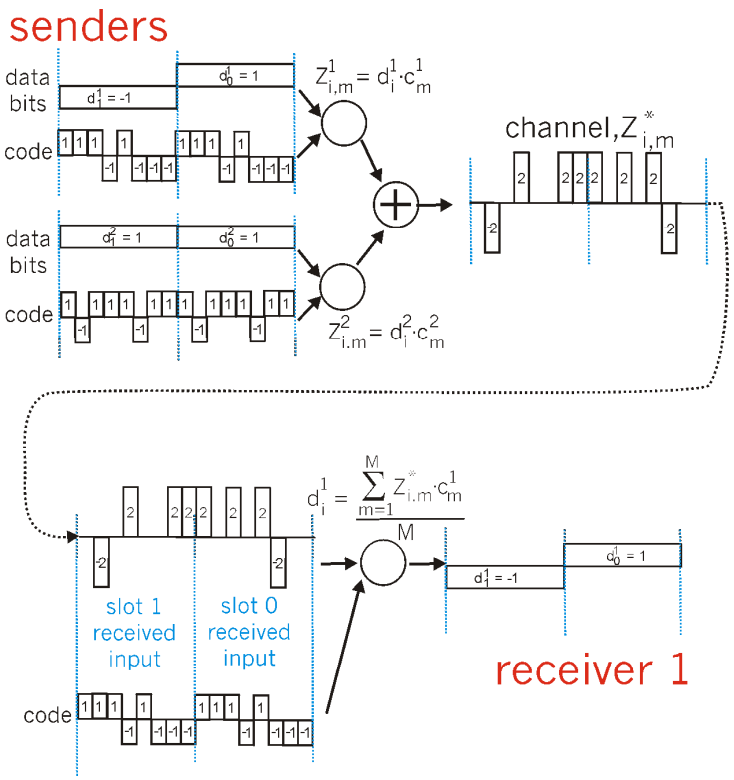
EE3009 Tutorial 6

(Multiple Access Control)

(Note: Throughput, by the definition given in lecture notes, is dimensionless. On the other hand, it is sometimes expressed in terms of bit per second or frame per second. In this course, we regard throughput as a dimensionless quantity, unless specified otherwise.)

1. Consider the two-user example for CDMA systems as shown below:



a) Consider sender 2. What is its transmitted signal, $Z_{i,m}{}^{2}$?

b) Show (by calculation) that the receiver is indeed able to recover sender 2's data from the aggregate channel signal by using sender 2's signature sequence.

c) Verify that the codes of sender 1 and 2 are orthogonal.

2. Consider a broadcast channel with N nodes and a transmission rate of R bps. Suppose the broadcast channel uses polling (with an additional polling node) for multiple access control. There is a polling delay of d so that when a node completes its transmission, it takes d time units until the subsequent node is allowed to transmit. Within a polling round, a given node is allowed to transmit at most Q bits. What is the maximum throughput of the broadcast channel in bps?

3. Consider a slotted ALOHA system with two terminals, A and B. Terminal A transmits at the beginning of a time slot with probability 0.6, whereas terminal B transmits with probability 0.3. Both terminals have a large number of packets to transmit.

   a) What is the throughput of terminal A?

   b) What is the throughput of terminal B?

4. In the lecture notes, we provided an outline of the derivation of the throughput of slotted ALOHA. In this problem, we complete the derivation.

   a) Recall that when there are N active nodes the throughput of slotted ALOHA is $Np(1-p)^{N-1}$. Find the value of p that maximizes this expression.

   b) Using the value of p found in (a), find the maximum throughput of slotted ALOHA by letting N approach infinity. Hint: $(1-1/N)^N$ approaches $1/e$ as N approaches infinity.

   c) Compare your result in part (b) with the maximum throughput of pure ALOHA. Which protocol has a higher maximum throughput? Why?