



POLITECNICO
MILANO 1863

Internet of Things Homework

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1 Exercise 3: RFID System - Dynamic Frame ALOHA

1.1 Task Summary

In this exercise, my task was to analyze an RFID system based on Dynamic Frame ALOHA (DFSA). The system is composed of $N = 4$ tags. My objectives were:

1. To find the overall collision resolution efficiency (η) for different initial frame sizes ($r_1 \in \{1, 2, 3, 4, 5, 6\}$). I assumed that after the first frame, the frame size is correctly set to the current backlog size.
2. To produce a plot showing the values of η over the initial frame sizes r_1 .
3. To determine for what value(s) of r_1 the maximum efficiency η is achieved and to comment on this.

1.2 System Parameters and Given Information

For my analysis, I used the following parameters:

- Number of tags (N): 4.
- L_k^* : Expected number of slots to resolve k tags when the frame size r is set to k .
 - $L_0^* = 0$
 - $L_1^* = 1$
 - $L_2^* = 4$
 - $L_3^* = 51/8 = 6.375$

1.3 1. Overall Collision Resolution Efficiency (η)

The efficiency is then defined as:

$$\eta = \frac{N}{L_N}$$

L_n is calculated using the recursive formula presented in the lecture slides:

$$L_n = \frac{r + \sum_{i=1}^{n-1} P(S=i)L_{n-i}}{1 - P(S=0)}$$

The resulting efficiencies and total expected slots for $N = 4$ tags, based on this methodology, are as follows:

Initial Frame Size (r_1)	L_n	Efficiency (η)
1	9.8241	0.4072
2	9.5995	0.4167
3	8.9544	0.4467
4	8.8241	0.4533
5	9.0377	0.4426
6	9.4661	0.4226

1.4 2. Plot of Efficiency (η) over r_1

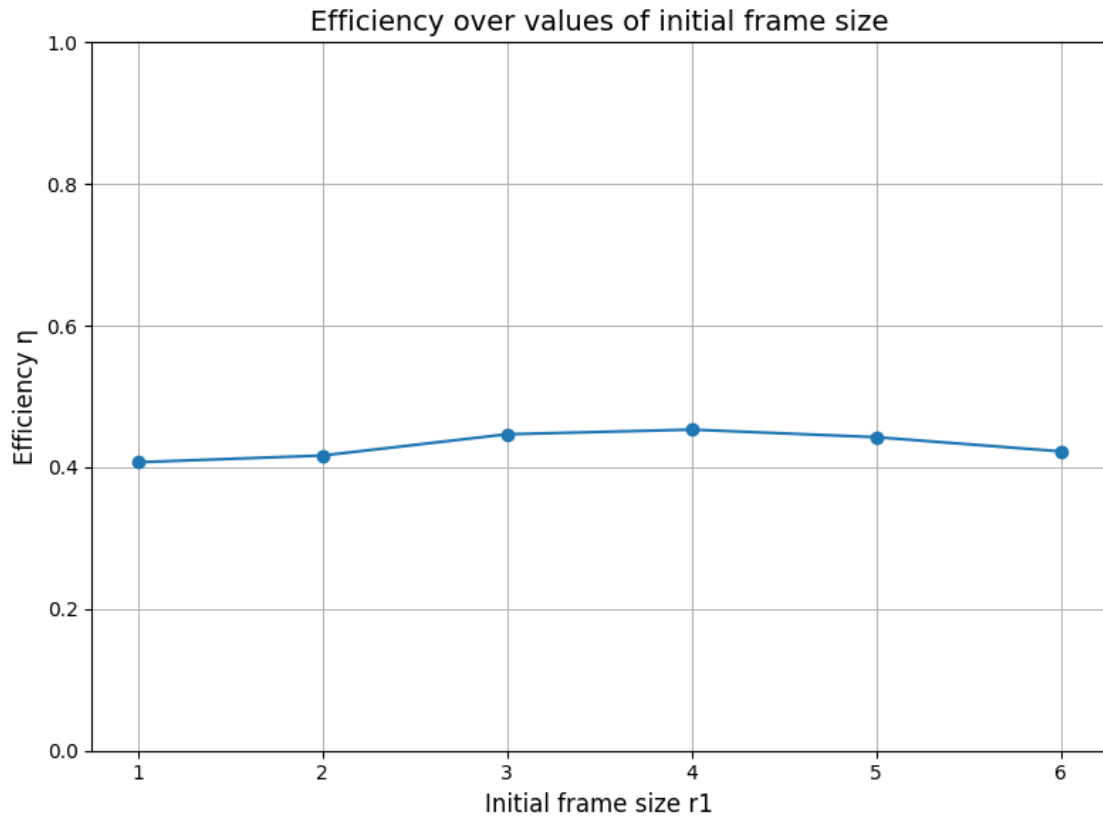


Figure 1: Efficiency (η) over values of initial frame size (r_1) for $N=4$ tags.

1.5 3. Optimal Initial Frame Size (r_1) and Comment

Based on my calculations and the plot:

Result:

This maximum efficiency is achieved at $r_1 = 4$

Comment: For this system with $N = 4$ tags, I found that the maximum overall collision resolution efficiency of approximately 0.4533 is achieved when the initial frame size (r_1) is set to 4. This result aligns with the general principle in ALOHA-based systems, including Dynamic Frame ALOHA, where setting the initial frame size close to the number of contending tags (N) yields the best performance. Thus, $r_1 = N = 4$ provides an optimal balance in this specific scenario.