Performance comparison of scheduling algorithms for IPTV traffic over Polymorphous OBS routers

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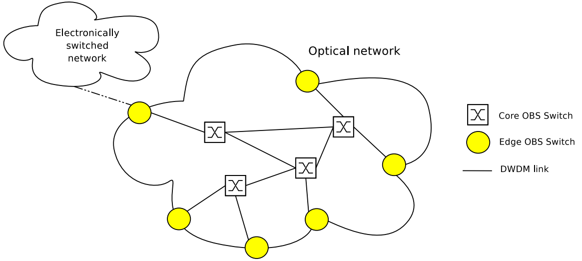
Optical Burst Switching review

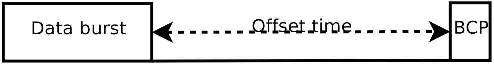
In OBS networks:

- Edge nodes aggregate incoming traffic into optical data bursts (1 optical burst contains many packets).
- Core nodes switch data bursts *all-optically* (no O/E/O conversion) accross the DWDM physical layer.



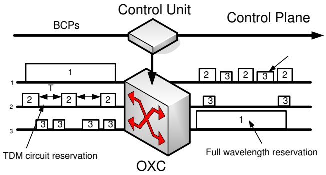
In an edge OBS node:

- For each data burst, a Burst-Control Packet (BCP) is generated and transmitted *after* the data burst is assembled.
- Typically, the BCP contains the size of the data burst and expected arriving time at the intermediate nodes. It reserves resources for the forthcoming data burst.
- The time difference between the BCP and its associated data burst is known as *offset time*.



Polymorphous OBS

- In the Polymorphous OBS architecture, a BCP (with extended attributes) may reserve:
  - A full wavelength (1)
  - Synchronous fixed-size time slots (2)
  - Asynchronous best-effort capacity (3)



- The synchronous reservations may be used by services which require periodic capacity, but do not need a full wavelength (for instance, IP TeleVision).

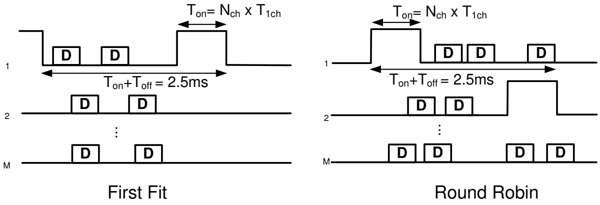
  Goal Find the best way to combine IPTV reservations with asynchronous best-effort traffic that brings best performance (less blocking probability).

IPTV Traffic characteristics

- Observed characteristics of IPTV service from a Spanish IPTV service provider:
  - MPEG-2 encoding
  - 4.16 Mbps per TV channel
  - Constant Bit Rate stream with packet interarrival times of 2,5ms
- This configuration belongs to Standard Definition TV

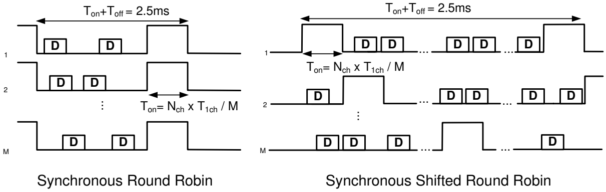
Scheduling algorithms for combining IPTV traffic together with best-effort

- First fit (FF): All TV channels are inserted together over the same wavelength.
- Round Robin (RR): TV channels are grouped together and allocated over different wavelengths following a Round Robin fashion.



Scheduling algorithms for IPTV traffic together with best-effort (2)

- Synchronous Round Robin (SRR): Channels are splitted into different wavelengths, and transmitted at the same time in each lambda.
- Synchronous Shifted Round Robin (SSRR): Same as SRR but the time is shifted for different lambdas.



Analytical approximations

- Using the Erlang-B formula, ignoring the retroblocking effect of OBS (which arises when offset times are highly variable):

$$P_{block} = P_{block|off} P(off) + P_{block|on} P(on)$$

- First Fit:

$$P_{block} = \frac{T_{on} + D}{T_{off} + T_{on}} E_B(I, M-1) + \frac{T_{off} - D}{T_{off} + T_{on}} E_B(I, M)$$

- Synchronous Round Robin:

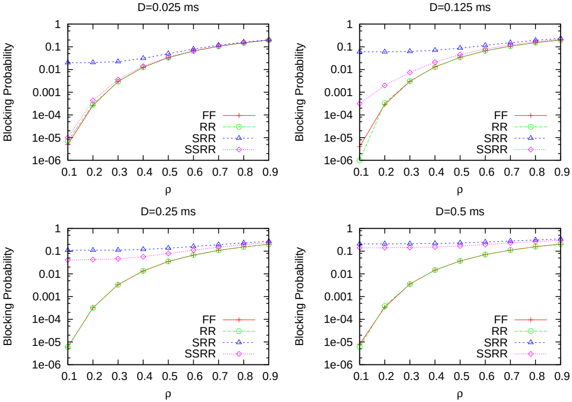
$$P_{block} = \frac{T_{on} + D}{T_{off} + T_{on}} + \frac{T_{off} - D}{T_{off} + T_{on}} E_B(I, M)$$

- D = burst size, M = Number of wavelengths, I = Offered traffic

Experiments: Scenario definition

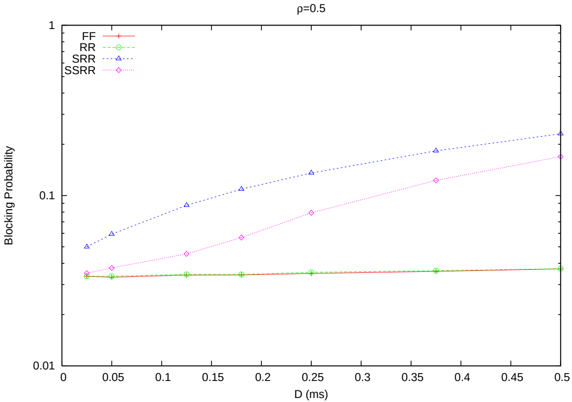
- We have considered 192 channels transmitted over the POBS network. $192 \times 4{,}16 Mbps = 799 Mbps$ over a $M = 8$-wavelength with capacity $10 Gbps$ per wavelength.
- $T_{on} + T_{off} = 2{,}5 ms$ as measured, $T_{off} = 2{,}3 ms$ for FF and RR, and $T_{off} = 2{,}475 ms$ for SRR and SSRR.
  - $T_{on} = \frac{N_{ch} \times B_{ch}}{C} = \frac{192 \times 4{,}16 Mbps}{10 Gbps} = 8\,\% \times 2{,}5 ms$ FF, RR
  - $T_{on} = \frac{N_{ch} \times B_{ch}}{M \times C} = \frac{192 \times 4{,}16 Mbps}{8 \times 10 Gbps} = 1\,\% \times 2{,}5 ms$ SRR, SSRR
- Load: $\rho = \frac{\lambda D}{M}$, where $D \in \{0{,}025, 0{,}125, 0{,}25, 0{,}5 ms\}$
  For instance, $D = \frac{150 packets \times 1024 \cdot 8}{10 Gbps} = 0{,}125 ms$

Simulations and results (1)



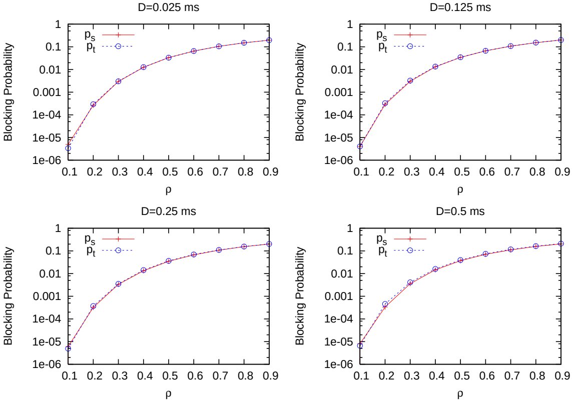
- FF and RR shows best performance, especially for large *D*.
- Hence, it is better to merge TV channel transmition than split them over different wavelengths.

Simulations and results (2)

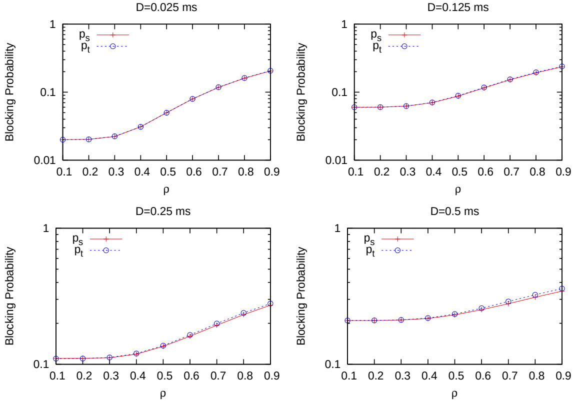


- FF and RR shows best performance, and same behaviour regardless of burst size D.

Simulations and results (3)



Simulations and results (4)



Summary and conclusions

- Main conclusions:
  - FF and RR show similar performance results and are the best strategies among the four scheduling algorithms studied.
  - It is better to group all channels and transmit them at once than splitting them over different wavelengths, especially when D is comparable to T_{off}.
- The analytical approximations for FF and SRR are shown to be accurate.

Questions

Thank you!!