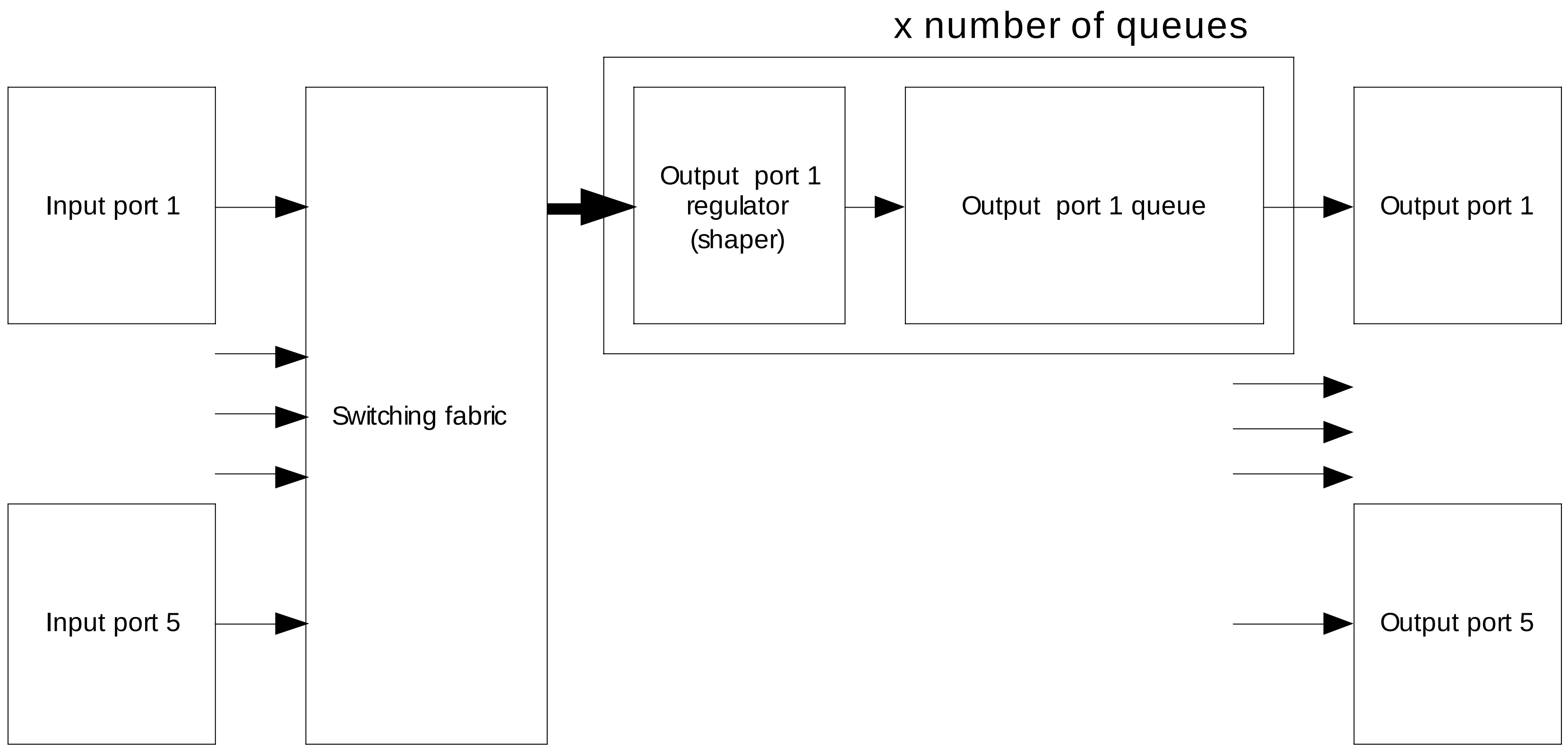
Quantifying stream distortion in 7-hop Fast Ethernet network

Max Azarov

v1.02

SMSC

Consider 5 port switch with regulator before priority output queue

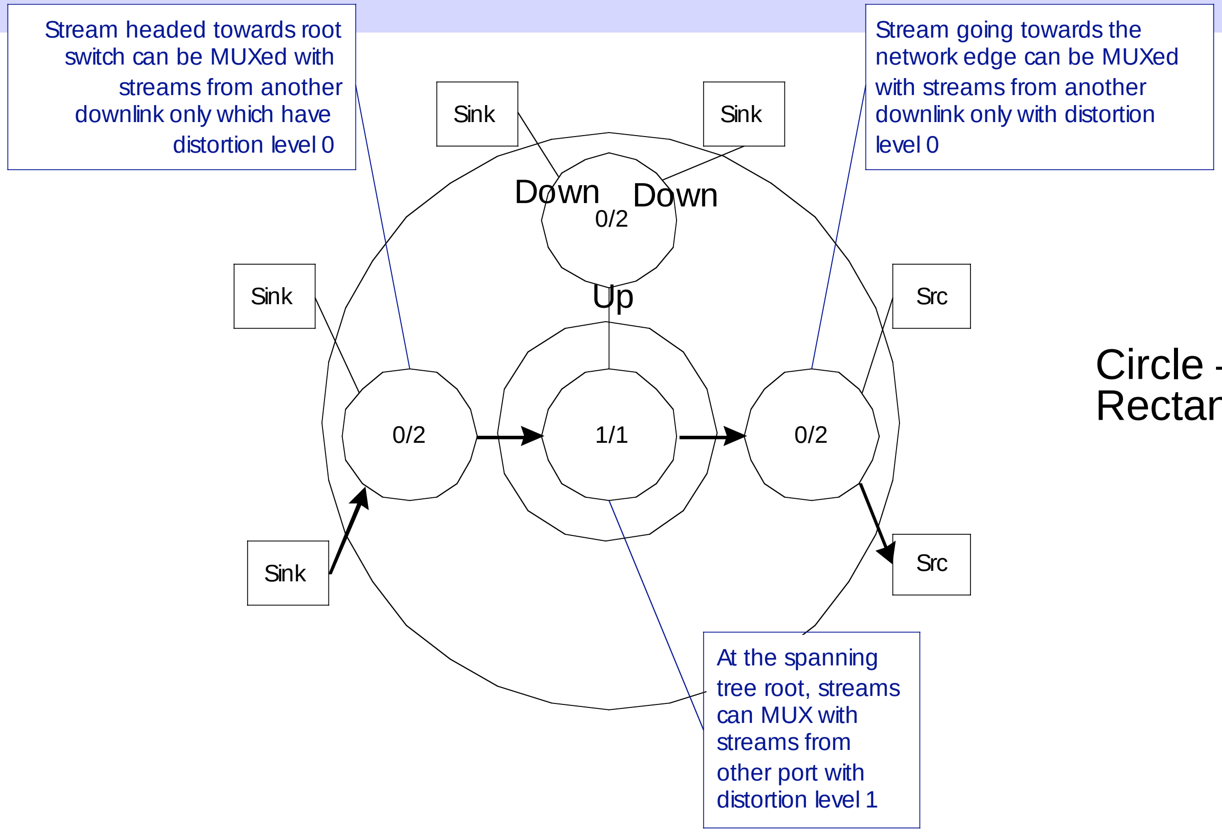


Output port receives measured steam and 3 interfering streams @ 18.75% each = 75% max load

Method of analysis

- To do quantitative analysis, we use graphical method with envelope charts
  - Network is running STP
  - Measured stream traverses full diameter of the network (7 hops)
  - For output port there's 4 input streams, ¼ of total allowable bandwidth each (75%/4=18.75%), among them is a measured stream
  - Each input stream initially has a leaky-bucket envelope. We take this as a distortion level 0
  - We evaluate envelope of the measured stream on the output. Output has a distortion level +1
    - In our model, combined input traffic experiences maximum queuing delay, at which point interfering streams cease and only measured stream continues
    - This inflicts maximum level of distortion on the measured stream (needs a prove)
  - Same repeated on the next switch with interfering streams with a new increased distortion level until whole network is traversed
- Gives quantitative estimate of a queuing delay
- Yet to provide a worst-case proof

Distortion level distribution in a 3-hop network

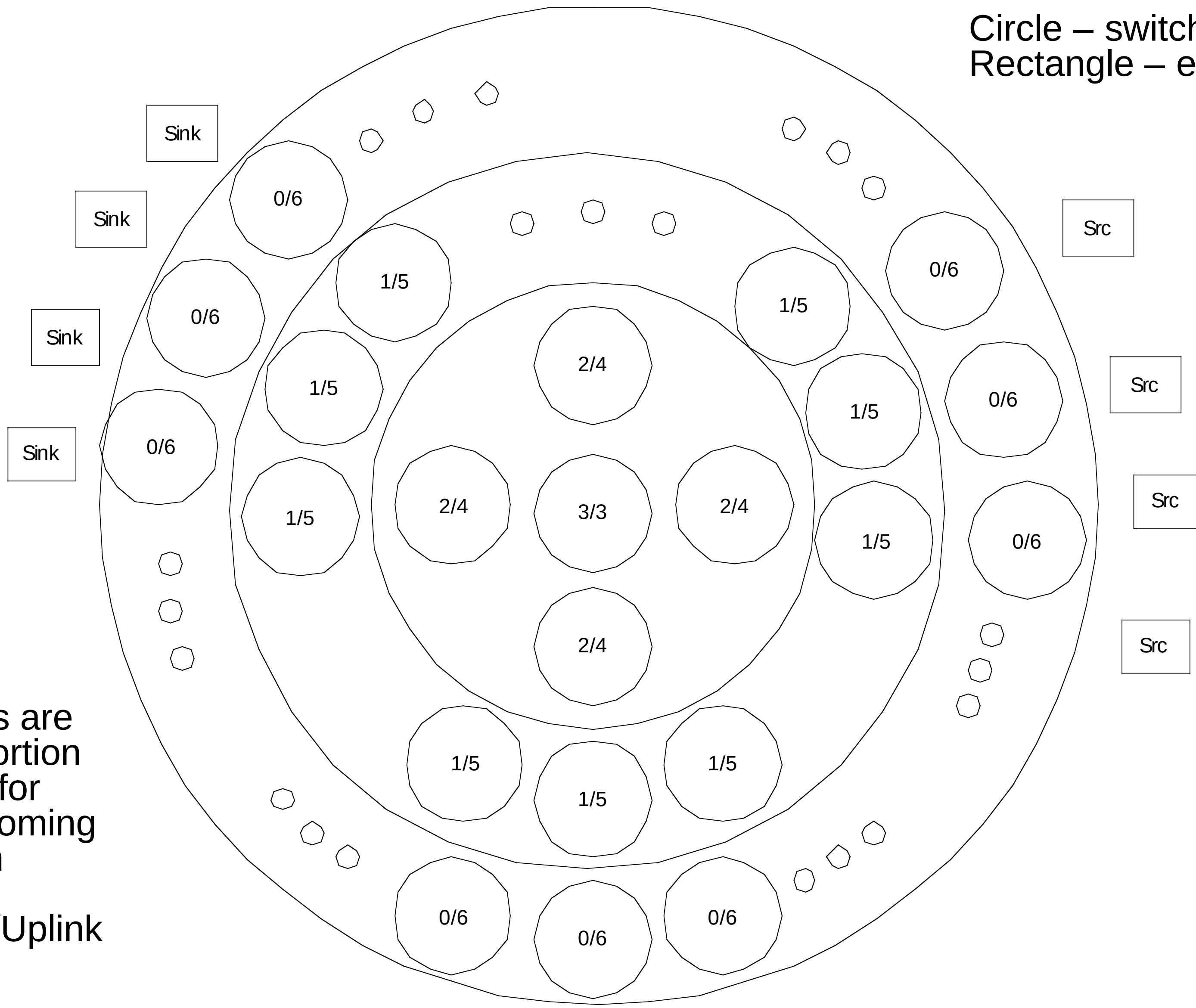


Circle – switch
Rectangle – end point

- For streams traversing whole network diameter end-to-end
  - Maximum distortion level of interfering streams raises as measured stream approaches STP root switch
  - Starts to fall as measured stream progresses away from the root towards the edge

We are on 7-hop network with STP

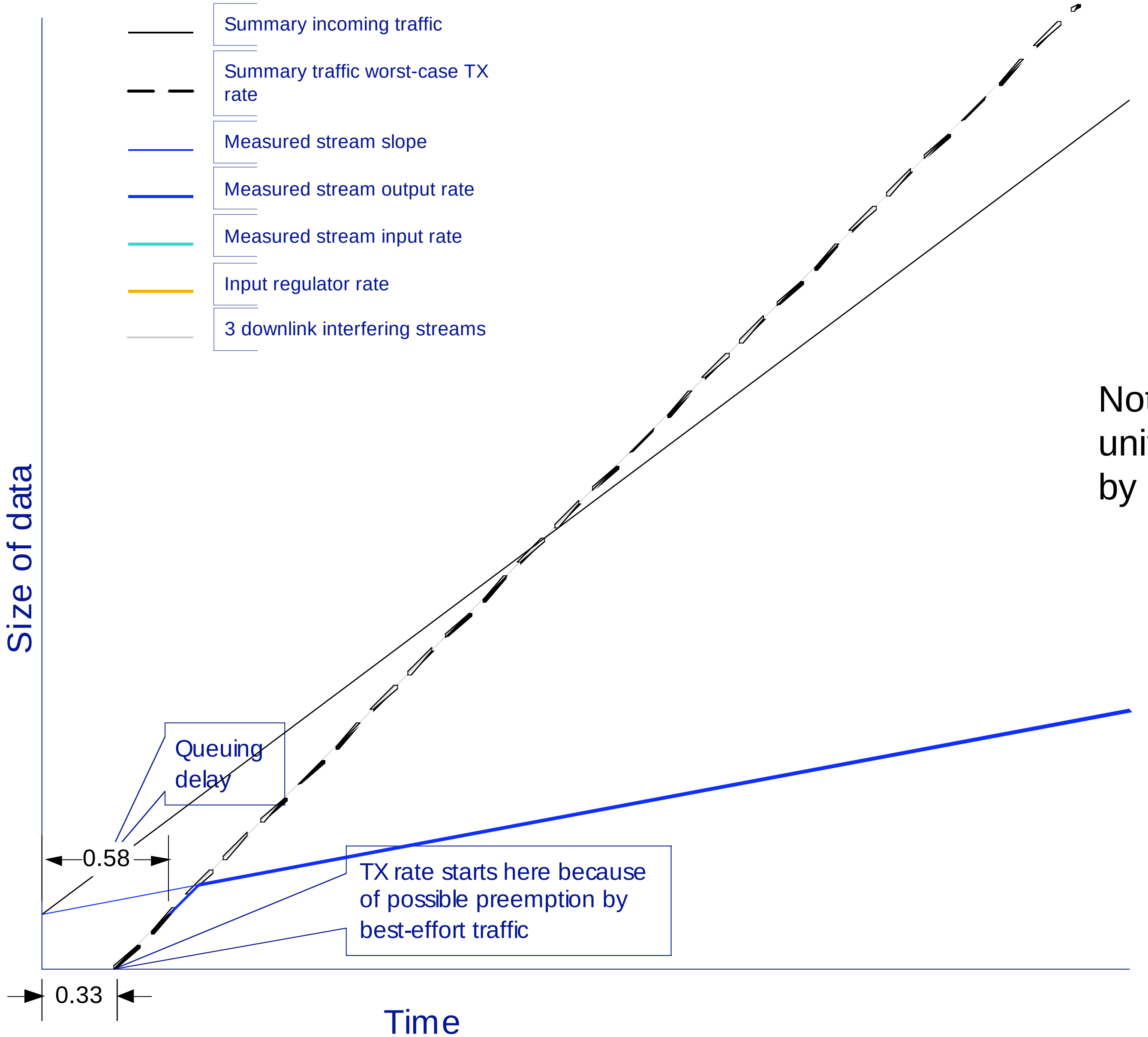
Circle – switch
Rectangle – end point



Numbers are max distortion levels for streams coming from

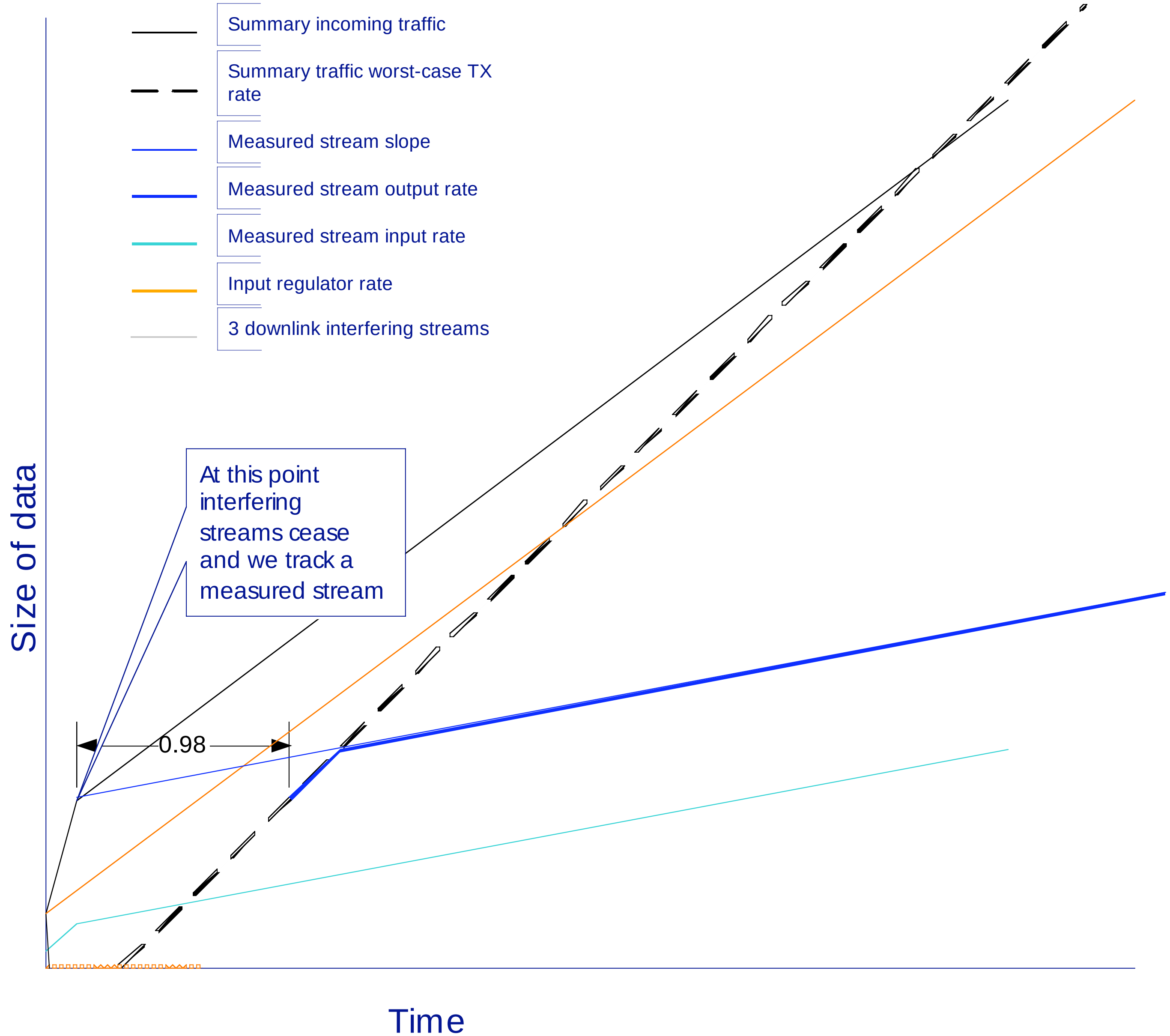
Downlink/Uplink

Switch 1 - input dist-n: 0/0 (measured/interfering)

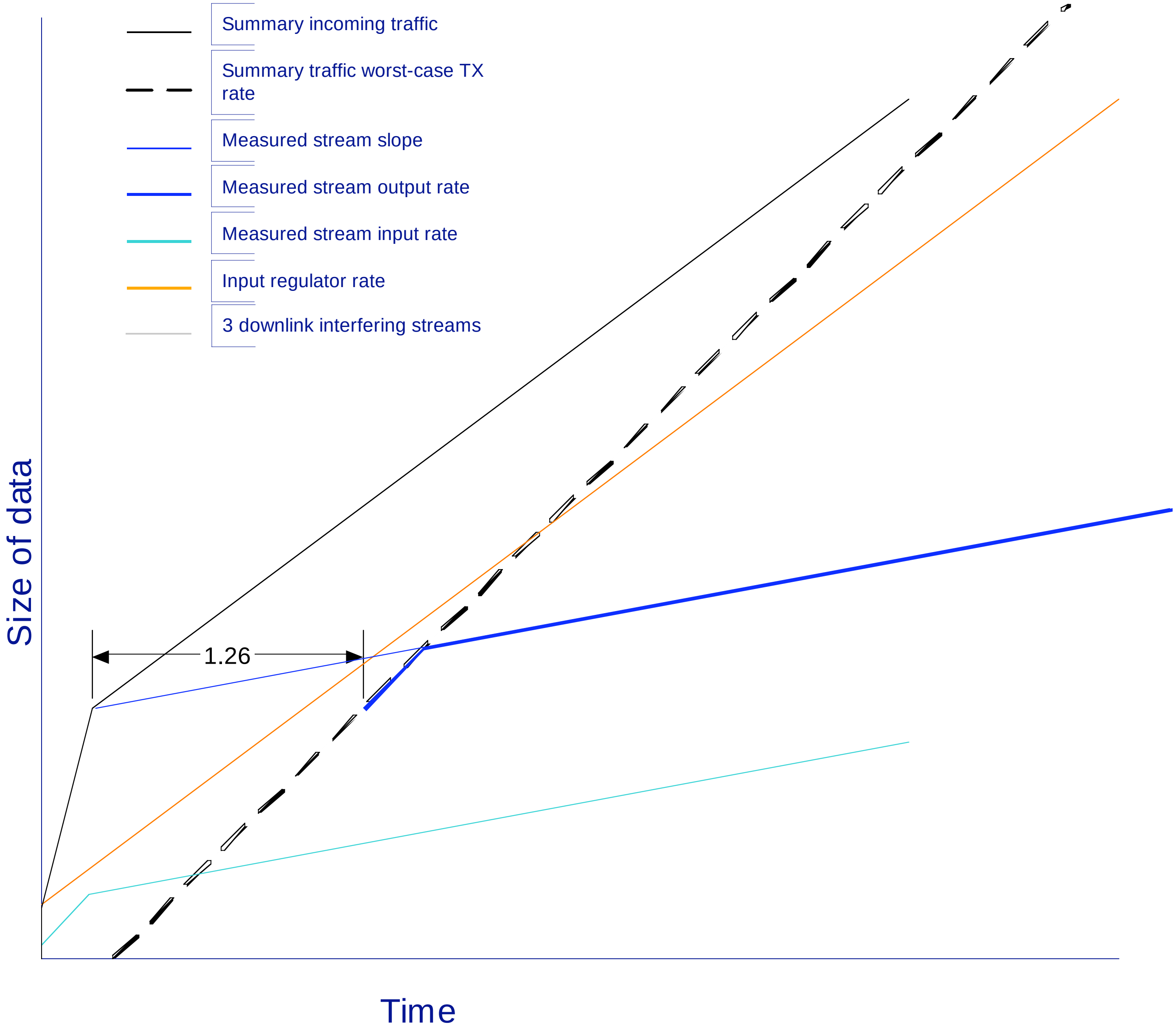


Note: To get *ms*, units are multiplied by 0.38

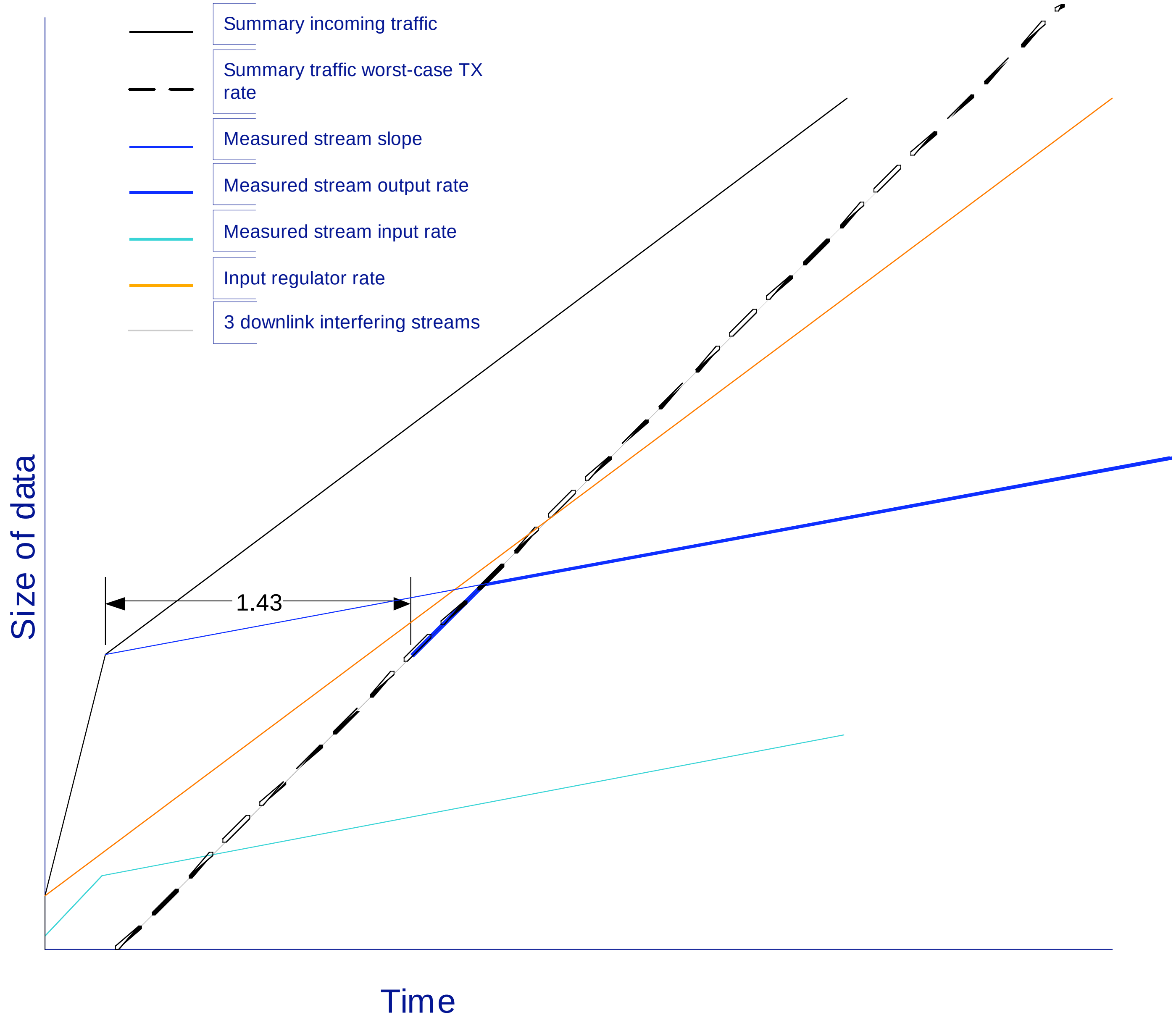
Switch 2 - input dist-n: 1/1 (measured/interfering)



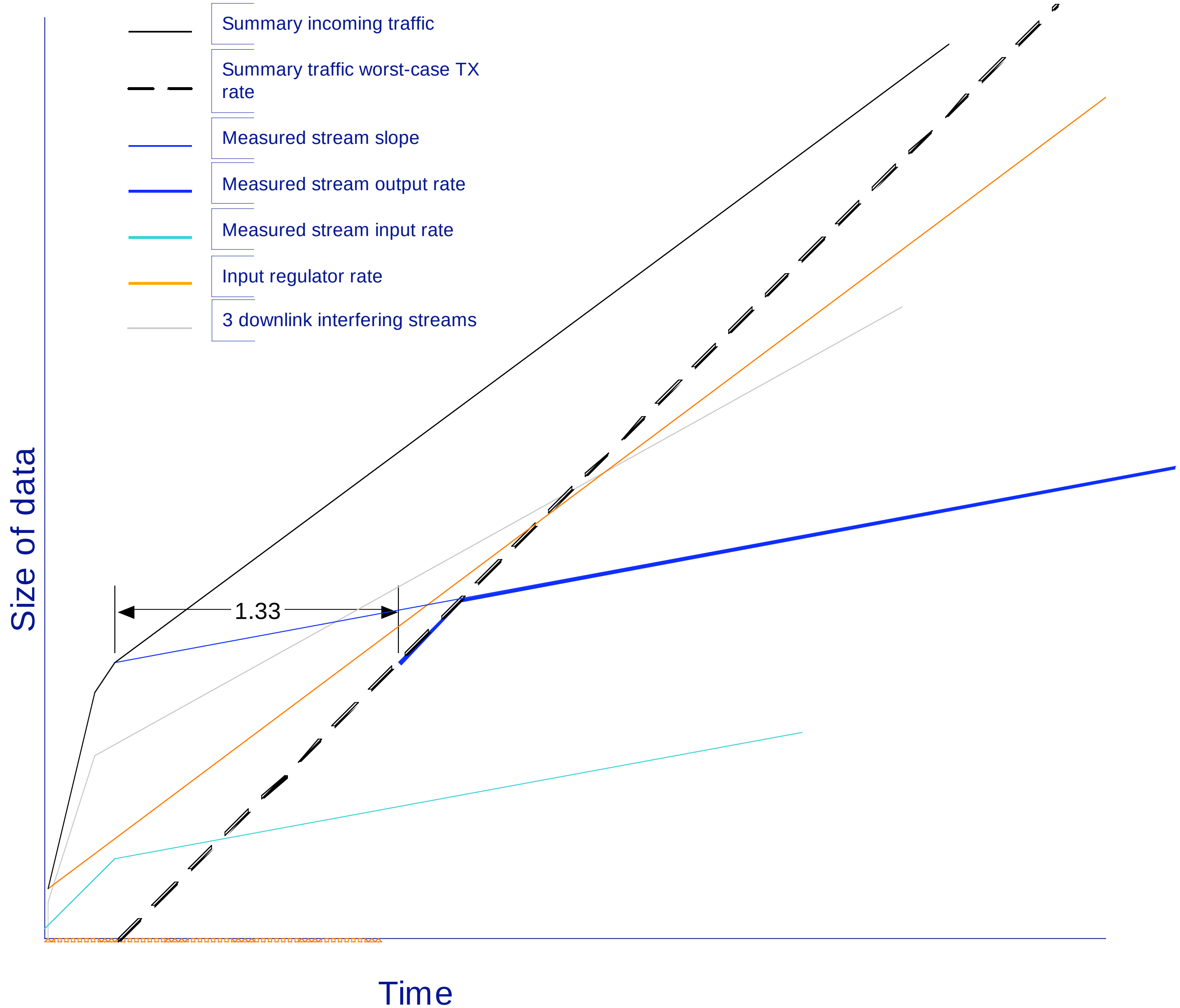
Switch 3 - input dist-n: 2/2 (measured/interfering)



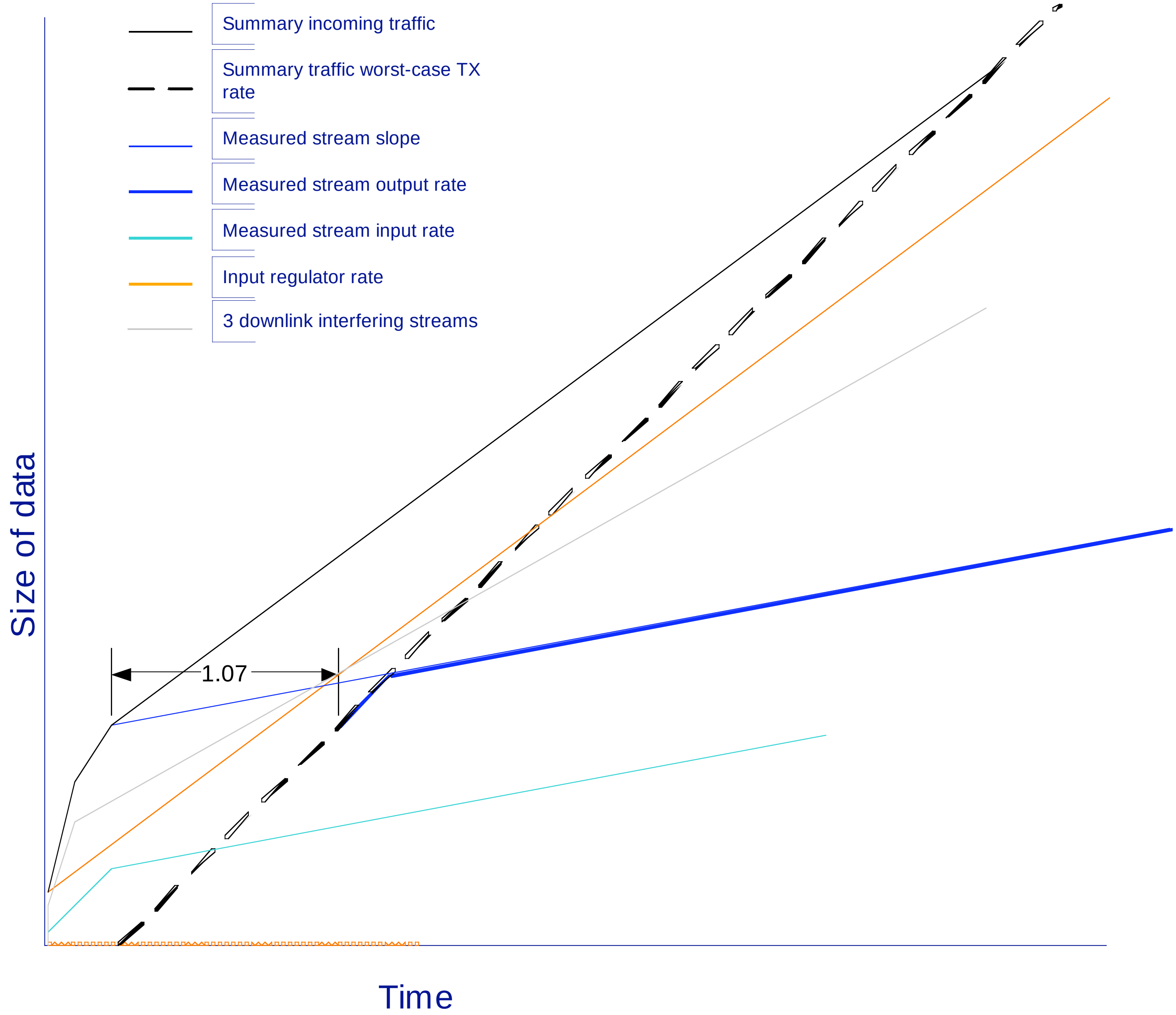
Switch 4 (root) – dist-n: 3/3 (measured/interfering)



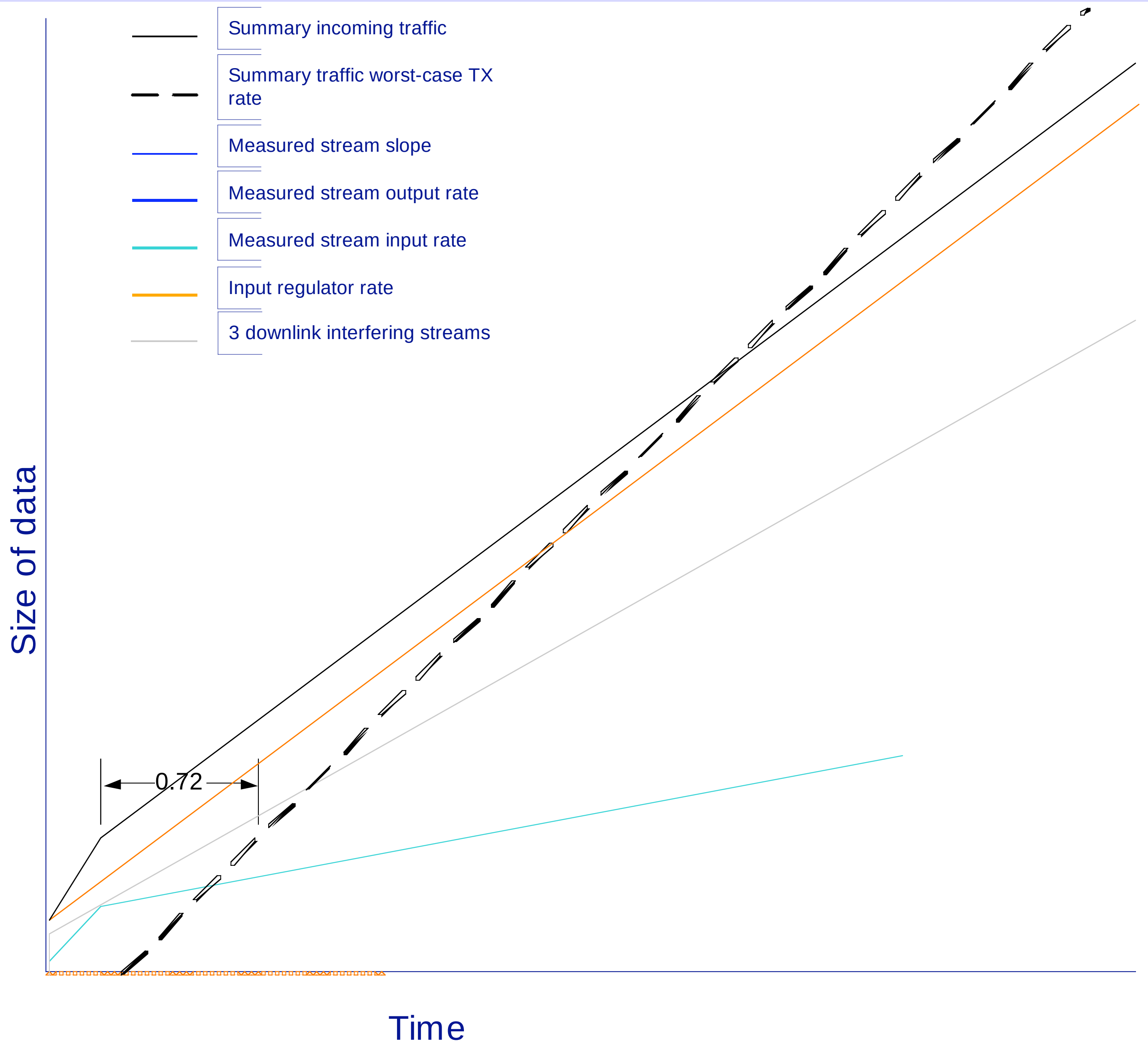
Switch 5 - input dist-n: 4/2 (measured/interfering)



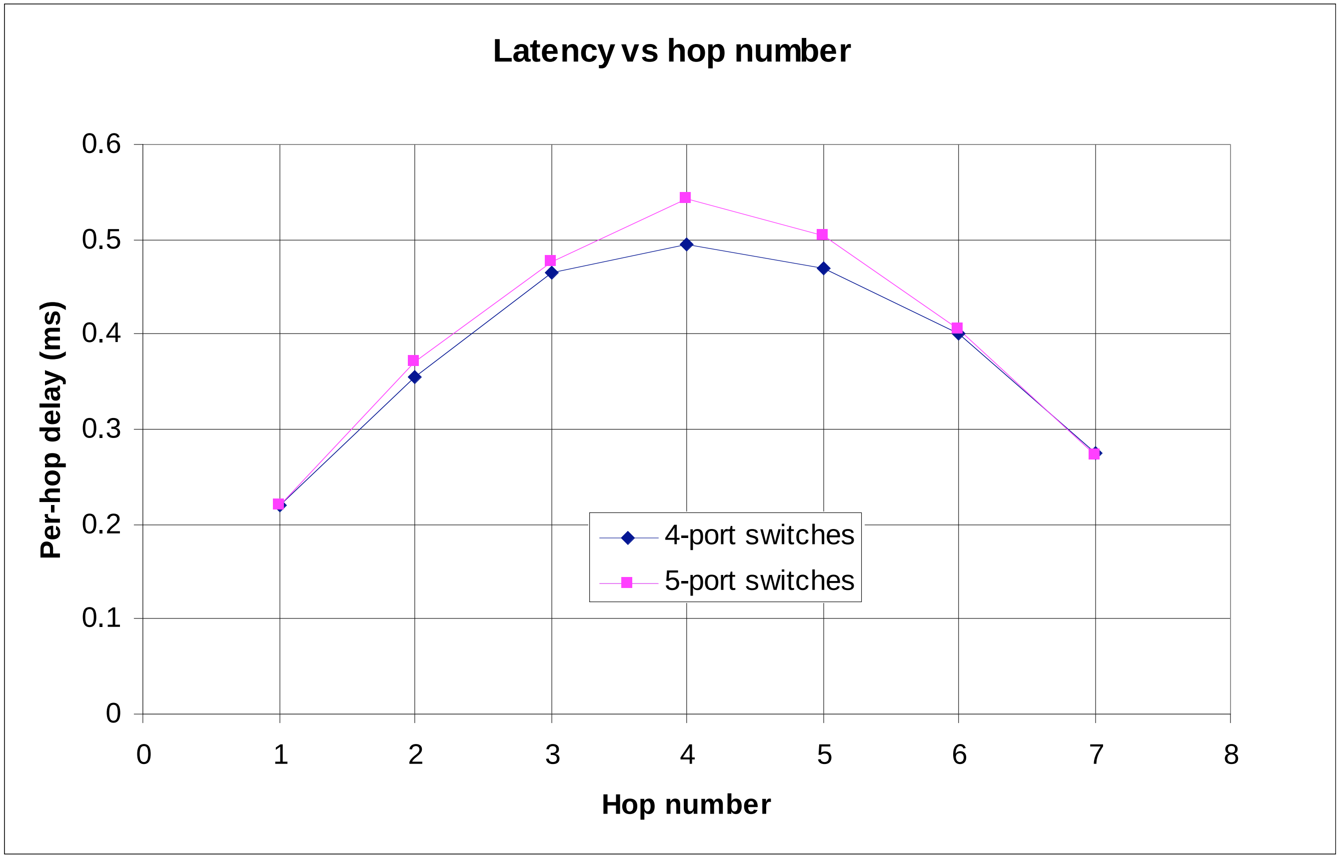
Switch 6 - input dist-n: 5/1 (measured/interfering)



Switch 7 - input dist-n: 6/0 (measured/interfering)



End-to-end delays



	4-port	5-port
End-end delay (ms)	**2.68**	**2.791667**

To-do

- Look at the case with regulators on the input, located before switching fabric
- Need formal proof for worst-case, i.e. need to provide definitive negative answer for:
  - Can other interfering stream bandwidth allocations cause bigger delay?
    - Perhaps equal distribution is not the most disadvantageous after all
  - Can measured stream traversing shorter path on the network experience bigger delay?
    - On one of the hops, such stream may experience interference from uplink with higher maximum distortion level, but on the other hand, it will pass through less hops overall

References

- Traffic envelopes and regulators
  - Rene L. Cruz, "A Calculus for Network Delay, Part I: Network Elements in Isolation", IEEE TRANSACTIONS ON INFORMATION THEORY, VOL. 37. NO. I , JANUARY 1991
  - Leonidas Georgiadis, Vinod Perk, "Efficient Network QoS Provisioning Based on per Node Traffic Shaping", IEEE/ACM TRANSACTIONS ON NETWORKING, VOL. 4, NO. 4**,** AUGUST 1996

Questions?