TP Performance - Session 5

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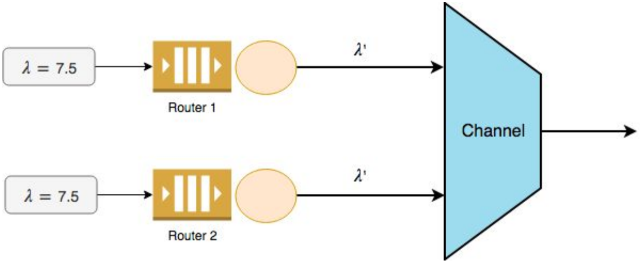
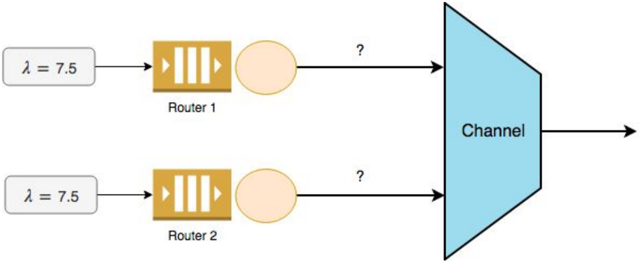
Aloha Model

- Packet arrival in the router: Poisson process of intensity λ
- Packet arrival in the channel (noted r): also a Poisson process of intensity λ' (M/M/1 queue)



Aloha Model

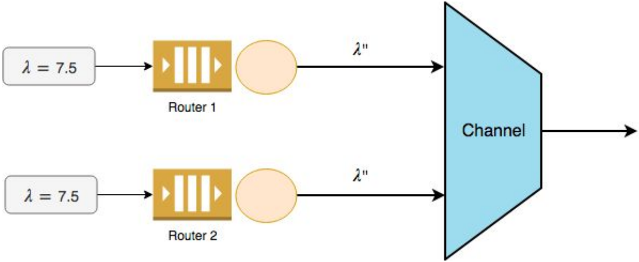
- Packet arrival in the router: Poisson process of intensity λ
- Packet arrival in the channel (noted r): also a Poisson process of intensity λ' (M/M/1 queue)
- Collison in Aloha = packet retransmission after random delay.
- Process of retransmitted packet arrival is noted R.



Aloha Model

Abramson assuption [1]

- The process $r + R$ is a Poisson process of intensity λ''. True if:
  - Random delay $\gg$ average packet transmission time
  - Number of retransmitted packet is small



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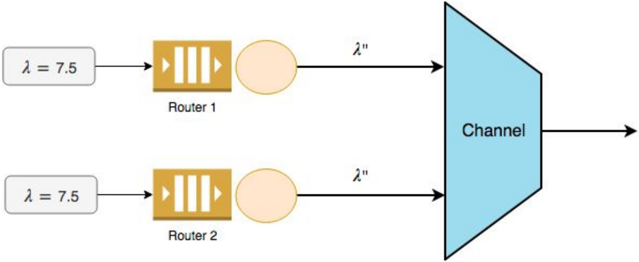

$$P(k \text{ arrival in interval } T) = \frac{[\lambda'' \cdot T]^k}{k!} e^{-\lambda'' \cdot T} \tag{1}$$

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Pure Aloha Model

- Let T_p be the average packet transmission time
- Suppose there is currently 1 packet transmission in the channel that started at t_0. When does a collision happen ?

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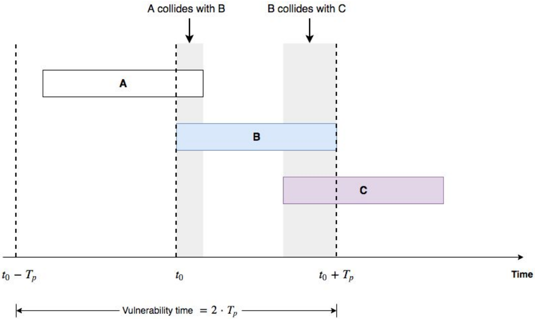

- A collision happens if:
  - Another packet has been sent between $t_0 - T_p$ and t_0
  - Another packet has been sent between t_0 and $t_0 + T_p$

Pure Aloha Model

- Probability of no collison:

$$P(0 \text{ arrival in } [t_0 - T_p, t_0 + T_p]) = e^{-2T_p \cdot \lambda''} \tag{2}$$

- We note $A = T_p \cdot \lambda''$ the average number of transmission attempts per time T_p
- The average throughput D is:

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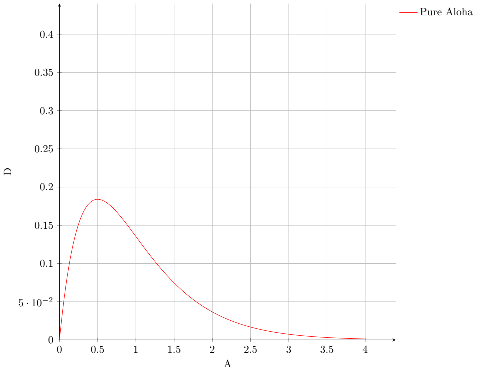
$$D = A \cdot P(\text{no collision}) = A \cdot e^{-2A} \tag{3}$$

Pure Aloha Model



- Maximal throughput:

$$\frac{dD}{dA} = 0 \Rightarrow A = 1/2 \quad (4)$$

- The throughput is maximized if the is 0.5 transmissions in time interval of T_P

Slotted Aloha Model

- Let S the duration of a time slot be equal to the average transmission time T_p
- Suppose there is currently 1 packet transmission in the channel that started at t_0. When does a collision happen ?

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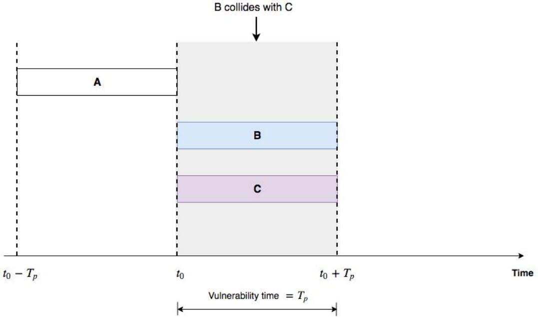


- A collision happens if:
  - Another packet is sent in the same time slot

Slotted Aloha Model

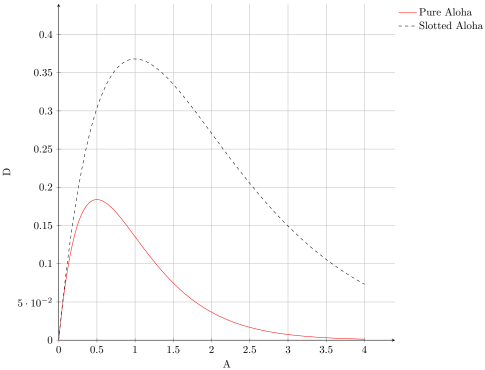
- Probability of no collison:

$$P(0 \text{ arrival in } [t_0, t_0 + T_p]) = e^{-T_p \cdot \lambda''} \tag{5}$$

- We note $A = T_p \cdot \lambda''$ the average number of transmission attempts per time T_p
- The average throughput D is:

$$D = A \cdot P(\text{no collision}) = A \cdot e^{-A} \tag{6}$$

Pure Aloha Model



- Maximal throughput:

$$\frac{dD}{dA} = 0 \Rightarrow A = 1 \tag{7}$$

- The throughput is maximized if the is 1 transmissions in time interval of T_P

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  - Channel idle: Transmit
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- Aloha does not consider the channel state
- A collision can be avoided simply by listening to the channel
- Carrier Sense Multiple Access (CSMA) $\approx$ Channel sense + Aloha
  - Channel idle: Transmit
  - Channel busy: Wait
- Is CSMA collision-free ? Does CSMA improve the throughput and latency ?