University of Waterloo

OFC 2020

San Diego, USA

HUAWEI

Poster Session II (Th2A.30)

Disruption-minimized Re-adaptation of Virtual Links in Elastic Optical Networks

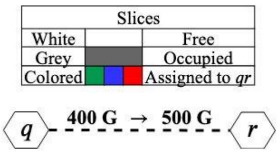
Nashid Shahriar[1], Mubeen Zulfiqar[1], Shihabur Rahman Chowdhury[1], Sepehr Taeb[1], Massimo Tornatore[2], Raouf Boutaba[1], Jeebak Mitra[3], Mahdi Hemmati[3]

[1]University of Waterloo, [2]Politecnico di Milano, [3]Huawei Technologies Canada Research Center

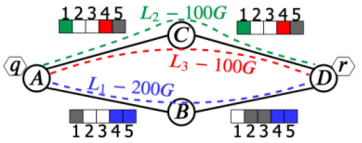
Introduction

- ❑ Applications hosted on a network slice evolve over time requiring increased bandwidth for virtual links
- ❑ We propose a novel solution to accommodate an existing virtual link's (i.e., lightpath's) bandwidth increase
- ❑ We assign different levels of disruption costs to different types of re-configuration actions
- ❑ Our solution minimizes disruption (Ds) to traffic and transponders (Tx) and spectrum (Sp) resources
- ❑ We devise a multi-objective integer linear program to tune priorities among different objectives

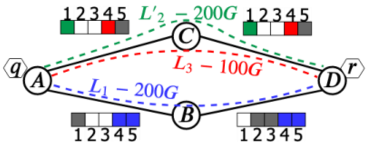
Adaptation with Different Re-configuration Actions



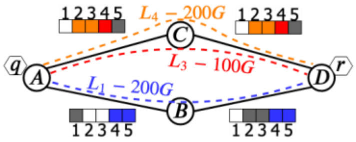
Adaptation request for virtual link *qr*



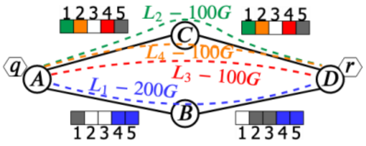
Embedding of *qr* before adaptation



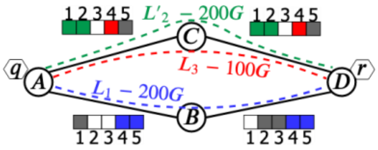
Action: Change modulation of lightpath L_2 (Low disruption)



Action: Reallocate Sp of L_2 to L_4 (Medium disruption)



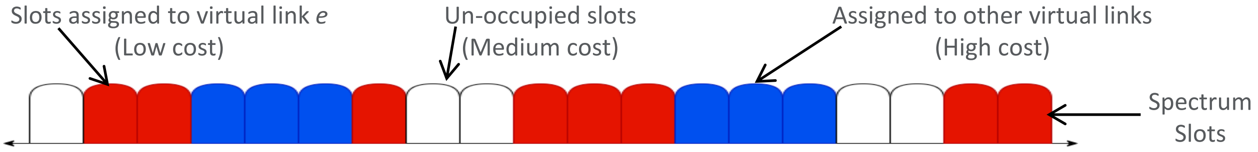
Action: Create a new lightpath L_4 (Medium disruption)



Action: Expand Sp of lightpath L_2 (High disruption)

Proposed Solution

- ❑ Free up spectrum slots used in virtual link *e*'s embedding and mark slots of other virtual links as occupied
- ❑ Assign differential costs to each slot, transmission configuration, and path combination based on action

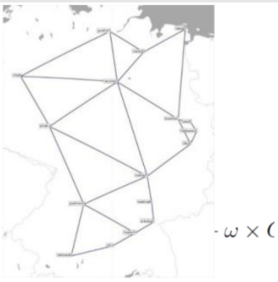


- ❑ Re-embed *e* such that each existing split of *e* takes one of the re-configuration actions
- ❑ Satisfy spectral continuity and contiguity constraints and new demand of *e,* while minimizing objective function

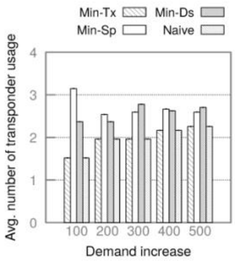
$$\text{minimize}(\theta \times Cost_{\bar{e}}^{tr} + \omega \times Cost_{\bar{e}}^{sp} + \sigma \times Cost_{\bar{e}}^{ds})$$

Evaluation Results

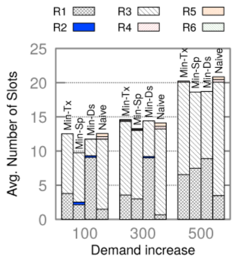
- ❑ Topology: fully-flexible Elastic Optical Network (EON) using Nobel Germany* (17 nodes and 26 links)
- ❑ Link capacity: 4THz spectrum divided into 160 slots of 25GHz in each direction
- ❑ Input generation: Embed virtual links using a discrete event simulator and select those with bandwidth of 500G
- ❑ Compared variants: Min-Tx, Min-Sp, and Min-Ds consider transponder, slot usage, and disruption as primary objectives; Naïve ignores disruption and considers transponder as primary objective



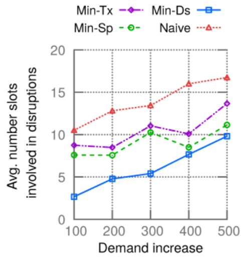
Nobel Germany



Transponder usage



Slot and action distribution



Traffic Disruption

Key Findings

- ❑ Min-Ds 1) disrupts 44%, 35%, and 58% less traffic compared to Min-Tx, Min-Sp, and Naïve, respectively; 2) reuses existing lightpaths to minimize disruption, 3) creates extra lightpaths incurring 23% more transponders and 6% more slots than Min-Tx and Min-Sp, respectively
- ❑ Disruption minimization has a trade-off with transponder and spectrum usage in an EON

*SNDlib Repository available at http://sndlib.zib.de

This work benefited from the use of the CrySP RIPPLE Facility at the University of Waterloo