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PRESENTATION #TU3F.3

POLITECNICO DI TORINO

DATA-RATE FIGURE OF MERIT FOR PHYSICAL LAYER IN FIXED-GRID RECONFIGURABLE OPTICAL NETWORKS

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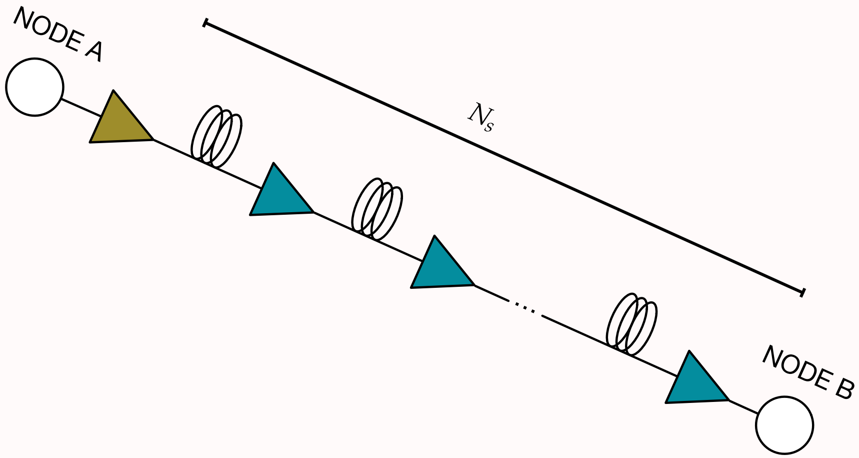
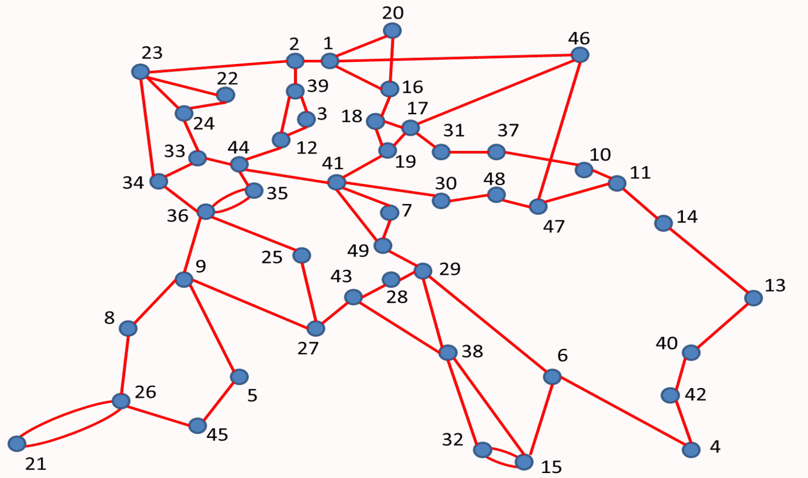
PRESENTATION OUTLINE

- Research Context and Motivation
- The Statistical Network Assessment Process (SNAP)
- Example of application
- Results
  - Flex Rate Transceivers comparison
  - NLI impact evaluation
  - NLI models comparison
- Conclusions

TWO GENERIC QUESTIONS

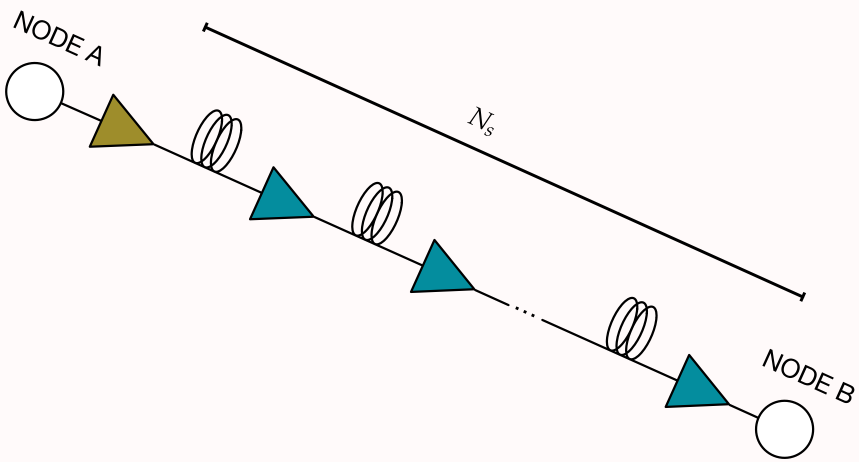


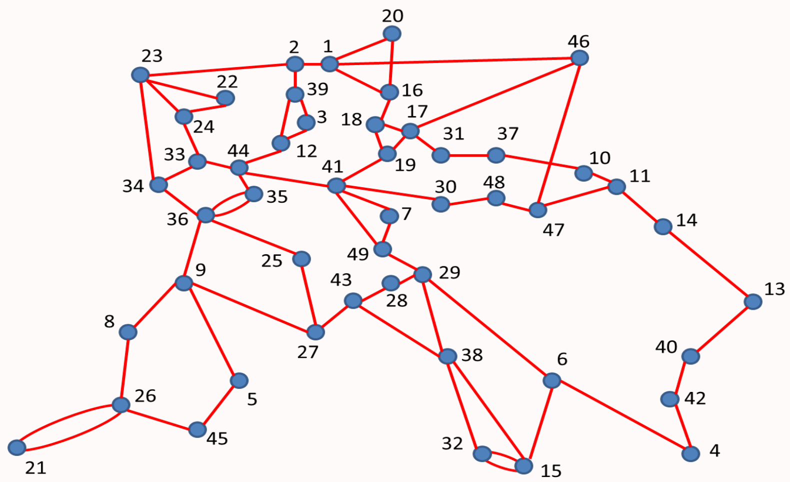


Can we estimate the **performance** of this **uncompensated link** operated with **coherent transponders**, given the physical layer technologies adopted in it?

Can we estimate the performance of this **optical network** made of **uncompensated links** operated with **coherent transponders**, given the physical layer technologies adopted in it?

TWO POSSIBLE ANSWERS

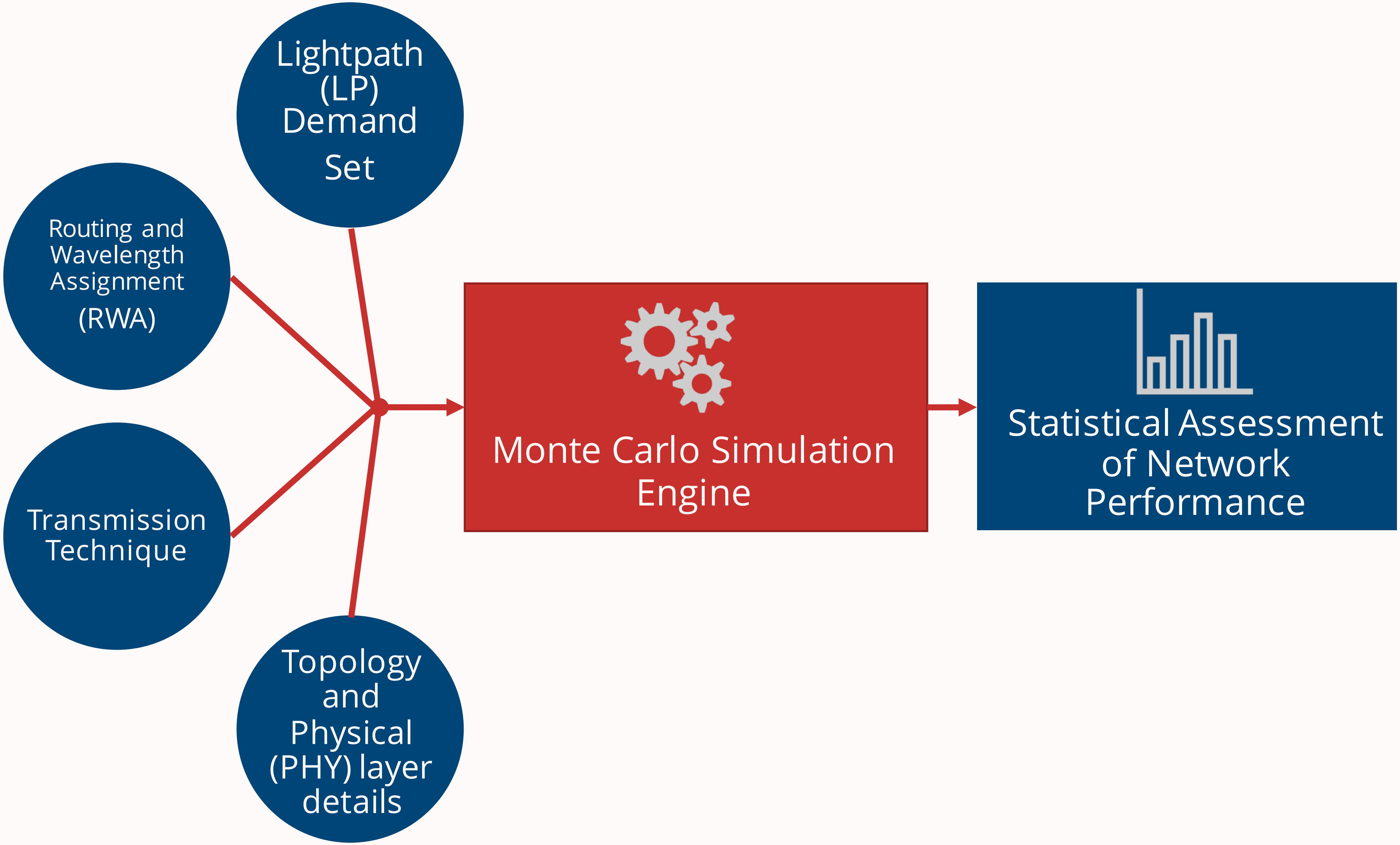




- Figure of merit: **Optical Signal to Noise Ratio (OSNR)**
- Computed through simulation or **Non-Linear Interference (NLI) models**

- Figure of merit: …
- Computed through …

INTRODUCING THE STATISTICAL NETWORK ASSESSMENT PROCESS (SNAP)



M. Cantono et. al. “Potentialities and Criticalities of Flexible-Rate Transponders in DWDM networks: a Statistical Approach” – To appear in Journal of Optical Communications and Networks (JOCN) – Special Issue on Elastic Optical Networks

SNAP – AN EXAMPLE OF APPLICATION

DATA-RATE FIGURE OF MERIT FOR PHYSICAL LAYER OF OPTICAL NETWORKS

TARGET ANALYSIS

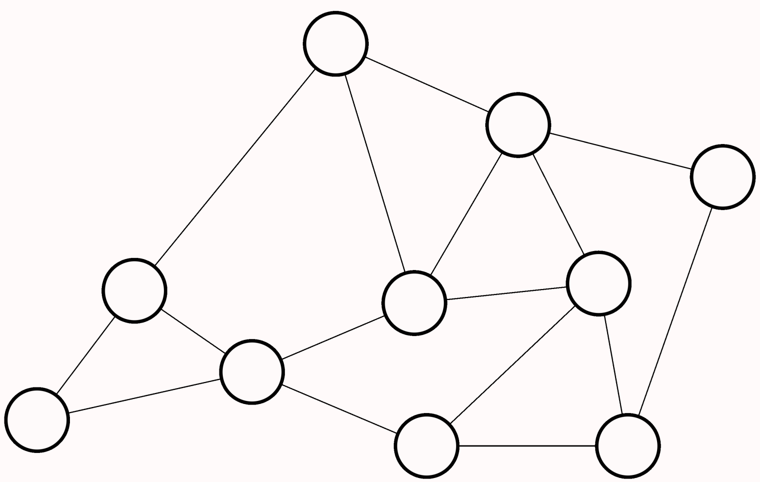
Network performance figure of merit: **Average BitRate per LightPath $R_{b,\lambda}$**

SNAP based analysis: **Monte Carlo** random loading of transparent optical network

Network load test: network loaded up to saturation

ALGORITHM – SINGLE MONTE CARLO RUN

Repeat until the network is fully saturated or allocation fails N_m consecutive times



Draw nodes' pair from uniform distribution

QoT routing and **first fit WA**

Assign a bitrate for each allocated LP given its OSNR and the adopted transmission technology

PHYSICAL NETWORK MODEL AND ROUTING METRIC

LOGO

Locally Optimized Globally Optimized (**LOGO**) Strategy – Each link operates at optimal power

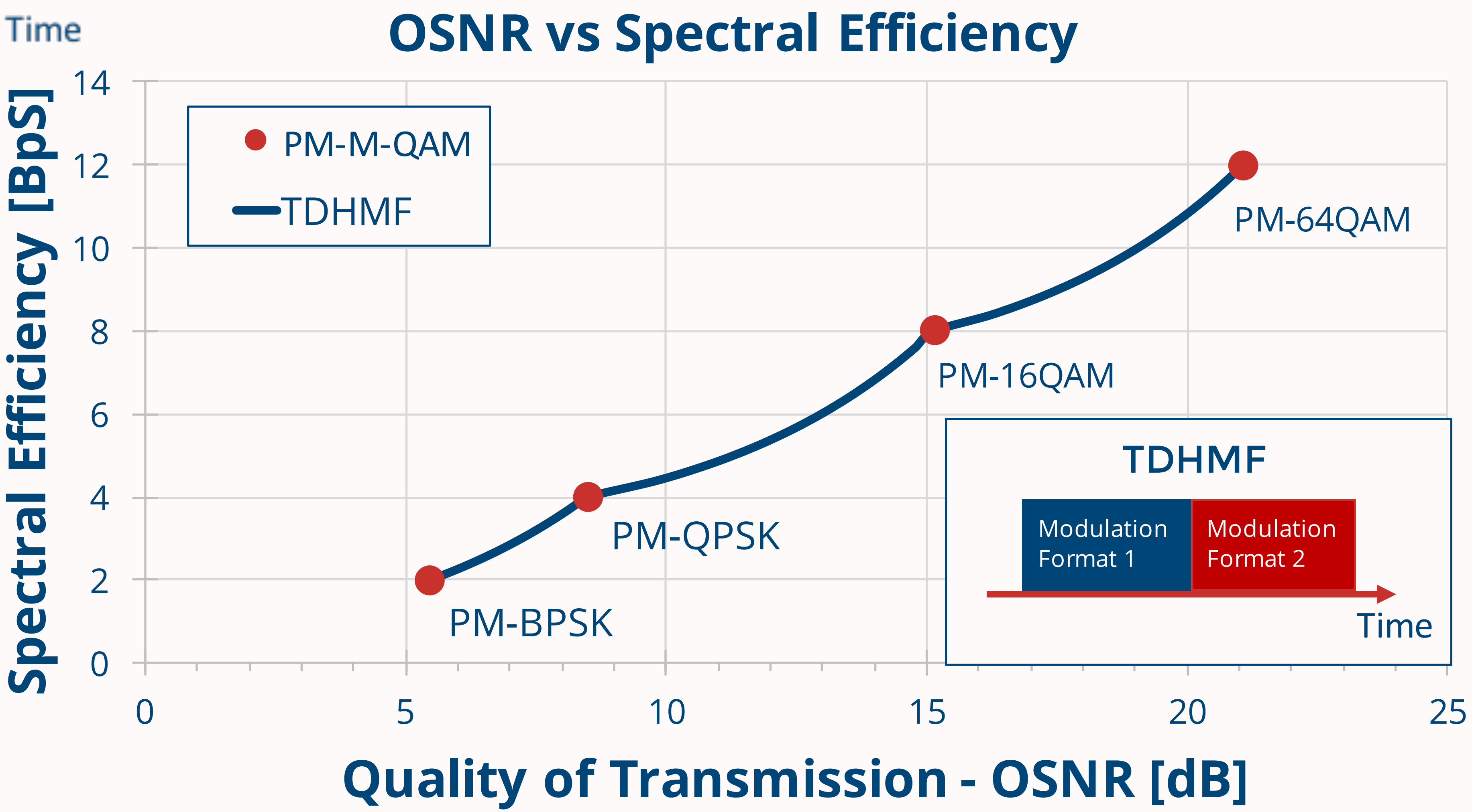
OSNR

Graph metric: Optical Signal-to-Noise Ratio (**OSNR**)

IGN

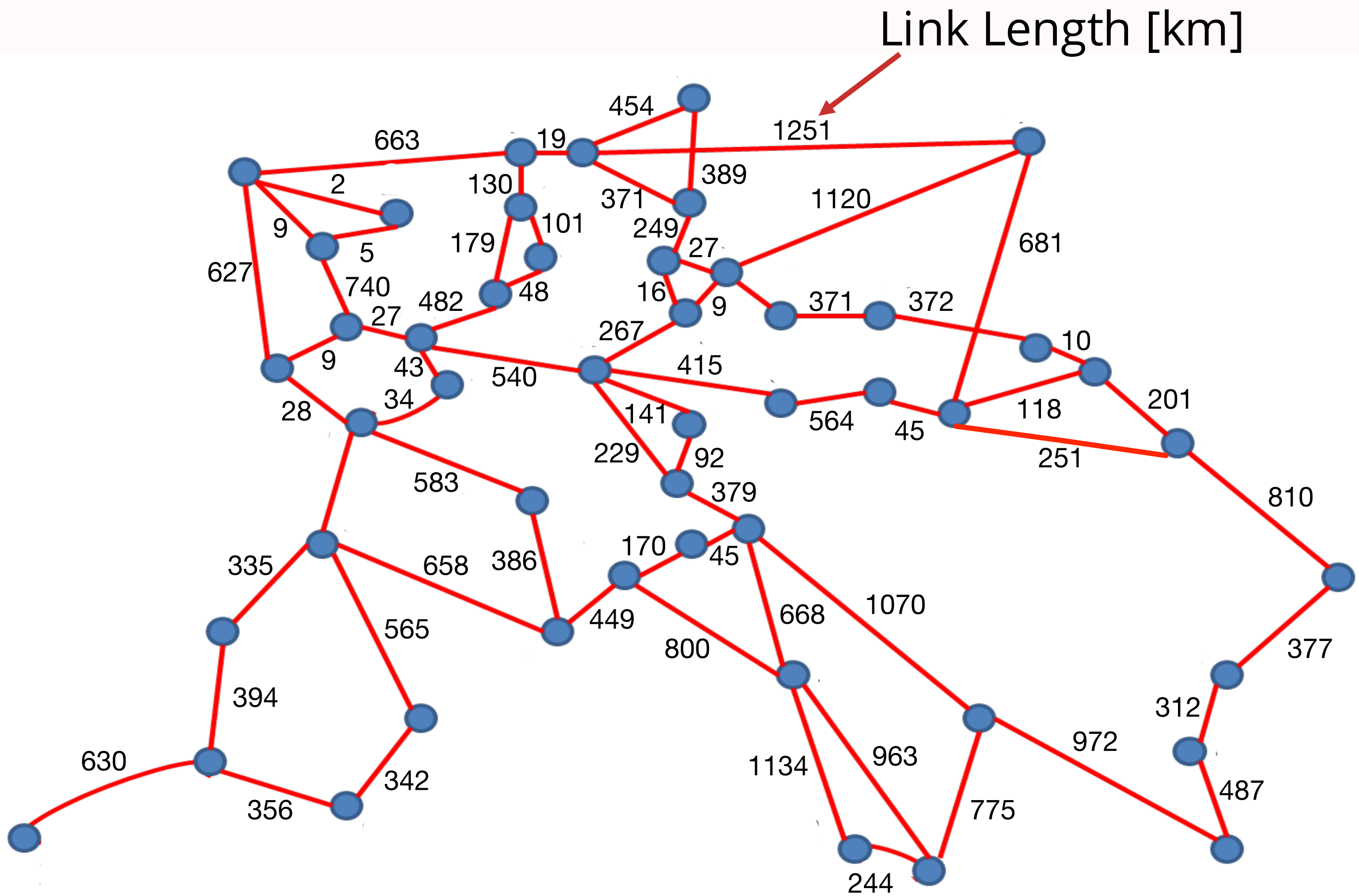
OSNR of LPs computed through the **Incoherent Gaussian Noise** (**IGN**) model

TRANSMISSION TECHNIQUES

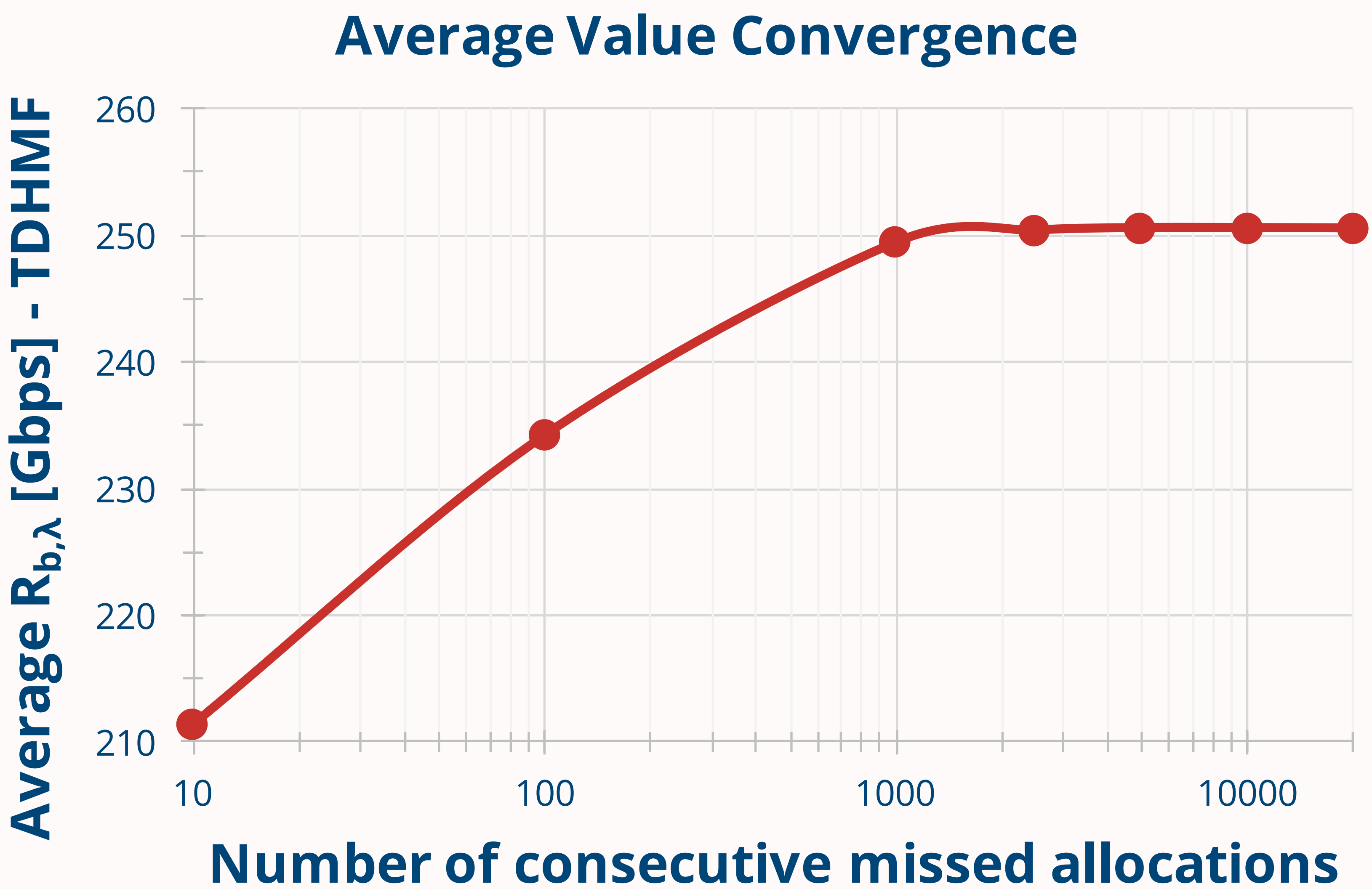


SCENARIO – PAN EUROPEAN TOPOLOGY

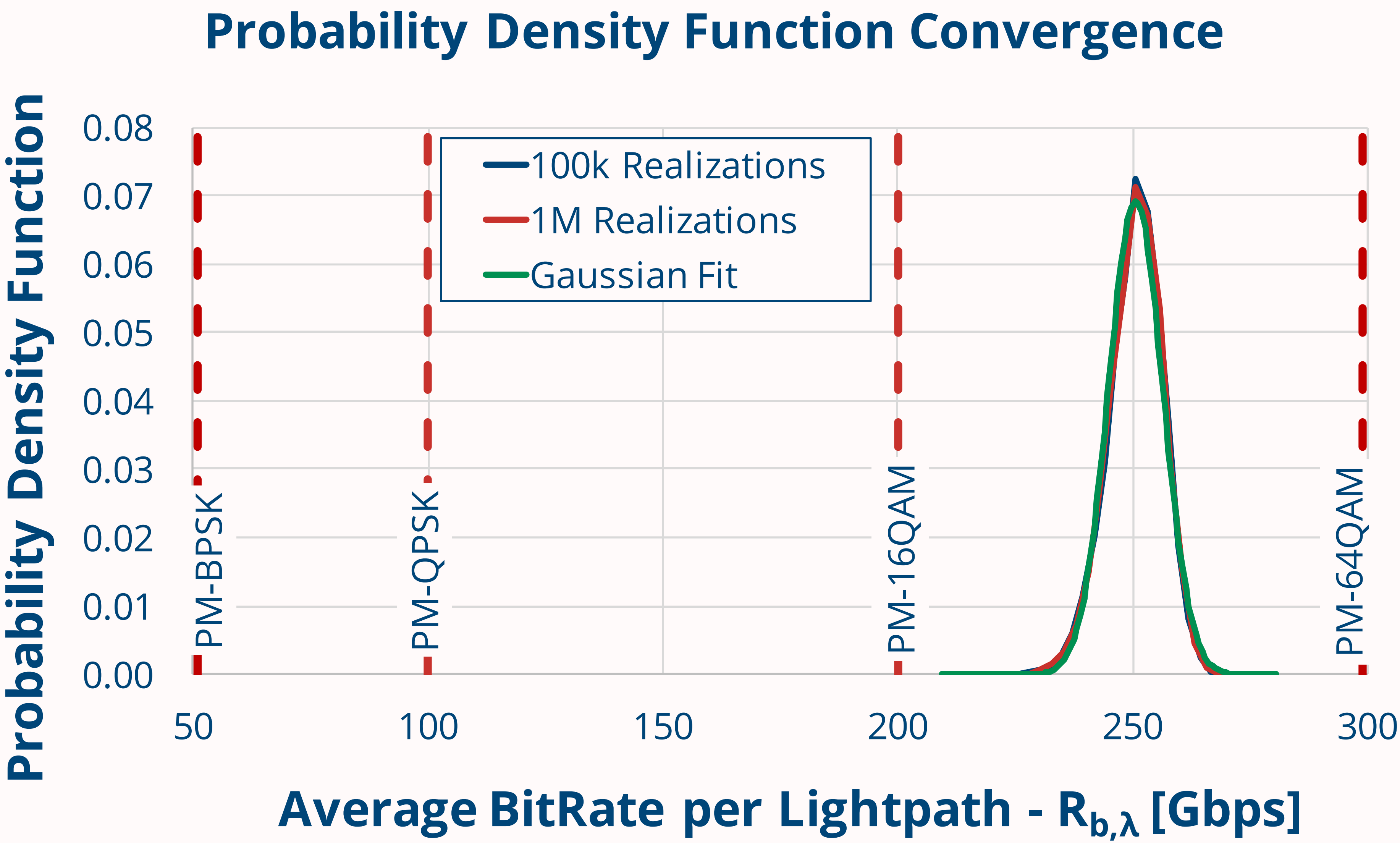
- 49 Nodes
- 68 Bidirectional Links
- Standard Single Mode Fiber (SSMF)
  - α_{dB}=0.2 dB/km
  - A_{eff} = 80 um^2
  - n_2=2.50E-20 m^2/W
  - γ = 1.27 1/W/km
  - D = 16.7 ps/nm/km
- Node Loss = 10 dB
- 80 DWDM channels at 32 GBaud gross (25GBaud net) symbol rate



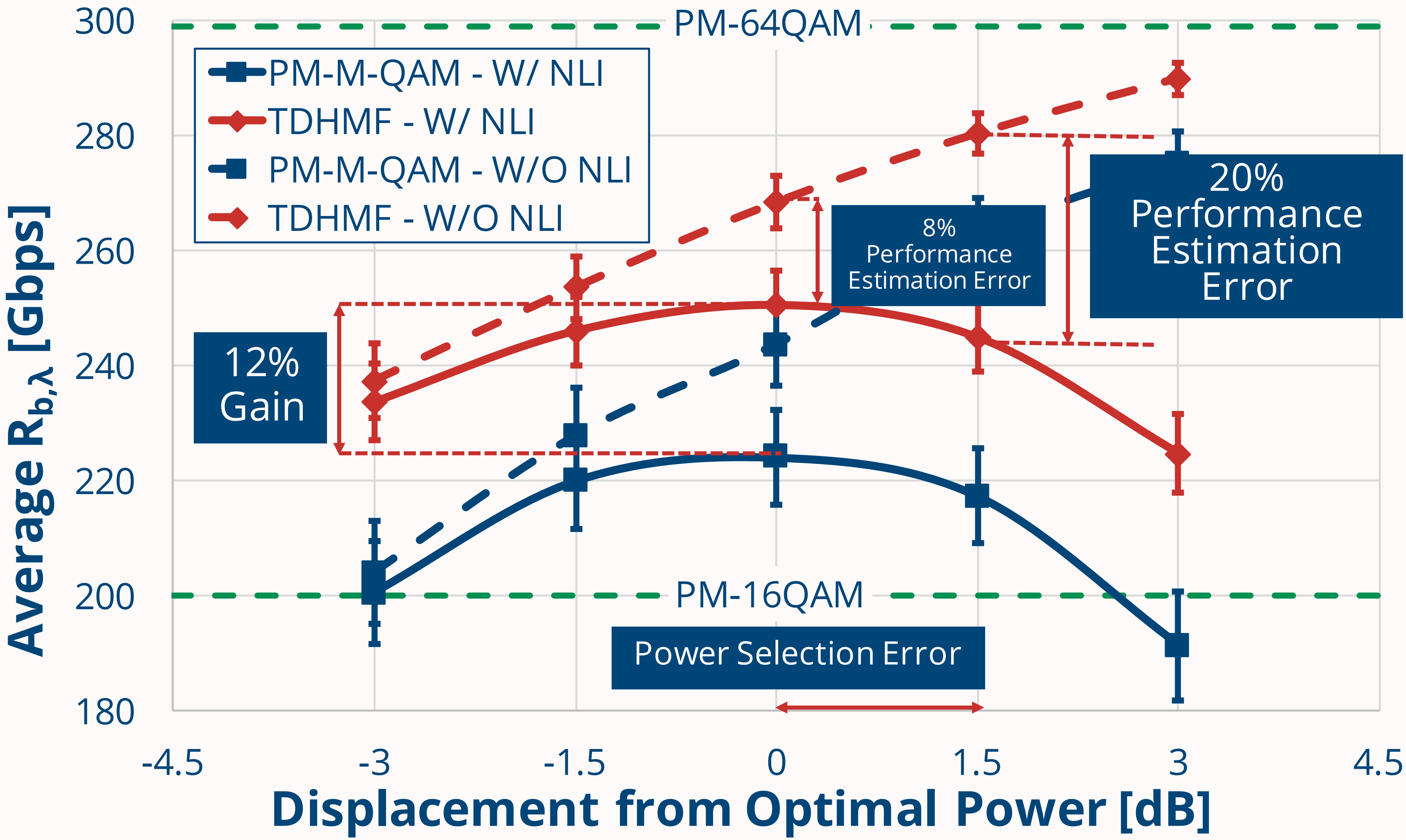
MONTE CARLO TUNING



MONTE CARLO TUNING



SYSTEM RESULTS



NLI MODELS COMPARISON

Incoherent Gaussian Noise (**IGN**) Model

P. Poggiolini et. al. “The GN-Model of Fiber Non-Linear Propagation and its Applications,” in JLT, vol. 32, no. 4, pp. 694-721, Feb.14

VS

Coherent Gaussian Noise (**GN**) Model

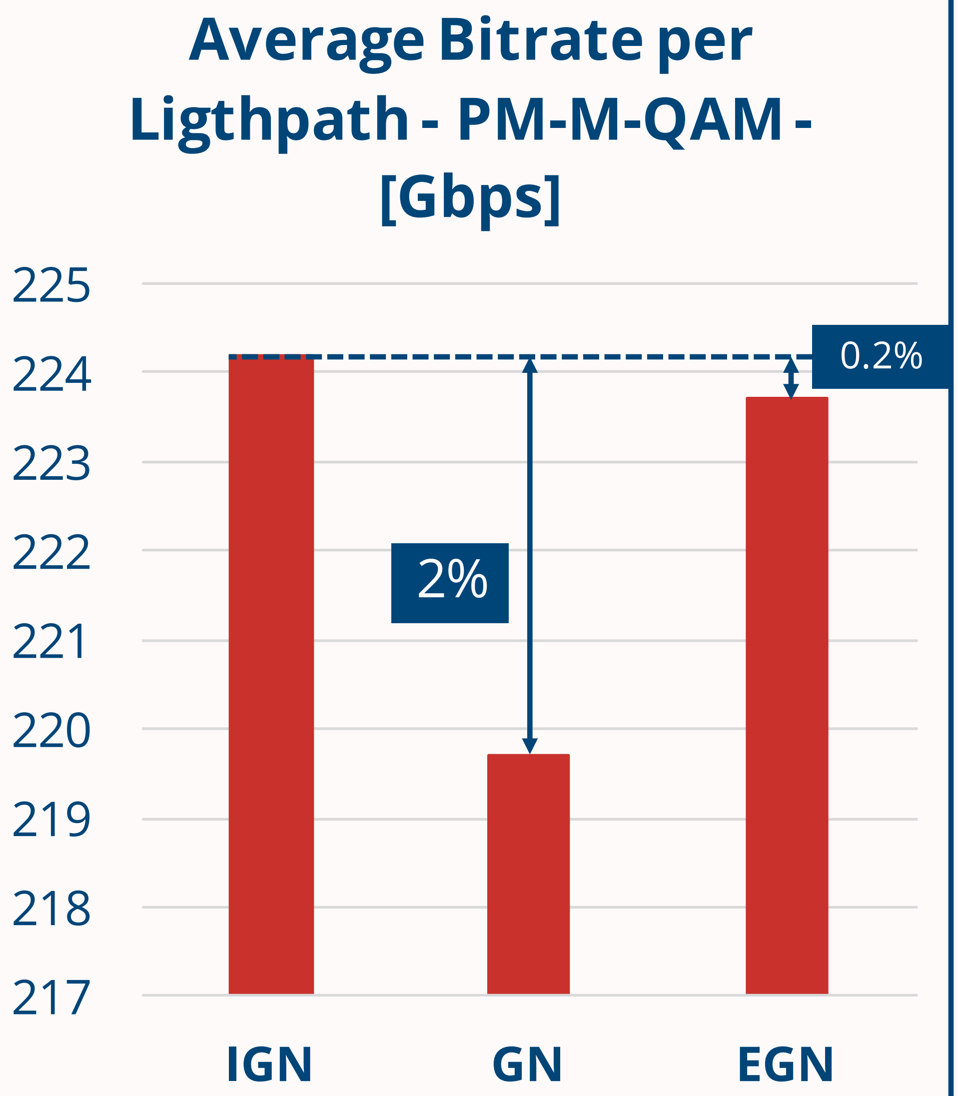
P. Poggiolini et. al. “The GN-Model of Fiber Non-Linear Propagation and its Applications,” in JLT, vol. 32, no. 4, pp. 694-721, Feb.14

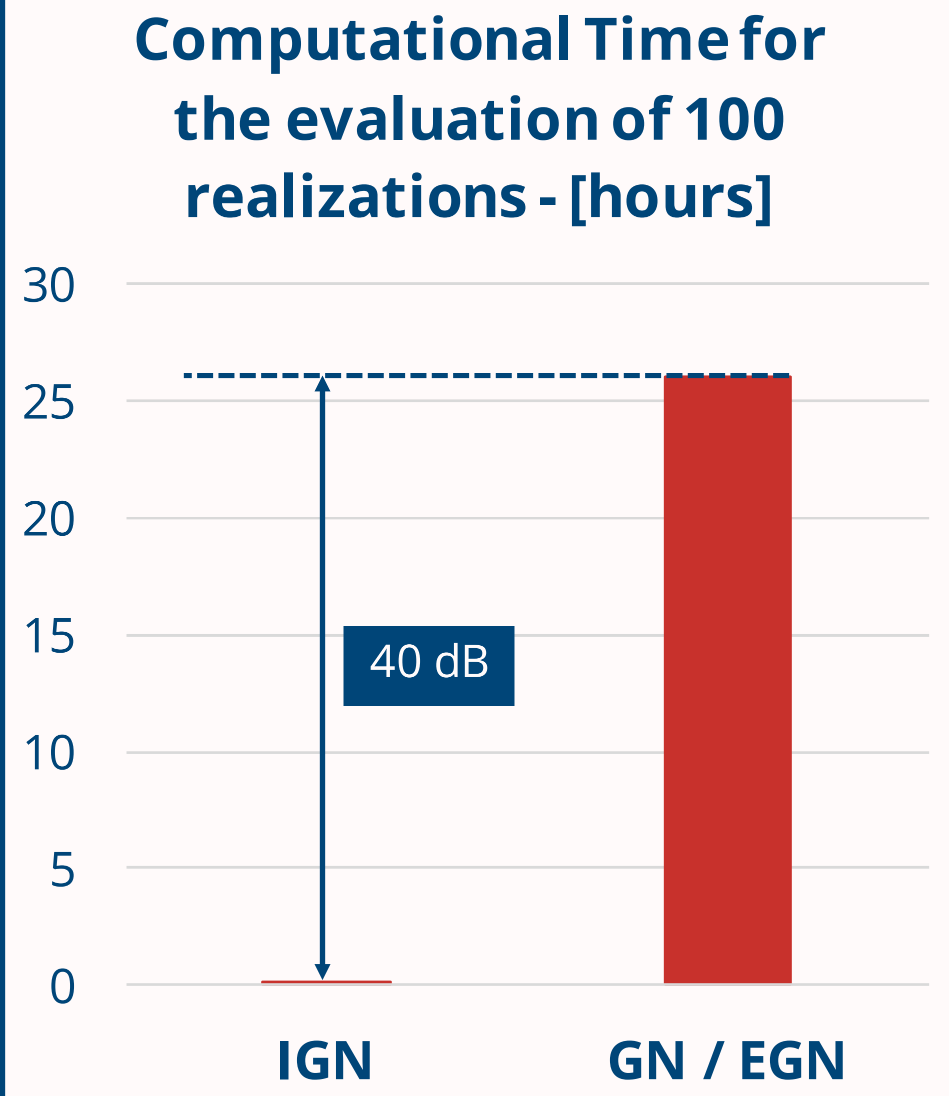
VS

Enhanced Gaussian Noise (**EGN**) Model

A. Carena et. al. “EGN model of non-linear fiber propagation” Opt. Express 22, 16335-16362 (2014)
P. Poggiolini “Recent Advances in Non-linear Fiber Propagation Modeling” OFC 2016 – Session W3I.4 - Invited Tutorial

SYSTEM RESULTS – NLI MODELING





CONCLUSIONS

- A **new algorithm for optical networks benchmarking** was also proposed.
- **TDHMF outperforms PM-M-QAM of 12%** at optimal launch power.
  - Better continuity and granularity in BpS vs OSNR
- **8% NLI penalty** in terms of average bitrate per channel is demonstrated at network level.
- **IGN model** should be the **non-linear modeling option of choice** in reconfigurable optical networks scenarios, as its **performance** are extremely **similar to** the one obtained with the more precise, yet more computationally expensive, **EGN model.**

THANK YOU!

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NLI COMPARISON

Consider the set of allocated LPs of each realization (route and assigned modulation).

Recompute each OSNR using the GN model (integration of GN reference formula). Considering the modulation assigned when using IGN, compute the EGN correction factor.

Assign a new bitrate for each allocated LP given its OSNR and the adopted transmission technology

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