An AWGN Multiaccess Channel*

Ballard Blair

6.441 - Transmission of Information
Massachusetts Institute of Technology
May 10, 2007

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

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:
\[ C \leq \frac{1}{2} \log(1 + \text{SNR}) \left( \frac{\text{bits}}{\text{dim}} \right) \]

- Energy Constraint for each transmitter (S₁ and S₂)
Achievable Rates

Constraints

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

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

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

2-Parallel AWGN Channels

\[
C = \sum_{n=1}^{2} \frac{1}{2} \ast \log \left( 1 + \frac{S_n}{\sigma^2} \right) = \frac{1}{2} \ast \log \left( 1 + \frac{S_1 + S_2 + S_1S_2}{\sigma^2} \right)
\]
Higher Dimensionality

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