Exploring the Effects of Physical Layer Parameters in WDM based Fixed and Flexible-Grid Networks

Abstract: Coherent technology with electronic compensation of fiber chromatic-dispersion has made it possible to use multilevel modulation formats that increase optical systems Spectral Efficiency (SE). Besides that, it has also drastically changed the key features of signal propagation and of non-linearity generation in the fiber. Hence, simplified models are no longer valid. This proposal accentuates the importance of investigating the impact of fiber nonlinearities in the design of optical networks.

GN-Model: (Gaussian-Noise Model)

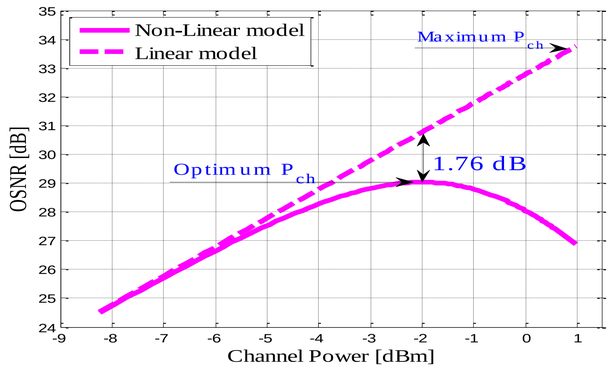

Figure 1: OSNR vs. Channel power for linear and non-linear model

- Performance prediction tool for non-linear propagation in dispersion Uncompensated Coherent Systems
- Signal Disturbance generated by non-linearity manifests itself as Additive Gaussian noise (AGN)

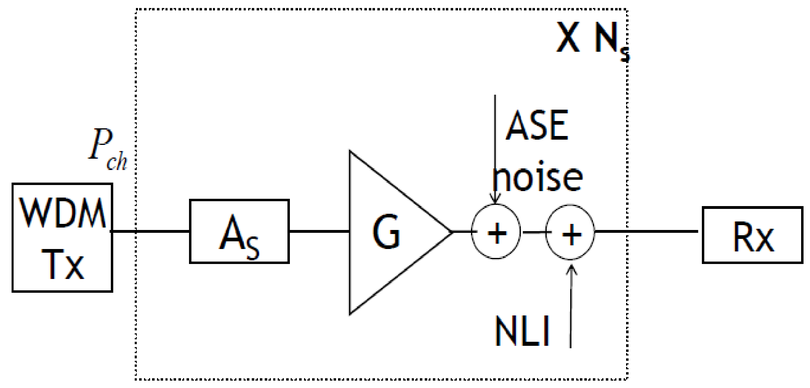

Figure 2: Point-to-point link layout

Our use case scenario

- **Three architecture scenarios:**
  - 1) Fixed-grid with pure formats (FPF),
  - 2) Fixed-grid with TDHMF (FHF) and
  - 3) Flexible grid with pure formats
- 20-nodes random network topology with uniform traffic matrices

FIBER CHARACTERISTICS

Fiber Type	α_{dB} (dB/km)	D (ps/nm/km)	A_{eff} (μm²)
NZDSF	0.2 dB/km	4 ps/nm/km	55 μm²
SSMF	0.2 dB/km	16.7 ps/nm/km	80 μm²
PSCF	0.17 dB/km	21.0 ps/nm/km	135 μm²

Results

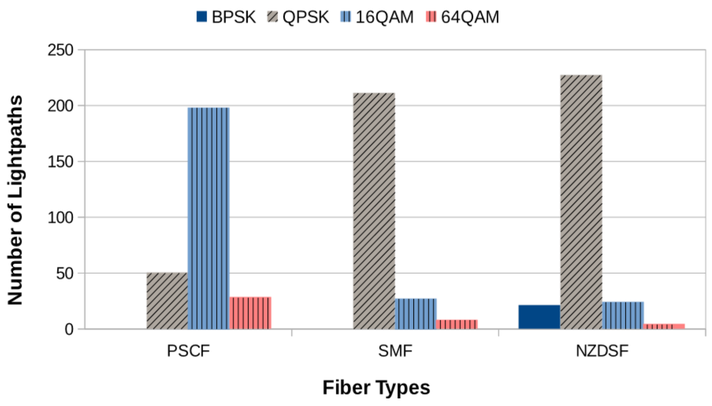

Figure 3: Flex-grid: Different fiber types

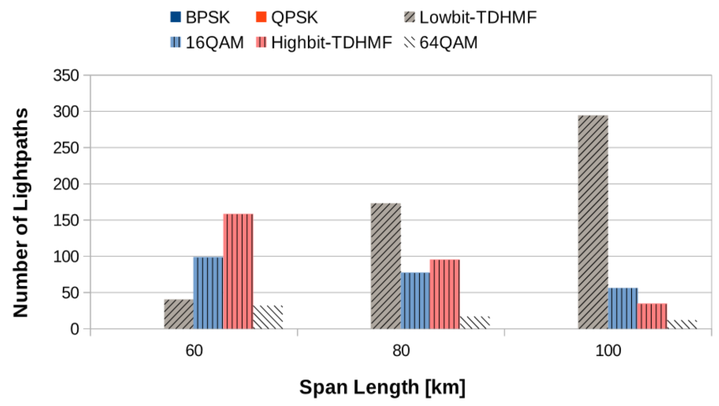

Figure 4: Fix-TDHMF: Varying span length

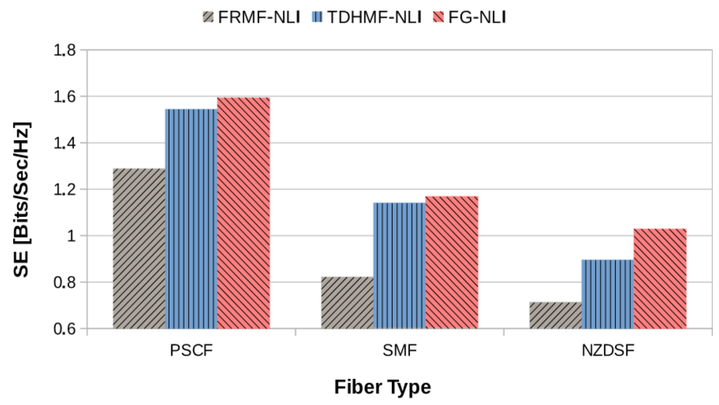

Figure 5: Spectral efficiency variation with changing fiber types

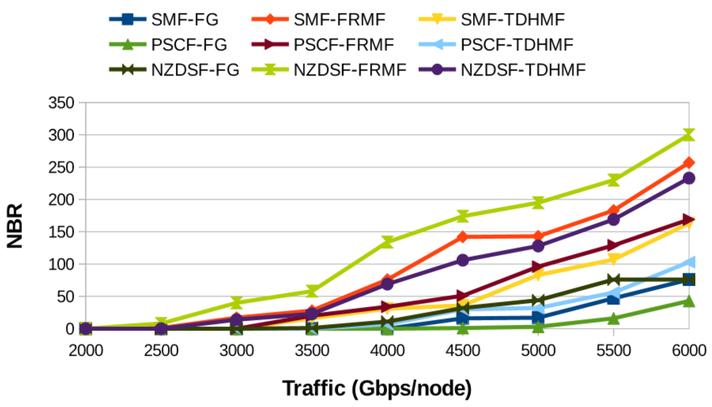

Figure 6: Number of blocked requests vs. Traffic (Gbps/node), varying fiber type for different network scenario

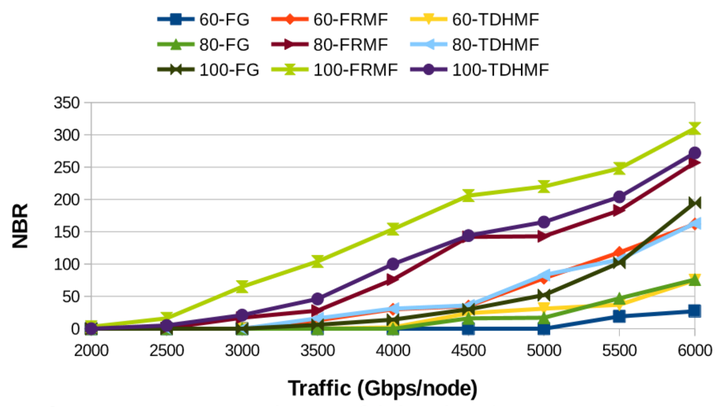

Figure 7: . Number of blocked requests vs. traffic (Gbps/node), varying the span length for different network scenario

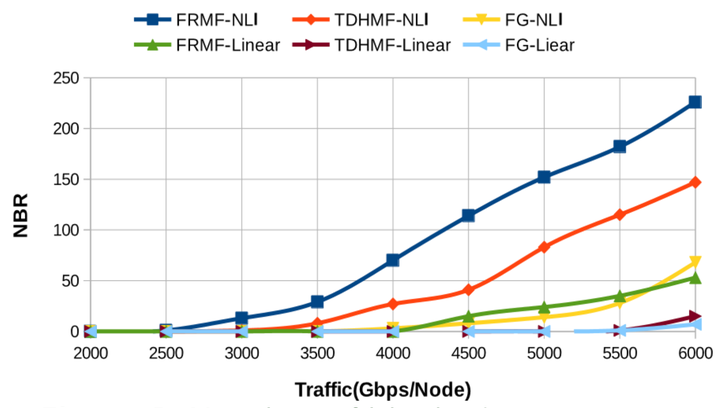

Figure 8: Number of blocked requests vs. traffic (Gbps/node), using a simplified physical layer model (Linear) vs. a detailed model with non-linear interference (NLI).

Summary

- **Inaccuracy** of using linear model can reach up to **25%,** this shows the importance of including non-linearity in calculating OSNR based on GN-model.
- **Non-linearity decreases** as fibers' **effective area increases** and consequently OSNR increases. Hence, fibers are odered as follows in terms of performance: PSCF, SMF and NZDSF.
- **TDHMF** shows to be a good solution to **increase** current DWDM fixed-grid network **capacity**.

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