EECE 580B
Modern Coding Theory

Information theory

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Binary Entropy Function

$$H_2(p) = -p \cdot \log_2(p) - (1-p) \cdot \log_2(1-p)$$
Capacity of BEC and BSC Channel

Capacity of different channels

BSC
BEC

Bits per channel use

Parameter
Point-to-Multipoint Communication
Cars see the satellite at random times and experience different losses. There is no feedback between car and satellite.
Point-to-Multipoint Communication

Trivial solution:
- Send the original data several times in a carousel manner.
- Original file consists of $k$ packets; cars tune in at a random times, and each time they receive $b$ packets.
- Assume that a complete transmission of $k$ packets takes one day.
- Every car tunes in 2 times per day. How many days $d$ of transmission are needed to ensure that 99.99% of the cars have received all the packets? (minimum is $k/2b$)

Model:
- throw $dk$ balls at random into $k$ bins. For a given bin, what is the probability that it has received at least one ball?
Point-to-Multipoint Communication

Each day, every bin receives a ball with probability \( \frac{2b}{k} \).
Probability that the bin is empty after \( d \) days is

\[
\left( 1 - \frac{2b}{k} \right)^d \approx \exp(-\frac{2bd}{k})
\]

Want this quantity to be less than 0.0001; so \( d \) is roughly \( \frac{4.6k}{2b} \),
that means every car receives \( 9.4k \) packets (instead of only \( k \))
of which many duplicate.

file = \( k \) packets
car receives \( b \) packets in one day
\( d \) = number of days needed

There is an elegant solution to this problem that needs only little bit more that \( k \) packets!