ALOHA PROTOCOL

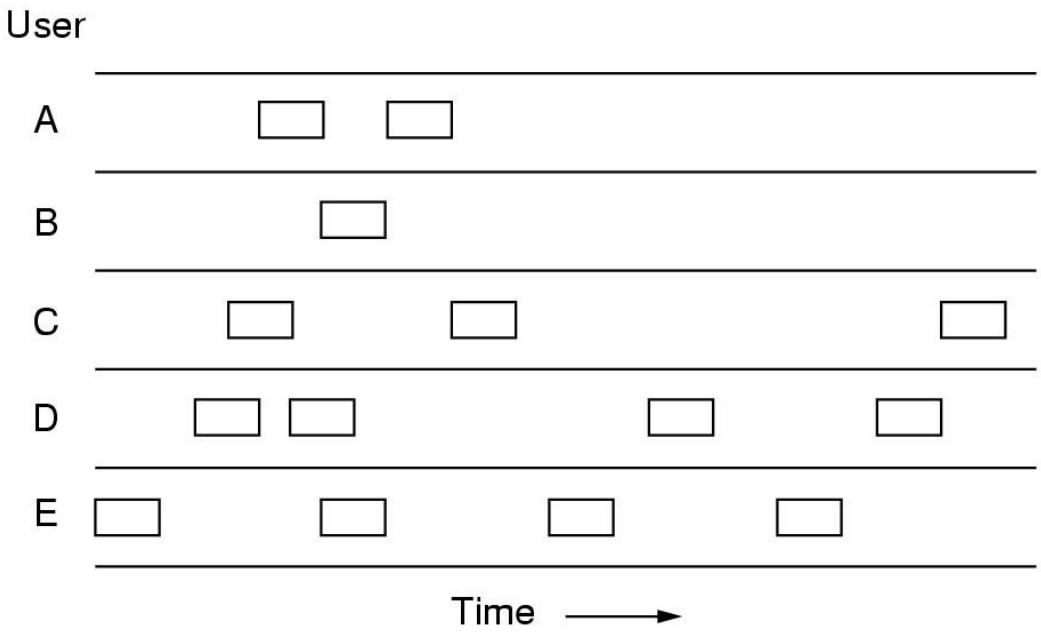
ALOHA Protocol

- ALOHA is developed in the 1970s at the University of Hawaii.
- The basic idea is simple:
  - Let users transmit whenever they have data to be sent.
- If two or more users send their packets at the same time, a collision occurs and the packets are destroyed.

ALOHA Protocol

- If there is a collision,
  - the sender waits a random amount of time and sends it again.
- The waiting time must be random. Otherwise, the same packets will collide again.

A Sketch of Frame Generation



Note that all packets have the same length because the throughput of ALOHA systems is maximized by having a uniform packet size.

Throughput

- Throughput:
  - The number of packets successfully transmitted through the channel per packet time.

- What is the throughput of an ALOHA channel?

Assumptions

- Infinite population of users
- New frames are generated according to a Poisson distribution with mean *S* packets per packet time.
  - Probability that *k* packets are generated during a given packet time:

$$\Pr[k] = \frac{S^k e^{-S}}{k!}$$

Observation on *S*

- If $S > 1$, packets are generated at a higher rate than the channel can handle.
- Therefore, we expect

$$0 < S < 1$$

- If the channel can handle all the packets, then *S* is the throughput.

Packet Retransmission

- In addition to the new packets, the stations also generate retransmissions of packets that previously suffered collisions.
- Assume that the packet (new + retransmitted) generated is also Poisson with mean *G* per packet time.

$$\Pr[k] = \frac{G^k e^{-G}}{k!}$$

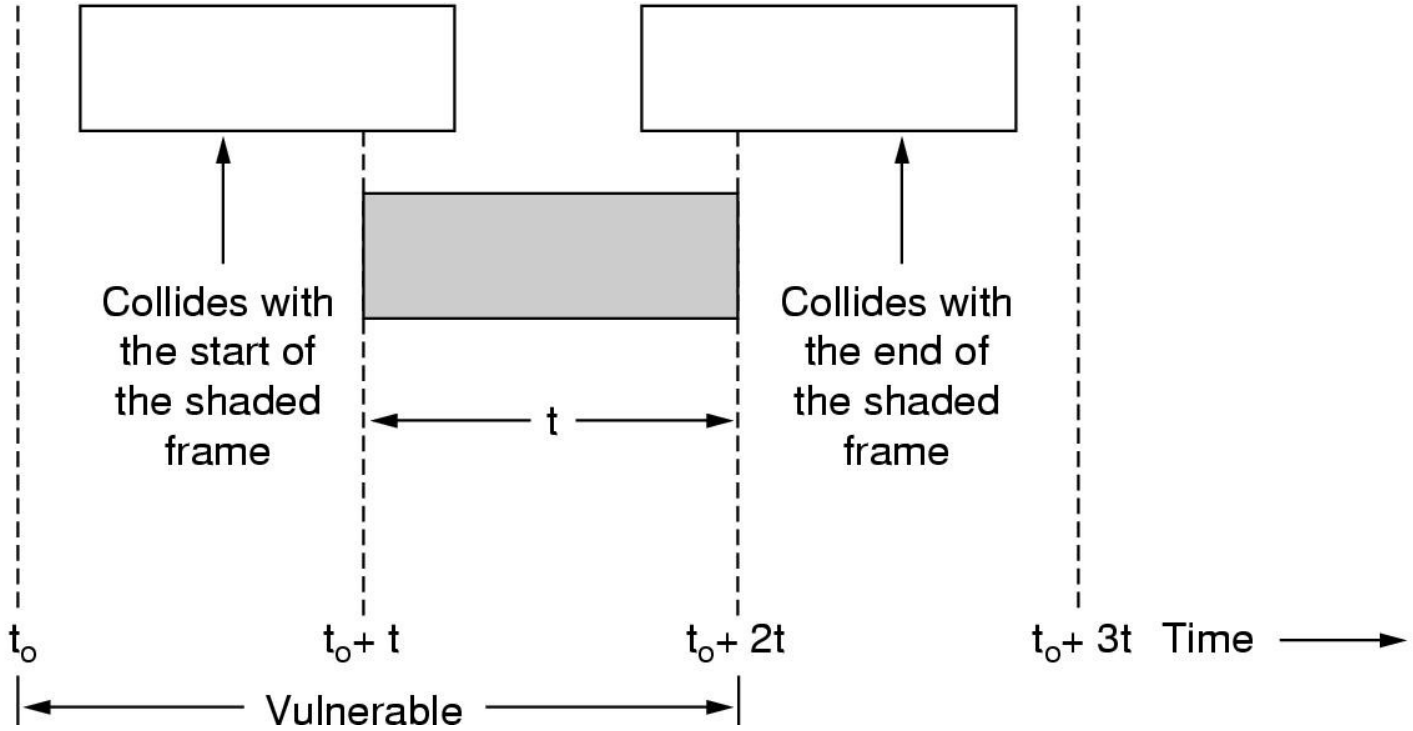
Relation between *G* and *S*

- Clearly, $G \geq S$
- At low load, few collisions: $G \approx S$
- At high load, many collisions: $G > S$
- Under all loads, $S = GP_0$

where P_0 is the probability that a packet does not suffer a collision.

Vulnerable Period

- Under what conditions will the shaded packet arrive undamaged?



Throughput

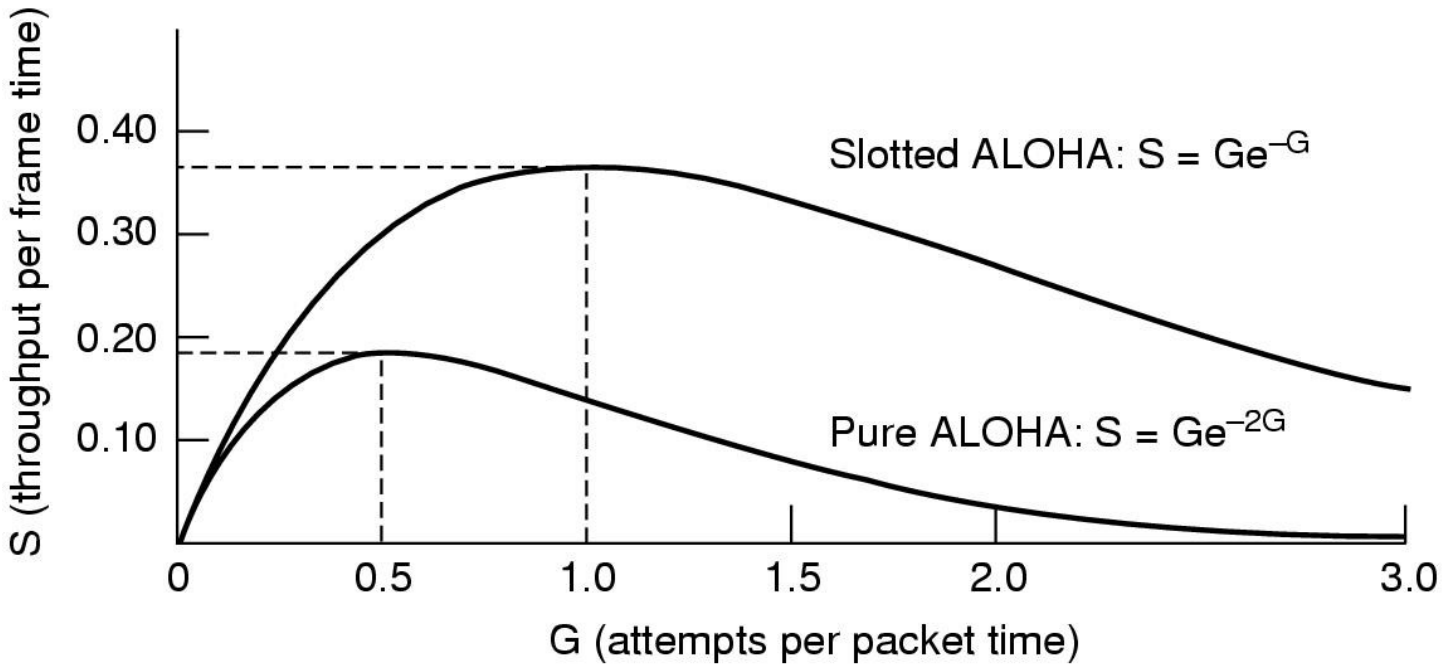
- Vulnerable period: from t_0 to t_0+2t
- Probability of no other packet generated during the vulnerable period is:

$$P_0 = e^{-2G}$$

- Using $S = GP_0$, we get

$$S = Ge^{-2G}$$

Relation between *G* and *S*



Max throughput occurs at G=0.5, with S=1/(2e)=0.184.

Hence, max. channel utilization is 18.4%.

Slotted ALOHA

- Divide time up into discrete intervals, each corresponding to one packet.
- The vulnerable period is now reduced in half.
- Probability of no other packet generated during the vulnerable period is:

$$P_0 = e^{-G}$$

- Hence,

$$S = Ge^{-G}$$

Carrier Sense

- In many situations, stations can tell if the channel is in use before trying to use it.
- If the channel is sensed as busy, no station will attempt to use it until it goes idle.
- This is the basic idea of the Carrier Sense Multiple Access (CSMA) protocol.