Power Control Strategies in C+L Optical Line Systems

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INTRODUCTION AND MOTIVATION

In order to maximize their returns on CAPEX, operators are pushing towards **multiband transmission**, at least on **C+L bands**, as a strategy to push further the capacity by exploiting the existing infrastructure. In this scenario, **power control implementation in the optical line system (OLS) controller** is a key point to maximize the SNR as a unique QoT metric determining the BER, independently on the transponder vendor [1].

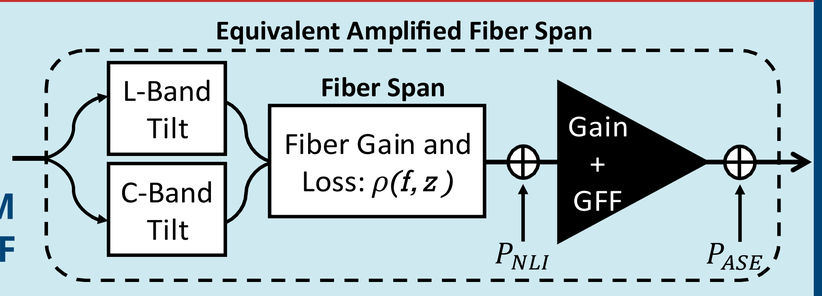
MULTIBAND TRANSMISSION ISSUES

- **LOGO implementation** [2] **is suboptimal** when filling the C-Band and beyond since it neglects any frequency dependence by focusing on the worst-case center channel SNR.
- Multiband transmission triggers intense **Stimulated Raman Scattering** (SRS), which is maximum over a 13 THz bandwidth, thus near to the C+L-Band extension [3].
- **NLI interaction with the frequency variations of the power profile** induced by SRS and DRA has to be taken into account using the generalized GN (GGN) model [3-4]
- The **ASE noise frequency dependence** enhanced by distributed Raman amplification (DRA) needs a frequency resolved approach to avoid large system margins

Pre-tilting C and L band as a different power control strategy to overcome LOGO frequency independence.

C+L SYSTEM SETUP

- **161, 200G** channels
- **83 C-Band** channels
- **78 L-Band** channels
- **32GBaud, PM-16QAM**
- **10 spans x 80km SMF**

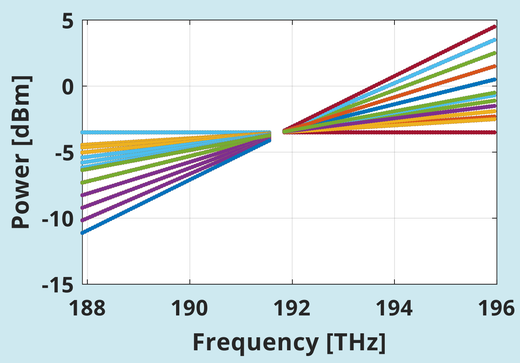


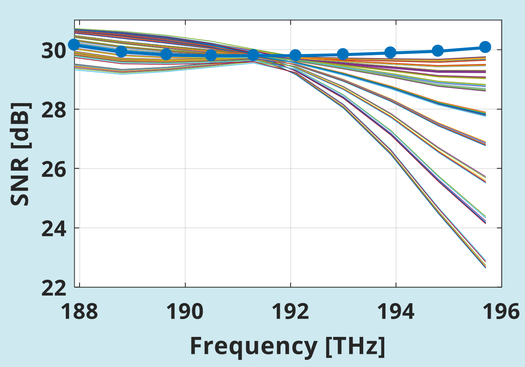
- **Hybrid fiber amplifier** (HFA) with 5 DRA pumps and EDFA with **gain flattening filter** (GFF) at each span and **flat noise PSD**.
- **250 GHz C/L guardband** due to intense **SRS**.
- Spectrum before each linear tilt filter has always the same shape.
- **Center of C+L** band kept at the **GN-model optimal power** [5]

Four tilt strategies at each span independently on C and L bands tested by simulation [6]:

- **0/0:** flat PSD launch on C+L bands at GN model optimal power
- **100/100**: full pre-compensation of total tilt induced by SRS+DRA
- **50/50:** half pre-compensation of total tilt induced by SRS+DRA
- **Optimal:** pre-tilt maximizing and equalizing the SNR on both C and L bands.

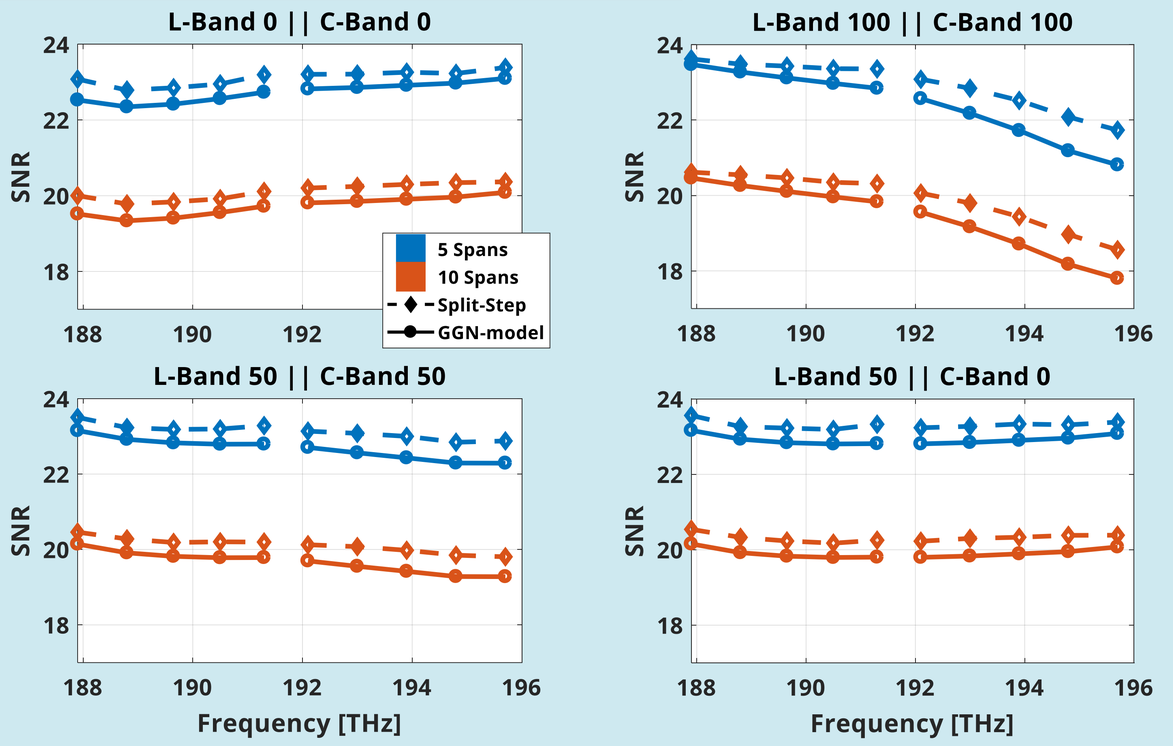
THE ANALYSIS





For optimal tilting we used GGN model to explore tilts between 0% and 200%. **50/0** (50% pre-compensation on L-band and 0% on C-band) **is the tilt strategy which maximizes and flattens the SNR.**

SPLIT-STEP VALIDATION



- **GGN model is an accurate yet conservative tool** for multiband QoT estimation. **Incoherent accumulation** of NLI is confirmed by the 3 dB gap between 5 and 10 spans curves.
- **100/100** strategy improves L-band performance but shows a **2 dB drop in SNR for C-Band**.
- **50/0** actually gives the best balance showing a **practically flat SNR curve**, where 0/0 and 50/50 were instead suboptimal

CONCLUSIONS

We exploited the GGN model to define an **engineering rule to equalize and maximize C+L systems performance** by applying independent tilts. **50/0 strategy was the better choice**, showing that the typical single band optimization is always suboptimal in presence of SRS+DRA

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