Collision Detection based on Transmission Time Information in IEEE 802.11 Wireless LAN

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Outline

- Introduction
- CD-TT Scheme
- Simulation
- Conclusion

Introduction

- In 802.11 WLAN, transmission failures occur by two causes:
  - collision
  - channel noise (error)
- A station can not identify the cause of a transmission failure
  - know only whether the transmitted frame has been received successfully by ACK

Introduction

- Many operations of 802.11 WLAN and proposed adaptive schemes assume that all transmission failures occur by one reason: collision or channel error
  - Backoff mechanism of 802.11 MAC
    - Assumes that transmission failures result from collisions
  - Automatic Rate Fallback (ARF)
    - A station lowers its transmission rate when the transmission failures occurs consecutively assuming that transmission failures are by channel errors

Introduction

- The author proposed a scheme which can differentiate the causes of transmission failures to improve the performance of 802.11 MAC and the proposed adaptive schemes
- This scheme can detect collision accurately with low bandwidth overhead without modifying the physical layer of existing WLAN devices

Collision Detection Based on Transmission Time (CD-TT)

- In CD-TT, each station stores the transmission time information (TT) of its transmission attempts in a queue
- TT is the two tuple timestamp of a transmission based on the station's local clock
  - start time (ST)
  - duration time (DT)

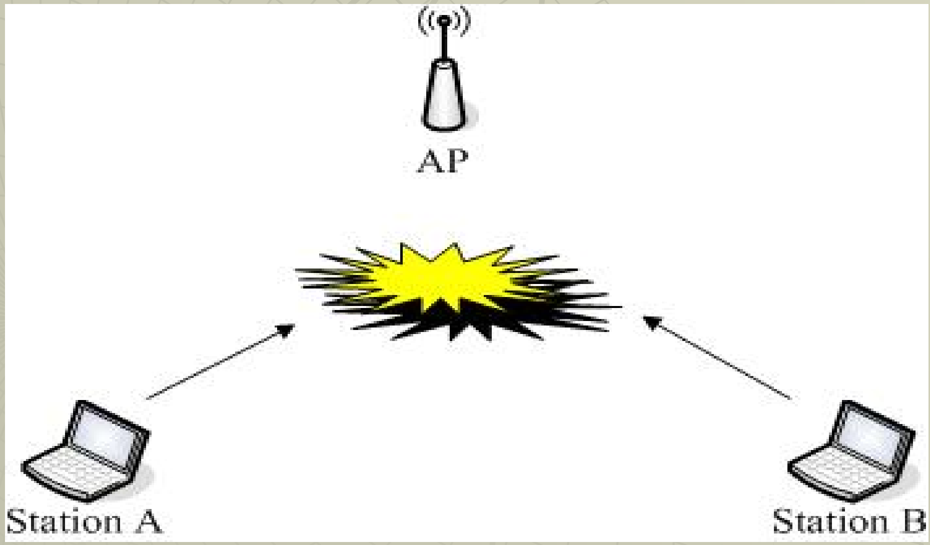
Collision Detection Based on Transmission Time (CD-TT)

- When a failed transmission occurs, the station exchange the TT of this failed transmission with other stations

- When other stations receive the TT, it checks the information against its previous transmission schedules

Collision Detection Based on Transmission Time (CD-TT)

- Consider the case when a collision occurs between two stations A and B in an infrastructure BSS



First Detection Phase

- When the station A does not receive an ACK frame for the transmitted frame
  - Piggybacks the failure notification (FN) to inform the other stations of its transmission failure
  - The FN contains the TT of the failed transmission

First Detection Phase

- Then, the AP piggybacks that FN on the ACK frame since the other collided stations can be hidden from the FN-sending station

- The ST of the FN is recalculated to ST' based on

$$\mathrm{ST}' = t_1 - \mathrm{ST} + \mathrm{T}[\mathrm{Data} + \mathrm{FN}] + \mathrm{SIFS} + \mathrm{T}[\mathrm{ACK} + \mathrm{FN}]$$

First Detection Phase

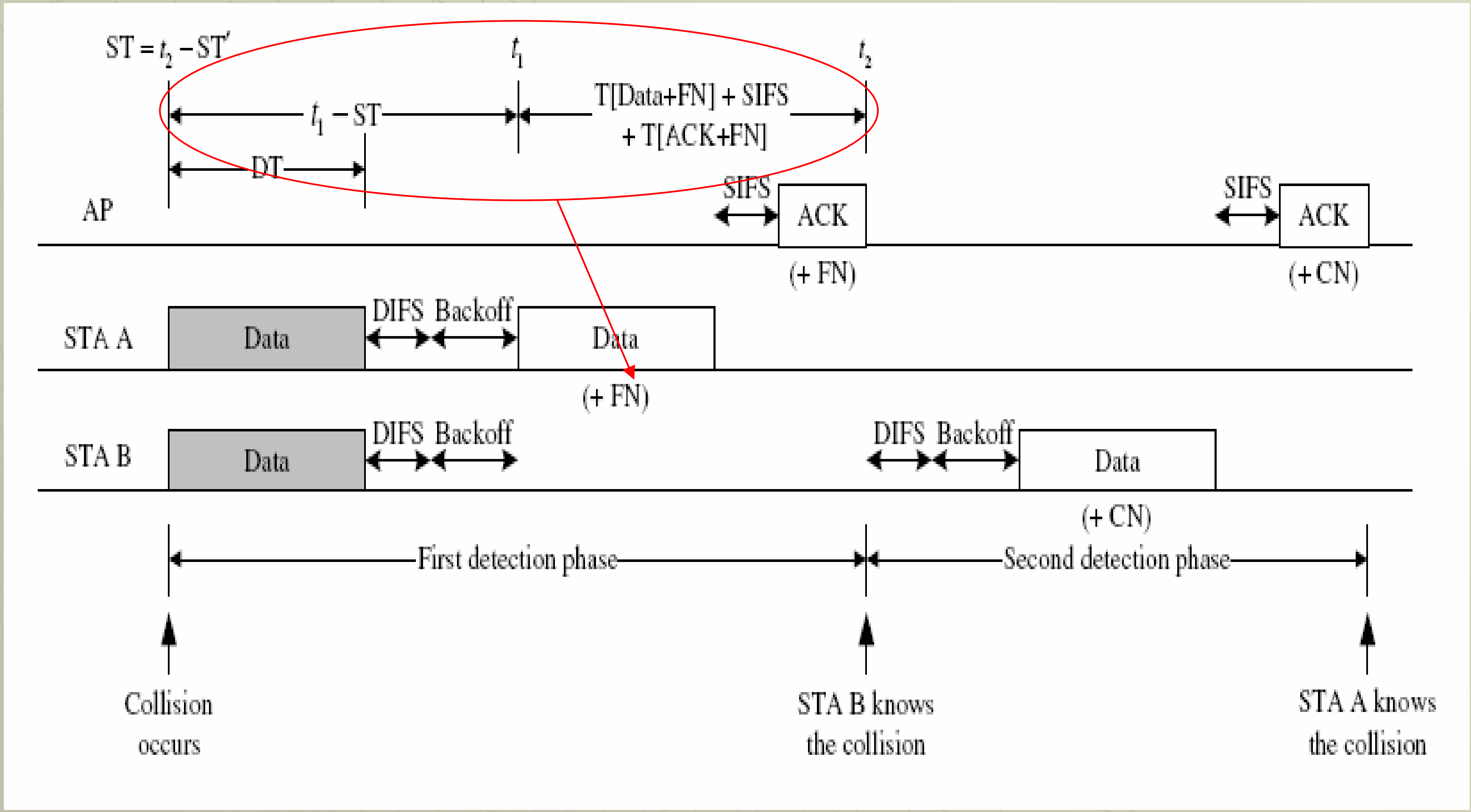
- Then, the other stations can infer the start time of the failed transmission by subtracting the received ST' from their local clock time *t*2 when the transmission of the ACK+FN frame finishes.
- The station B knows the collision because there was also its own transmission attempt which overlaps the transmission by the station A

First Detection Phase

- TT1 = (ST1,DT1) and TT2 = (ST2,DT2) are defined to overlap with each other when they satisfy the below condition:

$$(ST_1 \leq ST_2 < ST_1 + DT_1) \text{ OR } (ST_2 \leq ST_1 < ST_2 + DT_2)$$

Collision Detection Based on Transmission Time (CD-TT)

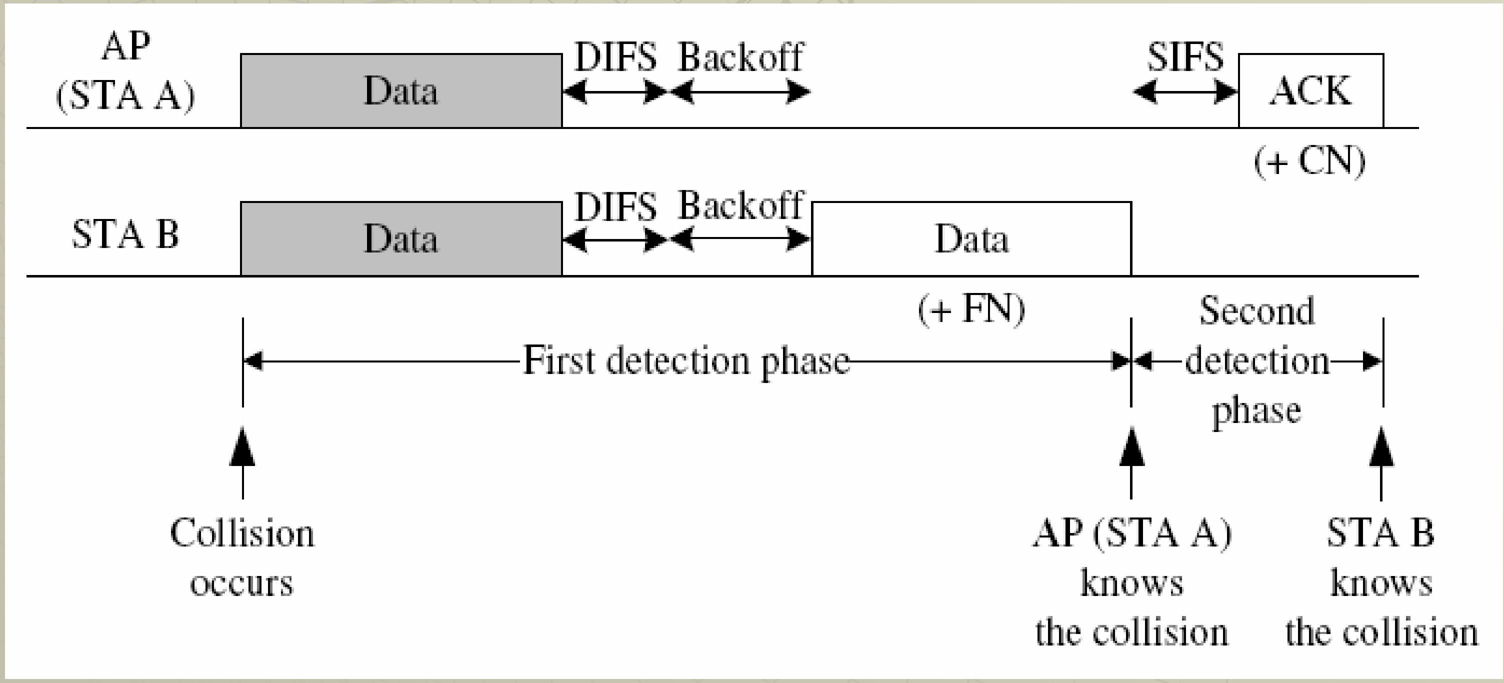


Second Detection Phase

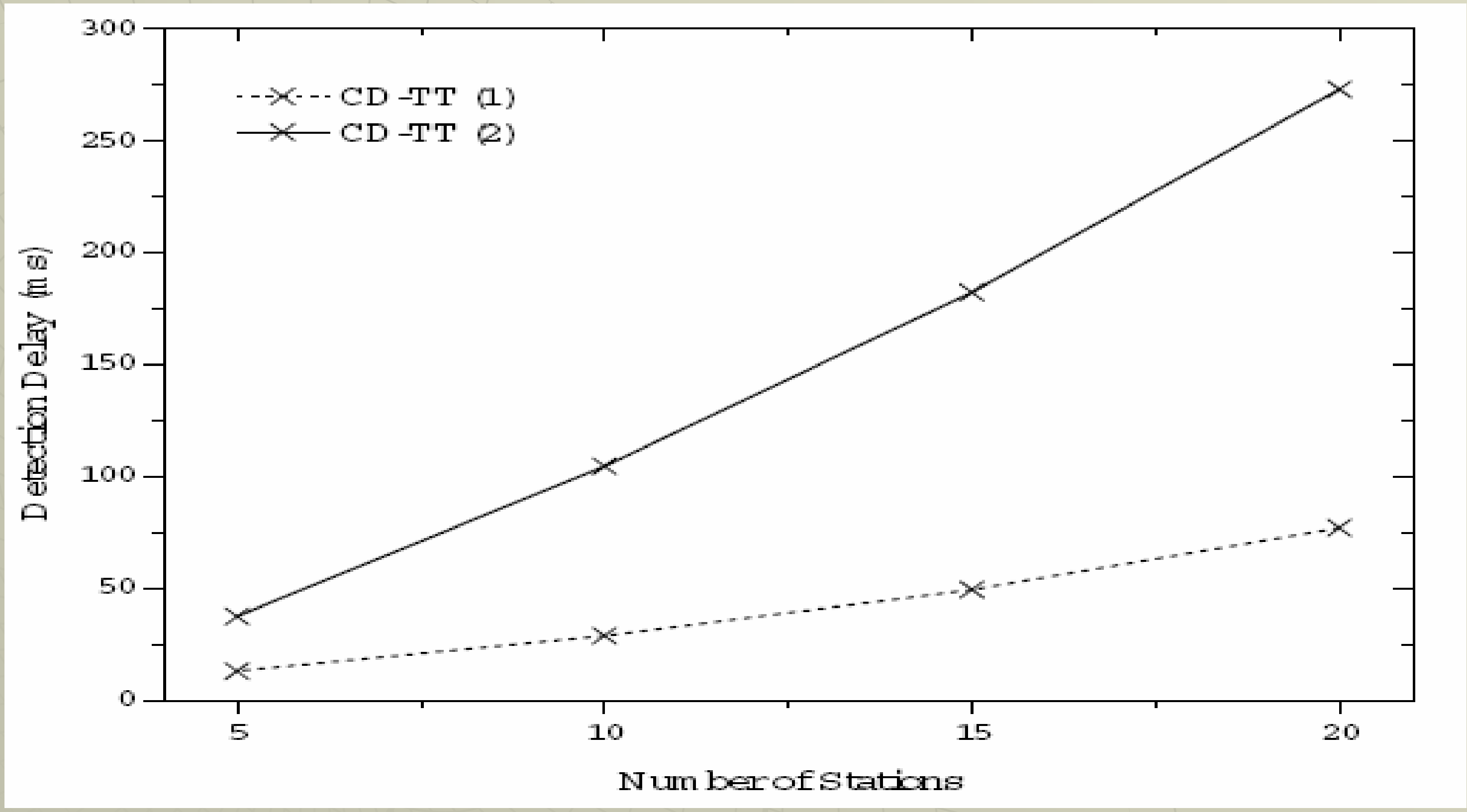
- To notify the station A of the collision, the station B piggybacks the collision notification (CN) on its next data frame, which contains the TT of the collided transmission
- Finally, the station A knows the collision by checking the CN against its queue

Collision Detection Based on Transmission Time (CD-TT)

- Consider a collision occurs between an AP and station(s)

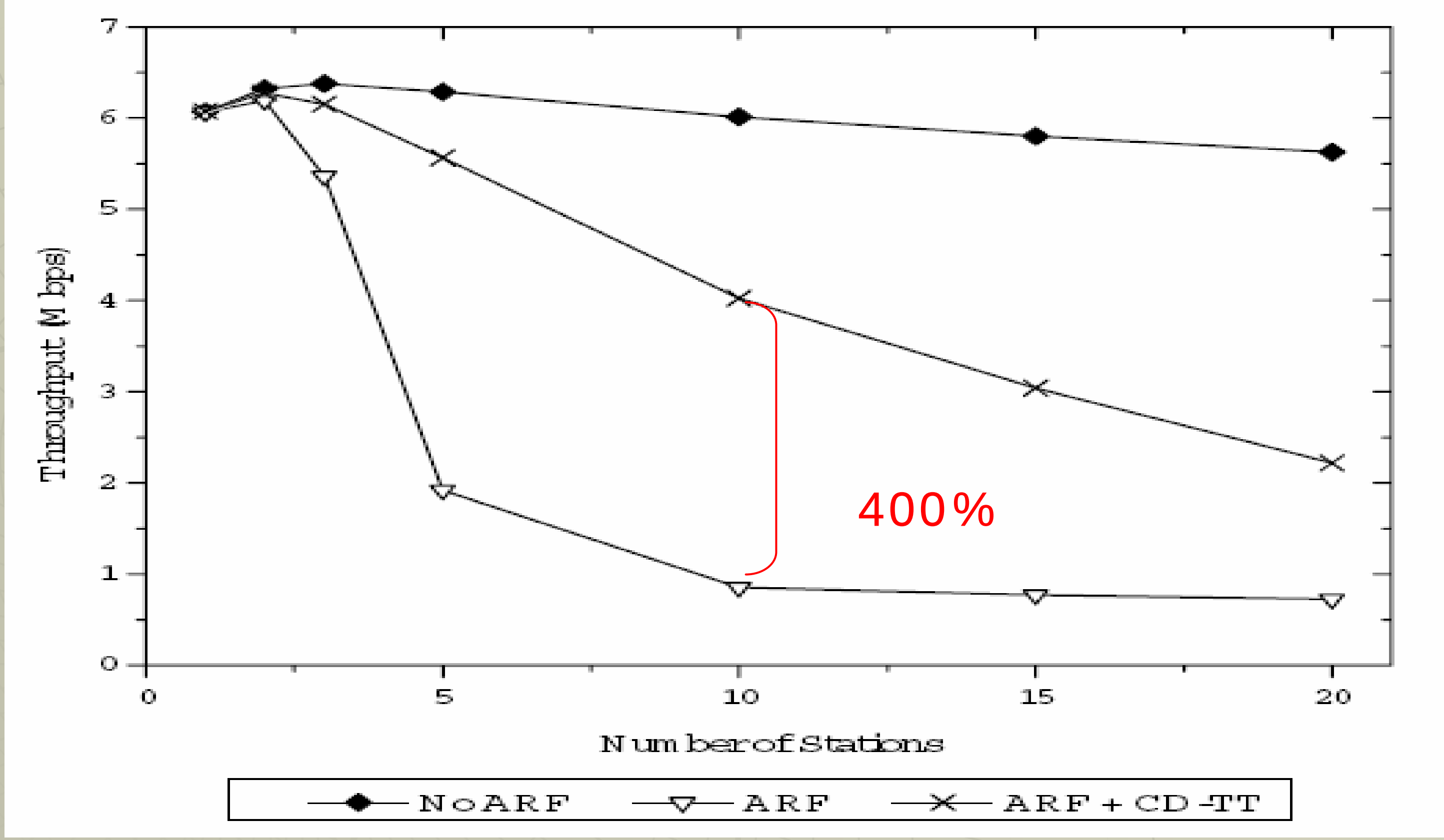


Simulation



Detection delay of each phase

Simulation



Throughput of ARF with and without CD

Conclusion

- In this paper, it proposed a novel collision detection scheme for IEEE 802.11 WLAN, which can detect collision accurately with small bandwidth overhead.

- This scheme can improve the performance of the wide range of adaptive schemes if transmission failures can be identified correctly.

Conclusion

- The limitation of the proposed scheme is that collisions are detected in some delay, can detect only the collision.
- One possible way to reduce the detection delay is to piggyback as many FNs and CNs as possible on a data frame.