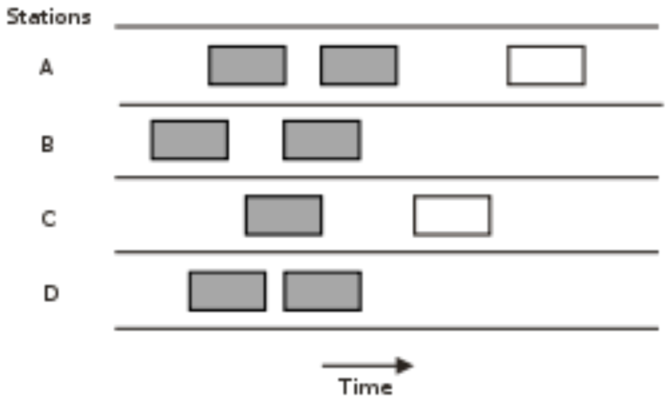
Pure ALOHA



Pure ALOHA protocol. Boxes indicate frames. Shaded boxes indicate frames which have collided.

The first version of the protocol (now called "Pure ALOHA") was quite simple:

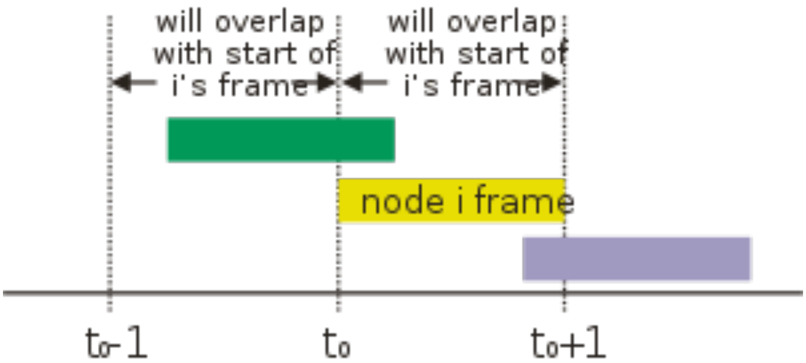
- If you have data to send, send the data
- If the message collides with another transmission, try resending "later"

Note that the first step implies that Pure ALOHA does not check whether the channel is busy before transmitting. The critical aspect is the "later" concept: the quality of the backoff scheme chosen significantly influences the efficiency of the protocol, the ultimate channel capacity, and the predictability of its behavior.

To assess Pure ALOHA, we need to predict its throughput, the rate of (successful) transmission of frames. (This discussion of Pure ALOHA's performance follows Tanenbaum [1].) First, let's make a few simplifying assumptions:

- All frames have the same length.
- Stations cannot generate a frame while transmitting or trying to transmit. (That is, if a station keeps trying to send a frame, it cannot also be generating more frames to send.)
- The population of stations attempts to transmit (both new frames and old frames that collided) according to a Poisson distribution.

Let "*T*" refer to the time needed to transmit one frame on the channel, and let's define "frame-time" as a unit of time equal to *T*. Let "*G*" refer to the mean used in the Poisson distribution over transmission-attempt amounts: that is, on average, there are *G* transmission-attempts per frame-time.



Overlapping frames in the pure ALOHA protocol. Frame-time is equal to 1 for all frames.

Consider what needs to happen for a frame to be transmitted successfully. Let "*t*" refer to the time at which we want to send a frame. We want to use the channel for one frame-time beginning at *t*, and so we need all other stations to refrain from transmitting during this time. Moreover, we need the other stations to refrain from transmitting between *t-T* and *t* as well, because a frame sent during this interval would overlap with our frame.

For any frame-time, the probability of there being *k* transmission-attempts during that frame-time is:

$$\frac{G^k e^{-G}}{k!}$$

The average amount of transmission-attempts for 2 consecutive frame-times is $2G$. Hence, for any pair of consecutive frame-times, the probability of there being *k* transmission-attempts during those two frame-times is:

$$\frac{(2G)^k e^{-2G}}{k!}$$

Therefore, the probability ($Prob_{pure}$) of there being zero transmission-attempts between *t-T* and *t+T* (and thus of a successful transmission for us) is:

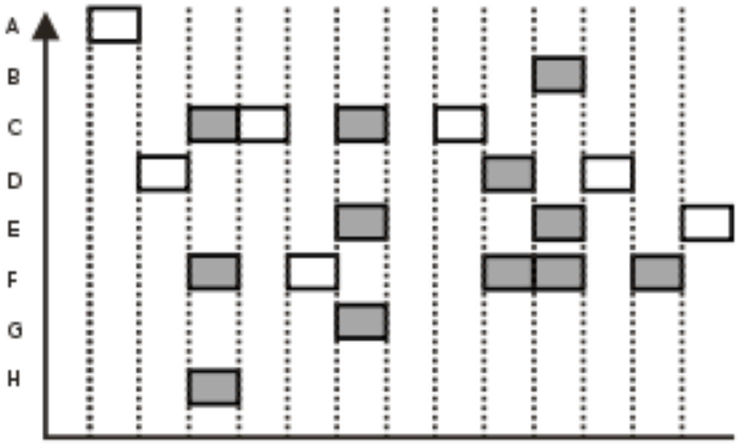
$Prob_{pure} = e^{-2G}$

The throughput can be calculated as the rate of transmission-attempts multiplied by the probability of success, and so we can conclude that the throughput (S_{pure}) is:

$S_{pure} = Ge^{-2G}$

The maximum throughput is $0.5/e$ frames per frame-time (reached when $G = 0.5$), which is approximately 0.184 frames per frame-time. This means that, in Pure ALOHA, only about 18.4% of the time is used for successful transmissions.

Slotted ALOHA



Slotted ALOHA protocol (shaded slots indicate collision)

Slotted ALOHA protocol. Boxes indicate frames. Shaded boxes indicate frames which are in the same slots.

An improvement to the original ALOHA protocol was "Slotted ALOHA", which introduced discrete timeslots and increased the maximum throughput. A station can send only at the beginning of a timeslot, and thus collisions are reduced. In this case, we only need to worry about the transmission-attempts within 1 frame-time and not 2 consecutive frame-times, since collisions can only occur during each timeslot. Thus, the probability of there being zero transmission-attempts in a single timeslot is:

$$Prob_{slotted} = e^{-G}$$

The throughput is:

$$S_{slotted} = Ge^{-G}$$

The maximum throughput is $1/e$ frames per frame-time (reached when $G = 1$), which is approximately 0.368 frames per frame-time, or 36.8%.