Communication Network Design - AY 2021/2022
Homework *2: 2052409*

1 Introduction

In this report I'm going to describe the procedure I used to estimate the TBF parameter in order to obtain a compliancy probability over 0.9. I'm also going to describe how and why some approximation were made and the limits of this procedure.

All the source parameters and their corresponding values are consistent with those specified in the assignment.

2 TBF Parameters

In our scenario we have an ON/OFF source which generates packets over the ON period with a VBR (which randomness is given by the variability of the geometrically distributed batch size) and that remains in the OFF period for an exponentially distributed time.

To determine the TBF parameters (ρ and b) we need therefore 2 independet equations. Nonetheless we cannot obtain a deterministic equation for them, while the probabilistic bound would be:

$$\mathbb{P}[\text{Pck is Compliant}] = \mathbb{P}_{joint}[(\mu - \rho)T_{ON} < b;\ \text{Fill the bucket in the OFF period}] > 0.9.$$

where $\mu = \text{Peak rate} = \frac{LB_i}{\tau}$.

This is a single equation with 2 unknown variables, moreover the 2 events are not independent and would require a joint probabilistic description (in facts the time we need to fill the bucket depends on the state of the bucket at the end of the ON period).

To solve this problem I considered an approximation of the original source based on the observation that the greater risk of "non-compliancy" occurs during the ON period and in particular when the batch size B_i at time t_i is "too big".

The approximation of the model is based on the following assumptions:

- $T_{OFF} = 0$.
- After τs the bucket must be filled again even if it was empty:

$$\rho\tau \geq b \tag{1}$$

- 90% of the packets are compliant if at every arrival time the batch size is less than b/L, namely:

$$\mathbb{P}[\text{Compliancy}] = \mathbb{P}[B_i < b/L] > 0.9 \tag{2}$$

From Equation 2, keeping in mind that B_i is a geometric r.v. with parameter 1/3, I estimated $b = 5678$[bit]. Replacing this value in Equation 1 I obtained: $\rho = 28395$[bit/s].

3 Experiments using the simulated Source/TBF

By using the values given in the assignment I simulated $N_C = 10000$ cycles of the ON/OFF source. I then fed the results found in the last section to the TBF and obtained the following results:

- Relative Frequence of 0 (non-compliant packets): 0.137662.

- Relative Frequence of 1 (compliant packets): 0.862338.

This result is not perfect due to the approximation, but could be even better if we build a source s.t. the "weight" of the arrival events is increased, namely decreasing the interarrival time to e.g. $\tau = 0.02$. In this case by computing ρ again with the new value of τ ($\rho = 283900$) I obtained a relative frequence for 1 of 0.868164 which represents a small improvement w.r.t. the first experiment.

Of course the entire model could be improved almost arbitrarily well by considering also the contribution of the OFF period and by computing the joint probability above, but this seems a good approximation nonetheless.

4 Proposed Experiment

The last experiment was performed by using the TBF's parameters proposed in the assignment (point 3).

Note that the parameters are:

$$b = 3000[bit] = \text{ Average number of bits arriving at each arrival time}$$

$$\rho = 8000[bit/s] \approx \text{ Average traffic in an entire ON/OFF cycle} = 7500[bit/s]$$

With these values I simulated the following performance for the TBF:

- Relative Frequence of 0: 0.461398.
- Relative Frequence of 1: 0.538602.

Note how even if we are using values which could intuitively perform well, the non-compliancy is extremely likely. This is due to the queue-like behaviour of the TBF filter.