Service Classes and RPR MAC Design

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Orlando

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Content

- Services and end-to-end delay
- MAC protocol and fairness
- Node structure, number of ring traffic classes
- Store-and-forward, cut-through, transmission scheduling
- Packet preemption
- Addressing

Services

Three traffic classes on the ring:

- Premium class (circuit emulation): guaranteed throughput, tight delay jitter
- High-priority packet switching: guaranteed throughput, bounded delay jitter
- Low-priority packet switching: best-effort

Further QoS traffic classes above MAC

Type of traffic

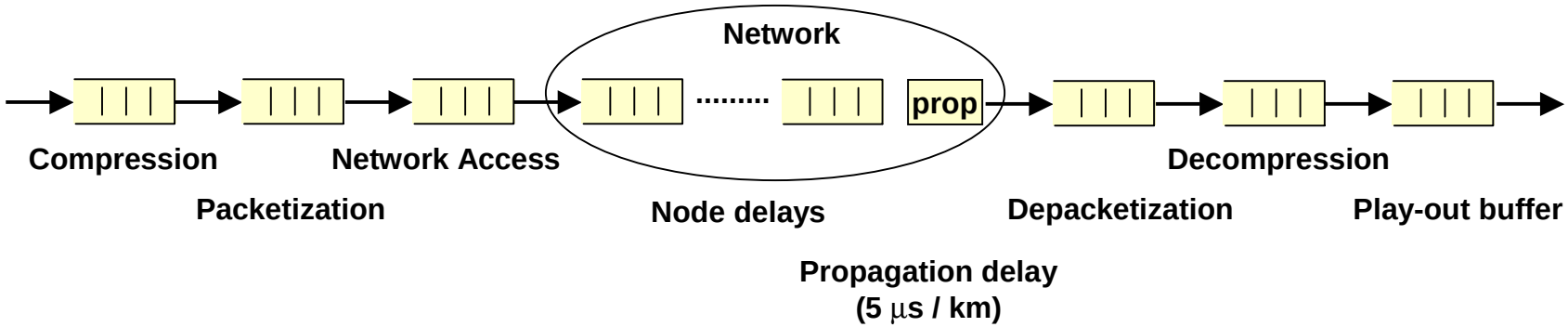
- Today: TCP-traffic dominant
- In future: shift to UDP-traffic (Voice-over-IP, multimedia-over-IP, high-speed applications with rate-control instead of window control)

Packet retransmissions

- no packet loss on ring, rejections only at the ingress nodes

Real-Time Connections

End-to-end delay components



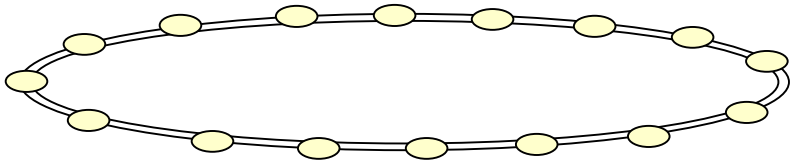
End-to-end delay requirement

- 80 ms allows natural interactive communication
- 100 -120 ms is tolerable
- Beyond 200 ms Conversation becomes cumbersome

End-to-end propagation delay determines remaining time of all delay components

Size of play-out buffer is given by maximal delay jitter

MAC-Protocol



Counter-rotating dual-ring
Destination removal (spatial reuse)

Purpose of MAC Protocol: coordination of medium access between distributed nodes that compete for transmission on that ring

Fairness protocol: Medium access control protocol to ensure that all competing nodes have fair access to the medium

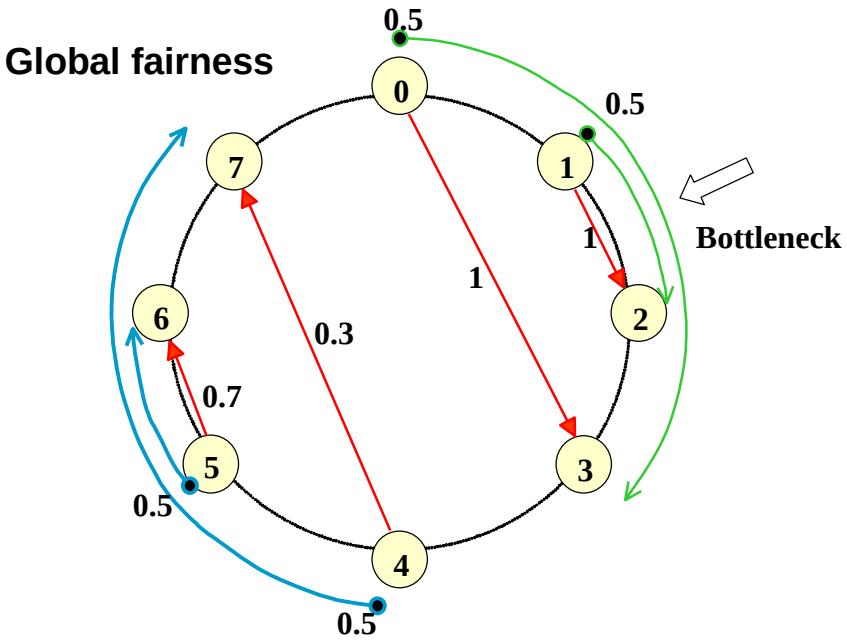
- Each ring is controlled independently
- Each traffic class is controlled independently

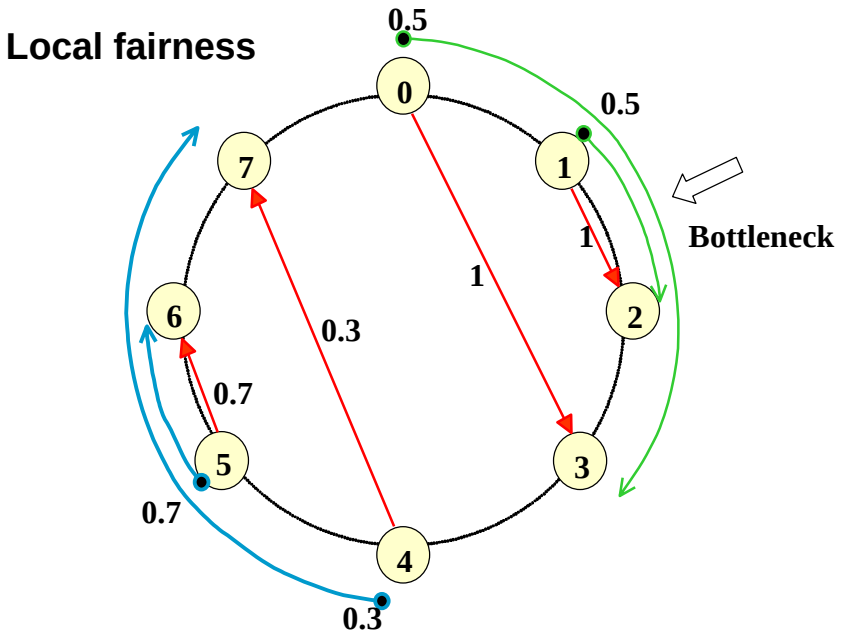
Fairness cycle: Constant or dynamic control period of the fairness mechanism

Fairness

Global fairness: Fairness based on a mechanism that allows nodes to share the same amount of the transmission capacity of the ring, independently whether their traffic interfere or not

Local fairness: Fairness based on a mechanism that coordinates ring access of only those nodes that interact during their packet transfer
Therefore, all nodes that do not interfere are not throttled in their performance





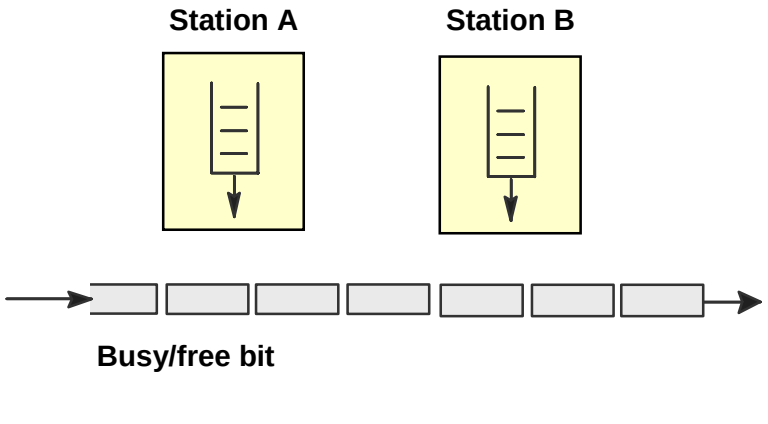
Fairness Protocol

Fairness protocol has to be standardized:

- How to monitor links
- Which commands
- Formats of commands
- What fairness criteria
- Determination of access rates per class
- Recovery scenarios in case of failures

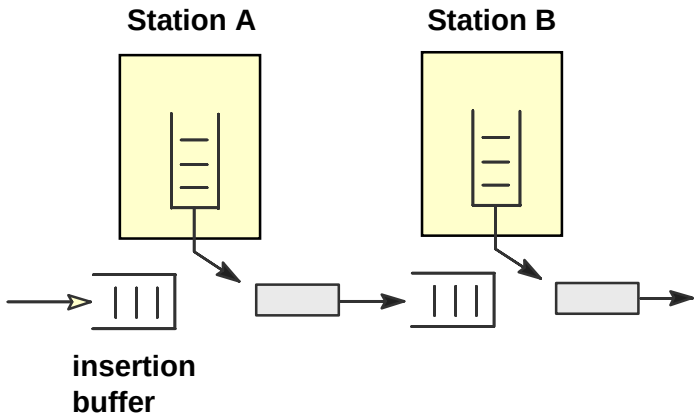
Simultaneous Access

Slots



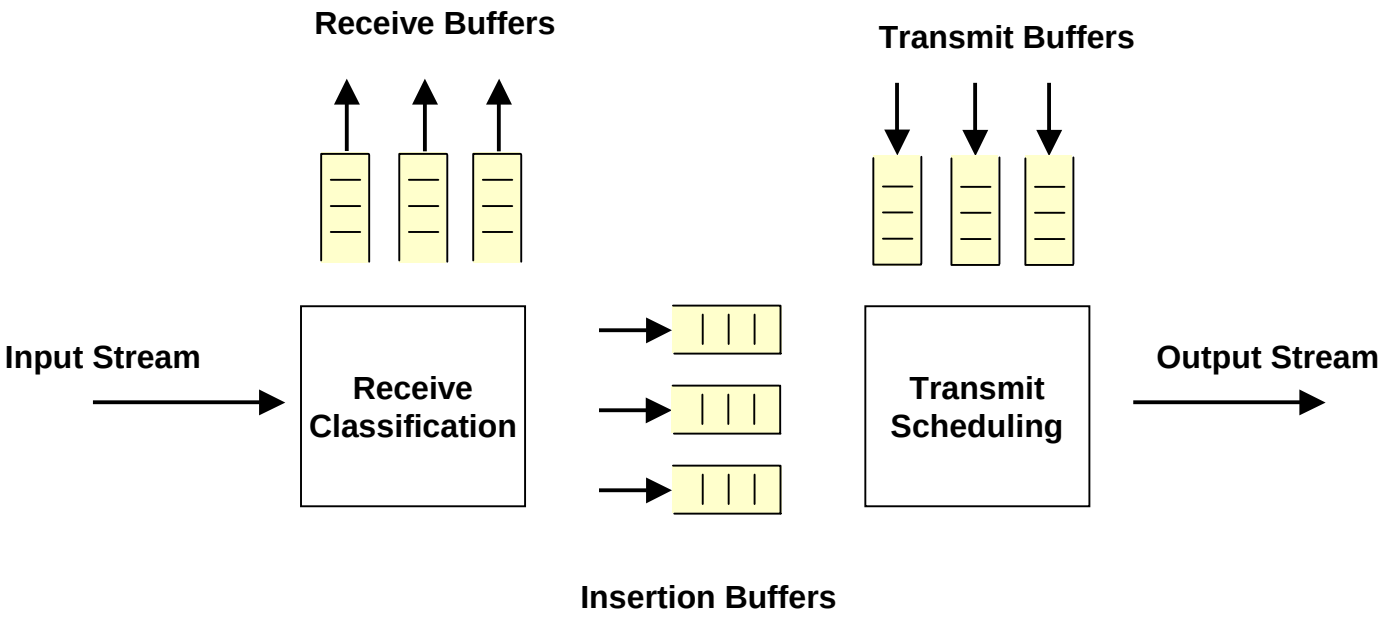
- Packet segmentation
- Reassembly machines at receiver

Buffer insertion



-Insertion buffer in transmit path
(Store-and-Forward, Cut-Through)

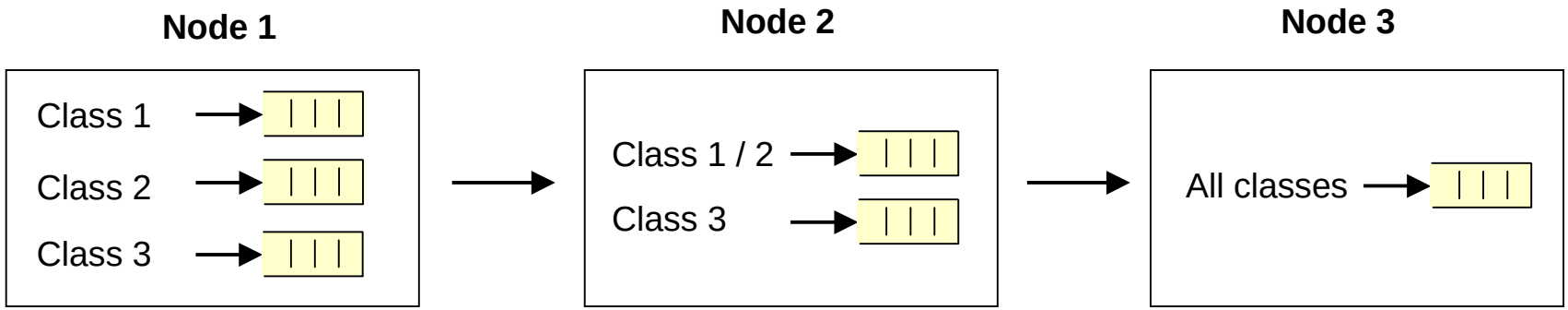
Node Structure



Decisions:

- Number of traffic classes on ring
- Store-and-forward or cut-through
- Transmit scheduling

Number of Classes on Ring

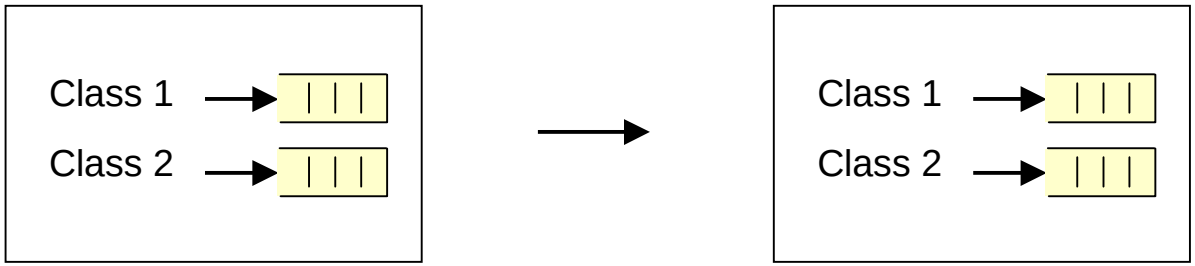


-**Nodes with different number of classes interwork**

- Performance will be different
- Different application areas might require different number of classes
- Different equipment costs

To be standardized:
- Max. number of classes on ring
- Mapping rules
- Discovery of node types

Store-and-Forward and Cut-Through



Store-and-forward:
Complete reception of packet
Min. buffer size: twice max. packet length

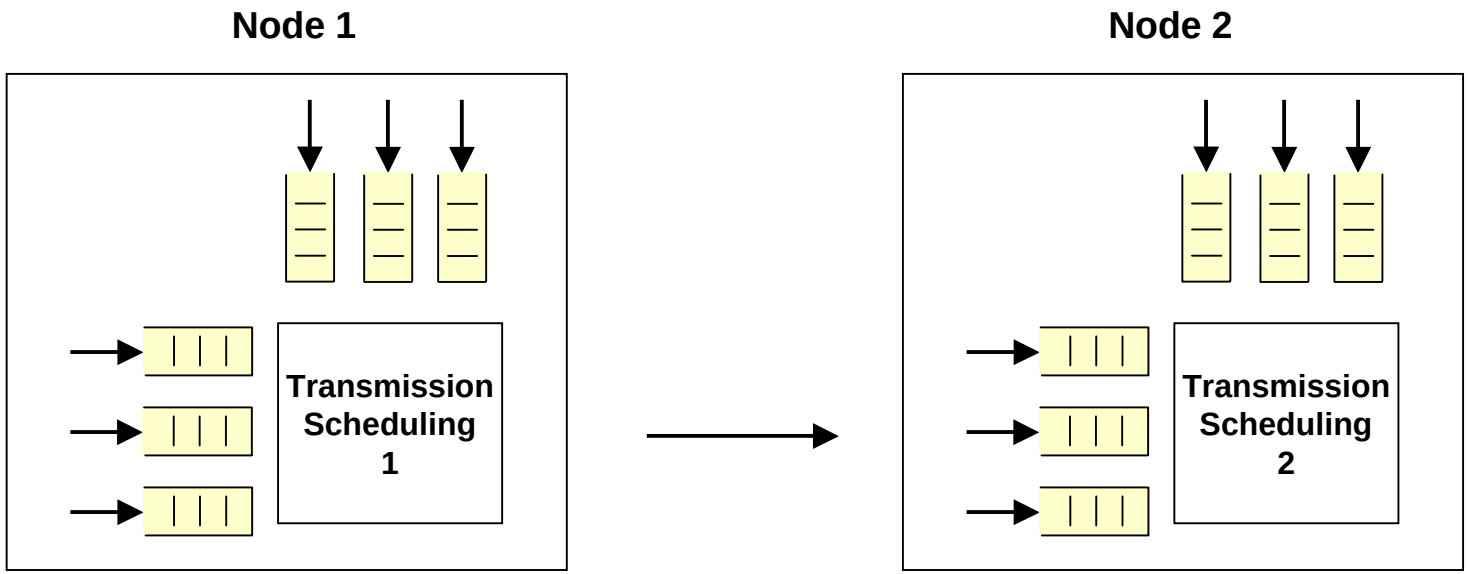
Cut-through:
Partial reception of packet
Min. buffer size: max. packet length

Both modes interwork

- Performance will be different
- Different application areas might require different modes
- Different equipment costs

No need for standardization

Transmission Scheduling



Both scheduling methods interwork

- Performance will be different
- Different application areas might require different scheduling methods
- Different equipment costs

No need for standardization

Store-and-Forward versus Cut-Through

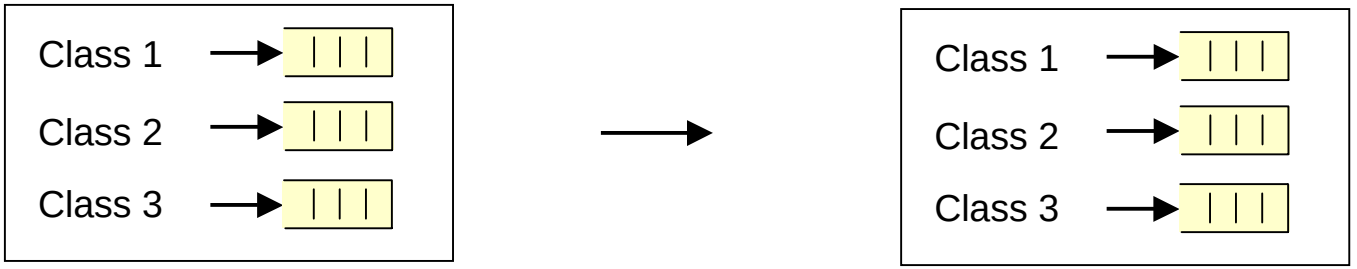
Store-and-forward mode: Operation mode to handle the MAC buffer in the transmission path of the ring with the purpose to buffer each transit packet completely before relaying it to the next node.

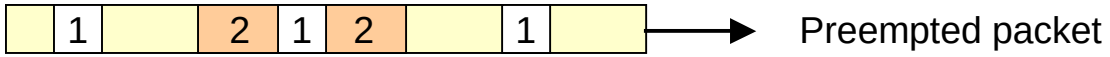
Cut-through mode: Operation mode to handle the MAC buffer in the transmission path of the ring with the purpose to hold up an upstream packet for the time that the node is transmitting a packet from its transmit buffer.

Thus, the filling of the insertion buffer is not necessary a complete packet. Assuming that the insertion buffer has priority over the transmit buffer, then the possibly partly buffered packet is immediately pulsed out again on the medium.

The additional insertion-buffer delay given by the amount of data that had to be held up is then experienced by all passing packets until the insertion buffer can be emptied during the absence of data on that part of the ring.

Packet Preemption



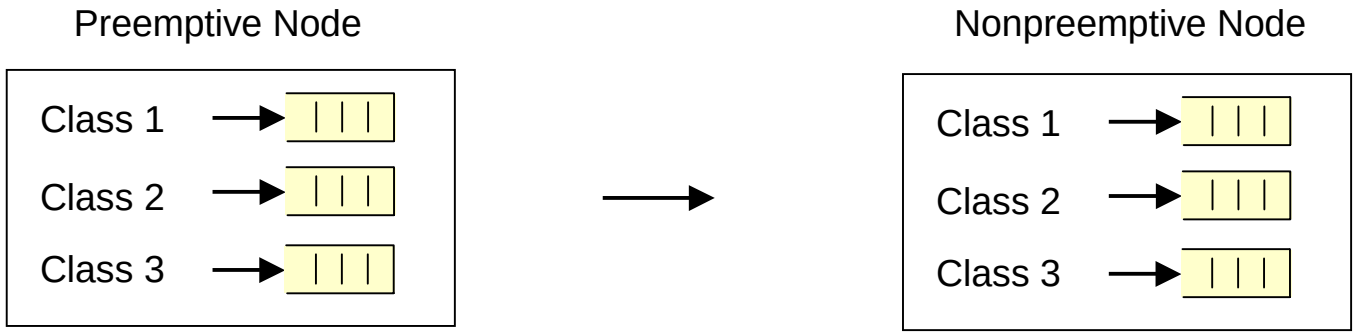


Preempted packet
(no loss)

- **Rules**

- Packet of higher class can preempt lower class
- Preemption of same packet is allowed
- Packet cannot preempt packet of same class
- Preemption occurs at word boundaries
- Preemption occurs at specified points

Packet Preemption

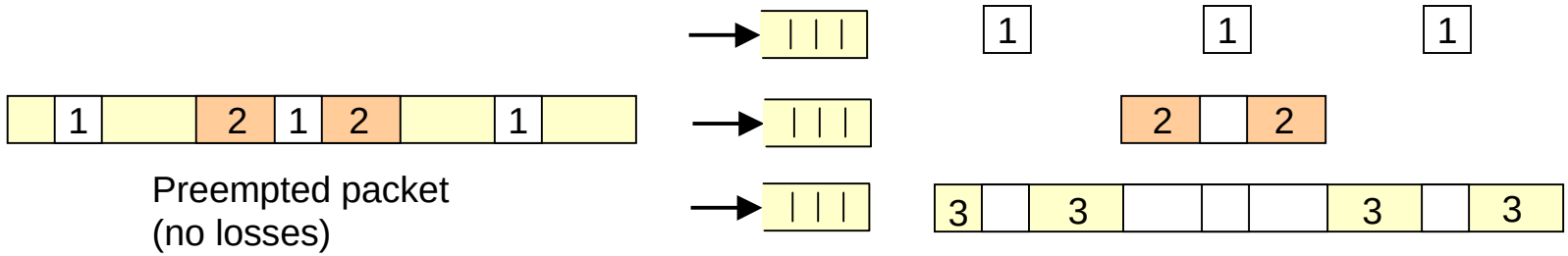


-**Preemptive and nonpreemptive nodes interwork**

- Performance at lower bit rates will be different
- Different application areas might require different modes
- Different equipment costs

To be standardized: - Discovery of node types
- Optionally: Receiver side of nonpreemptive node should be able to handle preemptive packets

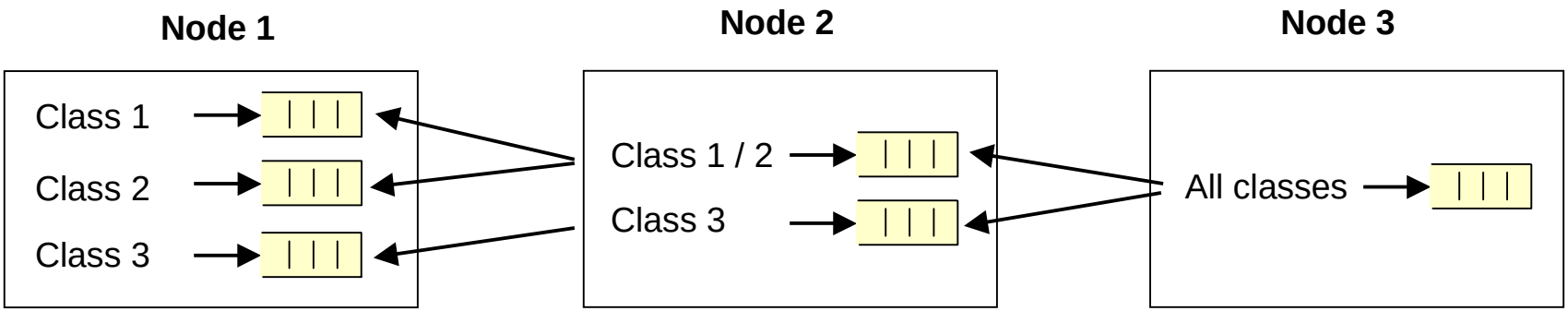
Handling of Preempted Packets



To avoid holes in preempted packets

- Use Cut-through for class 1
- Use Store-and-Forward for classes 2 and 3

Backpressure



To avoid packet loss on the ring, backpressure is required

- Backpressure threshold must consider round-trip delay to upstream node
- Backpressure for each class
- Backpressure command to appropriate classes

Addressing

What kind of addresses to be used:

- **IEEE Mac**
- **IPv4**
- **IPv6**
- **MPLS**
- **Internal addressing**