Service differentiation for variable length packets in OPS with recirculating FDLs

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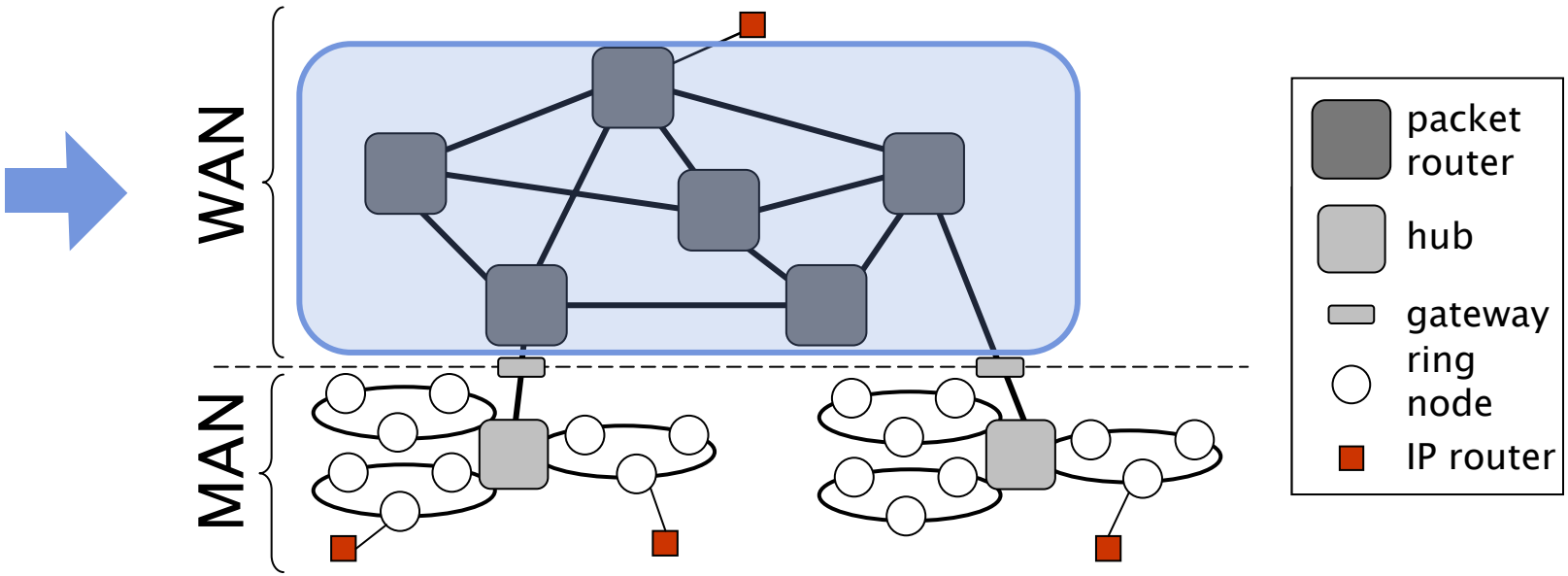
Outline

- Context: the DAVID-project
- Switch architecture
- QoS approaches
- Performance criteria
- Simulation set-up
- Results
  - influence of nr. of buffer ports
  - influence of “class offset”
  - influence of buffer delay
  - influence of load
- Conclusions

Context

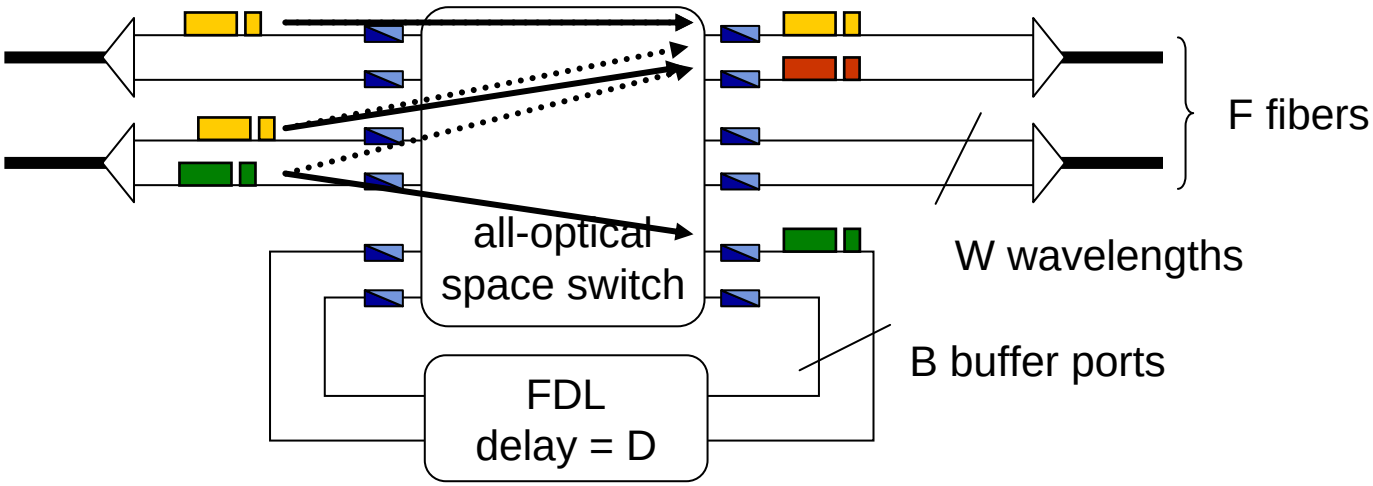
- Optical packet switching
- Network
  - MAN: metro rings, MAC protocol
  - WAN: full-mesh, (G)MPLS-based control
- Key components
  - Ring node (OPADM), Hub, Gateway, OPR

http://david.com.dtu.dk



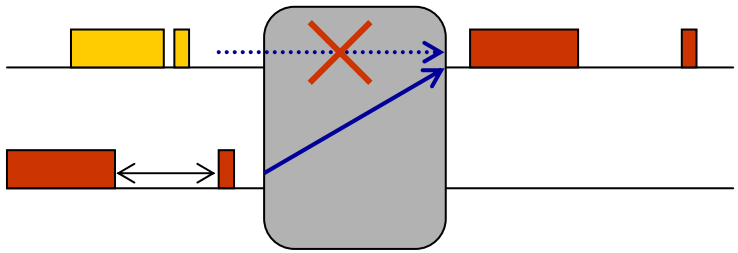
Switch Architecture

- Node in core OPS network (backbone)
- Switch functionality:
  - fully non-blocking switching matrix (SOA-based)
  - wavelength conversion to solve contention
  - FDLs to provide buffering

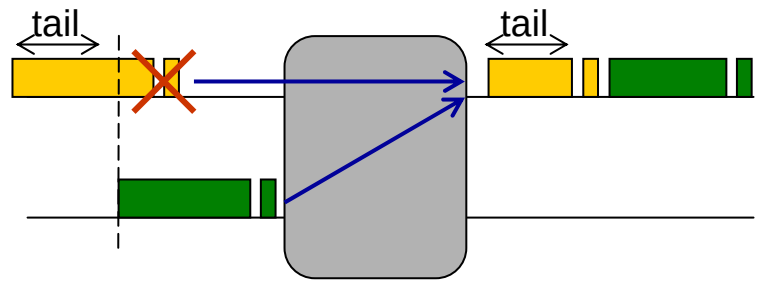


QoS approaches (1)

- Known approaches to provide QoS in OPS/OBS:
  - resource reservation (dedicated wavelength converters, buffers); static or dynamically
  - OBS-JET with differentiated offsets
  - burst segmentation: tails have larger survival chances (implicit QoS)
  - intentional drops: drop low priority traffic to free resources…



OBS-JET: higher offset = higher priority

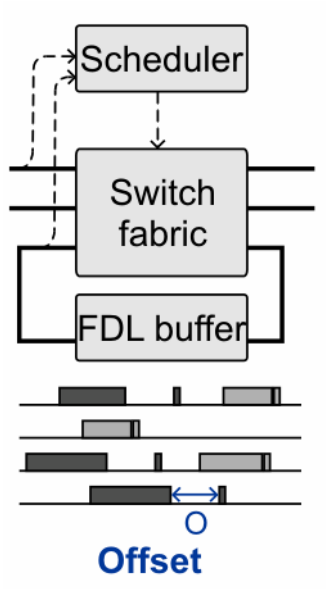


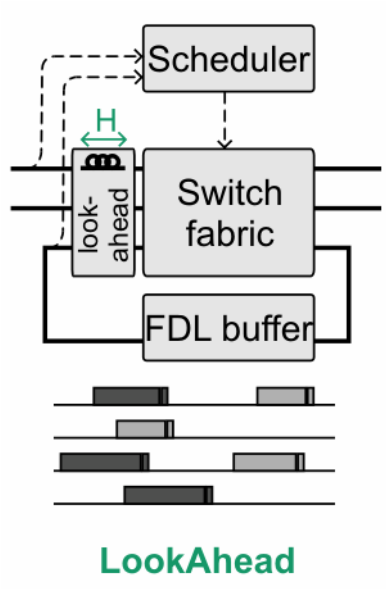
segmentation: drop head of overlapping packet

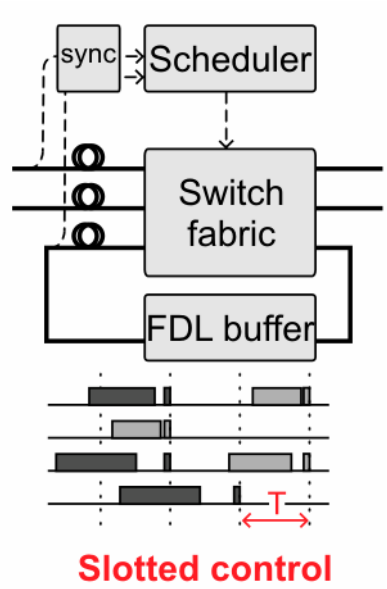
- This study:
  - ***no resource reservation, no intentional drops, no segmentation***

QoS approaches (2)

- Header offset differentiation: offset O
  - well-known OBS-JET; high priority = larger offset
  - high priority bursts are known to the switch longer in advance
- Look-ahead: look-ahead delay H
  - no different offsets; but look-ahead delay at input: time H to “change our mind”
- Slotted control: slot time T
  - headers are delayed electronically, and handled in batches each timeslot







Scheduling algorithm

- for each arriving packet, do:
  - check if there is a free wavelength on the output port it's destined for, using LAUC-VF
  - if no free wavelength: find free buffer wavelength, using LAUC
  - if packet is buffered: do not reserve output wavelength yet, but repeat scheduling upon re-entrance of switch (PostRes)

- look-ahead:
  - high priority packets may preempt low priority ones
  - preempted packets are re-scheduled using same algorithm upon time of preemption

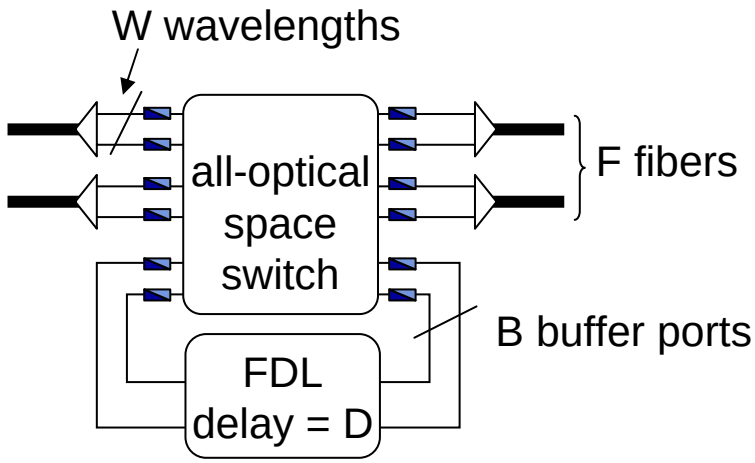
- slotted control:
  - packets scheduled at same time are sorted: first the high priority packets

Performance criteria

- loss rate:
  - amount of data lost / amount of data sent
- fairness:
  - are longer packets strongly discriminated against?

Simulation set-up

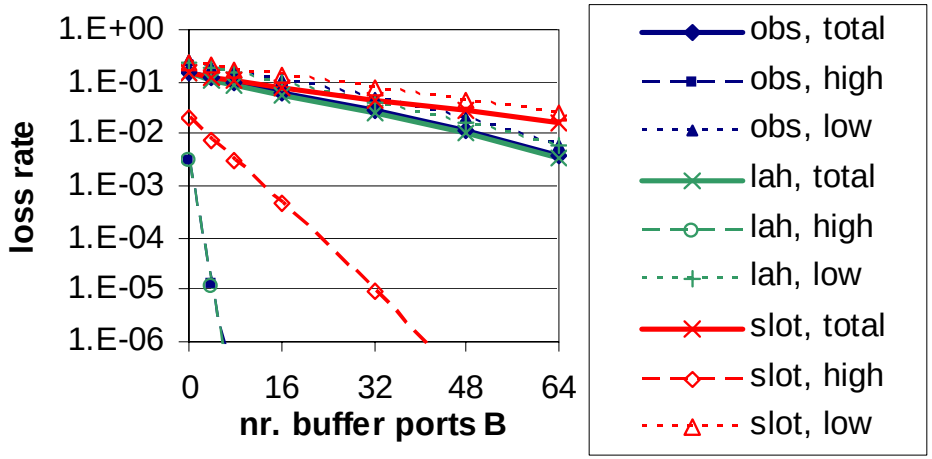
- Parameters:
  - F=6 input/output fibres
  - W=8 wavelengths per i/o fibre
  - B=0..64 recirculating buffer ports
  - D= delay in buffer
  - L= average packet length
  - 40% high priority; 60% low priority

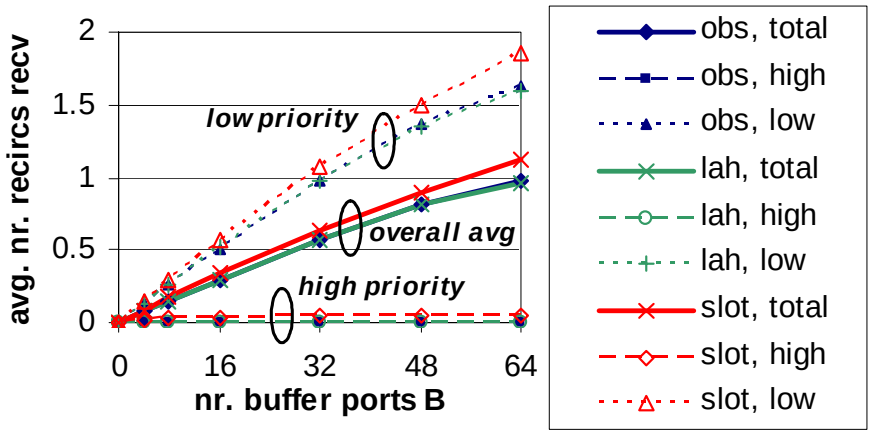


- Traffic model:
  - train length: minimal L/2, average L
  - train length distribution: (length - L/2) follows neg. expo distribution
  - train inter-arrival: Poisson process
  - uniform distribution over output fibres

Influence of nr. of buffer ports (1)

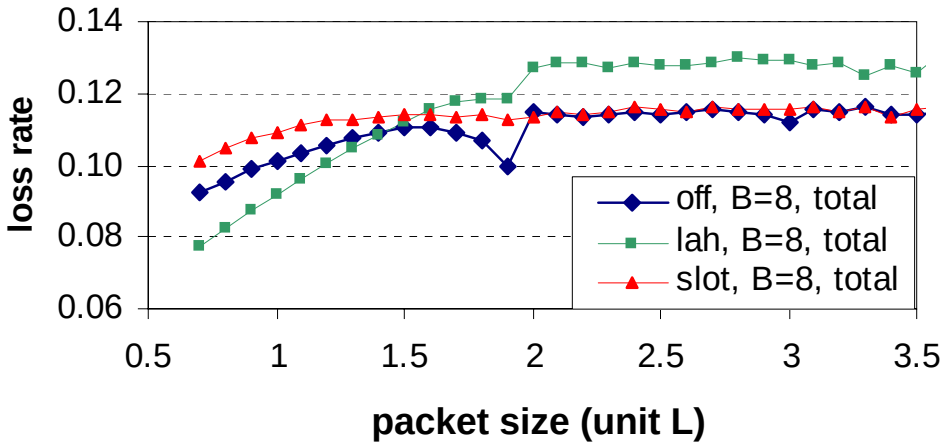
- settings:
  - O=H=T=2L; buffer D=2L
  - load 0.8
- loss rates:
  - fairly strong class separation
  - slotted control higher avg loss and less differentiated
  - no significant difference between look-ahead and diff. offsets
- delays:
  - slotted worse than others
  - more buff ports = delay instead of loss





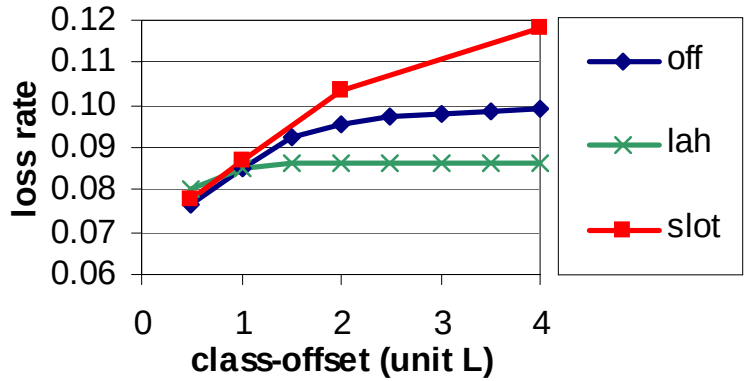
Influence of nr. of buffer ports (2)

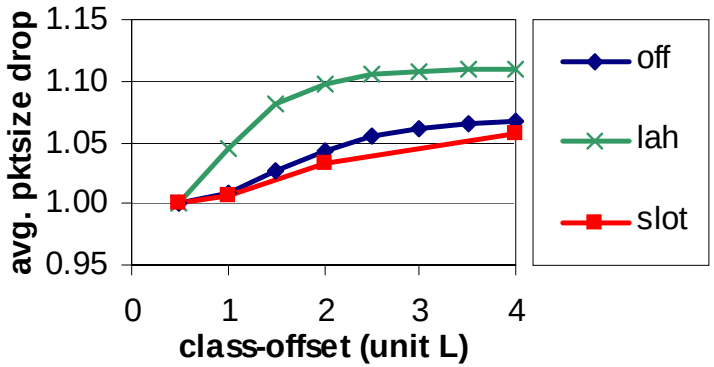
- unfairness:
  - more pronounced for look-ahead; which
  - stems from preemption: re-scheduling packets leads to less optimal wavelength allocation (ie. worse config of “gaps” left for other packets)



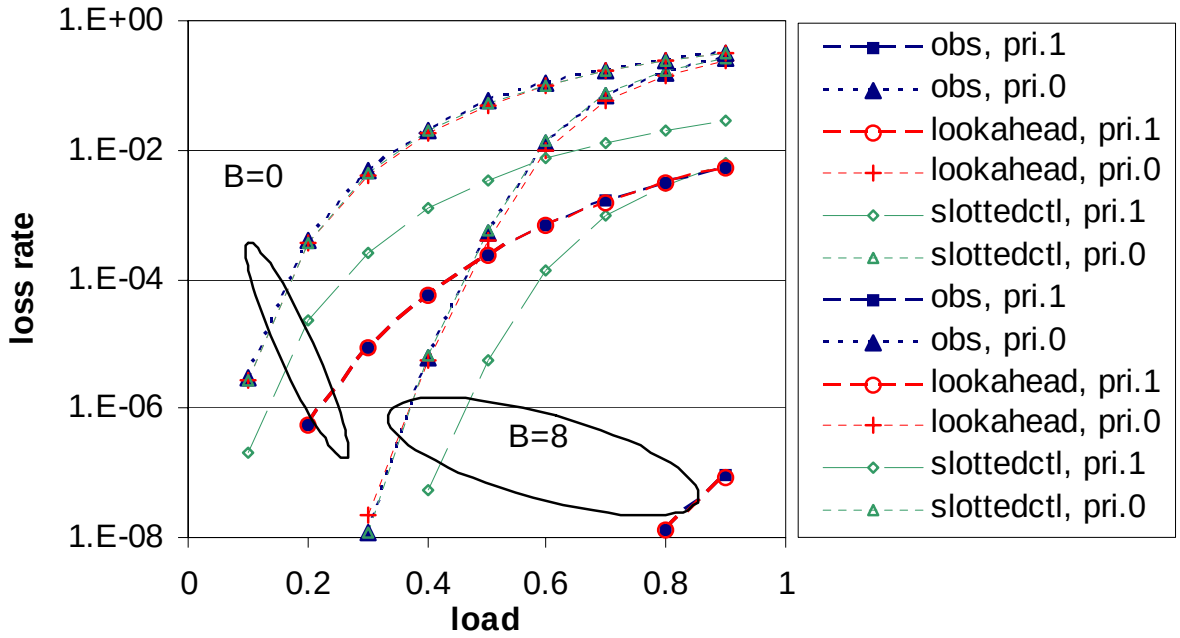
Influence of class offset

- settings:
  - buffer B=8, D=4L;
  - load 0.8
  - varying “class offset” O=H=T
- overall loss rate:
  - stronger class separation: high priority forces more low priority losses
  - boundary (reached for smaller “class offsets” with look-ahead)
- unfairness:
  - significantly stronger for look-ahead





Influence of load



- settings:
  - load =0.1…0.9; buffer: B=0 or 8, D=2L; "class offset": O=H=T=2L
- loss rates:
  - class separation slightly diminishes for increasing load
  - slotted control achieves much weaker separation; esp. if there is buffer (B=8)
  - buffer very much helps to increase sustainable load

Conclusions

- compared various QoS approaches

- slotted control achieves less strong separation, but
  - simpler scheduling algorithm
  - may be suitable for low to medium loads (cf. for load=0.5, high priority loss ~1E-6)

- look-ahead
  - achieves equally good (or slightly better) loss rates and delays as OBS-JET with differentiated offsets
  - separation limit is reached for shorter “class offsets” than OBS-JET
  - induces more intra-class unfairness (i.e. stronger discrimination of longer bursts)

That’s all, folks!

… thanks for your attention

… any questions?