

Evaluation of optical packet/burst switching – a technical & techno-economic comparison with competing technologies

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IST STOLAS Consortium



Industries

Lucent Technologies
Hymite
NKT Integration
Intune Technologies

Netherlands
Denmark
Denmark
Ireland

Operator

Telenor

Norway

Academic Research Centres

COBRA – Eindhoven Univ. of Technology
IMEC – INTEC Univ. of Ghent
Research Centre COM – TU Denmark
University College Dublin
Norwegian University of Science and Technology

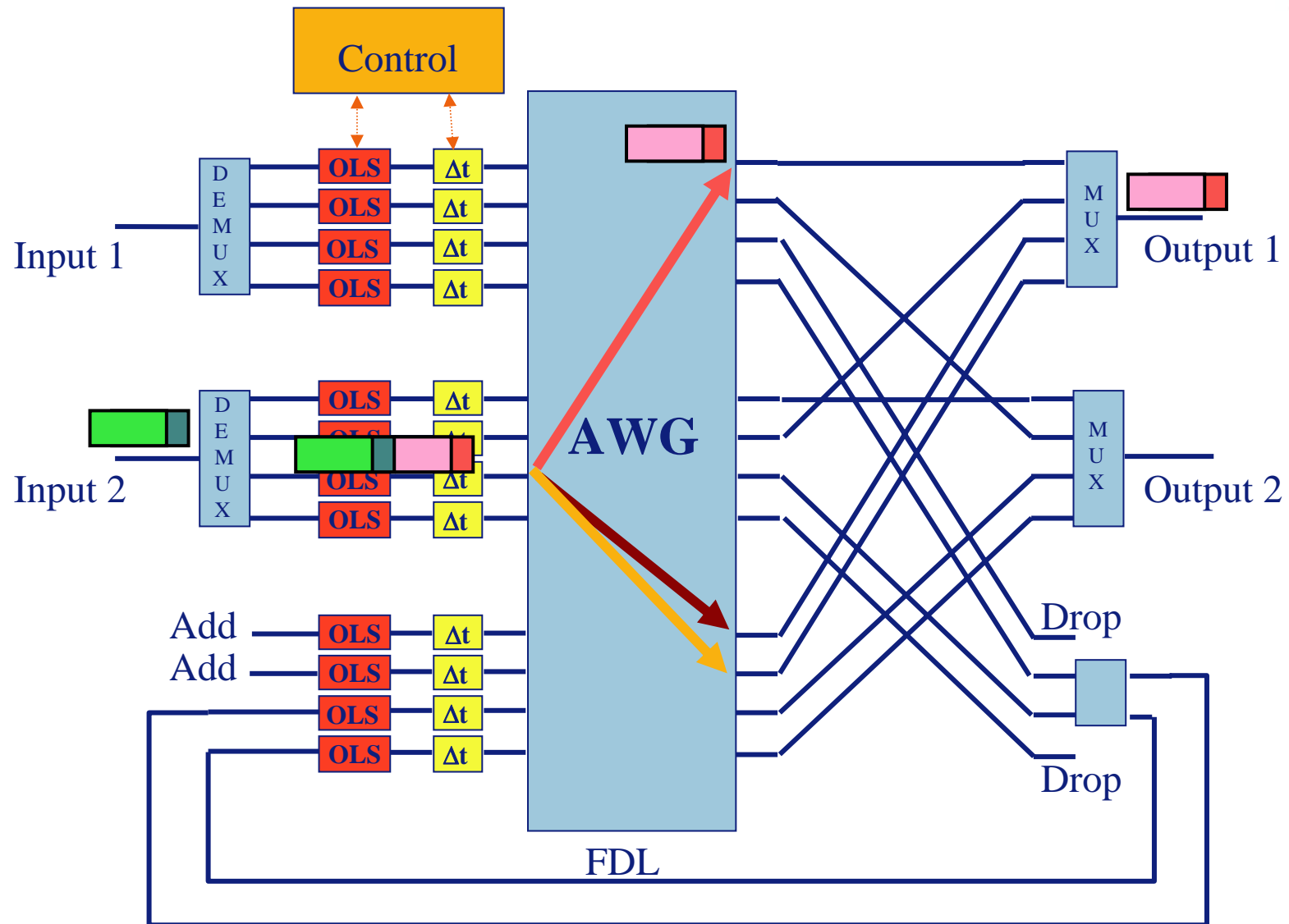
Netherlands
Belgium
Denmark
Ireland
Norway

Outline

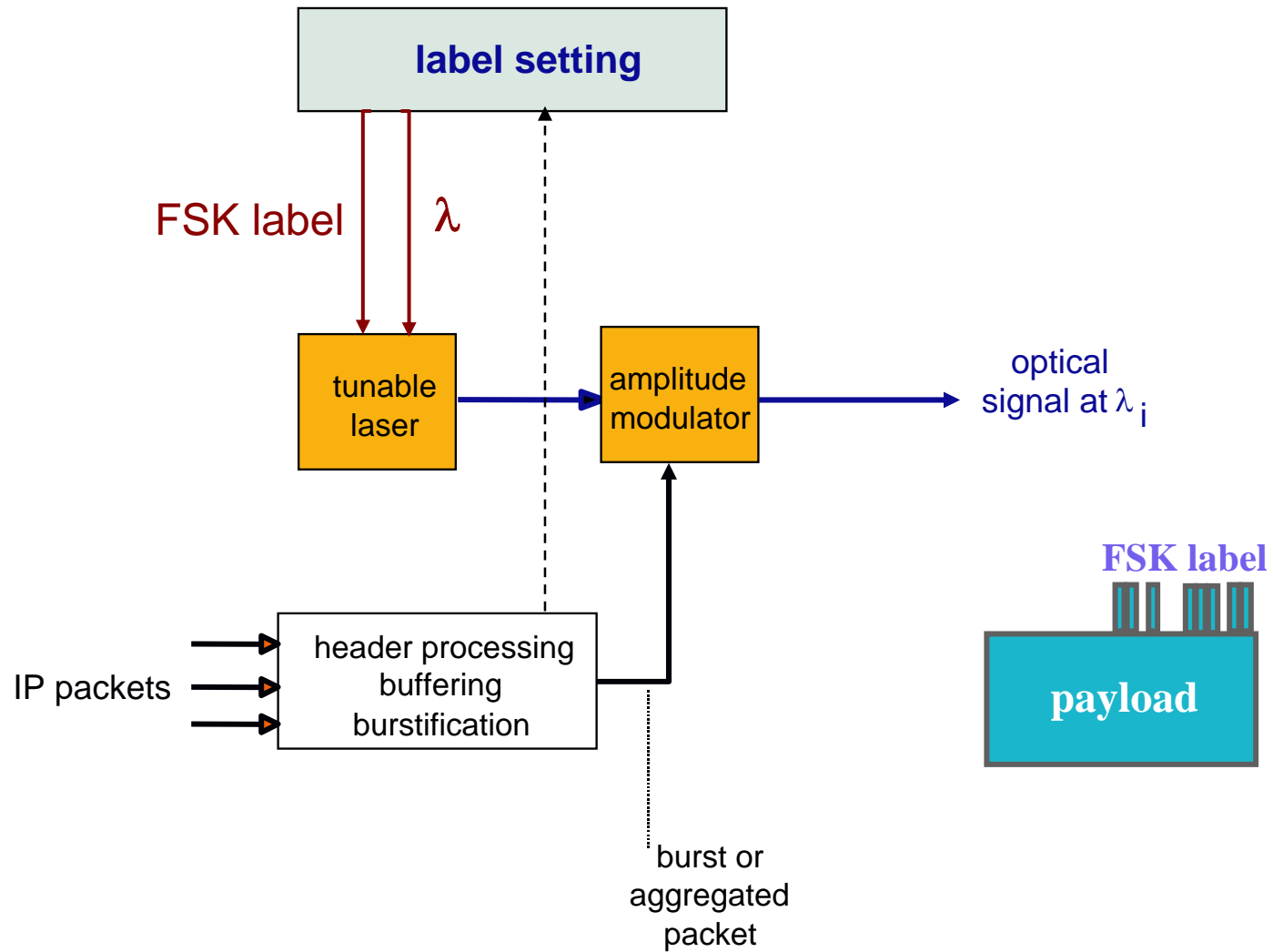
- Introduction: STOLAS Technical Concept
- Optical packet switching gains: analytical study and simulations
- Techno-economic comparison with commercial technologies
- Summary and conclusions

The STOLAS Technical Concept

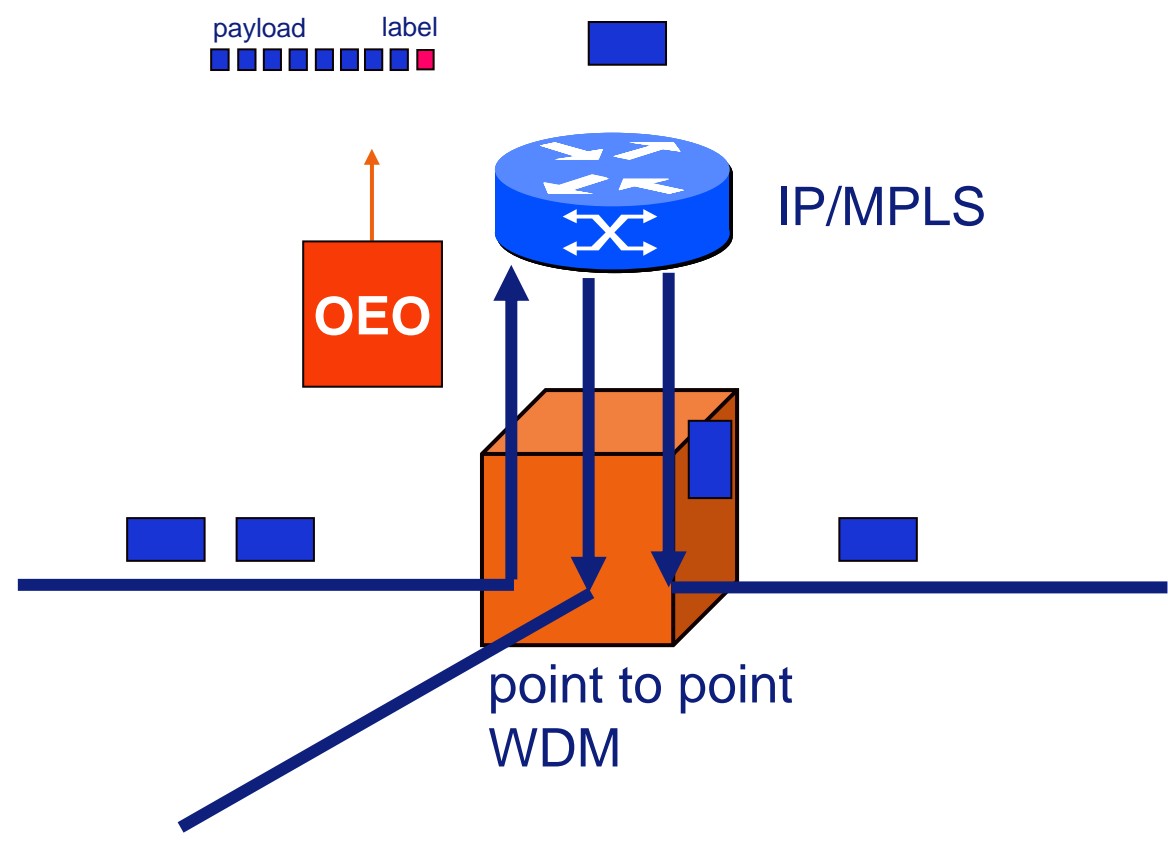
Optical Burst Switching Node



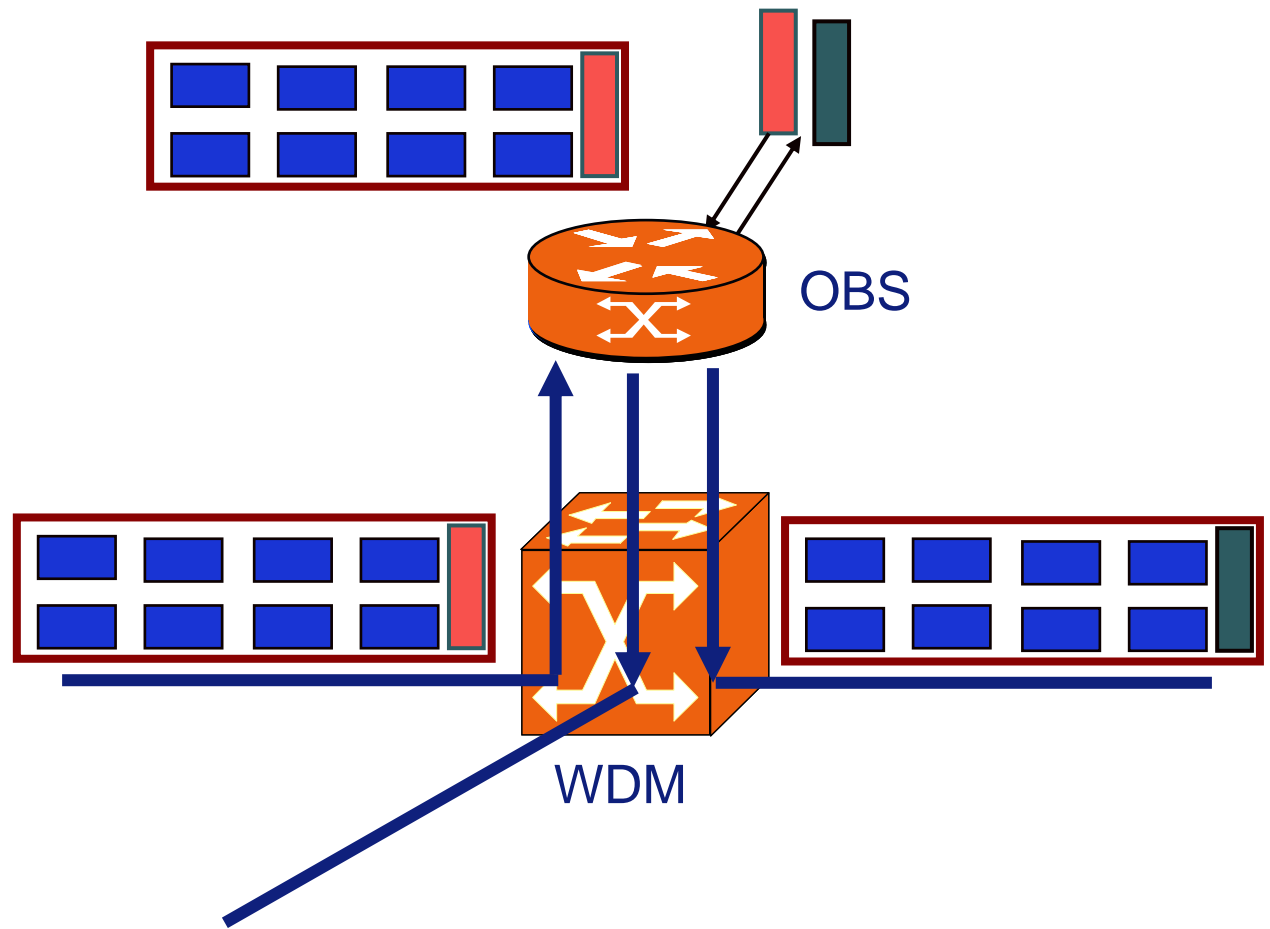
Label setting



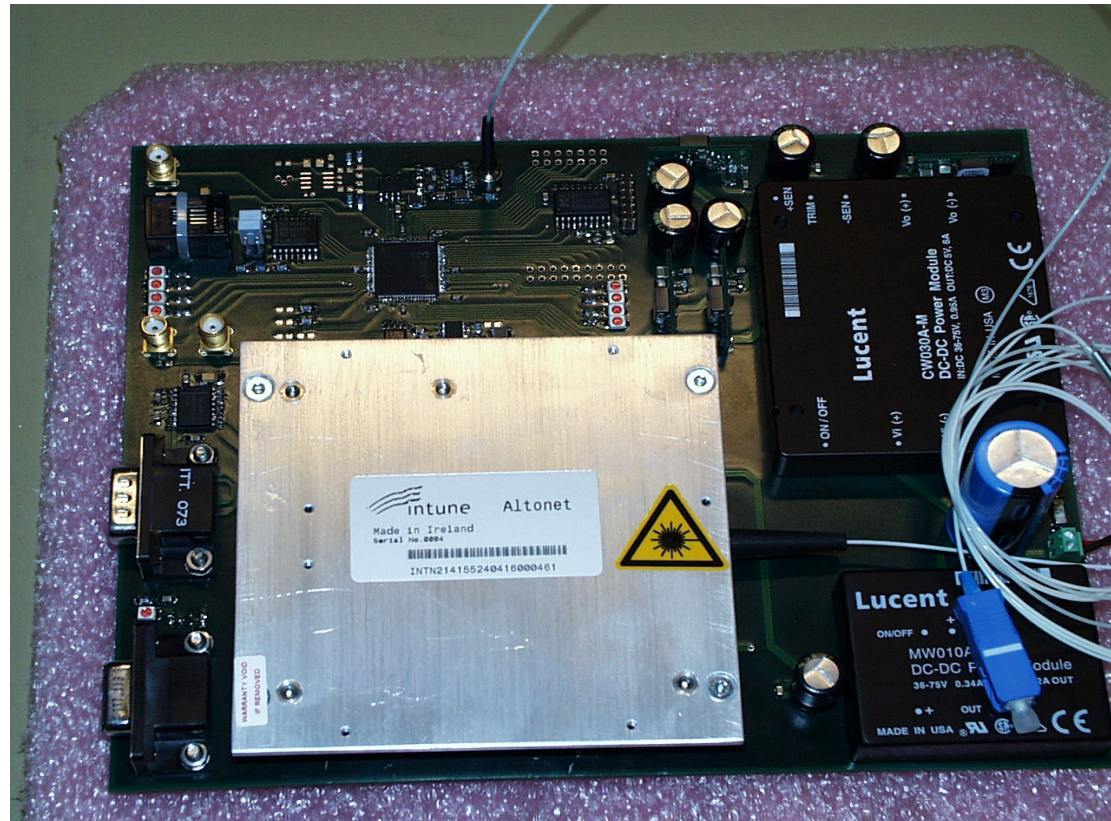
IP/ MPLS node



OBS node



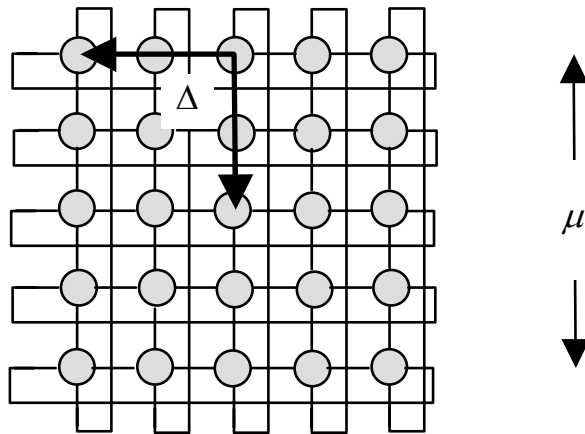
Label processing board



Lucent Technologies, Netherlands

OBS vs OCS: Analytical & simulations study

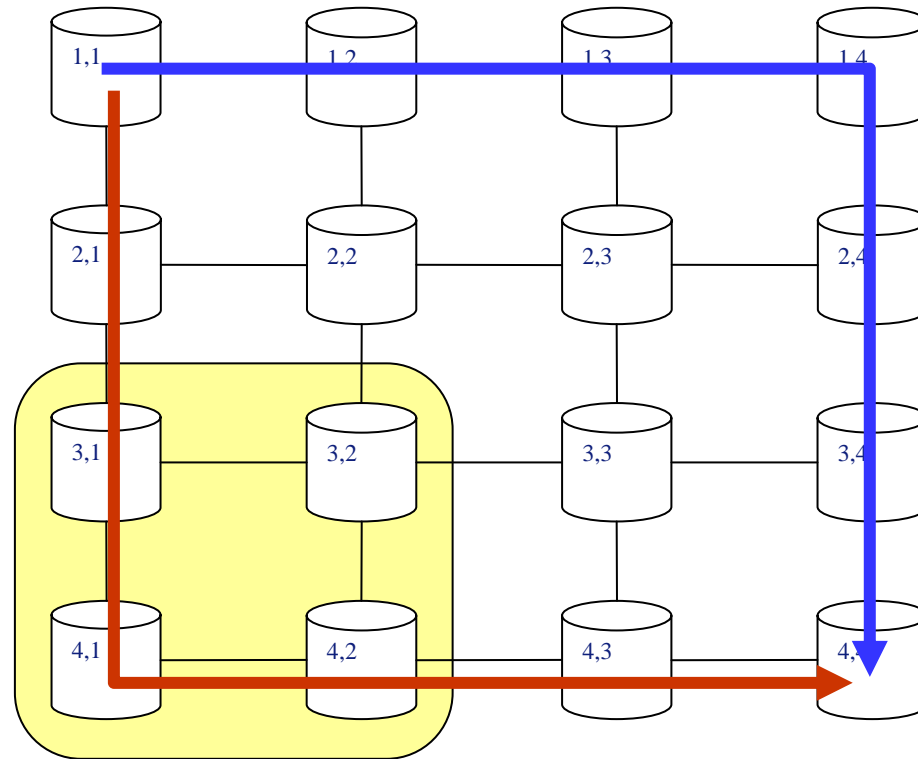
Multiplexing and granularity gains



K: **OCS resources / OPS resources**
 required for the same performance

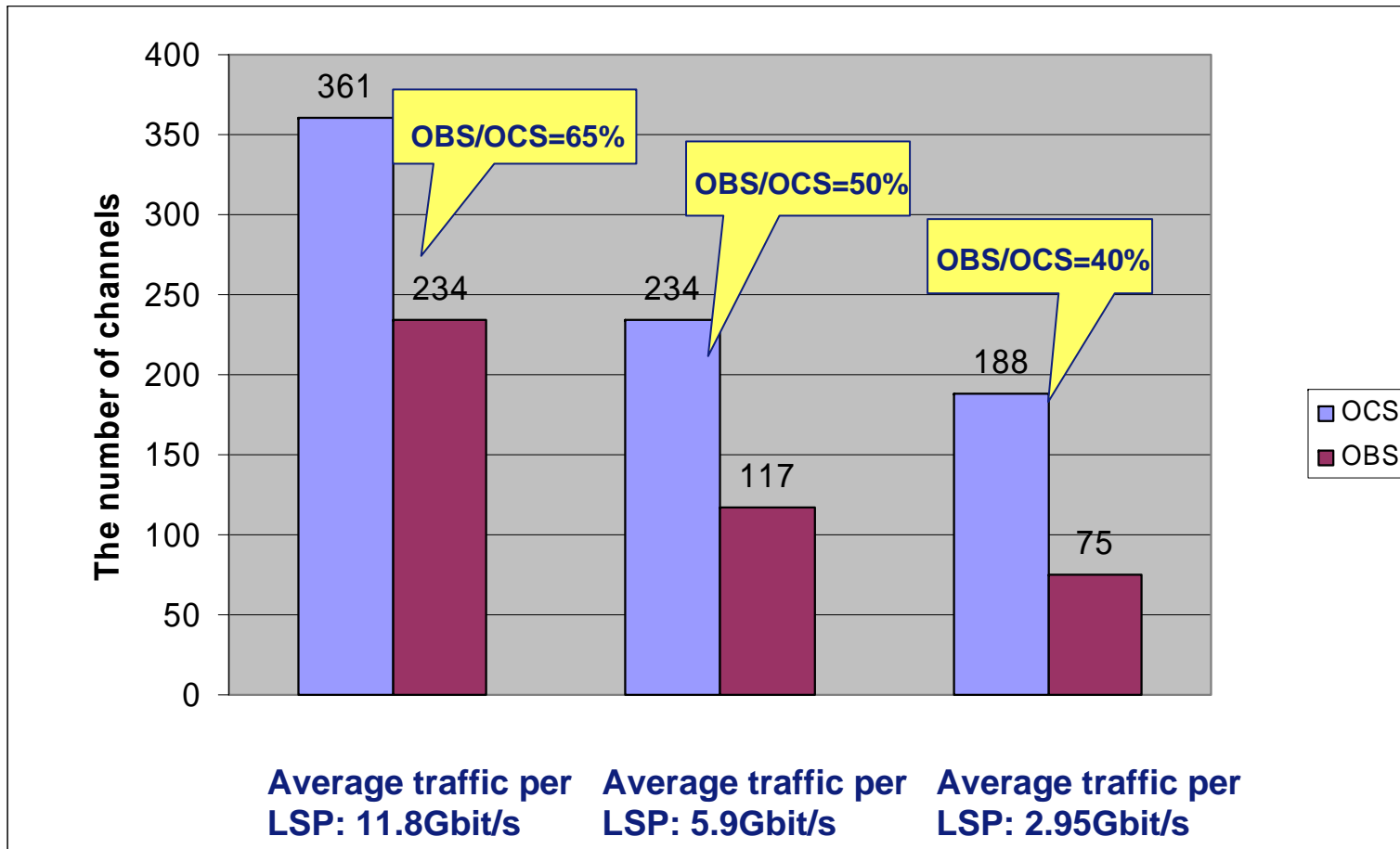
The multiplexing gains that can be obtained with OPS compared with OCS increase with network size, mean traffic volume and traffic burstiness. For realistic values of these it may be expected that OPS requires about half the resources than OCS in the near future – assuming that the mean volume per traffic source will gradually increase somewhat.

Network simulations – 4x4 grid network



Homogeneous traffic input and traffic interest between nodes

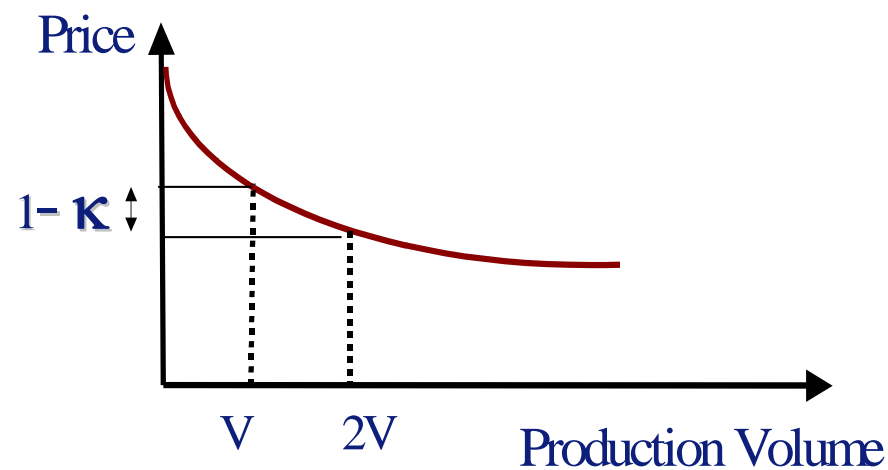
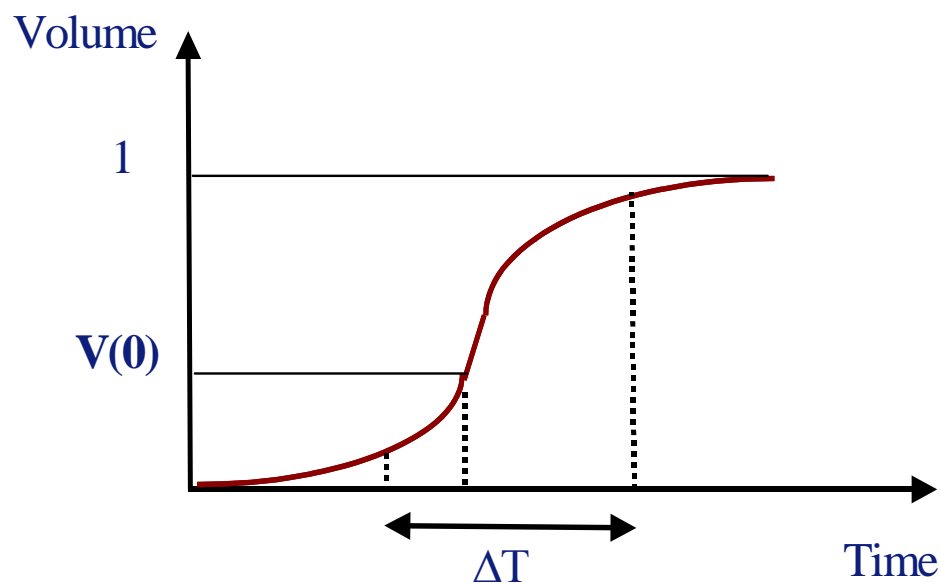
Network simulations – 4x4 grid network



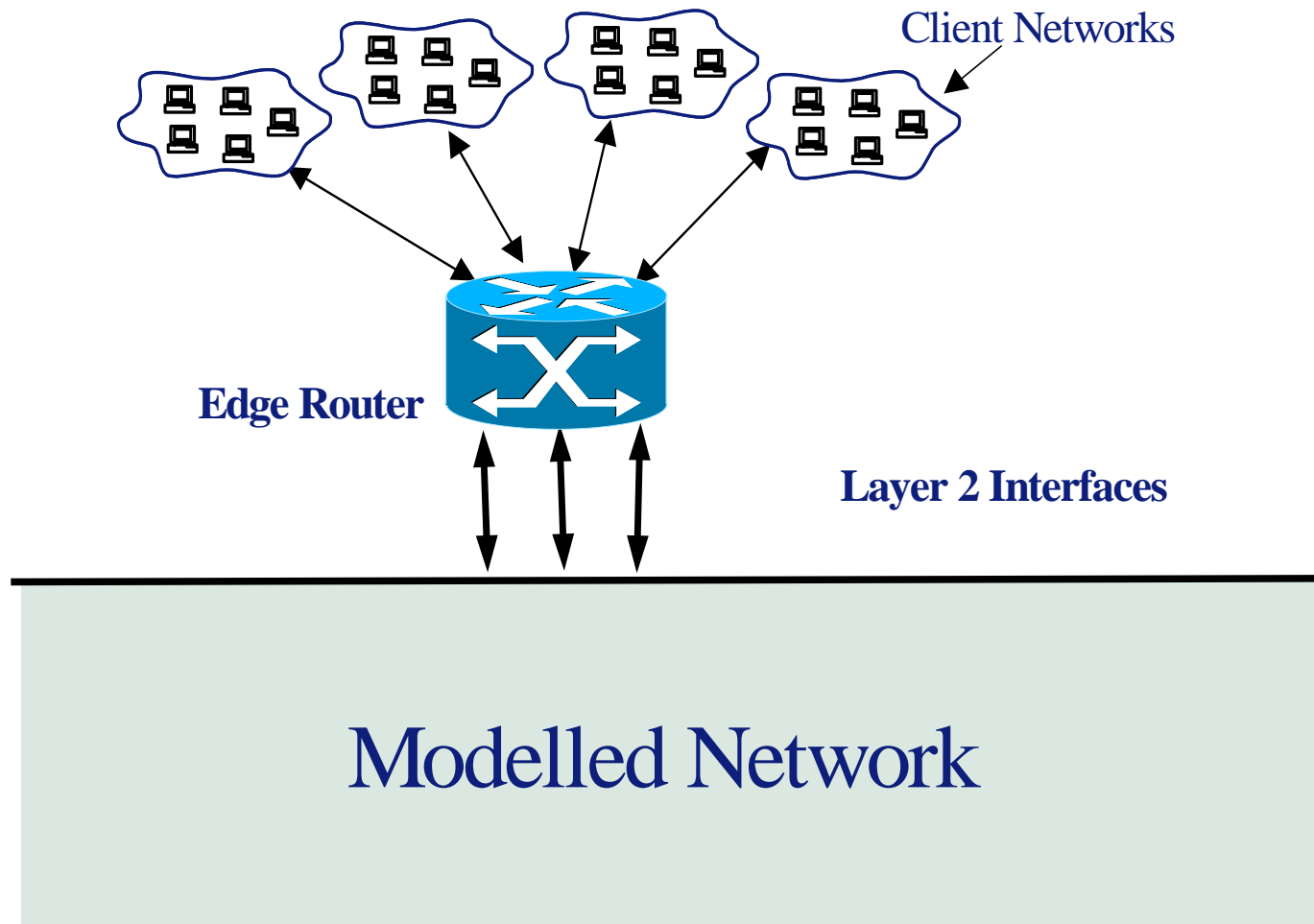
Techno-economic study

Techno-economic study – method

- comparison of OBS with IP/MPLS and OCS
- 4x4 grid and torus topologies
- Extended Learning Curve Method for cost evolution predictions
- typical prices for commercial technologies
- scenario analysis



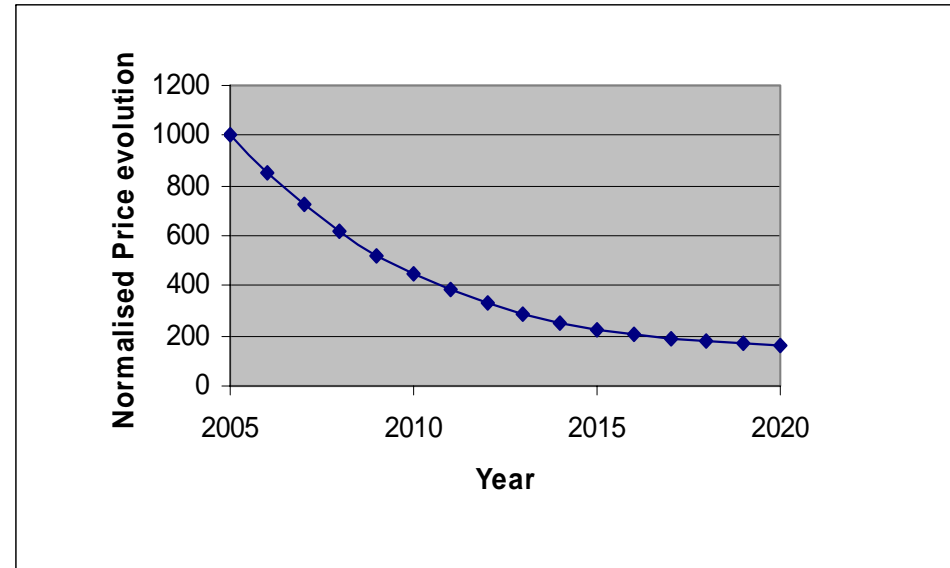
Network edge model



Techno-economic study – IP/MPLS

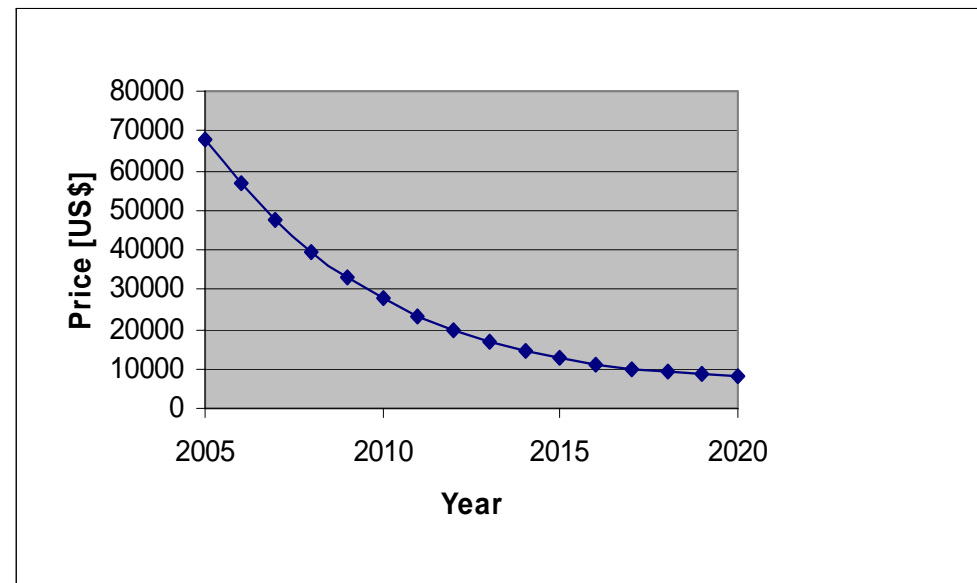
IP/ MPLS Switch price evolution

fall of about 10% the first years

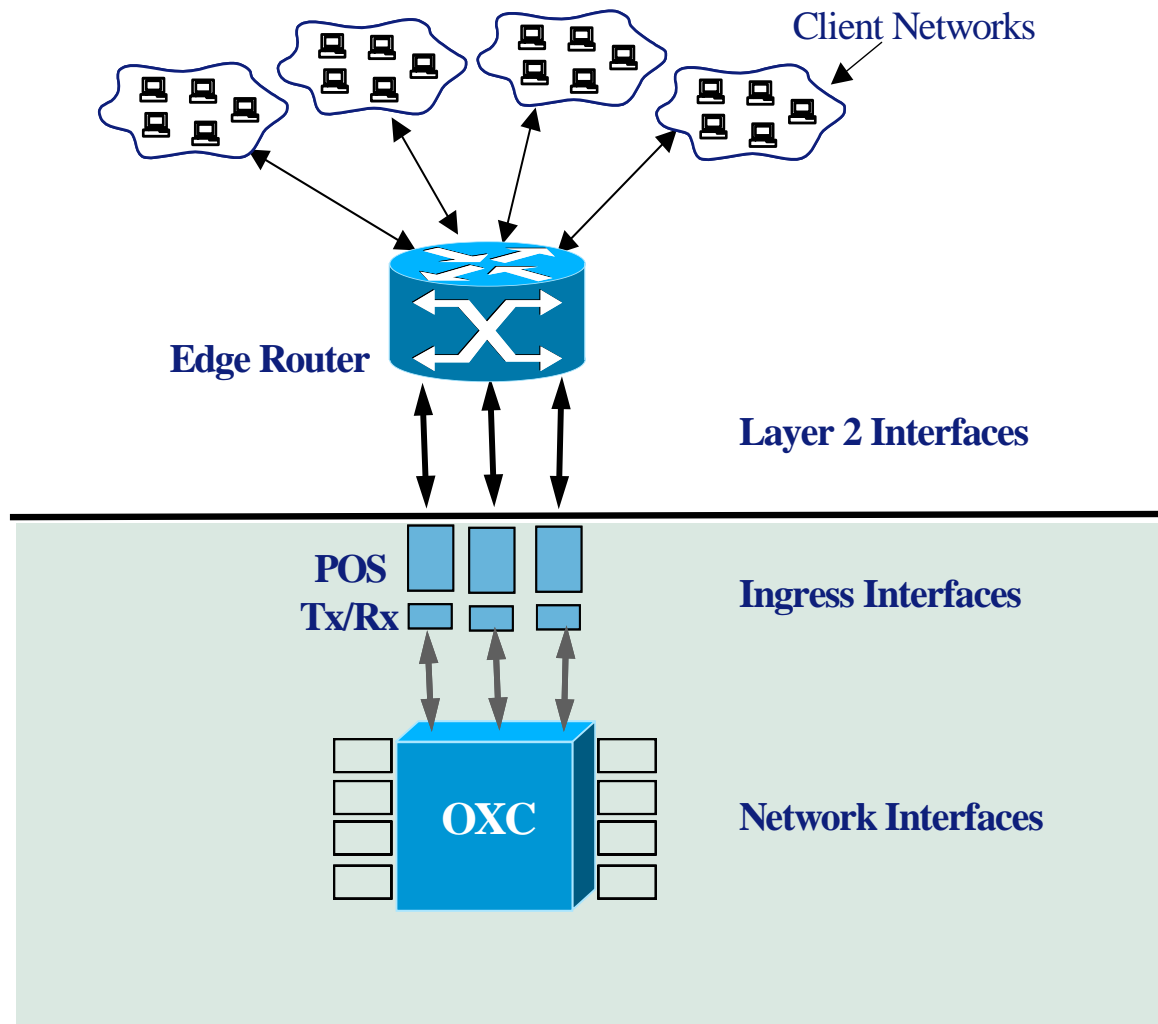


Ethernet Interface price evolution

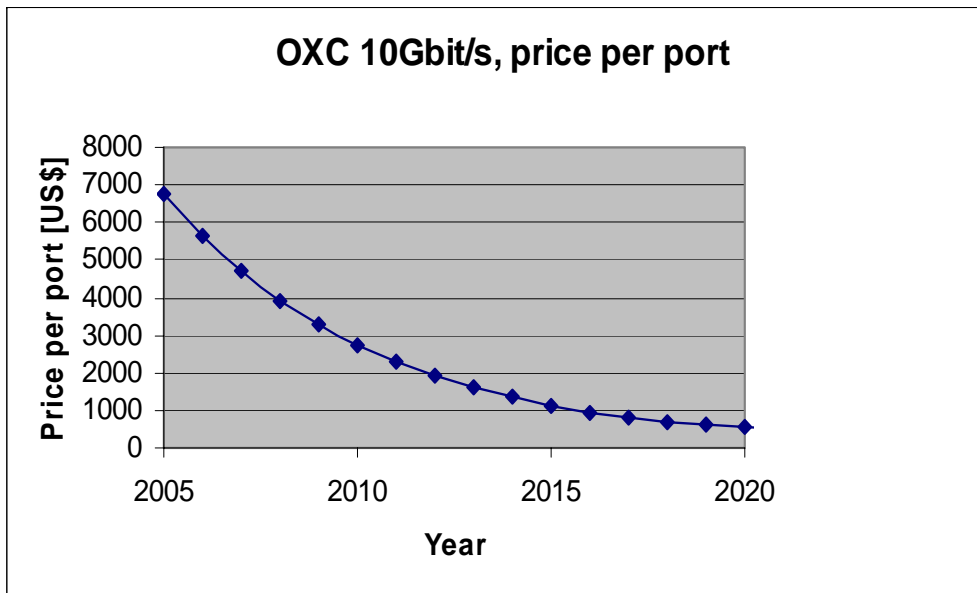
fall of about 17% the first years



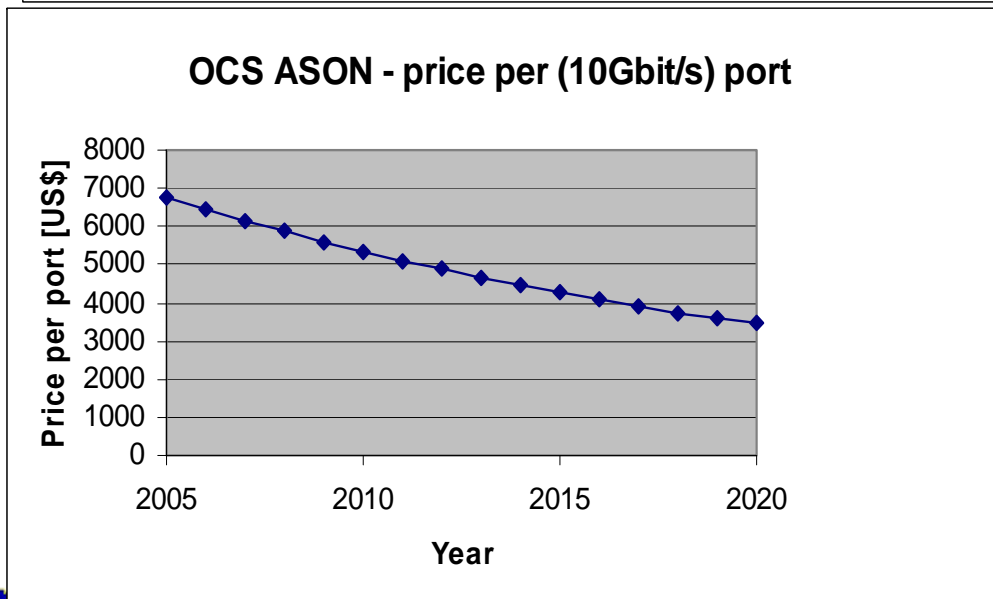
Techno-economic study – OCS model



Techno-economic study – OCS

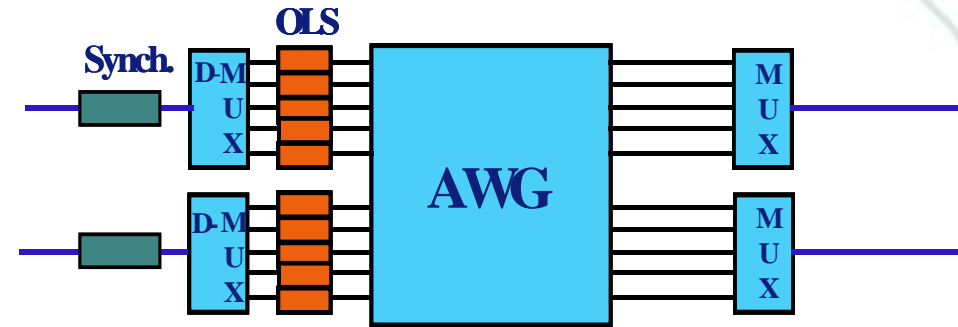
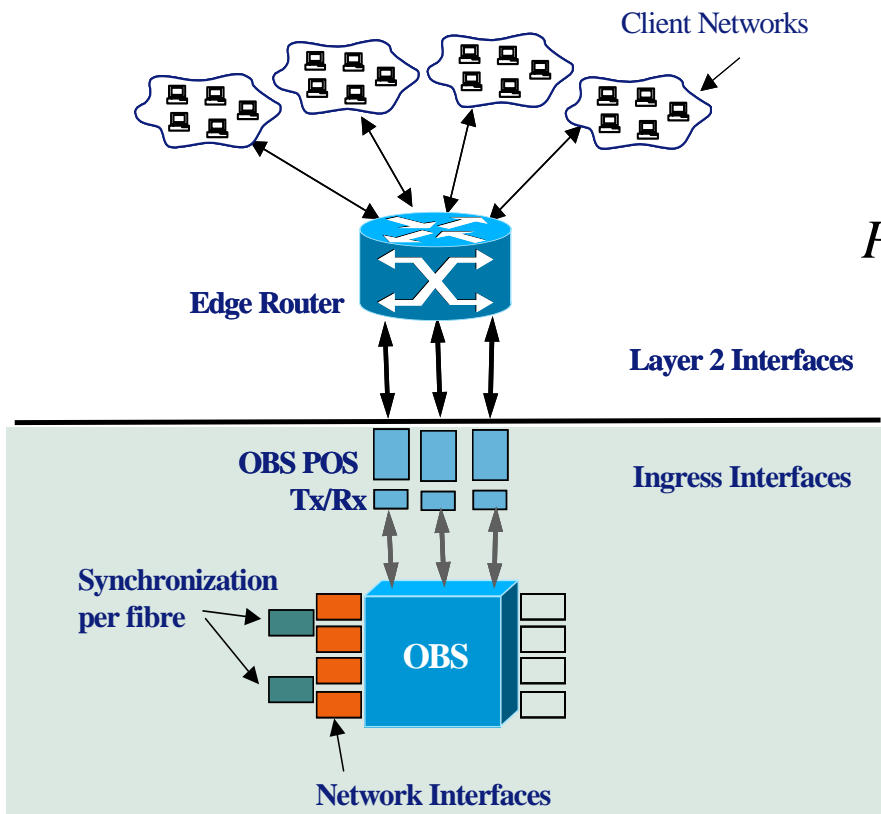


OCS Low Price scenario:
fall of 17% the first years



OCS ASON scenario

Techno-economic study – OBS model



Switch: cost based pricing assumption

$$P = 2.5 \cdot C_{Production} = 2.5 \cdot [3 \cdot [C_{HW} + C_{SW}]] = 2.5 \cdot [3 \cdot [1.3 \cdot C_{HW}]]$$

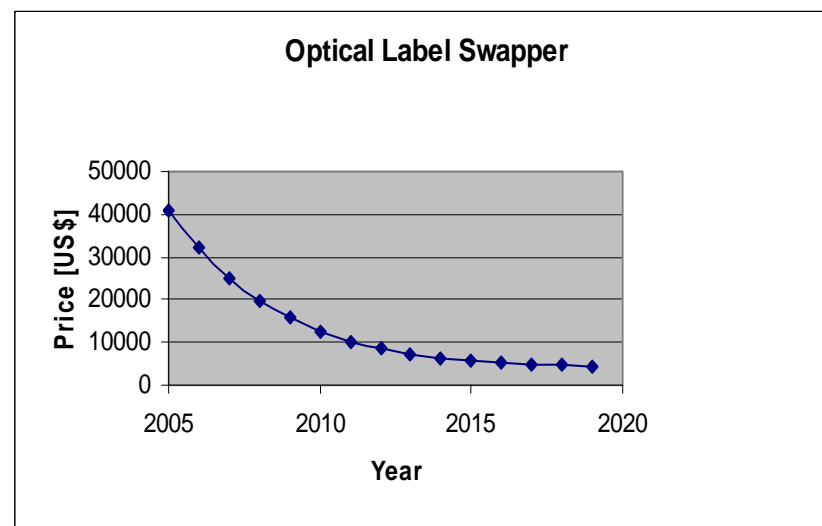
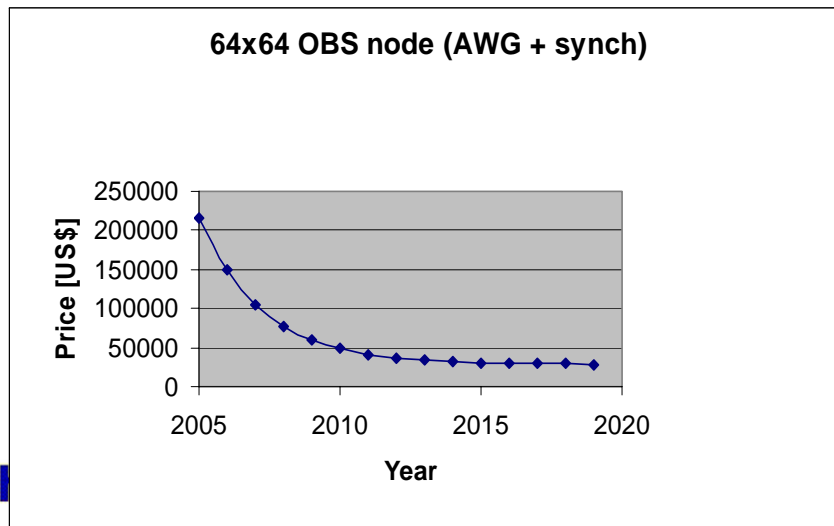
Main cost contributor: Ingress Interface →

Scenarios created around this interface

OBS – assumed component prices



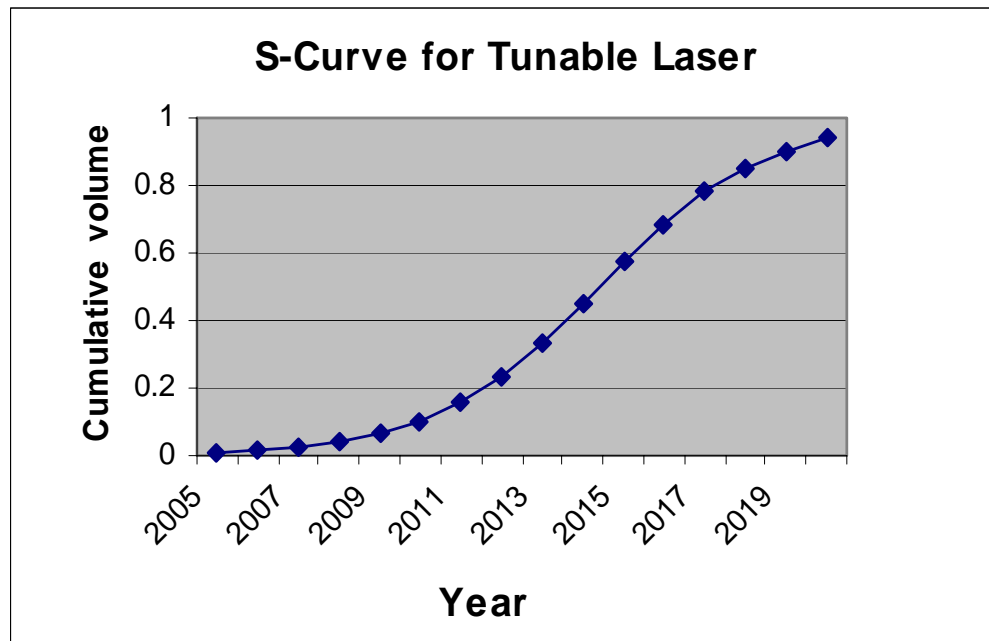
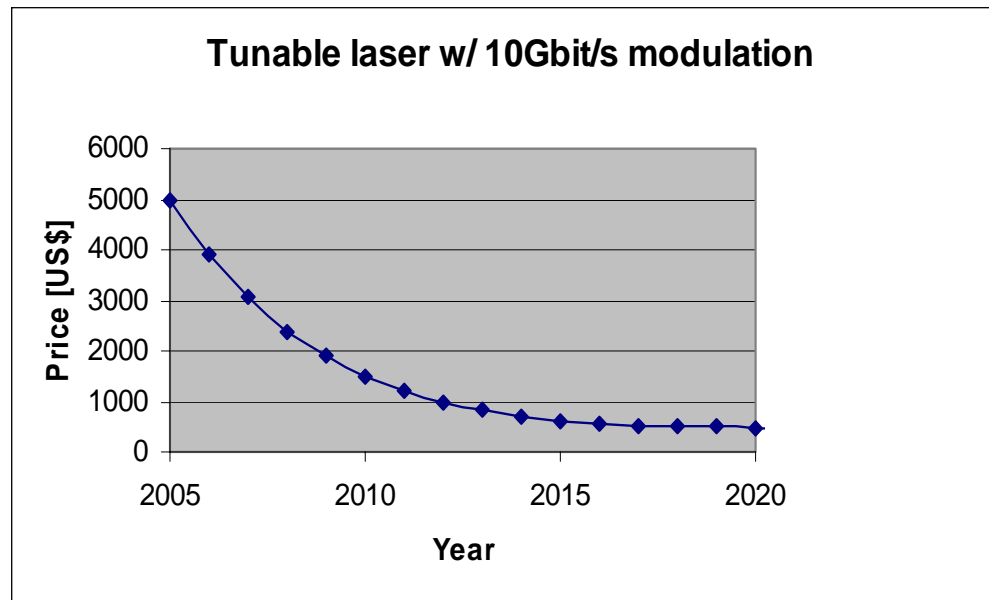
	Price per unit US\$ Year 2005
Tunable Laser, CW	3500
Tunable Laser, modulated at 2.5Gbit/s	5000
Tunable Laser, modulated at 10Gbit/s	5000
Tunable Laser, modulated at 40Gbit/s	7000
Synch: 14x(ms range 2x2 switch) + (μ s range 2x2 switch)	35000
DFB laser	500
SOA	300
AWG per port	40
OLS processing electronics	100



OBS – tunable laser evolution



price fall about 22%
the first years



OBS scenarios



Scenario A: OBS InI = 3x IP/MPLS InI in 2005
price fall: 25% the first years

realistic

Scenario B: OBS InI = 3x IP/MPLS InI in 2005
price fall: 17% the first years, i.e. as for IP/MPLS

unrealistically
pessimistic

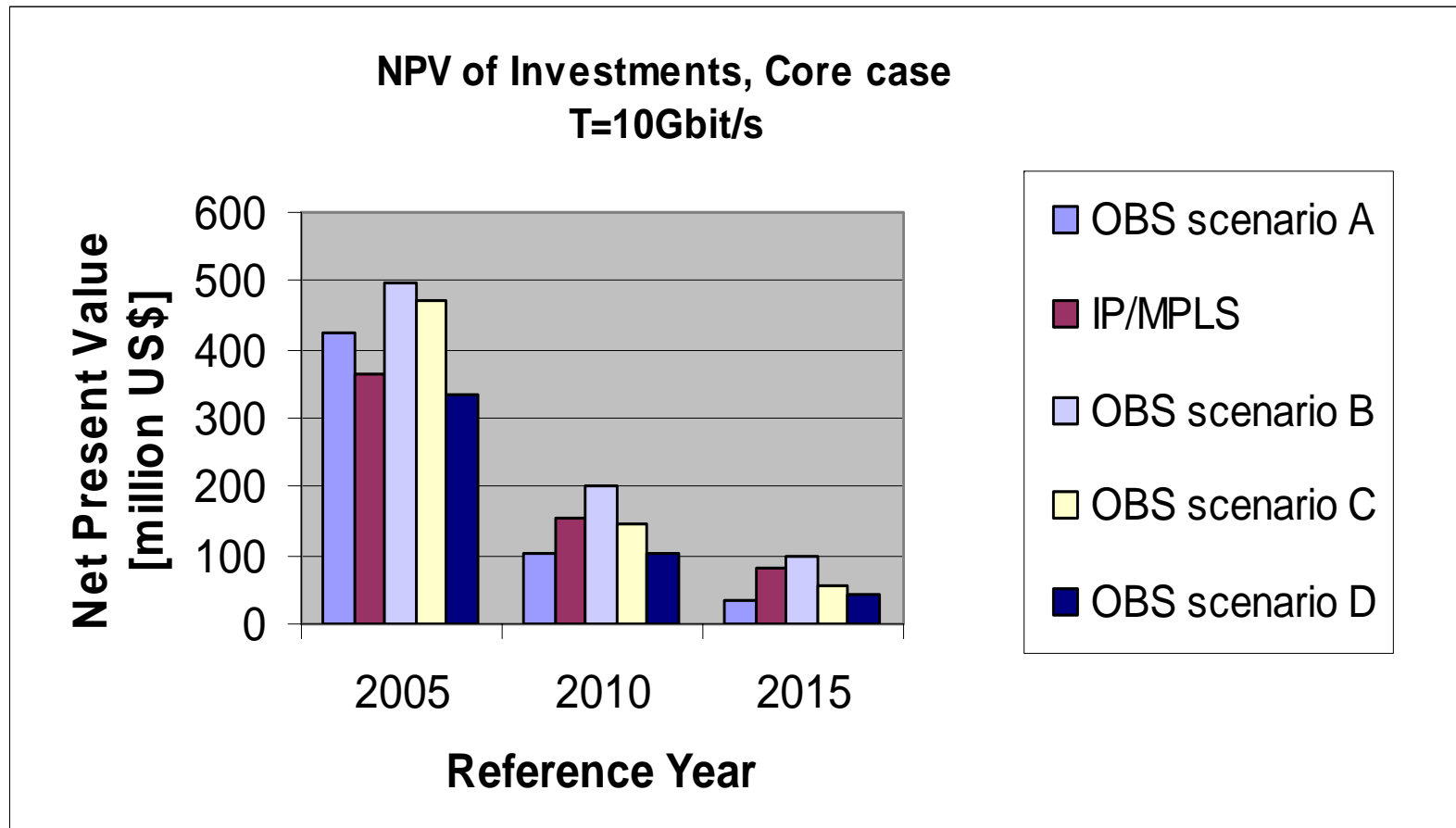
Scenario C: OBS InI = 3x IP/MPLS InI in 2005
price fall: 22% the first years

realistic

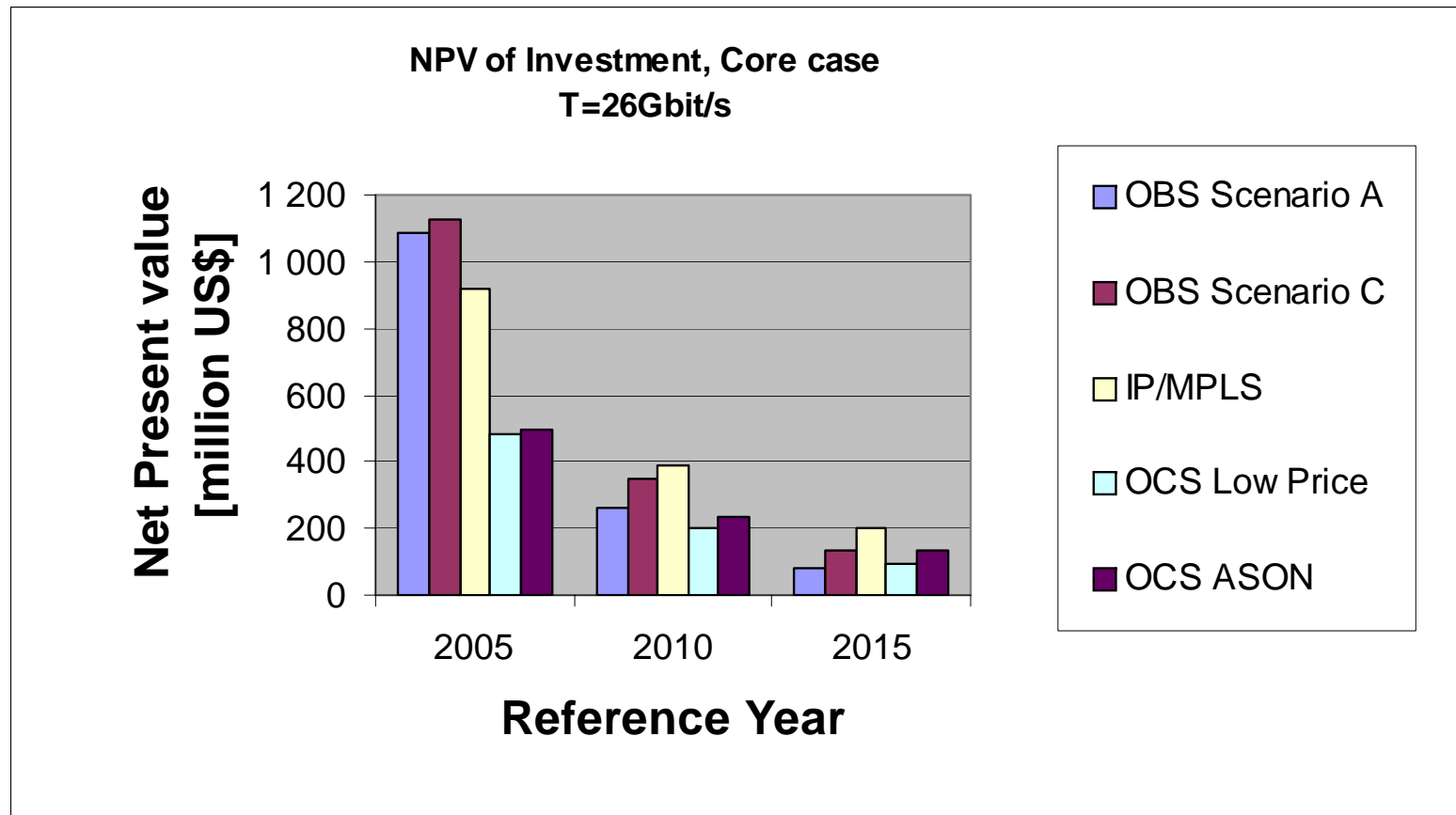
Scenario D: OBS InI = 2x IP/MPLS InI in 2005
price fall: 22% the first years

optimistic

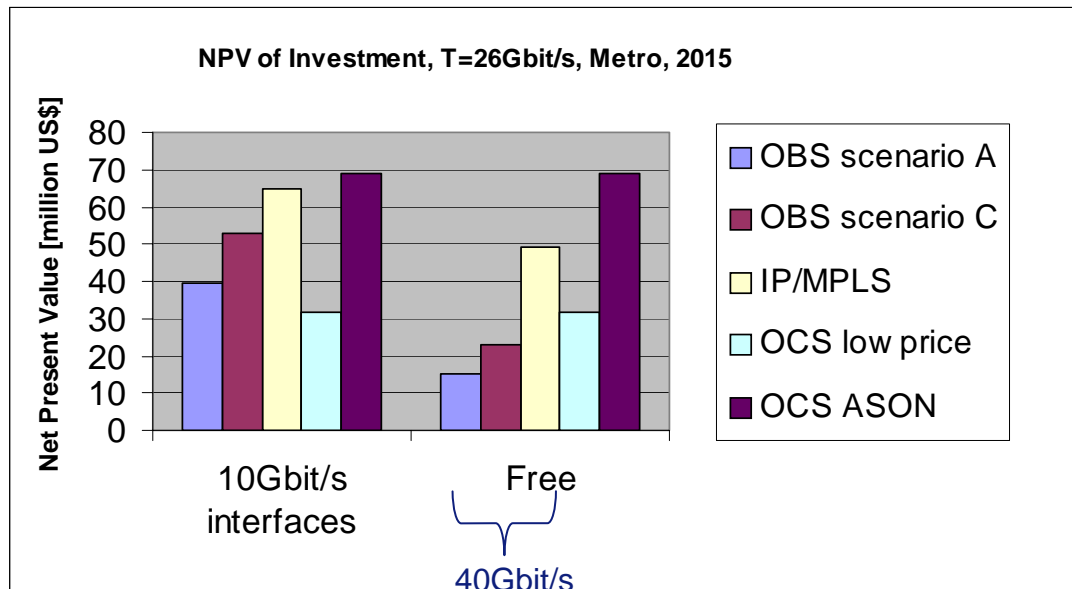
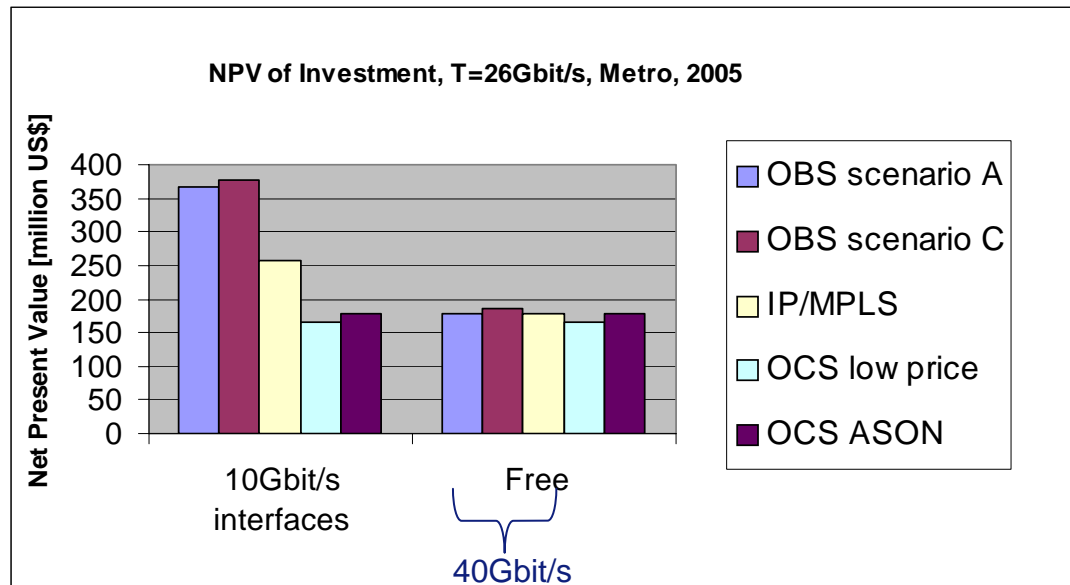
Techno-economic study – results



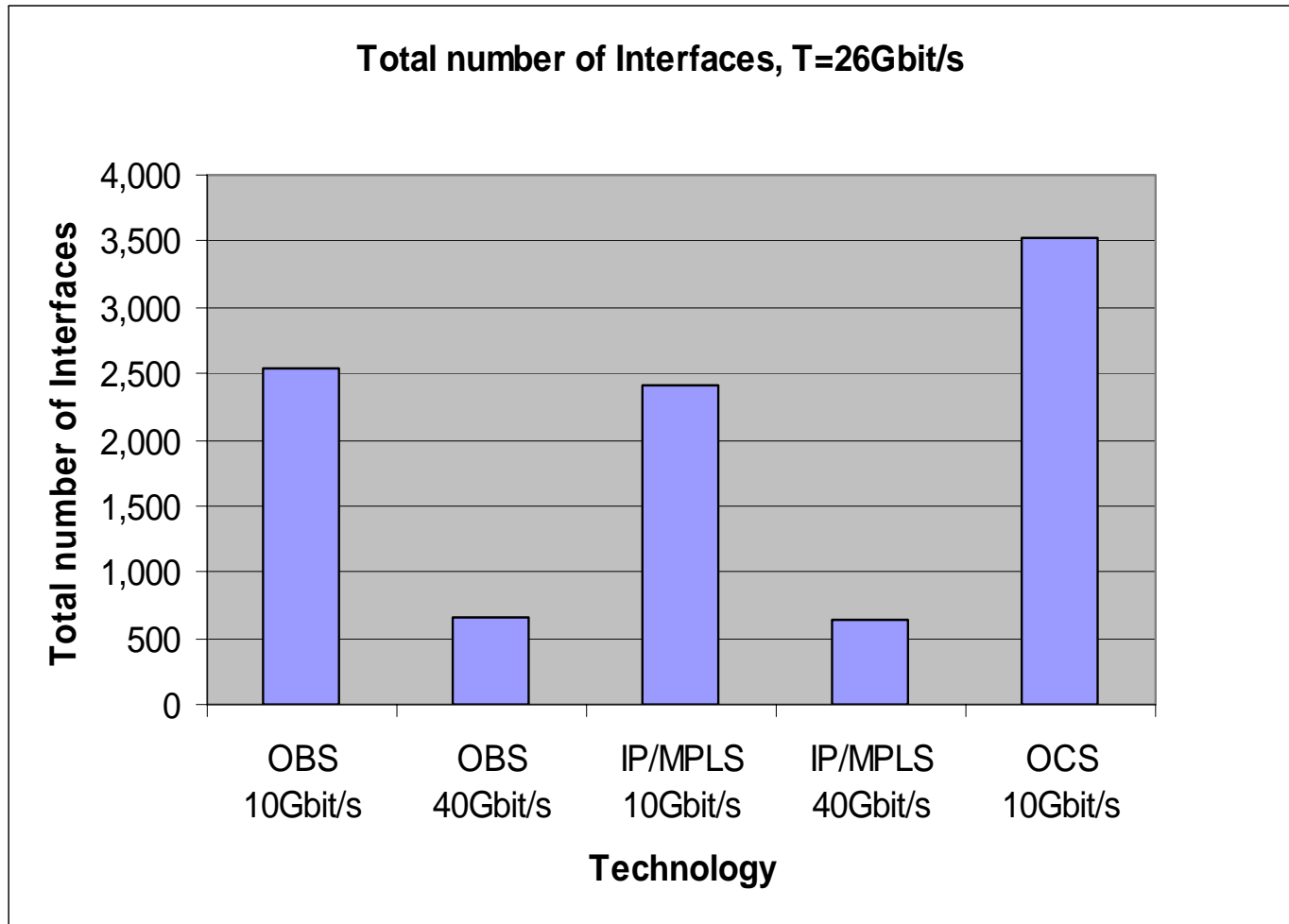
Techno-economic study – results



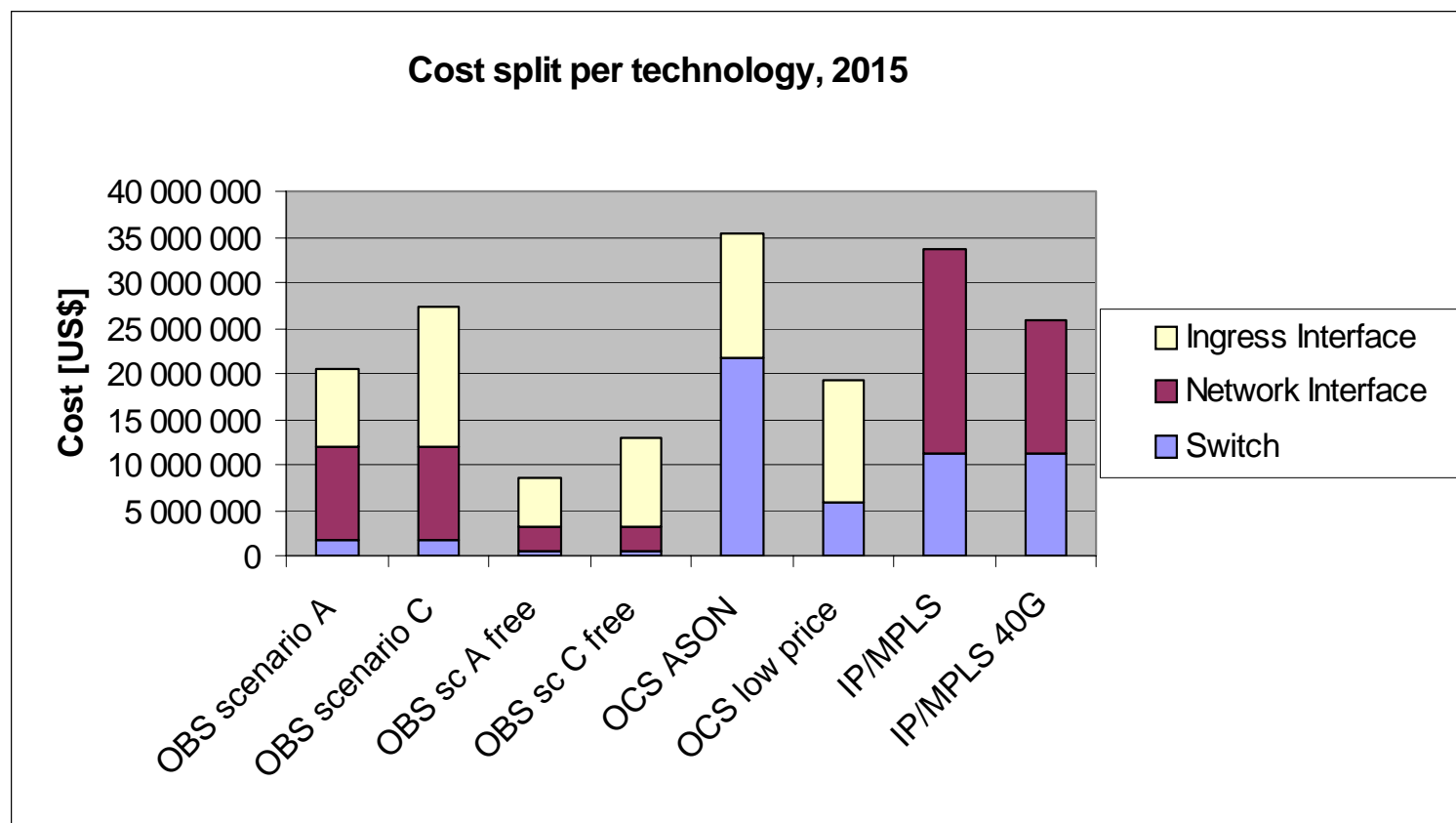
Techno-economic study – results



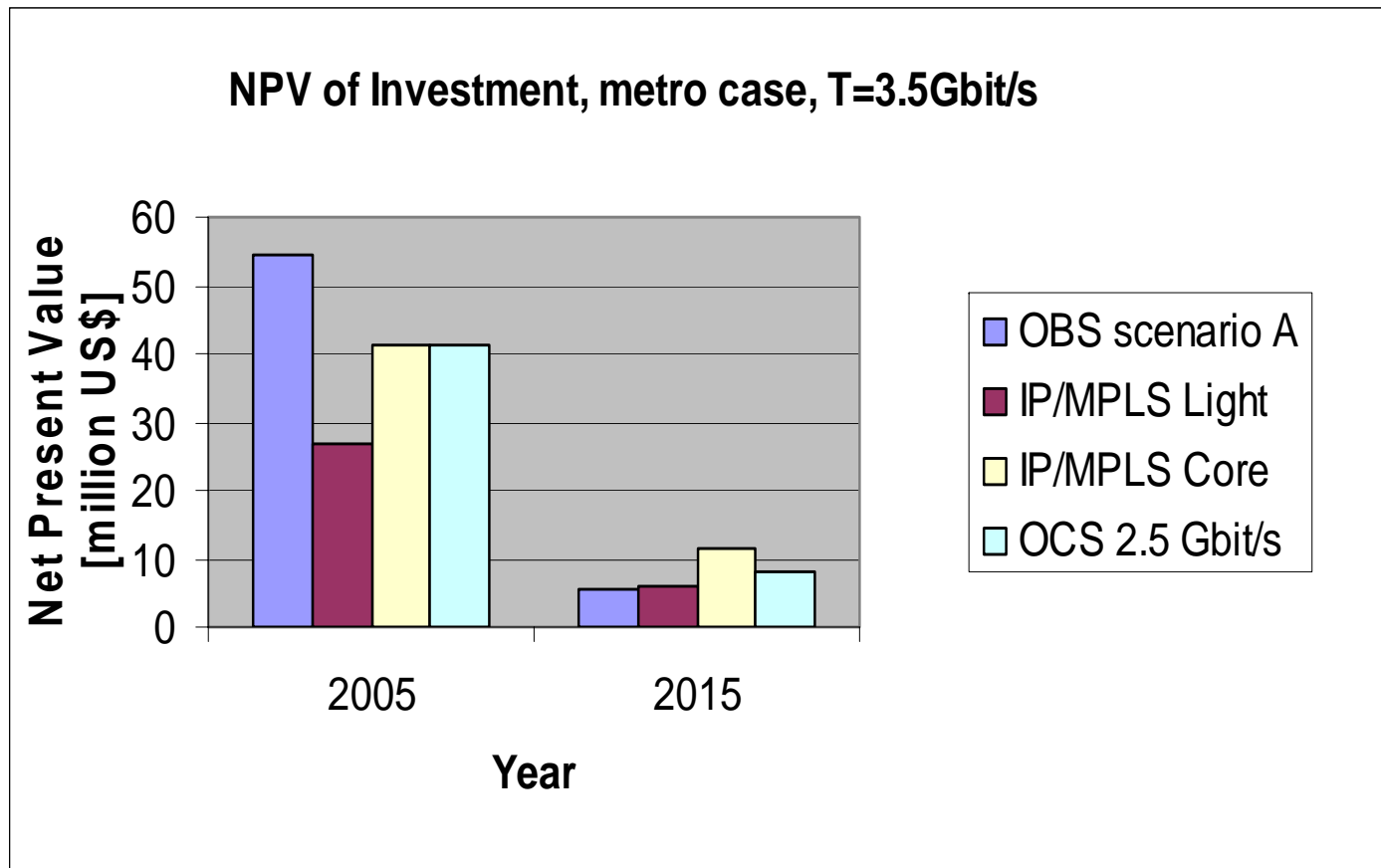
Number of Ingress interfaces per technology



Cost split per technology



Low-traffic density case



results for low traffic density: verifying that IP/MPLS is still competitive

Summary



Analytical and network simulation study showed:

- OPS/ OBS may require around half the resources required by OCS – subject to network topology and size and to traffic mean volume and burstiness

Techno-economic comparison with IP/MPLS and OCS:

- OBS nodes of reasonable cost may be produced using STOLAS technology
- However, if all technologies use the same interfaces (e.g. 10Gb/s) there is no clear advantage for moving to optical packet switching technologies
- OBS becomes a clear winner first when 40Gb/s interfaces are considered
- Flexibility, better traffic engineering, better QoS and restoration capabilities, come in addition

Conclusion



IP as we know it, is an efficient solution for low traffic density networks. For higher traffic density, optical technologies take over because they provide efficient switching to realise high throughput networks. OCS can provide this functionality in the short term.

In the longer term, OBS will be developed to provide a combination of efficient switching of large traffic volumes (a characteristic of optical technologies) with the low granularity and flexibility of packet based networks.