An AWGN Multiaccess Channel*

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6.441 - Transmission of Information

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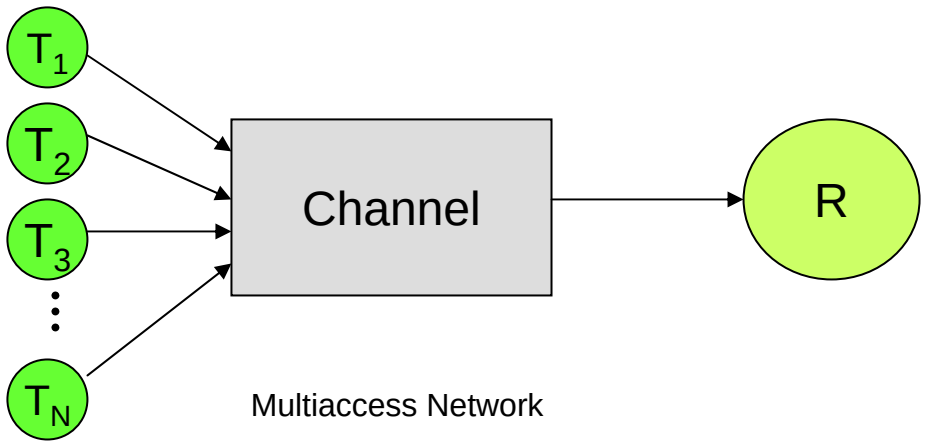
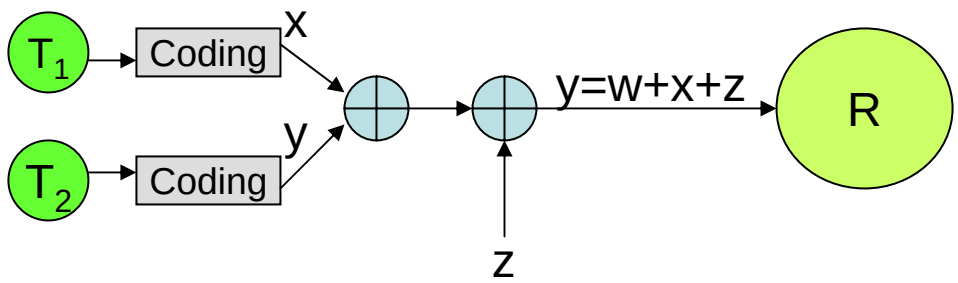
*Paper: Gallager, R, ***A Perspective on Multiaccess Channels***, IEEE transactions on Information Theory, March 1985

Motivation



- Generalization of point to point
- Transmitter not always ready
- Applicable to many situations
  - Cell phones
  - Ethernet
- Encoding Easy (Random), Decoding Hard
- Conclusion: Need better models and approaches

AWGN Channel Setup



Gaussian Multiaccess Setup

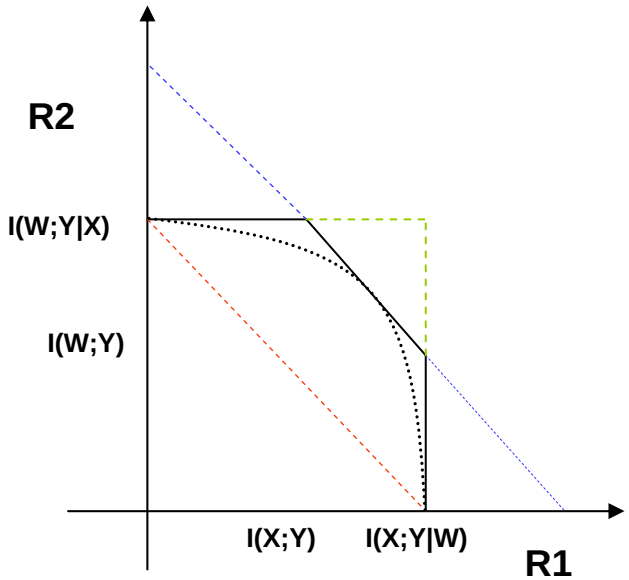
Types of Errors

- Only X decoded incorrectly (type 1)
- Only Y decoded incorrectly (type 2)
- X and Y decoded incorrectly (type 3)

Capacity of AWGN Channel: $C = \frac{1}{2} * \log(1 + SNR) \left(\frac{bits}{\dim} \right)$

- Energy Constraint for each transmitter (S_1 and S_2)

Achievable Rates



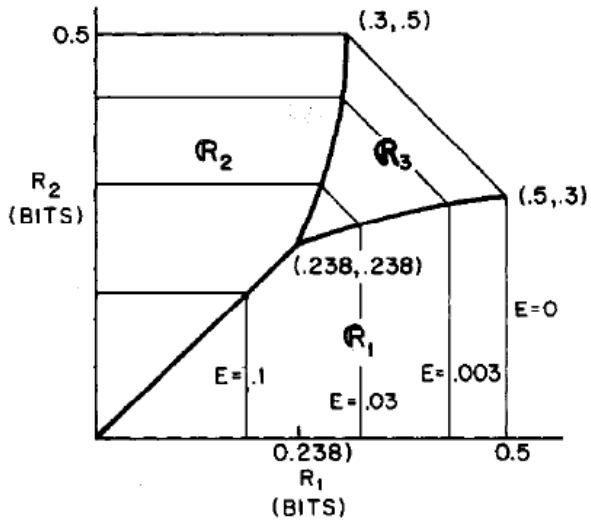


Fig. 8. Regions $\mathcal{R}_i$-where $E_{r,i}$ dominates error bound; for $A = 1$.

Constraints

$$R_1 + R_2 \le I(WX;Y) \le \frac{1}{2}\log\left[1+\frac{S_1+S_2}{\sigma^2}\right]$$

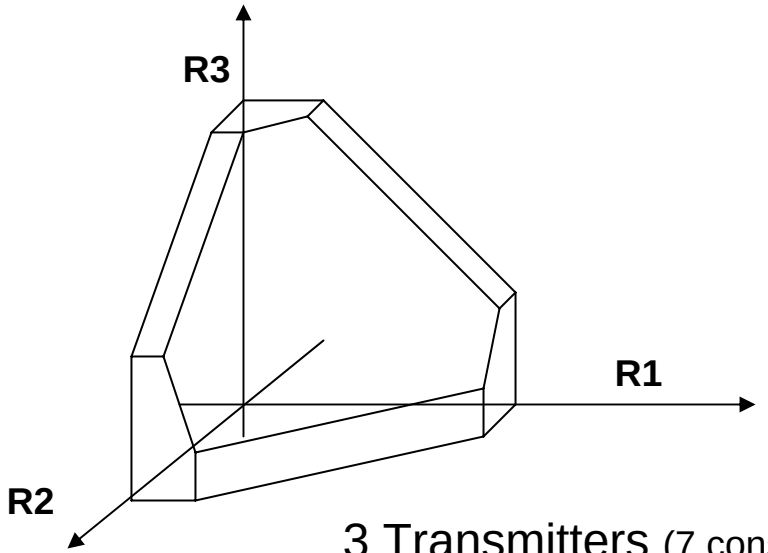
$$0 \le R_1 \le I(X;Y\,|\,W) \le \frac{1}{2}\log\left[1+\frac{S_1}{\sigma^2}\right]$$

$$0 \le R_2 \le I(W;Y\,|\,X) \le \frac{1}{2}\log\left[1+\frac{S_2}{\sigma^2}\right]$$

2-Parallel AWGN Channels

$$C = \sum_{n=1}^{2}\frac{1}{2}*\log\left(1+\frac{S_n}{\sigma^2}\right) = \frac{1}{2}*\log\left(1+\frac{S_1+S_2+S_1S_2}{\sigma^2}\right)$$

Higher Dimensionality



3 Transmitters (7 constraints)

Constraints quickly get out of hand (2^n-1 constraints for n-dim)

Conclusions

- AWGN Multiaccess
  - Interesting, not practical
  - Better Models needed (other than power lim)

- Modern Approaches
  - CDMA
  - OFDM

Questions?

http://www.ukuleleman.net/2005_08_01_ukemanspeaks_archive.html