Urgency Based Scheduler

- AVB Gen. 1 worst case with sub shapers -

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Contents

- **Recap Dallas Nov. 2013**
  - Presented
    - Egress Operation
    - Latency Math
    - Possible usage Algorithms
    - Downscaling Options
  - Requested
    - Old CBSA Worst Case Example with UBS
      Cmp. http://www.ieee802.org/1/files/public/docs2010/ba-boiger-bridge-latency-calculations.pdf, Case 4
- **Goals of this presentation**
  - Old CBSA Worst Case Example with UBS
  - Compare one Shaper per Class (CBSA) with Sub Shapers per Stream (UBS)
    →Shows purpose of Sub Shapers
    → Doesn‘t require Sub Priorities
    → FIFO operation of all queues shown on consecutive slides
- **No Goals of this presentation**
  - Analyze in detail how “bad” per class shaping with CBSA can become
  - Show other cases than the aforementioned
  - Discuss topics beyond the technical concept of Sub Shapers

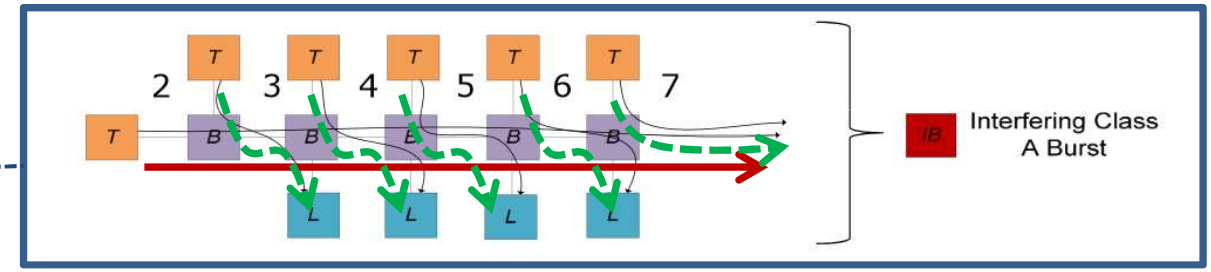
Cmp. http://www.ieee802.org/1/files/public/docs2010/ba-boiger-bridge-latency-calculations.pdf, Case 4

WORSE CASE SCENARIO CONSIDERATION

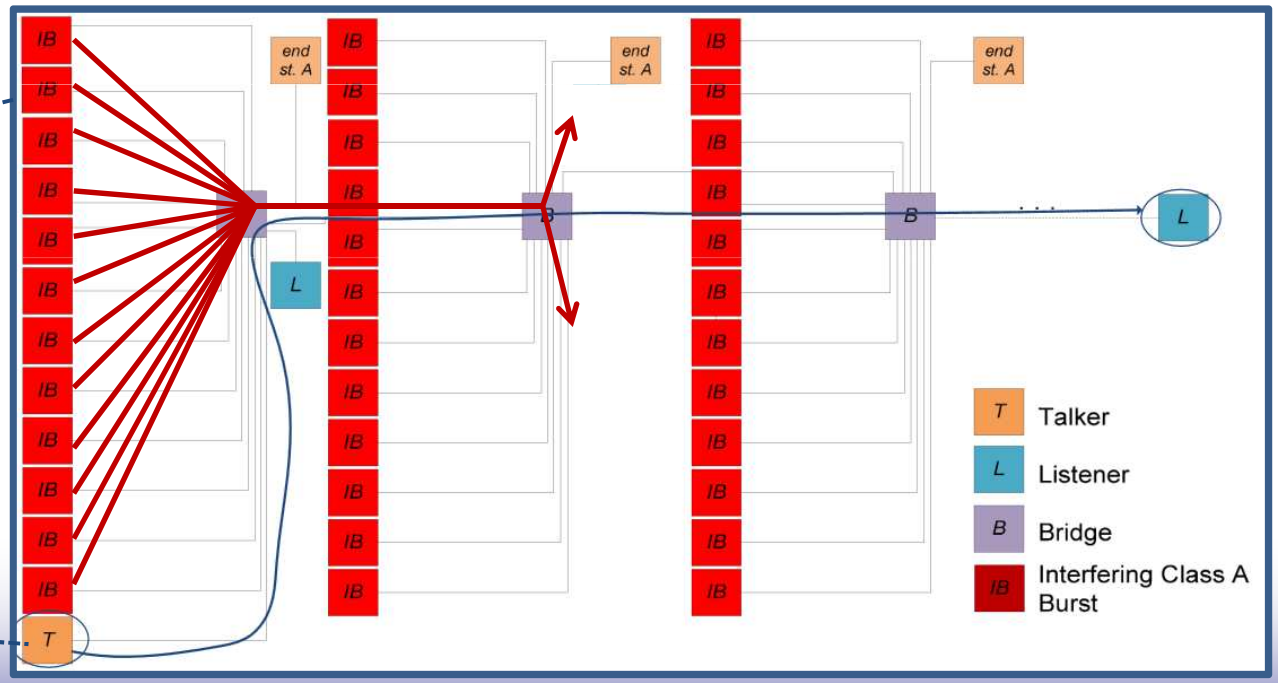
The scenario in a nutshell

- 100 Mbit/s; AVB Class A; Lower Strict Priority Class (Max. 1542 B./Frame)
- **Green (Class A):** Max. 1091 B./Frame, Max. 69.24 Mbit/s
- **Red & Blue (Class A):** Max. 90 B./Frame, Max. 5.76 Mbit/s

This "Macro"
accumulates a long class A burst (red stream) …



… interfering
the blue stream with maximum fan in at every bridge
(only shown for the first bridge/hop)



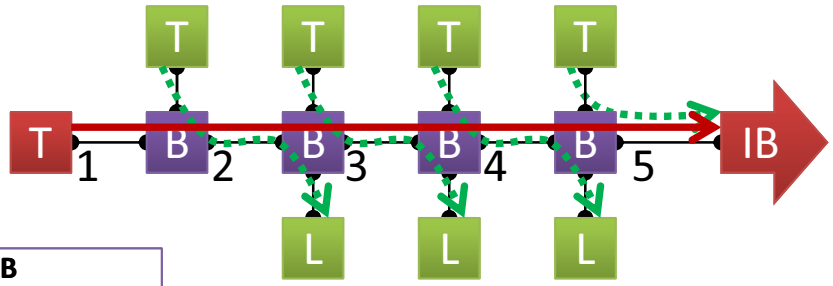
Blue stream starts here!

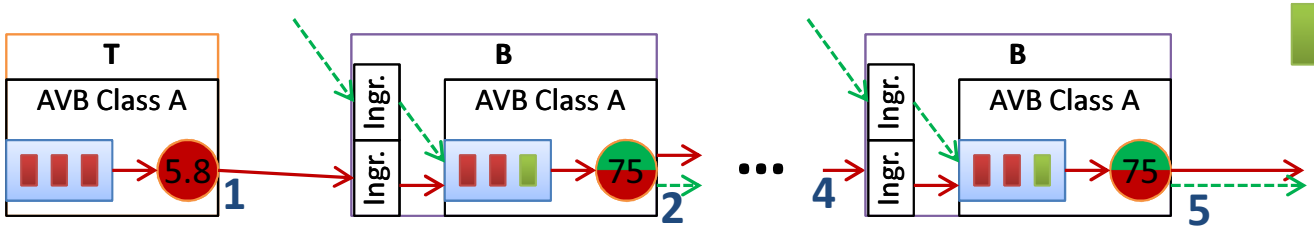
1 Shaper per Class: Burst Accumulation

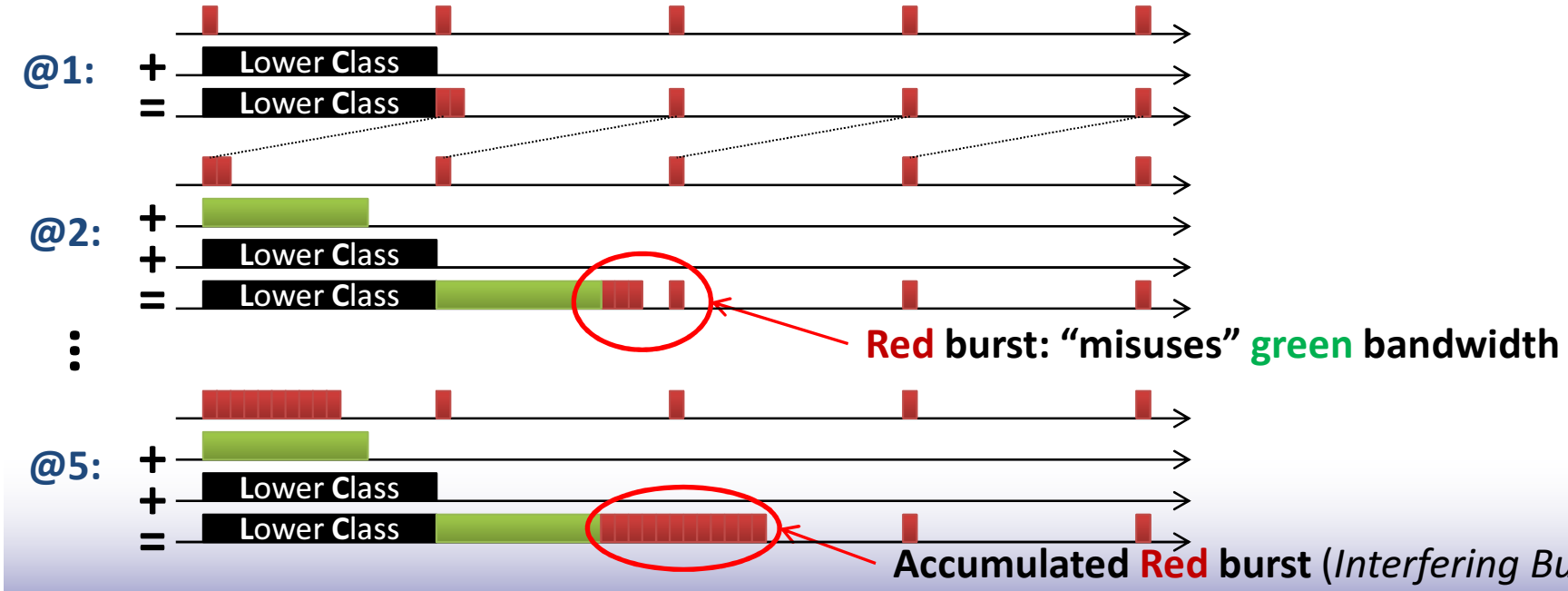
Red: 5.76M, Max. 90 Byte/Frame

Green: 69.24M (75M - 5.76M), Max. 1081 Byte/Frame

Lower Class: Max. 1542 Byte/Frame

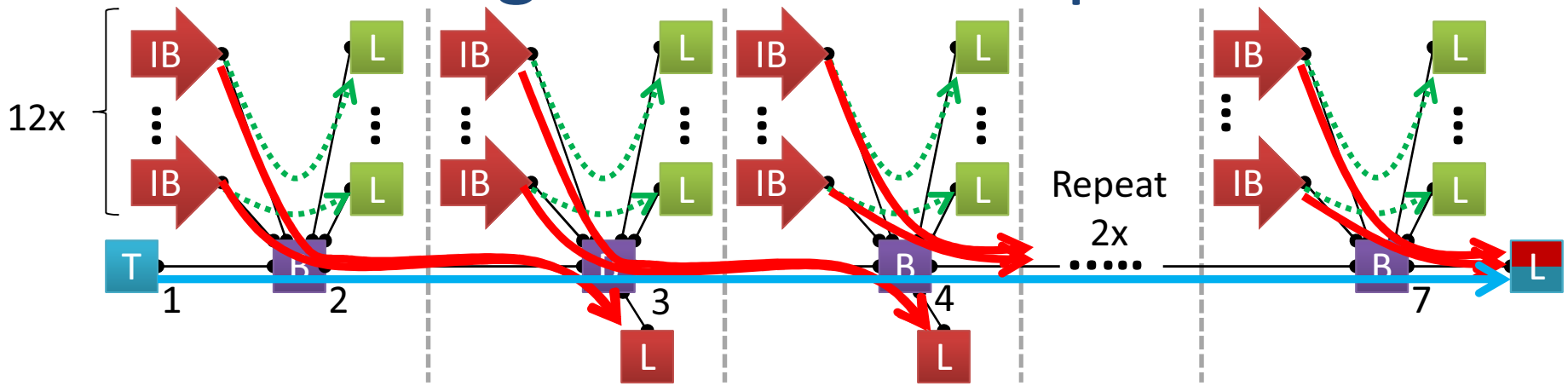


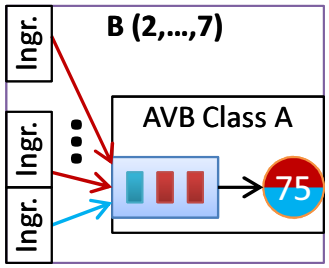


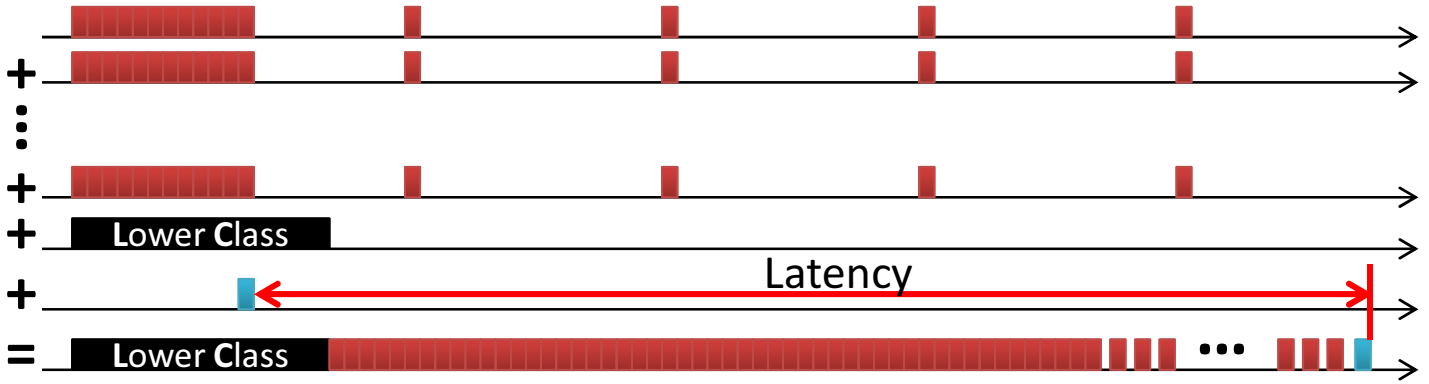


The time diagrams are for illustration only –scales/details may differ

Interfering Burst @ multiple Fan-In

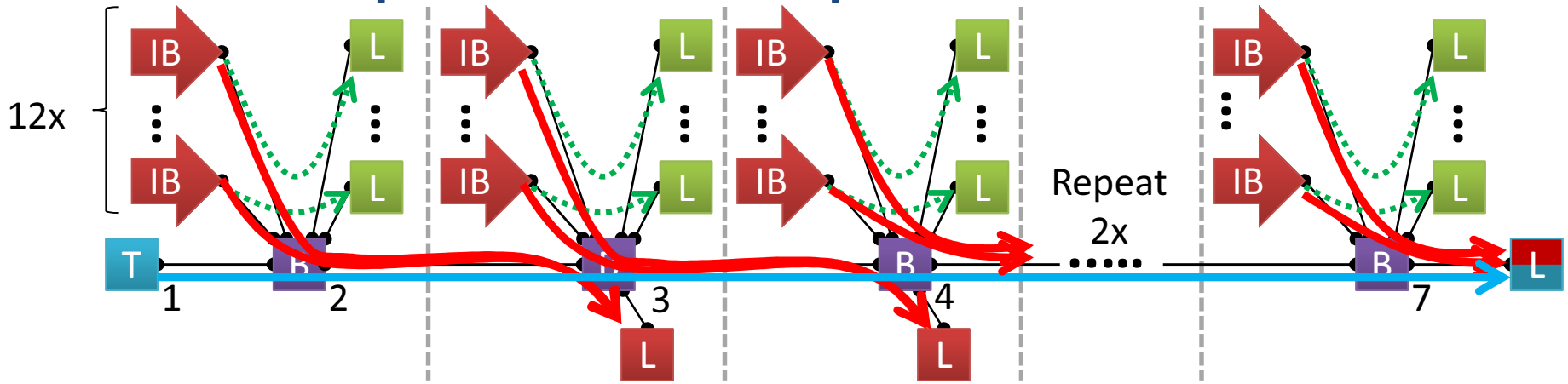


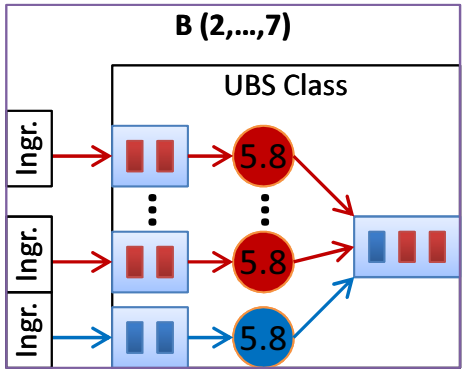


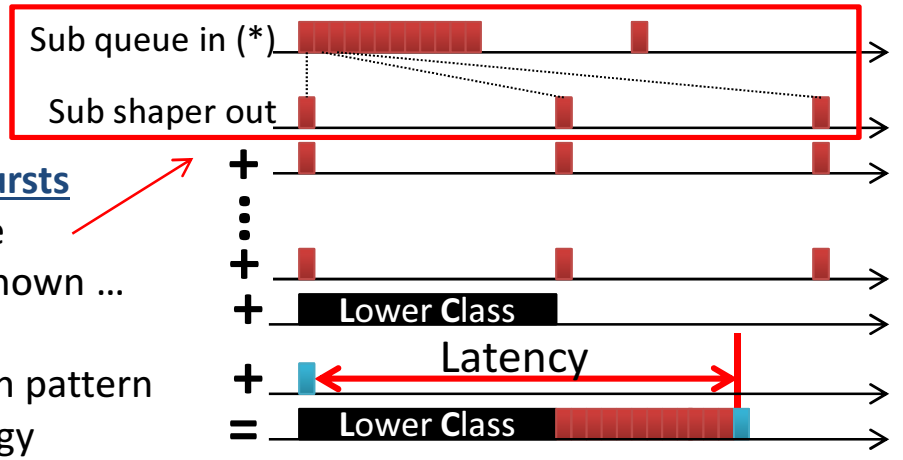


Egress port 1 identical to prev. slide

Sub Shapers: The important difference







Sub Shapers: spreads bursts

→bursts can‘t propagate

→Max. shaper output known …

… regardless of

- talker transmission pattern
- prev. hops/topology

$$W_{blue}^{max} = \underbrace{1 \times \frac{90{\cdot}8+1542{\cdot}8}{100M}}_{\text{Port 1 (talker)}} + \underbrace{6 \times \frac{13{\cdot}90{\cdot}8+1542{\cdot}8}{100M}}_{\text{Port 2,…,7 (bridge)}} = 1432.32\,\mu s$$

(*) This long interfering burst couldn‘t accumulate anyway with sub shapers on prev. egress ports along the paths of the red streams

Simplified latency math (without sub priorities) – see Backup Slides

Summary

Sub Shapers – what has been shown

(see also http://www.ieee802.org/1/files/public/docs2013/new-tsn-specht-ubs-perfchar-1113-v1.pdf)

- Bursts can‘t accumulate/propagate
- Latency can be calculated for each Hop independently
- Even without sub priorities, the end-to-end latency is low:

5612.2 µs (1 CBSA Shaper) **vs.** **1432.32 µs** (UBS Sub Shapers)

Underlying assumptions on Streams

- **Max. Rate** & **max. Frame Length**
- no further assumptions, e.g.
  - Talker transmission behavior
  - prev. Hops/topology

Further Cases

- Readers are encouraged to analyze UBS independently and present:
  - Counterexamples, other cases
  - Analyze whether the shown math. is totally wrong – or totally right
  - etc.

Latency for 1 CBSA Shaper taken from http://www.ieee802.org/1/files/public/docs2010/ba-boiger-bridge-latency-calculations.pdf

Thank you for your Attention!

Questions, Opinions, Ideas?

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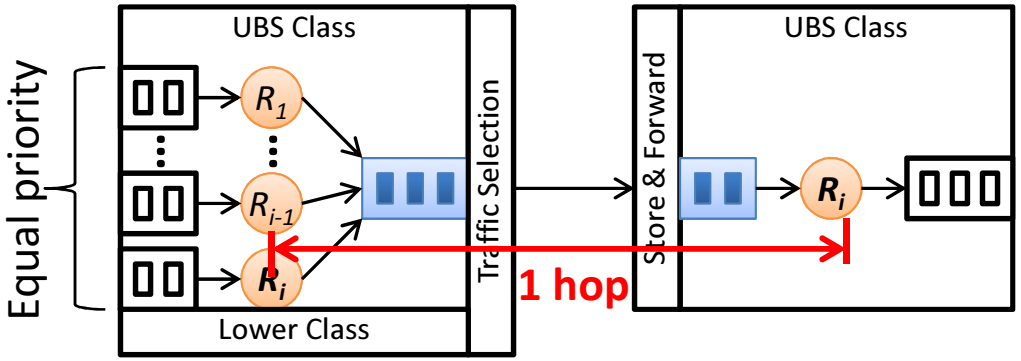
BACKUP

Simplified UBS Math.

No sub priorities

- One sub shaper per Stream
- Same priority for all sub shapers

→Priority queue behaves like a FIFO



$$W_i^{max} = \frac{\sum_{k=1}^{j-1} l_k^{max} + \sum_{k=j}^{i-1} l_k^{max} + max\{l_{LC}^{max}, l_{i+1}^{max}, \ldots, l_n^{max}\}}{R - \sum_{k=1}^{j-1} R_k} + \frac{l_i^{max}}{R}$$

Higher Prio. | Prio. of *i* | Lower prio.

interfering traffic | S&F

Max. frames from interferring sub shapers

Max. Lower Class frame

Max. frame from sub shaper of interest

$$W_i^{max} = \frac{\sum_{k=1}^{i-1} l_k^{max} + 1542 \cdot 8 + l_i^{max}}{R}$$

Max. Latency at one hop of the stream of interest

Link Speed

See http://www.ieee802.org/1/files/public/docs2013/new-tsn-specht-ubs-perfchar-1113-v1.pdf for the complete calculation on the left

See also „Network Calculus, Jean-Yves Le Boudec, Patrick Thiran, 2012“