Open Optical Networks
Lab 8

December 2, 2020

These exercise sets cover some aspects you will find useful for the final exam software development. 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.

Exercises

Given the weighted graph based on the GSNR metric of each path, we want to add the concepts of capacity and transceiver strategy.

1. Implement a method **calculate_bit_rate(path, strategy)** in the **Network** class that evaluates the bit rate R_b supported by a specific path given the corresponding GSNR and the transceiver technology using the following equations:

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

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

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

where (1) is for the `fixed-rate` transceiver strategy assuming PM-QPSK modulation, (2) is for the `flex-rate` transceiver strategy assuming the availability of PM-QPSK (100Gbps), PM-8-QAM (200Gbps) and PM-16QAM (400Gbps) modulations, given a BER_t of 10^{-3}. In conclusion, (3)

is the maximum theoretical Shannon rate with an ideal Gaussian modulation. R_s is the symbol-rate of the light-path and B_n is the noise bandwidth (12.5 GHz).

2. Add the attribute **transceiver** to the class **Node**. This attribute can be `fixed-rate`, `flex-rate`, `shannon` and must be read from the network description json file. If the transceiver is not provided in the description file, it has to be set as `fixed-rate`.

3. Modify the **stream()** method of the **Network** class that has to call the **calculate_bit_rate(path, strategy)** once the path for the connection is given and using the transceiver attribute value of the first node in the path. If the path does not reach the minimum GSNR requirement for the specified transceiver strategy (zero bit rate case), the connection has to be rejected. Add the attribute **bit_rate** to the **Connection** class that stores the assigned bit rate R_b.

4. Run the main that evaluates the distribution of the SNR on a list of 100 randomly chosen connections for both the network description json files and plot the histogram of the accepted connections bit rates calculating the overall average. Also calculate the total capacity allocated into the network.