

# Class-based Traffic Aggregation In Optical Packet Switched WDM Networks

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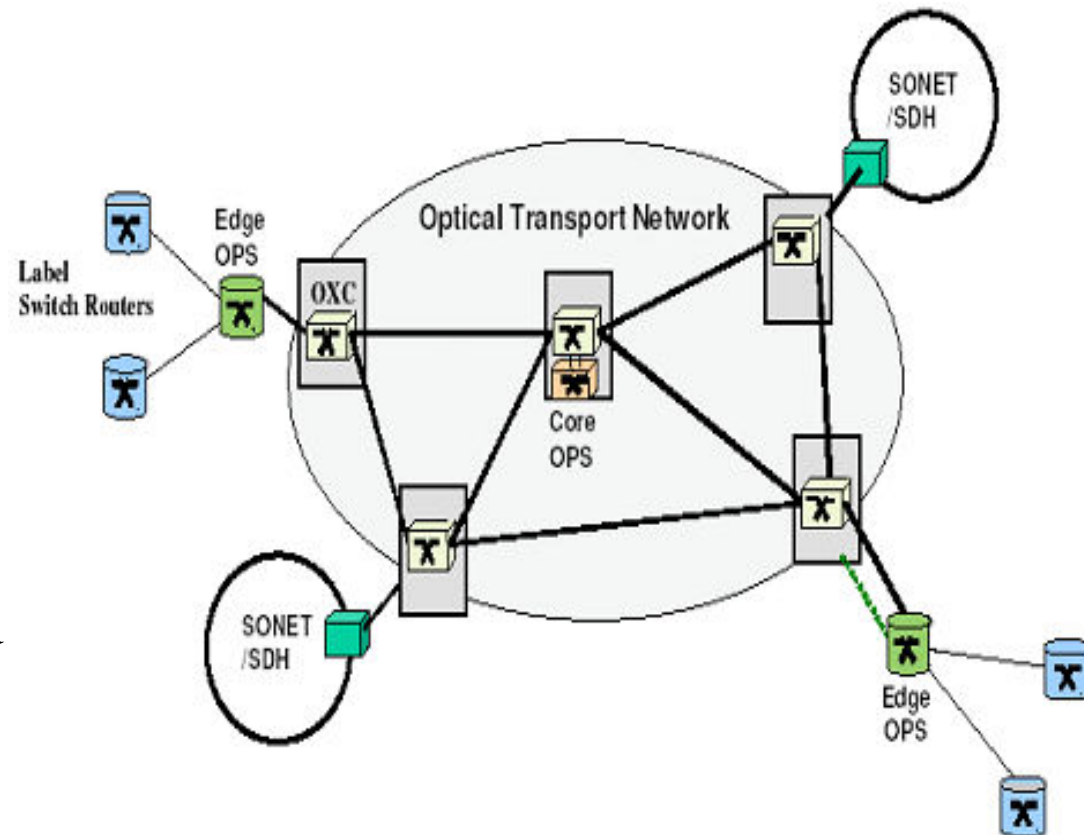


- **Optical packet switching**
- **Network scenario**
- **Edge optical packet switch router**
- **Optical packet assembly and packet aggregation**
- **Traffic shaping in edge optical packet switch router**
- **Realisation of the edge optical packet switch router**

- Spectral efficiency
  - Multi-service traffic is bursty in nature
  - Future networks are IP-centric network
  - Circuit switched channels must have sufficient bandwidth to cope with peak transmission
  - In packet networks capacity is allocated at per packet demand
  - Improved network economics in packet networks (smaller OXCs)
- Circuit switched networks provide granularity only at wavelength level, packet technology supports higher granularity
- Convergence of electronic and optical technologies (IP/OPS)
  - Control and management integration and simplification (GMPLS)

- Opto-electronic in the edges, all-optical techniques in the core of the network

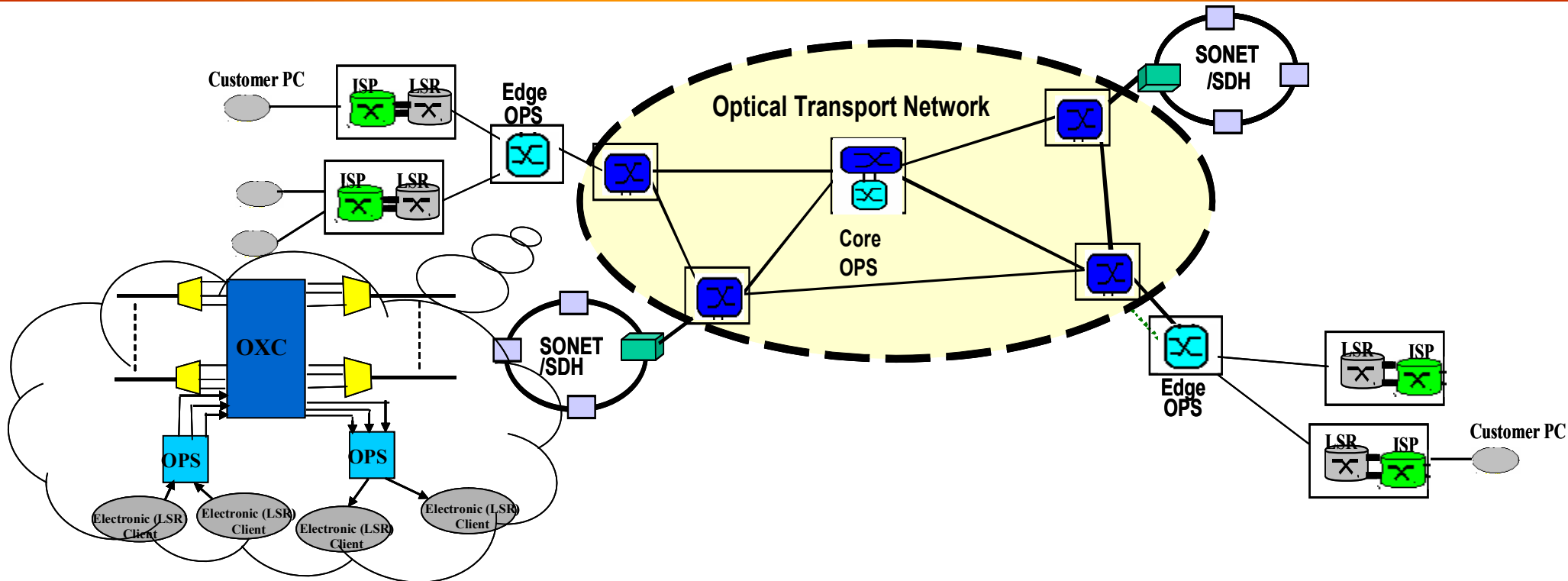
- In the edges : aggregation, classification, packetisation, traffic shaping and QoS
  - In the all-optical core nodes: optimisation of network resources, label swapping, space switching, contention resolution with dedicated physical resources per QoS, regeneration



- Optical bandwidth partitioning between circuit switching and packet switching
  - Circuit switching : some wavelengths dedicated
  - Packet switching : the rest of the optical band

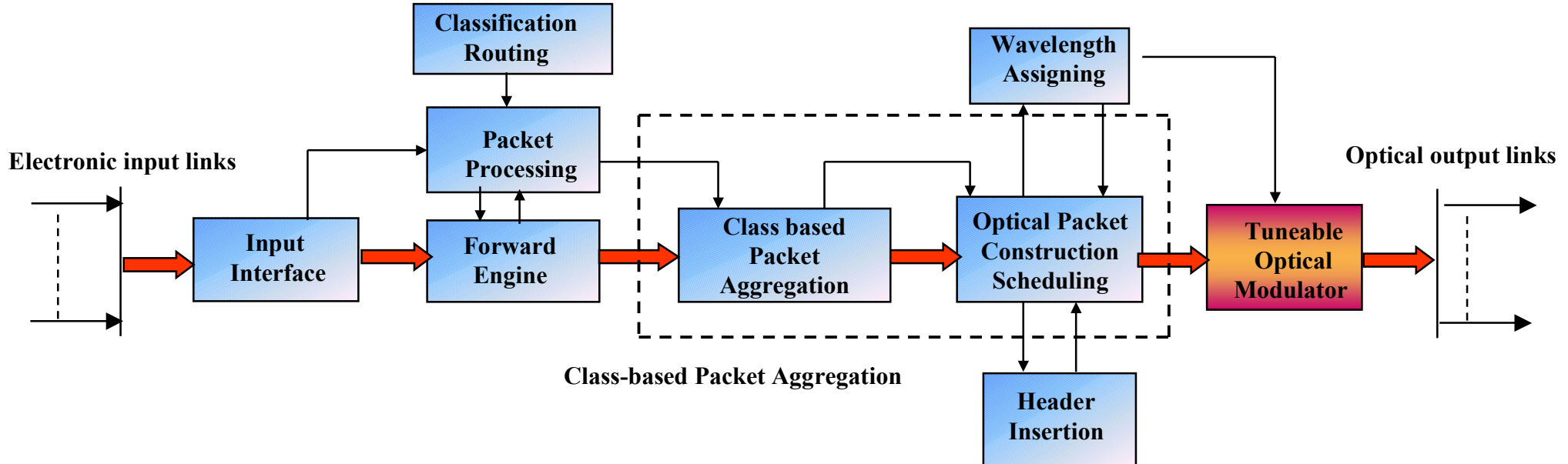


# OPS as Ingress Node and Egress Node for the OTN



- OPS provides an aggregation mechanism that maps higher layer packets such as IP and ATM from multiple sources into optical packets
  - The aggregation brings about traffic shaping, QoS classification, bit rate adaptation etc. for transmission at the core network
  - Aggregating nodes map these optical packets onto appropriate wavelengths for routing over the optical network

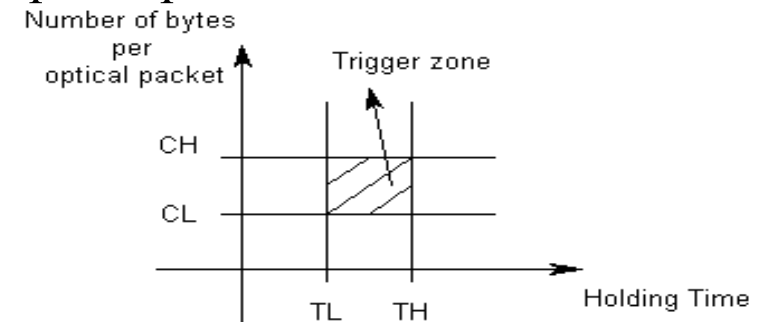
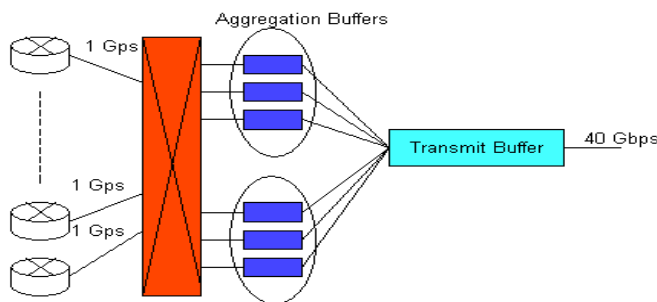
- Generic functions of the edge OPS router as an ingress node:
  - Header (label) extraction
  - Forwarding and classification
  - Aggregation and optical packet construction
  - Optical packet scheduling
  - Optical header insertion
  - Dynamic wavelength assignments



- Packet aggregation:
  - To reduce number of entities that must be processed in the core per unit time
  - To classify packets and to shape the traffic
- Packets are aggregated based on two parameters:
  - Destination address and class of service
- Aggregated packets are scheduled based on two parameters:
  - Number of bytes and maximum experienced delay
- Aggregation method has directly impact on the traffic characteristics
  - Degree of self-similarity and correlation of traffic
- Aggregation mechanism can be used for traffic shaping to :
  - Reduce effect of self-similarity, burstiness, traffic correlation
  - Make period of congestion more predictable
  - Make congestion feeble and decrease losses during periods of network congestion

## Traffic aggregation algorithm:

- Based on increasing the probability of optical packet transmission with same size and same experienced delay.
- Define an aggregation window (trigger zone):
  - Aggregation window on experienced delay (maximum aggregation time)
  - Aggregation window on number of bytes per optical packet



## Simulation has been used:

- To evaluate Effect of the aggregation algorithm on traffic characteristics

## Simulation setup

- 20 clients each 1Gbps
- One output link with 40 Gbps
- Three class of service
- Three aggregation buffers
- Two destination addresses



# Simulation Results (Aggregation Delay)

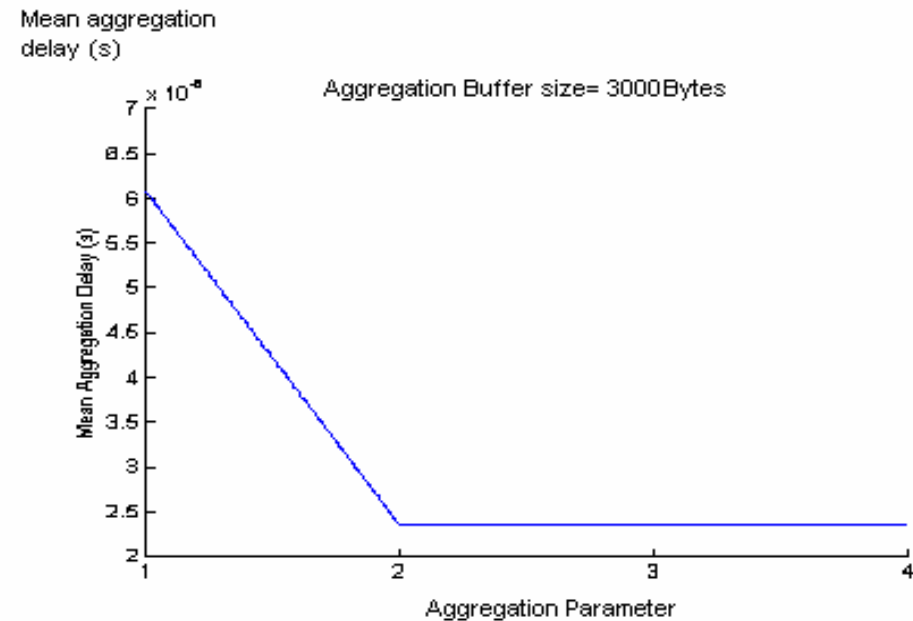
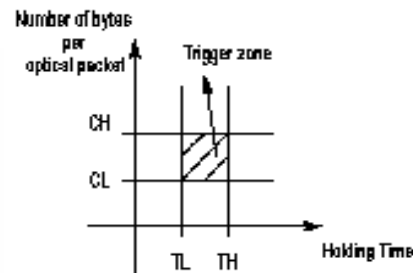
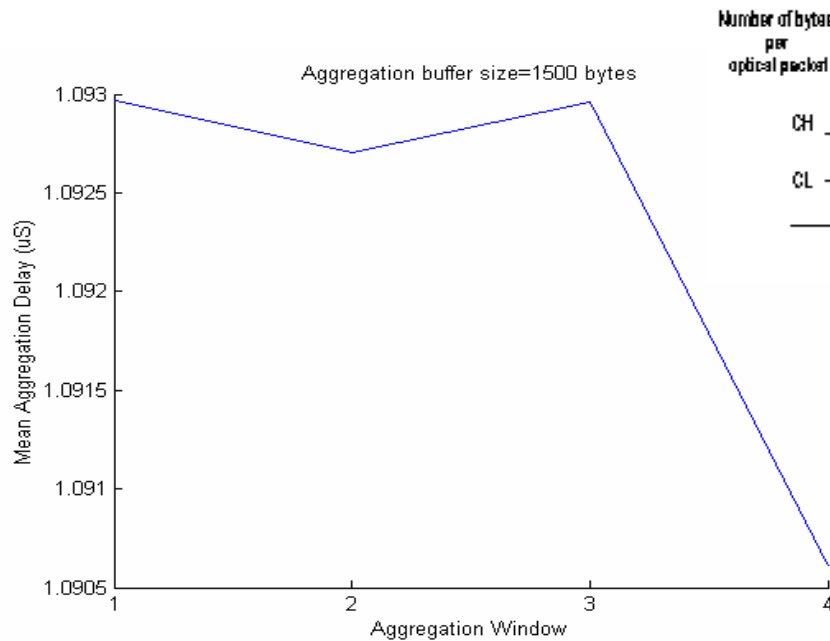
Aggregation Window	CL (bytes)	CH (bytes)	TL (uS)	TH (uS)
1	1400	1500	1.1	—
2	1400	1500	1	1.2
3	1000	1500	1.1	1.2
4	1000	1500	1	1.2

Table 1. Aggregation window parameters for aggregation buffer size of 1500 bytes

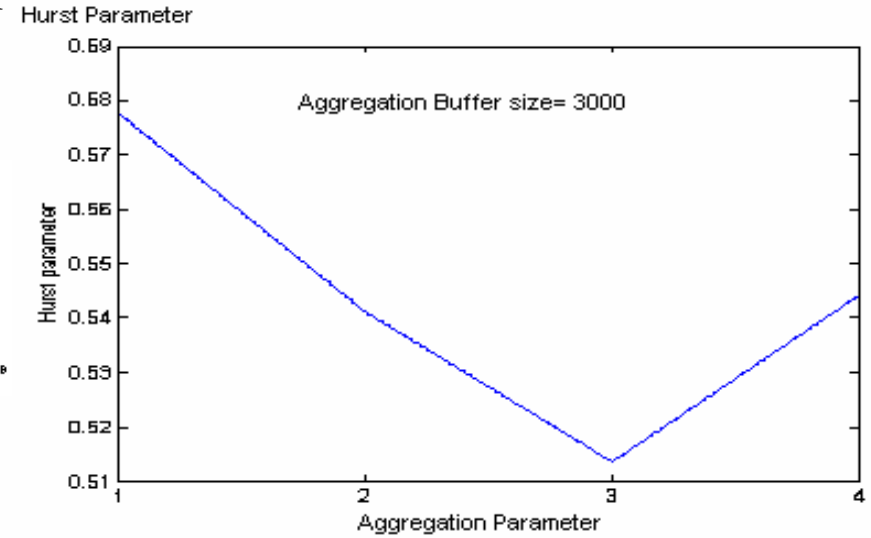
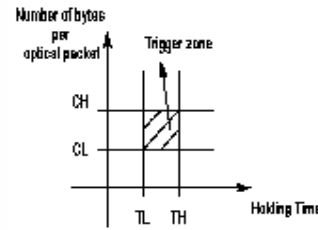
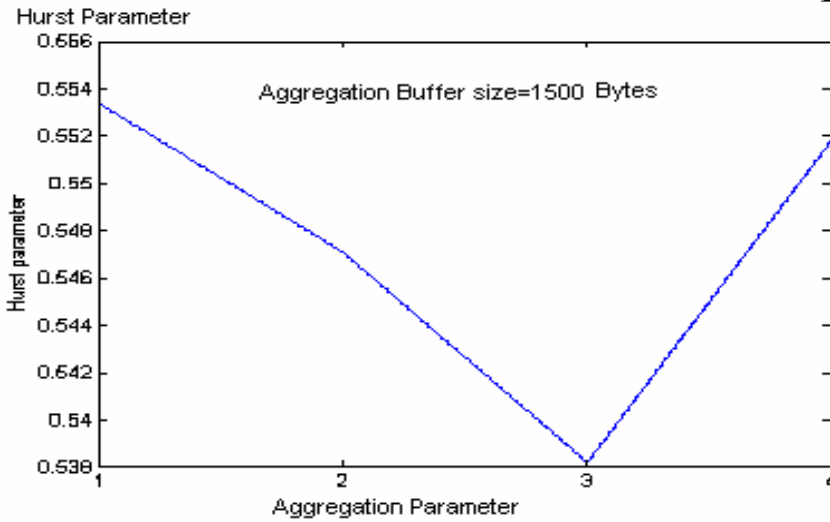
Aggregation Window	CL (bytes)	CH (bytes)	TL (uS)	TH (uS)
1	3000	3100	2.3	—
2	3000	3100	2	2.4
3	2000	3000	2.3	2.4
4	2000	3000	2	2.4

Table 2. Aggregation window parameters for aggregation buffer size of 3000 bytes

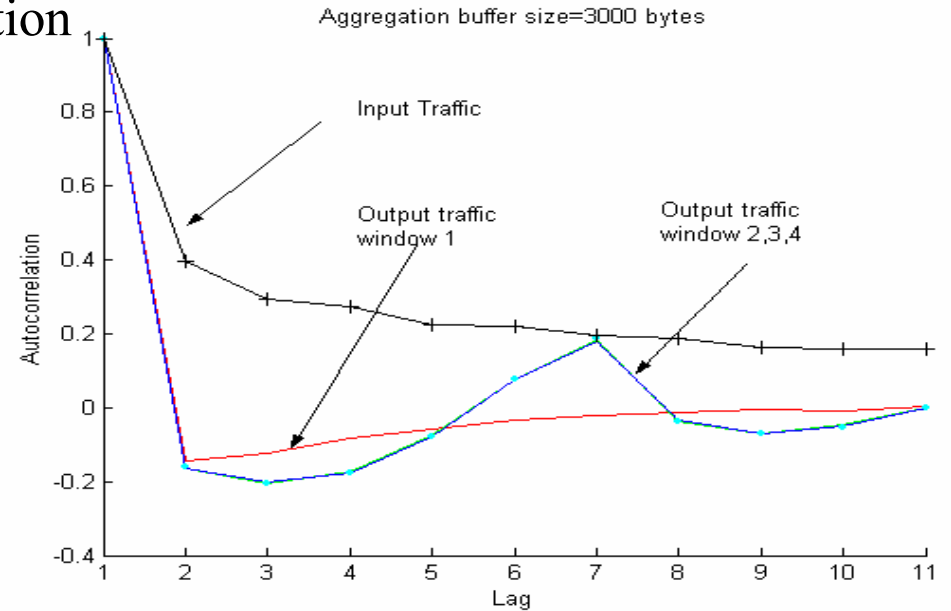
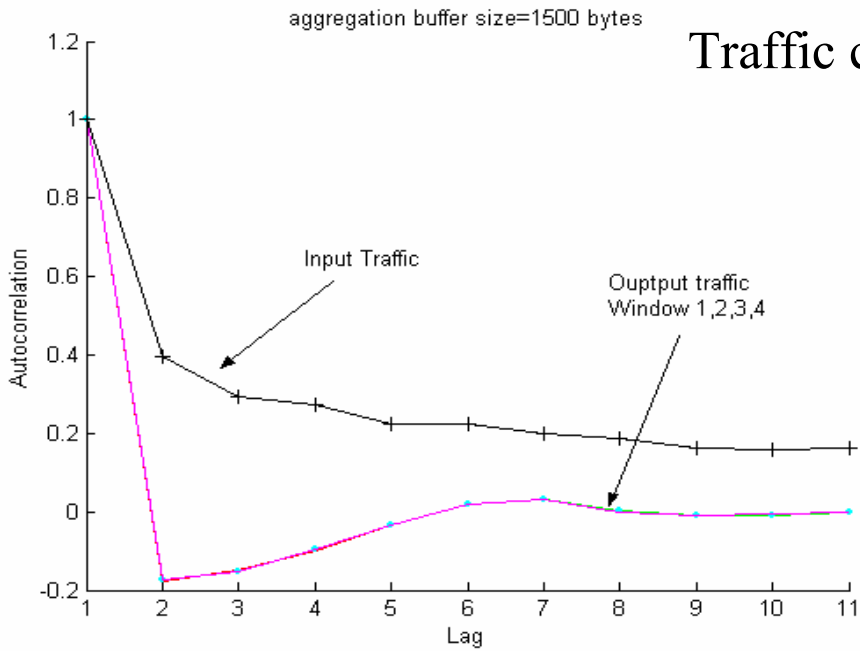
## ■ Mean aggregation delay



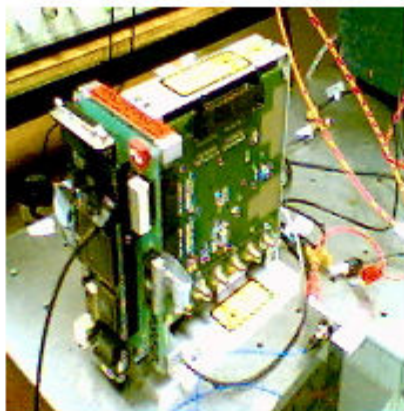
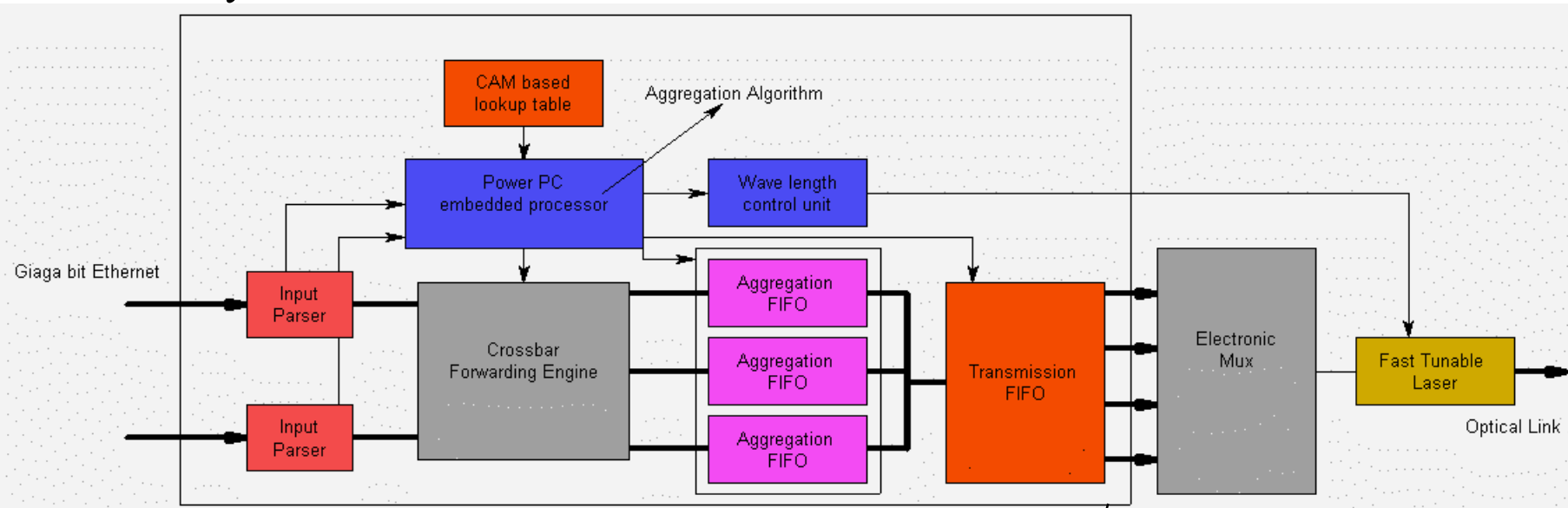
## Hurst parameter



## Traffic correlation

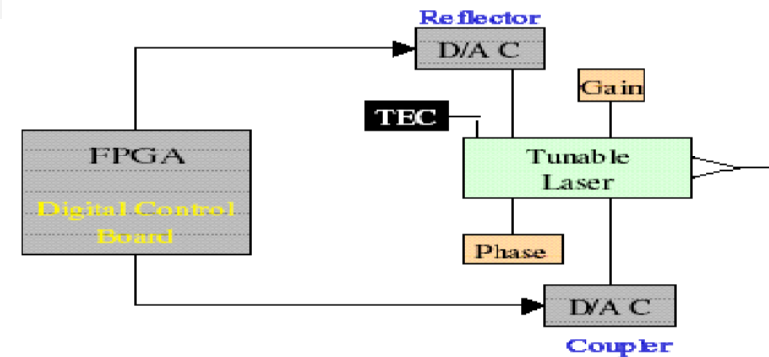


Fast tunable laser and high-speed reconfigurable hardware (fast FPGAs) with embedded processor provide a suitable hardware platform for implementing network processor functionality.

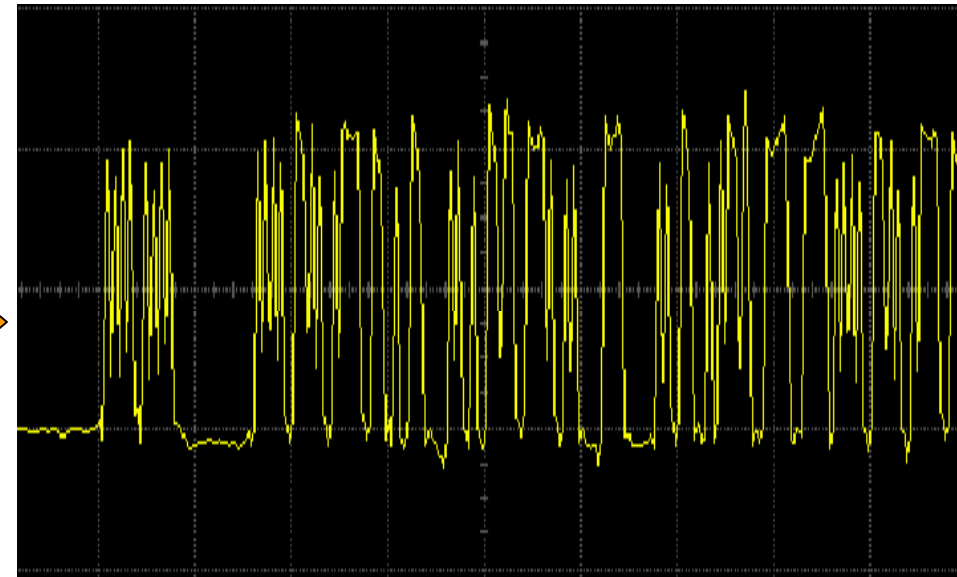
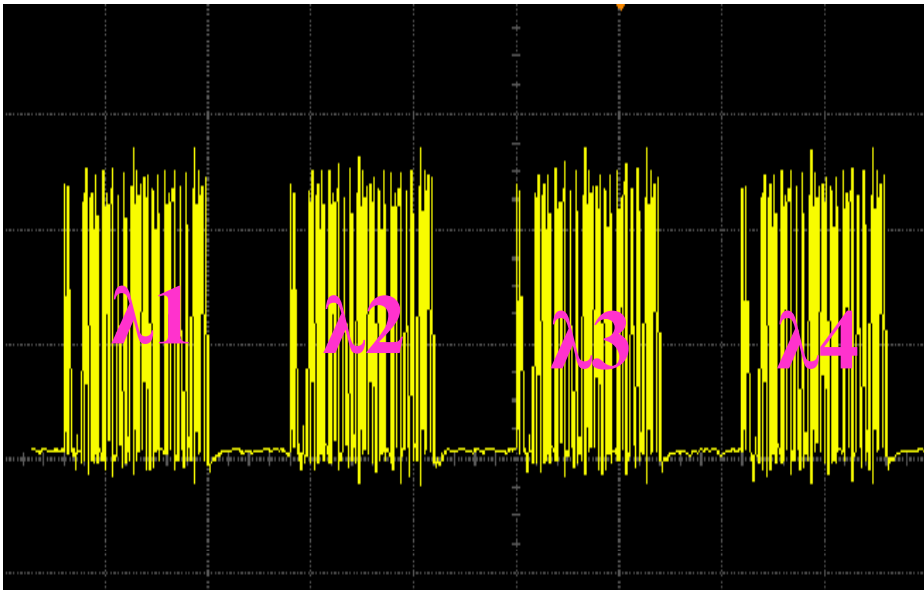
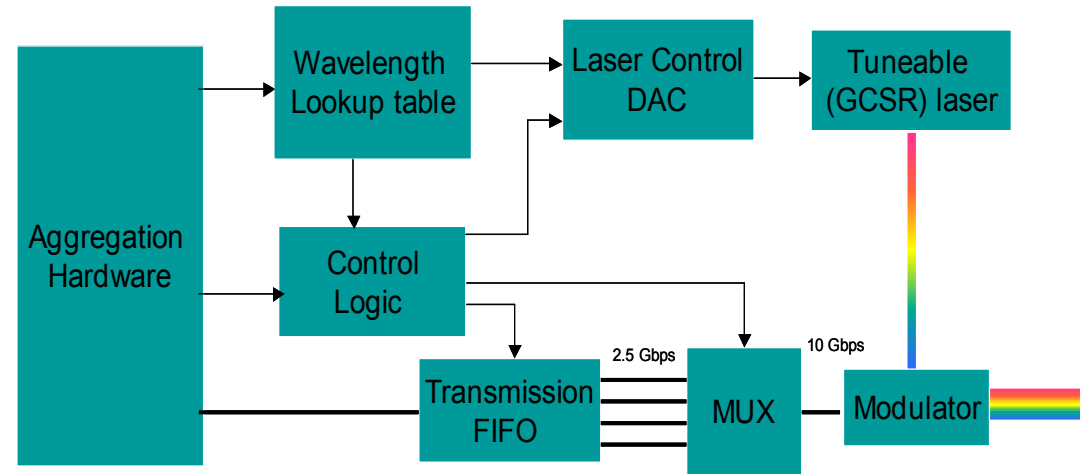
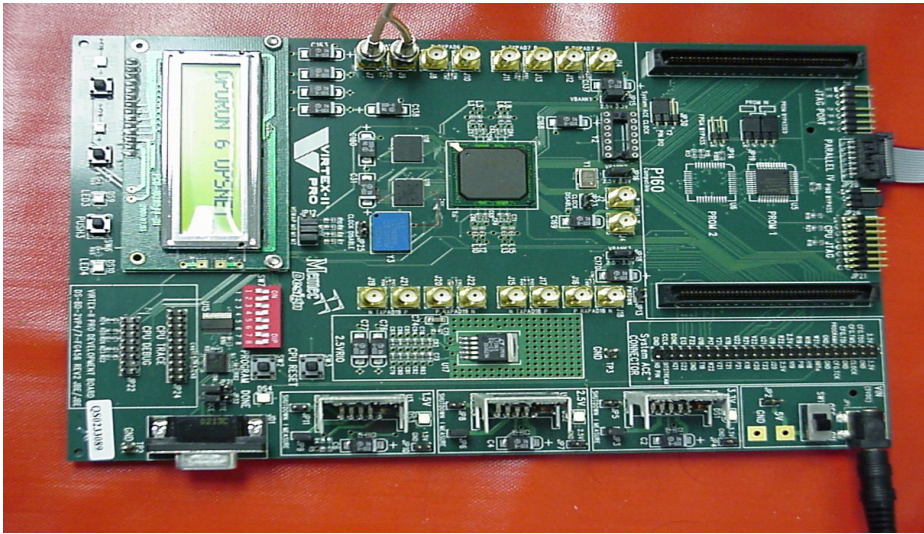


VirtexII- Pro Plat Form

2.5Gbps Links



# Hardware Implementation (Results)



- Optical packet switching is an attractive alternative for efficient realising IP over WDM networks
- Traffic aggregation can be used :
  - To increase performance of the core
  - To provide quality of service
  - To shape traffic for the core
- The proposed aggregation algorithm improves traffic characteristics :
  - Decreases the experienced delay by packets in the aggregation buffers
  - Reduces Hurst parameter and degree of self similarity
- By using fast tunable laser and high-speed reconfigurable hardware it is possible to achieve required functionality for the fast tuneable optical packet generator in the edge OPS router

**Thank you**

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