

# Resilient Packet Ring

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## Outline

- Introduction
- The present transmission technologies in MAN
- A new technology for MAN – RPR
- The advantages of RPR
- The challenges of RPR
- Frame Formats
- Conclusion
- Reference

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## Introduction

- In order to optimize transport networks to meet the requirements of a packet-based MAN, a new Media Access Control (MAC) layer protocol – Resilient Packet Ring (RPR), is under development.

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## The present transmission technologies in MAN

- SONET/SDH ( circuit-switched )
- Ethernet ( packet-switched )

## **The advantages of SONET/SDH**

- Point-to-point circuits among ring nodes
- Provide guaranteed bandwidth, delay, and delay jitter
- Provide fast recovery time from faults smaller than 50ms

## **The disadvantages of SONET/SDH**

- Fixed circuits ( circuit-based)
- Bandwidth inefficiency
- Only one node can transmit at a time

## The advantages of Ethernet

- Low cost
- Ease of manageability
- Simple integration with existing equipment
- Packet based

## The disadvantages of Ethernet

- Lacks a distributed fairness algorithm which can result in undesirable distributions of bandwidth among nodes
- When a link or node fails, an Ethernet ring requires recomputation of the spanning tree
- Don't provide guaranteed bandwidth, delay, and delay jitter

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## A new technology for MAN – RPR

- RPR not only shares SONET's ability to provide fast recovery from link and node failure, but also benefits from Ethernet's cost and simplicity

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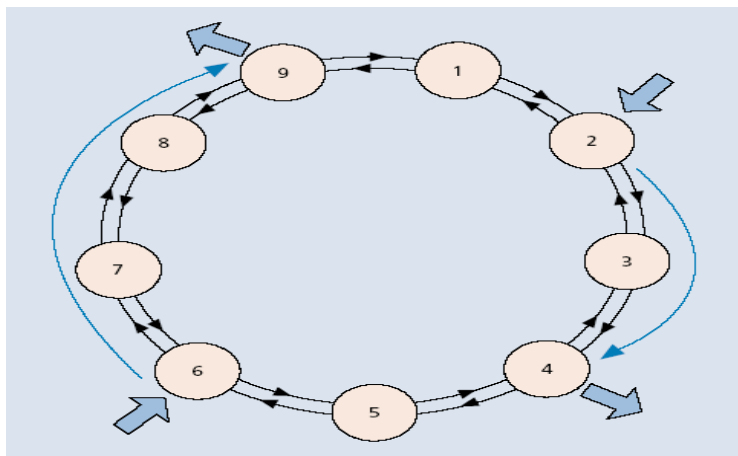
## The advantages of RPR

- Supports destination packet removal thereby enabling spatial reuse
- Provide a three-level class-based traffic priority scheme
- Fairness of bandwidth
- Automatic topology discovery
- Fast protection and recovery time
- Interoperability with major transmission standards

## Spatial reuse

- An RPR station is the receiver of a frame, it removes the frame completely from the ring instead of just copying the contents of the frame and letting the frame traverse the ring back to sender
- The bandwidth is available for use by other sending stations

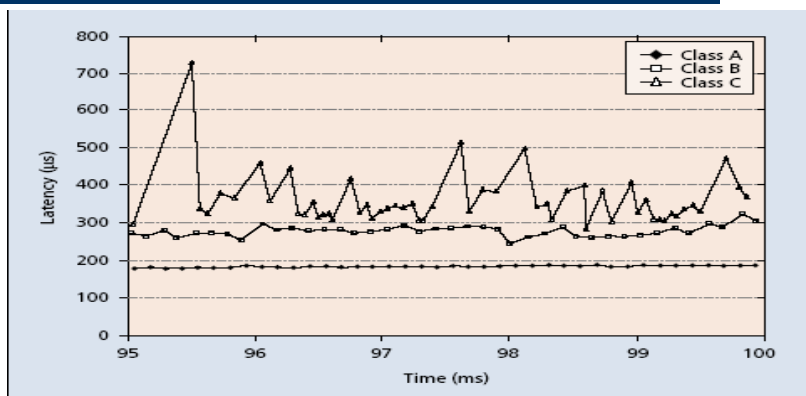
## Spatial reuse illustrated on the outer ring



## Three-level class-based traffic priority

- The IEEE 802.17 RPR standard supports three types of service: class A (high-priority), class B (medium-priority) and class C (low-priority)

## Simulation result of frame latency in different class traffics



## **Bandwidth allocated for traffic classes**

- Class A traffic is divided into class A0 and A1
- Class B traffic is divided into class B-CIR (committed information rate) and B-EIR (excess information rate)
- Class C and B-EIR are called fairness eligible (FE)
- In order to fulfill the service guarantees for class A0,A1 and B-CIR traffic, bandwidth needed for these traffic classes is preallocated

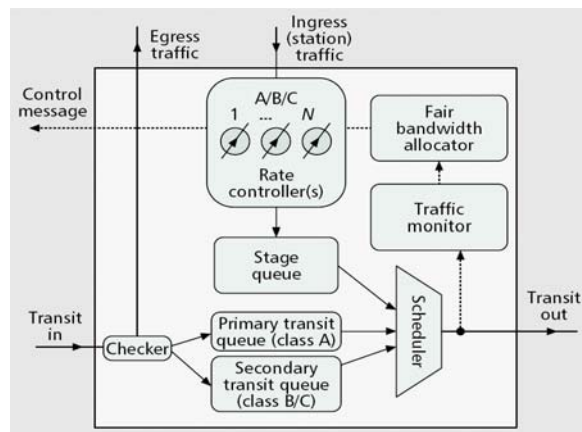
## **Bandwidth allocated for traffic classes (cont.)**

- Bandwidth preallocated for class A0 traffic is called reserved
- Bandwidth preallocated for class A1 and B-CIR traffic is called reclaimable

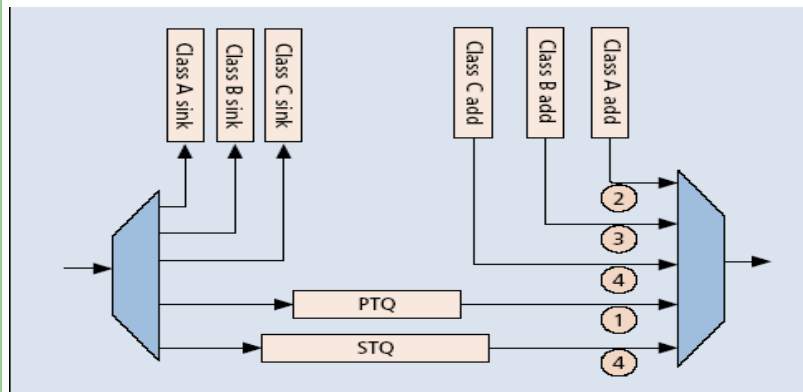
## PTQ and STQ

- PTQ: Primary transit queue
- STQ: Secondary transit queue
- High-priority transit frames (class A) are queued in PTQ
- Class B and C frames are queued in STQ

## The generic RPR node architecture



## The attachment to one ring by a dual-transit-queue station



## Fairness of bandwidth

- The objective of the fairness algorithm is to distributed unallocated and unused reclaimable bandwidth fairly among the contending stations and use this bandwidth to send class B-EIR and C (FE) traffic
- There are two modes of operation for the RPR fairness algorithm. The first, aggressive mode (AM). The second, conservative mode (CM).

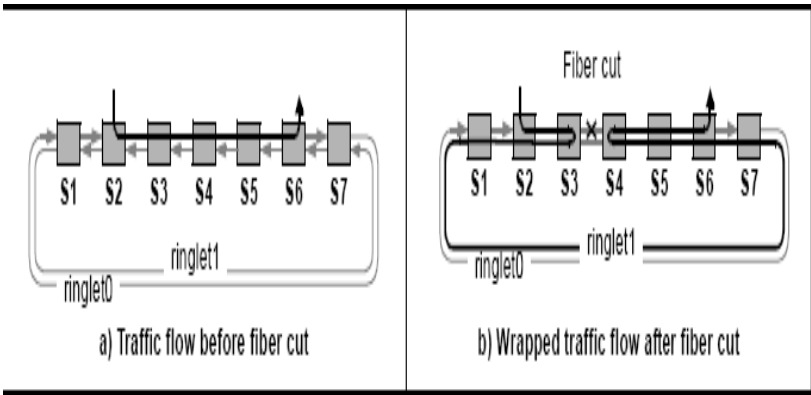
## Automatic topology discovery

- Topology discovery determines connectivity and the ordering of the stations around the ring
- The collected information is stored in the topology databases of each station
- When a new station is inserted into a ring or a station detects a link failure, the first station that notices a change starts ripple effect, resulting in all stations transmitting their updated status information and rebuilding their topology images
- The nodes use a topology discovery protocol to obtain a topology map of the ring, which is then used for the shortest path computation

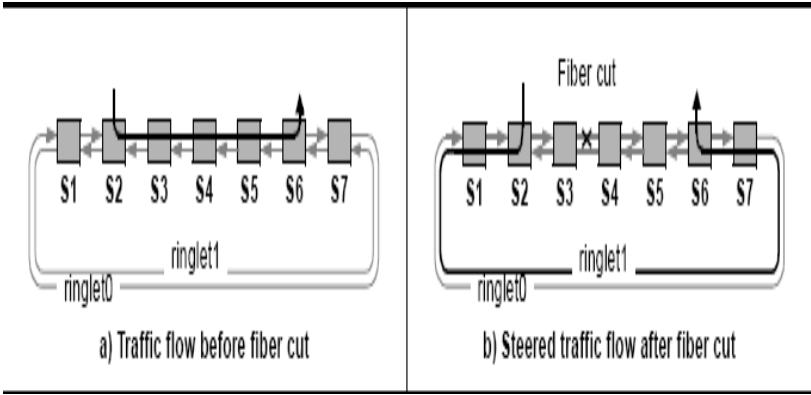
## Fast protection and recovery time

- Wrapping: If a failure condition is detected, the traffic going toward the failure is looped onto the opposite ringlet by the nodes adjacent to the failure. It prevents loss of the traffic in transit on the ring when a failure occurs.
- Steering: It is based on the ability to choose the ringlet on which the data is sent. If the preferred path is unavailable due to a failure, the other path is used.

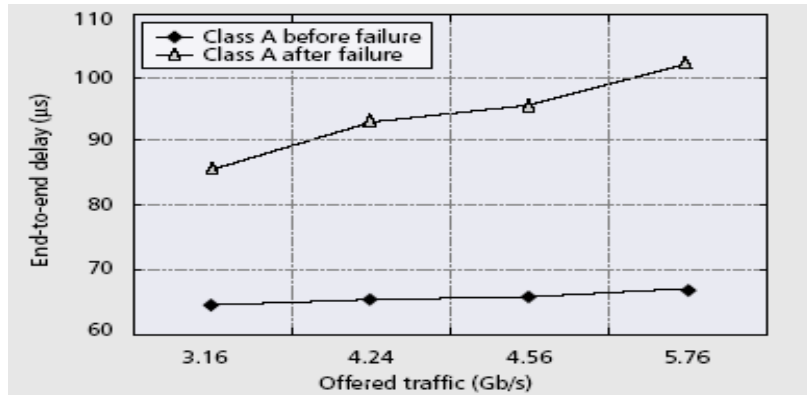
# Wrapping



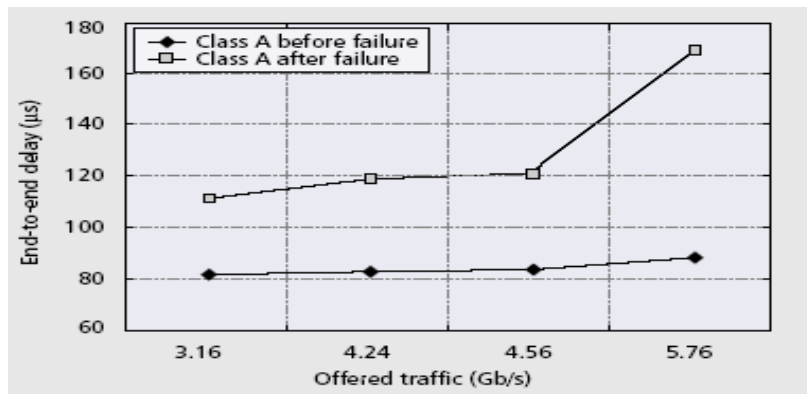
# Steering



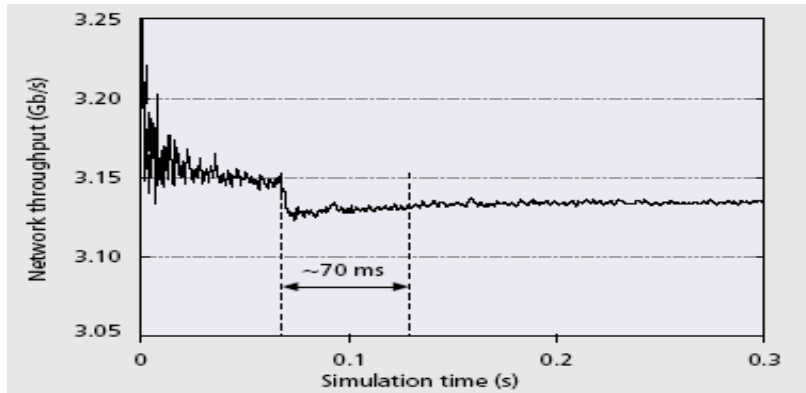
## Impact of link failure on end-to-end delay for high-priority



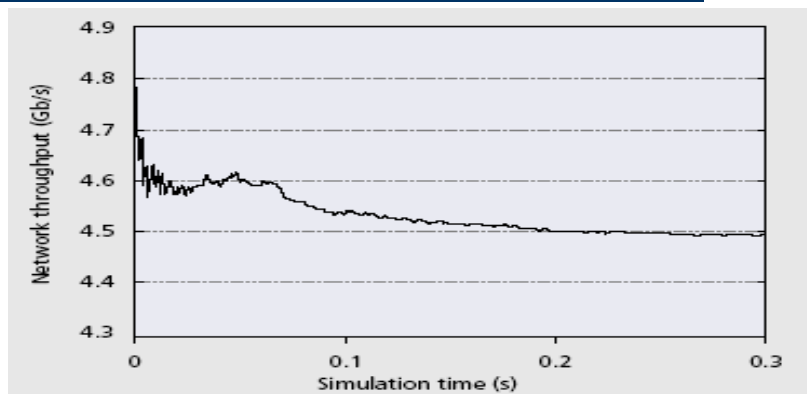
## Impact of link failure on end-to-end delay for low-priority



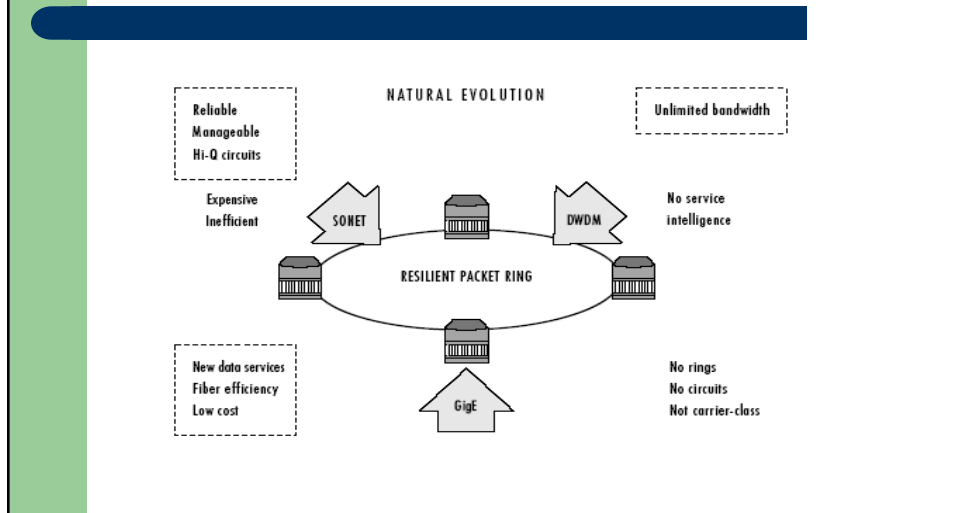
## Network throughput evolution after a node failure with no video traffic



## Network throughput evolution after a node failure with video traffic



## Interoperability with major transmission standards



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## The challenges of RPR

- The technical standard is similar to NG SDH, so both of them will overlap seriously in some application fields

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## Frame formats

- Data frame
- Control frame
- Fairness frame
- Idle frame

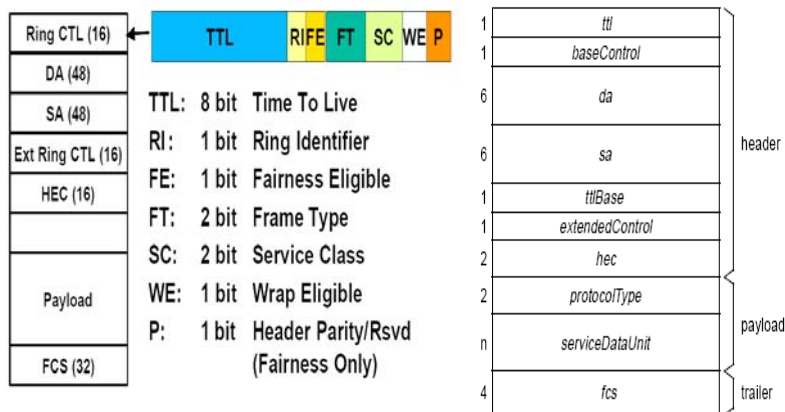
## Data frame size constraints

Value	Name	Row	Description
24	DATA_MIN	1	Minimum data frame size
12	EXT_HDR_SIZE	2	Additional size of extended data frame
1616	REGULAR_MAX	3	Maximum regular data frame size
9216	JUMBO_MAX	4	Maximum jumbo data frame size

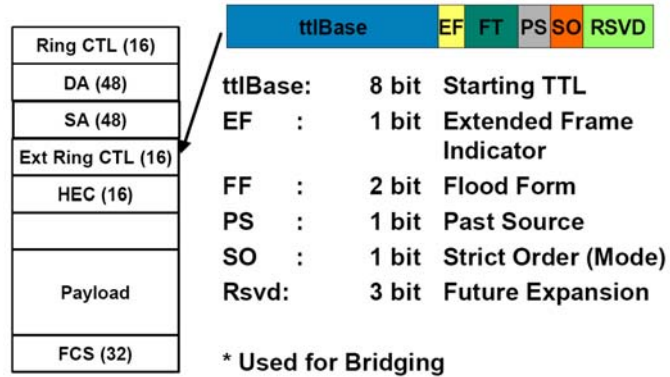
## Data frame size constraints

- The smallest data frame consists of a header, a 2-byte payload consisting of only the *protocolType* field, and a trailer
- The number of additional bytes in an extended data frame header, beyond those in a basic data frame header. The extra bytes consist of the *daExtended* field and the *saExtended* field
- The largest regular data frame has a 1500-byte serviceDataUnit field, and up to 92 reserved bytes
- The largest jumbo data frame has a 9100-byte serviceDataUnit field, and up to 92 reserved bytes

## Basic frame format



## Basic frame format



## Ringlet identifier

Value	Name	Description
0	RINGLET_0	Transmitted on ringlet0
1	RINGLET_1	Transmitted on ringlet1

## Fairness eligible

- A value of 0 indicates that the frame is not fairness eligible
- A value of 1 indicates that the frame is fairness eligible

## Frame type

Value	Name	Description
00 <sub>2</sub>	FT_IDLE	Idle frame
01 <sub>2</sub>	FT_CONTROL	Control frame
10 <sub>2</sub>	FT_FAIRNESS	Fairness frame
11 <sub>2</sub>	FT_DATA	Data frame

## Service class

Value	Name	Description
00 <sub>2</sub>	CLASS_C	classC
01 <sub>2</sub>	CLASS_B	classB
10 <sub>2</sub>	CLASS_A1	classA, subclassA1
11 <sub>2</sub>	CLASS_A0	classA, subclassA0

## Service class and fairness eligible encodings

<i>sc</i>	<i>fe</i>	Name	Description
00 <sub>2</sub>	0	—	reserved
	1	CLASS_C	classC opportunistic
01 <sub>2</sub>	0	CLASS_B_CIR	classB—committed information rate
	1	CLASS_B_EIR	classB—excess information rate
10 <sub>2</sub>	0	CLASS_A1	classA reclaimable
	1	—	reserved
11 <sub>2</sub>	0	CLASS_A0	classA reserved
	1	—	reserved

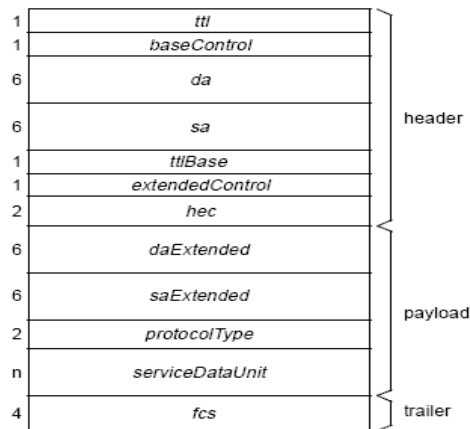
## Wrap eligible

- A wrap eligible bit that indicates whether the frame is eligible to be wrapped during a wrap condition
- A value of 0 indicates that the frame is not wrap eligible
- The *we* bit is ignored when received by steering stations. Its value has meaning only when received by wrapping stations. The value set for transmission from steering stations is 0.

## Parity

- The *parity* bit is set such that the total number of 1 bits in the *ttl* and *baseControl* fields, including the *parity* bit, is odd . In data frames and control frames, the *parity* bit is reserved for future use and shall be set to 0, and ignored on receipt

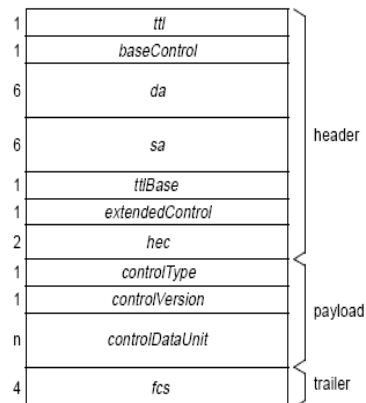
## Extended frame format



## The parameters of Extended frame

- The *daExtended* field is present only when the *ef* bit is 1
- The *saExtended* field is present only when the *ef* bit is 1

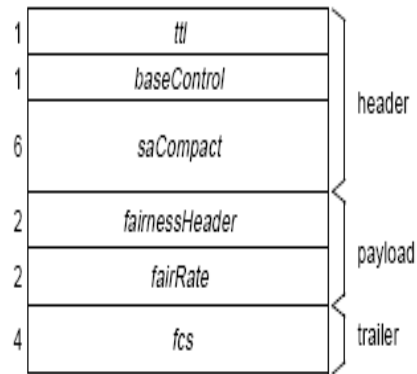
## Control frame format



## Control frames

- The largest control frame has a 1500-byte *controlDataUnit* field and 92 reserved bytes.
- A control frame is similar to the data frame, but is distinguished by a designated *ft* field value
- There are different types of control frames in RPR, such as topology and protection information and operations, administration, and maintenance

## Fairness frame format



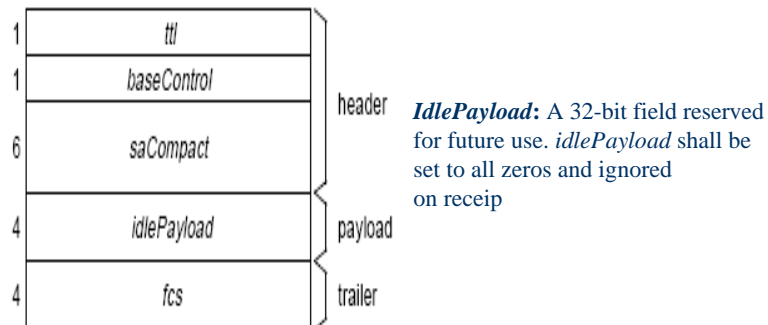
## Fairness frame constraints for basecontrol sub-field values

Field	<i>stationProtectionConfig</i>	Field value	Description
<i>fe</i>	—	0	Fairness frames are excluded from fairness protocols.
<i>sc</i>	—	CLASS_A0	Fairness frames always use reserved bandwidth.
<i>we</i>	STEERING	0	Fairness frames on steering stations are not wrap eligible.
	WRAPPING	1	Fairness frames on wrapping stations are wrap eligible.

## Fairness frames

- The 16-byte fairness frame mainly provides the advertised fairRate and the source of the fairness frame. The information is used in the RPR fairness algorithm

## Idle frame format



## Idle frame constraints for basecontrol sub-field values

Field	Value	Description
<i>fe</i>	0	Idle frames are excluded from fairness protocols.
<i>sc</i>	CLASS_A0	Idle frames always use reserved bandwidth.

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## Conclusion

- RPR is a technology for network of various sizes, from LAN to MAN or even WAN. Its ability to work over different kinds of underlying physical technologies makes it useful for both network operators.
- Three features: resilience, fairness and automatic topology discovery

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