

# Flow-Level Simulation of Call Admission Control schemes in EDCA-based WLANs

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# Introduction/Motivation



- Low number of simultaneously VoIP calls due to:
  - Protocol overheads.
  - Capacity-varying channels (multi-rate).
  - Random Access MAC.
    - Bandwidth penalty due to the distributed access.
    - Unfairness D/U.
    - Node based scheduler
    - Difficult coexistence between rigid and elastic flows.
- IEEE 802.11e
  - EDCA (WMM).
  - Service differentiation (MAC parameters) + *CAC signalling*
- EDCA is too conservative.

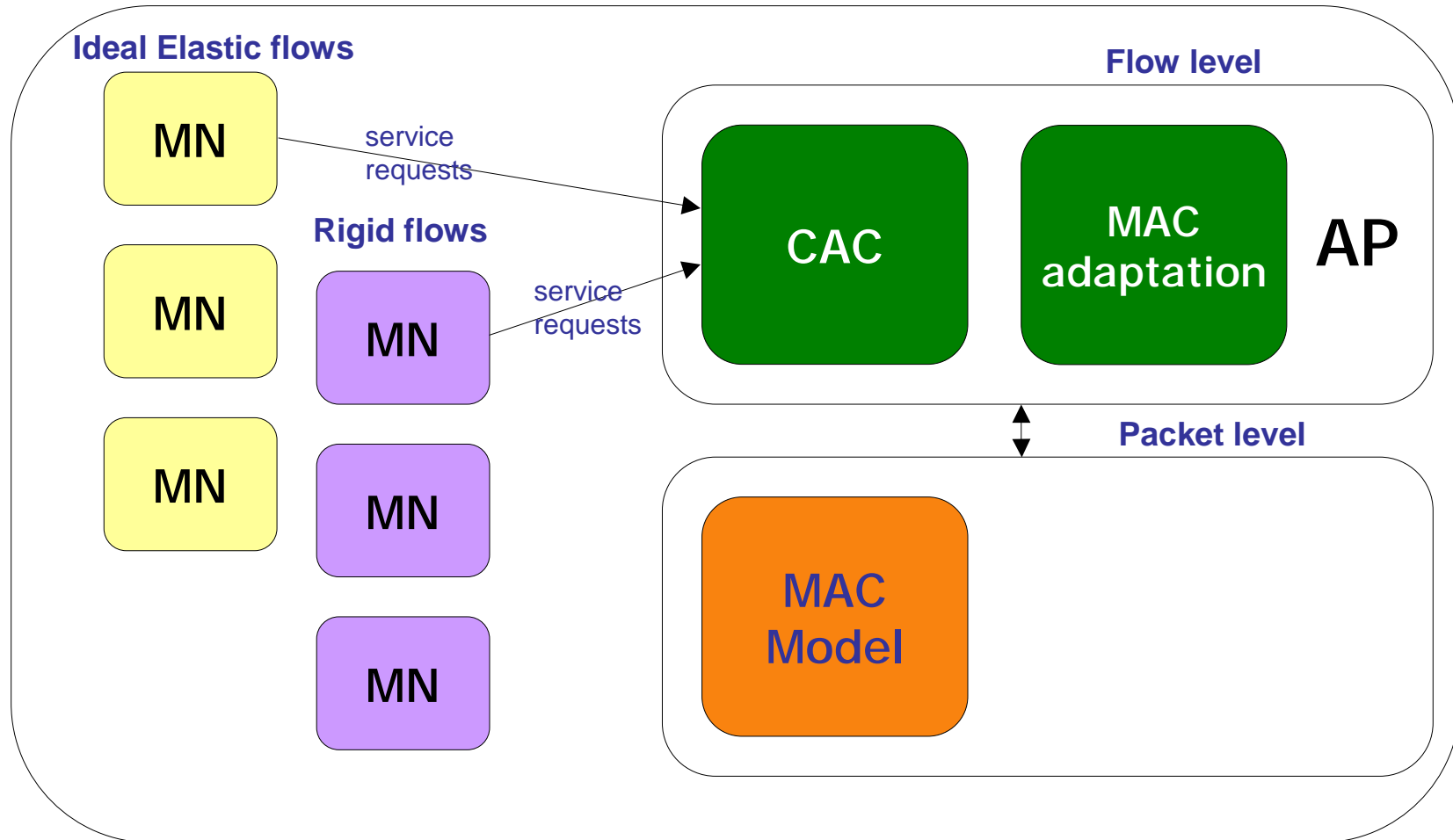
# Introduction/Motivation

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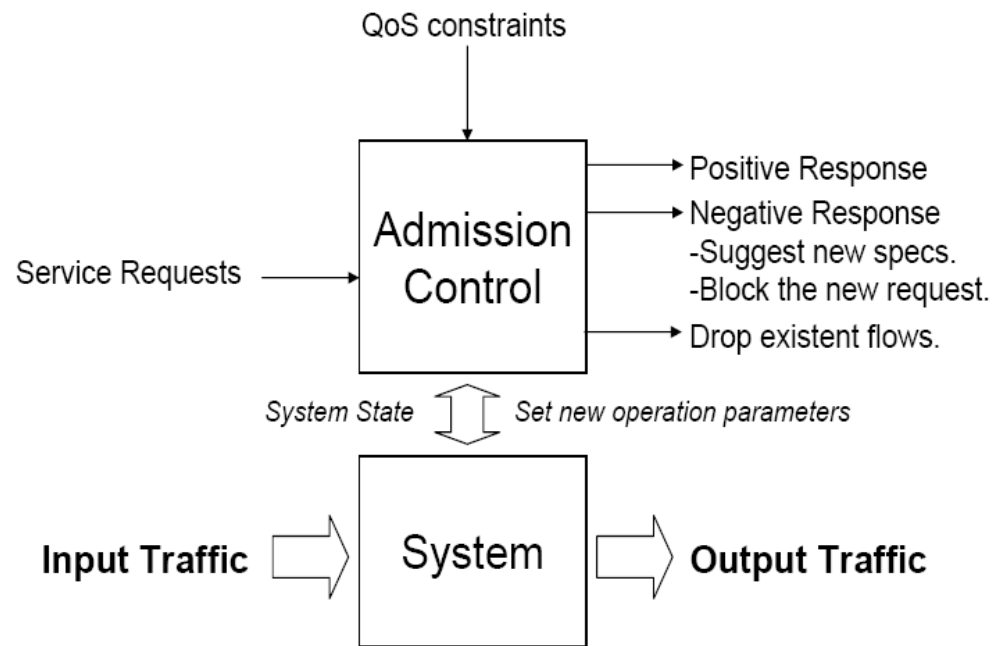


- Possible solution
    - *Flow-level Admission Control*: Guarantees the system stability (the system never will work under saturation conditions).
    - *Change MAC parameters dynamically*: AIFS, CWmin and TXOP
  - Goals
    - Guarantee QoS of multimedia flows
    - Maximize best-effort throughput
  - WLAN Admission Control Simulator
    - Develop a tool which help to design and evaluate CAC algorithms for WLANs.
    - Infrastructure networks (a single AP WLAN).
    - New metrics: such as Blocking, dropping, flow delay transfer, ...
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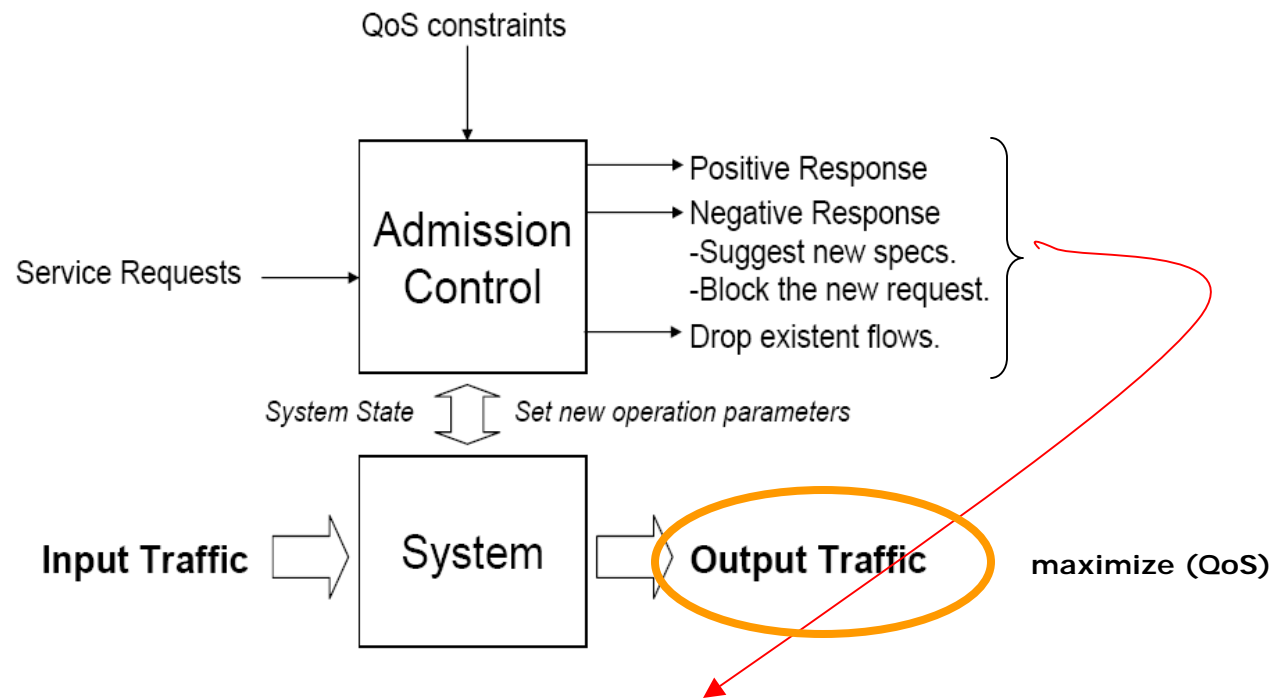
# CAC Simulator



# Admission Control



# Admission Control

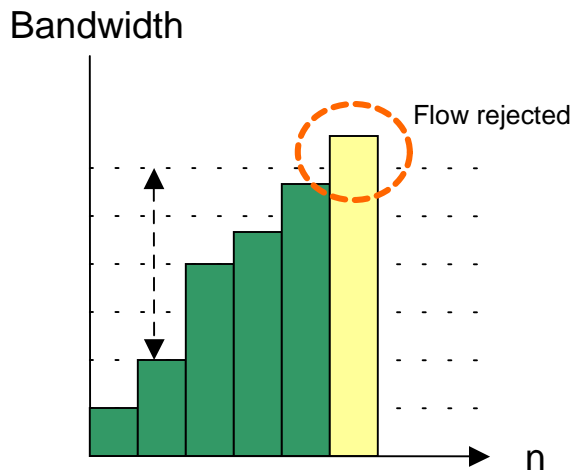


random access MAC  
 $(\text{Performance}) = f(\text{MAC parameters}, \text{number of nodes active}, \text{traffic profile each node})$   
non-linear relation

# Available bandwidth estimation

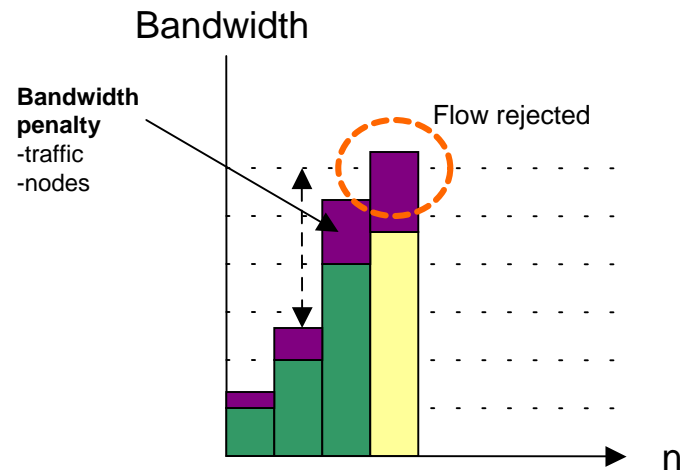


Ideal Channel Sharing



$$B_a - B_r \geq 0$$

Random Access Channel Sharing



$$B_a - (B_r + B_o) \geq 0$$

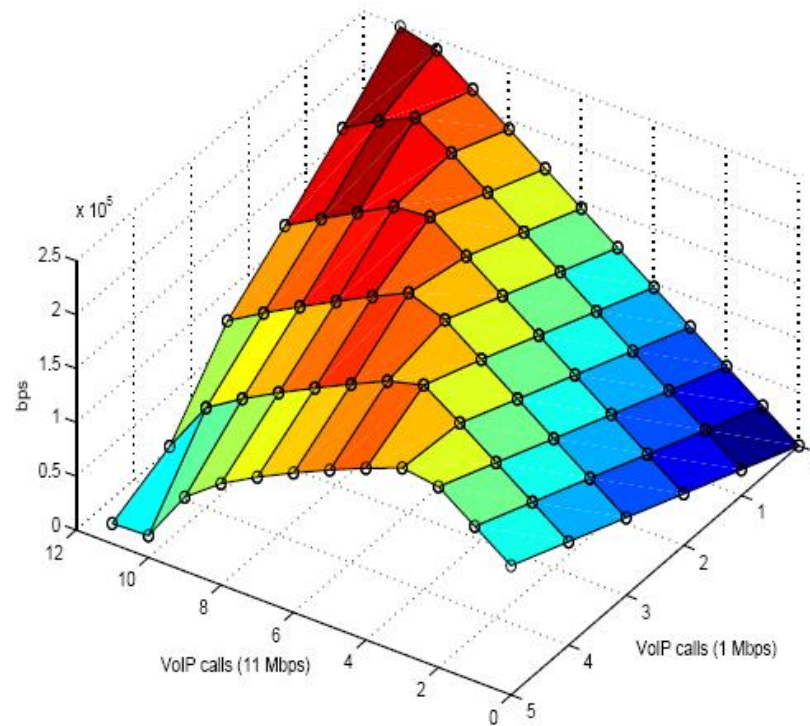
... the bandwidth penalty due to the distributed access depends on the number of flows active and the traffic profile of each flow.

... how to decide if a flow can be admitted? We have to compute or to test if the new flow is possible.

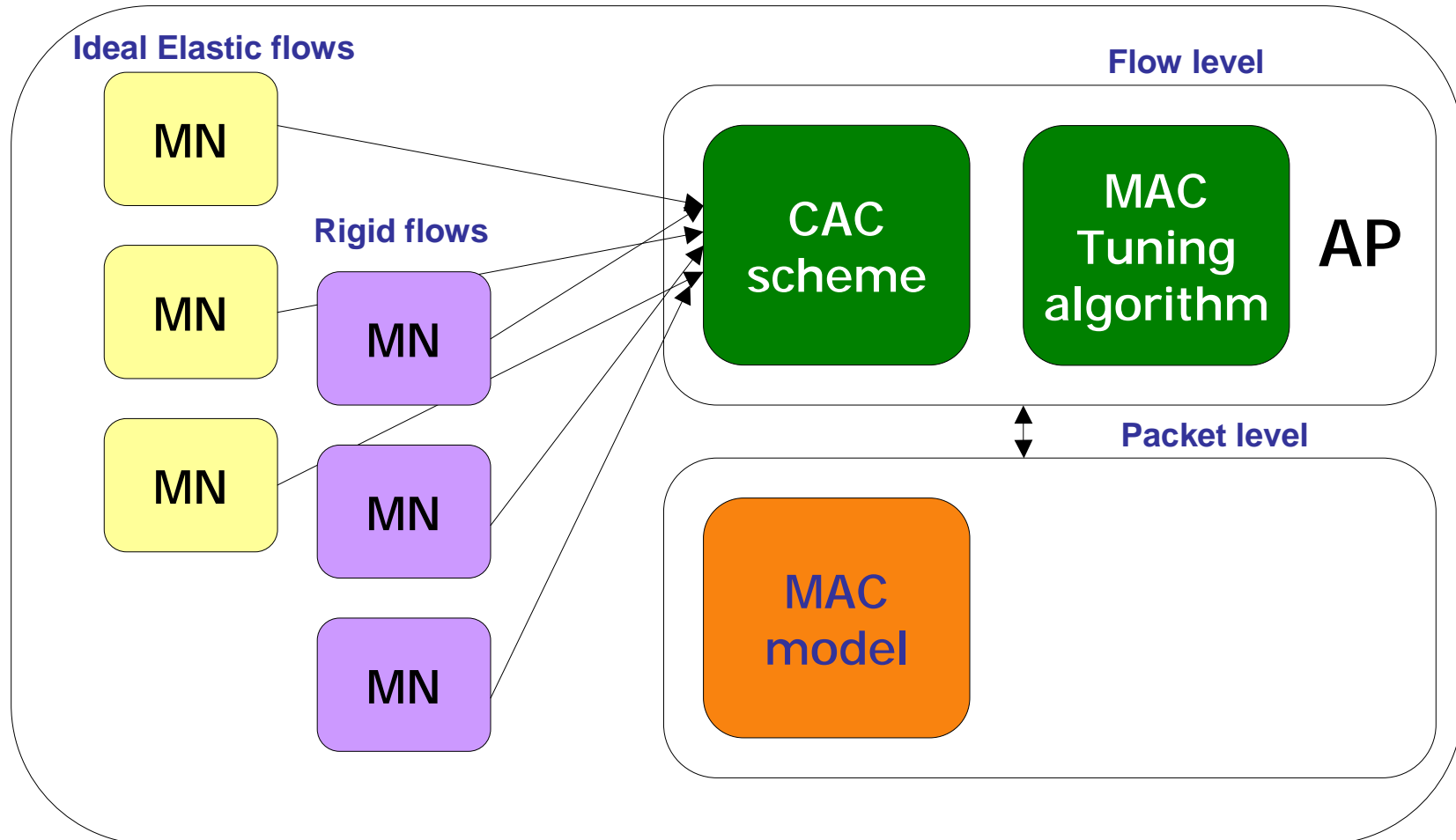
# Available bandwidth assurances



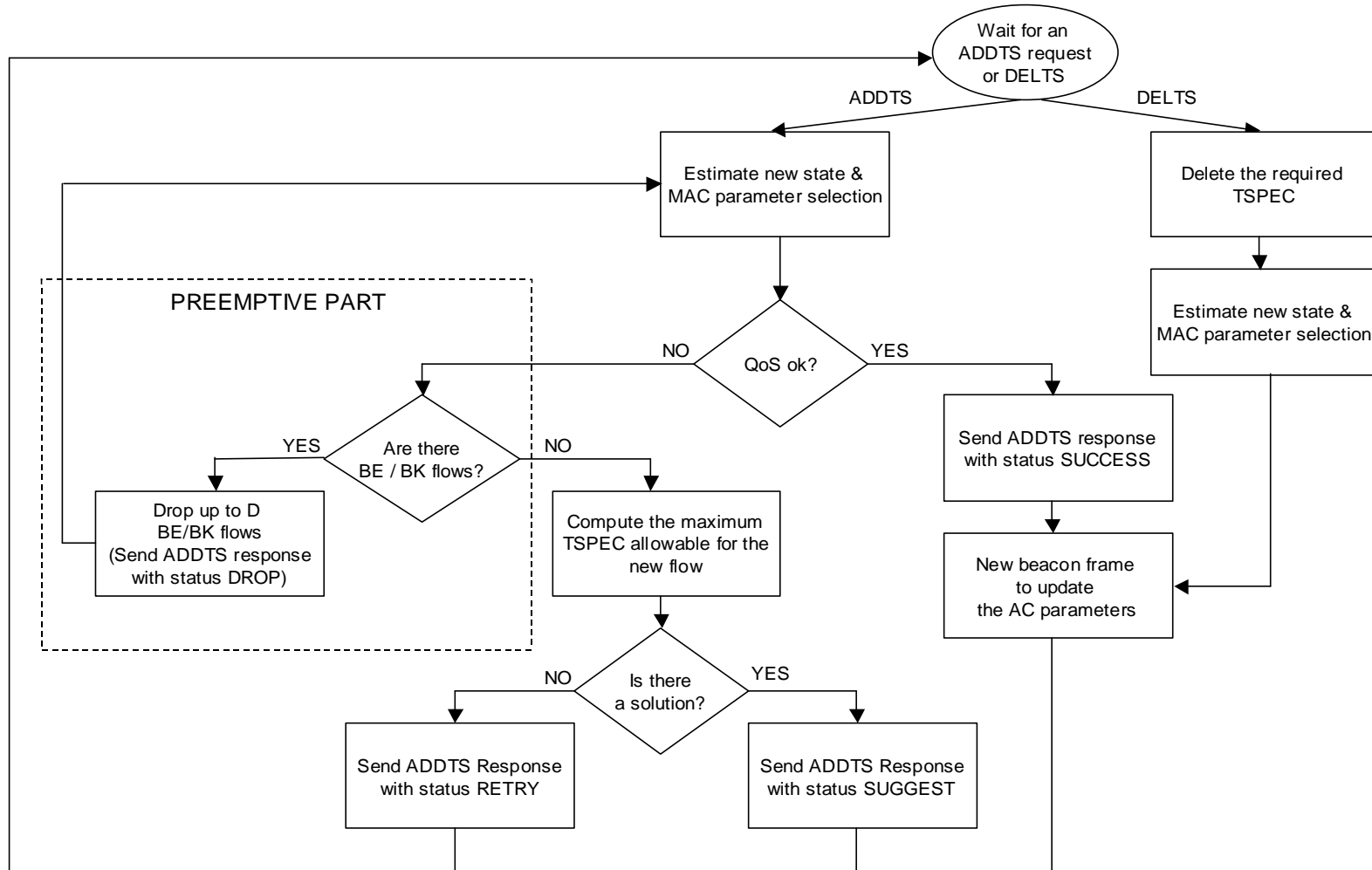
- Guaranteeing quality for duration of connection
  - Time-varying channel conditions (multi-rate environment)



# CAC Simulator

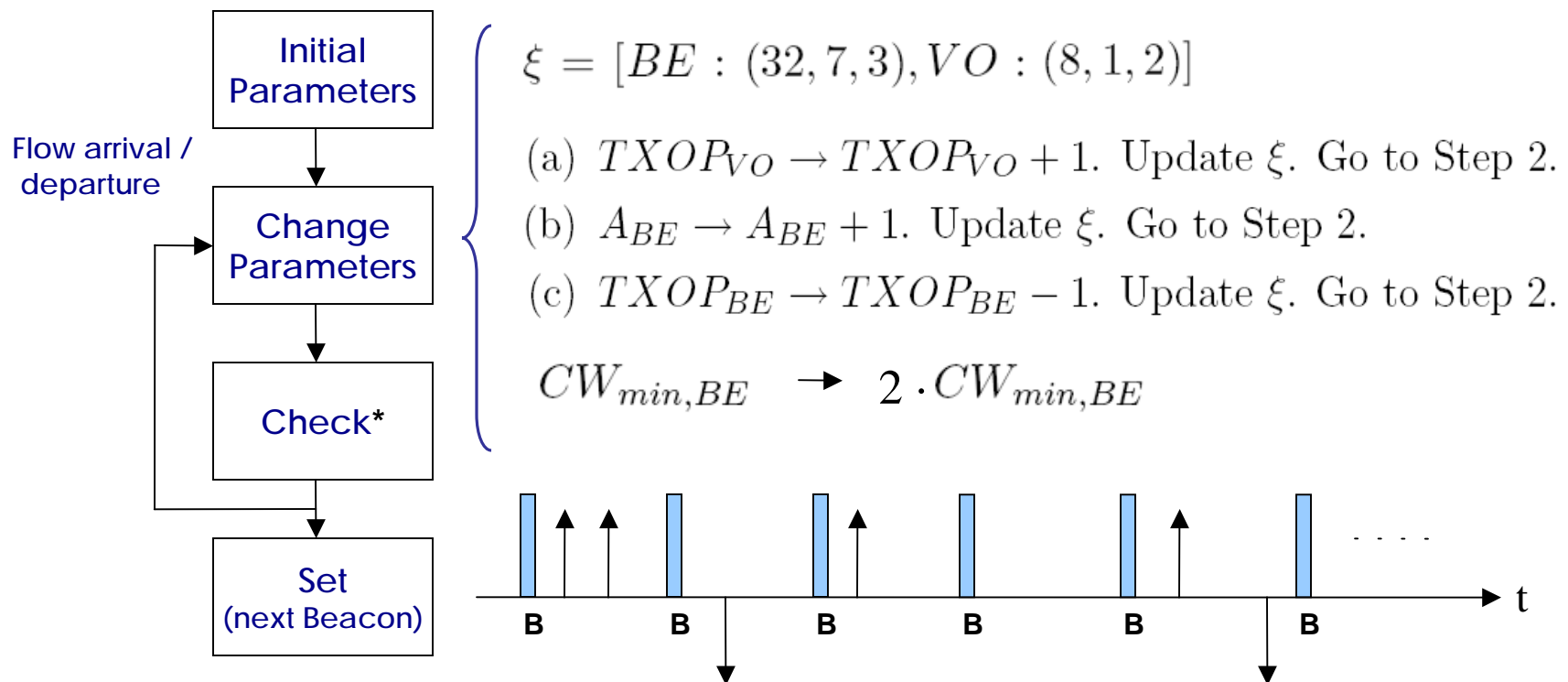


# Block 1: Admission Control



# Block 2: Iterative algorithm

- To define an algorithm to tune the MAC parameters
- Objective: Closest performance to the “optimal”.



(\*) In the infrastructure mode, the check is done considering the AP (bottleneck) throughput.

# Block 2: Real Time algorithm

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- The iterative solution can not work in real time.
- The solution must not require “flow monitoring”.
  - Ksentini et al., Adaptive Transmission Opportunity with Admission Control for IEEE 802.11e Networks. ACM/IEEE MSWIM 2005, Montreal, Quebec, Canada, October 2005.
  - Freitag et al., Tuning of 802.11e Network Parameters, IEEE Communications Letters, Vol 10. No 8, August 2006.
- CAC Information:
  - Number of flows active in each AC.
  - Uplink/Downlink.
  - Bandwidth (and other parameters) required by each flow.

# Block 2: Real Time algorithm



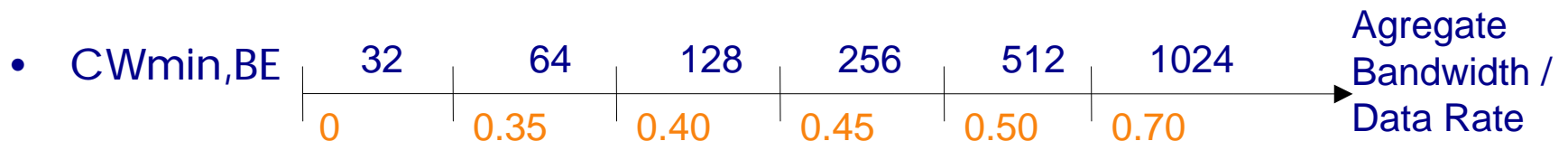
- Agregate bandwidth (sum of the bandwidth of all rigid flows and the minimum bandwidth of elastic flows).

- TXOP AC\_VO and AC\_BE

$$TXOP_{VO} = 12 - TXOP_{BE} \quad TXOP_{BE} = 10 - \frac{9(TotalBW)}{0.4*DataRate}$$

- AIFS BE

$$AIFS_{BE} = 3 + \frac{9(TotalBW)}{0.4*DataRate}$$



- Downlink Fairness

• TXOP ↑ AIFS ↓ CWminUL ↑

- $AIFS_{AC,DL} = AIFS_{AC,EDCA-TA} - 1$ ,  
 $AIFS \geq 1$
- $TXOP_{AC,DL} = TXOP_{AC,EDCA-TA} * n_{DL}$ ,  
 $TXOP \leq 10$

The Cwmin of the elastic flows in the uplink is changed, this algorithm is implemented jointly with algorithm 1.

$$Cwmin_{BE,UL} = \min(1024, 32 * n_{UL})$$

# Preliminary results

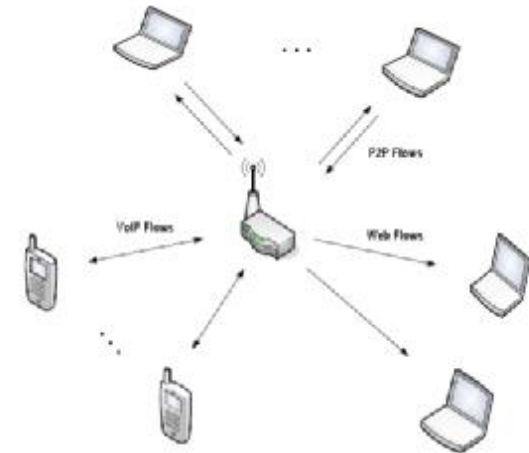


## Scenario 1

- Mobile Nodes: 4 VoIP, **0-20 P2P uplink**, 2 P2P Downlink, 2 Web

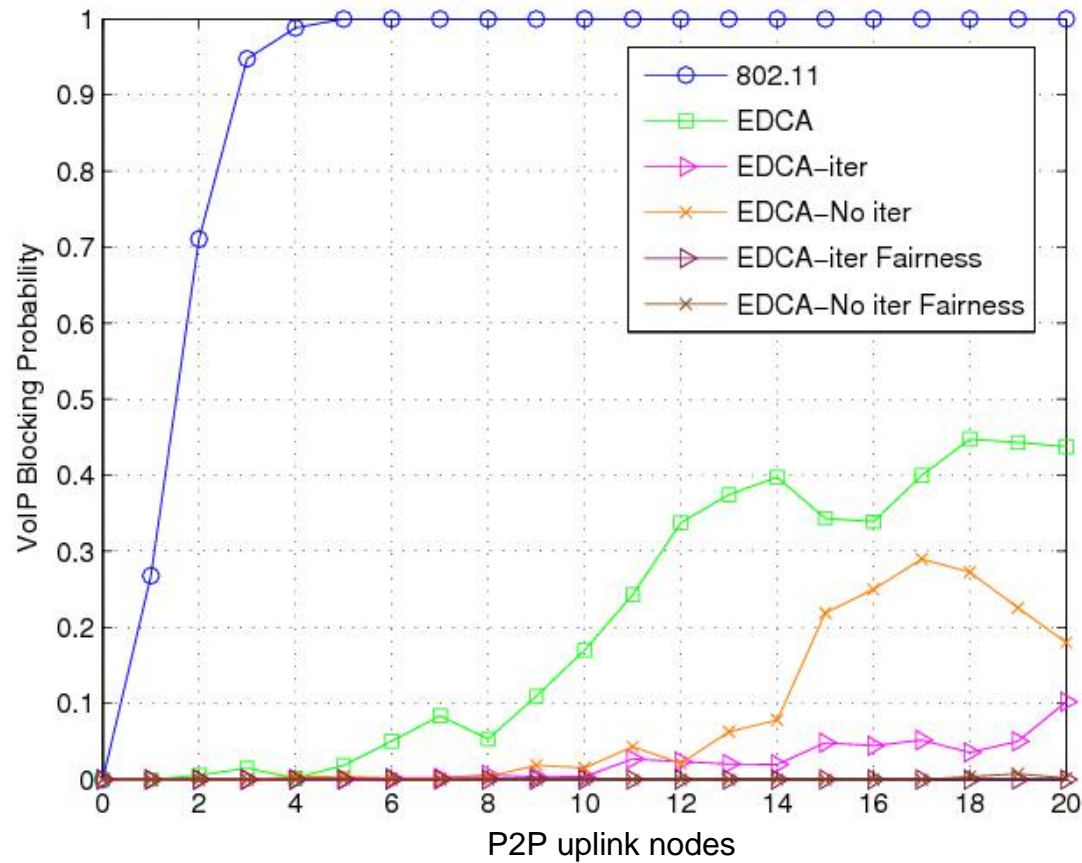
## Scenario 2

- Mobile Nodes: **0-25 VoIP**, 5 P2P uplink, 2 P2P Downlink, 2 Web

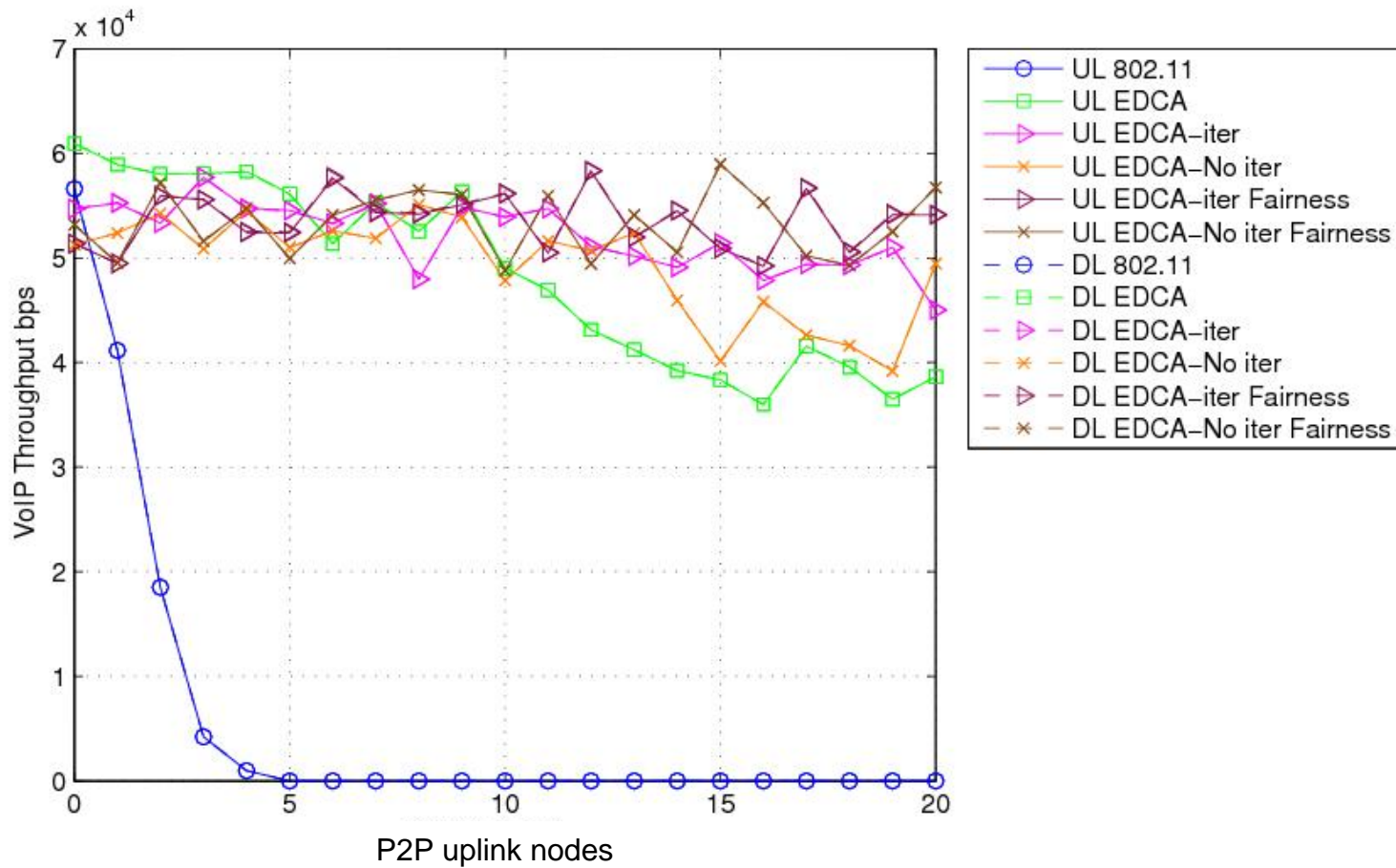


Characteristic	Web	P2P	VoIP
Application/Codec	Web browsing	File sharing	G.711
Type	Elastic	Elastic	Rigid
Bandwidth	> 10Kbps	> 10Kbps	80Kbps
Packet Length	1500bytes	1500bytes	200bytes
Average flow duration/Total transfer	50Kbytes	10Mbytes	120s
Average Inter-arrival Time	30s	30s	600s/300s

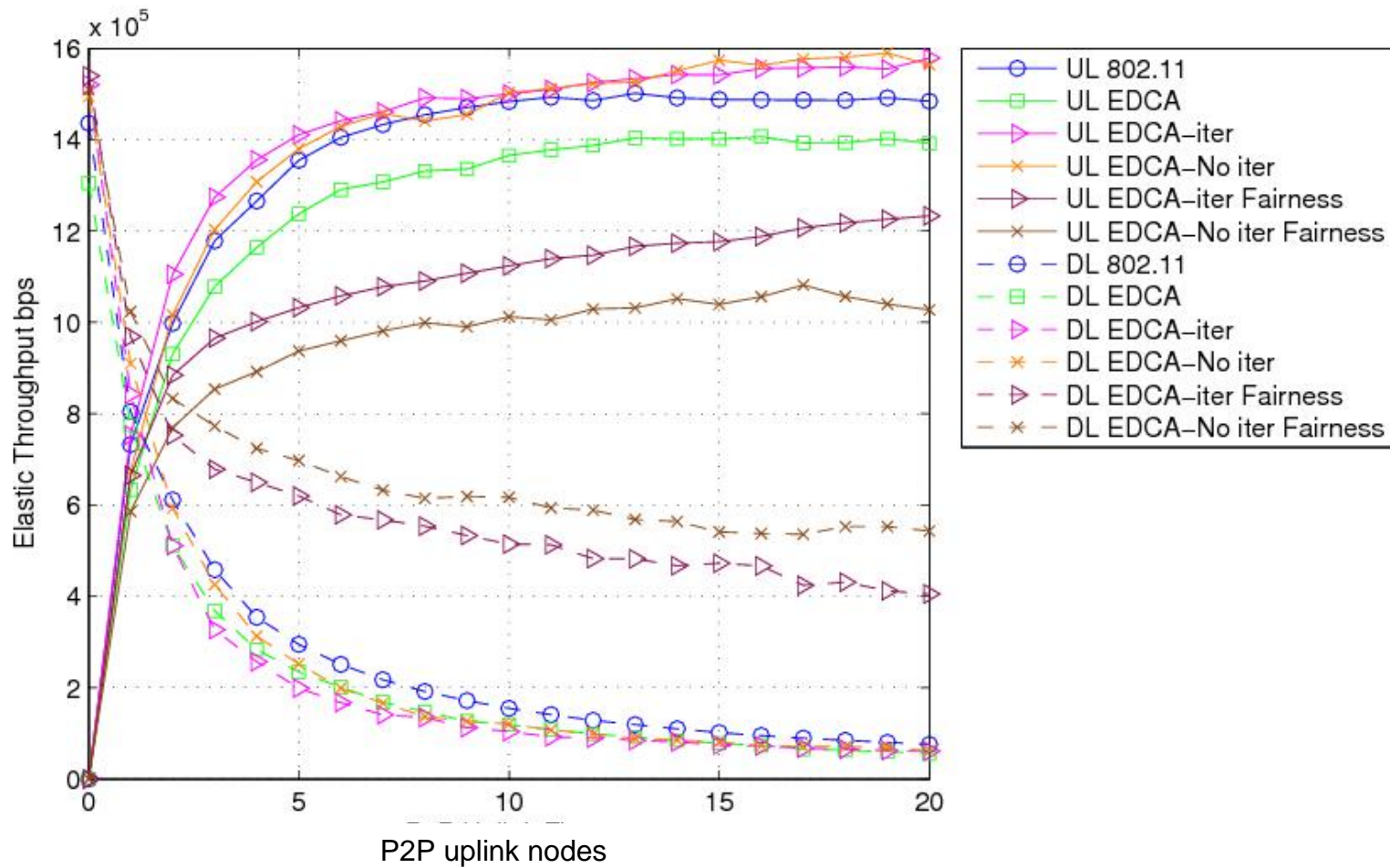
# Results (Scenario 1)



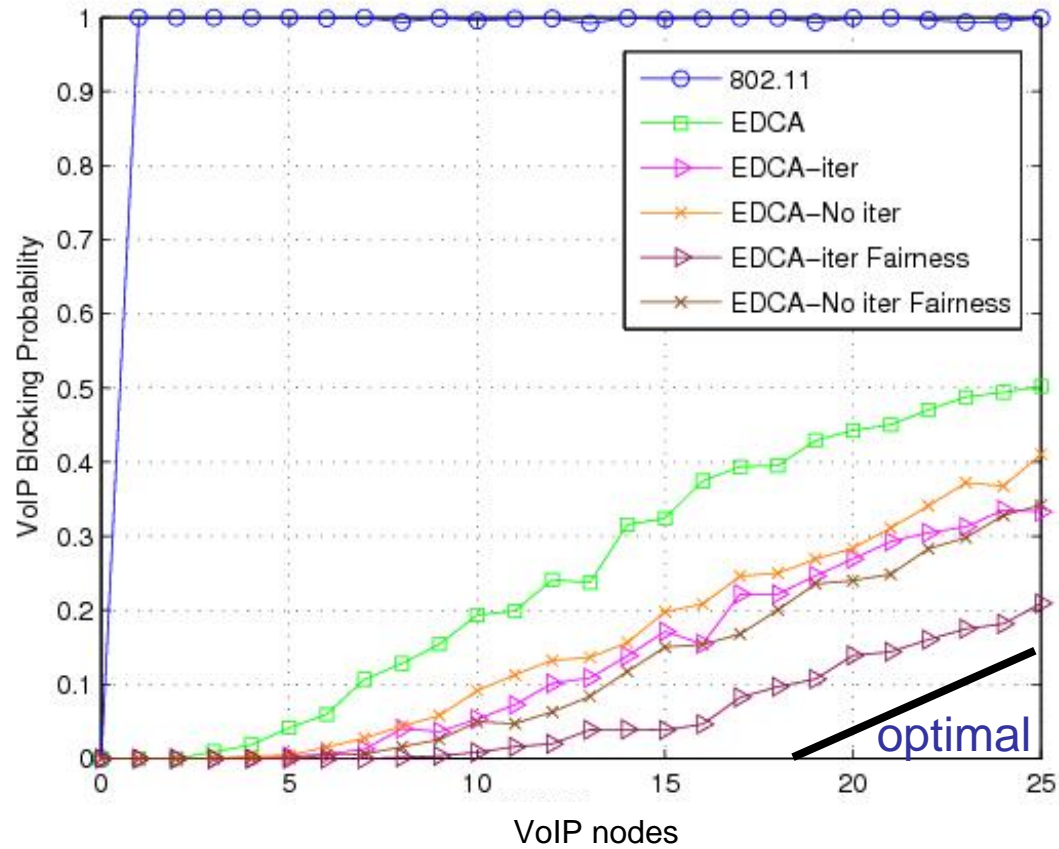
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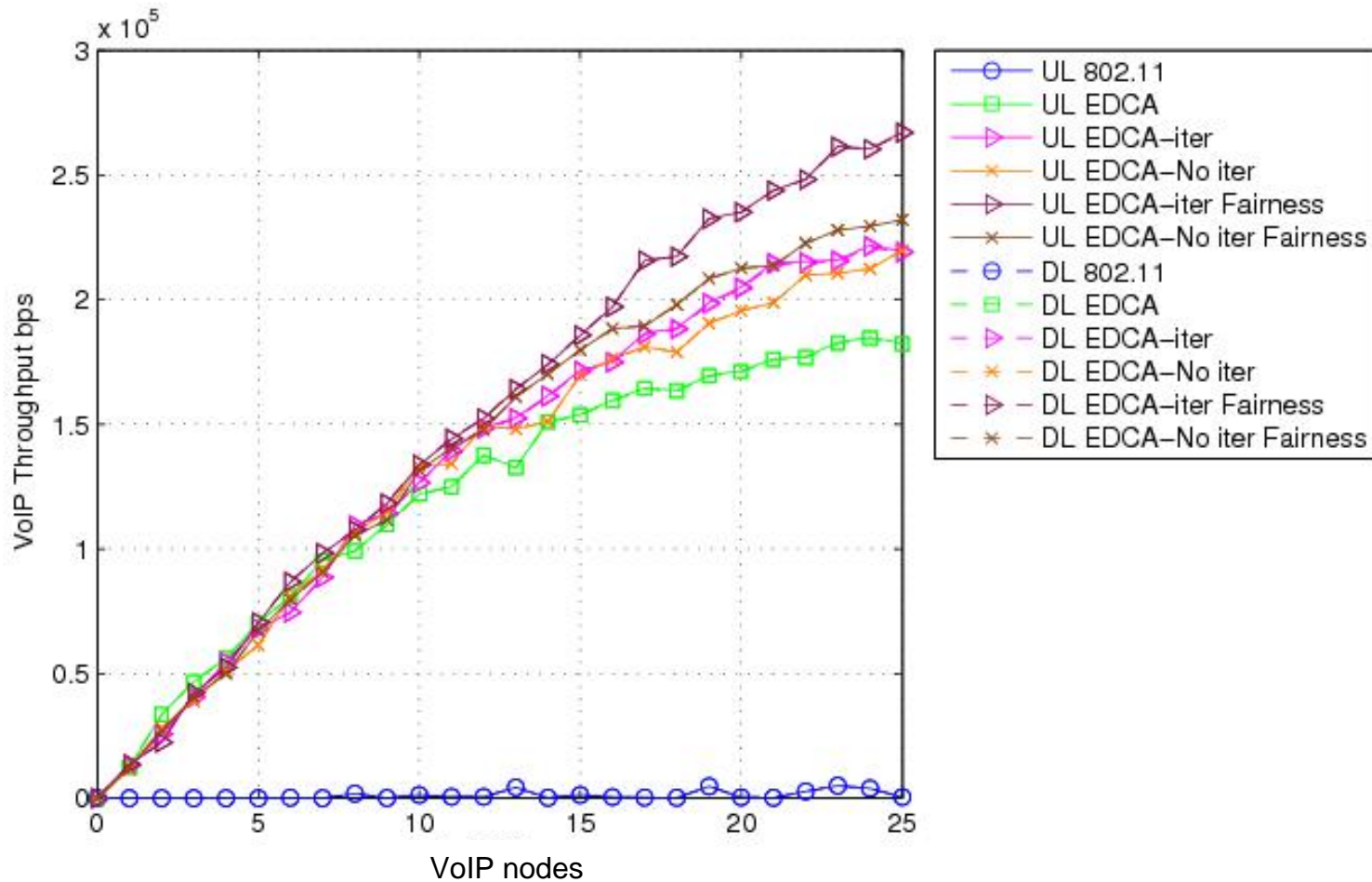
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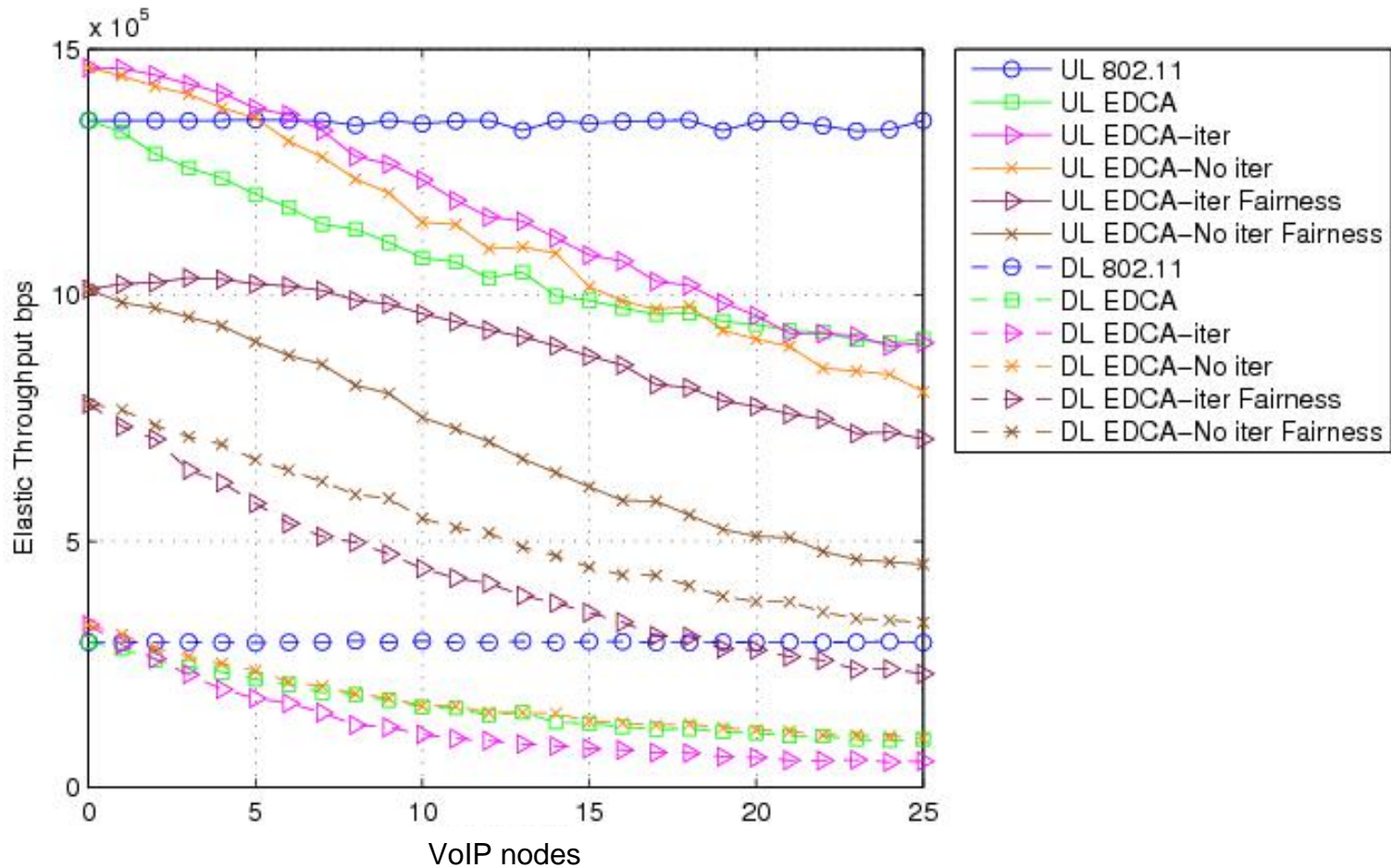
# Results (Scenario 2)



# Results (Scenario 2)



# Results (Scenario 2)



# Conclusions

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- QoS in WLANs (EDCA)
  - Intended solution
    - Call Admission Control policies.
    - Dynamic MAC parameters.
  - Results
    - QoS guarantee for multimedia flows
    - Throughput of best-effort flows.
    - > *Clear improvement compared with EDCA.*
  - Real Time algorithms
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# Future Work

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- Include Preemption
  - Block best-effort flows when QoS is not achieved
- Mobility
  - Define the mobile nodes movement
  - Effect of MultiRate
- ACKs and aggregation schemes (Block ACK)
- Non-ideal channels
- Comparative analysis with other proposals.