Open and virtualized networks - Network Exercises - Part 8

Network Exercise

The aim of these exercises is to define in the network abstraction a more precise evaluation of the noise introduced by the propagation through a fiber-optic line. This exercises can be part of the material for the final exam questions. You are strongly encouraged to find yourself a solution to the presented problems.

1. Modify the **set_weighted_path** method of the **Network** class such that it calculates the GSNR of a propagating **Lightpath** with the optimal signal power of each line composing the path. Use the **Node** class to set the correct optimal power at the input of each line.

2. Add an attribute **transceiver** to the class **Lightpath** defining the modulation formats supported, which can be `fixed-rate`, `flex-rate`, `shannon`. Add another attribute **bitrate** to **Lightpath** class which stores the bitrate R_b supported by the lightpath. Implement a method **calculate_bitrate()** of the **Network** class giving the bitrate R_b supported by the lightpath accordingly to the available GSNR and transceiver technology using the following equations.

$$R_b = \begin{cases} 100 \text{ Gbps}, & \text{if GSNR} \geq 2\,\text{ierfc}^2\left(2\text{BER}_t\right)\frac{R_s}{B_n} \\ 0, & \text{otherwise} \end{cases} \tag{1}$$

$$R_b = \begin{cases} 0 \text{ Gbps}, & \text{if GSNR} < 2\,\text{ierfc}^2\left(2\text{BER}_t\right)\frac{R_s}{B_n} \\ 100 \text{ Gbps}, & \text{if } 2\,\text{ierfc}^2\left(2\text{BER}_t\right)\frac{R_s}{B_n} \leq \text{GSNR} < \frac{14}{3}\,\text{ierfc}^2\left(\frac{3}{2}\text{BER}_t\right)\frac{R_s}{B_n} \\ 200 \text{ Gbps}, & \text{if } \frac{14}{3}\,\text{ierfc}^2\left(\frac{3}{2}\text{BER}_t\right)\frac{R_s}{B_n} \leq \text{GSNR} < 10\,\text{ierfc}^2\left(\frac{8}{3}\text{BER}_t\right)\frac{R_s}{B_n} \\ 400 \text{ Gbps}, & \text{if GSNR} \geq \ 10\,\text{ierfc}^2\left(\frac{8}{3}\text{BER}_t\right)\frac{R_s}{B_n} \end{cases} \tag{2}$$

$$R_b = 2R_s \log_2\left(1 + \text{GSNR} \cdot \frac{B_n}{R_s}\right) \text{ Gbps} \tag{3}$$

where (1) is for the `fixed-rate` transceiver assuming PM-QPSK modulation; while (2) is for the `flex-rate` transceiver assuming it is capable to use PM-QPSK (100Gbps), PM-8-QAM (200Gbps) and PM-16QAM (400Gbps) modulations, given a BER_t of 10^{-3}. (3) is the maximum theoretical Shannon rate with ideal Gaussian modulation. R_s is the symbol-rate of the lightpath and B_n is the noise bandwidth (12.5 GHz). Modify the **stream()** method **Network** class so that the connection request is blocked if the lightpath doesn't meet the GSNR requirements according to the chosen **transceiver** mode (zero bitrate case).

3. Write a method **calculate_capacity()** in the class **Connection** that calculates the bitrate supported by the lightpath deploying the connection, based on the lightpath GSNR.

4. Plot the histogram of the accepted connections bitrates and calculate its average. Also calculate the total capacity allocated into the network