channel Achievable Region  $H(Y^2|Y^1)$ Achievable Region  $H(Y^{1}|Y^{2})$
- •DBC [4] dual to SW [5] but developing practical codes is non-trivial •Encoding is hard, decoding easy
- •On opposite side of entropy boundary so using off-the-shelf LDPCs yields exponentially many codewords consistent with what observed





Dualize the algorithm + dualize the linear code

### Proposition:

Consider a linear code with generator matrix G and its dual code with  $G^{\perp} = H$ . Then

**ERASURE-DECODE-BEC**(G, y) fails if and only if **ERASURE-ENCODE-DBC** $(H, \underline{s}, \underline{z})$  fails where y has erasures specified by  $\underline{e}$  and  $\underline{z}$  has erasures specified by  $\underline{e}^{\perp} = 1 - \underline{e}$ .

# A low-complexity capacity-achieving strategy mance on simulated of CONCLUSION

- Architecture paradigm for cooperative communication: dumb relays, force complexity at broadcast encoder.
- •Develop low-complexity provably good encoders
- Interference management enabled at the application layer

## **FUTURE WORK**

- Generalize these approaches to larger alphabets for more relays and receivers, beyond erasures. [9] Provides optimism this can be done with low complexity
- •Generalize this framework to include space-time codes [10]

## REFERENCES

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