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%

IMPLICATIONS OF LASER POWER BUDGET

<table>
<thead>
<tr>
<th>P2P (unshared)</th>
<th>2-way sharing</th>
<th>4-way sharing</th>
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</thead>
<tbody>
<tr>
<td>All-to-All traffic: 4 x 4b/cycle + 16b/cycle</td>
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<tr>
<td>Permutation traffic: 4b/cycle</td>
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<tr>
<td>All-to-All traffic: 4 x 3b/cycle + 12b/cycle</td>
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<td>Permutation traffic: 6b/cycle</td>
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<tr>
<td>All-to-All traffic: 4 x 1b/cycle + 4b/cycle</td>
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Increasing sharing degree: ‘s’
- Reduces effective capacity 😞
- Increases peak N-N BW followed by drop-off 😞

Optimal sharing gain ~ 1.7x
Optimal sharing degree s_{total} = 3

WAVELENGTH STEALING ARCHITECTURE

- **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

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