Effects of Crosstalk on the Performance and Design of All-Optical Networks with Fiber Nonlinearities

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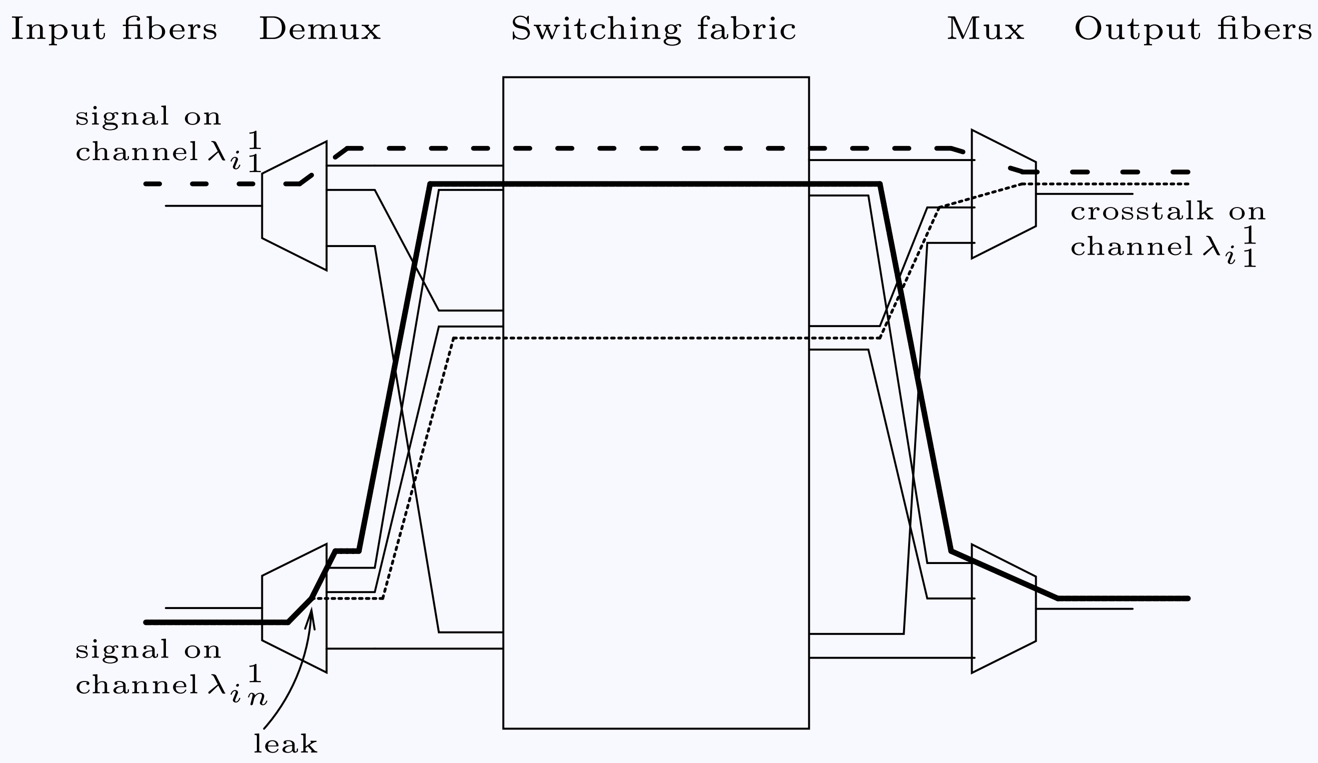
Overview

- ▷ Introduction
- ▷ System description
- ▷ Performance: numerical results
- ▷ Application: design of all optical-networks, RWA

Introduction

- Current high-speed optical networks
  - Bottleneck due to electrical conversions
- New issues arise with all-optical networks
  - Nodes (OXCs) are subject to crosstalk
  - Crosstalk is transmitted over extremely long paths without electrical signal regeneration
- Implementation

OXC (all-optical switch) and crosstalk

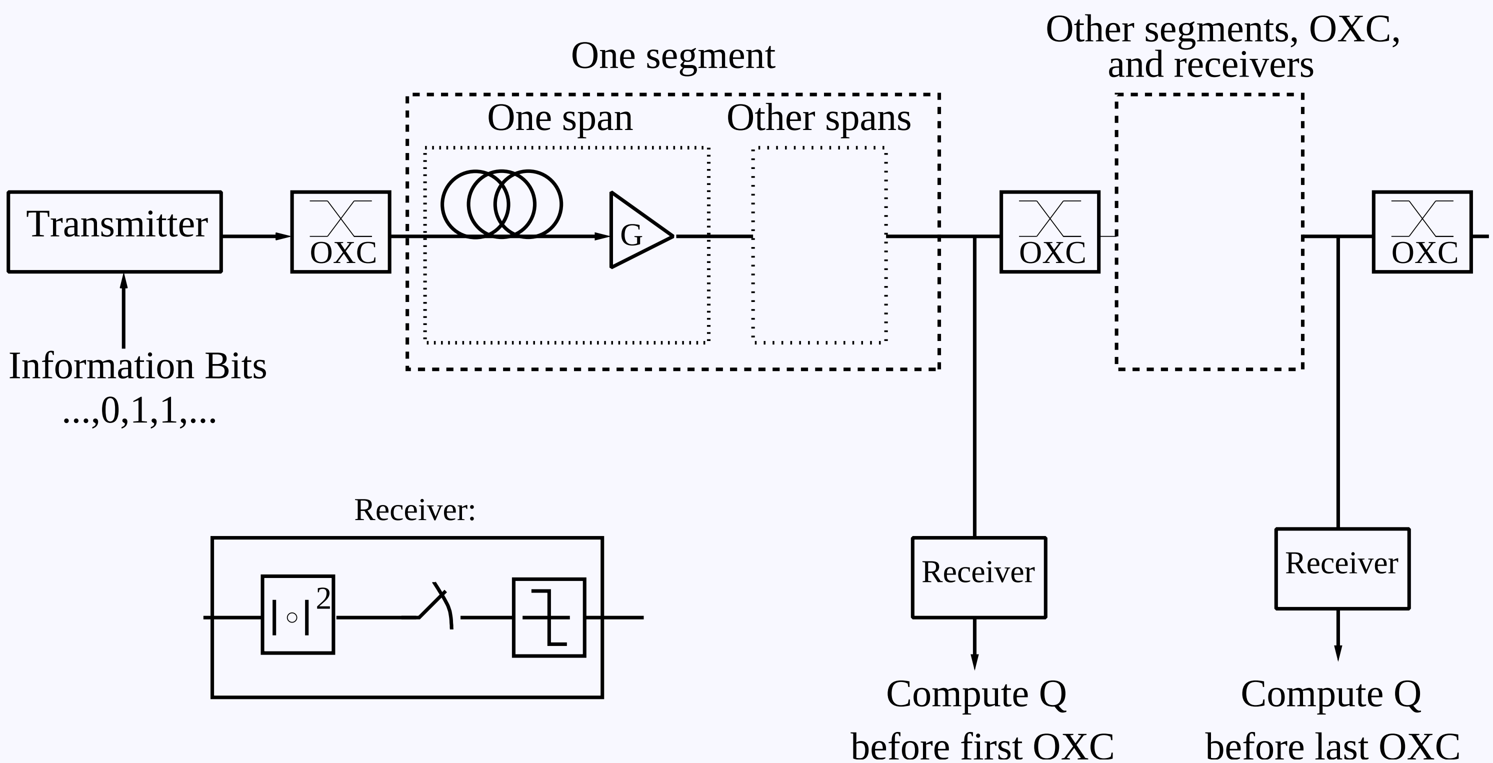


- ▷ Leaks can originate from imperfect demultiplexing, or transmission within the switching matrix

Problem statement

- We want to assess the performance degradation of a the signal corrupted by crosstalk
  - Fiber nonlinear transmission on very long paths enhances crosstalk effects dramatically
  - Take into account wide ranges of both fiber and network parameters
  - Use a simulation tool
  - Apply results to crosstalk-aware network design

Network model



- ▷ Each OXC adds a crosstalk component to the input signals

Simulation parameters

▷ Modulated signal and crosstalk

- 2.5 Gbps NRZ pulses
- Max power P_0=5 mW, crosstalk power attenuation: -26 dB
- Small detuning between crosstalk and main signal (8 GHz)

▷ Fiber and network

- NZ-DSF fiber
- 2 crossconnects, 100-km spans

▷ We only account for impairments due to fiber nonlinearity and crosstalk.

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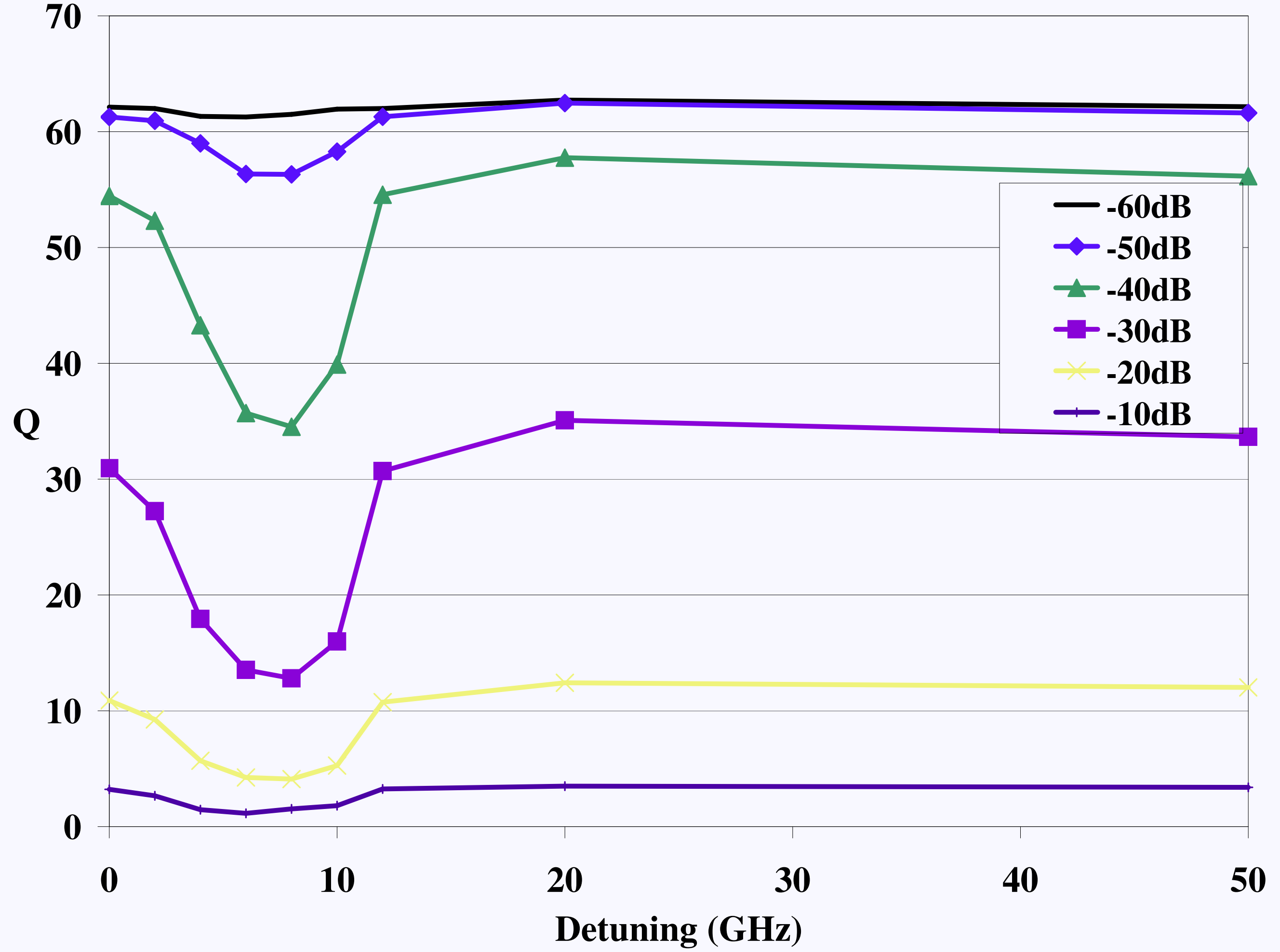
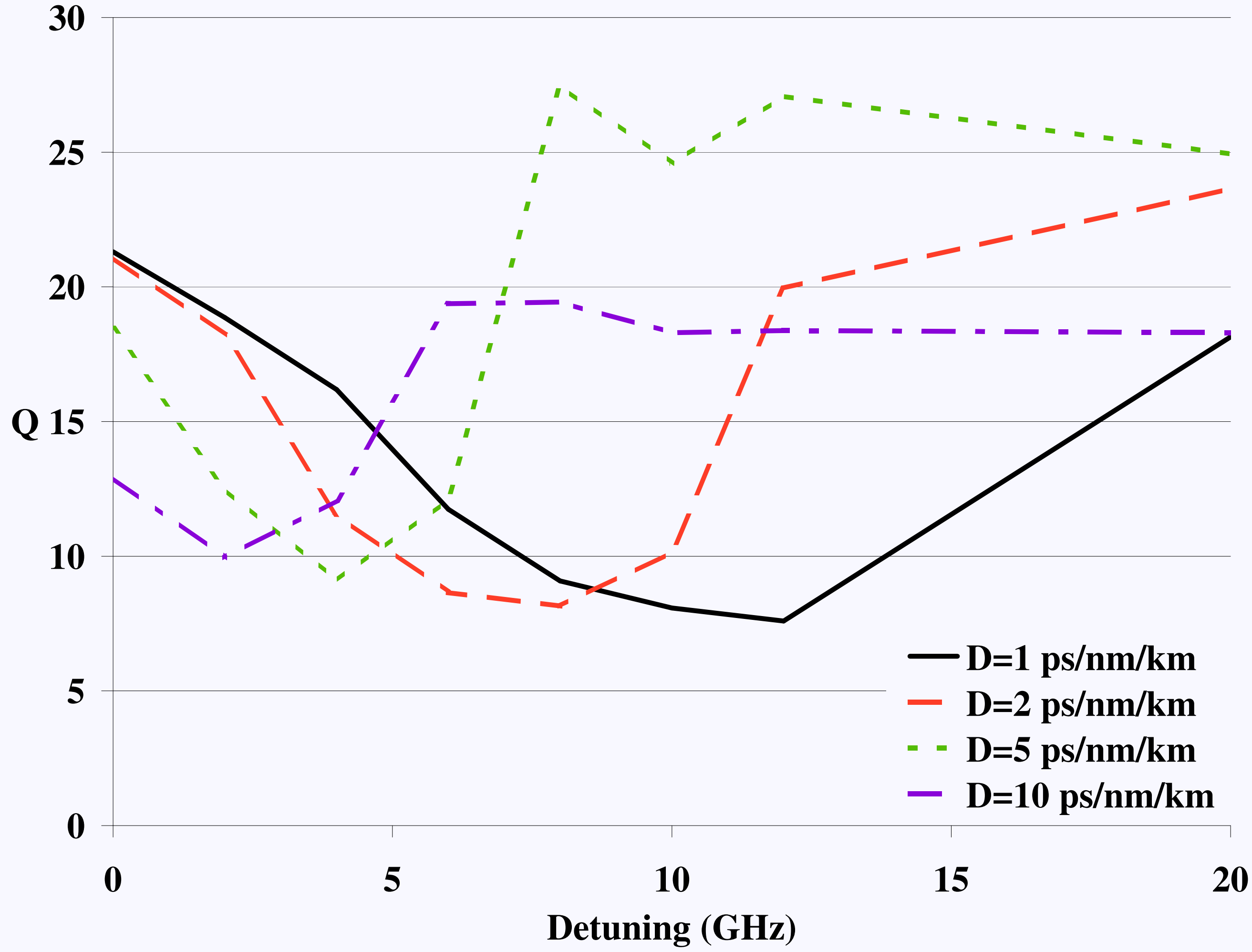
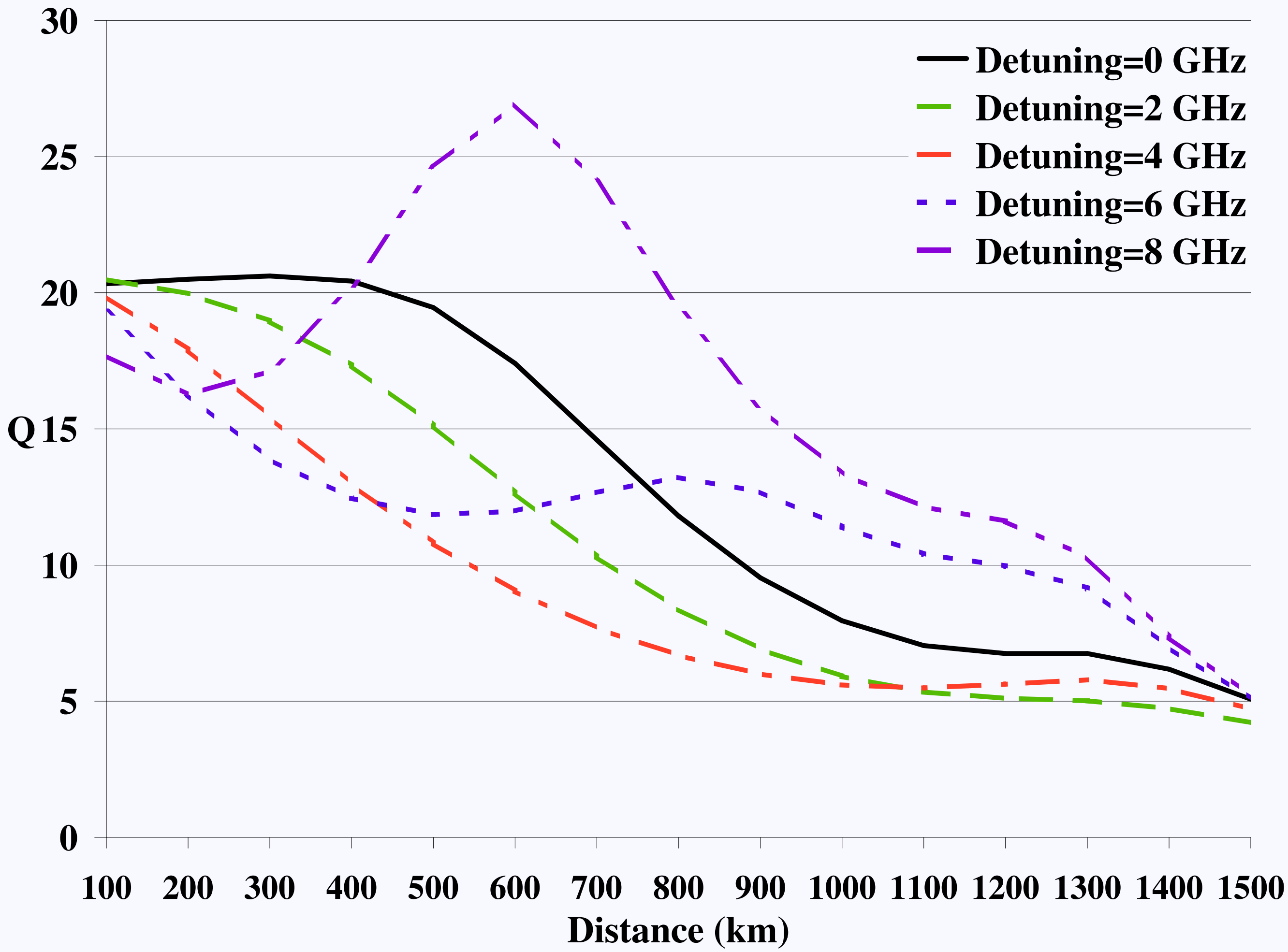
Detuning, crosstalk power attenuation



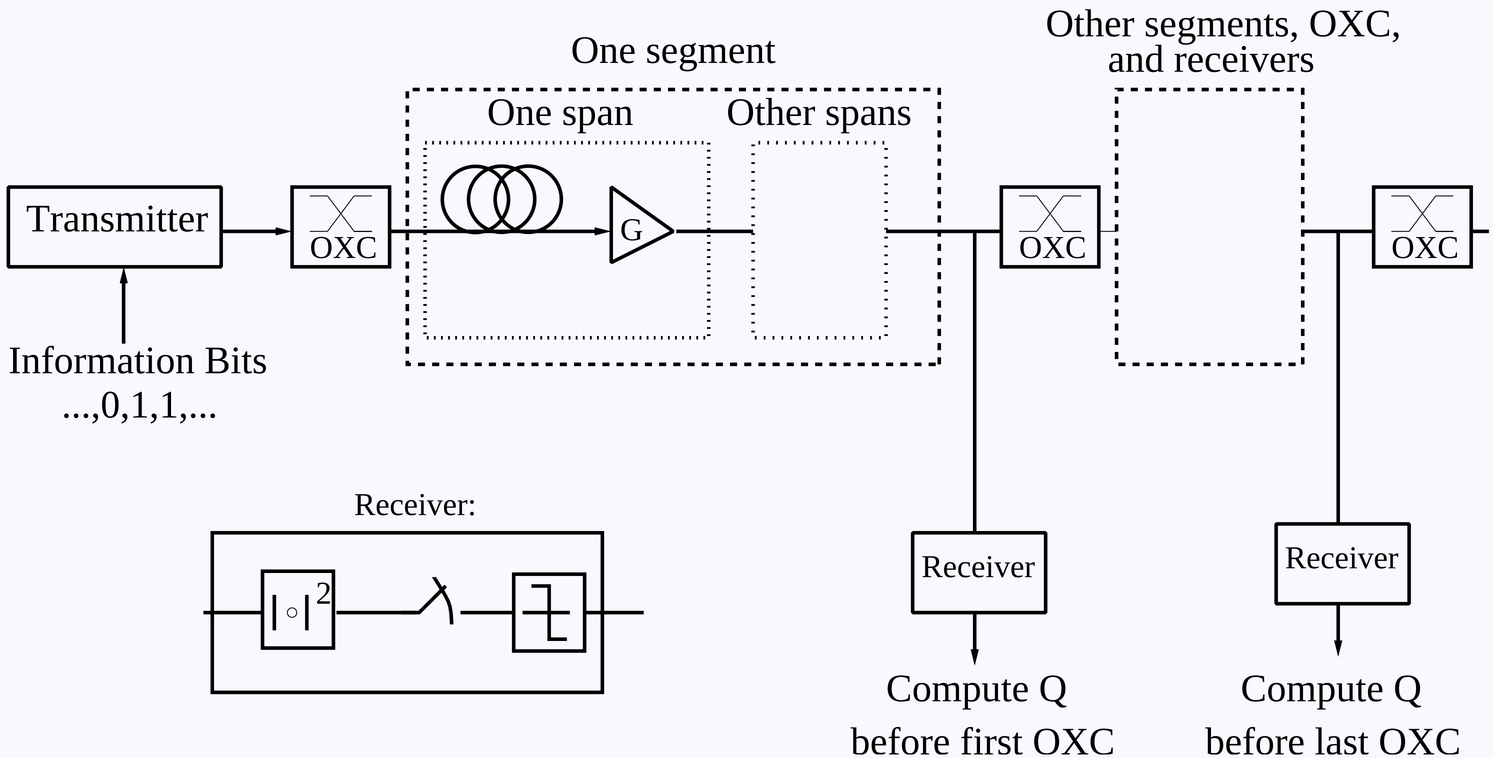
Detuning, dispersion



Distance, detuning

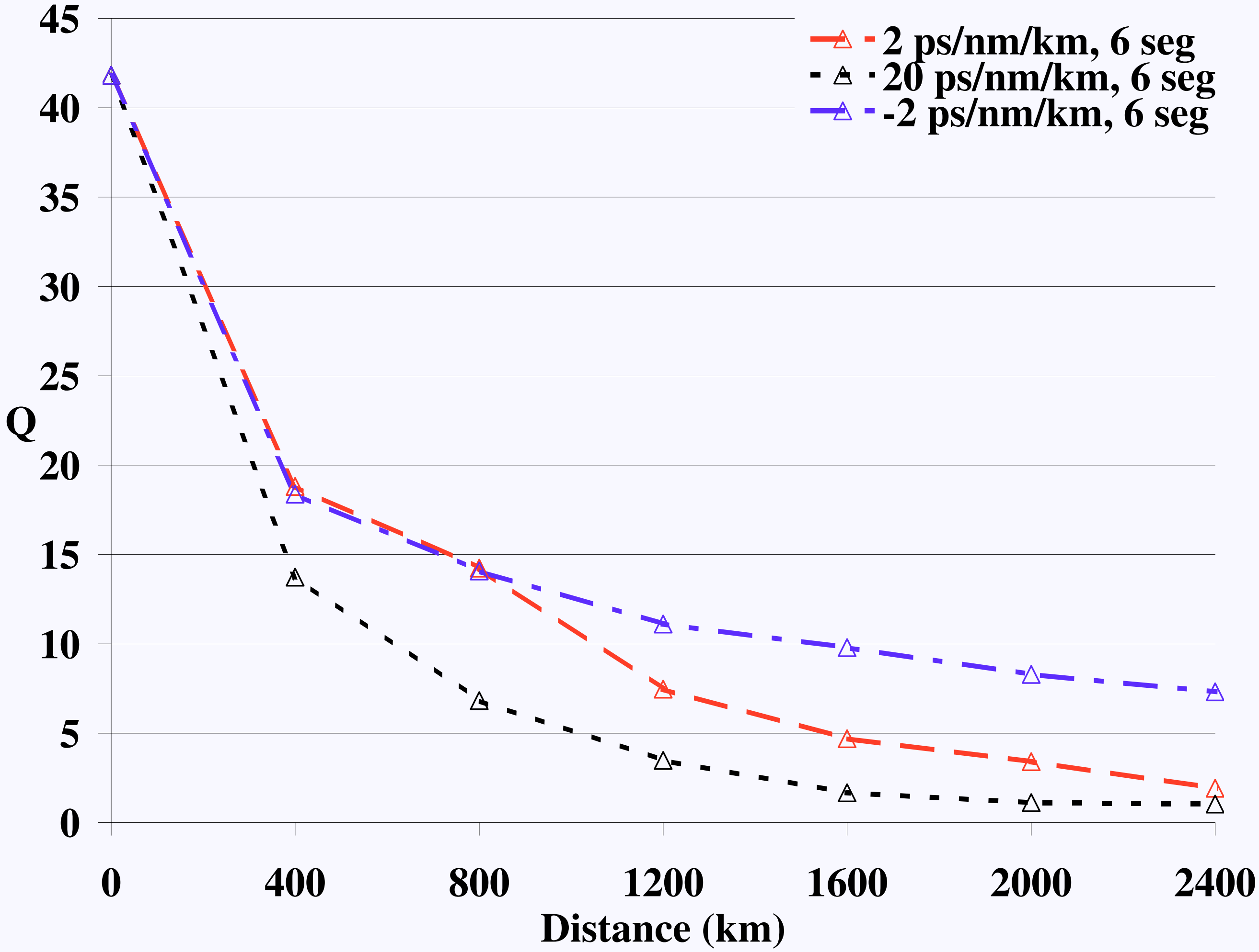


Network model

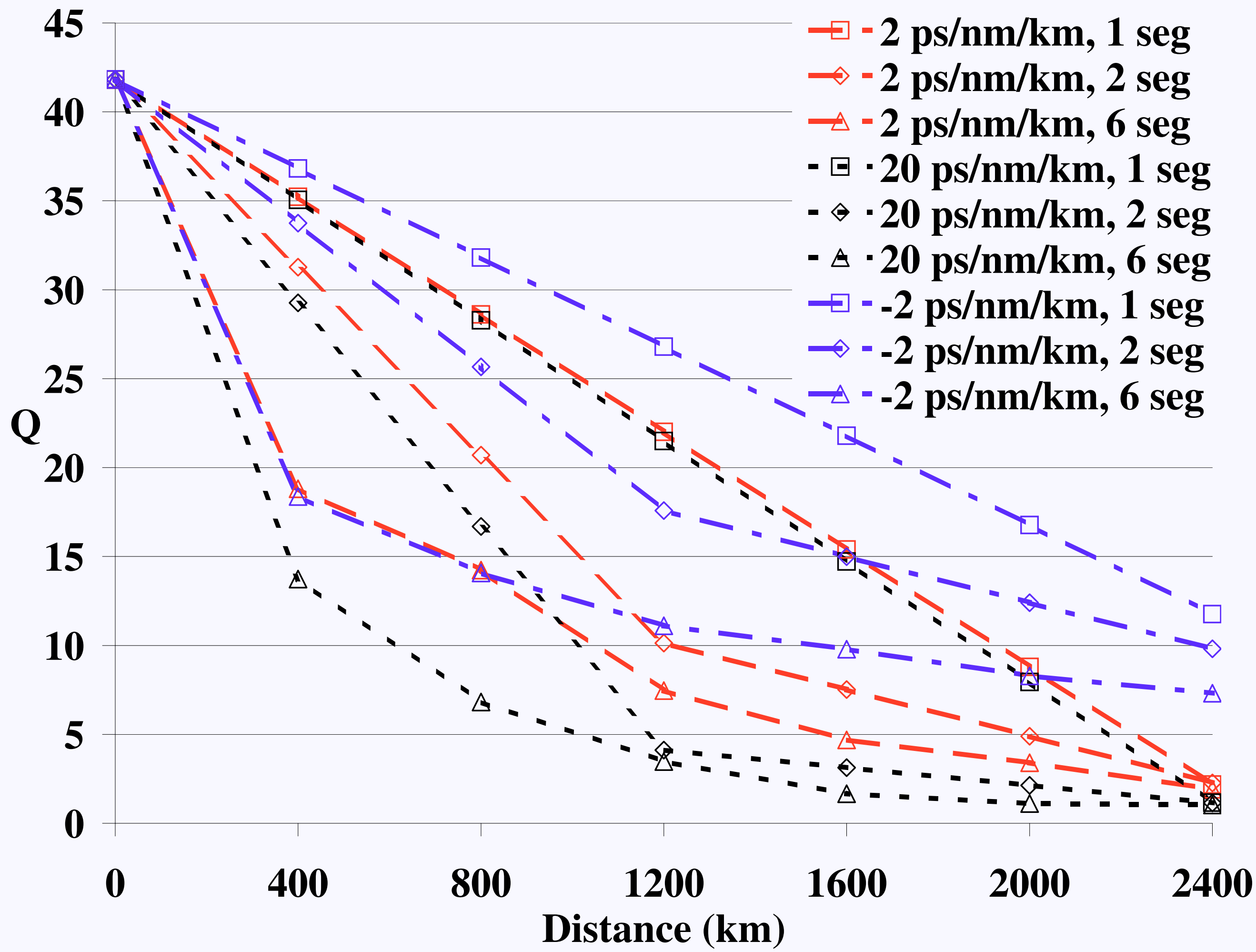


▷ Each OXC adds a crosstalk component to the input signals

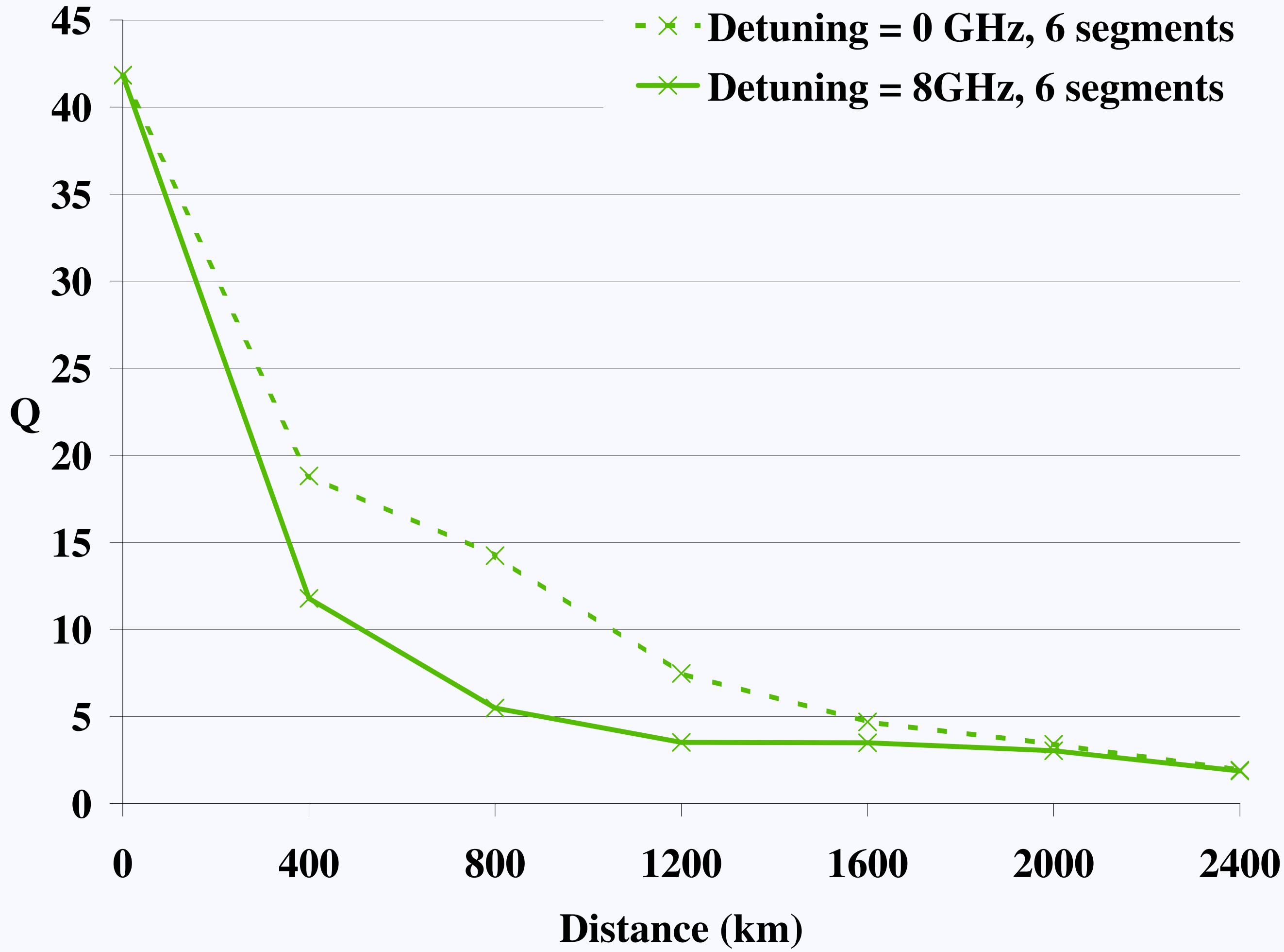
Large network: dispersion - 1/2



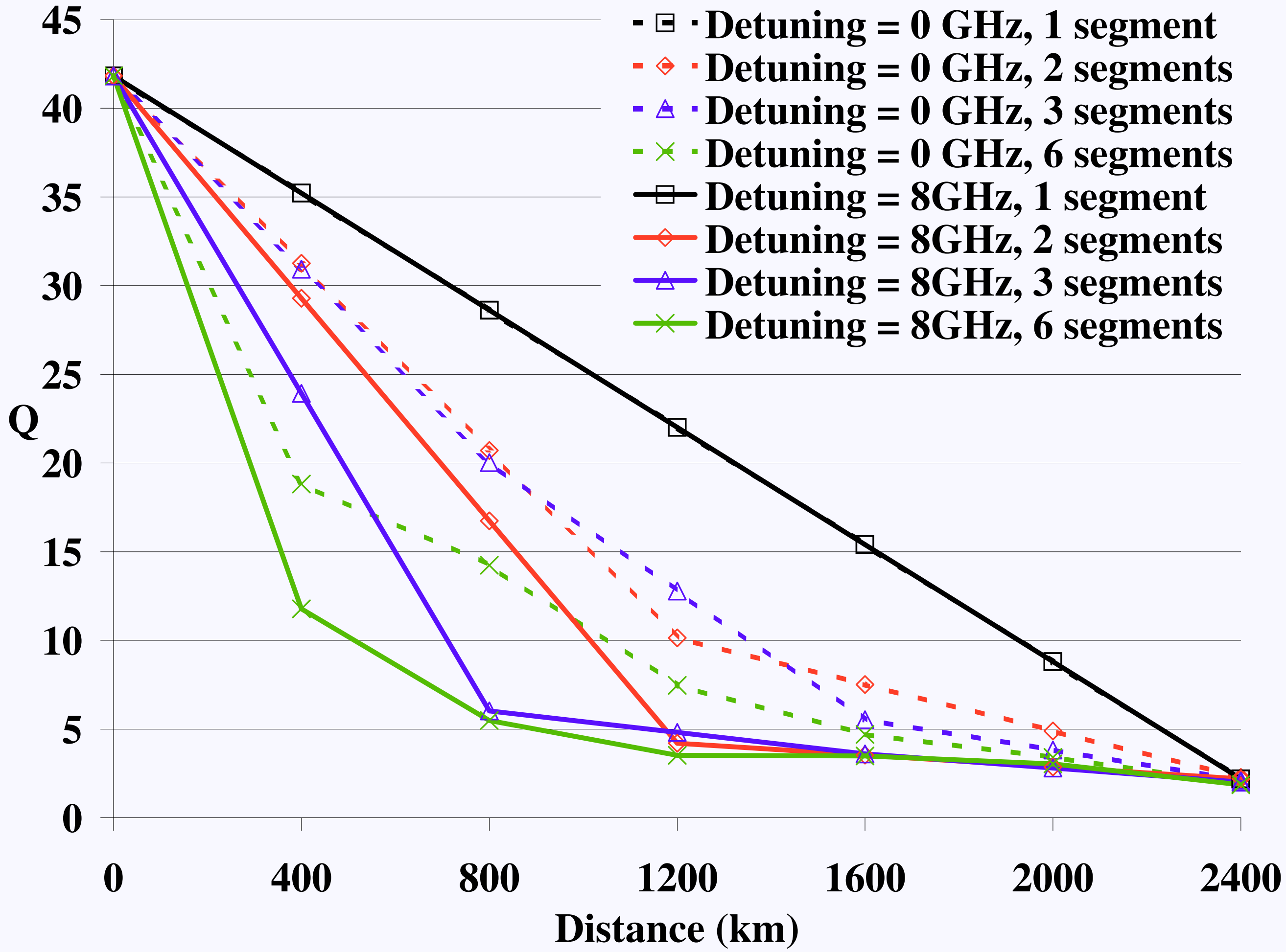
Large network: dispersion - 2/2



Large network: detuning - 1/2



Large network: detuning - 2/2



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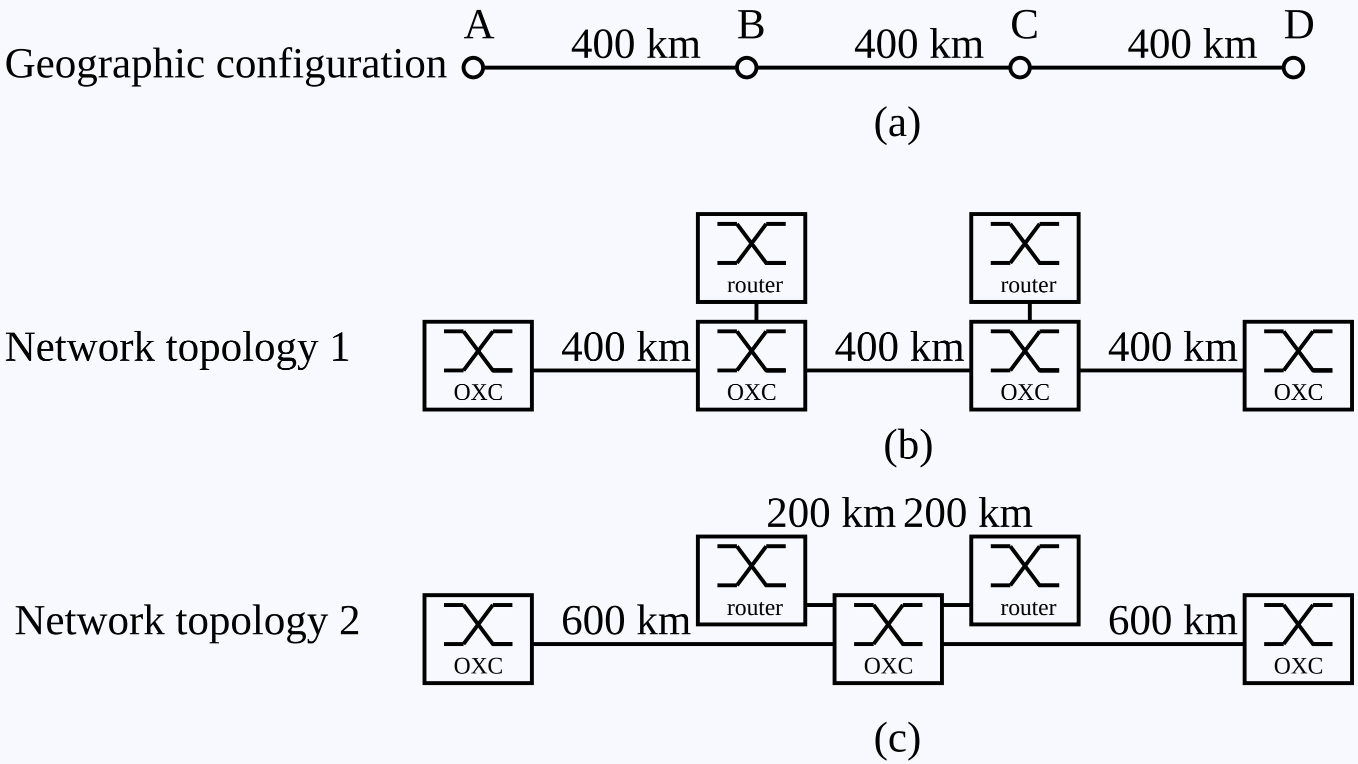
Application 1: network design

- Design problem: topologies



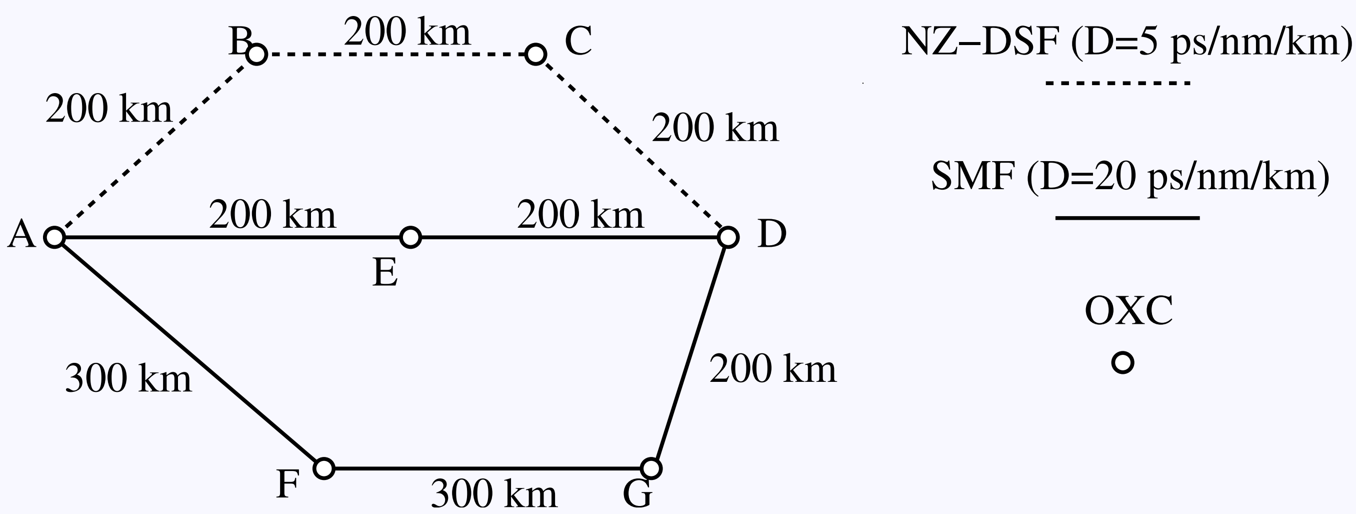
- Assume crosstalk with detuning 8 GHz

Application 1: solution

- From slide 14: small dispersion yields better performance (simulation for longest path: Q=4.5)
- From slide 10: D=2 ps/nm/km and 8 GHz detuning lead to catastrophic performance (Q=4.2)
- From slide 11: if D=5 ps/nm/km and detuning is 8 GHz, best performance is achieved for 600 km transmission (Q=11.5 vs. Q=11.8)
- Topology 2 with a D=5 ps/nm/km is a good choice for this network

Application 2: RWA setup

- ▷ Design problem: routing and wavelength assignment given a network



- ▷ Assume detuning can be 0 or 8 GHz for path $ABCD$, and 0 GHz for paths AED and $AFGD$

Application 2: solution

- From slide 11: if D=5 ps/nm/km and detuning is 8 GHz, best performance is achieved for 600 km transmission, so the best choice is path *ABCD* (Q=11.8). If detuning is 0 GHz: Q=11.3
- Second choice is path *AED* because of its (short) length (Q=10.8)
- Path *AFGD* should be avoided (Q=6.6)

Conclusions and future work

- ▷ Crosstalk is enhanced while propagating in fiber optics
- ▷ The resulting performance degradation depends on
  - topology
  - hardware parameters: laser detuning, fiber
- ▷ Crosstalk should accounted for when designing all-optical networks or RWA algorithms