

WIRELESS RATE CONTROL PROTOCOL

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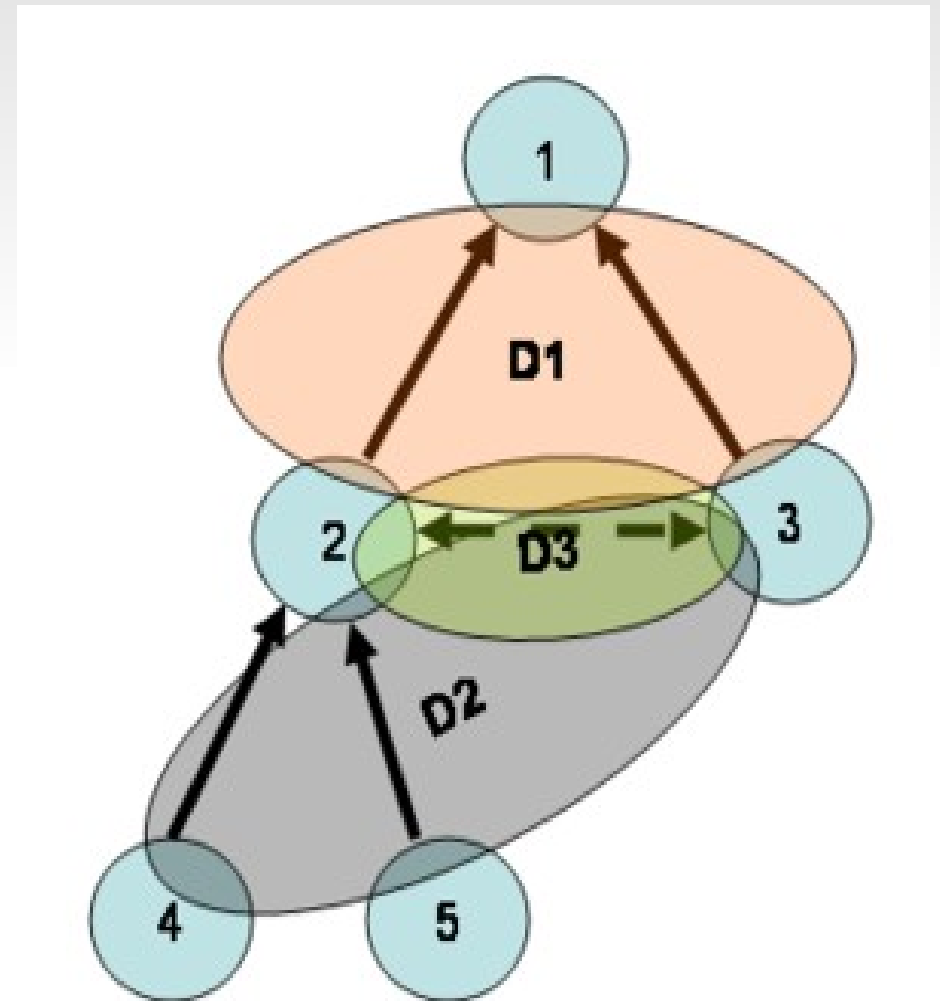
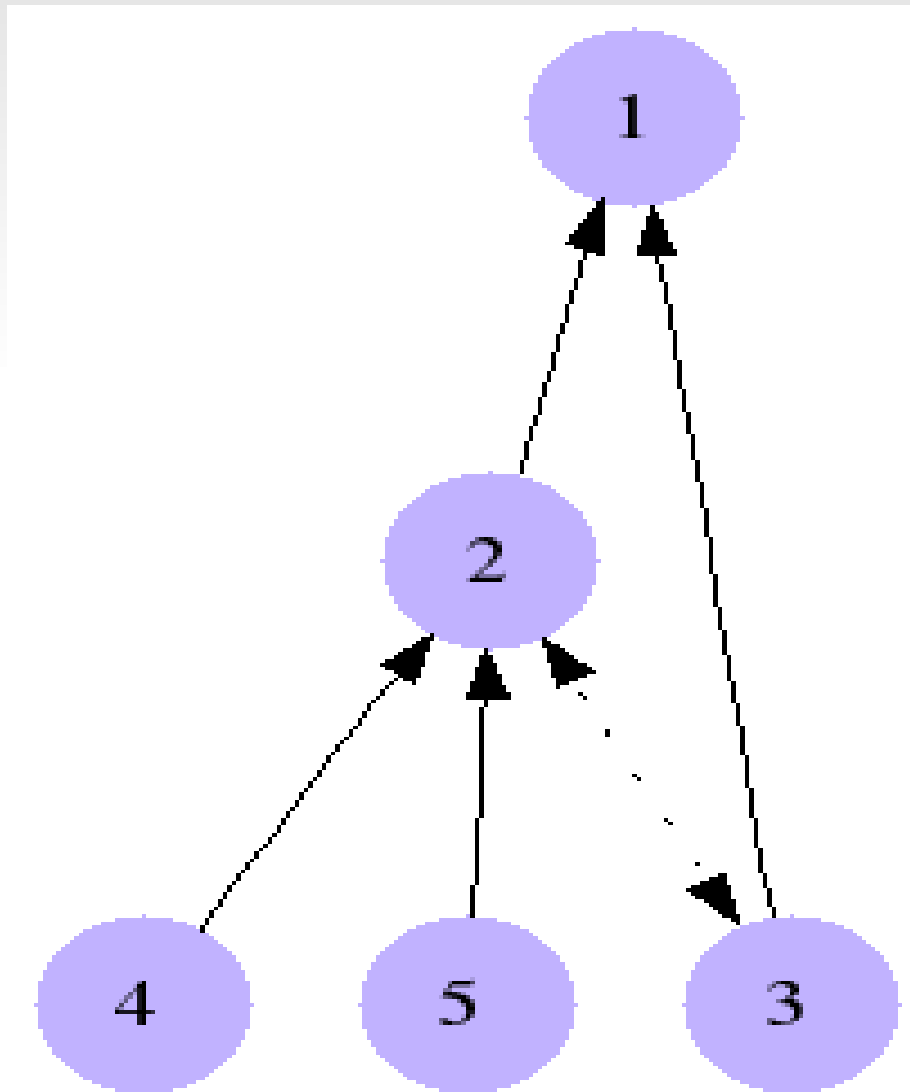
Whats WRCP ?

- WRCP is a rate control algorithm that operates with the precise knowledge of the capacity available in a wireless sensor network.
- The result, fast convergence, small queue size, hopefully small delays

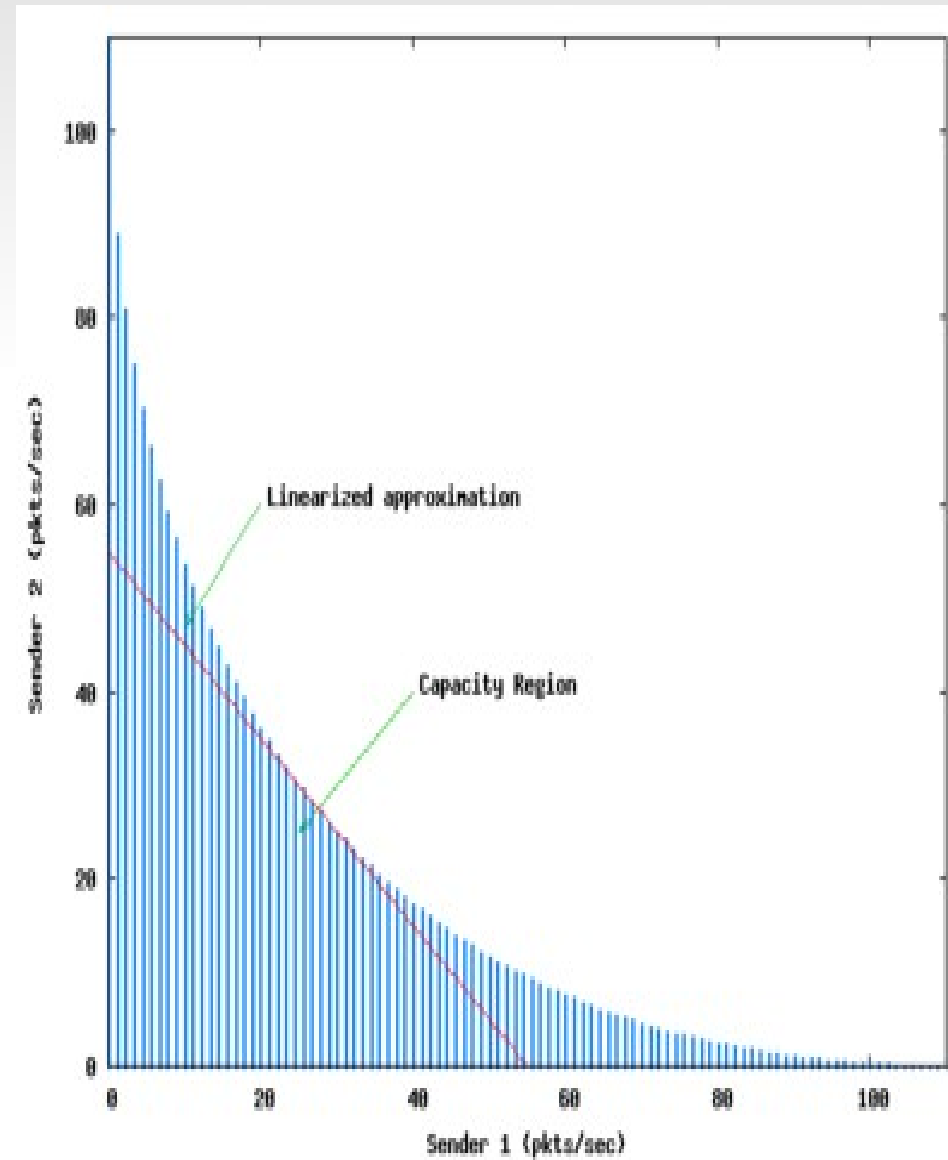
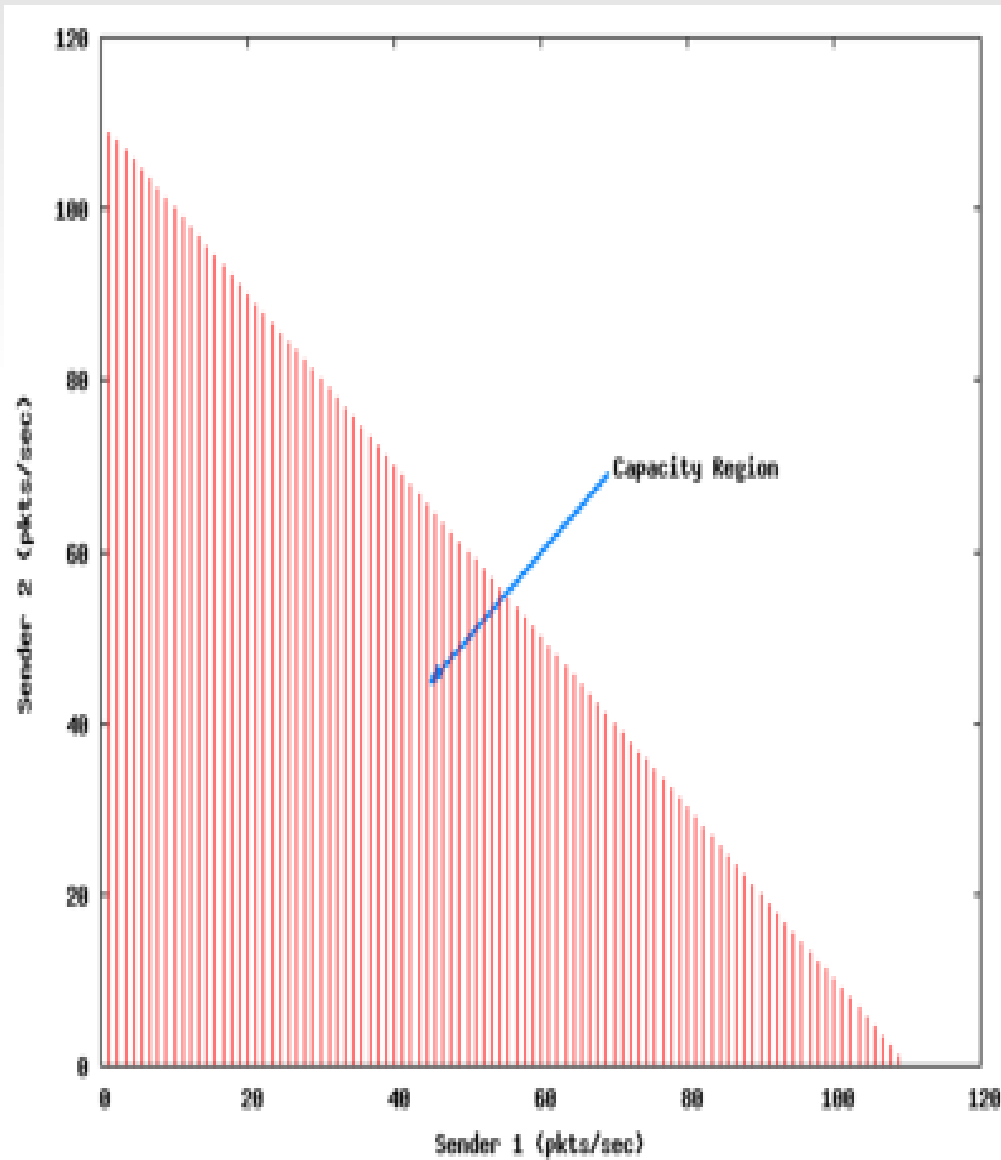
Whats Novel About it?

- Defining the notion of capacity in wireless networks is difficult.
- There are no point to point links just broadcast domains.
- Hence we model the graph as node capacitated graph rather than a link capacitated graph.

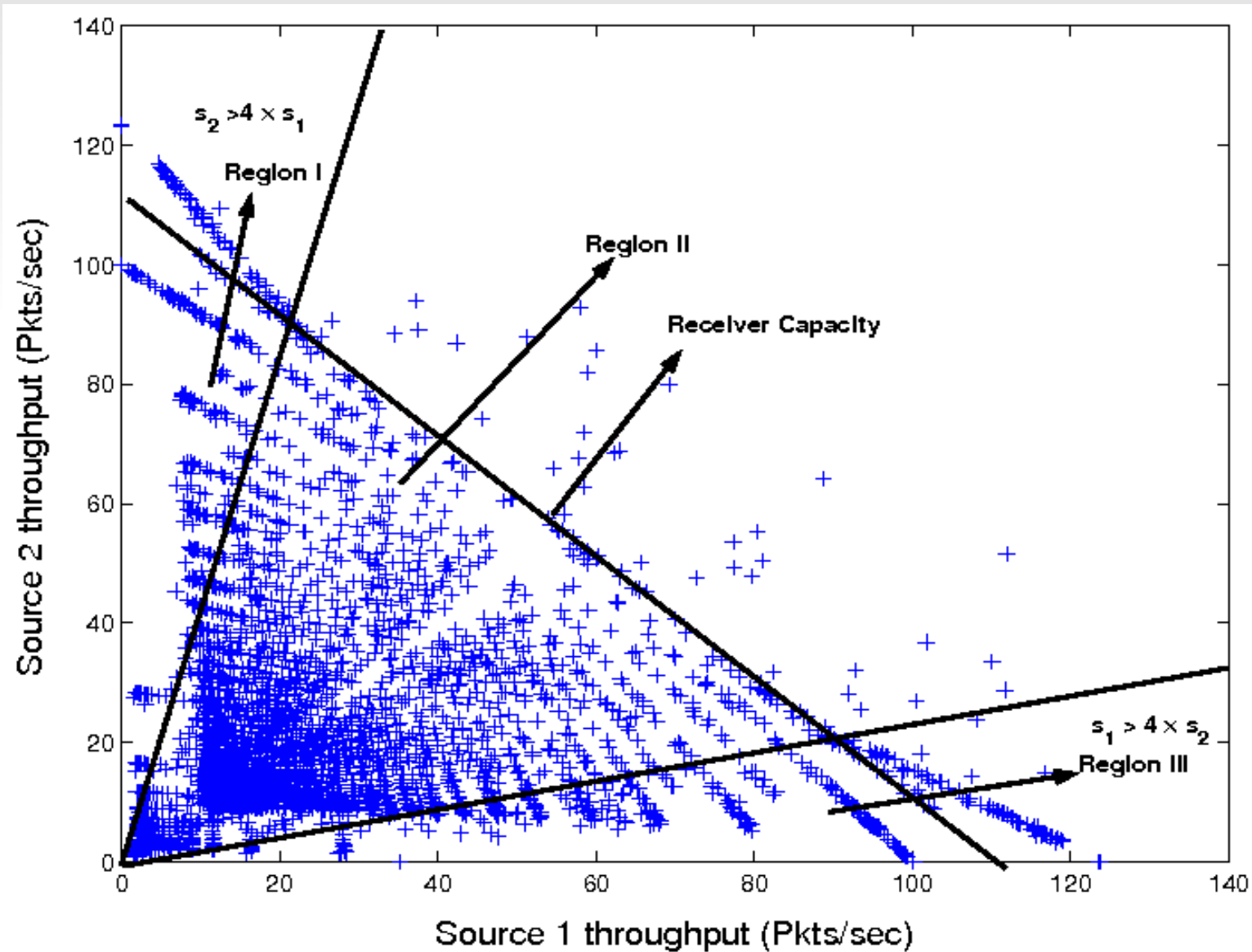
Link capacitated vs Node capacitated



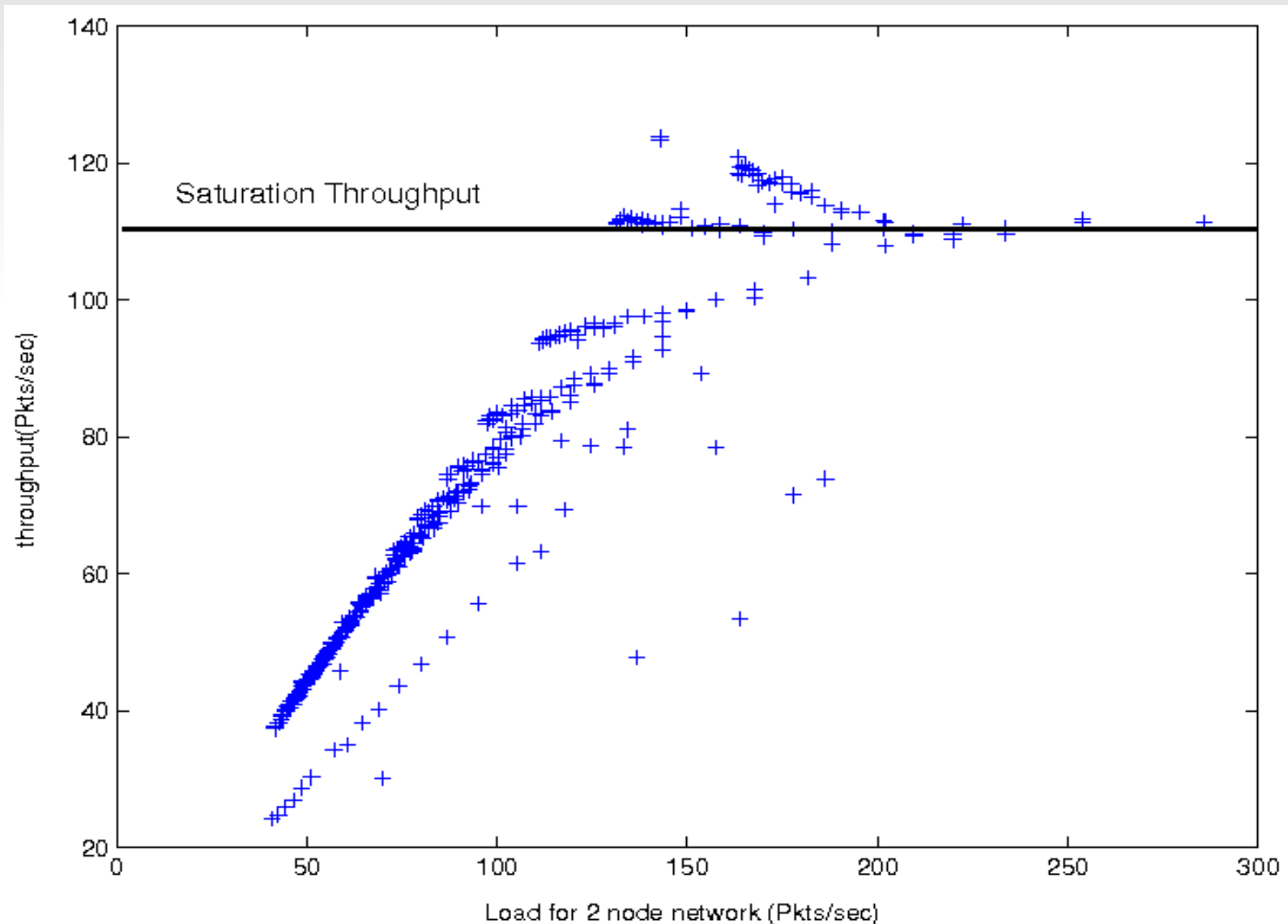
How does a linear capacity region help ?



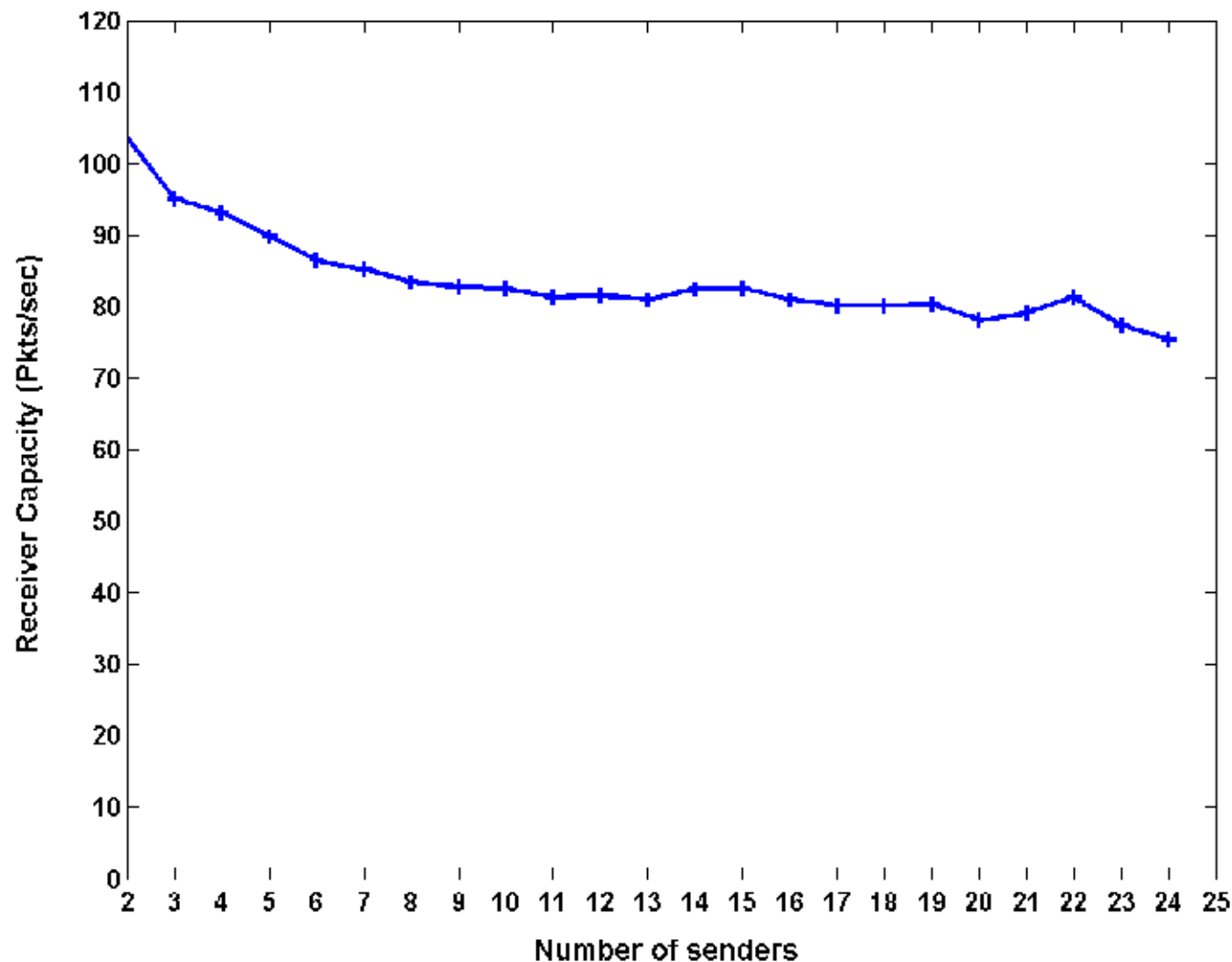
How does the capacity region for TinyOS CSMA look ?



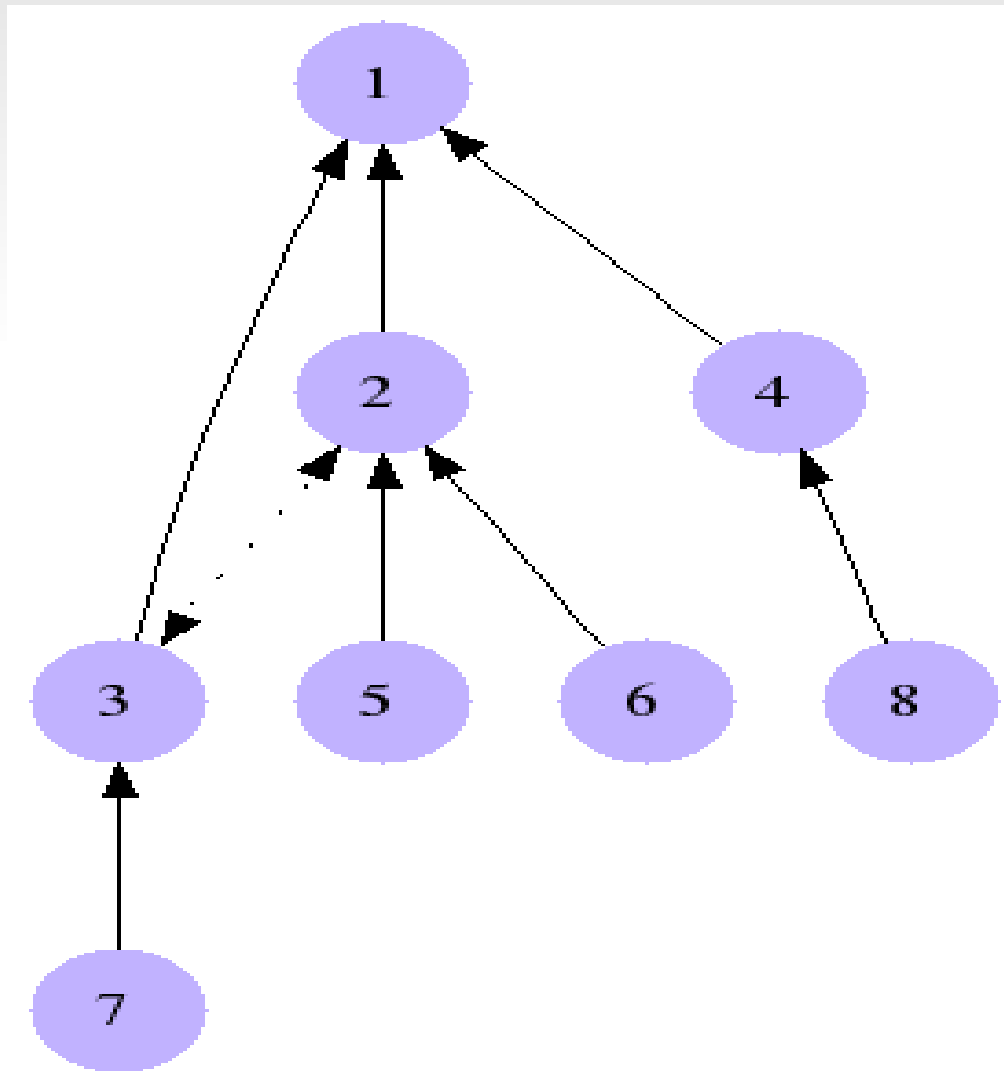
What does the boundary of the capacity region mean ?



Why should it hold for Multiple senders



Using receiver capacity to achieve fair rate allocation



$$Flow_2 = \frac{B_2}{5}$$

$$Flow_8 = \frac{B_2}{5}$$

$$Flow_3 = \frac{B_2}{5}$$

$$Flow_3 = \frac{B_2}{5}$$

$$Flow_4 = \frac{B_4}{2}$$

$$Flow_5 = \frac{B_2}{5}$$

$$Flow_6 = \frac{B_2}{5}$$

The WRCP Algorithm

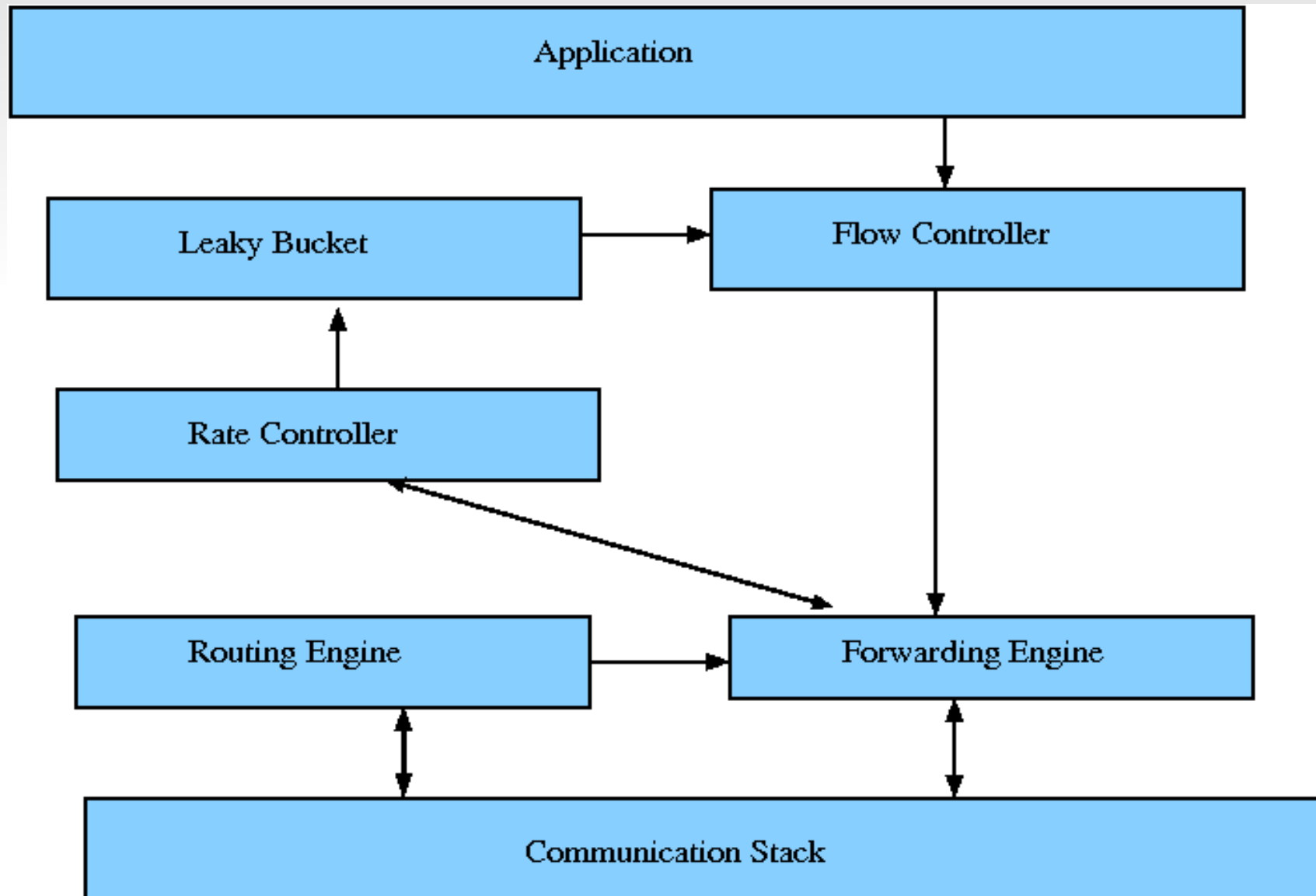
- Every T seconds calculate the following
 - Receiver capacity.
 - Nodes transmission rate.
 - All the neighbors transmission rates (including children).
 - Total number of flows
- Calculate the available flow capacity using the above quantities.

$$\text{per flow available capacity} = \frac{(\text{capacity} - \text{TxRate} - \sum_i^j \text{TxRate}_j)}{(\text{Total number of flows})}$$

- Choose between our available flow capacity and your neighbors available flow capacity, which ever is minimum
- Update Per Flow Rate using:

$$\text{per flow rate} = \text{per flow rate} + \alpha * \text{minimum available capacity}$$

Software Architecture



WRCP Implementation Challenges

- Bootstrapping WRCP
- Calculating Transmission Rates.
- Maintaining SOFT STATES.
- Dampening oscillations at convergence.

Bootstrapping WRCP

- Question :
 - What is rate that the per flow rate of source should be initialized to ?
- Answer:
 - Set it to the parents rate.

Calculating Transmission Rates

- We do not want long term averages. Inflexible to dynamics.
- Lets maintain a moving average:
$$currTxRate = \beta * (instTxRate) + (1 - \beta) * (currTxRate)$$
- Calculating instantaneous rate:
$$instTxRate = \frac{pktCnt}{beaconTime}$$

Maintaining Soft States

- Problem: Links can be bad. What do you do if you receive one packet from a node and then never hear from it ?
- Solution: age out the entry

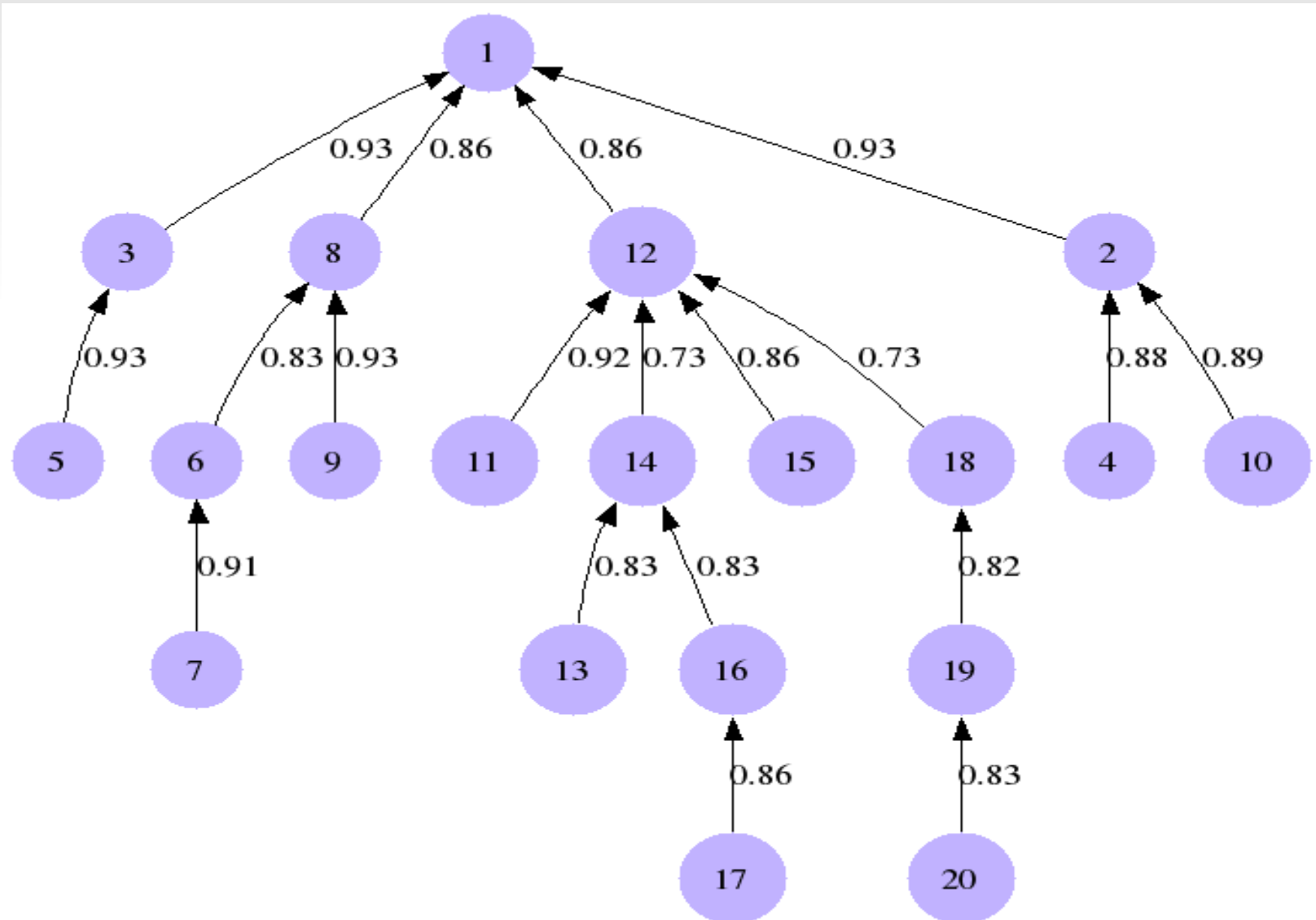
Dampening Oscillations

- As WRCP approaches optimal it might overshoot the optimal. This might lead to oscillations
- Once optimal has been crossed enforce a band to allow for changes.
- The rate of increment before optimal is reached and after optimal is reached should be different.

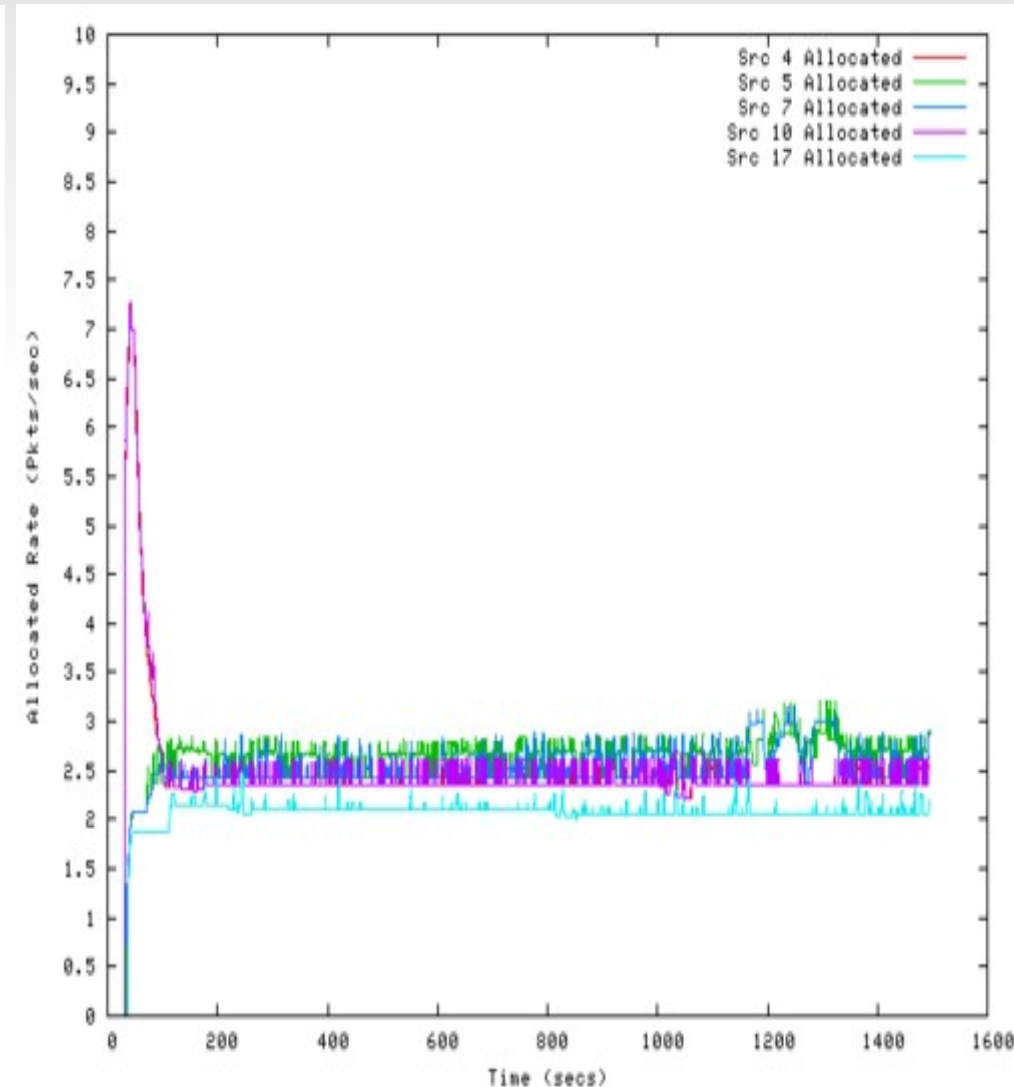
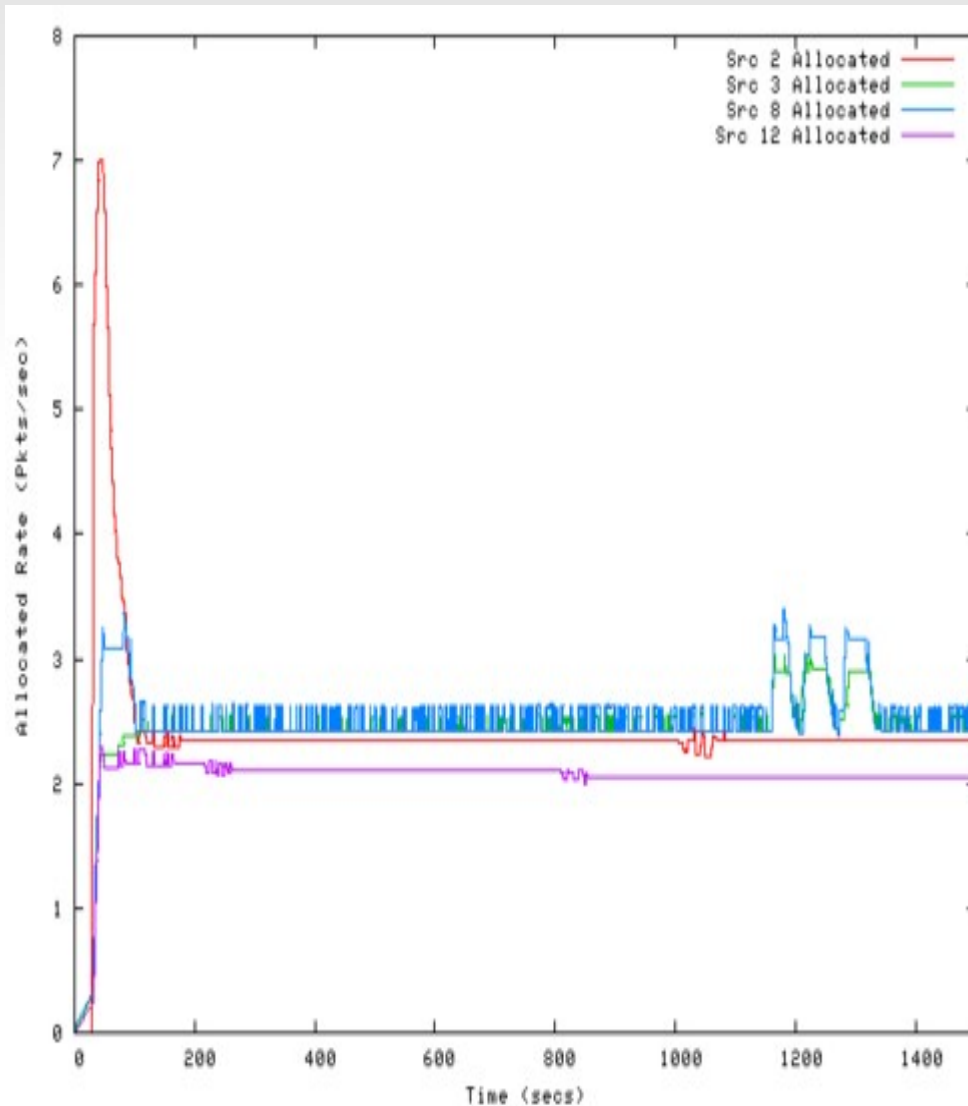
A summary of Parameters affecting WRCP

- α : Parameter used to increment and decrement the per flow rate.
- β : The exponent used to maintain the exponential moving average of the current transmission rate.
- WRCP update time: Interval used to update the available capacity.

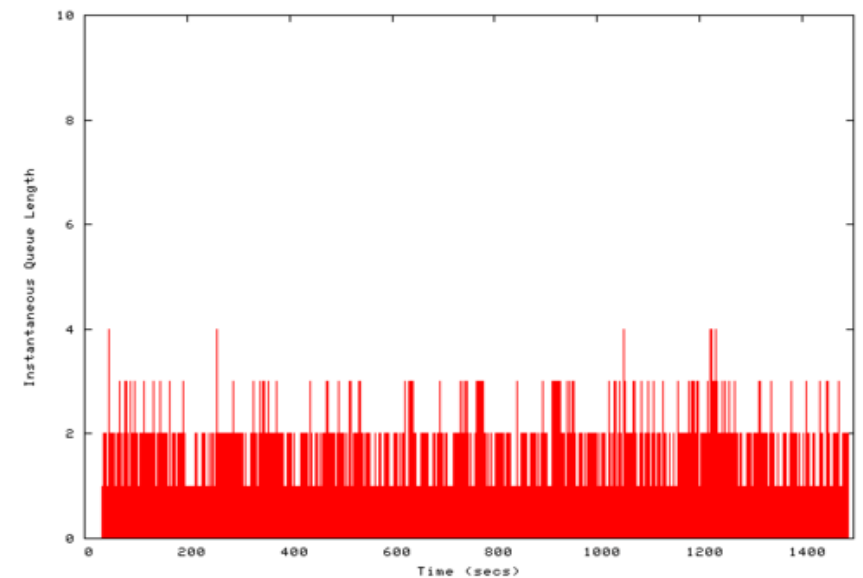
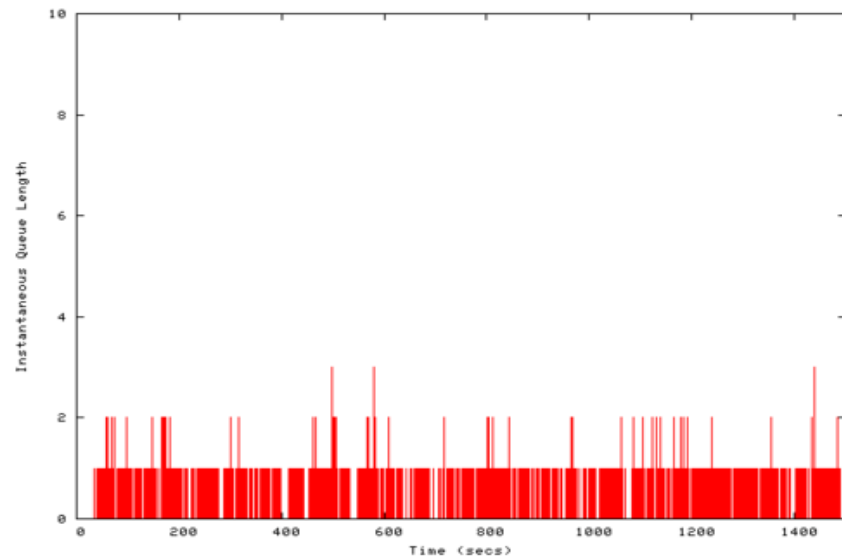
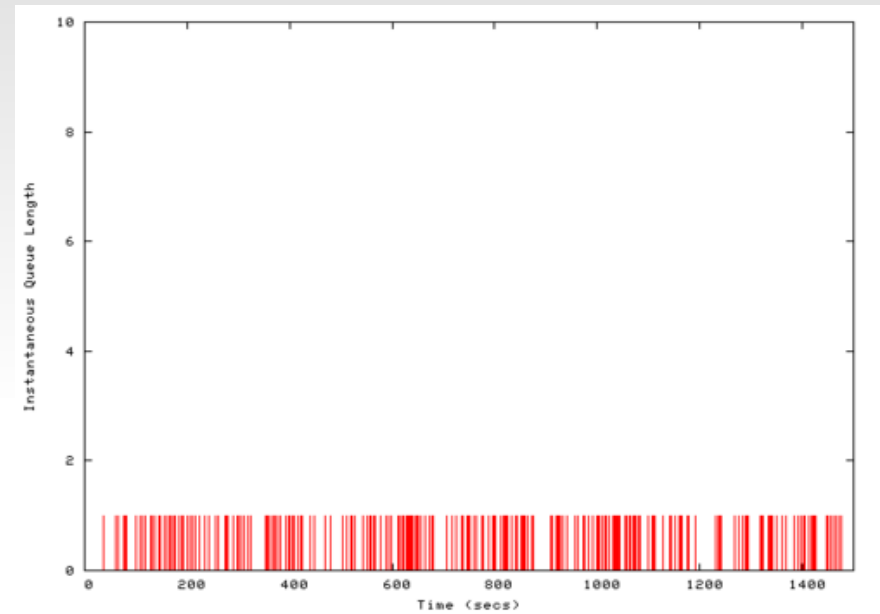
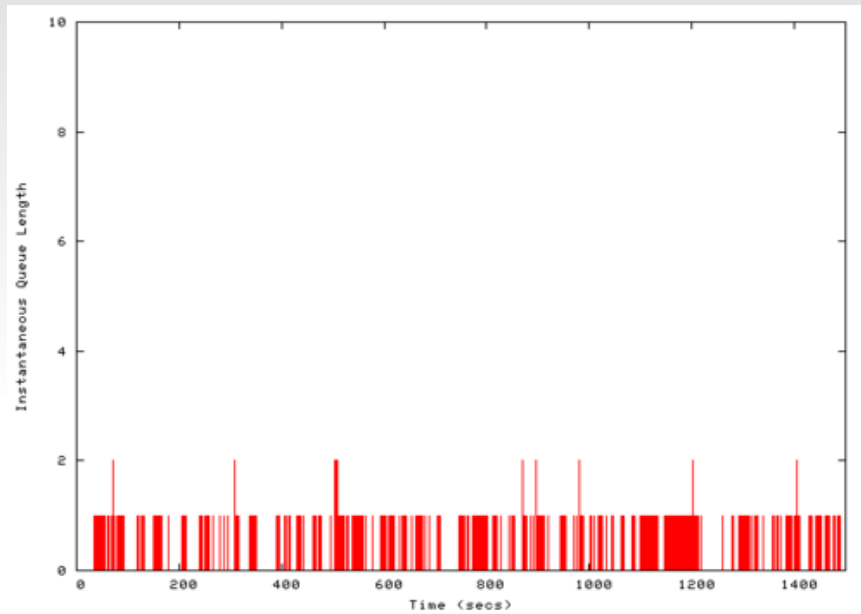
Experiments



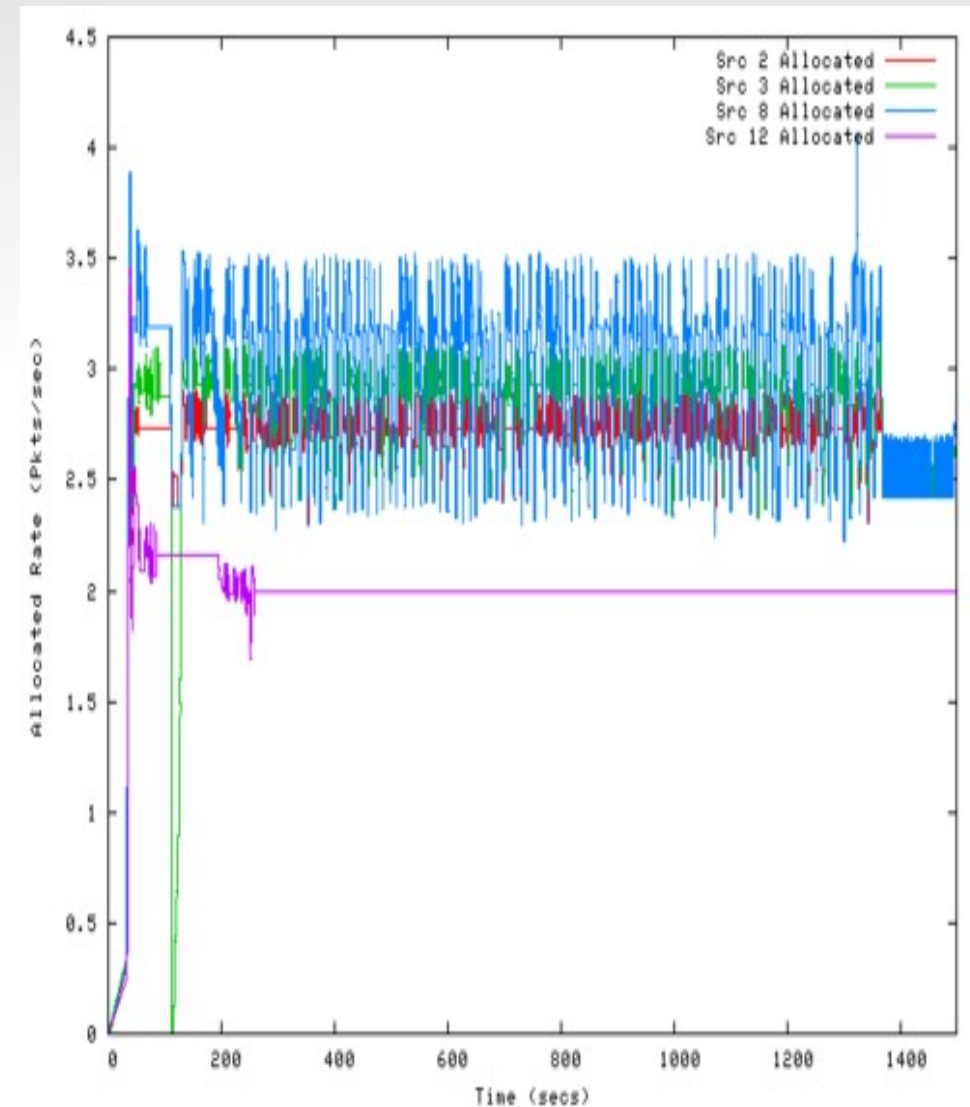
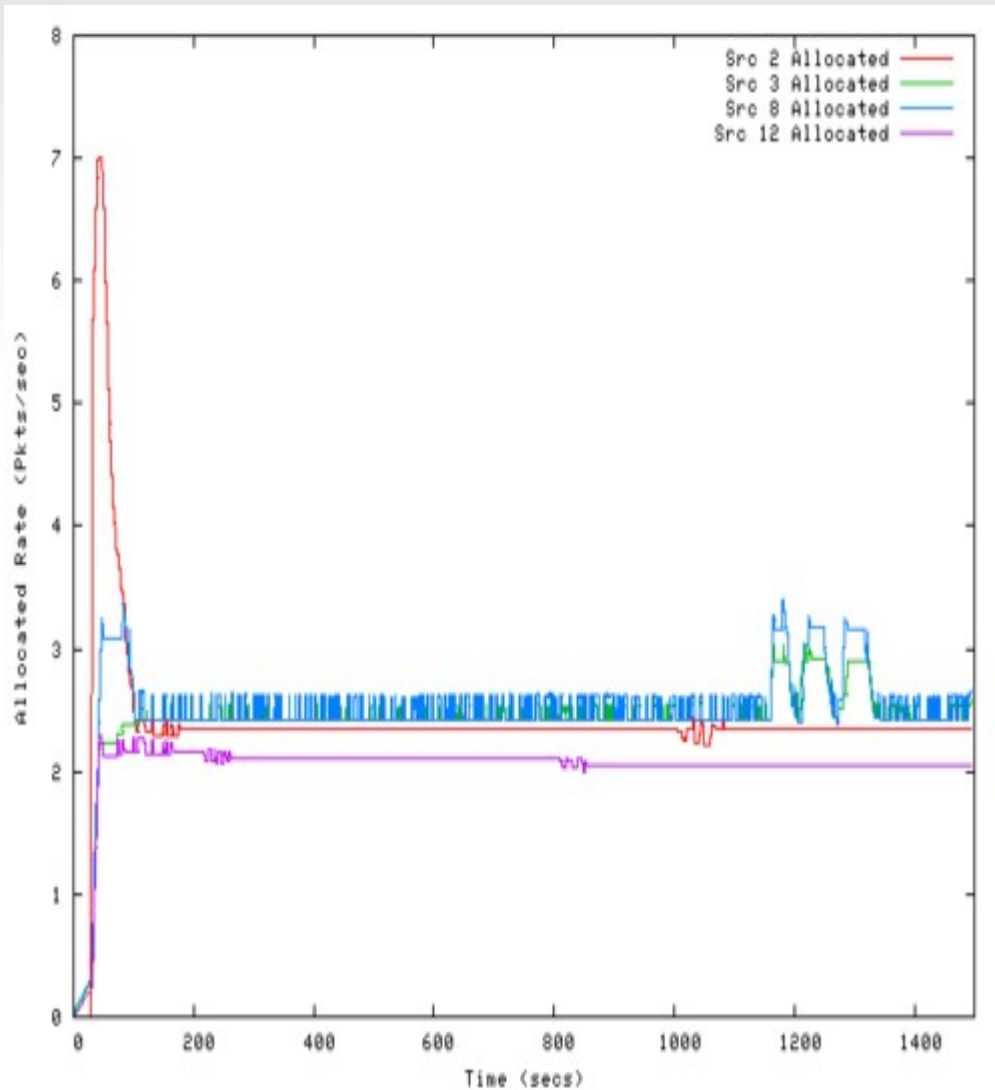
Performance with best parameter settings



Queue backlogs



The effect of varying WRCP update Time



Things to do

- How optimal is our optimal ?
- IFRC comparison on 2.x ?
- See the behavior on larger topologies.
- We need to see the affect of delays with parameter variation.