



## 802.11e, QoS-supporting WLANs standard

Suong Hong Nguyen  
Centre for Advanced Internet Architectures



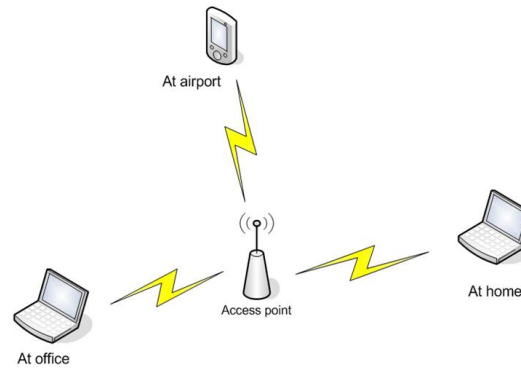
### Overview



- Why WLANs?
- Why 802.11e?
- Features of 802.11e
- Modelling 802.11e
- Example of optimizing 802.11e



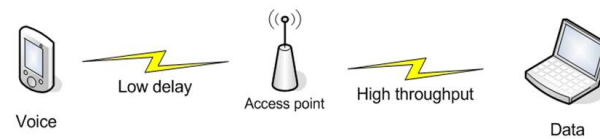
## Why WLANs?



## Why 802.11e



- 802.11 can not provide different QoS for different types of traffic.



## 802.11e



### ■ An QoS extension to 802.11

- QoS guarantee
  - HCCA (HCF-controlled channel access):
    - Polling based
    - rarely implemented
- QoS classification
  - EDCA (Enhanced Distributed Channel Access):
    - Contention-based
    - Common implementation

## EDCA

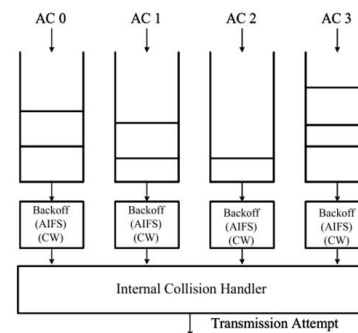
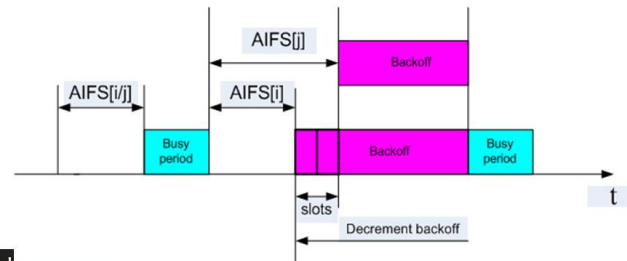


Fig. Four Access Categories (ACs) for EDCF

## EDCA access mechanism



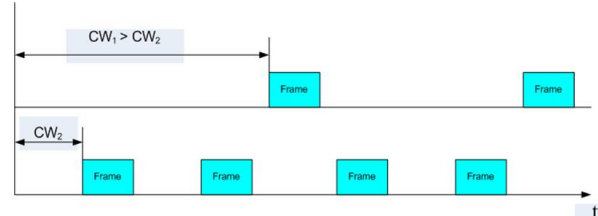
- Enhanced DCF: CSMA/CA
- Backoff = random(0, CW)
- AIFS = AIFSN \* SlotTime + SIFS (AIFSN: integer variable)



## CW differentiation



- How often a station can transmit

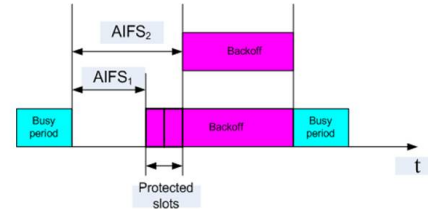


- Lower CW: lower service time -> higher throughput
- Modeling: different attempt probability.

## AIFS differentiation



- Reserve channel slot for high priority flow: protected slot



- Network congestion increases -> percentage of protected slots increases
- Hard for modeling because of non-homogeneous slot

## AIFS differentiation



- Scenario
  - Number of stations: N 802.11b DCF and N EDCA
  - AIFS EDCA = 1
  - DCF can approximated as using AIFS = 3
  - Same CW<sub>min</sub> = 31
  - Saturation condition.

## AIFS differentiation



■ Bianchi, 2005

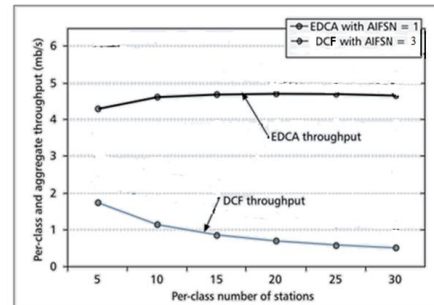
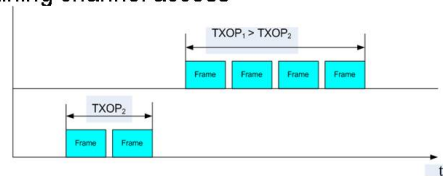


Figure . DCF vs. EDCA throughput with AIFS differentiation.

## TXOP differentiation

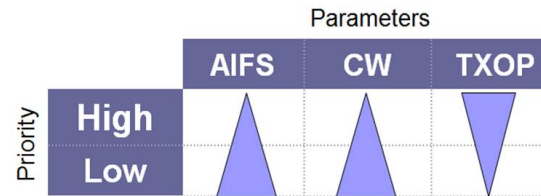


■ The max amount of time a STA can transmit once gaining channel access



- Large TXOP: more throughput, less delay
- Doubling TXOP roughly double throughput
- Modeling: different packet sizes.

## EDCA parameters



## Modeling EDCA



- Input: 4 types of traffic with AIFS, CW, and TXOP differentiation
- Saturated condition
  - Method
    - Markov chain: L.Xiong, 2007; J.Y.Lee, 2009.
    - Mean-value: Y.Lin, 2006; D.Xu, 2008.
  - Output:
    - Throughput
    - Access delay

## Modeling EDCA

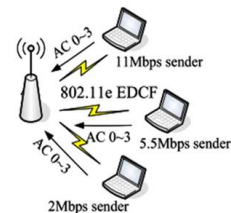


- Non-saturated condition:
  - Method:
    - Markov chain: B.Xiang, 2007; J.Hu, 2008.
  - Output:
    - Throughput
    - Delay
    - Loss probability

## Example of optimizing 802.11e EDCA



- Scenario: stations with different access rate



- Objective: stations have the same throughput for the same AC.
- Algorithm: adaptive TXOP which is inversely proportional to access rate.



## Fairness



### ■ Result

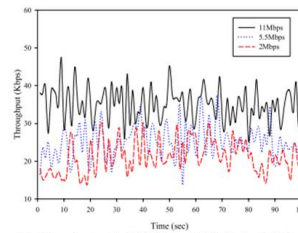


Fig. Throughput under IEEE 802.11e at AC 3 with fixed TXOP

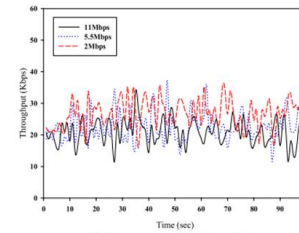


Fig. Throughput with ATXOP at AC 3



## Conclusion



- 802.11e can support QoS
- High priority: small AIFS, small CW, and high TXOP
- Fine tuning MAC parameters to achieve an objective



## References



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