Wavelength Stealing: An Opportunistic Approach to Channel Sharing in Multi-chip Photonic Interconnects

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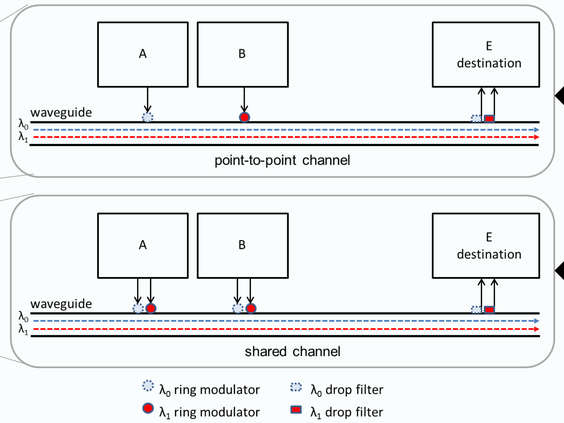
Problem: What is the "best" topology design for photonic substrates?

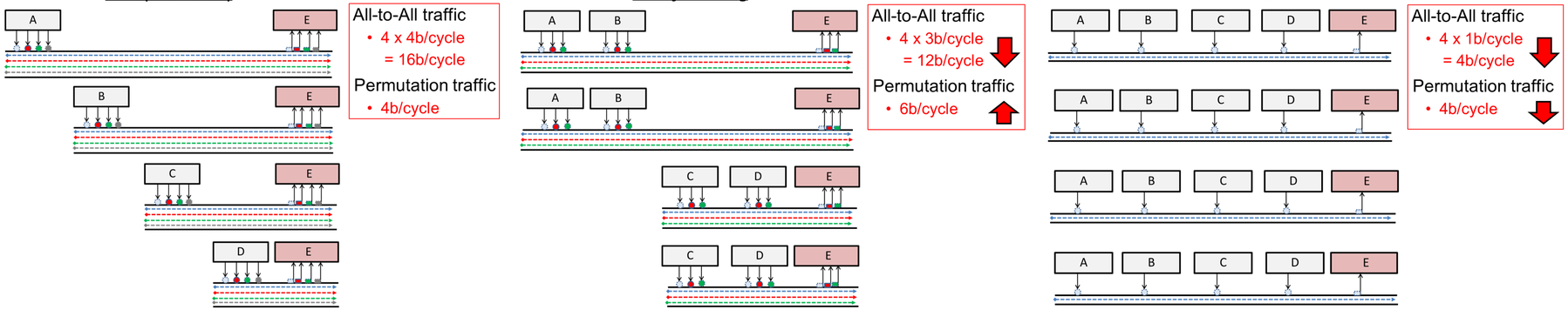
Point-to-Point
or
Channel sharing



- Extra ring-resonators on shared wavelengths lead to higher laser power consumption
- Photonic networks are static power dominated: laser, ring-resonator tuning power
- Efficiencies of WDM lasers: 1-5%

→ **Fixed input laser-power budget for all designs**

Implications of Laser Power Budget

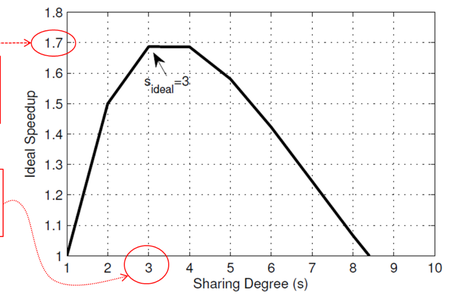


Increasing sharing degree: 's'

- Reduces effective capacity ☹
- Increases peak N-N BW followed by drop-off ☺

Optimal sharing gain
~ 1.70x

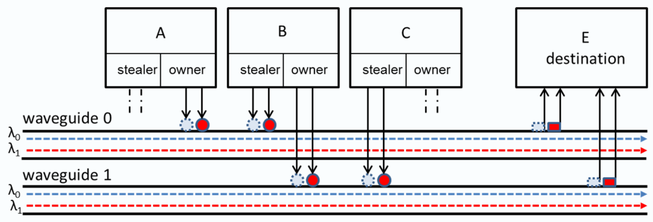
Optimal sharing degree
s_{ideal} = 3



Wavelength Stealing Architecture

- Same topology as the P2P network: N^2 channels
- Every channel has **one owner** and **one or more stealers**

2-way stealing



- **Owner node**
  - Guaranteed non-blocking access
- **Stealer node**
  - Arbitration-free access on an owner's channel: possible packet corruption
  - Notification to halt stealing when channel busy
- **Destination node**
  - Corrupted phit: perform correction
  - Valid phit: identify sender (owner or stealer?)

- **Two Designs:**
  - Abort
    - (+) Fewer waveguides
    - (−) Conservative performance
    - (−) More ring-resonators
  - Sense
    - (+) Aggressive performance
    - (+) Fewer ring-resonators
    - (−) More waveguides