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TP 2 – Exploring LoRa Technology – Performance Evaluation – Collisions and Packet Delivery Ratio

Questions to be Answered :

* Draw the PDR as a function of the average arrival rate. Analyze your results.
* What type of mathematical model enables to theoretically compute the PDR? Verify the obtained results.

# Draw the PDR as a function of the average arrival rate. Analyze your results.

We have repeated this experiment 5 times. The difference between each, was that we were changing the spreading factor or the delay between each sent message.

**Case 1:**

For , we vary between .

**Case 2:**

For , we vary between .

We agreed on sending the same message with small changes in order to recognize the sender’s number and the message number. The message would look like the following :

Sender#<Groupe\_Sender\_Number><0\_or\_1>:<Message\_Number>:Hello World

In order to compute the PDR value. We counted the number of packets that we received, then we divided by the total number of messages that were sent by a single device.

As an output we have managed to get a dictionary (key value pairs) containing the percentage of messages that we received by a specific sender. Example :

Average Dictionary:

{'80': 0.76, '9.1': 0.12, '19.1': 0.73, '9.0': 0.91, '16.1': 0.52, '41.1': 0.88, '10.0': 0.43, '5.0': 0.64, '12.1': 0.94, '3.0': 0.56, '12.0': 0.94, '6.1': 0.9, '6.0': 0.88, '81': 0.83, '10.1': 0.64, '7.1': 0.95, '7.0': 0.93, '1.1': 0.91, '3.1': 0.73, '5.1': 0.83, '1.0': 0.81}

We can see in the extract above, that the sender number 0 of group 8 has an average of 76 %. In the first case we have set , sent 100 messages and the number of devices that were sending were 21.

To summarize :

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SF** | **Delay** | **PDR of our device (90)** | **PDR of our device (91)** | **PDR moyen** |
| 7 | 5s | 91 % | 12% | 75.43 % |
| 11 | 5s | 0% | 10% | 9.84% |
| 9 | 5s | 100% | 63% | 50.63% |
| 9 | 1s | 3% | 6% | 8.9% |
| 9 | 20s | 95% | 95% | 63.80% |

We can deduce from the graph that the bigger was SF, the more collisions we have. This happens because the Time on Air increases when SF increases. As we can see, for a delay = 5s we have the average PDR as follows:

|  |  |
| --- | --- |
| **SF** | **Avg. PDR** |
| 7 | 75.43% |
| 9 | 50.63% |
| 11 | 9.84% |

On the other hand, if we increase the delay, the collision decreases because we are decreasing the probability of having multiple devices sending their messages at the same time. So, for a delay that is varying and SF fixed at 9, the PDR is :

|  |  |
| --- | --- |
| **Delay** | **Avg. PDR** |
| 1s | 8.9% |
| 5s | 50.63% |
| 20s | 63.80% |

# What type of mathematical model enables to theoretically compute the PDR? Verify the obtained results.

And

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| SF | Delay | ToA | Lambda | N | PDR Avg Th | PDR Avg. Exp |
| 7 | 5s | 61.7 ms | 1/5 | 21 | 62% | 75.53% |
| 9 | 5s | 205.82 ms | 1/5 | 21 | 17% | 50.63% |
| 11 | 5s | 823.3ms | 1/5 | 21 | 1% | 9.84% |
| 9 | 1s | 205.82 ms | 1 | 21 | 0.01% | 8.9% |
| 9 | 20s | 205.82 ms | 1/20 | 21 | 64% | 63.8% |

So,

**Case 1 (7\_5s):**

**Case 2 (9\_5s):**

**Case 3 (11\_5s):**

**Case 4 (9\_1s) :**

**Case 5 (9\_20s) :**

In conclusion, we can see that the experimental and theoretical values are almost the same. We can deduce that when SF increases, PDR decreases and when the delay increases, the PDR increases.