

Performance evaluation of Threshold-based Multi-layer Traffic Engineering strategies

Víctor López¹, Óscar González de Dios², José Alberto Hernández¹, Raúl Duque², Carlos García Argos², Javier Jiménez Chico², Juan Pedro Fernández-Palacios², Javier Aracil¹

¹Universidad Autónoma de Madrid

²Telefónica I+D

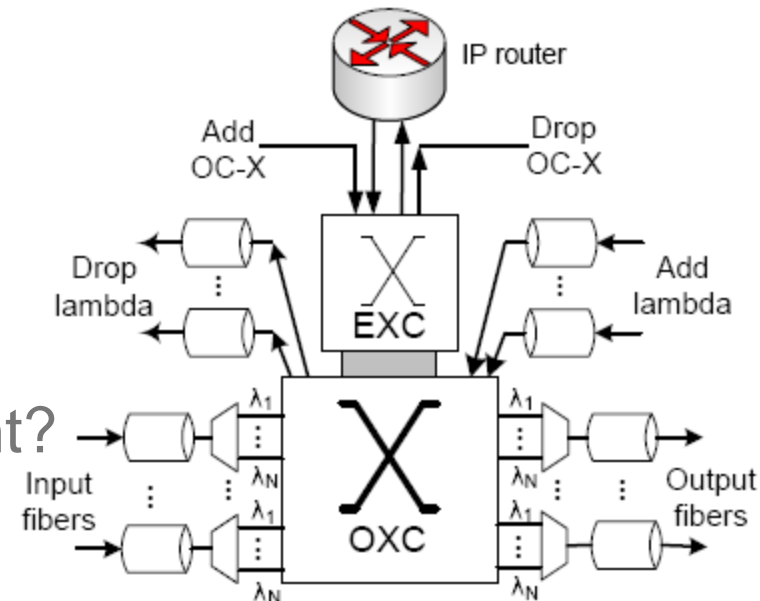
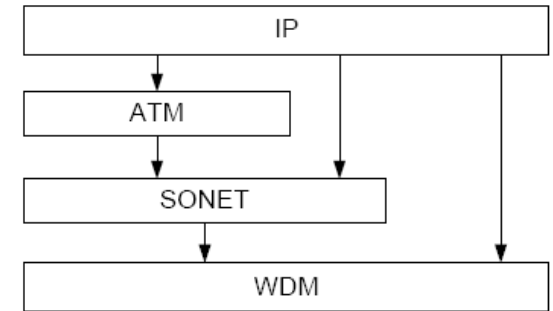
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Outline

- **Motivation**
- Network evolution towards IP over GMPLS
 - Control Plane
 - Data Plane
- Multi-layer Traffic Engineering Mechanisms
- Impact of MTE on the IP over WDM architecture
- Conclusions

Motivation

- Current backbone networks are migrating to an IP over WDM scenario.
- Common control plane for IP and optical layers.
- Open issues:
 - How should the IP and optical resources be used?
 - Which is the impact of MTE algorithms at network equipment?



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Evolution of IP and transport networks

- Transport plane legacy technology is SDH.

IP over WDM Backbone solution

Data Plane

Control Plane

Management Plane

DWDM

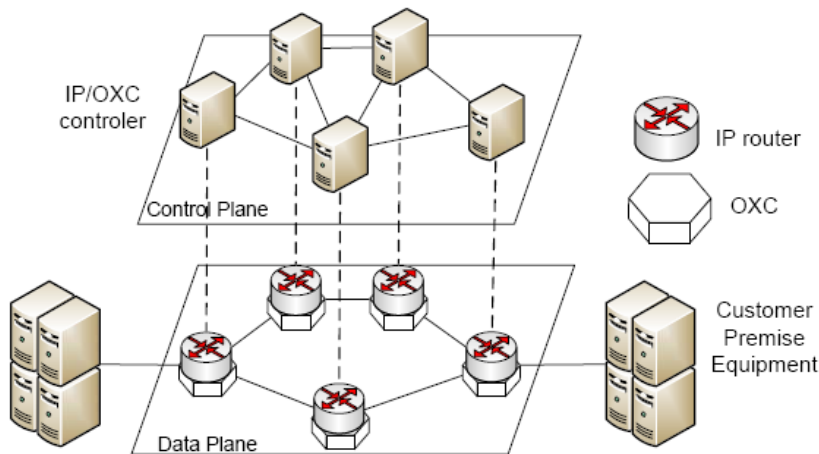
ASON MP

GMPLS

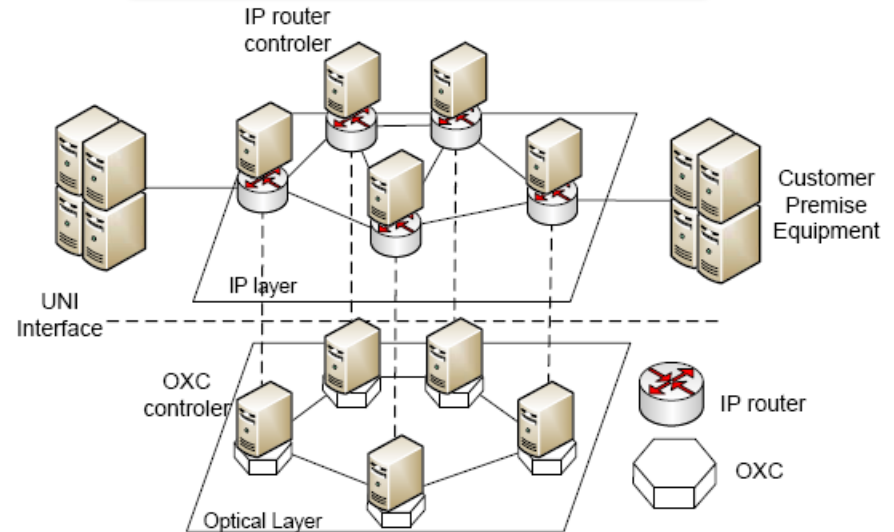
IP

Control plane: Interconnection models

Integrated Model

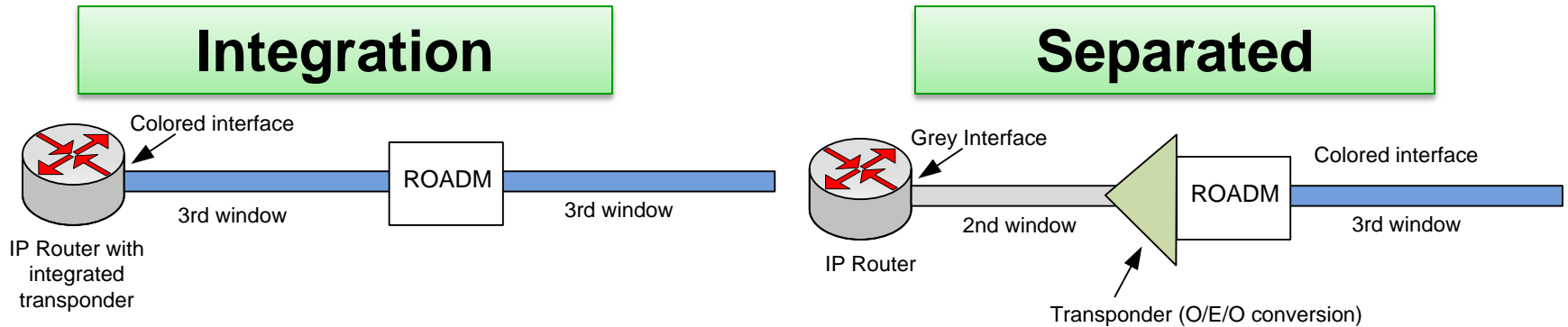


Separated Model



Control plane	Integrated	Separated
Multi-layer traffic engineering	Complete	Limited
Complexity	High	Low
Performance	Relatively slow	Fast
Stability	Average	High
Architecture	Distributed	Either
Restoration	Integrated	Possible instability
Online restoration	Slow	Fast

Data plane



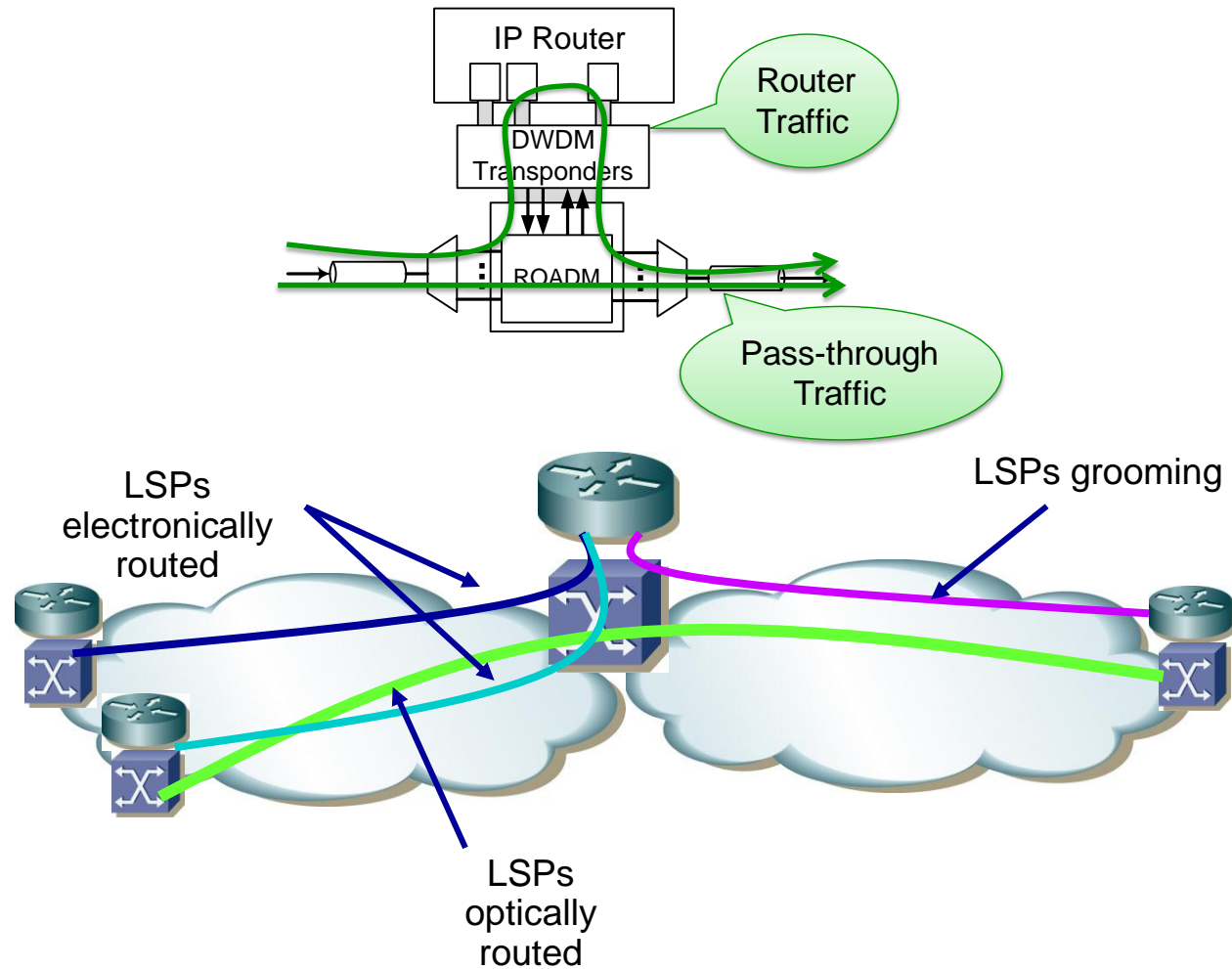
Open Issues

- Interoperability problems
- Reduction of the DWDM equipment

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Multi-layer Traffic Engineering Mechanisms



Definition of MTE engineering mechanisms

Algorithm 1 Single Threshold Longest By-Pass Algorithm

$L \leftarrow \text{Map_Demand_WDM_Layer}(D, T, \text{Routing})$

for all V as v do

$(CP_v, BCP_v) \leftarrow \text{Cand_Paths}(v, C_{min})$

$CP \leftarrow CP \cup CP_v$

$BCP \leftarrow BCP \cup BCP_v$

end for

for $i = \text{maxlength}(CP)$ to 2 do

 for all $CP(\text{length} == i)$ as cp do

 if $Bcp > C_{min}$ then

$L \leftarrow \text{update_load}(cp)$

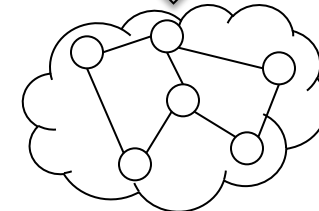
$(CP, BCP) \leftarrow \text{update_cand_list}(L)$

 end if

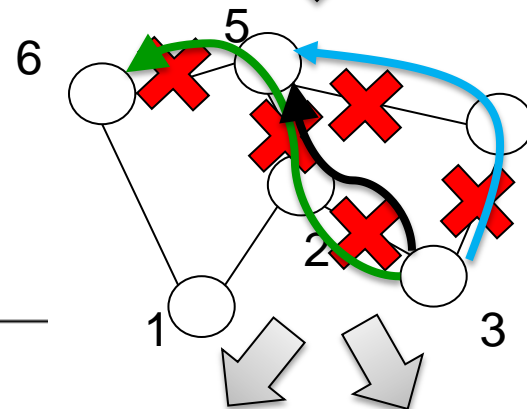
 end for

end for

Demands



Routing algorithm

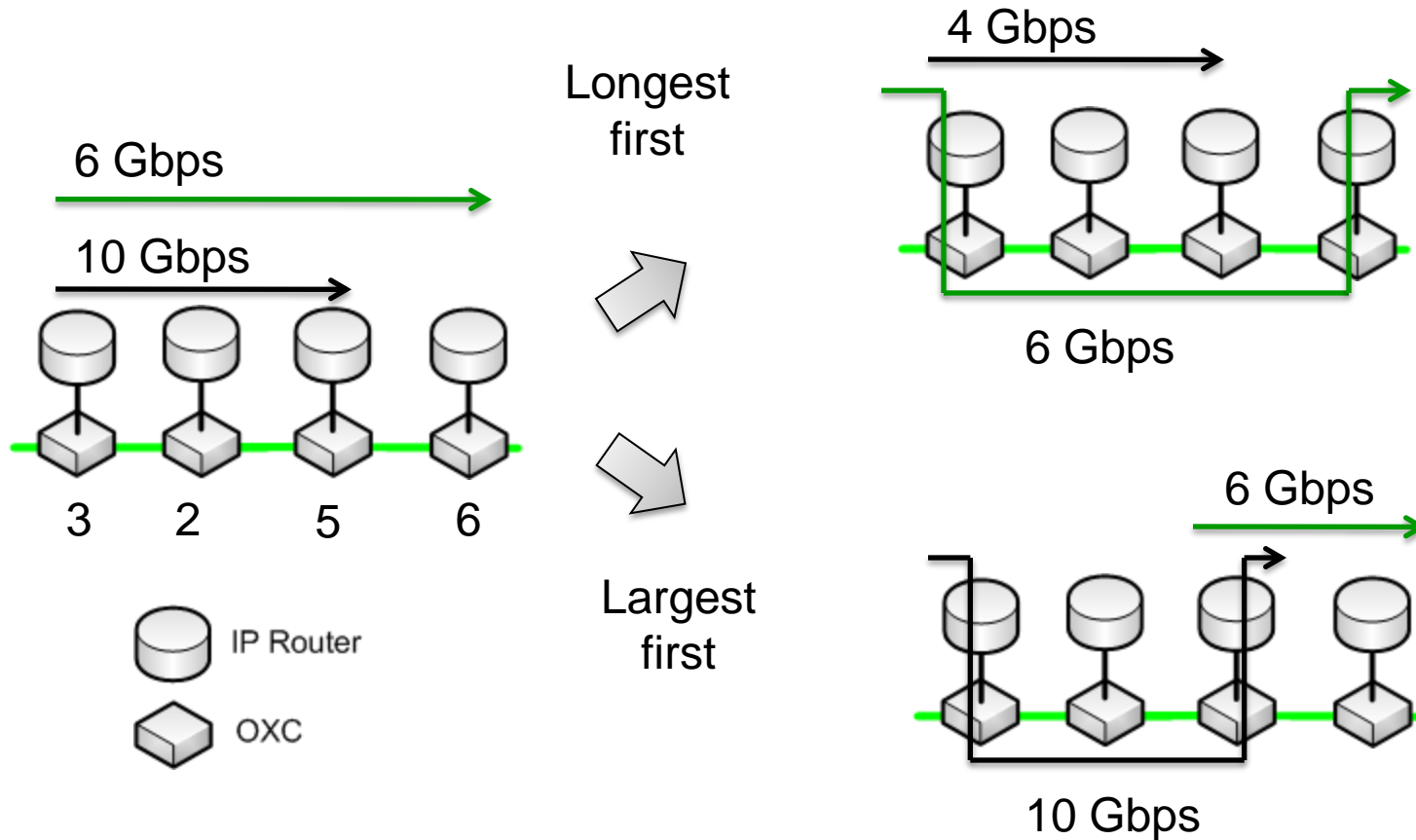


Find possible bypasses

Longest first

Largest first

Definition of MTE engineering mechanisms



Outline

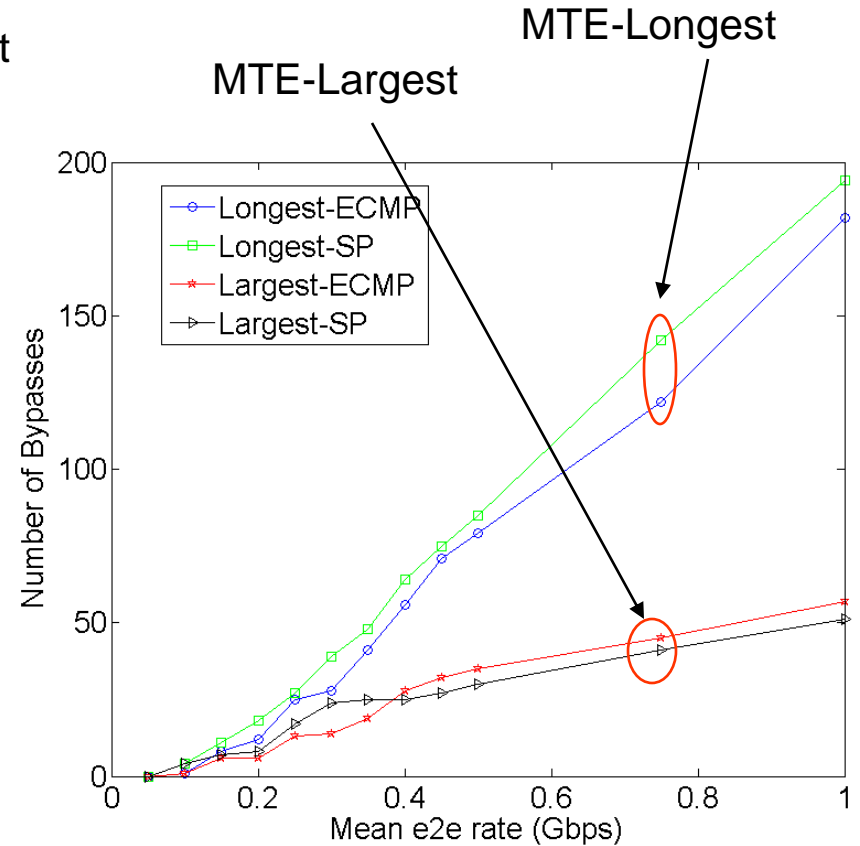
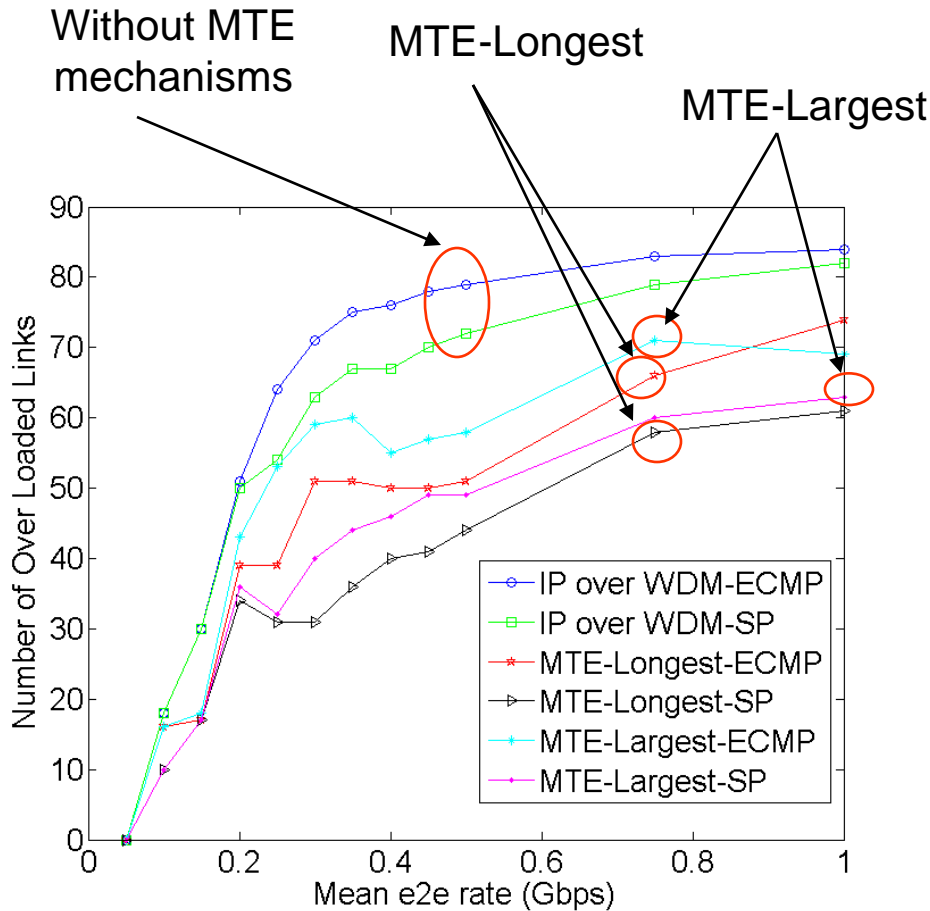
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Impact of MTE on the IP over WDM architecture

- Traffic Matrix $\sim U[0,1]$
 - End-to-end traffic scaled.
- European network with Multi-layer routers in each node.
- Routing mechanisms SP and ECMP.



Results



MTE-Longest
less congestion
more bypasses

MTE-Largest
more congestion
less bypasses

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Conclusions

- Definition of two MTE algorithms to deal with the congestion of the IP layer in network operator.
 - Firstly use the already deployed IP resources.
- Performance:
 - Longest algorithm achieves a higher congestion reduction.
 - Largest algorithm establishes less lightpaths.
- Future work:
 - Comparison of these mechanisms with cost oriented optimization algorithm.
 - Implementation of such algorithms in PCE based architectures.

Thank you!!
Questions?



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