

RPR Bandwidth Management

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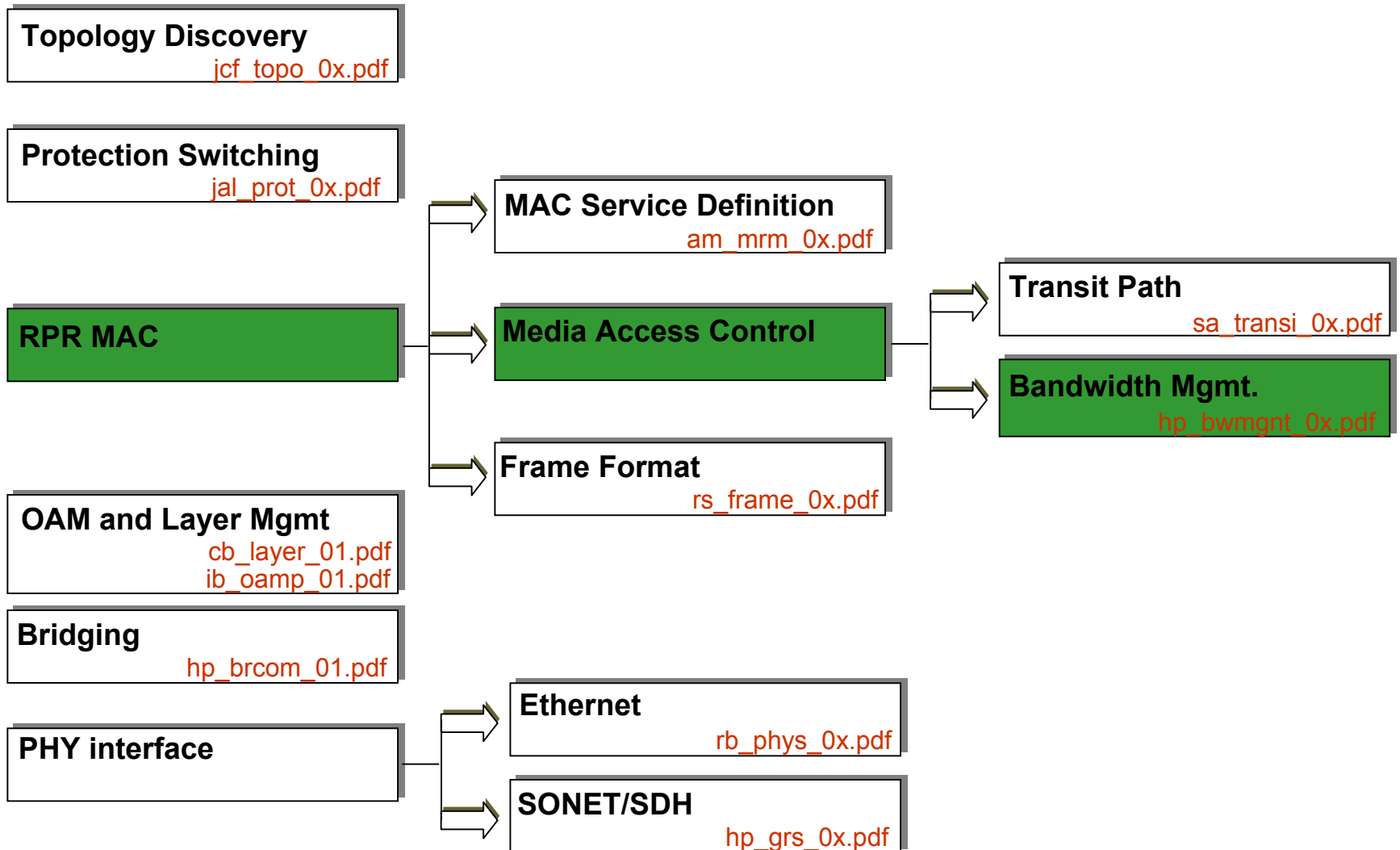
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Components of a Complete RPR Proposal



Contents

- RPR Attributes
- RPR BW Management
- BW Management Protocol
 - Congestion avoidance
- BW Management Entities
 - Link BW Allocation Entity
 - Fairness Message Management Entity
 - Media Access Rate Policing Entity
- Rate Control Message Format
- Conclusions

RPR Attributes

- Shared Medium
- Contention domain
- Source packet is temporal and spatial unaware of contention
- Parking lot problem
- Downstream disadvantage
- Spatial reuse

Objective: “Dynamic weighted BW distribution“

RPR BW management

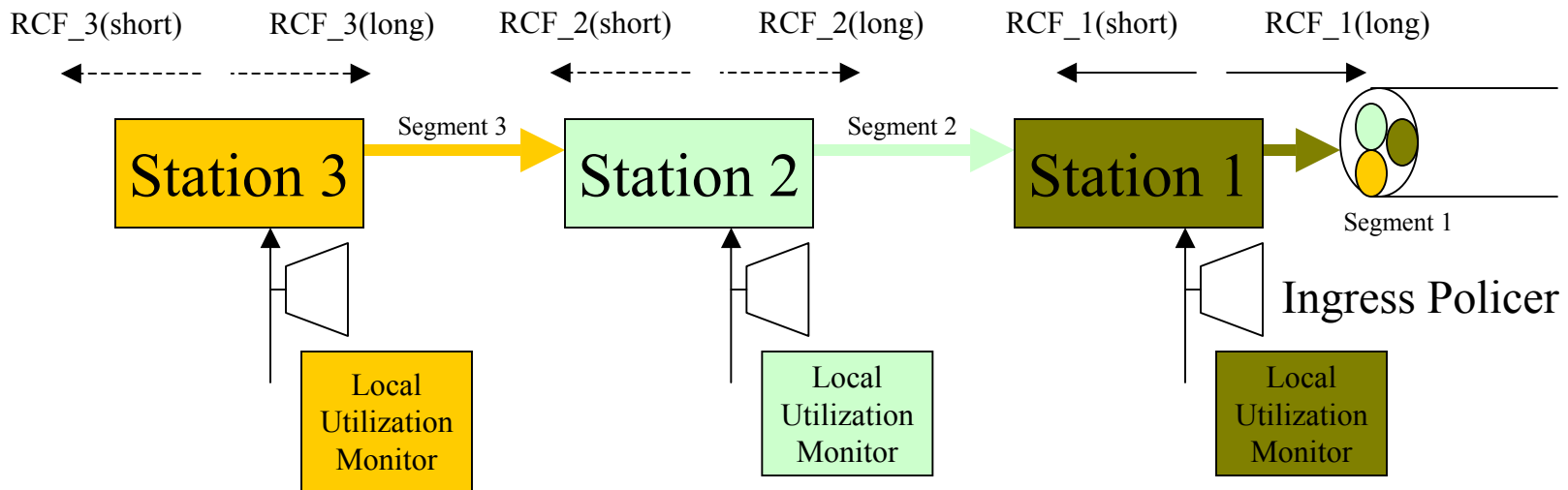
- Congestion avoidance
- Active BW management
 - Fair access as traffic pattern changes
- Dynamic
 - Reallocate resource, high through put as traffic profile changes
- Support for VoQ
 - Eliminate HoL blocking maximize throughput on all links
- Support for N+1 ringlets
- Support for weight fairness

BW Management protocol

- Monitor station output link BW usage
 - = (Passthru + transmit)
 - Monitor number of active sources
- Calculate advertised rate: Rate Control Factor (RCF)
- Advertise RCF to upstream stations using Rate Control Messages (RCM)
- Source station polices based on received RCF
- Supports performance monitoring: RCF operation compliance
- Scalable: ring BW, stations, ringlets

Active dynamic BW manager reallocate resources

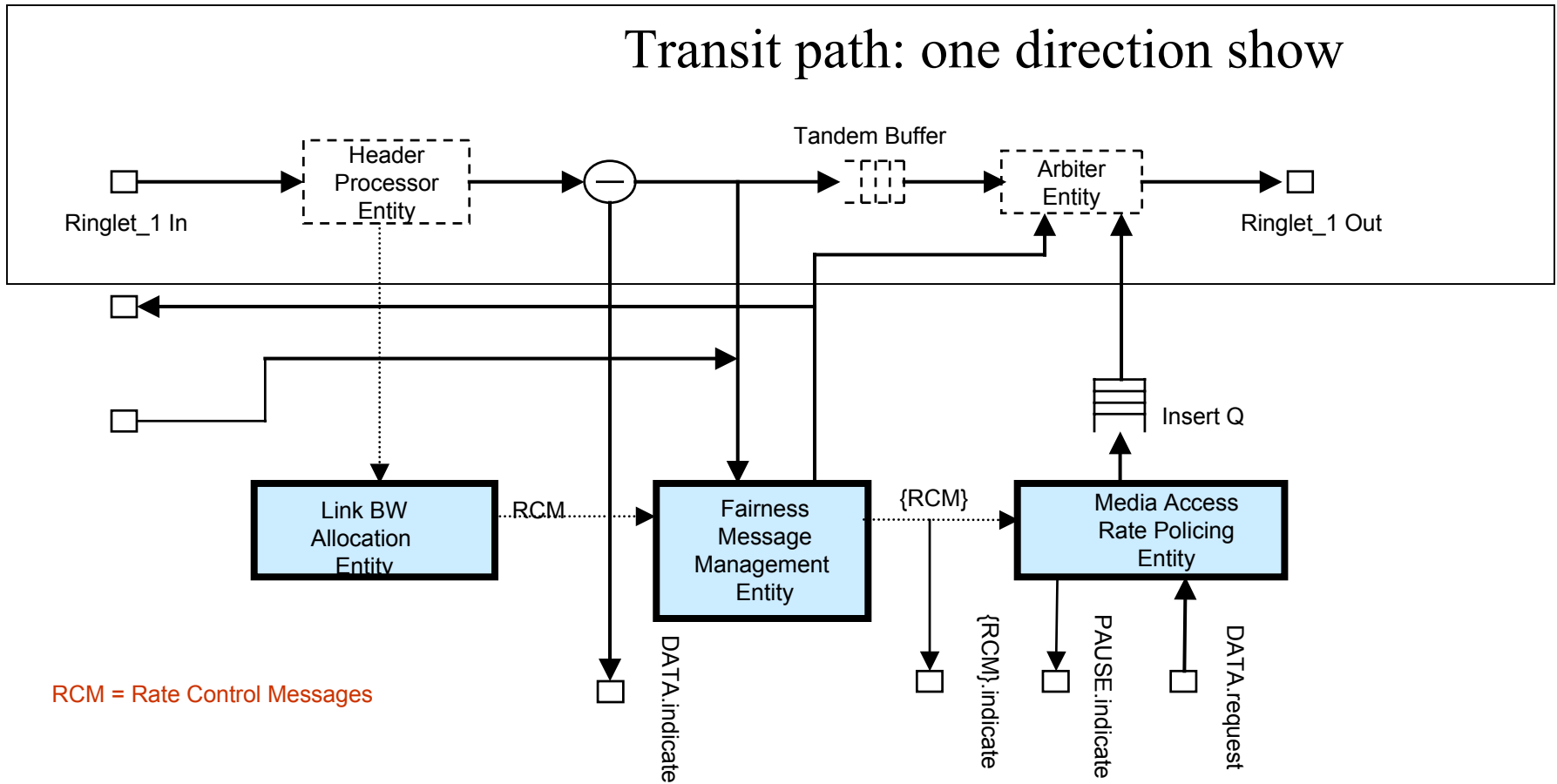
Basic Concept-Congestion Avoidance



- RCF indicates BW each station's allowed rate to send through its output link
- Congestion conditions: BW, delay

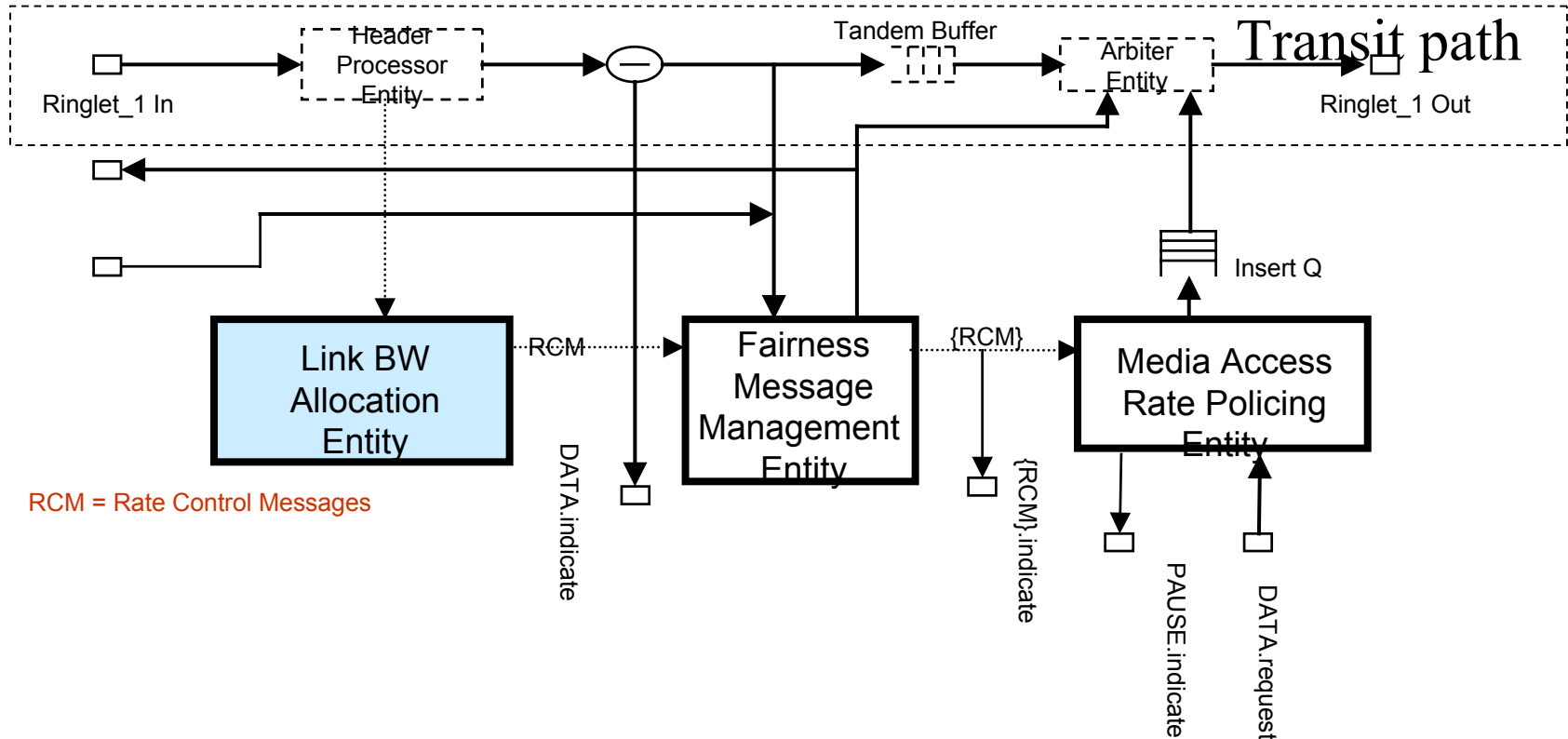
BW Management entities in MAC

Transit path: one direction show



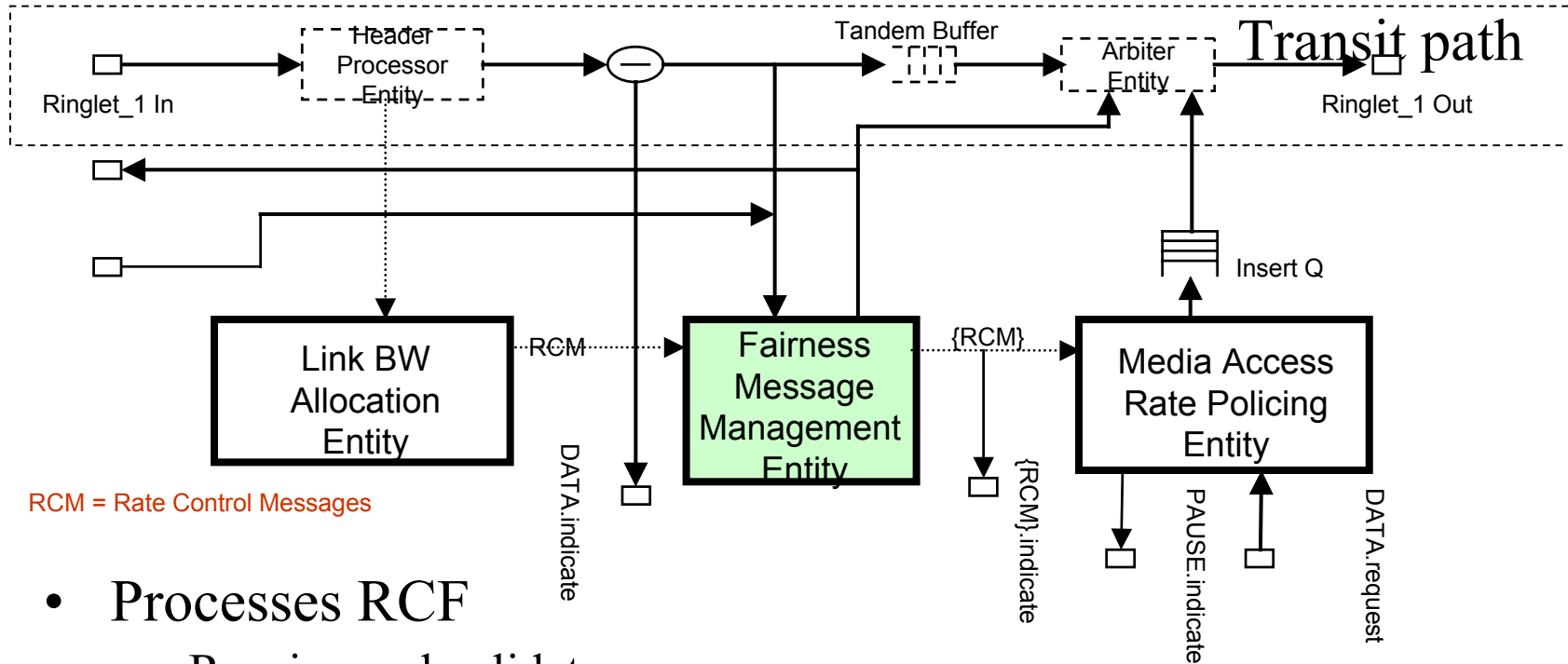
RCM = Rate Control Messages

BW Management Entities: Link BW Allocation Entity



Monitors active sources and passthru utilization

BW Management Entities: Fairness Message Management Entity



- Processes RCF
 - Receive and validate message
 - Calculates local RCF
- Generates advertised RCF:
 - Periodic transmit RCF

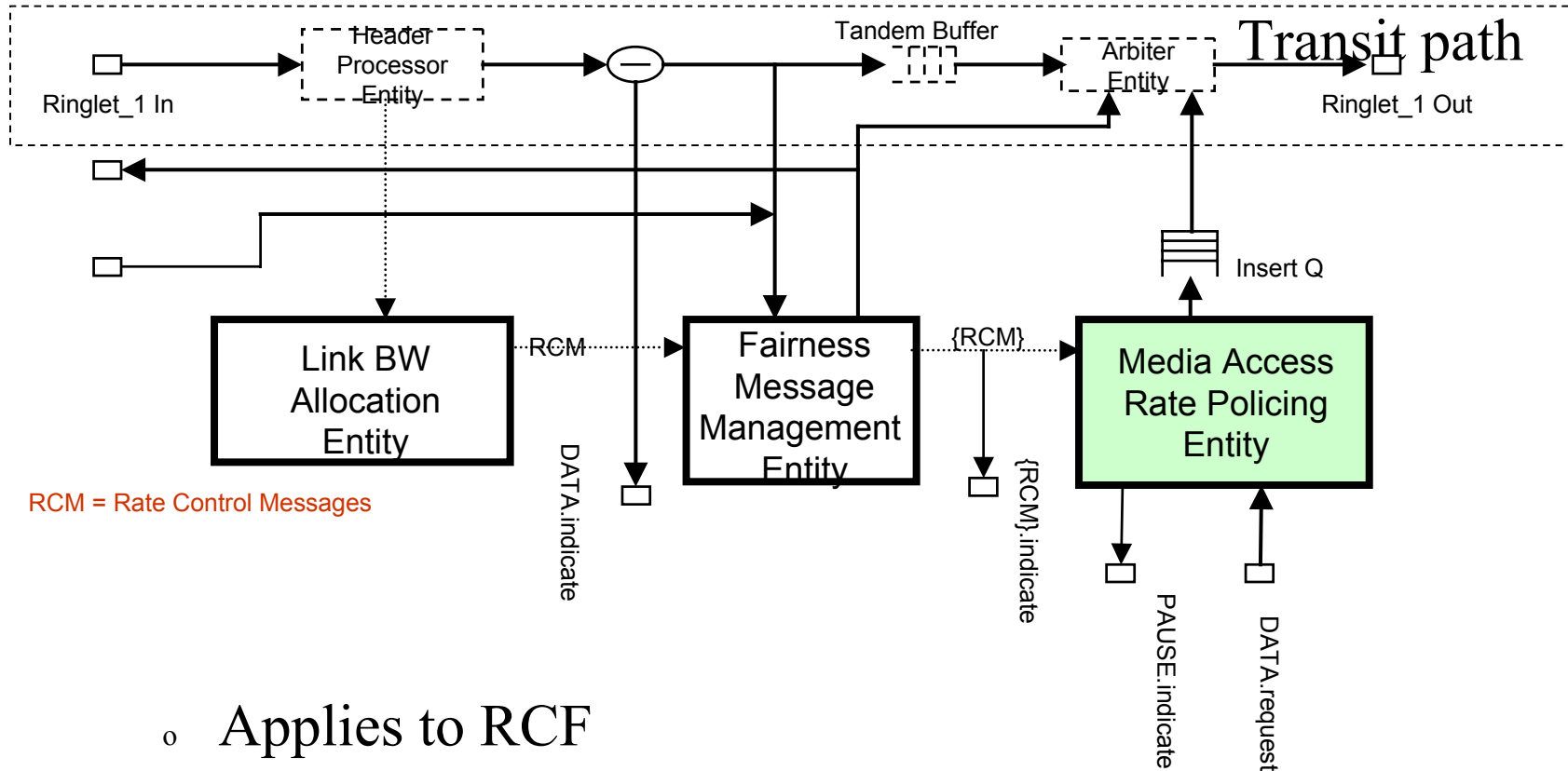
$$LocalRCF_{span_i} = w_{local} * RCF_{span_i}$$

Rate Control Factor

- Rate estimator on output link per source
- RCF_{sample} : usage per sample window
- Filtering:

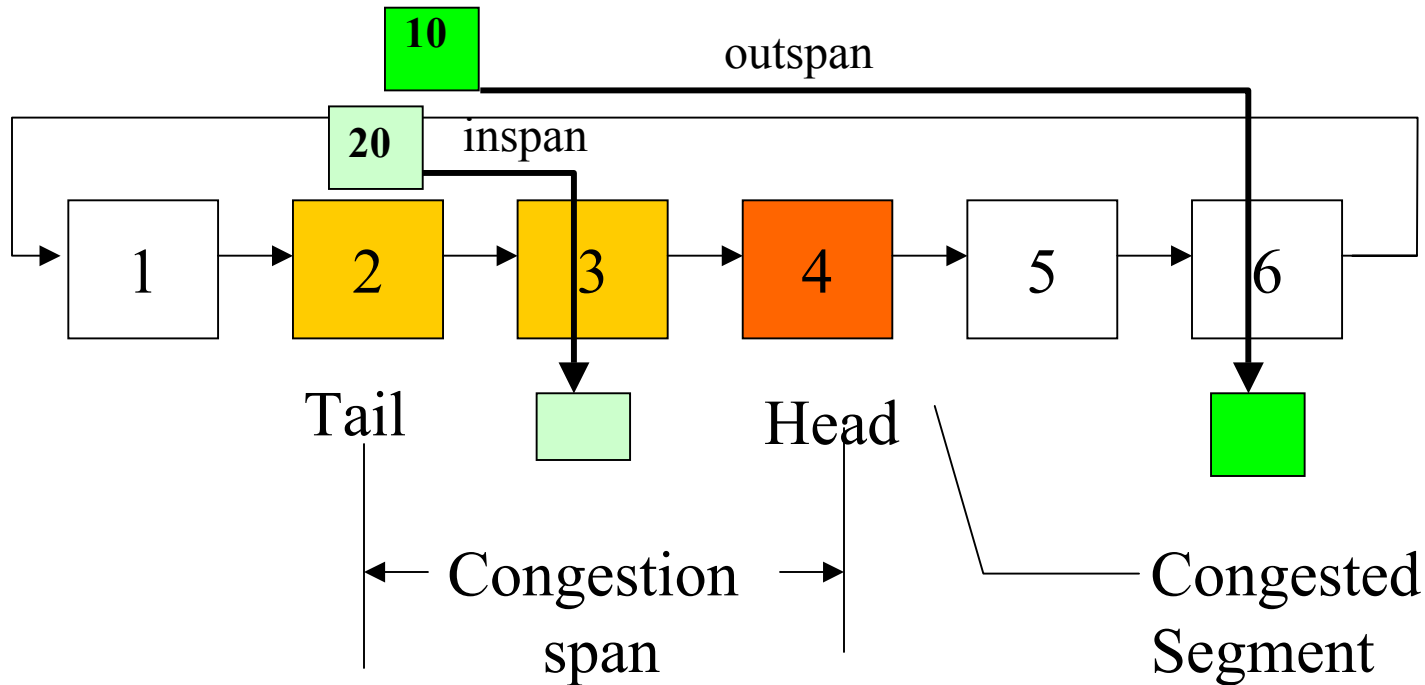
$$RCF_{(t)} = weight_1 RCF_{(t-1)} + weight_2 RCF_{sample}$$

BW Management Entities: Media Access Rate Policing Entity



- Applies to RCF
- Generates PAUSE.indicates when over transmit

Definitions:



Congestion created by 2, 3, and 4 to 5

Outspan: e.g. when Station 2 sends a packet to station 5, 6 or 1

Inspan: e.g. when Station 2 sends a packet to station 3 or 4

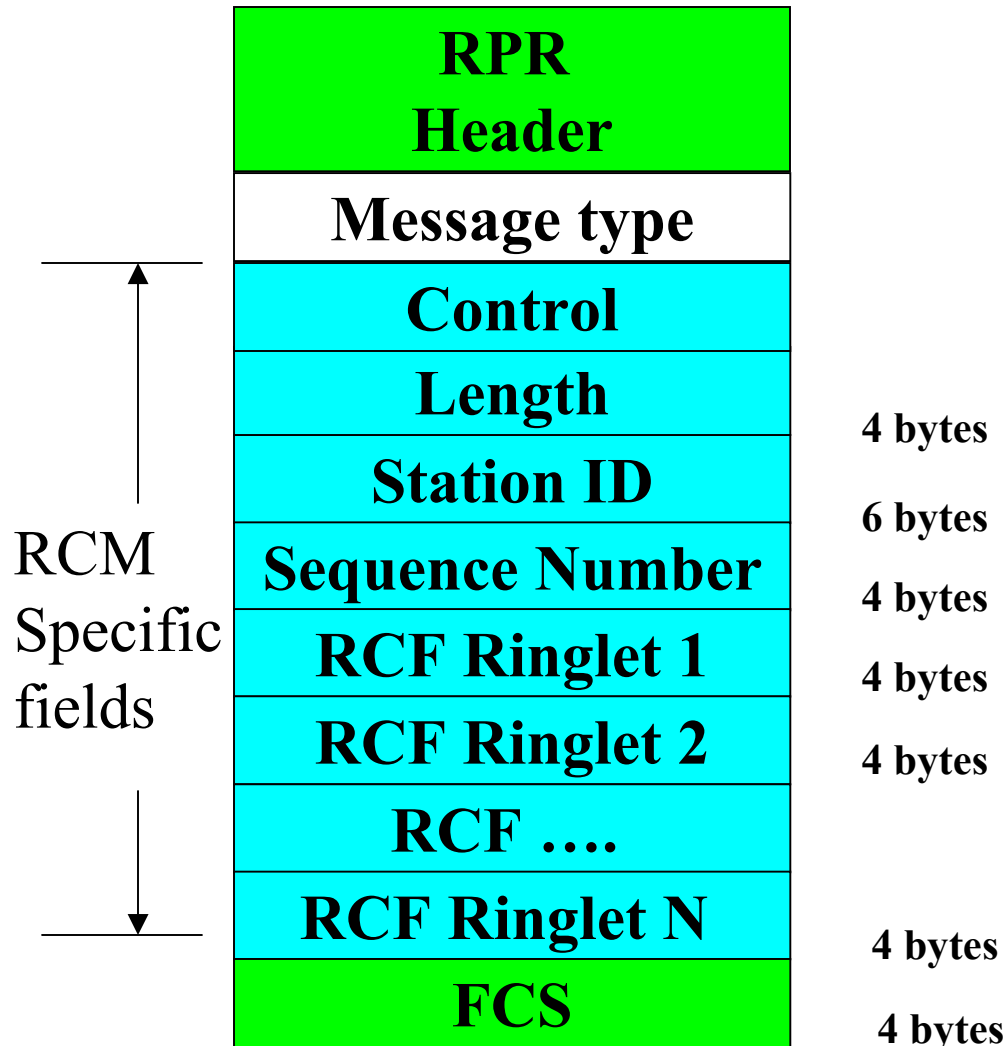
Ingress Rate Policing:

- A picture's worth few words:
 - It is simple. Do decrement.

station #:	Credit(t)=RCF	Credit(t+1);packet=20 for 3 inspan	Credit(t+2);packet=10 for 6 outspan	
1	100	100	100	
2	70	50	40	Tail
3	40	40	30	chain
4	10	10	0	Head=congestion point
5	60	60	50	
6	100	100	100	

Eliminates HoL blocking with inspan and outspan awareness.

Rate Control Message Format

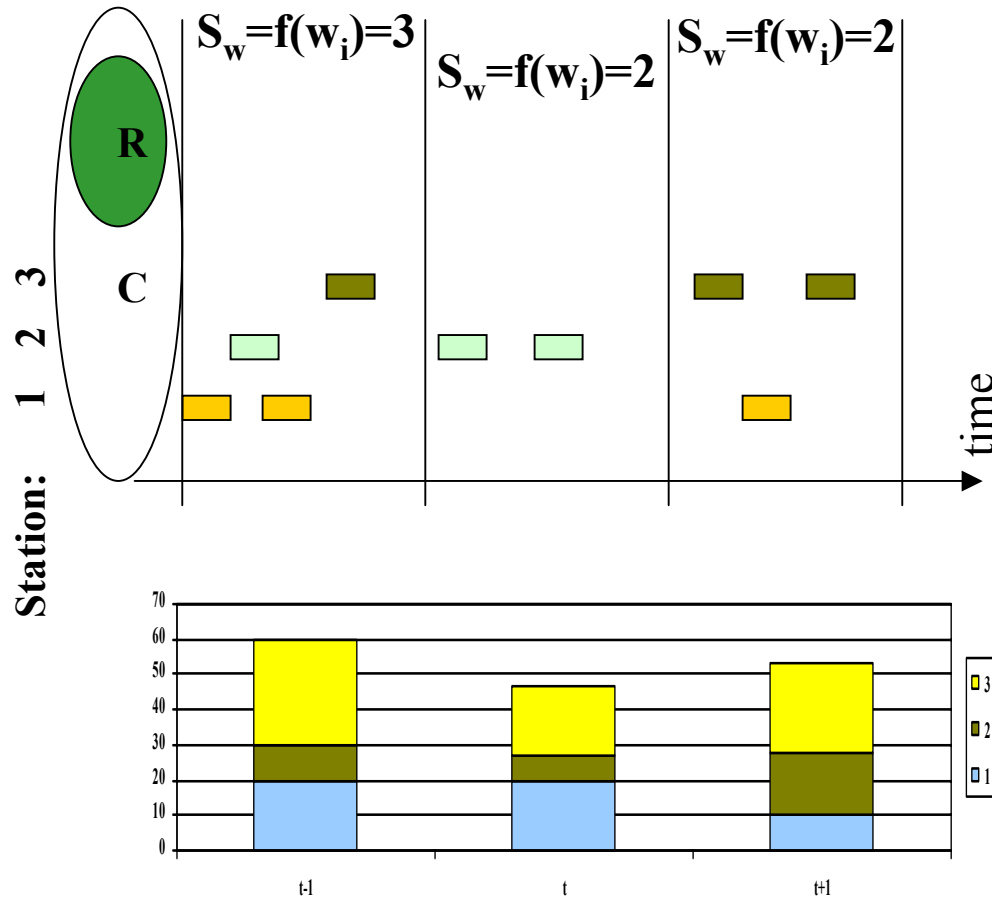


- **Common control frame and message type=RCM:**
 - Control: specific control bits-version etc.
 - Length: length of RCM packet
 - Station ID: packet source station address
 - Sequence number: message synchronization
 - RCF: rate control factors. One for each ringlet
 - FCS: error detection for RCM

Conclusions

- Started with a clean sheet
 - designed for carrier, service provider, and enterprise requirements.
- Complete functional BW management protocol that is simple, scalable and logical
 - Interworks with higher layer protocols
 - No HoL blocking
 - Stable, robust, predicable performance
- Proposals captured by several Models and are available
- Large number of simulation results from various individual participants

Backup RCF



- Sample window time
- Measure instantaneous BW usage in passthu and add:
 - $\sum_{\text{active}} w_i = S_w$
 - where w is the weight assigned to station i
- $C =$ ring capacity
- $R = \sum r_i$
 - Where r is the reserved BW of station i
- Instantaneous Rate Control Factor:

$$iRCF = \frac{C - \sum_{i=\text{active}} r_i}{\sum_{i=\text{active}} w_i}$$

- Smooth filtering:

$$RCF_{\text{new}} = \text{weight}_{\text{old}} RCF_{\text{old}} + \text{weight}_{\text{current}} RCF_{\text{current}}$$