IKN
Institut für
Kommunikationsnetze

Performance Comparison of RPR MAC Protocols

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Proposed fairness mechanisms for RPR

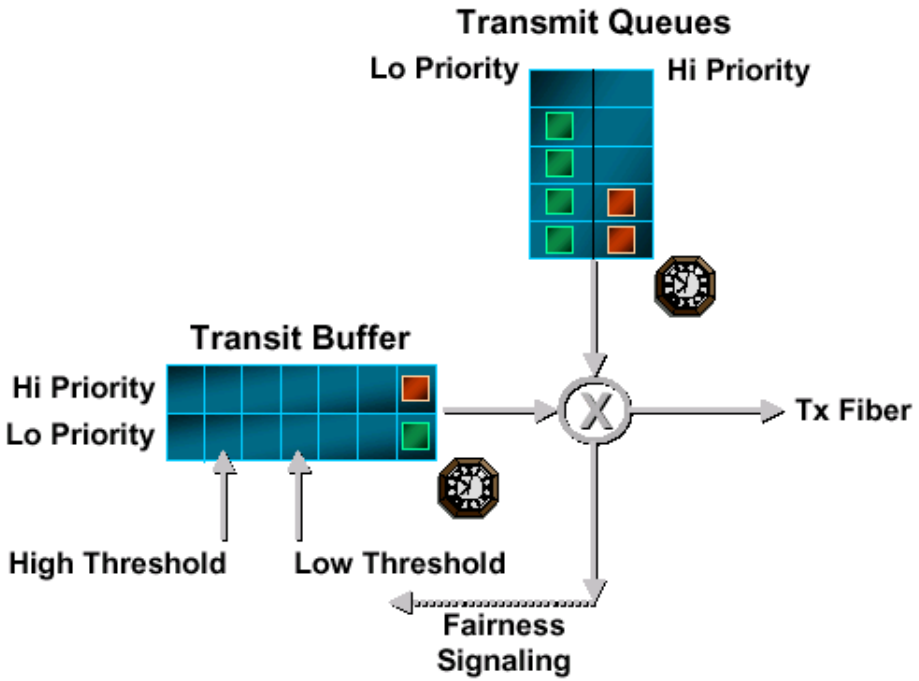
Reactive:
- Back pressure (Cisco, Nortel)
- Signalling to upstream node (Dynarch, Fujitsu)

Pro-reactive:
- Control cycle with credit-based rates (Lantern, Vienna Univ: of Technology)
- Control cycle with reservation-based rates (Vienna Univ: of Technology)

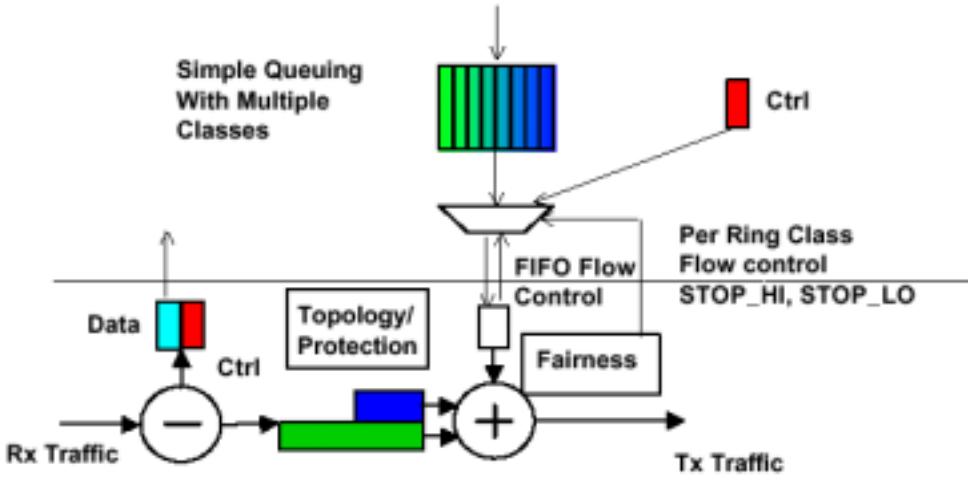
Hop-by-hop scheduling (Luminous)

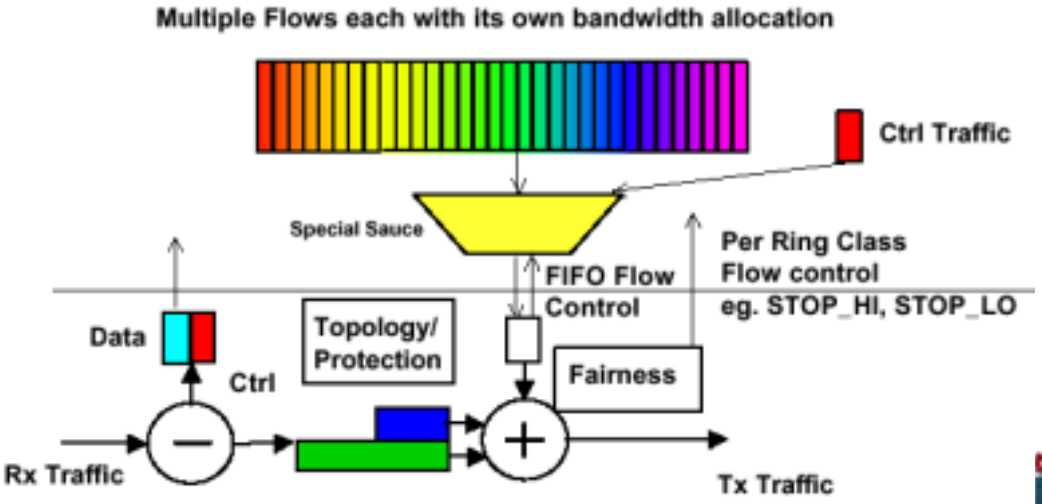
Transmit Packet Handling

Priority handling
Transmit decision algorithm
Fairness



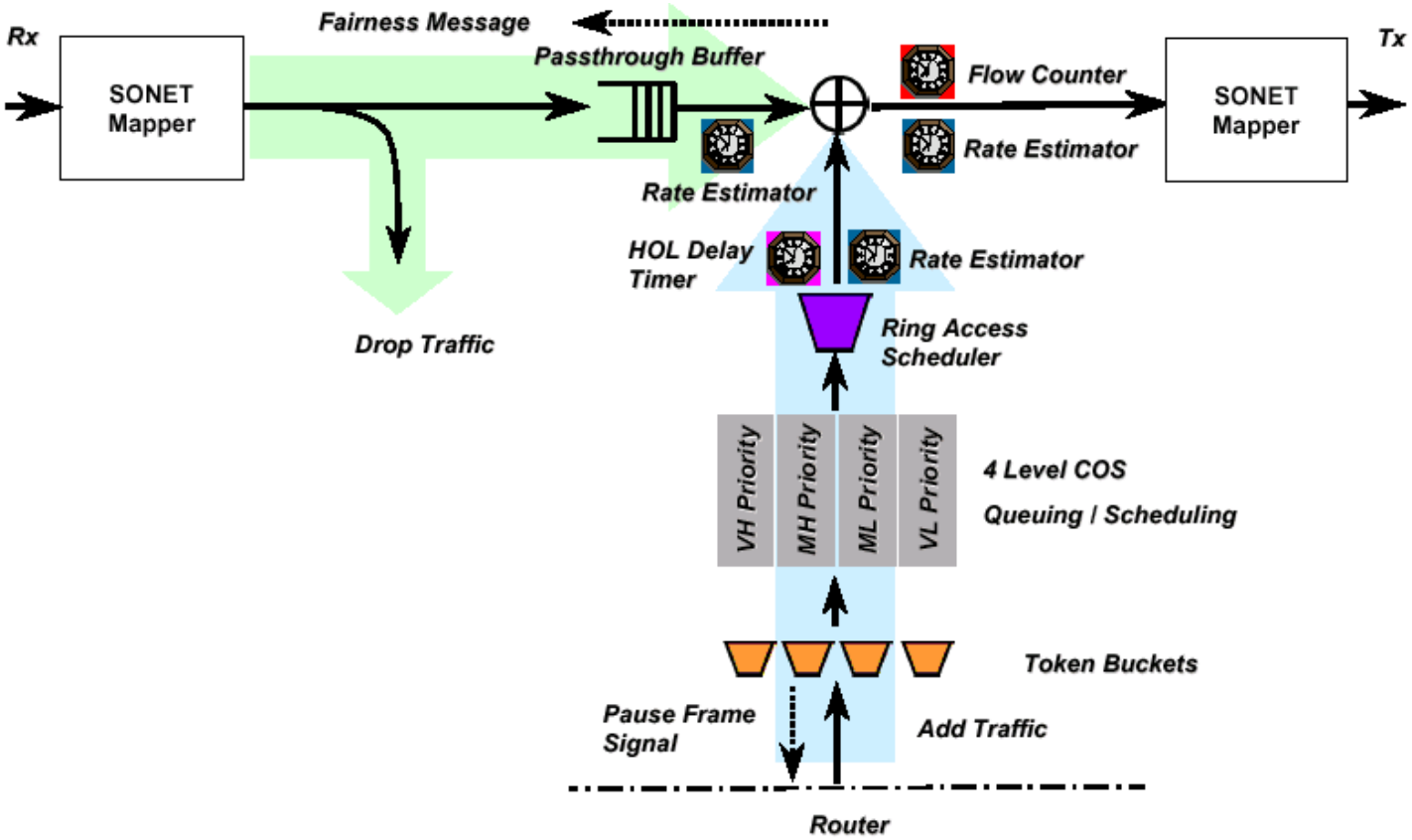
RPR MAC Model





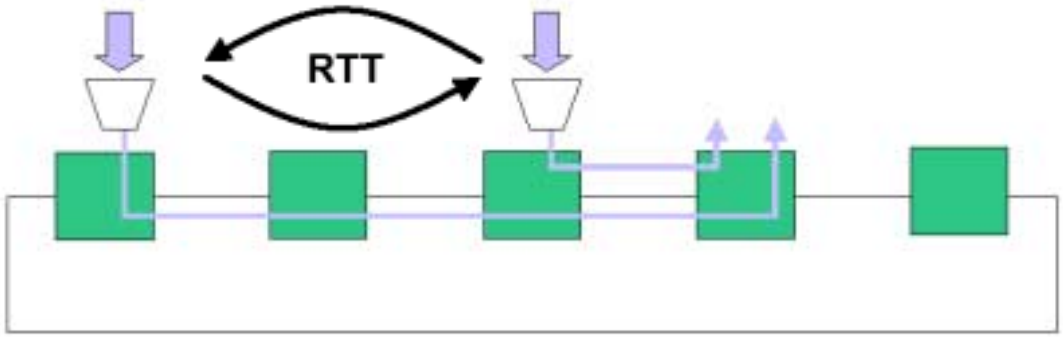
IEEE March 2000

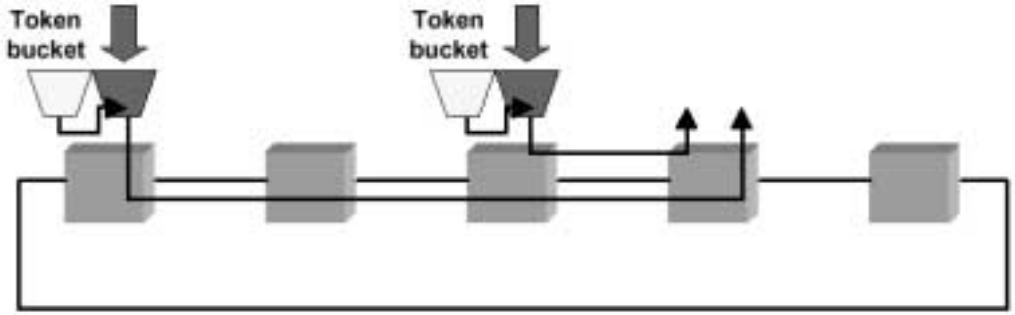
iPT Fairness Controlled Access Protocol



IEEE May 2000

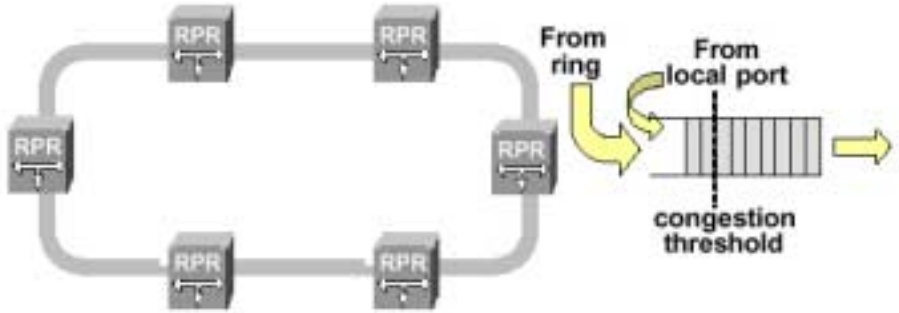
Distributed resource management



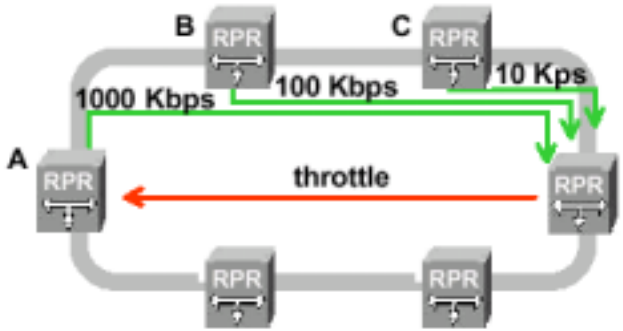


DYNARC

Congestion management and fairness parameters



Best Effort Model
Throttle individual sender



rate cache (per CUG)

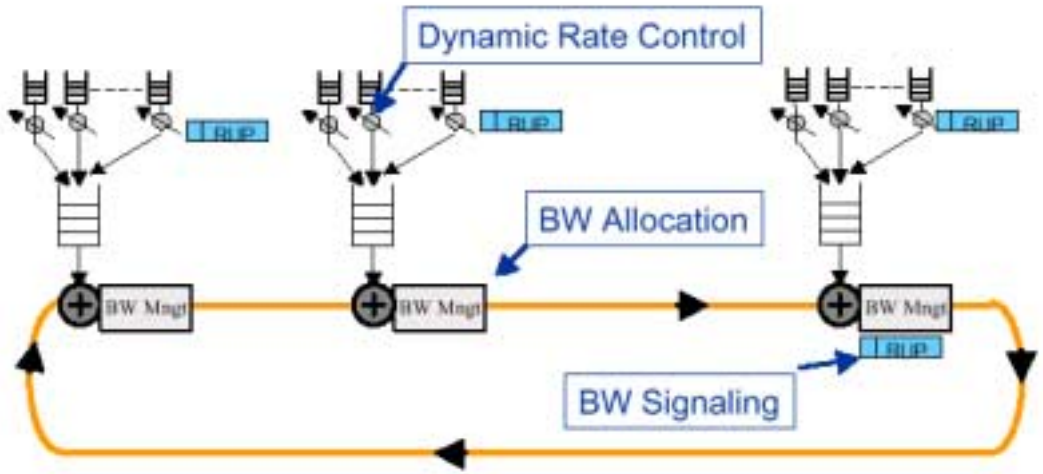
sender	rate
A	1000
...	...
...	...
B	100
...	...
...	...

C

FUJITSU

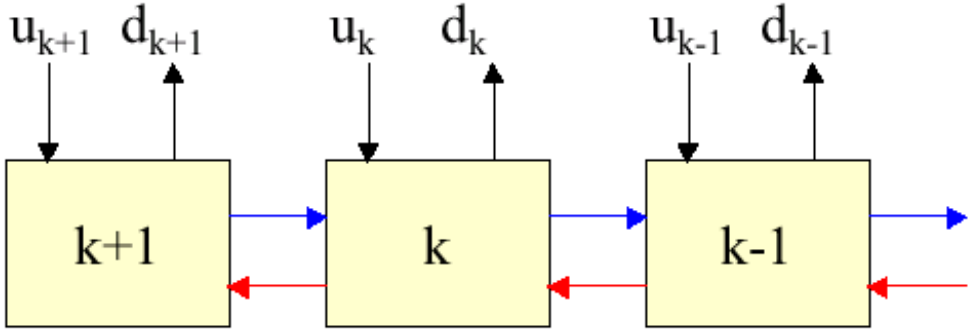
THE POSSIBILITIES ARE INFINITE

Ring Access Control

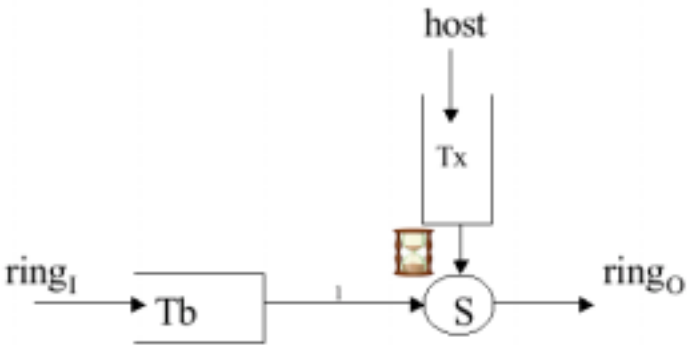


- **WFQ Model of bandwidth allocation**
- **Support per-SLA QoS guarantee**
- **No upstream unfairness (BW, delay, Jitter)**
- **High utilization (> 95% per link)**
- **100% spatial reuse**
- **Scalable (#nodes, #rings, # customers)**
- **Simple and *robust* (aggregate) congestion control signaling**

Congestion management and fairness parameters

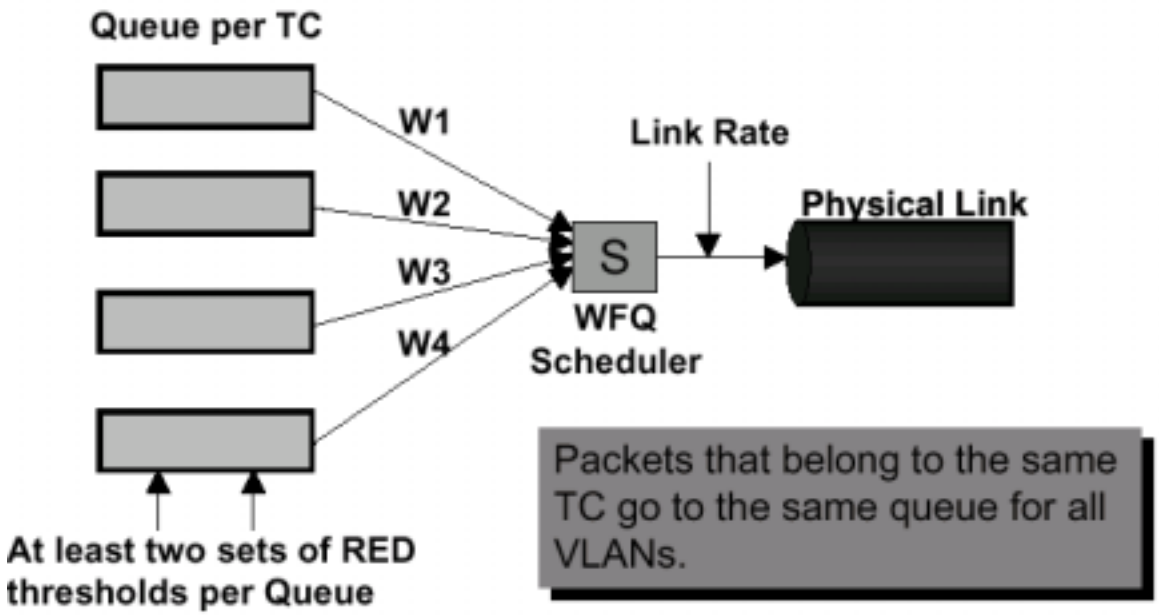


u_k : actual usage (sourced traffic rate) of node k
a_k : allowed usage (sourced traffic rate) of node k
d_k : drop traffic rate at node k
f_k : actual forward rate from node k+1 to node k-1
u_{max_k} : maximum provisioned usage rate factor for node k
u_{max} : maximum provisioned usage rate factor of downstream node
u : usage value received from downstream node



AuroraNetics, Inc.

DiffServ Switch



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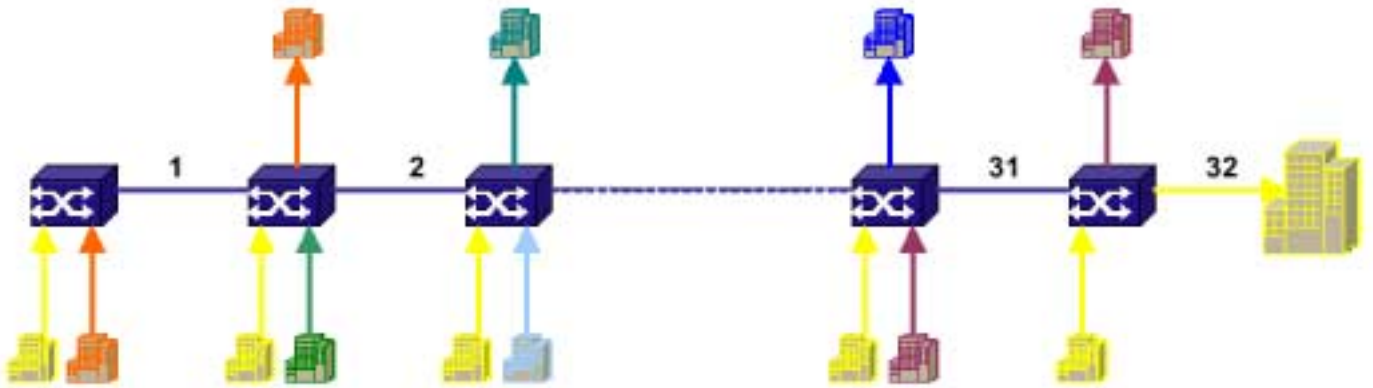
Juha Heinanen

DiffServ Operation



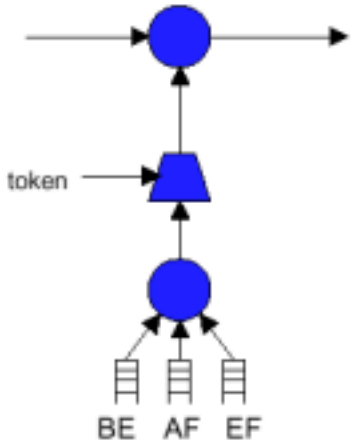
Per hop Behavior

- Expedited Bandwidth
- Assured Bandwidth
- Best Effort

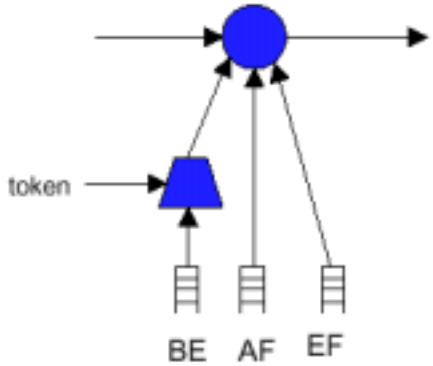
Waited fair queueing

LUMINOUS NETWORKS

Nortel OPE-RPR Ring



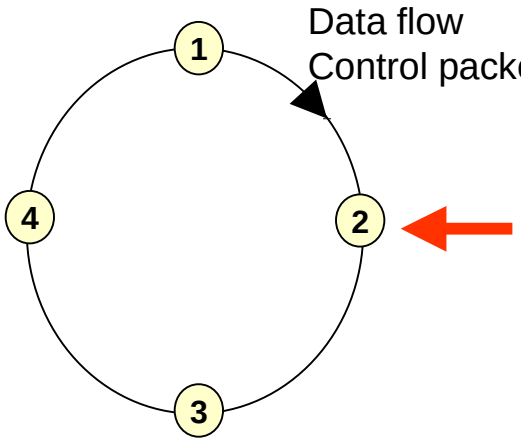
1-add



3-add

Fairness mechanism (2)

Example with single ring



Coordinated table values
In node 2

Cycle i-1

Flow	High	Low
1 -> 2	H12	B12
1 -> 3	H13	B13
1 -> 4	H14	B14
2 -> 3	H23	B23
2 -> 4	H24	B24
2 -> 1	H21	B21
3 -> 4	H34	B34
3 -> 1	H31	B31
3 -> 2	H32	B32
4 -> 1	H41	B41
4 -> 2	H42	B42
4 -> 3	H43	B43

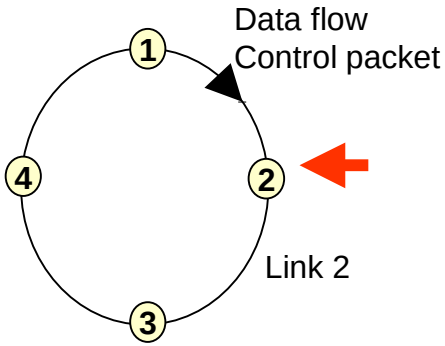
Old table in node 2

Cycle i

Flow	High	Low
1 -> 2	H12	B12
1 -> 3	H13	B13
1 -> 4	H14	B14
2 -> 3	H23	B23
2 -> 4	H24	B24
2 -> 1	H21	B21
3 -> 4	H34	B34
3 -> 1	H31	B31
3 -> 2	H32	B32
4 -> 1	H41	B41
4 -> 2	H42	B42
4 -> 3	H43	B43

New table in node 2

Fairness mechanism (3)



Cycle i-1

Flow	High	Low
1 -> 2	H12	L12
1 -> 3	H13	L13
1 -> 4	H14	L14
2 -> 3	H23	L23
2 -> 4	H24	L24
2 -> 1	H21	L21
3 -> 4	H34	L34
3 -> 1	H31	L31
3 -> 2	H32	L32
4 -> 1	H41	L41
4 -> 2	H42	L42
4 -> 3	H43	L43

Old table in node 2

Cycle i

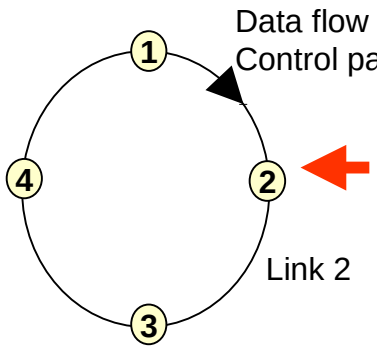
Flow	High	Low
1 -> 2	H12	L12
1 -> 3	H13	L13
1 -> 4	H14	L14
2 -> 3	H23	L23
2 -> 4	H24	L24
2 -> 1	H21	L21
3 -> 4	H34	B34
3 -> 1	H31	B31
3 -> 2	H32	B32
4 -> 1	H41	B41
4 -> 2	H42	B42
4 -> 3	H43	B43

New table in node 2

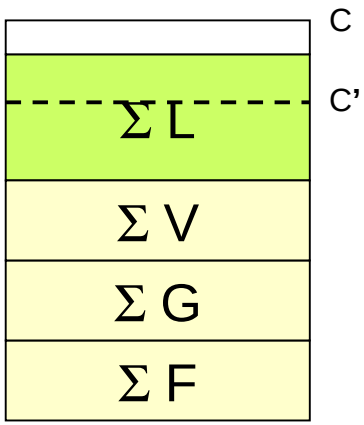
Actions in node 2:

- Determine fairness on link 2
  - Correct flows H13, H14
    H23, H24, H21, H43
  - Correct flows L13, L14
    L23, L24, L21, L43
- Determine total amount of coordinated capacity over link 2
- Write new demand of node 2 into control packet
- Send control packet to next node at the scheduled time
- Transmit coordinated flows H23, H24, H21, L23, L24, L21
- Refrain from transmission during rest of the coordinated capacity
- Transmit by immediate access according to the stored rates for each destination

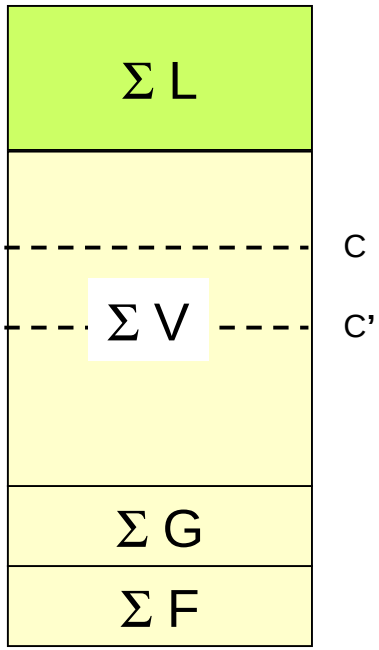
Fairness mechanism (4)



Σ L : all low-traffic flows
Σ V : all non-guaranteed high-traffic flows
Σ G : all guaranteed high-traffic flows
Σ F : all CBR traffic flows
$V_i = H_i - G_i$: variable part of high-priority traffic flow



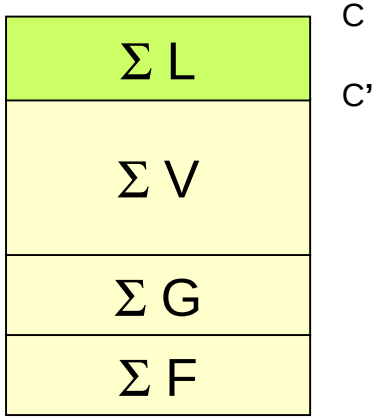
No correction



Link bottleneck
Correction required

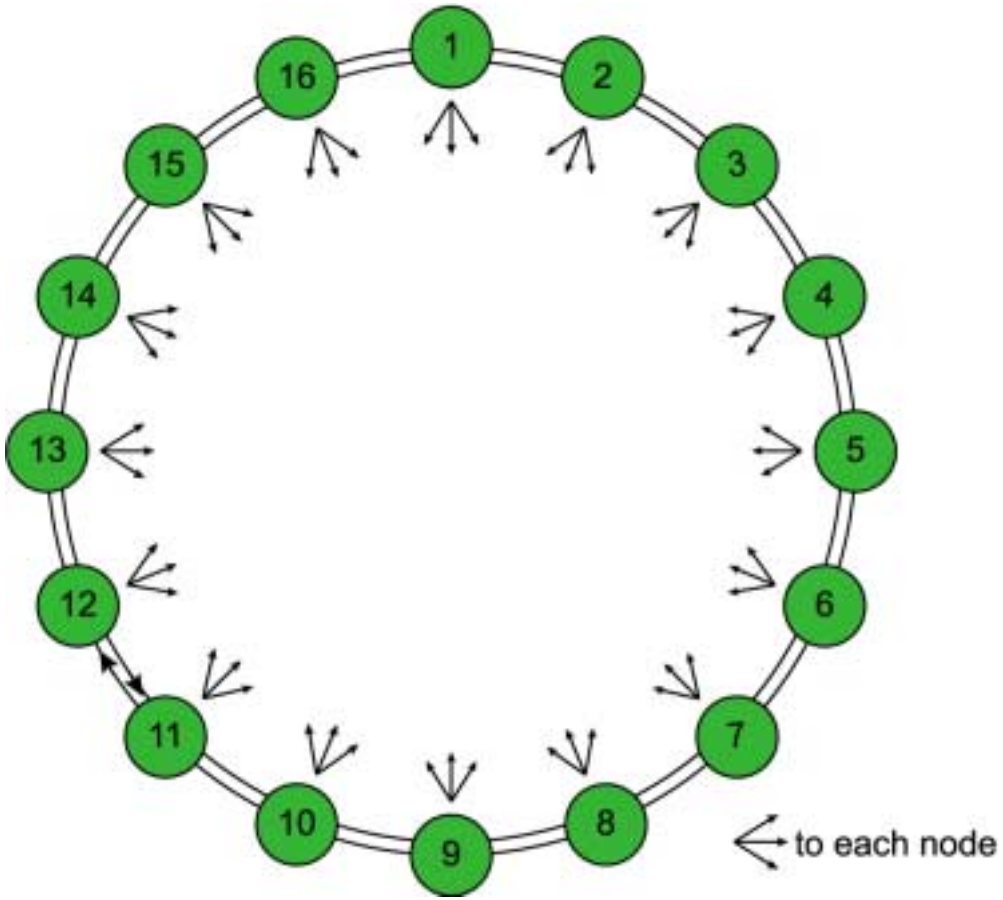
Link capacity C

C- C' is minimal capacity
for low priority when present



Link bottleneck
Coordinated flows

Dual-Ring - Traffic scenario 1

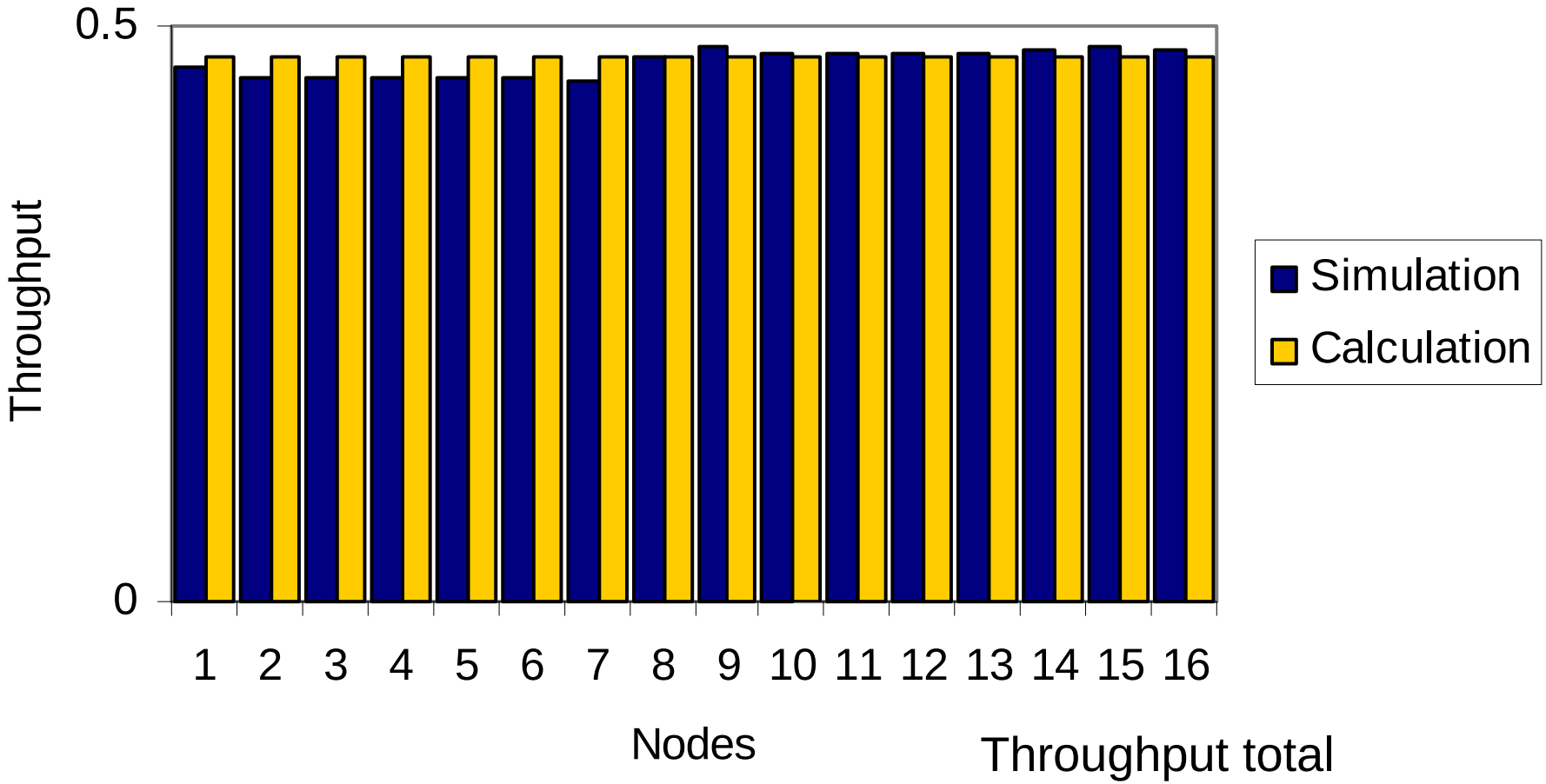


Uniform traffic
Saturated sources
16 nodes

Constant packets
8000 bits

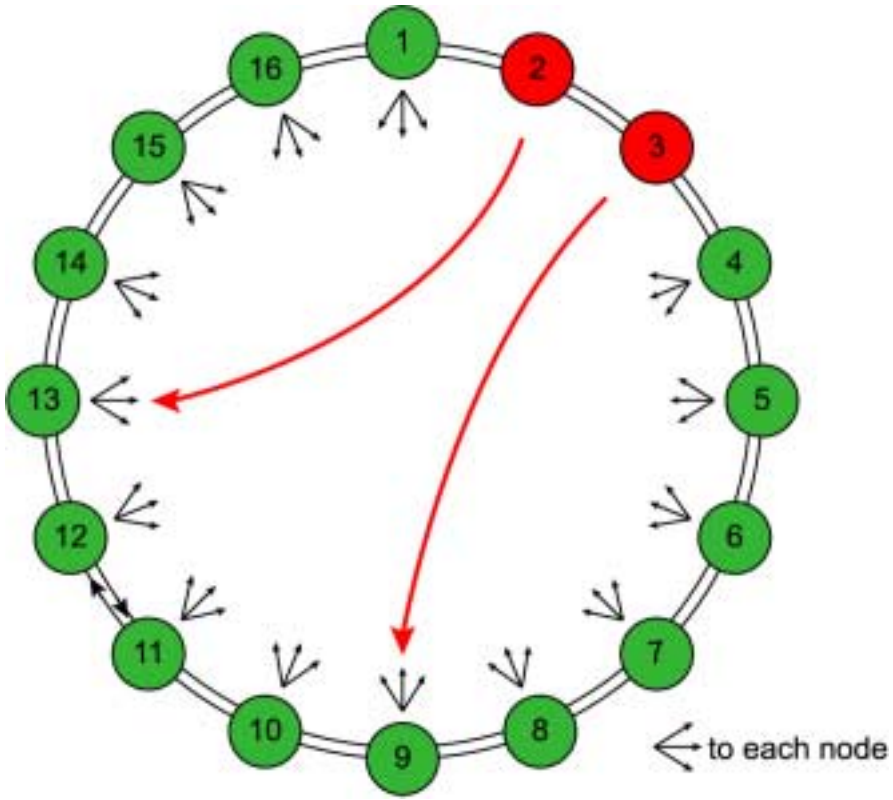
Cyclic reservation protocol

Dual-Ring - Traffic scenario 1



Throughput total
Simulation : 7.5
Calculation : 7.55

Dual-Ring – Traffic scenario 2

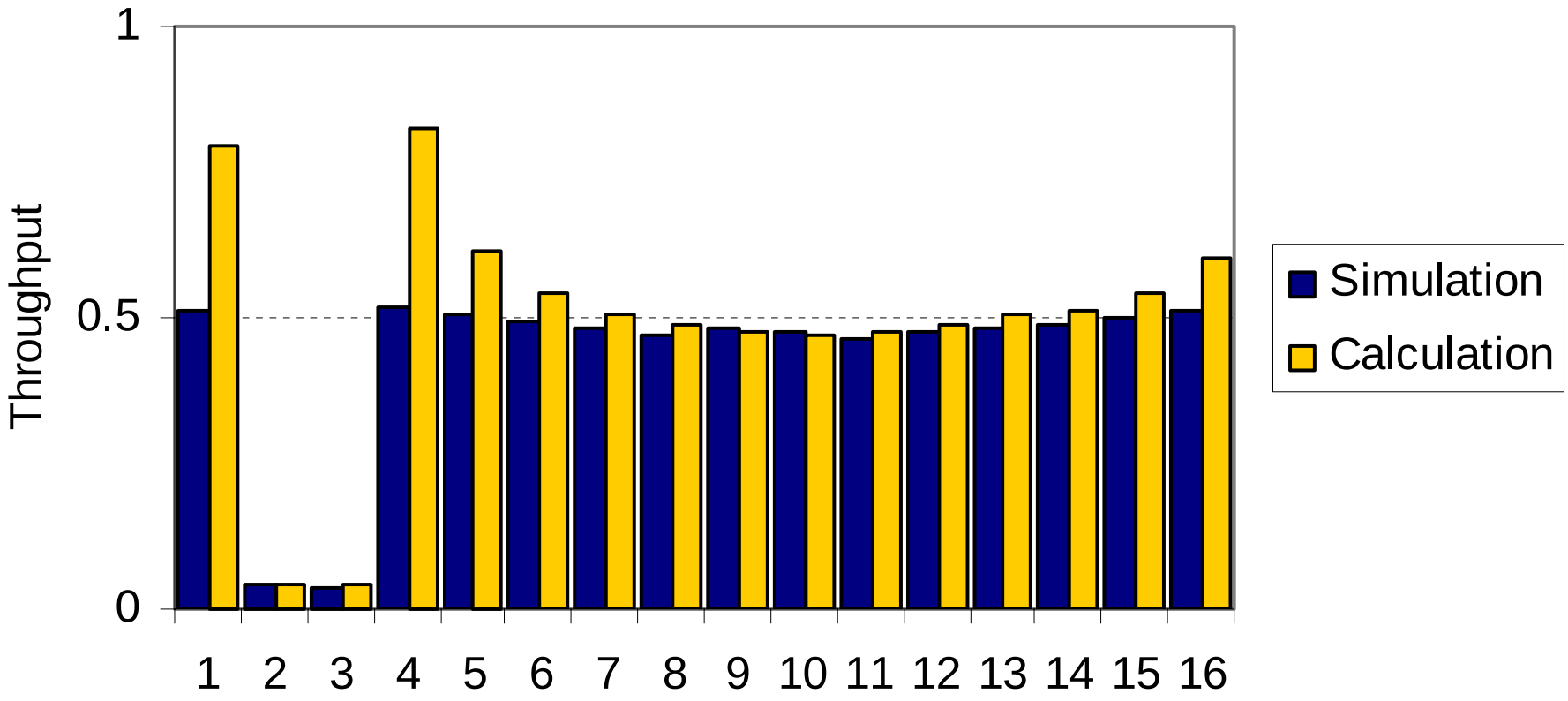


Uniform traffic
Saturated sources
16 nodes

Constant packets
8000 bits

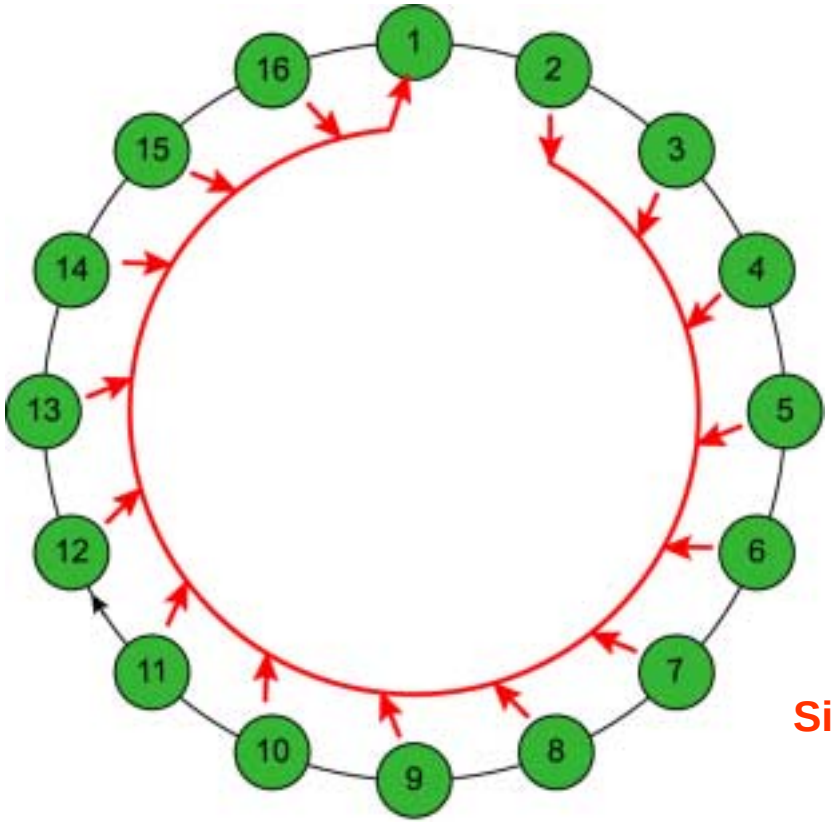
Cyclic reservation protocol

Dual-Ring – Traffic Scenario 2



Throughput total
Simulation : 6.9
Calculation : 7.9

Single Ring-Traffic scenario 3



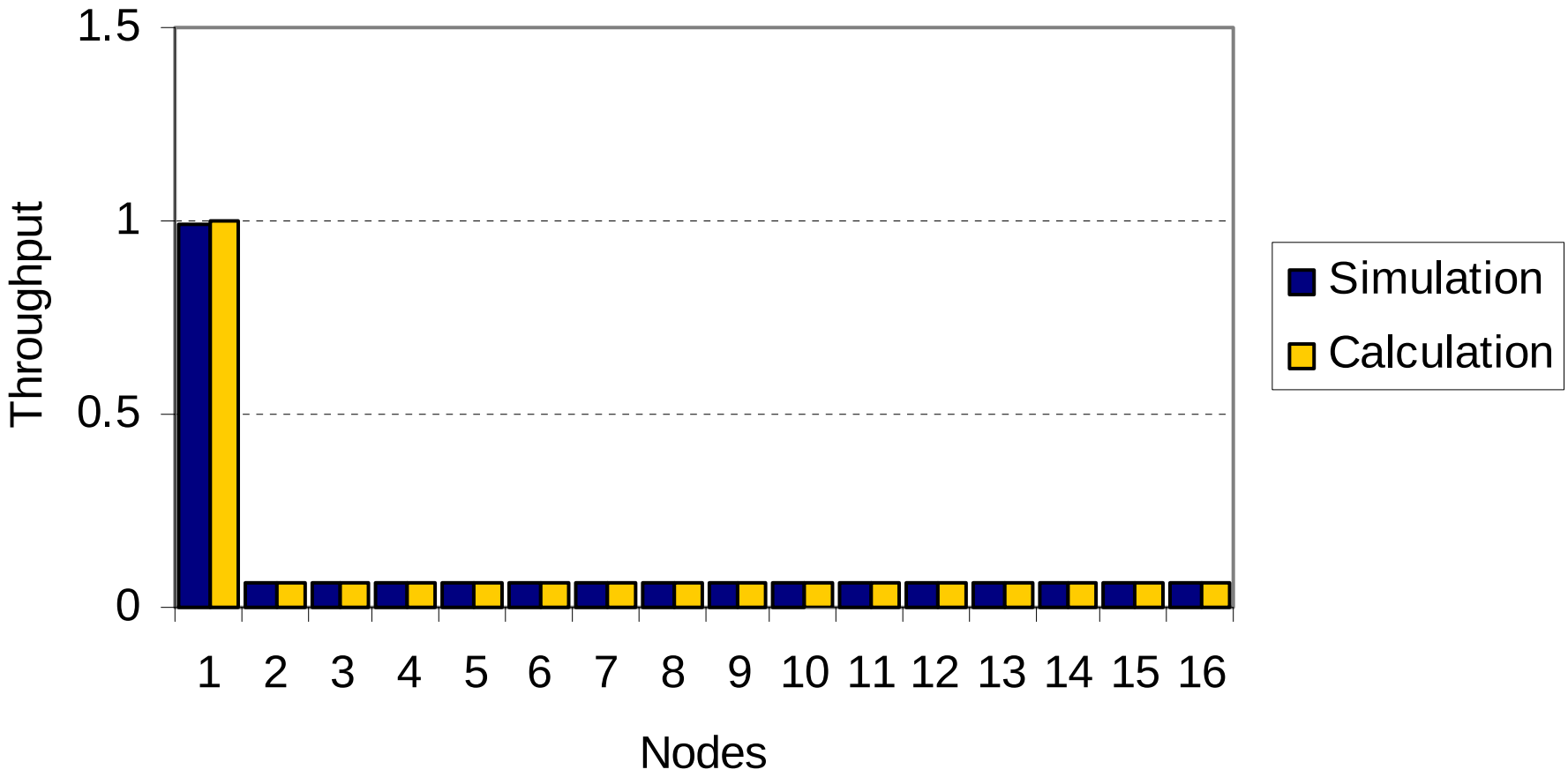
Single ring

Uniform traffic
Saturated sources
16 nodes

Constant packets
8000 bits

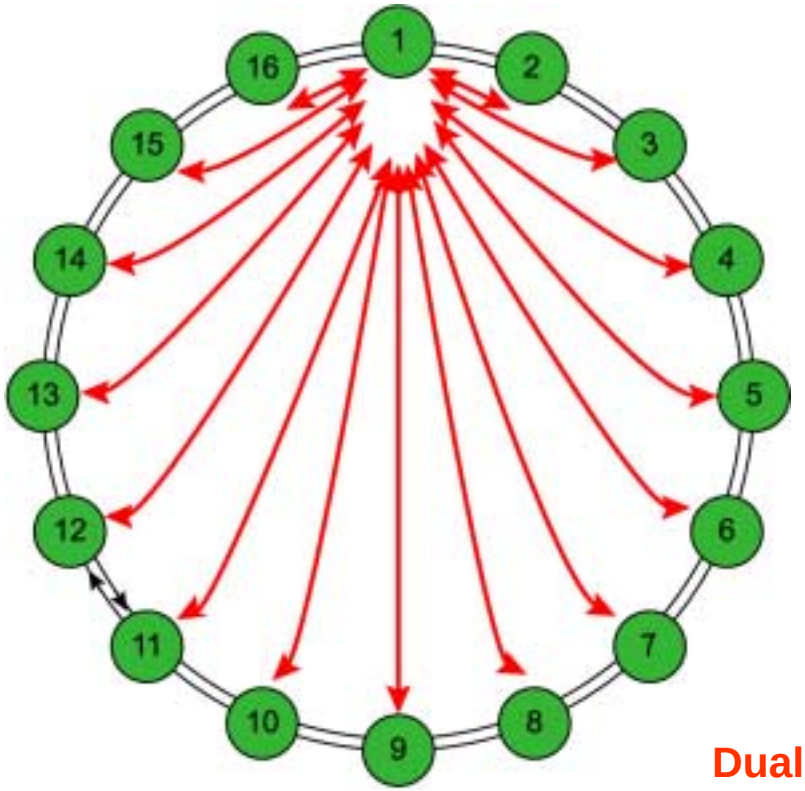
Cyclic reservation protocol

Single Ring-Traffic scenario 3



Throughput total
Simulation : 1.98
Calculation : 1.99

Dual-Ring – Traffic scenario 4



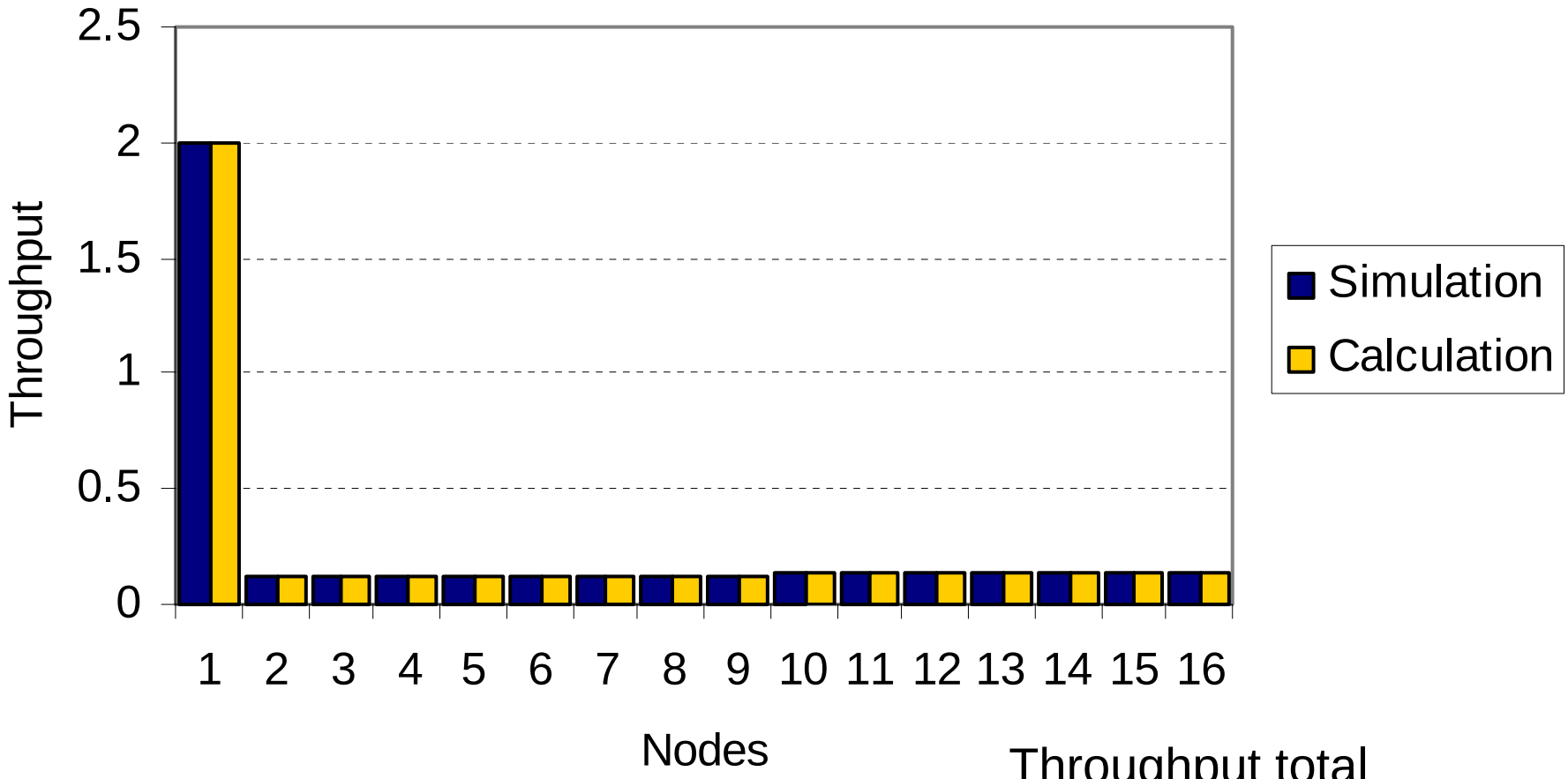
Dual ring

Uniform traffic
Saturated sources
16 nodes

Constant packets
8000 bits

Cyclic reservation protocol

Dual-Ring – Traffic scenario 4



Throughput total
Simulation : 3.98
Calculation : 3.99