

ARSM: a cross-layer auto rate
selection multicast mechanism for
multi-rate wireless LANs

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OUTLINE

- ▶ INTRODUCTION
- ▶ BACKGROUND
- ▶ Auto rate selection for multicast(ARSM)
- ▶ Dynamic multicast data transmission procedure
- ▶ Performance evaluation
- ▶ Conclusion



INTRODUCTION

- ▶ Nowadays, the IEEE 802.11 Media Access Control (MAC) protocol makes use of a physical (PHY) layer capable of operating at various rates.
 - ▶ IEEE 802.11a standard: 6, 9, 12, 18, 24, 36, 48 and 54 Mbps
 - ▶ IEEE 802.11b standard: 1, 2, 5.5 and 11 Mbps



INTRODUCTION

- ▶ The Auto Rate Fallback(ARF) protocol:
 - ▶ After the reception of ten consecutive acknowledgement (ACK), the next higher mode is selected for future data frames.
 - ▶ If the delivery of the 11th frame is unsuccessful, it immediately falls back to the previously supported mode.
 - ▶ During other cycles with less than ten consecutive ACKs, it switches to a lower rate mode after two successive ACK failures.



INTRODUCTION

- ▶ The ARF protocol is only suitable for point-to-point communications.
- ▶ it is more difficult to determine the highest data rate to be used since the channel conditions between the AP and each one of the MTs in the multicast group may differ and no feedback is available.



BACKGROUND

- ▶ Since the 802.11MX mechanism does not need a leader to operate, it performs better than the LBP protocol in terms of both data throughput and reliability.
- ▶ The 802.11MX protocol is very costly because it requires a signalling channel to send NACK and busy tones.



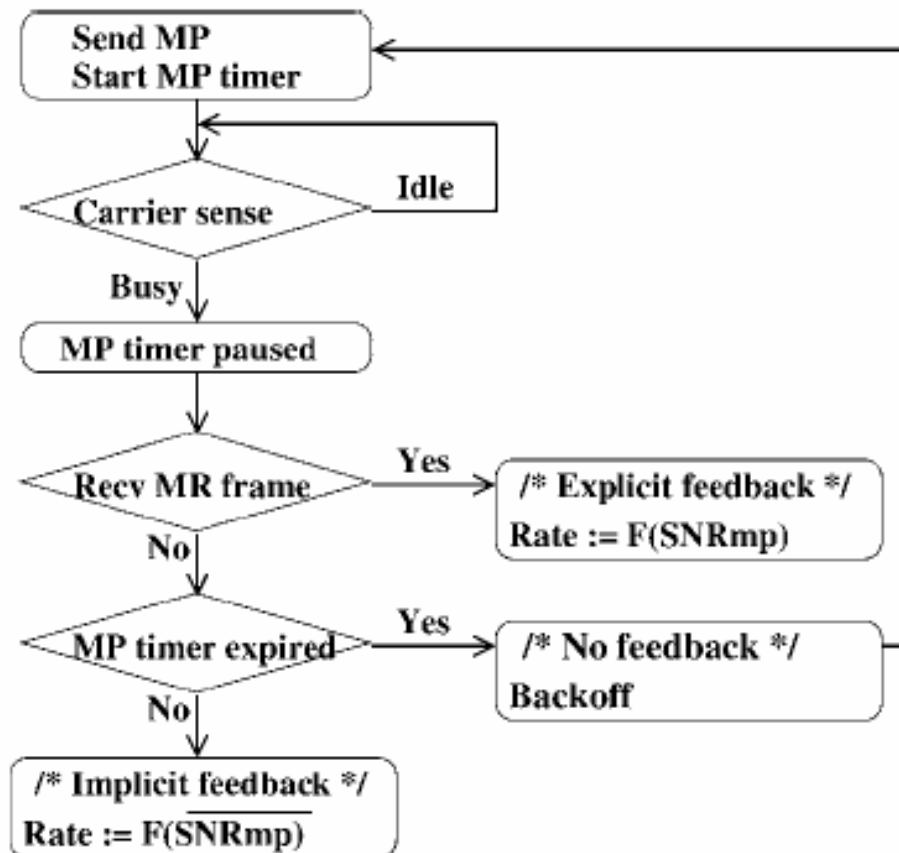
BACKGROUND

- ▶ the mechanisms just described above only focus on solving the reliability of the multicast service in WLANs.
- ▶ Only the mechanisms presented in [12, 13] adapt the PHY transmission rate of the multicast data frames.



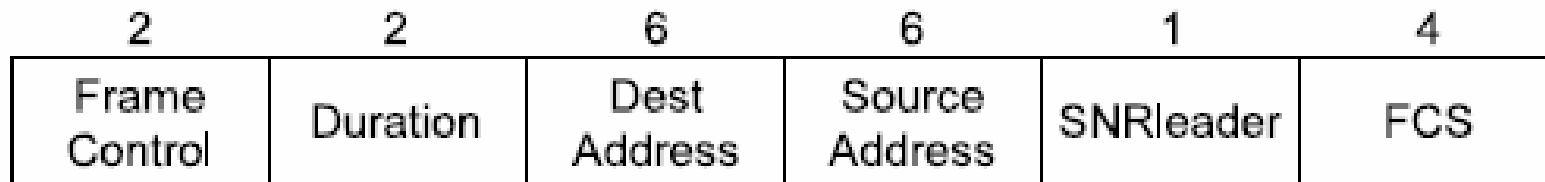
Auto rate selection for multicast(ARSM)

- ▶ Multicast channel probe operation of ARSM

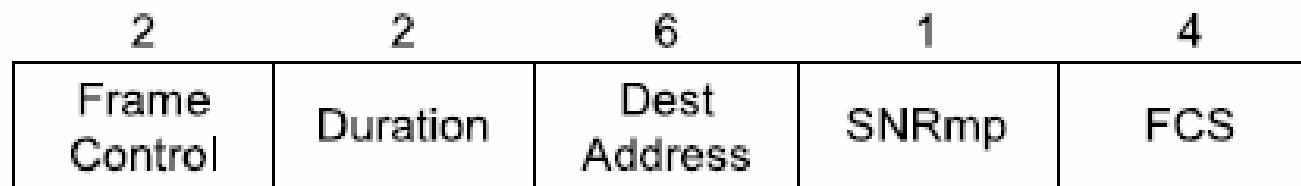


Auto rate selection for multicast(ARSM)

- ▶ The duration field of the MP frame is initially set to $\underline{CW}_m \times \underline{SlotTime}$
- ▶ The SNR_{leader} field is set to the SNR received in the latest ACK received by the AP.



(a) Multicast Probe Frame



(b) Multicast Response Frame

Auto rate selection for multicast(ARSM)

$$\text{Backoff timer} = \begin{cases} [0, 2] & \text{SNR}_{\text{mp}} < \text{Th}_{\leftarrow 2} \\ [3, 5] & \text{Th}_{\leftarrow 2} \leq \text{SNR}_{\text{mp}} < \text{Th}_{\leftarrow 1} \\ [6, 7] & \text{Th}_{\leftarrow 1} \leq \text{SNR}_{\text{mp}} \end{cases}$$

- ▶ $\text{Th}_{\leftarrow i} \in \{\text{Th}_{1 \leftrightarrow 2}, \text{Th}_{2 \leftrightarrow 5.5}, \text{Th}_{5.5 \leftrightarrow 11}\}$, for $i = 1$ and 2
 - ▶ if $\text{Th}_{5.5 \leftrightarrow 11} \leq \text{SNR}_{\text{leader}}$, $\text{Th}_{\leftarrow 1} = \text{Th}_{5.5 \leftrightarrow 11}$ and $\text{Th}_{\leftarrow 2} = \text{Th}_{2 \leftrightarrow 5.5}$
 - ▶ If $\text{Th}_{2 \leftrightarrow 5.5} \leq \text{SNR}_{\text{leader}} < \text{Th}_{5.5 \leftrightarrow 11}$, then $\text{Th}_{\leftarrow 1} = \text{Th}_{2 \leftrightarrow 5.5}$ and $\text{Th}_{\leftarrow 2} = \text{Th}_{1 \leftrightarrow 2}$
 - ▶ If $\text{Th}_{1 \leftrightarrow 2} \leq \text{SNR}_{\text{leader}} < \text{Th}_{2 \leftrightarrow 5.5}$, then $\text{Th}_{\leftarrow 1} = \text{Th}_{1 \leftrightarrow 2}$ and $\text{Th}_{\leftarrow 2} = \text{Th}_{\leftarrow 1} / 2$.
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Auto rate selection for multicast(ARSM)

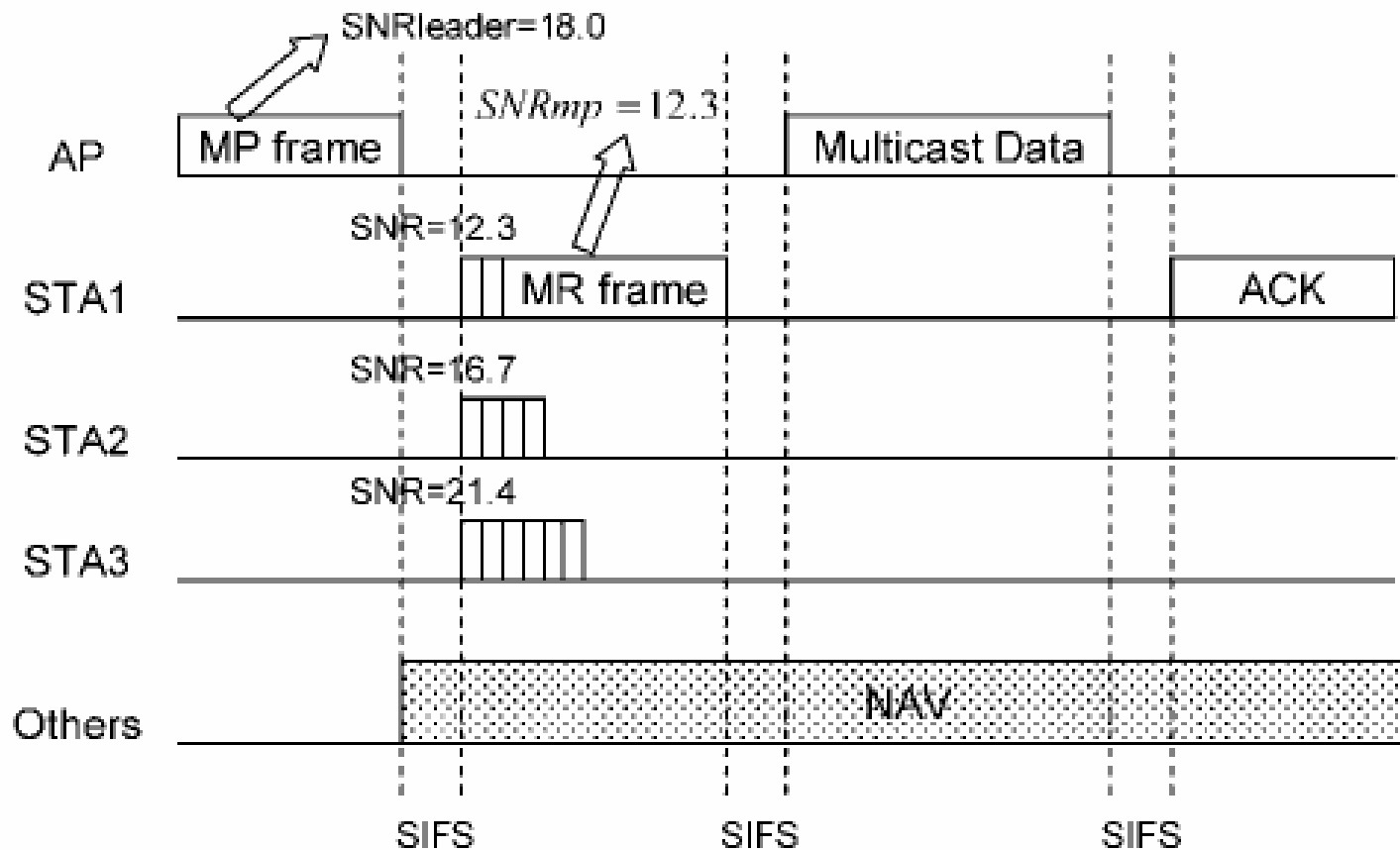
The AP could receive three different kinds of feedback information:

- ▶ **Explicit feedback:** The AP receives the MR frame from an MT within the multicast group.



Auto rate selection for multicast(ARSM)

- ▶ Explicit feedback scenario



Auto rate selection for multicast(ARSM)

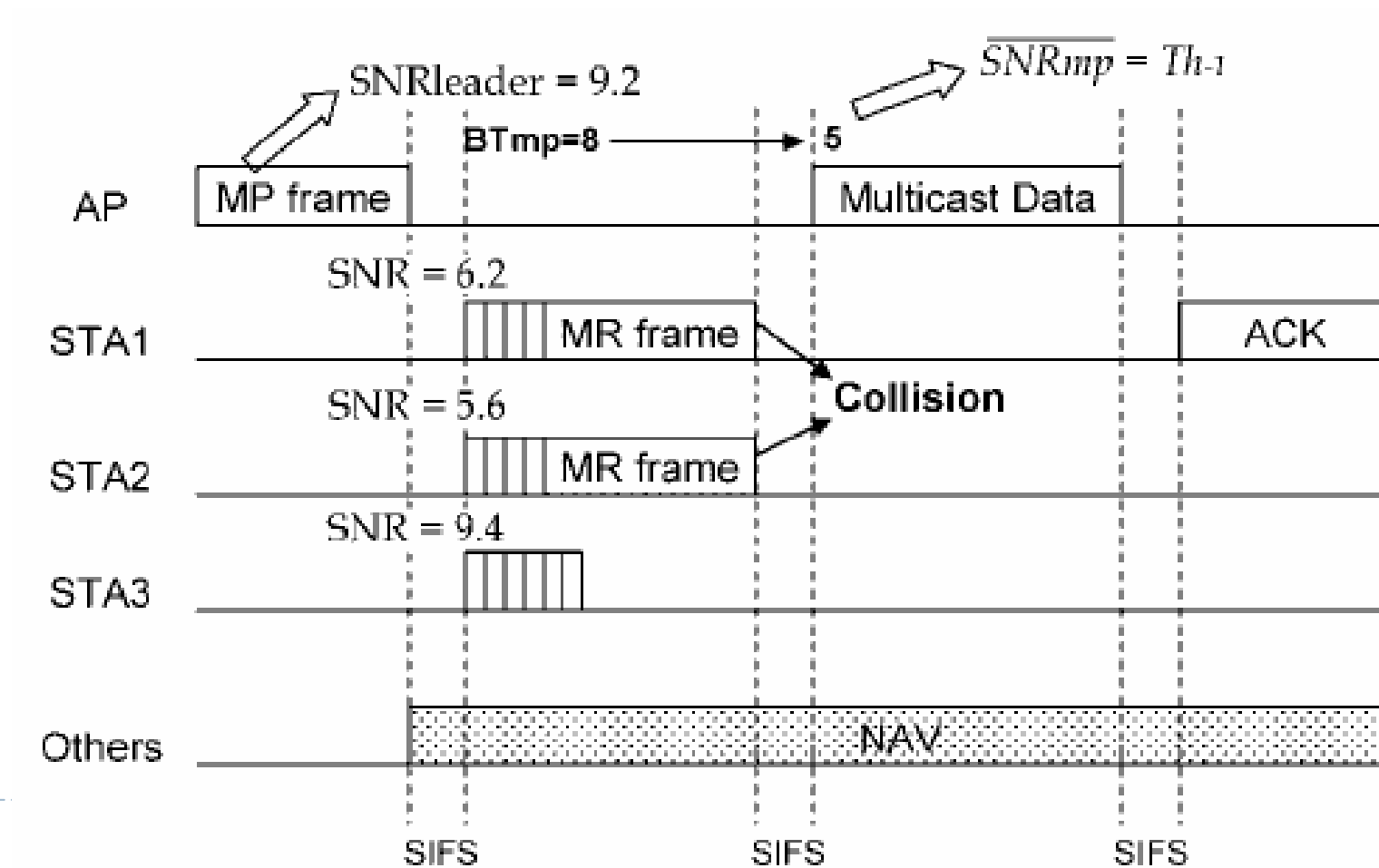
- ▶ **Implicit feedback:** The AP receives a corrupted MR frame and the MP_timer of the AP has not expired.

$$\overline{\text{SNR}}_{\text{mp}} = \begin{cases} 0 & \text{BT}_{\text{mp}} \geq 6 \\ \text{Th}_{\leftarrow 2} & 6 > \text{BT}_{\text{mp}} \geq 3 \\ \text{Th}_{\leftarrow 1} & 3 > \text{BT}_{\text{mp}} \geq 1 \end{cases}$$



Auto rate selection for multicast(ARSM)

- ▶ Implicit feedback scenario



Auto rate selection for multicast(ARSM)

- ▶ The AP is unable to identify the new leader.
- ▶ The AP will have to send a second MP frame before sending the following multicast data frame. The new MP frame to be sent out will set the SNR_{leader} field to a negative value.
- ▶ those MTs sent to this a new MR frame and use the backoff mechanism based on a random value between $[0, CW_m - 1]$.



Auto rate selection for multicast(ARSM)

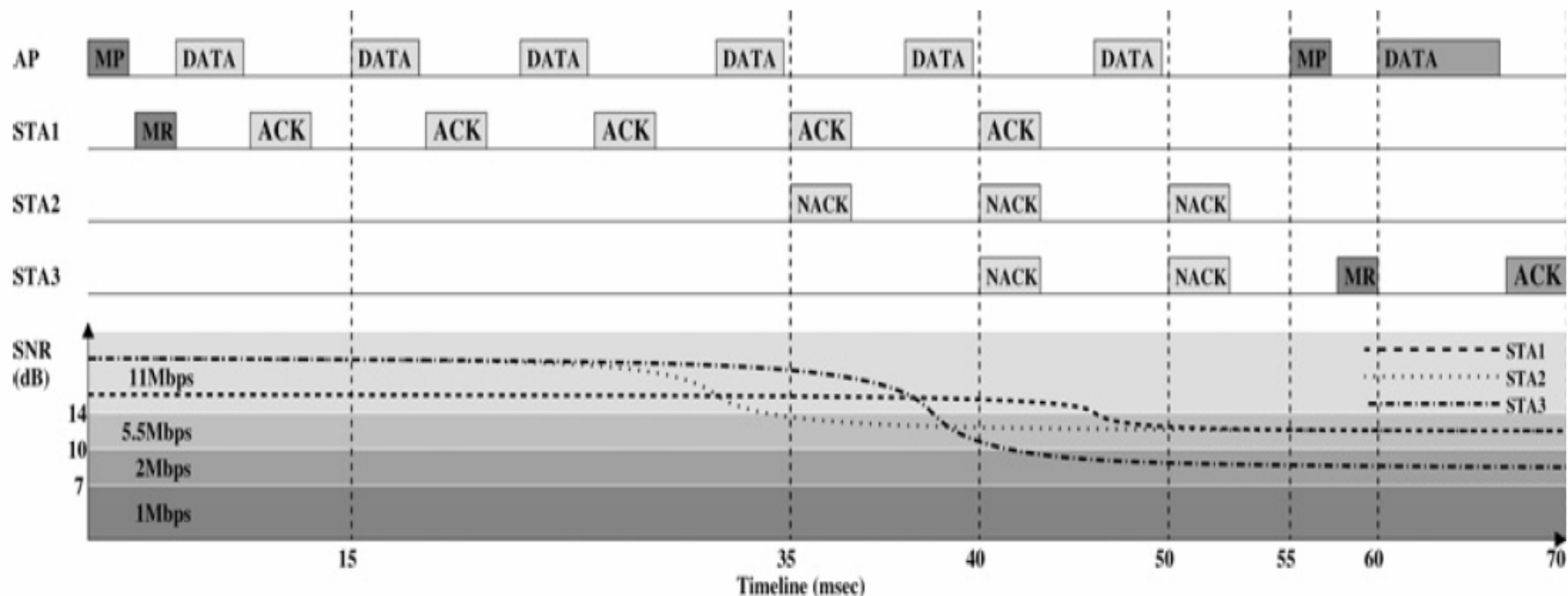
▶ **no feedback:**

- ▶ The AP does not receive an MR frame and the MP_timer of the AP expires.
- ▶ The AP will retransmit the MP frame after waiting for a period of time.
- ▶ The number of retransmission attempts for a given MP frame is limited to 4.



Dynamic multicast data transmission procedure

- ▶ If the AP shows a failure of N_{th} consecutive multicast transmissions (detected via NACKs), it initiates the MCPO.

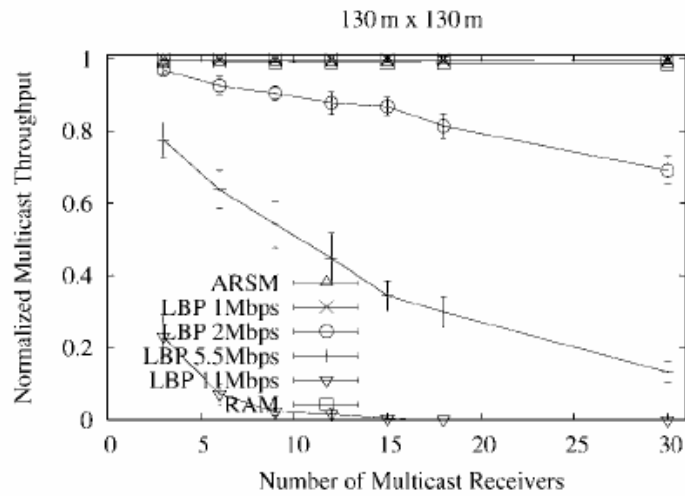


Performance evaluation

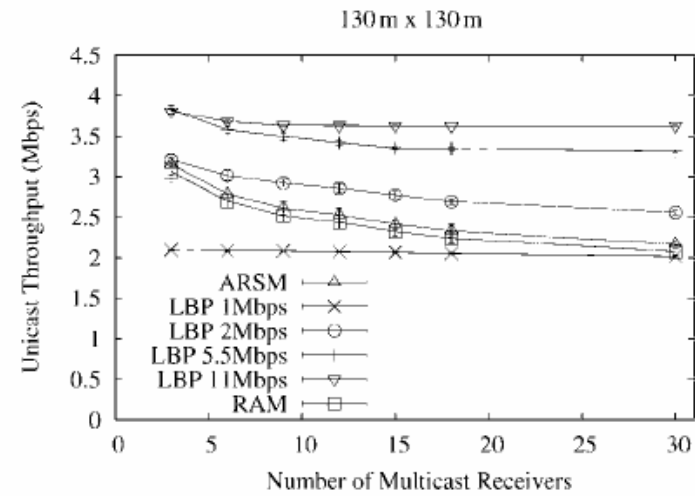
- ▶ We model an IEEE 802.11b WLAN consisting of an AP, several multicast wireless MTs, and five unicast wireless MTs.
- ▶ every MT is able to detect a transmission from any other MT.
- ▶ The multicast MTs move randomly within the BSS(basic service set) with a constant speed of 5 km/h
- ▶ $N_{th}=3$



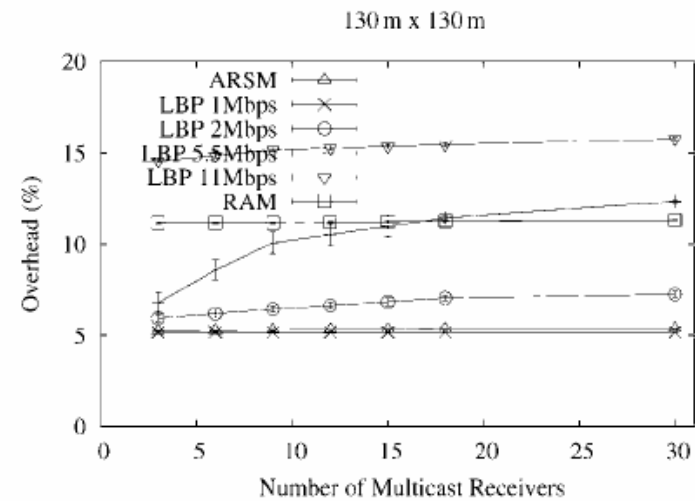
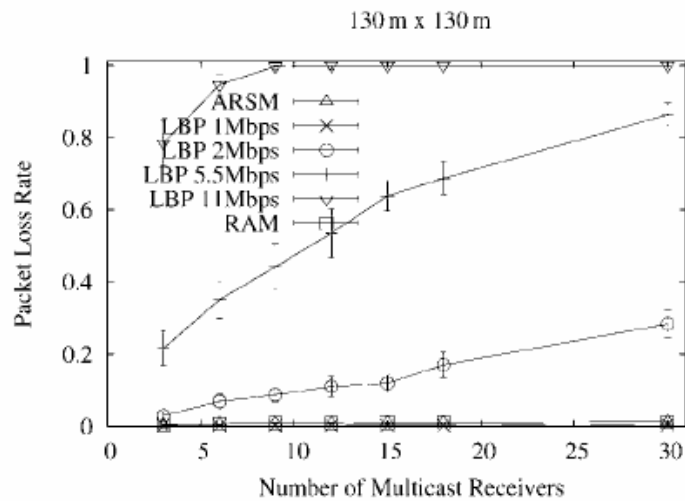
Performance evaluation



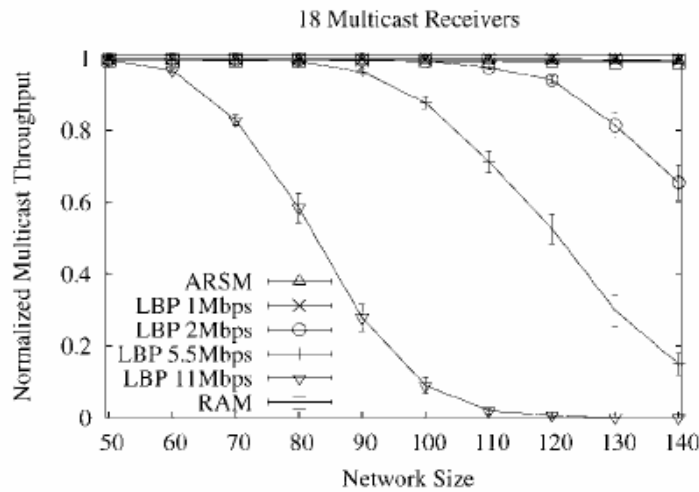
a



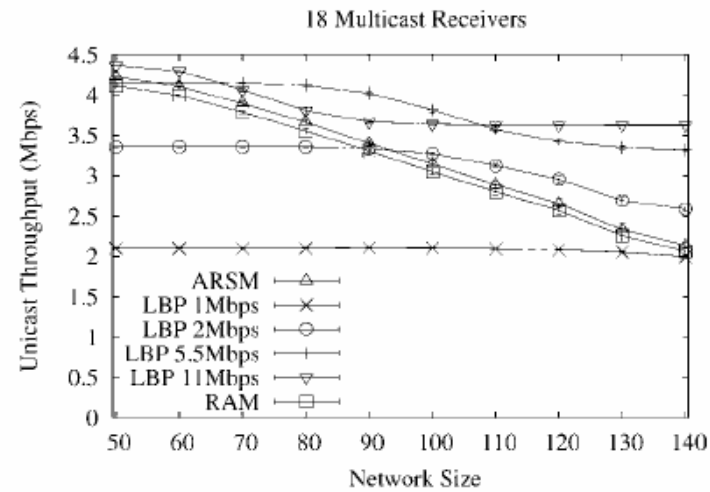
b



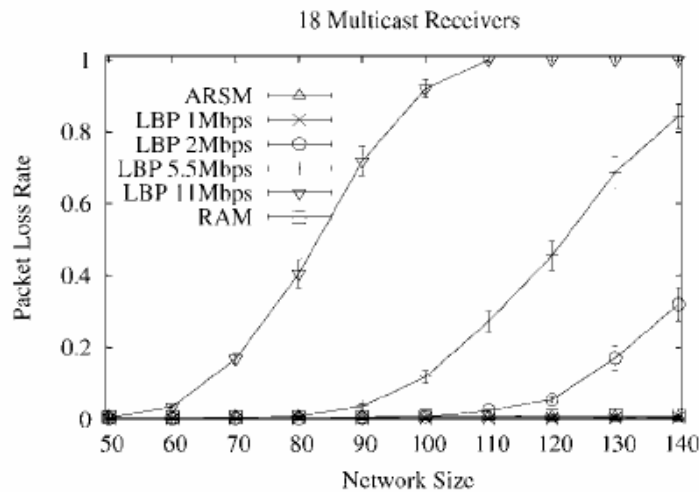
Performance evaluation



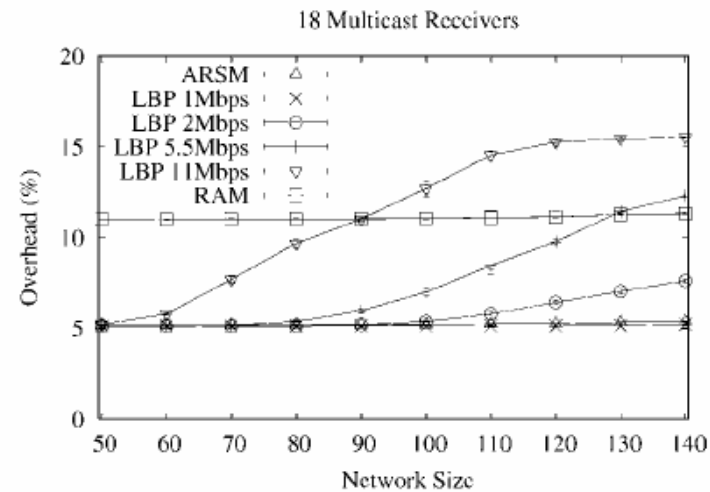
a



b



c



d

Conclusion

- ▶ The transmission rate to be used for the multicast traffic is determined based on the feedback received by the group leader.
- ▶ Our results have shown that the ARSM mechanism outperforms the IEEE 802.11, RAM and LBP mechanisms.

