Identification Systems

Exercises 2

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1. Let us assume MAC model, and IDs of length $n \geq 8$. Assume that there are 16 tags in the vicinity of a reader, and that their ID is sampled at random from the pool, estimate the number of rounds required by QT protocol to find all the IDs.

2. Let us assume MAC model, and IDs of length $n \geq 8$. Assume that there are $k \leq \log_2 n$ tags in the vicinity of a reader, and that their ID is sampled at random from the pool, estimate the number of rounds required by QT protocol to find all the IDs. Try to find a rule for various ranges of k.

3. Let us assume slotted ALOHA protocol with 16 tags in the range of a single reader. For transmission probability equal to $\frac{1}{2}, \frac{1}{4}, \frac{1}{16}, \frac{1}{256}$ in each round, estimate number of rounds that

   (a) first tag successfully messages the reader with probability greater than $\frac{1}{2}$

   (b) first tag successfully messages the reader with probability greater than $\frac{15}{16}$

   (c) all tags successfully messages the reader with probability greater than $\frac{1}{2}$

   (d) all tags successfully messages the reader with probability greater than $\frac{3}{4}$

   Note: Assume that after successful transmission, the tags stops transmitting. Remember that both: the transmission and the ACK may fail due to collision.

4. Let us assume slotted ALOHA protocol with k tags in the range of a single reader. For transmission probability equal to $\frac{1}{2}, \frac{1}{4}, \frac{1}{k}$ in each round, estimate number of rounds that

   (a) first tag successfully messages the reader with probability greater than $\frac{1}{2}$

   (b) first tag successfully messages the reader with probability greater than $\frac{k-1}{k}$

   (c) at least $\frac{k}{2}$ tags successfully messages the reader with probability greater than $\frac{1}{2}$

   (d) all tags successfully messages the reader with probability greater than $\frac{1}{2}$

Note: Assume that **even after a success, the tags transmits** with given probability.
Remember that both: the transmission and the ACK may fail due to collision.

5. Recall the properties of Gaussian distribution, Gamma distribution, Binomial distribution, Geometric distribution and Hypergeometric distribution.

6. Recall the definition of Hamming weight and Hamming distance.

7. Let us assume binary sequences of length $4n$ and let us select at random $k \leq \log_2(4n)$ sequences. Estimate the probability that any two of the selected sequences:

   (a) are equal,

   (b) have Hamming distance equal to 2,

   (c) have Hamming distance equal to n,

   (d) have Hamming distance at least n,

   (e) have Hamming distance equal to $2n$,

   (f) have Hamming distance at least $2n$,

   (g) have even Hamming distance,

   (h) have Hamming distance divisible by n.

   Implement the selection and calculation of the distance in a selected programming language and estimate the values for $k << n$, $k \approx 4n$ and $k \approx 2^{2n}$.