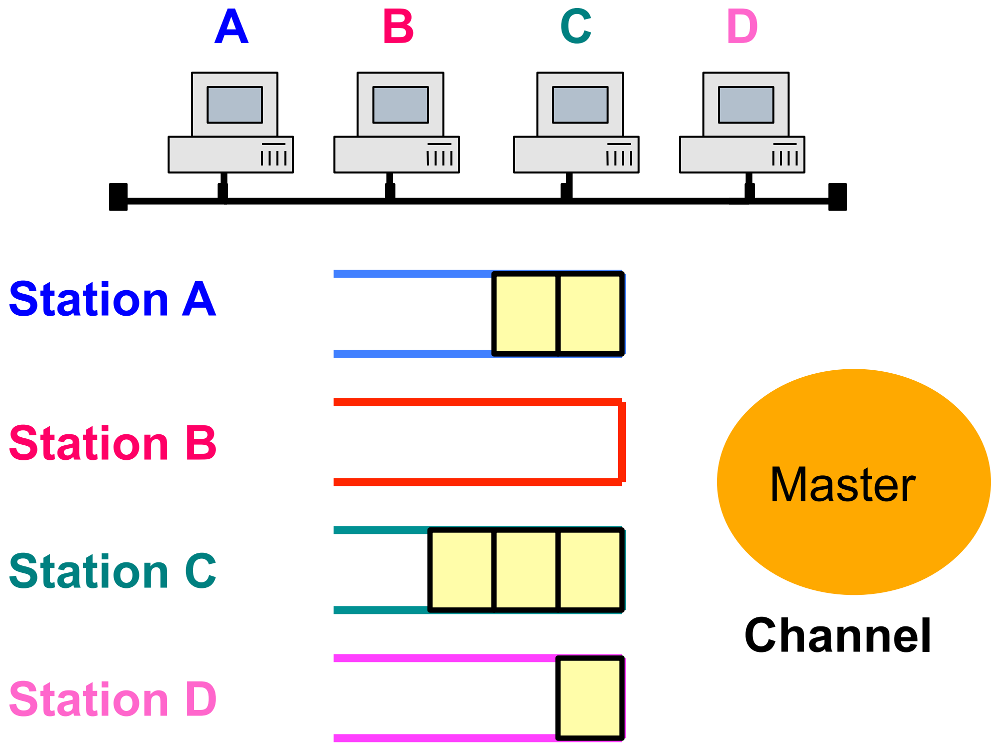
Accesso Multiplo - modelli

Conceptual Model of Multiple Access

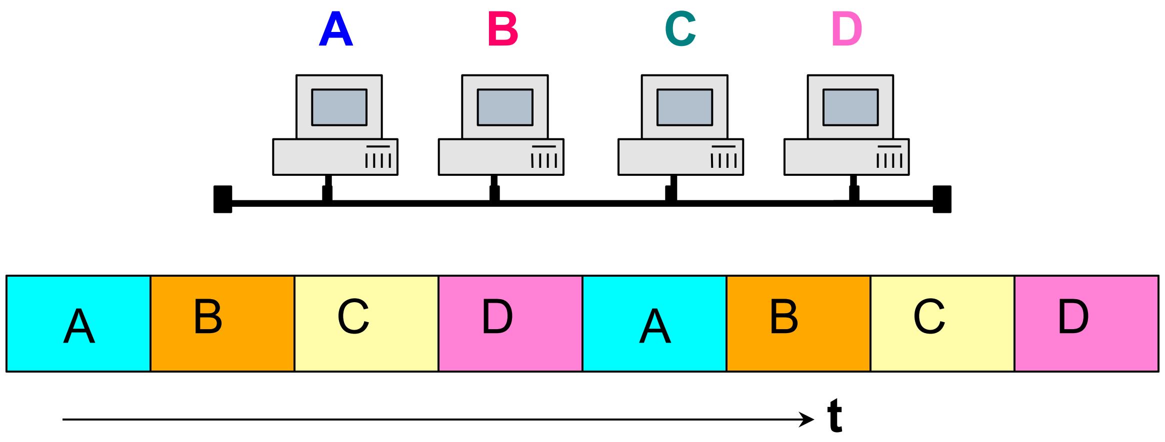


- The Master does not know *if* and *how many* packets are present in each queue (i.e., if and how many packets are produced by each station)
- Each station does not know the state of other stations' queue

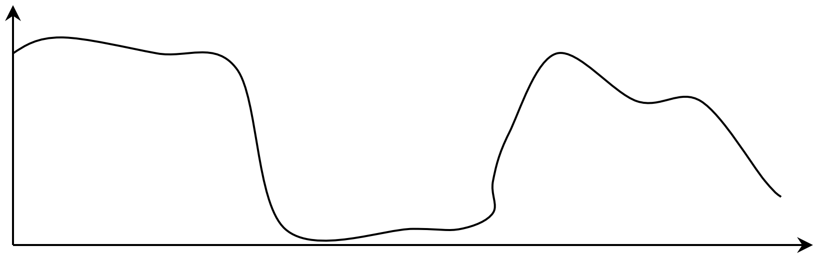
Multiple Access Techniques Classification

- We have two types of access techniques
  - Ordered Access
    - TDMA
    - Round Robin
    - Polling
      - Roll Call Polling
      - Hub Polling
  - Random Access
    - CSMA/CD (Ethernet)
    - CSMA/CA (IEEE 802.11, WiFi)

Example: TDMA



In LANs, taffic is **bursty**, and we have **several stations**



TDMA is inefficient: **high delays, low throughput**

Example: Round Robin

- Each station has, in each round, the <u>opportunity</u> to transmit
- When it is the turn of the station:

→ <u>if she has no packet to transmit:</u>

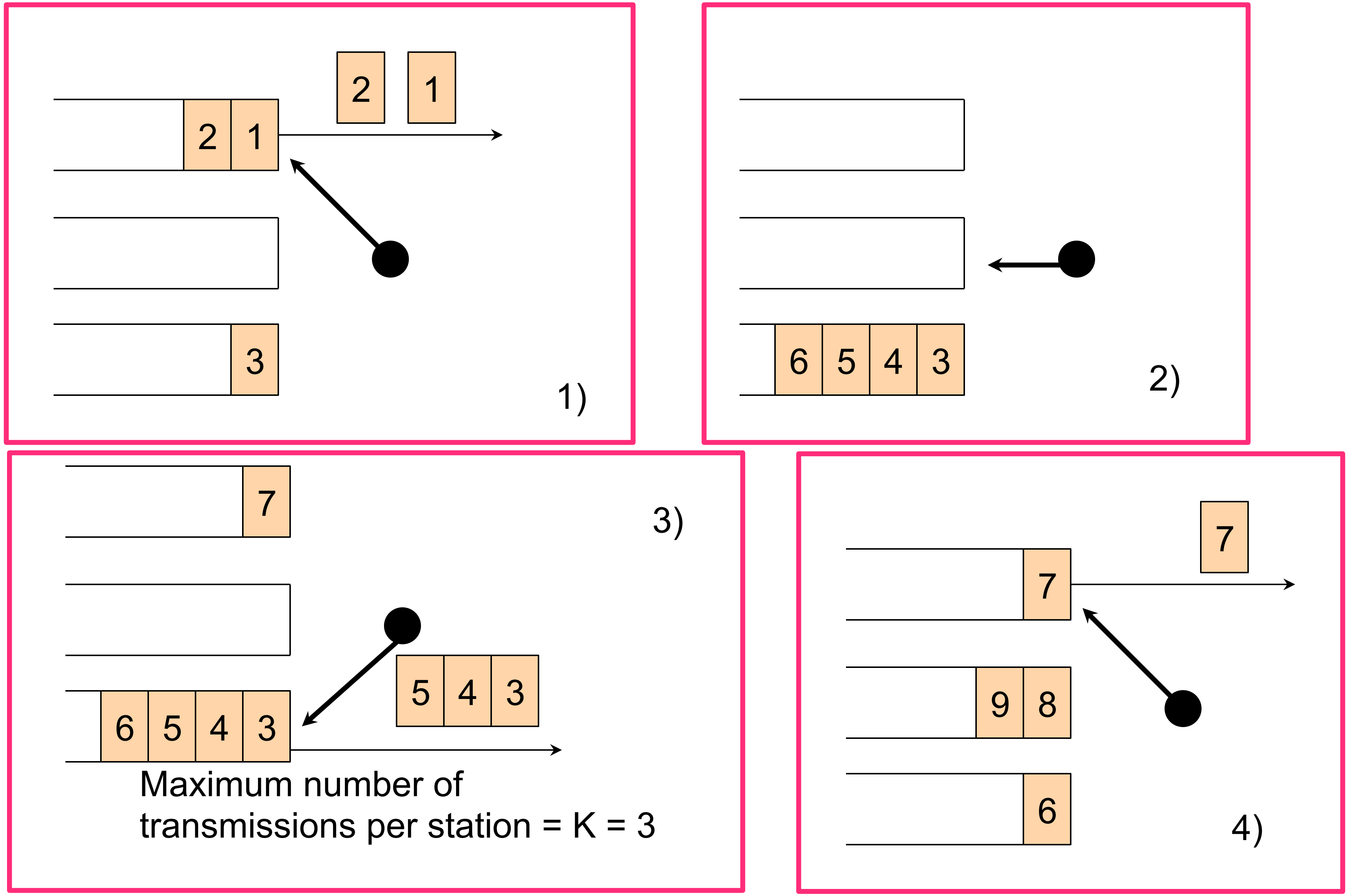
she declines the transmission opportunity, which will be given to the subsequent station

<u>if she does have packets to transmit:</u>

→ she transmits her packets up to a maximum number (K), defined by the protocol itself

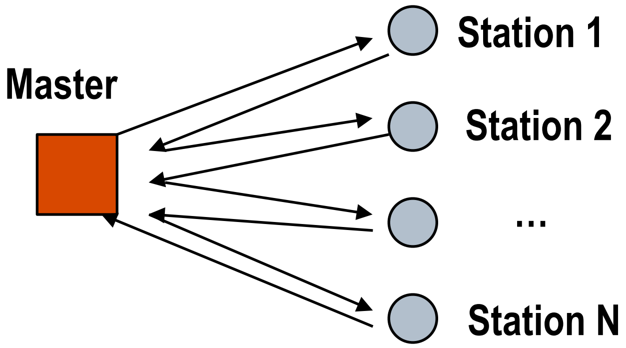
Then, the transmission opportunity (the right to transmit) is sent to the subsequent station

Example: Round Robin



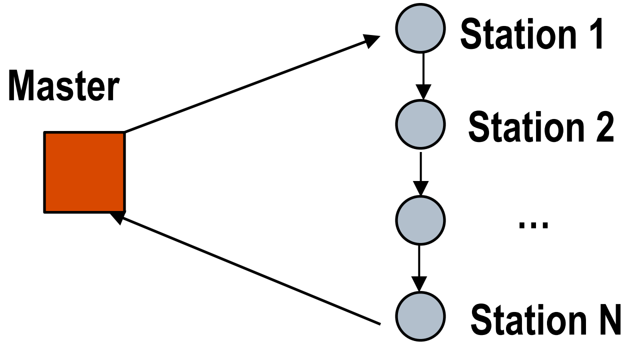
Ordered Access: Polling

➡Roll-call polling



◆The token (the control packet which guarantees the transmission opportunity) is always sent back to the Master station

➡Hub polling



◆The token comes back to the Master only at the end of the cycle

Random Access Protocols

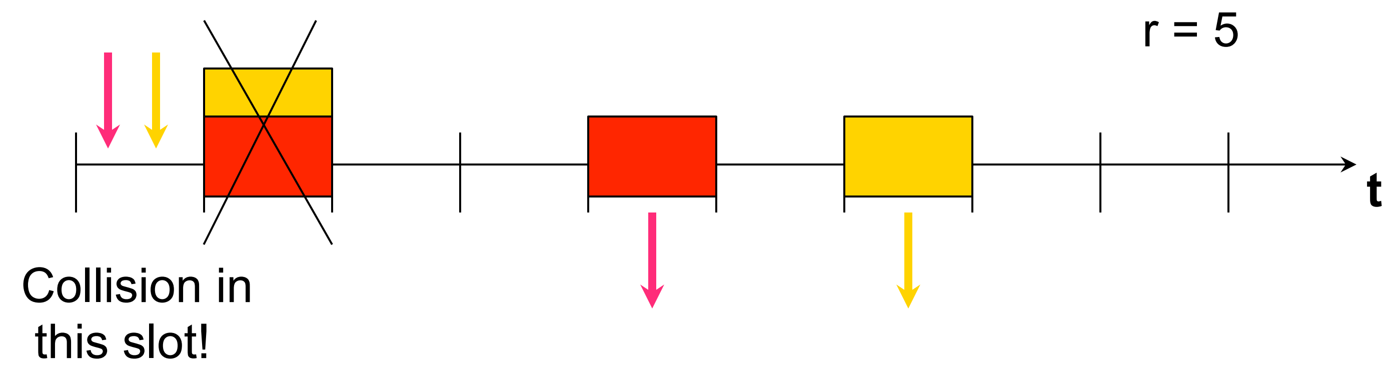
- Random access protocols do not have an explicit coordination among stations…
- … hence, collisions may occur

- They differ in *how* they resolve collisions …
- … and also in the feed-back from the channel (i.e., the information that derives from listening to the channel)

- Collisions are overcome by introducing a random mechanism

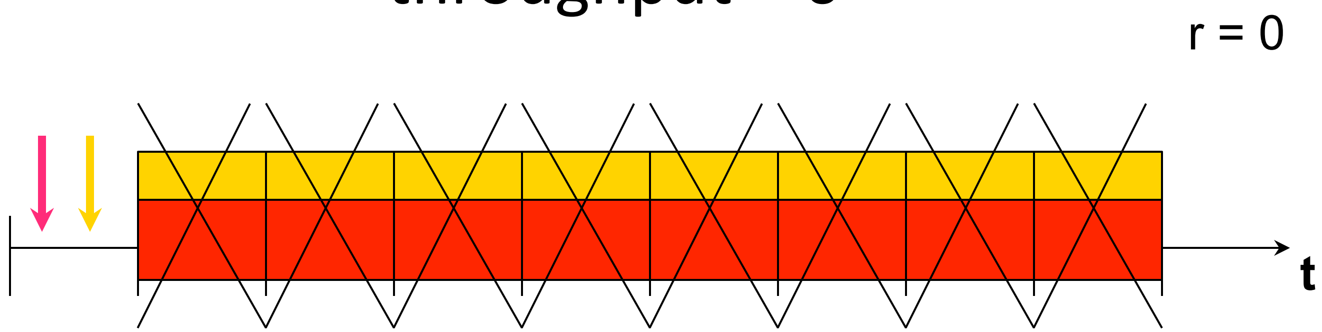
Random Access Protocol
Example: Slotted Aloha

- Slotted channel (time is divided into slots)
- When a packet arrives at a station, she tries to send it in the first available slot
- If a collision occurs, the station tries to re-send it after a random number of slots …
- … such random number is chosen uniformly at random in an interval [0,r]



Slotted Aloha: Collision Resolution

- If r = 0 → collision repeats infinite times!
  → throughput = 0



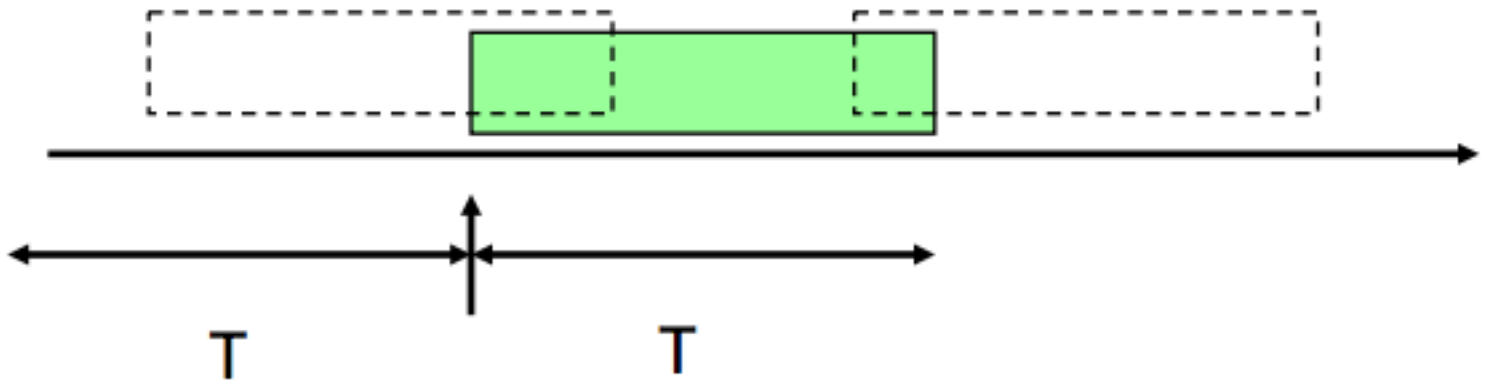
- If the offered traffic is high, we need a high *r* value to avoid instability

To summarize: we would like to have small *r* values when the network is empty and large *r* values when the network is congested !!!

Aloha: Performance analysis

In Aloha, the access mechanism is very simple:

- When there is a packet to be transmitted, just transmit it.
- If transmission fails, wait for a random time and retransmit



Aloha: Performance analysis

- Let us assume the transmission starting times on channel are a Poisson process with rate λ
- Let us consider the normalized rate $G=\lambda T$
- The success probability is given by the probability that there is no other transmission in a $2T$ interval

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

- The normalized throughput S is therefore given by:

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

Slotted Aloha analysis

- **Consideriamo uno scenario con**
  - *N* stazioni
  - Ogni stazione ha sempre un pacchetto pronto per la trasmissione
  - Ogni stazione trasmette in uno slot con probabilità *p*
- Se un stazione trasmette, la probabilità di successo è data dalla probabilità che le altre *N-1* non trasmettano:

$$P_S = (1 - p)^{N-1}$$

Slotted Aloha analysis

- La probabilità che in uno slot arbitrario **una particolare stazione** trasmetta e abbia successo è dunque uguale a:

$$p \cdot P_S = p(1-p)^{N-1}$$

- E dunque la probabilità che **una qualunque stazione** trasmetta e abbia successo è

$$S = Np(1-p)^{N-1}$$

- Questo è anche il numero medio di trasmissioni con successo in uno slot, che chiamiamo *throughput* (S), $0 \leq S \leq 1$

Slotted Aloha analysis

- Il numero medio di trasmissioni sul canale, che chiamiamo traffico (G) è dato da:

$$G = Np$$

- Sostituendo nella formula del throughput $p = G/N$ si ha:

$$S = G\left(1 - \frac{G}{N}\right)^{N-1}$$

- Questa formula ci dà il numero medio di successi in funzione del numero medio di trasmissioni
- E' dunque la frazione di slot utilizzati proficuamente

Slotted Aloha Analysis

- Il limite per N che tende ad infinito del throughput è noto (vedi corso Analisi Matematica) ed è:

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

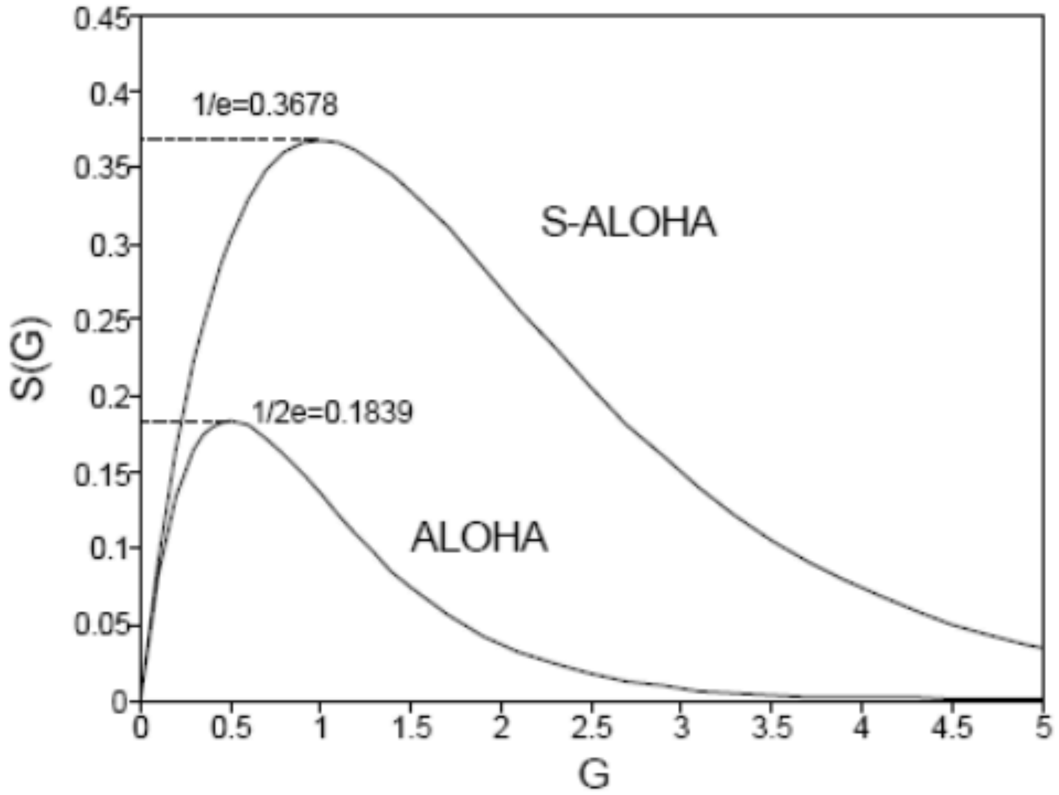
Per Aloha (non slottato) la collisione è più probabile, dunque l'efficienza è minore

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

Aloha and Slotted Aloha: Performance analysis

- If transmissions are somehow synchronized (slotted Aloha) the vulnerability period reduces to T and therefore

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



Infinite population model