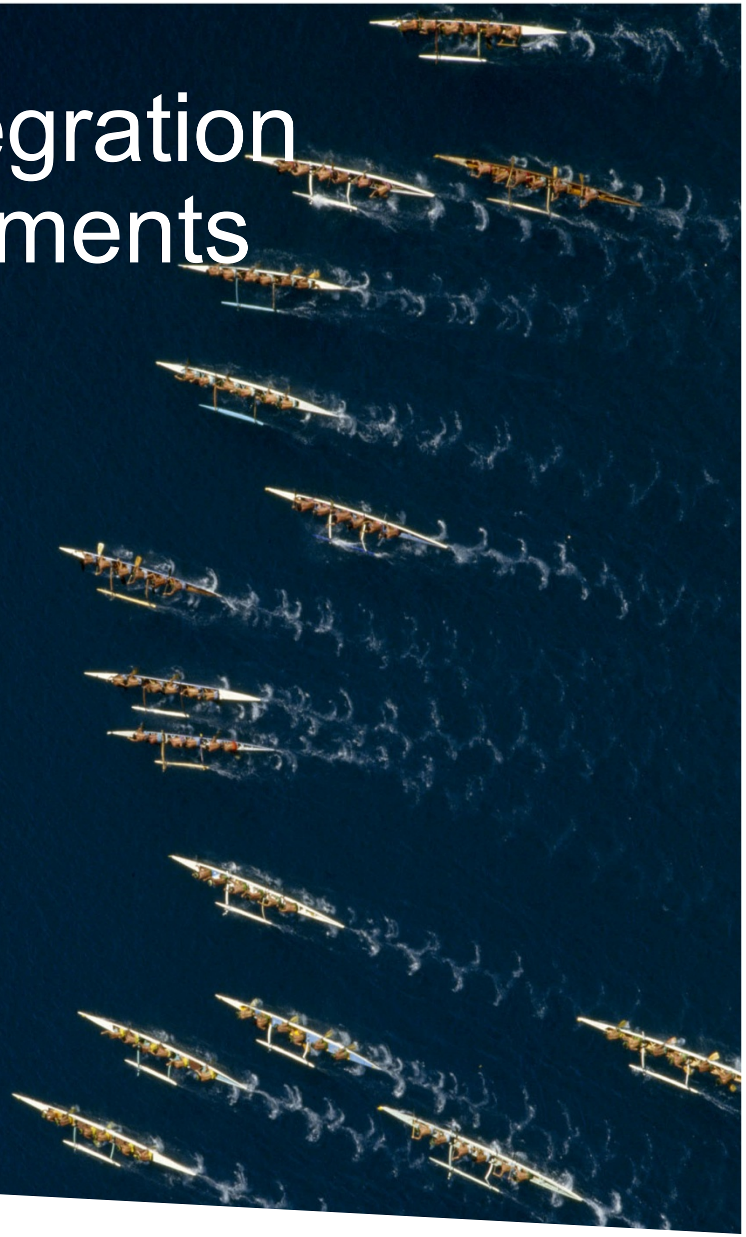
Cost evaluation of the integration of IP/MPLS and WDM elements

R. Duque, V. López, A. González, O. González de Dios, J.P. Fernández-Palacios



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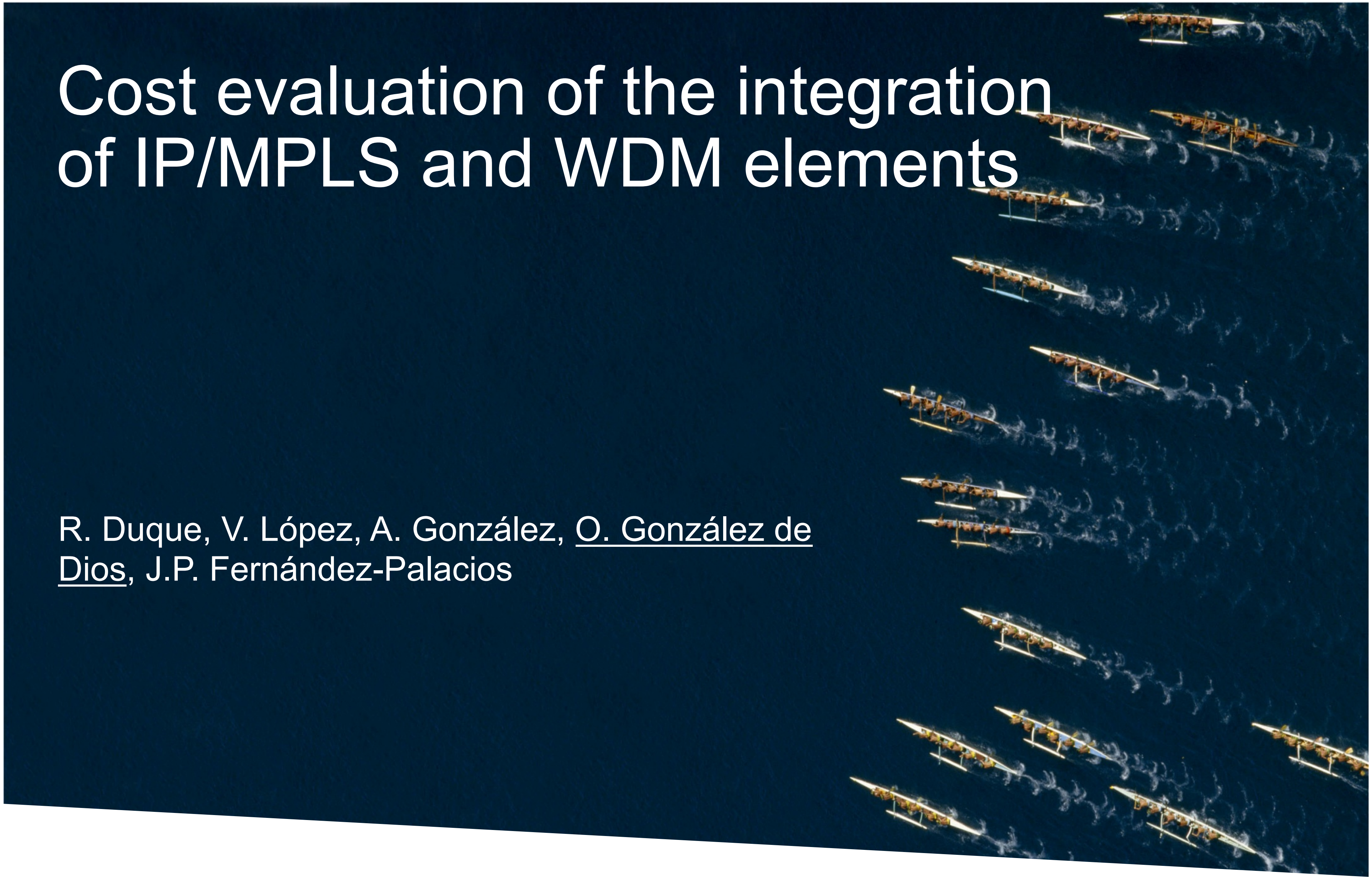

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Telefónica

Outline

01 Introduction and motivation

02 Scenario Definition

03 Methodology

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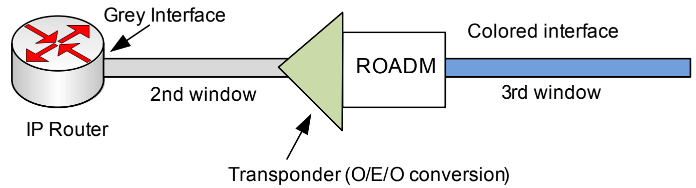
01

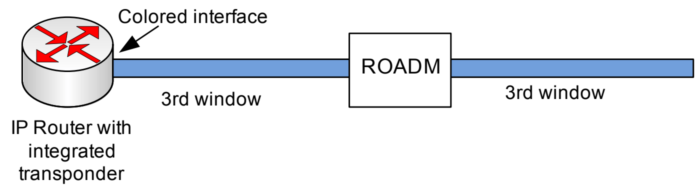
Introduction and motivation

Motivation

- Some vendors are proposing the integration of coloured transponders in the IP cards reducing the cost of current separate solution.



(a) Independent



(b) Integrated

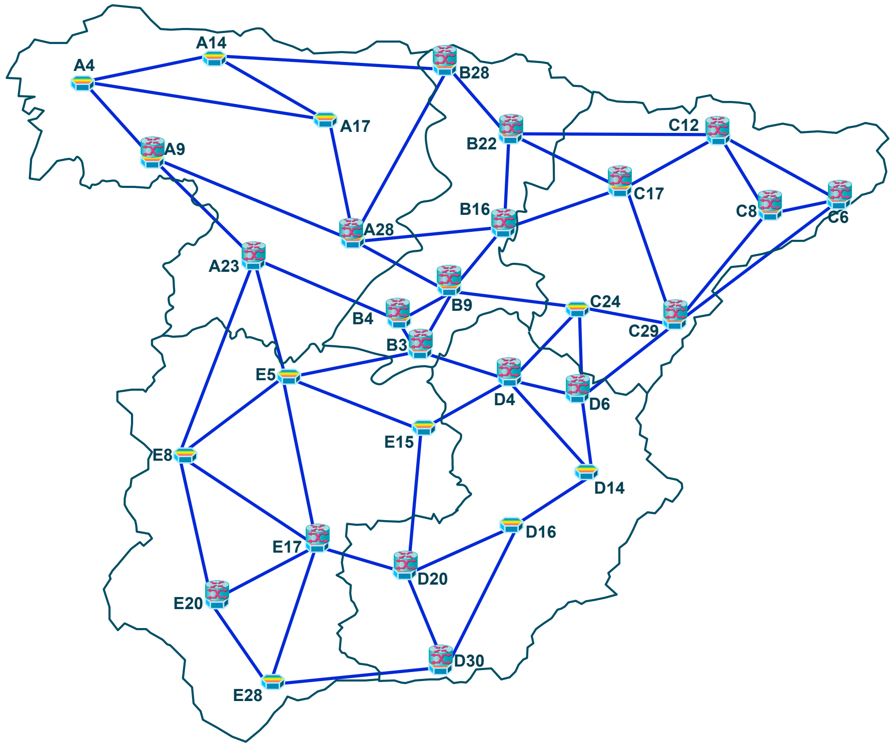
- This situation can lead to a single vendor scenario, which is not convenient for an operator.
- This study assesses the CAPEX savings due to this integration.

02

Scenario definition

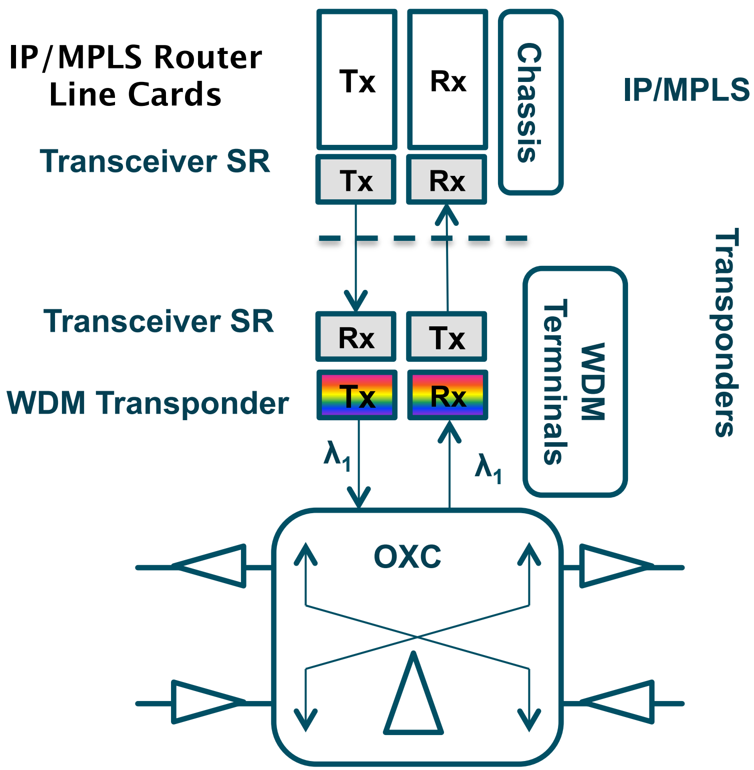
Assumptions

- Spanish backbone network has 20 ML nodes and 10 ROADMs.
- Initial total traffic matrix of 1.4 Tbps obtained from internal Telefónica data.
- Traffic growth of 50% per year has been assumed.

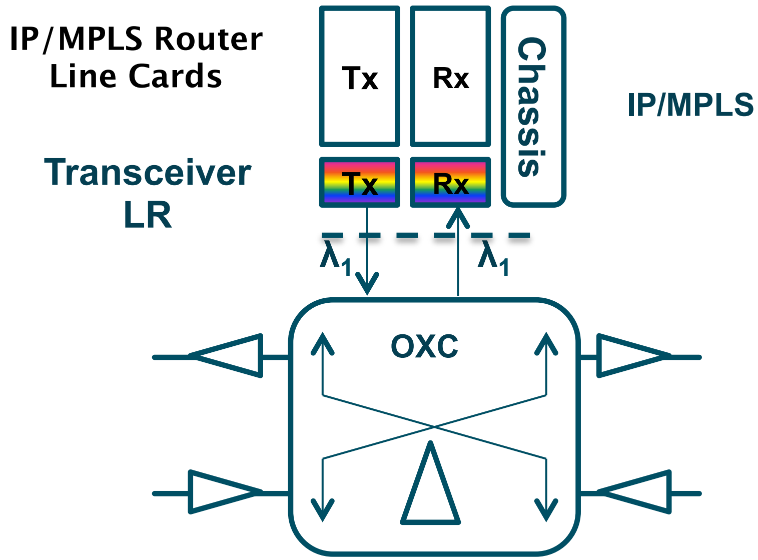


Node Models

Separate model

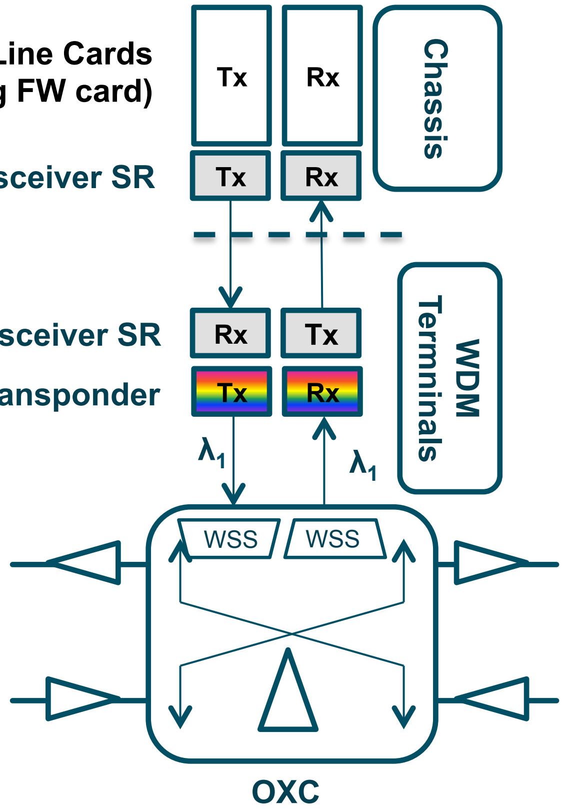


Integrated model



Cost model

- Based on STRONGEST model:



Includes FW card and transceivers costs

		Slots/ Ports	Relative Cost
IP/MPLS line cards 40GbE		10	35.98
IP/MPLS line cards 100GbE		4	40
IP/MPLS line cards 400GbE		1	37.48
IP single chassis		16	53.79
IP multi-chassis		32	285.92
WDM Transponder 40Gbps		1	6.4
WDM Transponder 100Gbps		1	16
WDM Transponder 400Gbps		1	20.2
WDM terminal (chassis)		40	3.4
Photonic Switch.	WSS_{1x20} - TS	20	6
	WSS_{9x9} - OC	9	48
	WSS_{1x9} - LS	9	4
	Amplification (Amp)		0.8

OXC cost mainly depends on number of WSSs

$$OXC_{cost} = N \cdot (2 \cdot WSS_{1x9} + 2 \cdot Amp) + 2 \cdot N \cdot AD(20) \cdot WSS_{1x20} + 2 \cdot WSS_{9x9}$$

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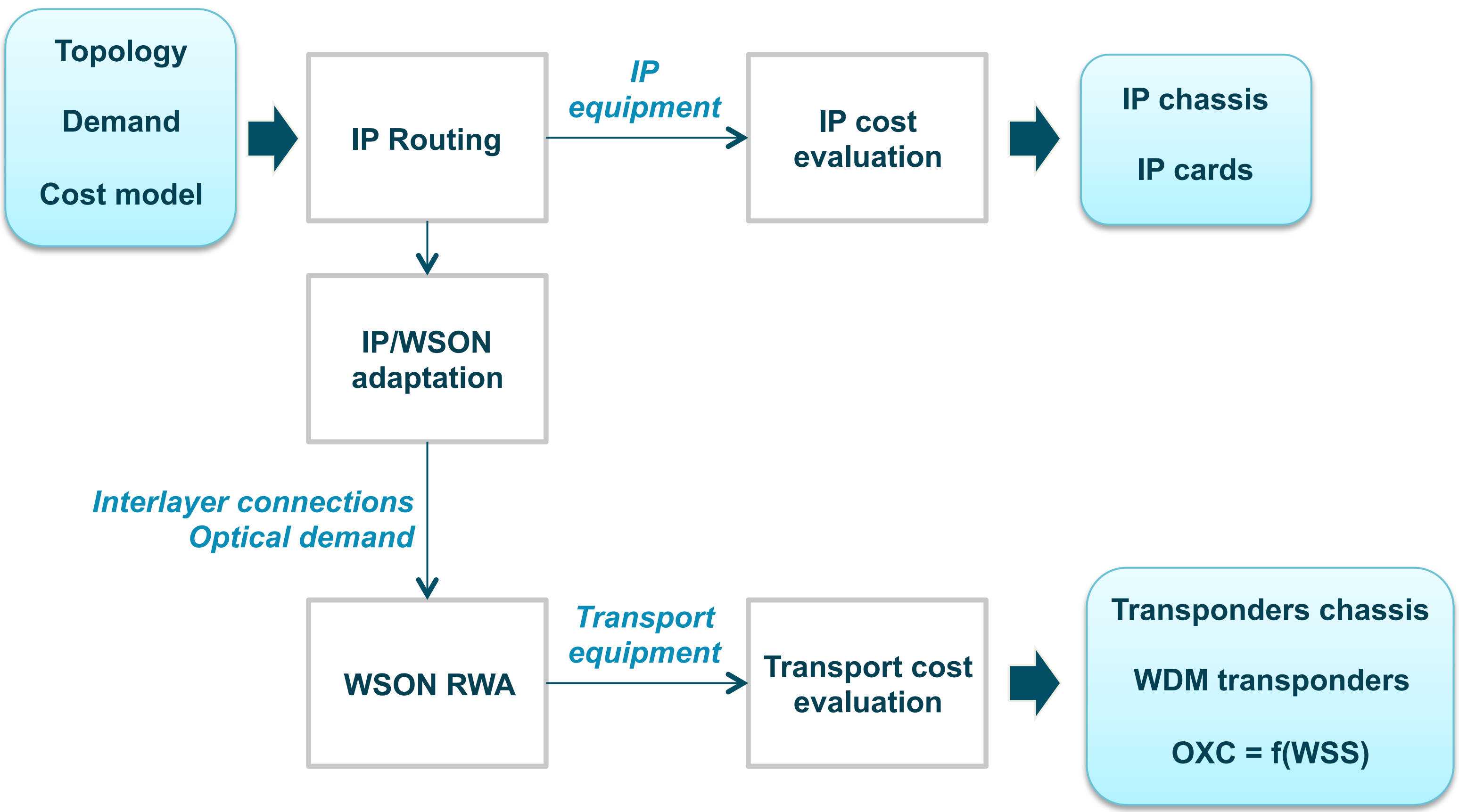
Methodology

Methodology



Traffic routing

- The traffic matrix is created based on the aggregation of the traffic in regional networks.
- The traffic is routed over an already established IP topology. To request for lightpaths three algorithms are proposed:
  - **Same capacity (sameC):** assigns the required capacity with the same granularity for all transport connections (40Gbps or 100Gbps).
  - **Max capacity (maxC):** maximizes the lightpaths utilization in terms of capacity. If there are two traffic rates that maximize the lightpath utilization, this technique uses the highest bitrate to minimize the number of requested lambdas.
  - **Min lambdas (minL):** minimizes the total number of connections in order to obtain a transport demand as lower as possible.
- As an example, for a 130 Gbps (assuming 10G, 40G and 100G interfaces):
  - SameC algorithm uses 4 lightpaths of 40Gbps or 2 lightpaths of 100Gbps
  - MaxC assigns 1 lambda of 100Gbps and 3 lambdas of 10Gbps
  - MinL reserves one lambda of 100Gbps and one of 40Gbps.

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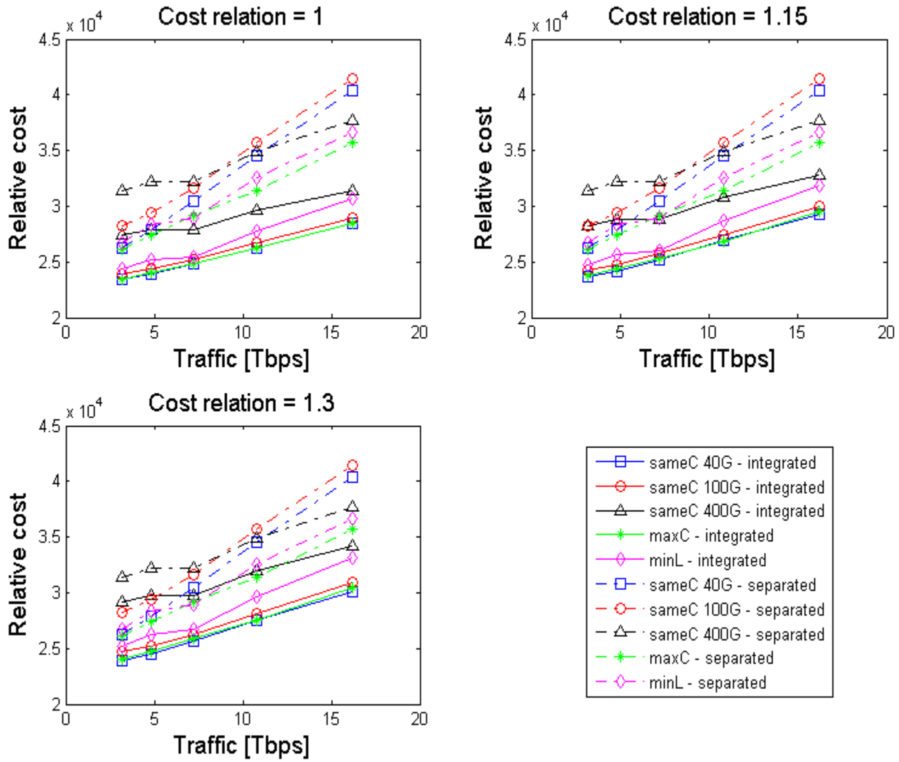
Results

Cost relation

- As the cost of an integrated card is uncertain a sweep is done to check the impact of this evolution.
  - CR=1 is assumed when two SR interfaces and a WDM transponder in the separate node to the cost of an IP/MPLS card in the integrated model.
  - Let us remark that this starting point is a lower cost threshold, because we are considering that integration would lead from the cost of an IP/MPLS card,
  - In order to find a less optimistic scenario, a cost relation of 1.15 and 1.3 (i.e. a cost increment of 15% and 30%, respectively, with respect to CR=1) for the integrated cards are assumed.

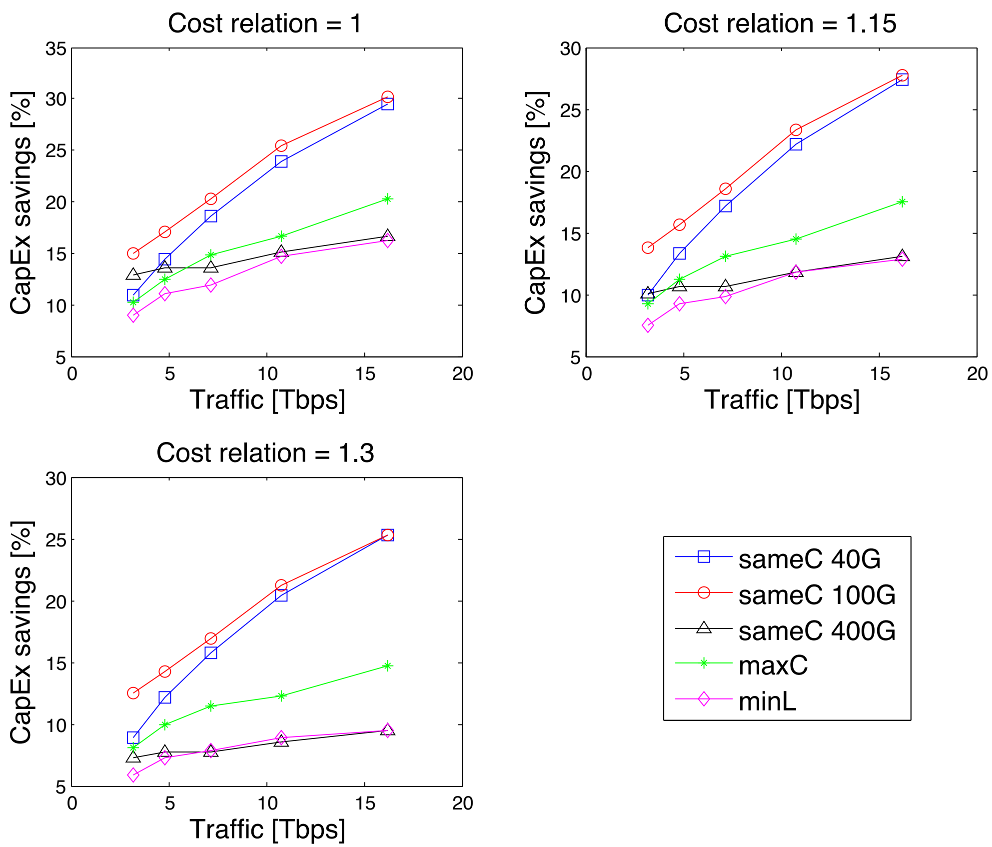
Relative network cost

- Figure shows CapEx investment in the core transport network for the two node models (relative units).
- The separate node (dashed lines) is more expensive than the integrated node (solid lines).
- The algorithm that achieves the lowest investment in network elements is the sameC 40-Gbit/s algorithm.
- The reason is that the price per Gbit/s is cheaper in the 40-Gbit/s technology than in the 100-Gbit/s or 400-Gbit/s technology.
- The cost of the network with minL and maxC algorithms lie within the envelope of the sameC 40-Gbit/s and 400-Gbit/s curves.



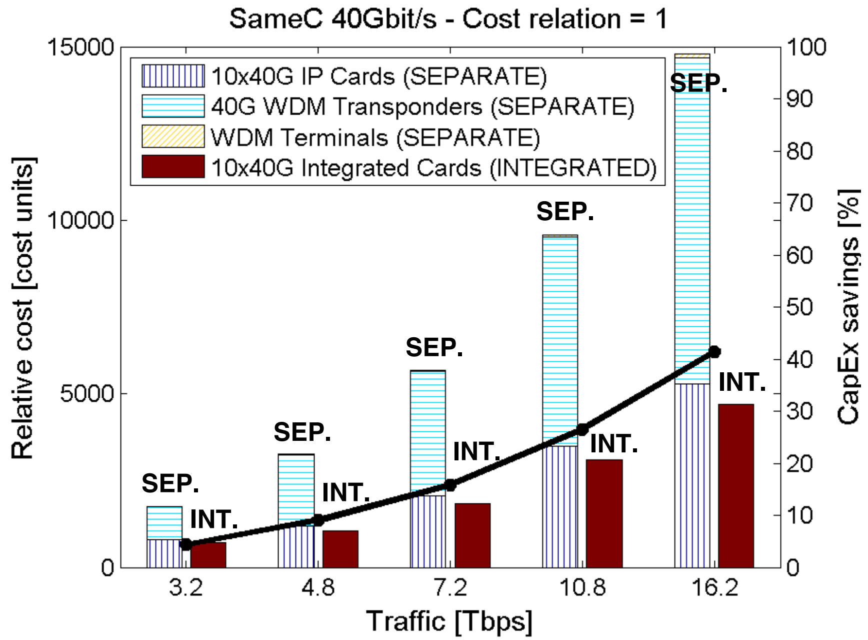
CAPEX savings

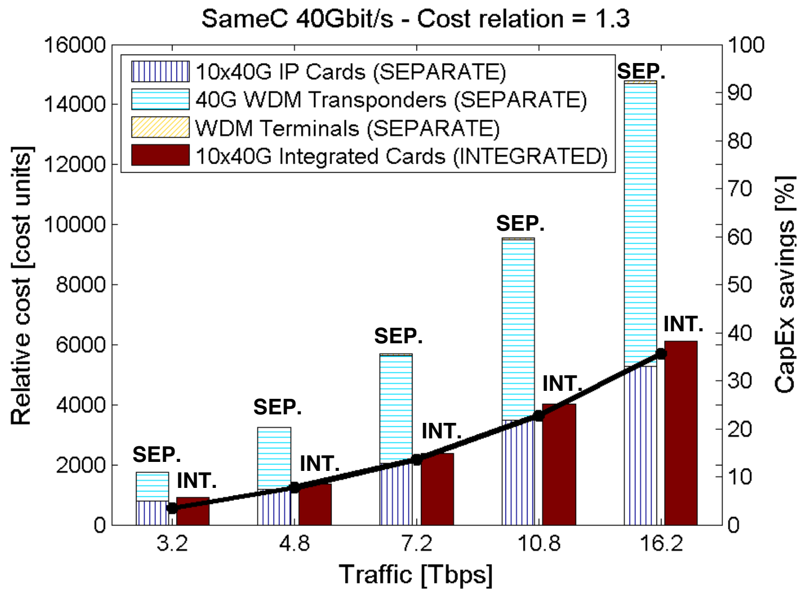
- Algorithms which achieve the greatest savings are sameC 100-Gbit/s and sameC 40-Gbit/s algorithms.
- However, sameC 100-Gbit/s is more expensive than sameC 40-Gbit/s



Incremental cost analysis

- The sameC 40-Gbit/s algorithm is used since it achieves the best results.
- The proposed integration could lead to cost savings around 40% for CR=1 and 35% for CR=1.3 for a traffic matrix of 16.2 Tbps (i.e. year 7 in our analysis).





05

Conclusions

Conclusions

- The integration of colored transponders in the IP cards could lead to CapEx reduction up to 40% if such integrated transponders have a similar price (or, at most, a 30% increase) than separated components.
- This study does not consider other cost related to the integration, such as organizational changes or multi-layer control plane coordination which are mandatory for this evolution.
- Finally, let us remark that these integrated transponders must be interoperable at the optical domain in multi-vendor scenario to motivate its deployment.