Mobile Communication Performance at Link Layer

Medium Access Control

Mobile entities

- **User** mobility – access form different physical host
- **Personal** mobility – uses unique personal identity
- **Host** mobility – change attachment point without interrupt of data delivery.
- **Local** mobility and **global** mobility

Mobile entities (User Mobility)

- User has account on different host
- Host does not restrict users
- Corporation Network

Mobile entities (Personal mobility)

- Based on personal number
- Ability to track and to provide location
- Security and AAA
- Ability to initiate the session
- SIP or DNS server

Mobile entities (Host mobility)

- Maintain integrity of ongoing communication
- Logically independent on user mobility
- Mobility over 'large' area is 'global'.
  Inter-domain.
- Mobility over 'small' area is local. Inside singe domain.

Performance model at link layer

- Family of 802.11(x) protocols recommend international standard for Wireless Local area networks (WLAN)
- Medium Access Control (MAC)
- Physical Layer Specification (PHY)
- MAC fundamental is Distributed Coordination Function (DCF)

Performance Model (DCF fundamentals)

- DCF is based on Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)
- Station with a packet to transmit monitors wireless channel activity
- Channel is idle during Distributed Interframe Space (DIFS) – station transmits
- Otherwise channel is busy and station continues monitoring until DIFS is observed

Performance Model (DCF fundamentals)

- Station generates random back off interval and then transmits
- Station must generate random back of between two consecutive packet transmission even if DIFS was observed

Performance Model (DCF fundamentals)

- DFC employs discrete back off scale
- Time after DIFS is slotted.
- Station may transmit only in the beginning of each slot
- Slot size is enough to detect transmission from any other station

Performance Model (DCF fundamentals)

- Back off time is uniformly chosen form the range (0, w-1). w is **contention** window
- Contention window depends on number of failed transmissions
- At each fail contention window changes from Cw_{min} to $2^m Cw_{min}$. Vales are defined by 802.11 standard
- Back off counter is decremented of frozen

Performance Model (DCF fundamentals)

- Destination station sends ACK
- ACK is transmitted immediately after receiving packet and Short Interframe Space (SIFS)
- Two-way handshaking is Basic Access Mechanism
- Four-way handshaking RTS/CTS fights ‘Hidden Terminal problem’

Performance Model (DCF fundamentals)

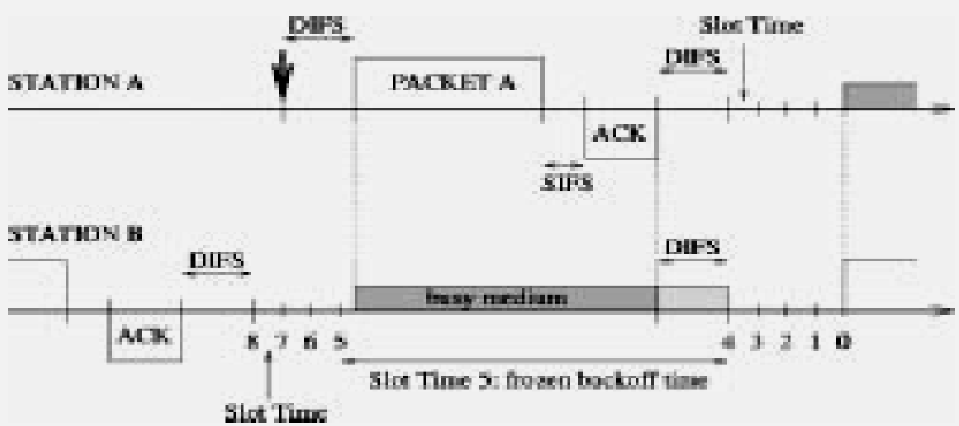


Fig. 1. Example of basic access mechanism.

Performance Model (DCF fundamentals)

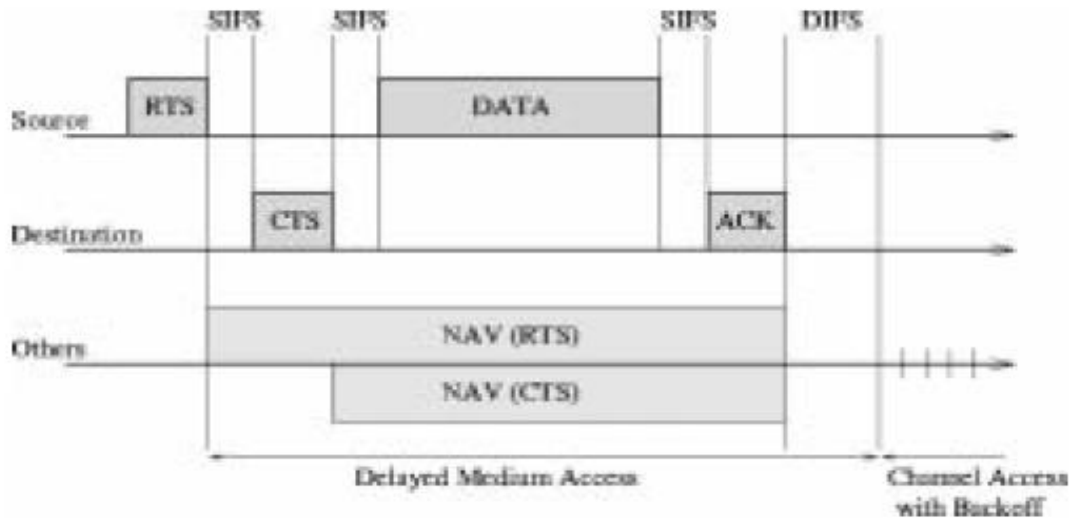


Fig. 2. RTS/CTS Access Mechanism.

Performance Model (DCF fundamentals)

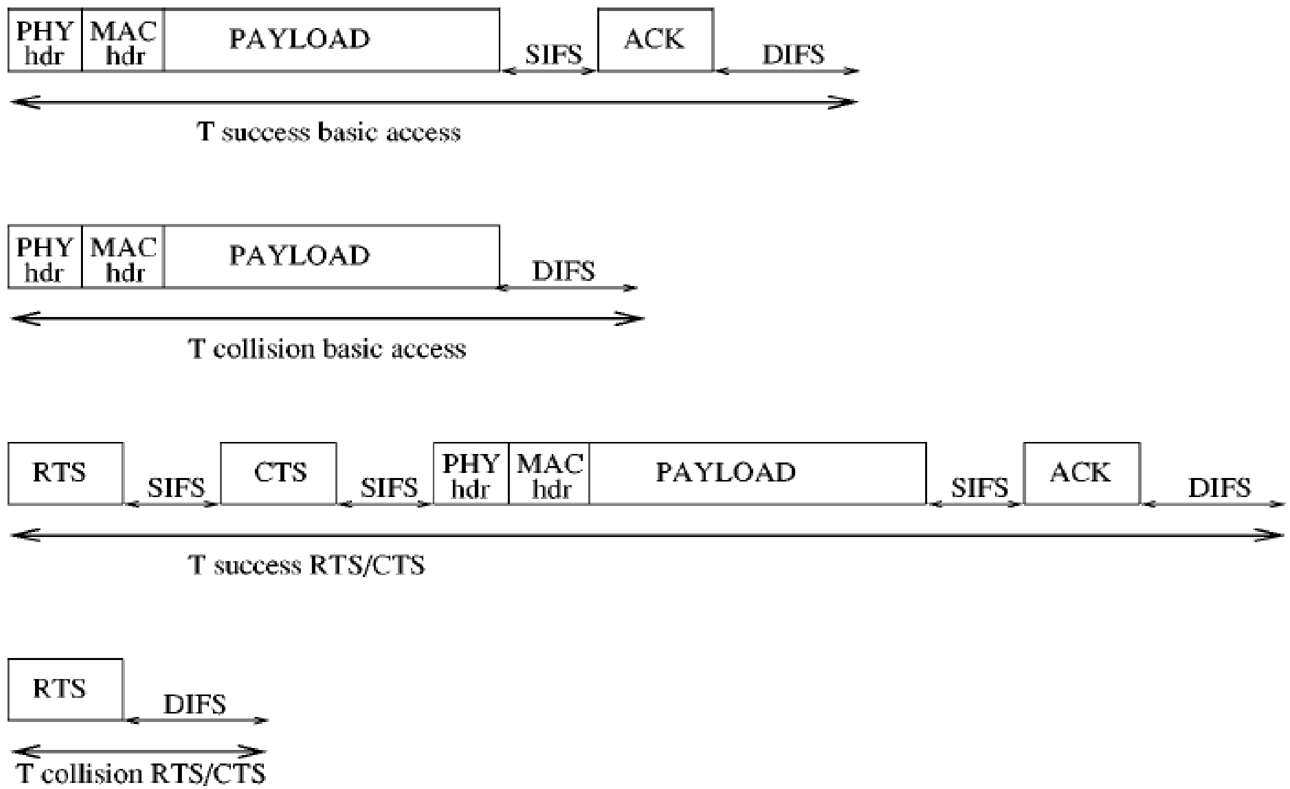


Fig. 5. T_s and T_c for basic access and RTS/CTS mechanisms.

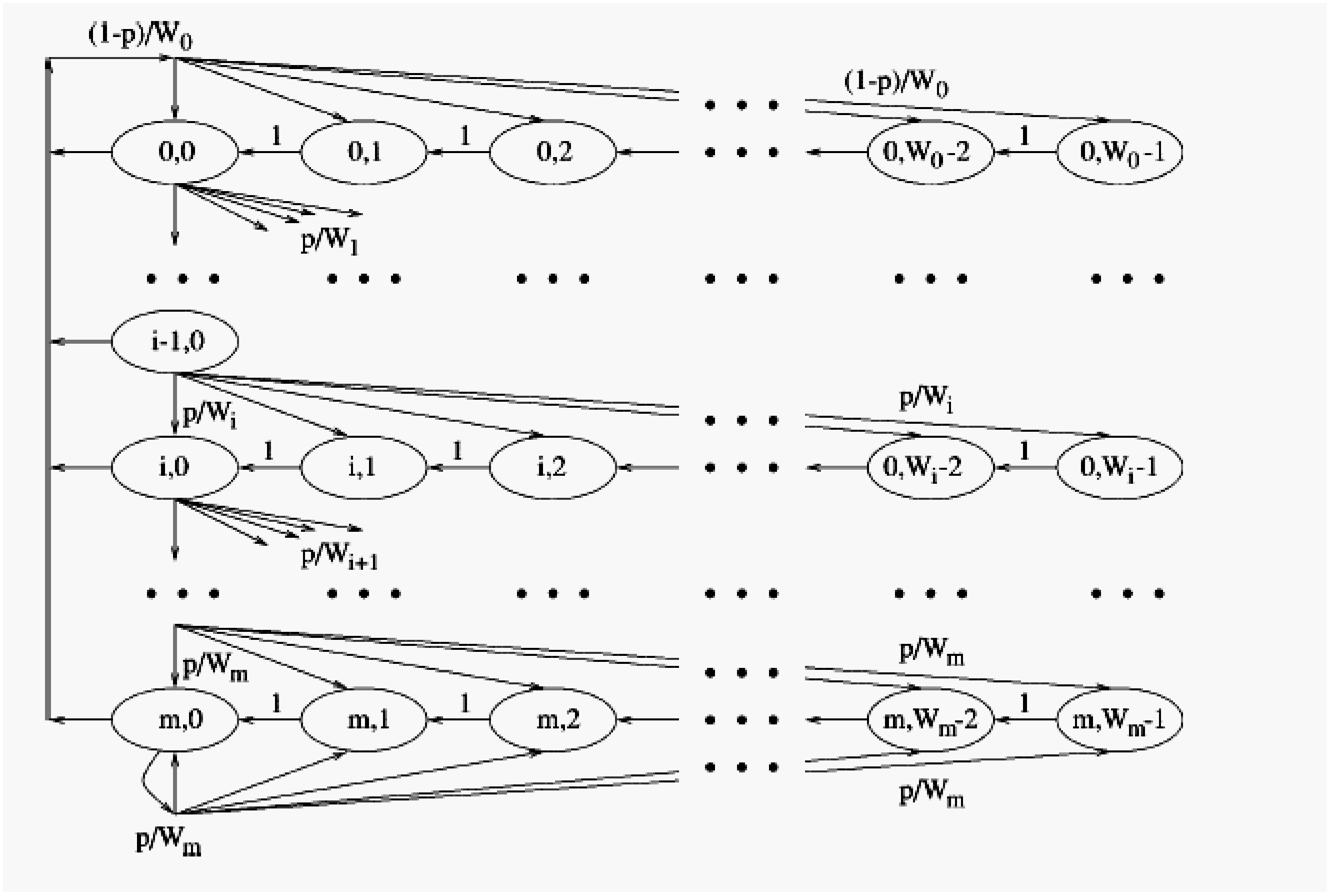
Performance Model (Saturation)

- Load and throughput
- Saturation throughput
- Each station has a packet to transmit

Markovian Model (G. Bianchi)

- In the WLAN n stations contend
- We consider back off counter at a single station
- Discrete integer time scale is adopted
- No hidden stations
- Each packet collides with independent constant probability p

Markovian Model (G. Bianchi)



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Markovian Model (G. Bianchi)

- Let τ be probability that station transmit

$$\tau = \sum_{i=0}^{m} b_{i,0} = \frac{b_{0,0}}{1-p} = \frac{2(1-2p)}{(1-2p)(W+1) + pW(1-(2p)^m)}$$

$$p = 1 - (1-\tau)^{n-1}$$

Evaluation of DCF Performance

- **Input parameters of performance model**:

  Number of contending stations,

  Number of back off levels,

  Contention window limits

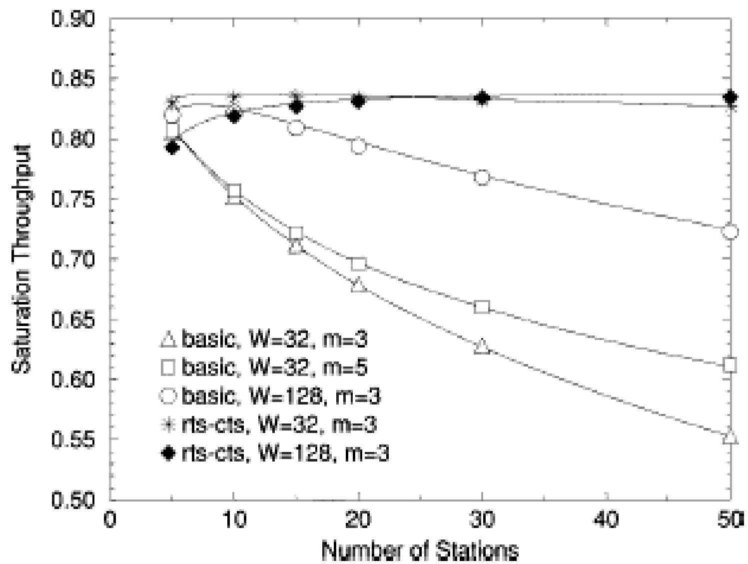
- **Model results:**

  Probability that packet collides

  Probability that station sends packet

  Throughput

Numerical example (G. Bianchi)



Numerical example (G. Bianchi)