Retransmission-based Access Class Barring for RAN overload control in Machine Type Communications [?]

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Outline

Aim

- **In order to alleviate the RAN overload,**
  - We focus on the objective that can increase access success probability and relieve the access delays.
- **Accroding to traditional ACB factor is fixed.**
  - We proposed an algorithm to make eNB be able to change ACB factor dynamically.

Background

- **Random Access Procedure**
  - When UE device is switched on or handover from on eNB to another.
  - UEs will contend resource blocks with others.
  - Is classified into two type in LTE, contend based and contend free.

Background

- 4 step in random access procedure

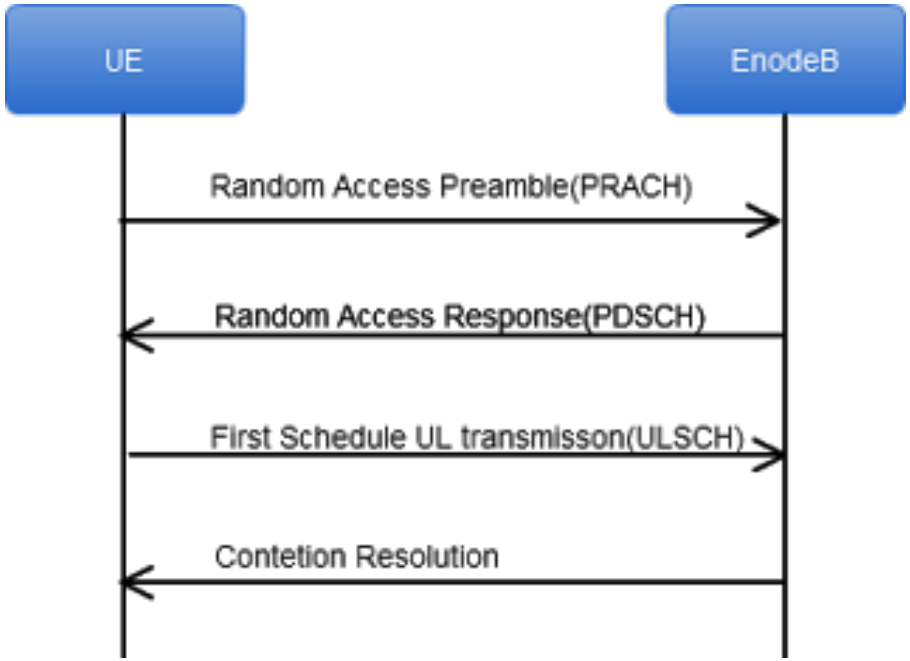

Figure: RAP

System model
Random Access Procedure

- Devices will receive info from SIB2
- Device will choose a preamble and increase preamble transmission
  - wait for Random Access Response(Msg2)
  - if fail to receive RAR, it will wait for a backoff time to retry if the times of transmission is smaller than maximum
- Sending the connection request(Msg3)
  - If successfully to transmit the preamble to eNB, it will finish the RAP
  - if it fail to receive contend resolution(Msg4), it will wait for a backoff time to retry if the times of transmission is smaller than maximum

System model
Random Access Procedure

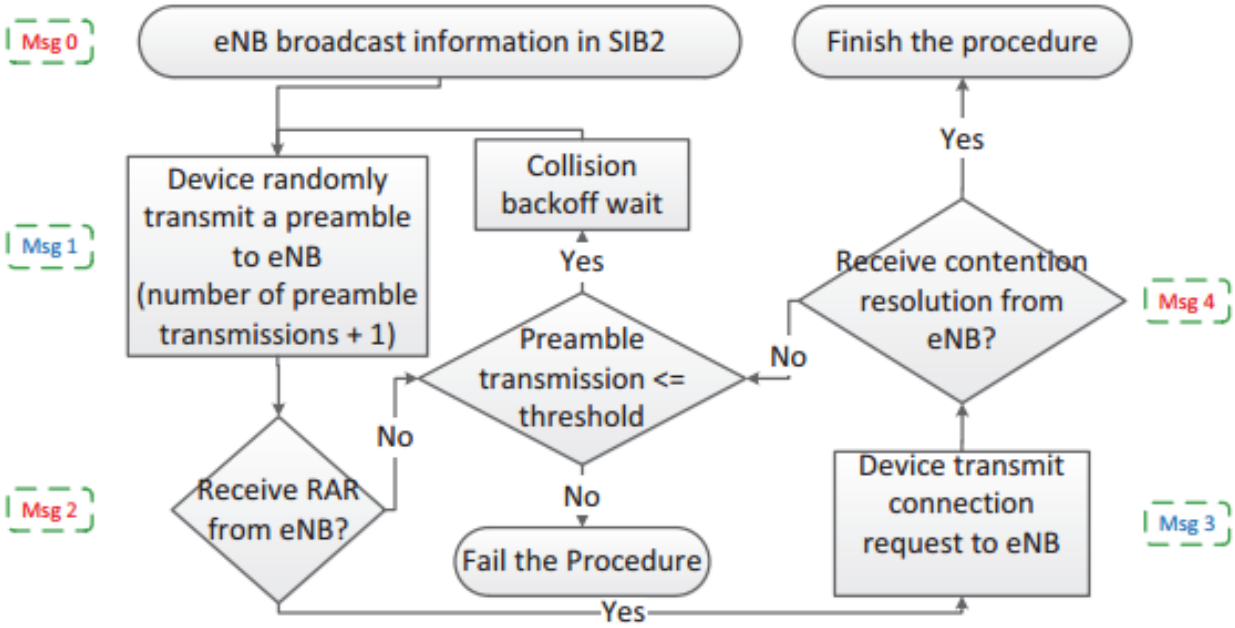

Figure 3.3: Random access flow chart

Figure: RAP flow chart

System model
Access Class Barring Scheme

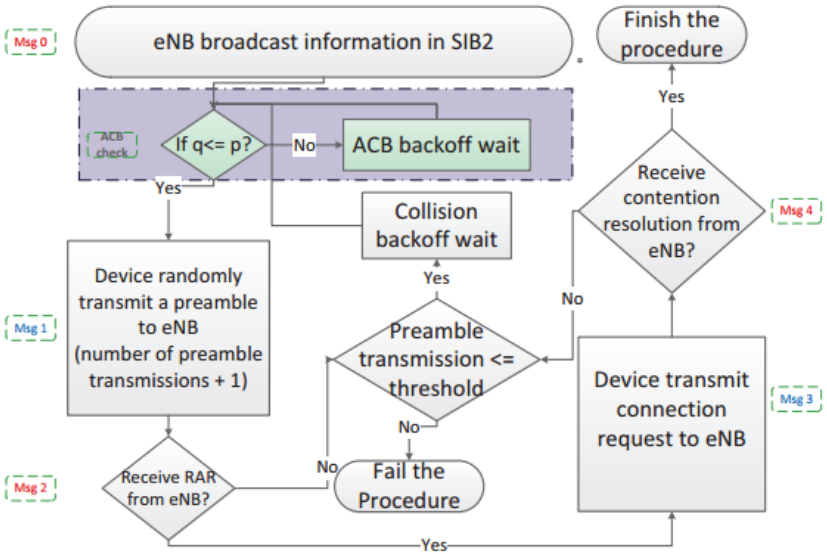

Figure 3.5: ACB flow chart

Figure: add ACB check in rap flow

System model
Access Class Barring Scheme

- ACB factor is broadcasted by eNB
- Each device yield a random value q, if q less than p, it passed the check of ACB and allowed to perform RAP
- If not, it will be barred and wait for a backoff time of ACB to retry.

System model
Performance Metric

- Access success probability
  - the probability to successfully complete the RAP within the maximum times of retransmission
- Access Delay
  - the RACH slots between the first random access attempt and the completion.

New grouping concept

- Add a new message in SIB2 used to group devices into several groups.
- the new message are the range of the times of preamble transmissions.

New grouping concept

Group 1: 1<=number of preamble transmissions <=5
Group 2: 6<= number of preamble transmissions <=10

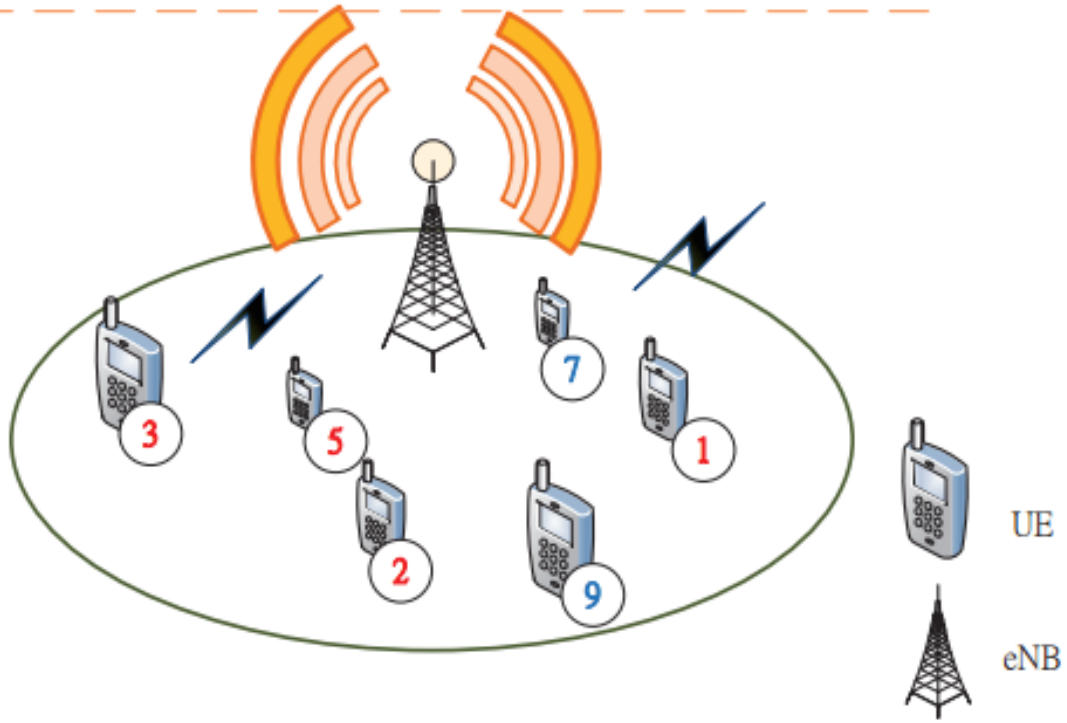

Figure 4.1: Group model of proposed method

New grouping concept

- We obtain it's estimation N' according to the existing information
  - number of success preambles and collision preambles.
  - N is all number of device that perform preamble transmission.
- We let device who success to perform preamble transmission return it times of preamble transmissions in Msg3 of RAP.

New grouping concept

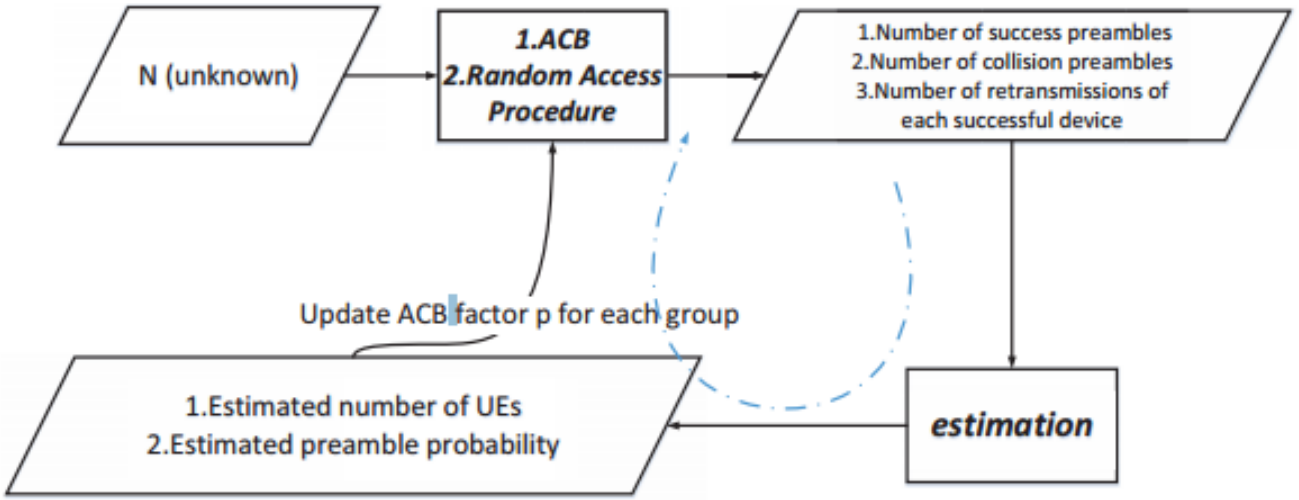

Figure 4.2: The block diagram of our proposed retransmission-based ACB scheme

New grouping concept

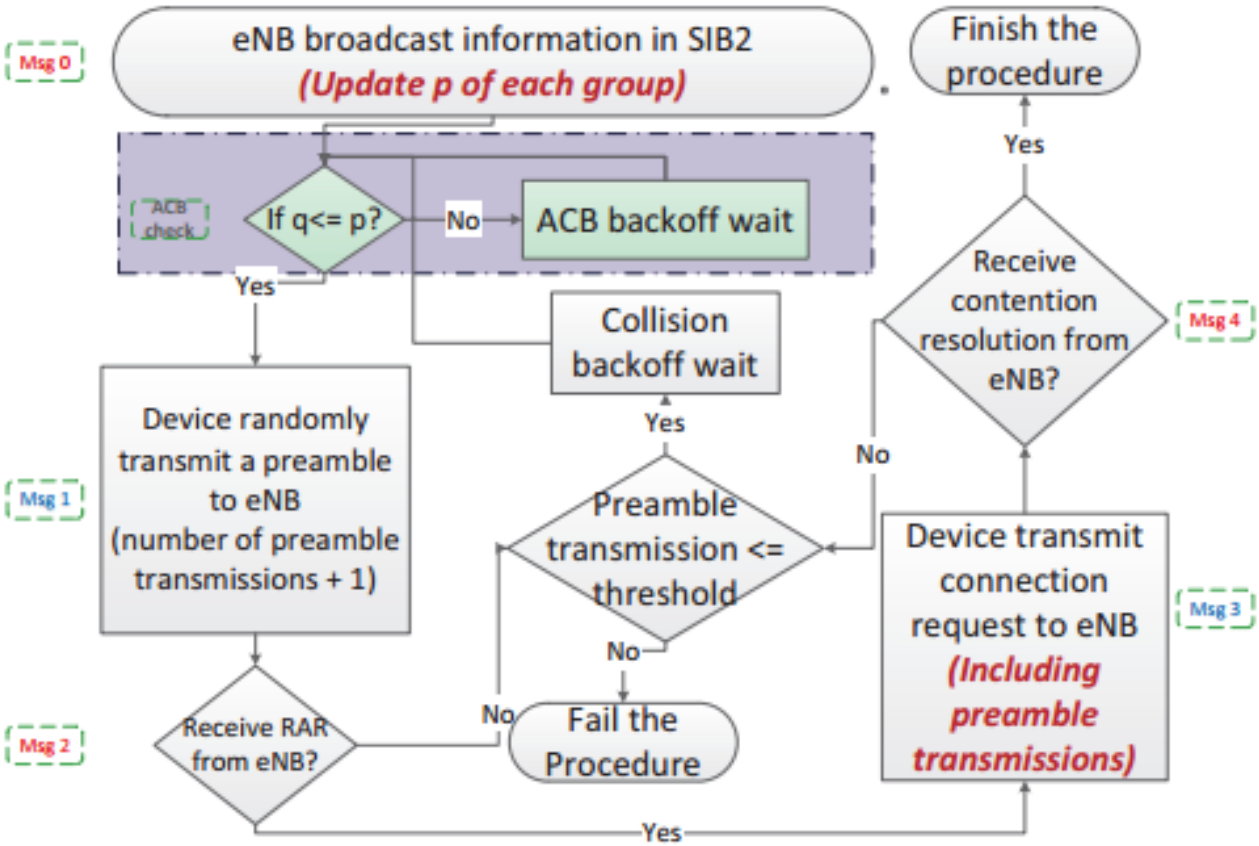

Figure 4.3: Retranmission based ACB flow chart

Update ACB factor dynamically

- The group which has larger threshold has higher priority.
  - To accomplish this; we assign each group to a different weight w_m
- w_m can be consider as the proportion of the allocation of RACH resource.
  - so that $\sum w_m = 1$

Update ACB factor dynamically

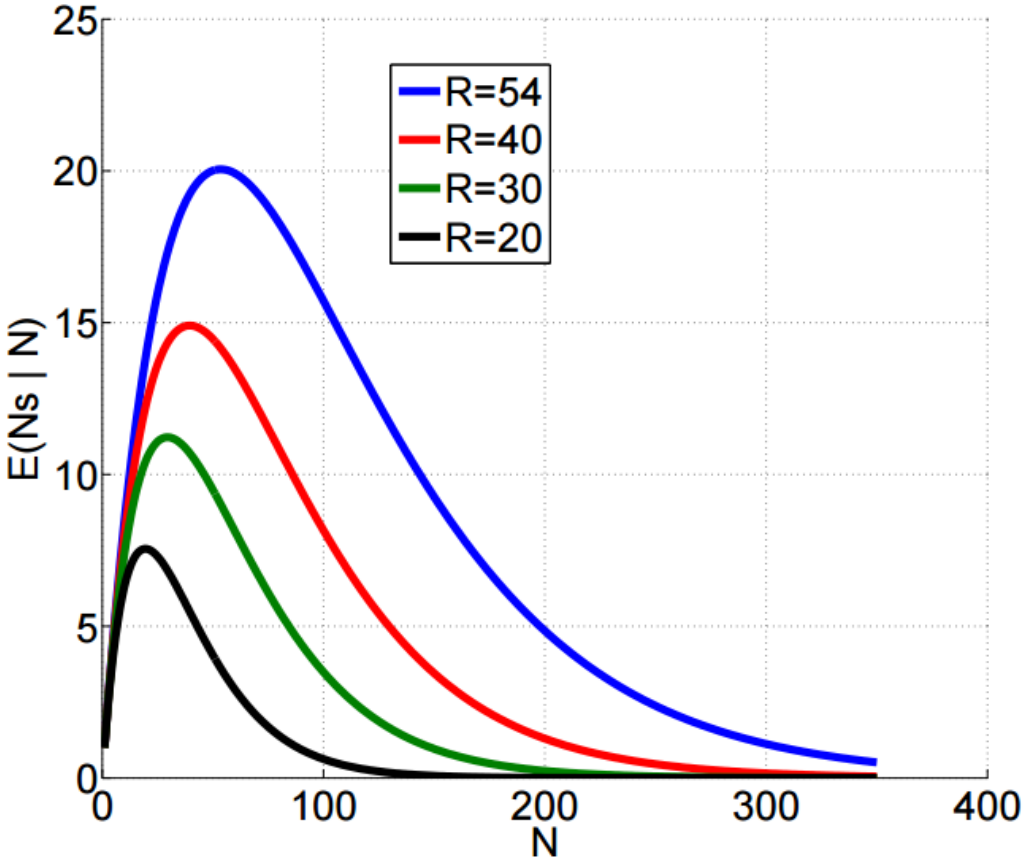

Figure 5.1: The expected number of success UEs

Update ACB factor dynamically

- Due to the $E(N_s|N)$ be maximum while N is equal to R or R-1
  - we hope that there are only $N \approx R$ device who attemp to perform preamble transmission in a RACH slot.
- P_m is the ACB factor of group m and R is the number of devices which passed the ACB.
- $p_m = \frac{W_m R}{N'}$

Update ACB factor dynamically

Algorithm 2 Update ACB Barring Factor Dynamically with congestion control

input: R, number of success preambles and collision preambles, design parameters w_m
set $time\ slot = 0$; $p_m = 1$, for all m
while do $N_s + N_f < N$
    $time\ slot = time\ slot + 1$;
    if (activate preamble ≥ 50 percent) **then**
        check the table and then set max(N')
    else
        check the table and then set min(N')

        if (number of success transmitted preambles $\leq 0.2*$ number of activate preambles) **then**
%Congestion Control
            $W = \{w_1, w_2, .., w_m\}$, sort W to an descending order
            set $w' = m^{th}$ weight in set W
            $p_m = \frac{w'R}{N'}$;
        else
%No congestion Control
            $W = \{w_1, w_2, .., w_m\}$, sort W to a ascending order
            set $w' = m^{th}$ weight in set W
            $p_m = \frac{w'R}{N'}$;
        end if
    end if
end while

Simulation Result

Parameter	Value	
Number of devices	20000 to 30000	[7]
Number of preambles	54	
Maximum allowable transmissions	10	
Collision Backoff time	20 ms	
Arrival period	10s	
PRACH Configuration Index	6	
ACB Backoff time	320 ms	
ACB factor for group 1	1	
ACB factor for group 2	1	

Figure: Simulation parameter

Simulation Result

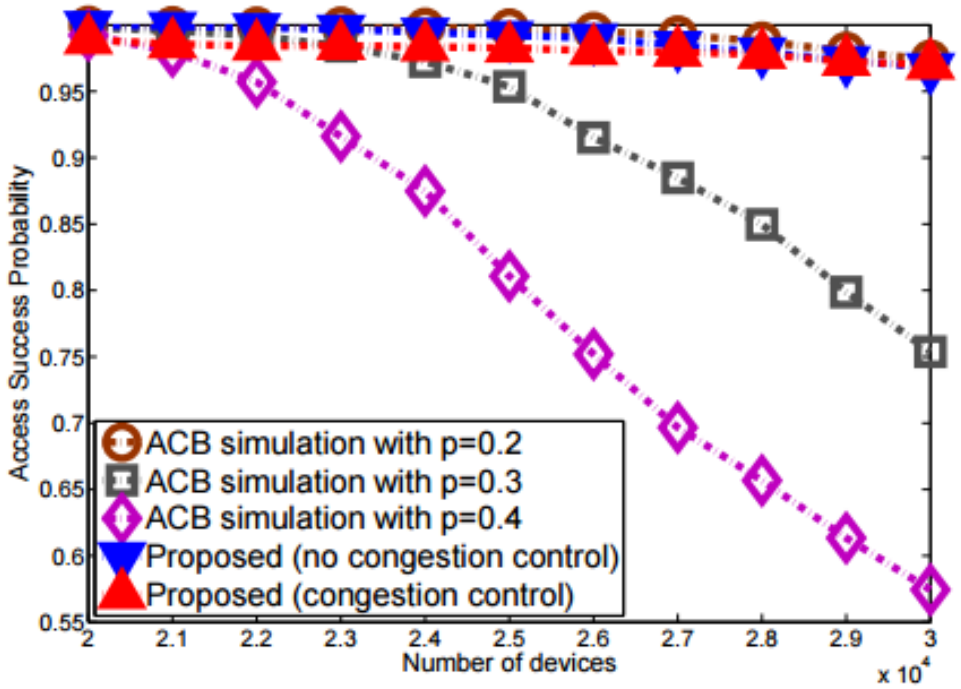

Figure 6.1: Effects of congestion controls and no congestion controls on access success probability

Simulation Result

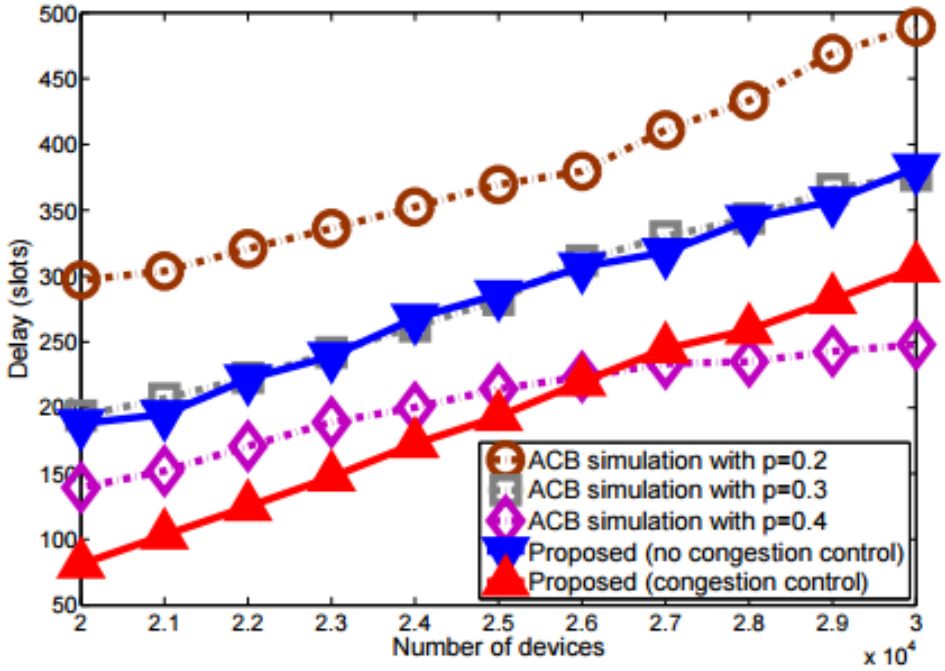

Figure 6.2: Effects of congestion controls and no congestion controls on access success delay

Simulation Result

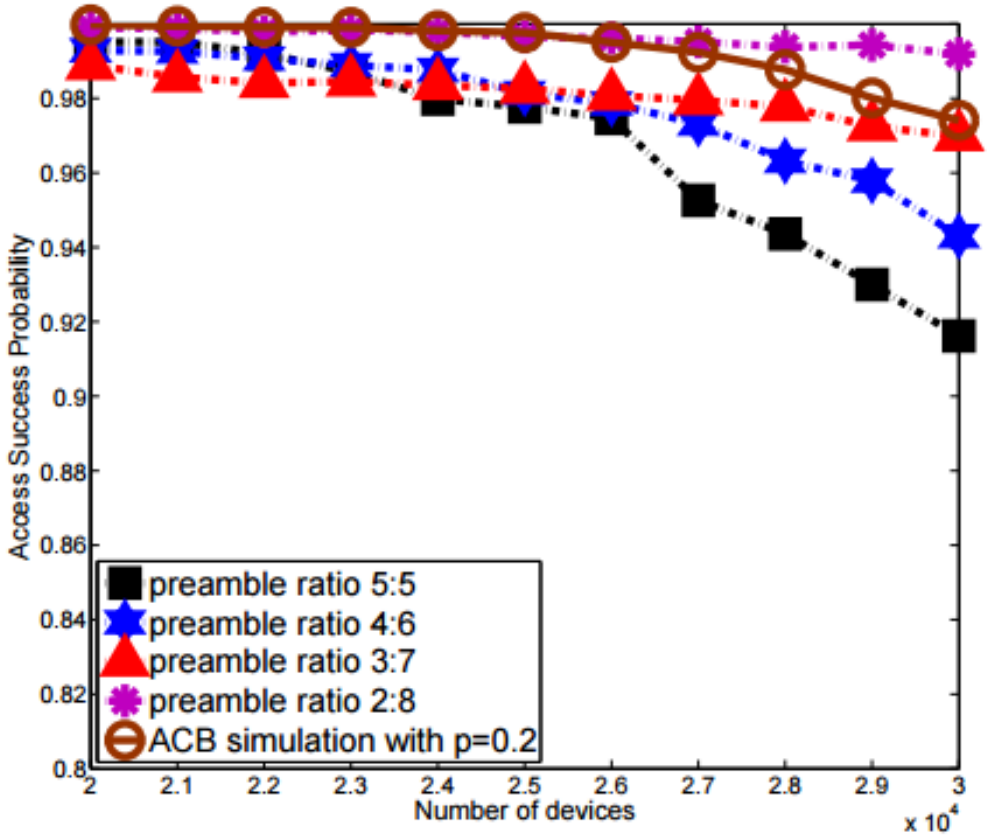

Figure 6.3: Effects of congestion controls and preamble ratio on access success probability

Simulation Result

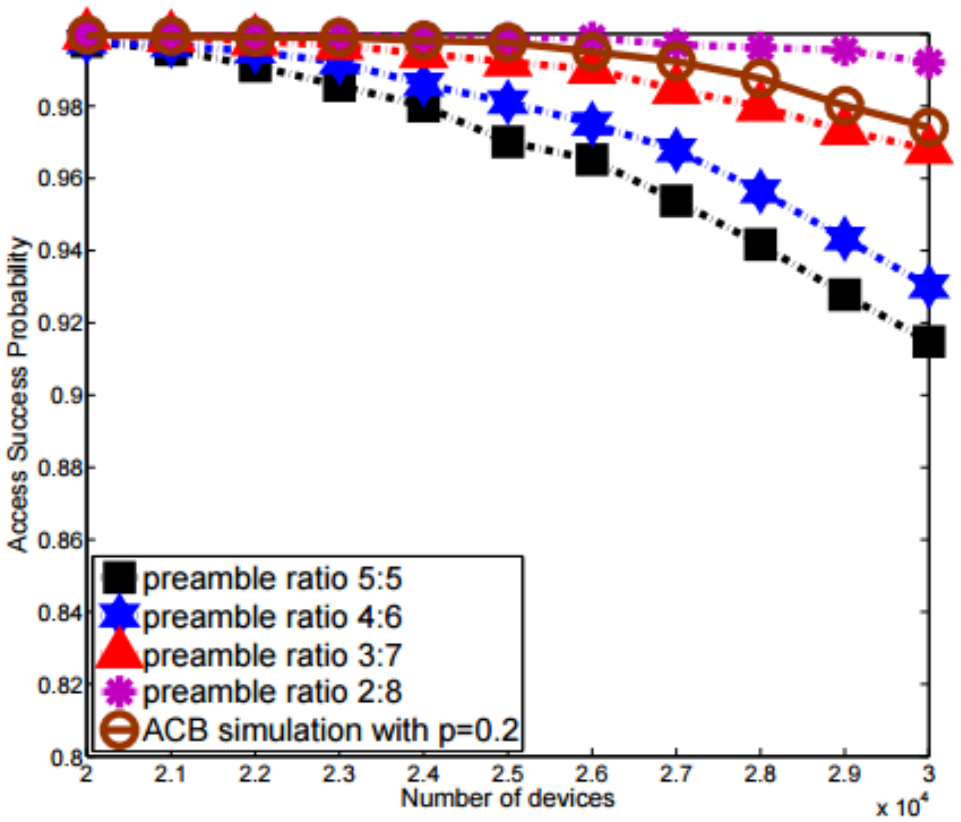

Figure 6.4: Effects of no congestion controls and preamble ratio on access success probability

References

Thanks for Your Attentions