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Performance Simulation of Multi Protocol Optical Switch (MPOS) with Multicasting Capable Transponders for Optical GRID Networks

by

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Presentation Layout

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- Introduction to GRID Networking
- Requirements for Optical GRID
- Operational Concept of MPOS
- SOA-based wavelength switched routing fabric for MPOS
- Modeling of SOA using VPI
- Experimental and Simulation Setup
- Experimental & Simulation Results & Discussions
- Conclusions

GRID Networking

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The ideology of the GRID network is based upon the concept of distributed computing

This concept is trying to 'kill' the need for expensive mainframes & supercomputers & the conventional hierarchical network

All available computing resources connected to the GRID can be aggregated to act as a single super entity

The Grid is the **most generalised, globalised form of distributed computing**

Distribute data storage to reduce load at the main server and ease traffic congesting in the network

Requirements for GRID

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- Scalable, flexible and reconfigurable
- Ability to support bulk data transfer
- Low cost
- Able to provide bandwidth on demand
- Variable bandwidth services in time
- Able to provide wavelength and sub-wavelength services (optical packet /burst/circuit)
- Broadcasting or Multicasting capabilities
- Hardware flexibility to be able to support wide range of different distributed resources in the network

Multi-Protocol Optical Switch (MPOS)

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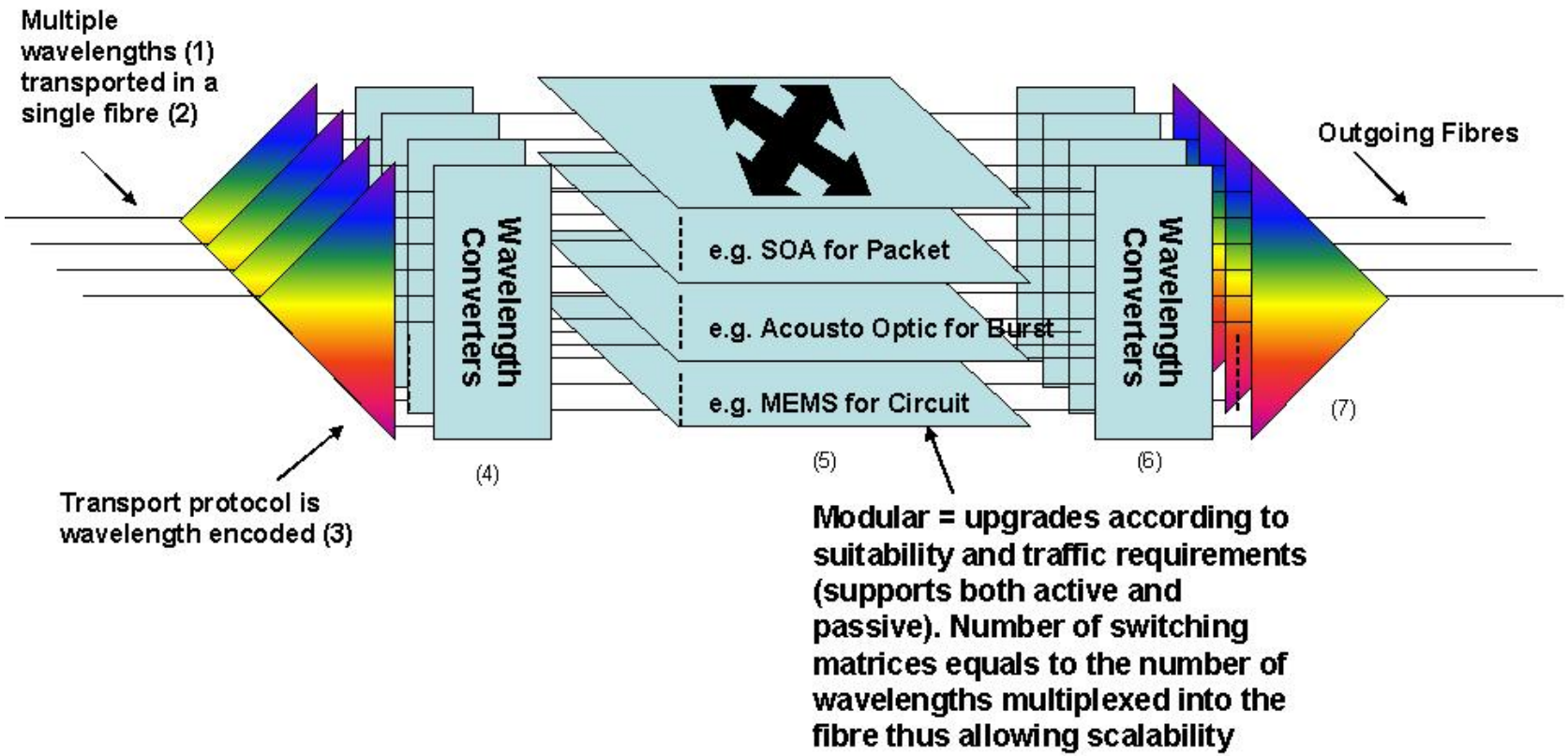

The optical switch is also designed to be modular and flexible in terms of upgrade where switching plans can be upgraded with the advancement of switching technology and users' budget.

MPOS Operation

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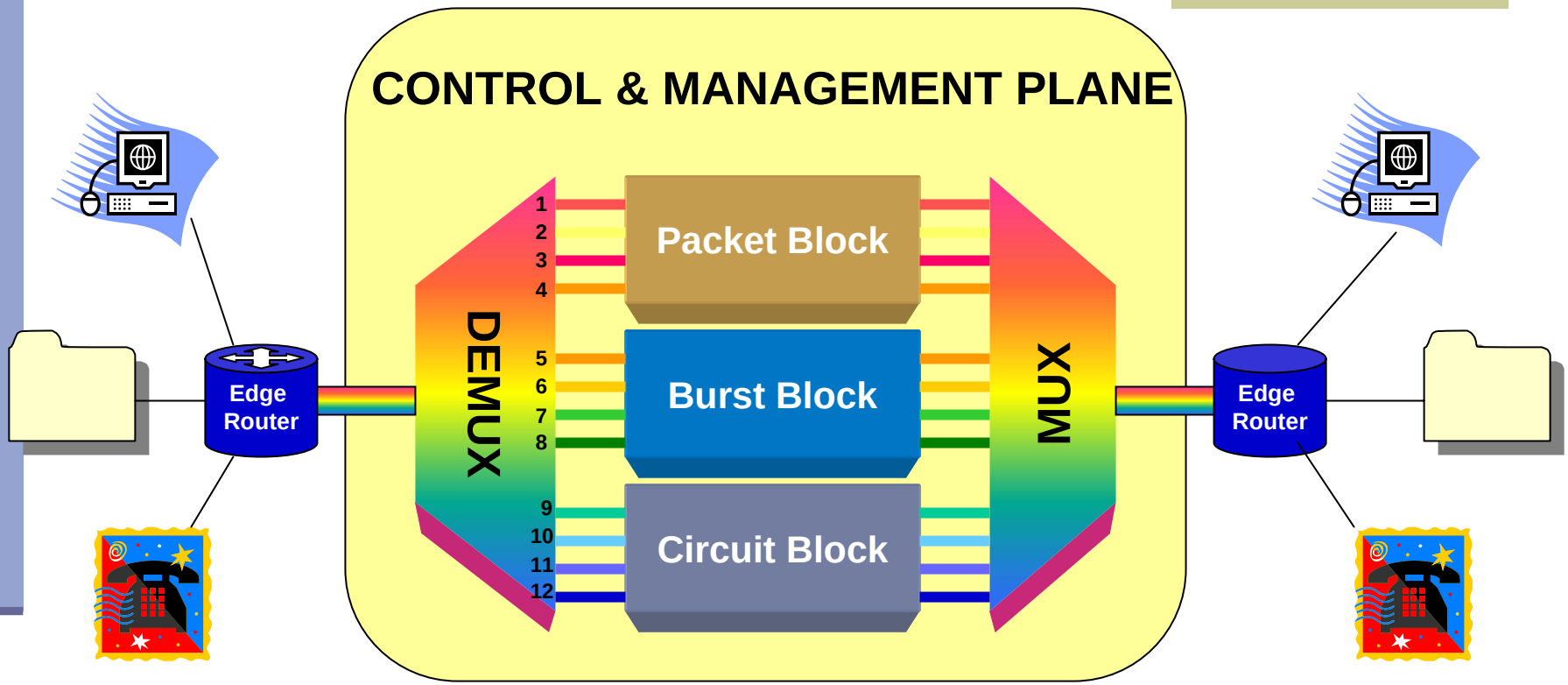

- Packet, Burst and Circuit traffic from the edge are modulated onto designated wavelengths depending on the traffic's transport protocol (e.g. $\lambda 1$–$\lambda 4$ for packet traffic, $\lambda 5$–$\lambda 8$ for burst traffic and $\lambda 9$–$\lambda 12$ for circuit traffic)

- The wavelengths are demultiplexed and then fed into their corresponding switching blocks, switched and then multiplexed together at the output

MPOS Operation

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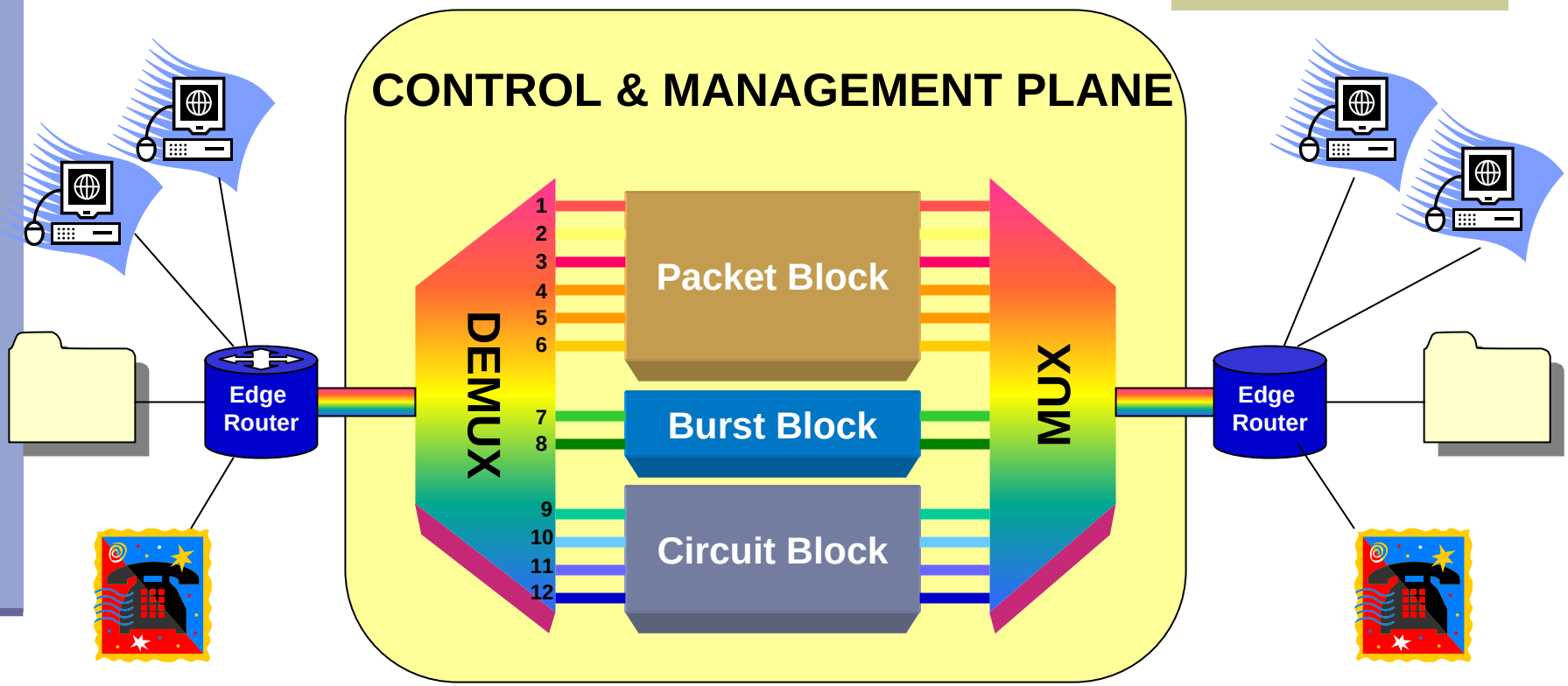

•Due to the modular design of the MPOS, as the traffic pattern changes (e.g. increase in internet usage) ratio of wavelength allocations can be easily updated by changing the algorithm in the control and management plane

•Therefore it leaves room for upgrade and introduction of new services yet still maintain the legacy services until they are eventually phased out.

SOA-based MPOS

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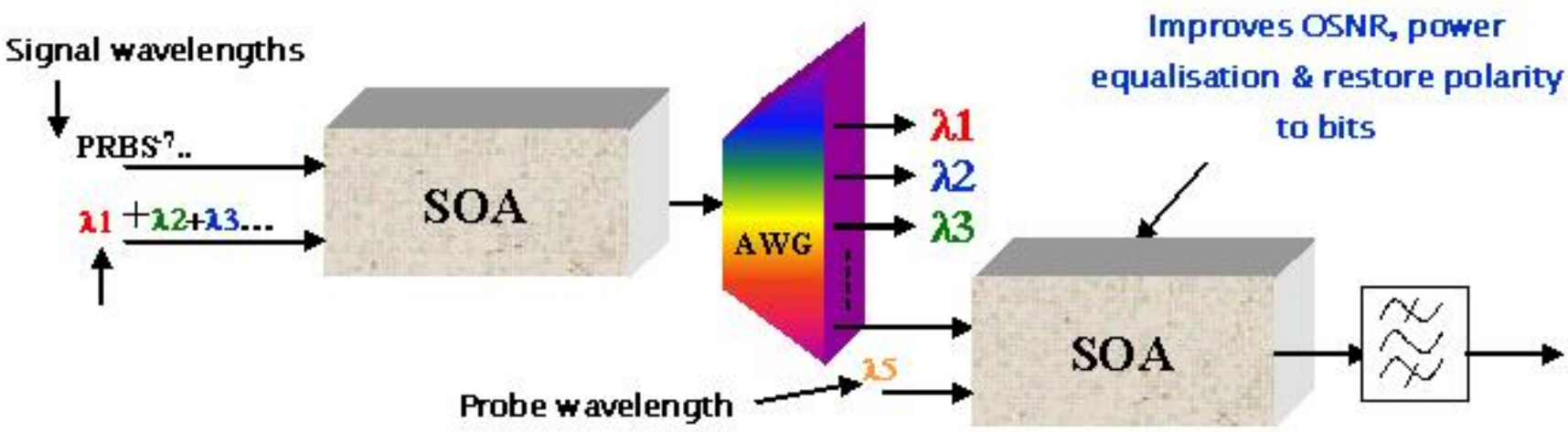

- The multicasting capability is provided by the SOA XGM based wavelength converters.
- This technique is possible due to the mechanism of the XGM process, which allows the device to copy a single input signal onto multiple wavelengths by varying the total gain of the SOA.
- The gain variation will in turn vary the intensity of all the CW wavelengths coupled into the probe signal.

Theory & Concept

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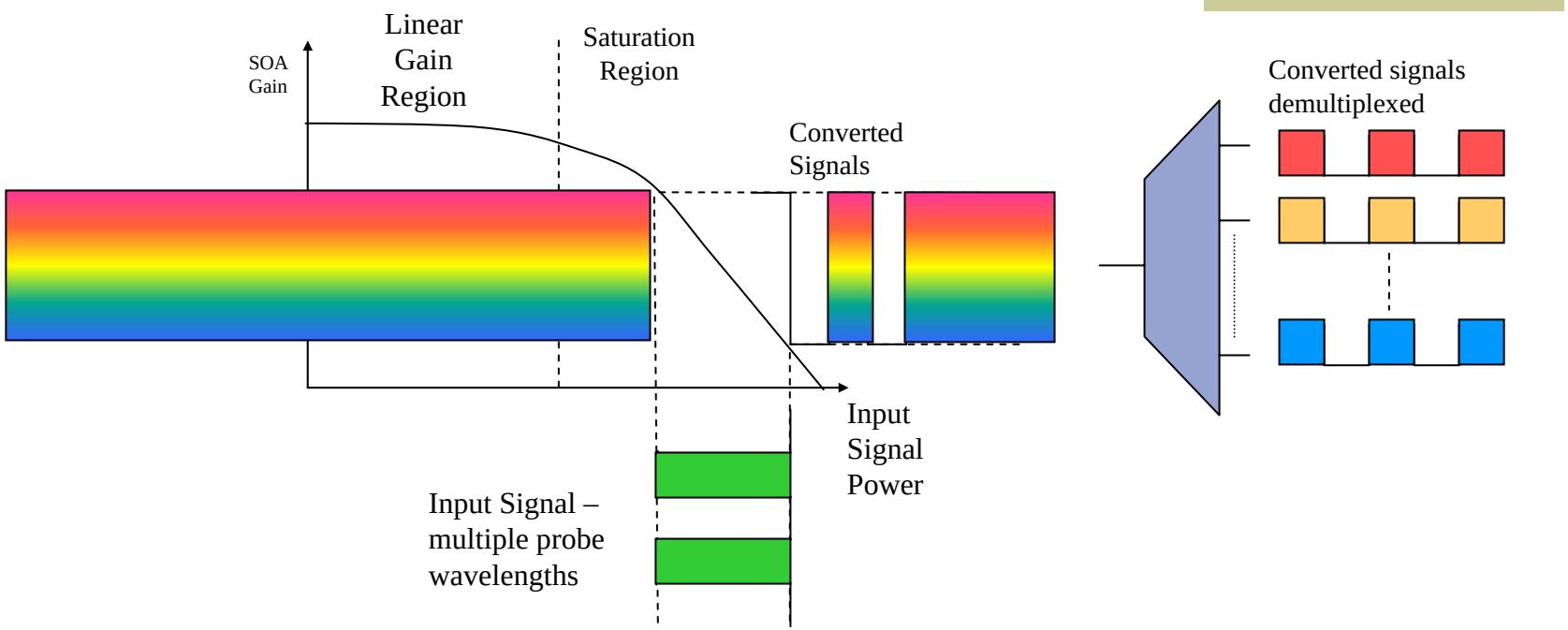

- **A constant multi-wavelength probe signal is injected into the SOA cavity forcing the SOA to reach its saturation region. A modulated Input Signal is later injected into SOA cavity as well thus varying the gain of the device.**

- **The probe signal will then be modulated with the inverse of the Input Signal due to the varying gain of the SOA. The probe signal is then demultiplexed into its individual wavelengths using a optical demultiplexer**

Modelling of SOA via VPI

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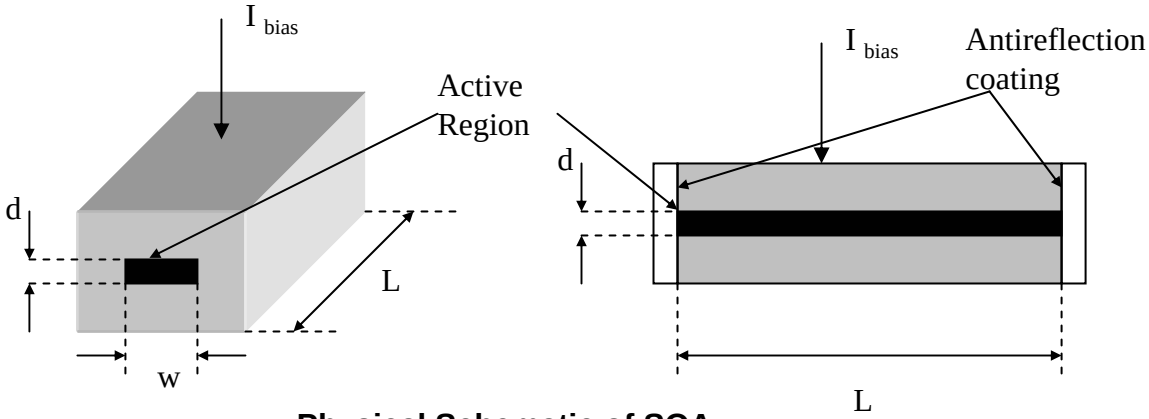
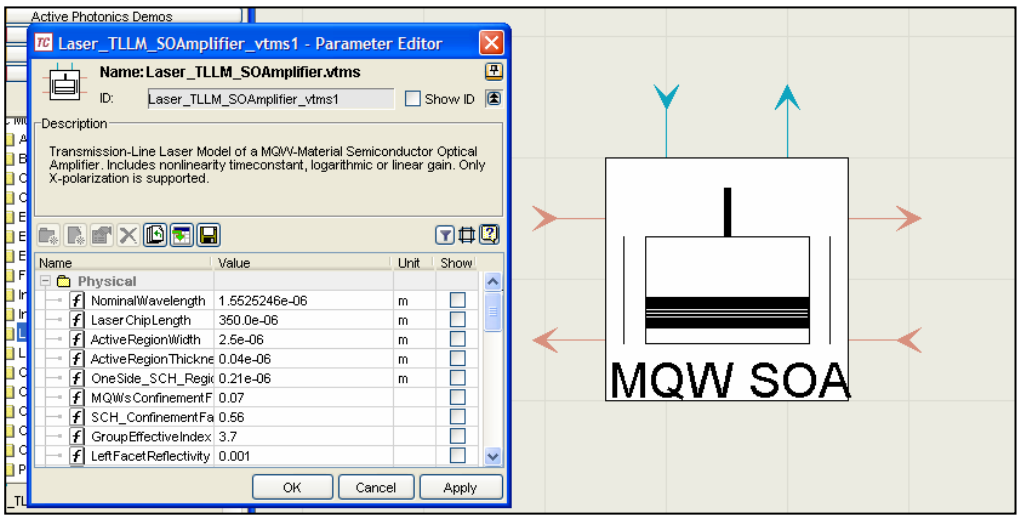


Physical Schematic of SOA



VPIphotonics™ design automation

Equivalent SOA Model in VPI

Modelling of SOA via VPI

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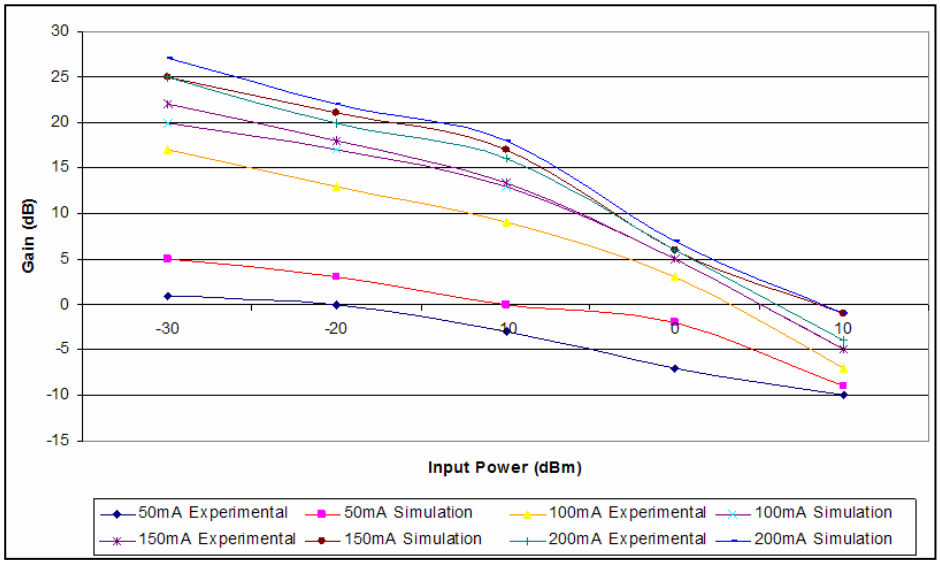
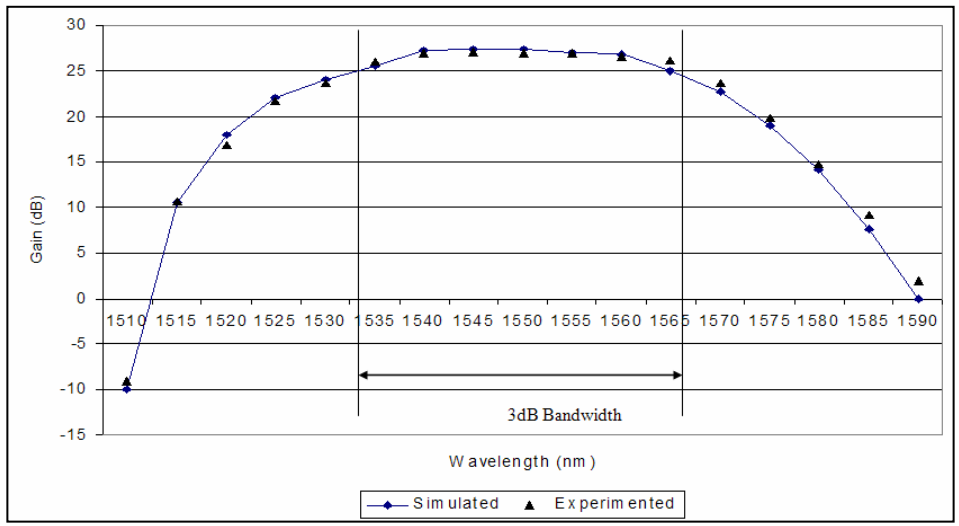
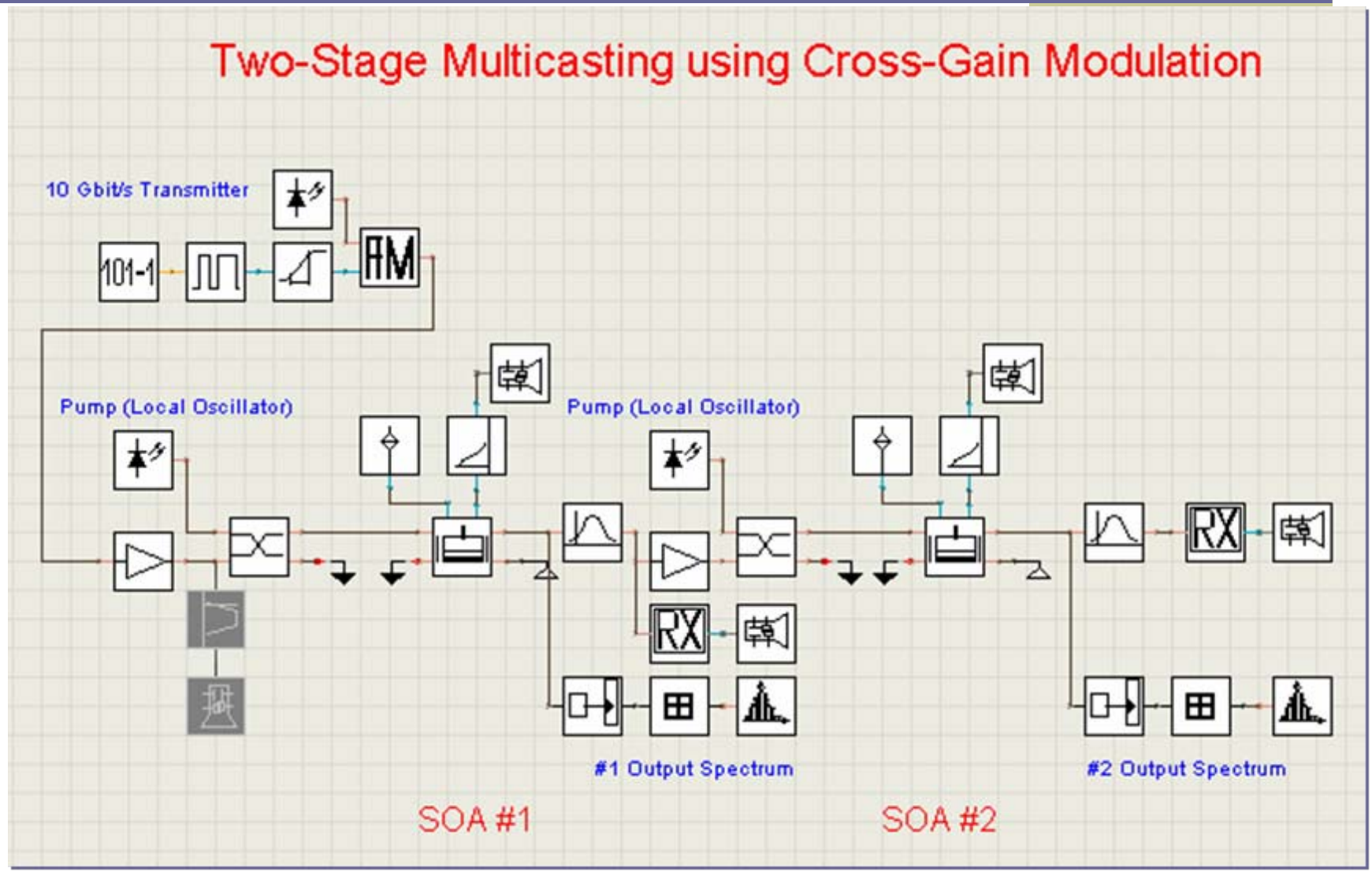


Gain **comparison between physical SOA module and the equivalent SOA Model in VPI**

Bandwidth **comparison between physical SOA module and the equivalent SOA Model in VPI**



Simulation & Experimental Setup



Experimental Results

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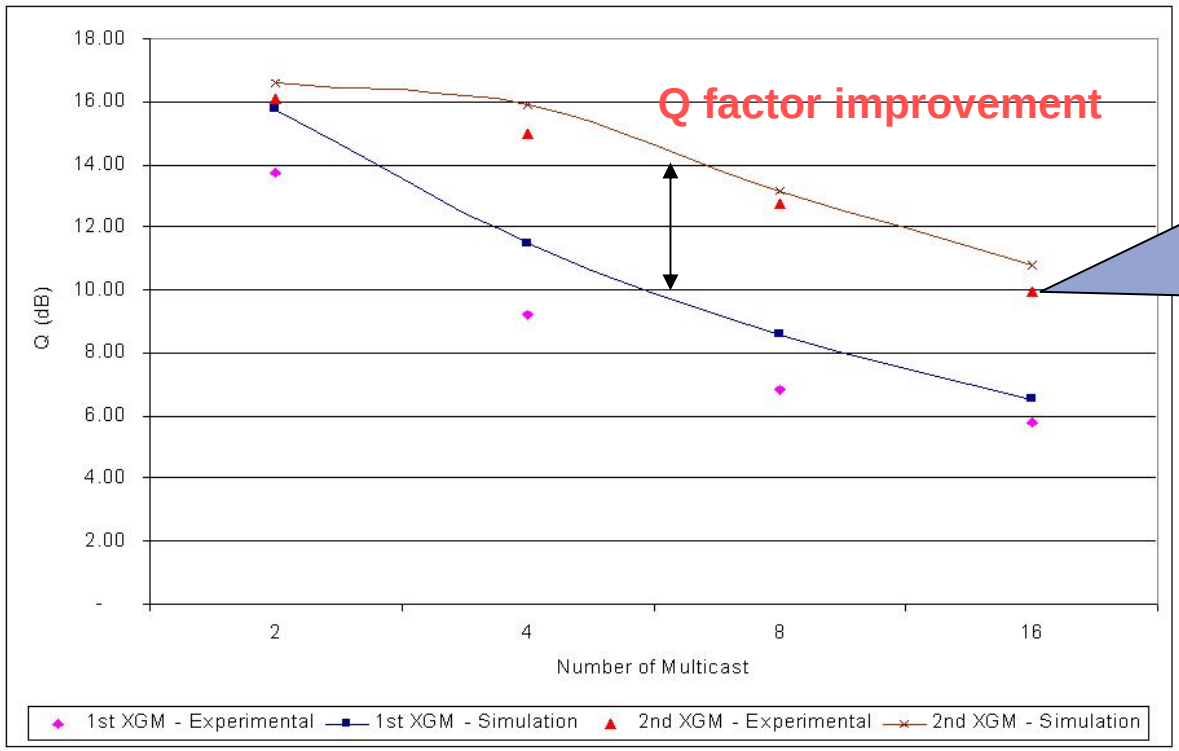

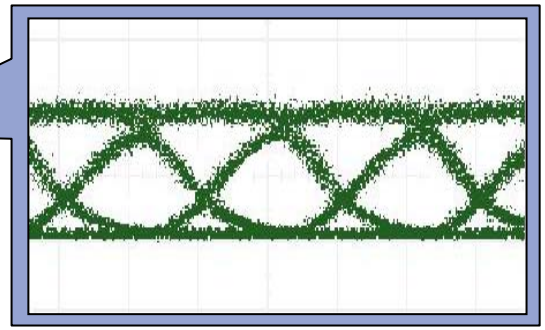

- **A 10Gbps PRBS optical signal was copied onto a maximum of 16 different probe wavelengths thus achieving 1-to-16 multicasting before the Q factor degrades below 6 (BER = 1x10-9). The eye diagram of one of the 16 multicast optical signals after the 2nd SOA is shown.**
- **The 2nd SOA gives an average improvement of a factor of 5 to the multicast signals from the 1st SOA. This is due to the 2R regenerative effect of XGM.**

Discussion

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Advantages

- One single switch is able to accommodate all types of traffic in the network
- Modular system allows progressive upgrades in the future depending on traffic pattern and customer requirements
- All optical multicasting technique reduces the strain on the electronic processing of the switch

Disadvantages

- Increases complexity of on the control and management plane of the switch
- Non-efficient use of optical bandwidth since the MPOS will have an over-built scenario

Conclusion & Acknowledgement

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- A novel optical switch architecture has been introduced in this paper which has the capability to switch multiple transport protocol traffic and also perform all optical multicasting.
- The modular concept allows the switch to be gradually upgraded in synch with the ever changing traffic pattern.
- Such traits are required in an optical switch in order to support diversified traffic requirement of the GRID network.
- Currently traffic studies are being conducted at TMR&D to determined the performance of this switch.

Acknowledgement

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Thank you for your attention...