Block-Poll Coordination Function for Improving Throughput Performance in Wireless LANs

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  - Chunk-based design
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  - Simulation results
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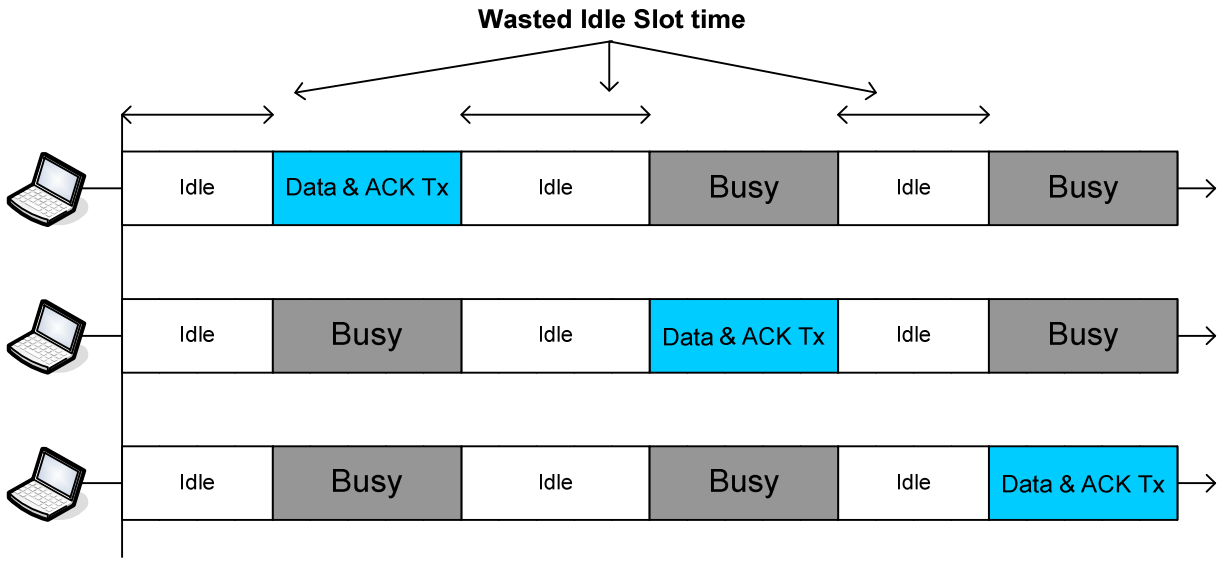
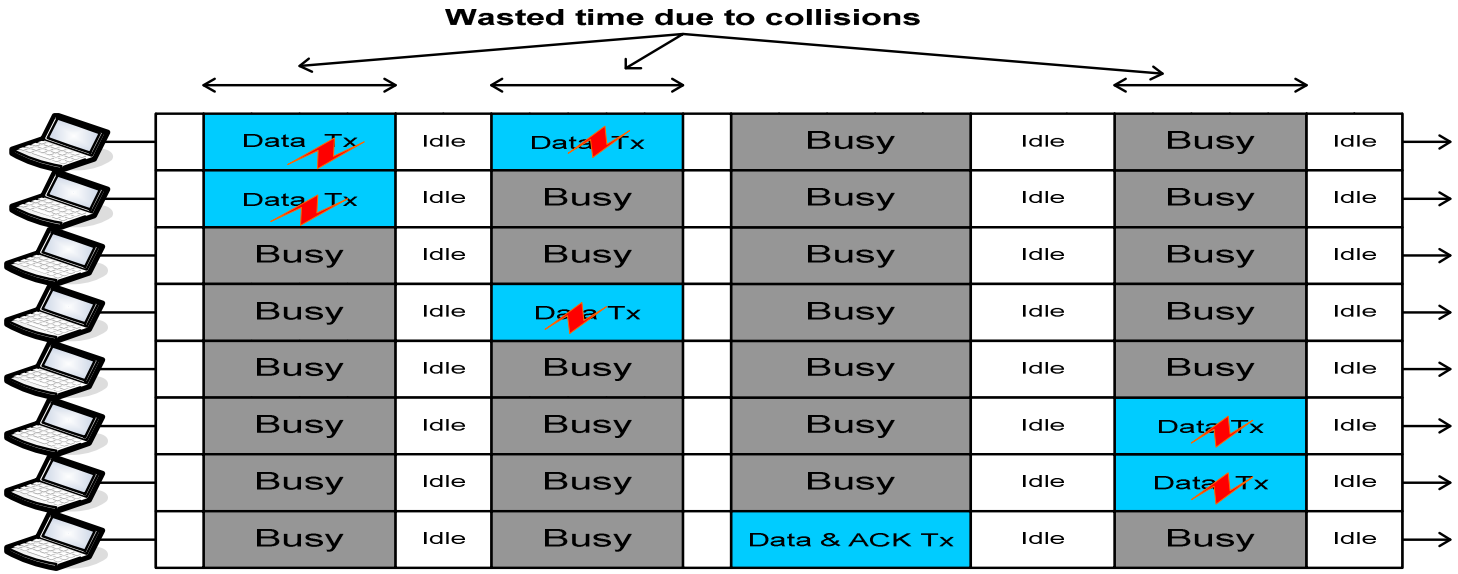
Motivation (1/3)

- IEEE 802.11 DCF
  - Theoretical maximum throughput is about three quarters.
    - Sources of the performance degradation
      - **Control overhead**: overhead due to backoff process when the # of stations is small



Motivation (2/3)

- IEEE 802.11 DCF
  - Theoretical maximum throughput is about three quarters.
    - Sources of the performance degradation
      - **Contention overhead**: wasted time due to collision when the # of stations is large

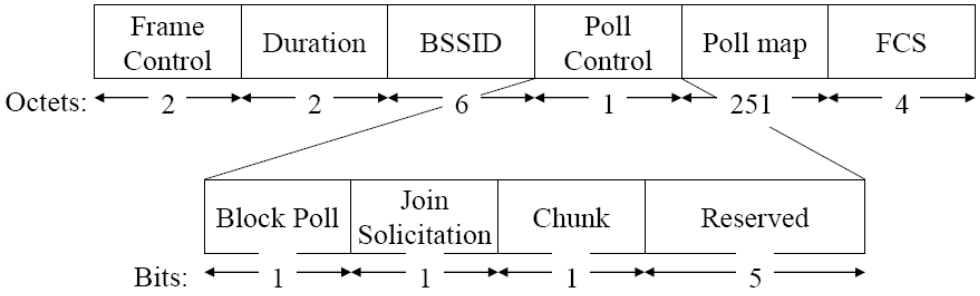


Motivation (3/3)

- IEEE 802.11 DCF - Possible solution
  - RTS/CTS exchange
    - Can reduce collision probability
    - Transmitted in basic rate set
    - Introduces additional control overhead
  - PCF
    - Can reduce collision
    - Polling overhead: CF-poll and corresponding ACK
  - Multi-user polling mechanism
    - Can reduce polling overhead
    - Polling list overhead: polling list increases linearly
  - What if…
    - Adopt controlled access mechanism
    - Reduce the polling overhead

Protocol Design – BCF (1/6)

- Assumption
  - Users' traffic pattern
    - A burst manner
      - Ex) FTP, web surfing
      - TA:active, TI:idle
      - Temporal locality
- Basic idea
  - Similar to Multi-user polling
  - Poll-map instead of poll-list
    - TIM field in the beacon frame
    - 251 bytes long to accommodate 2007 AIDs
      - 0 stands for the TX of the coordinator (AP)
  - Periodic Block-poll frames are broadcasted
    - Every m rounds with poll-map



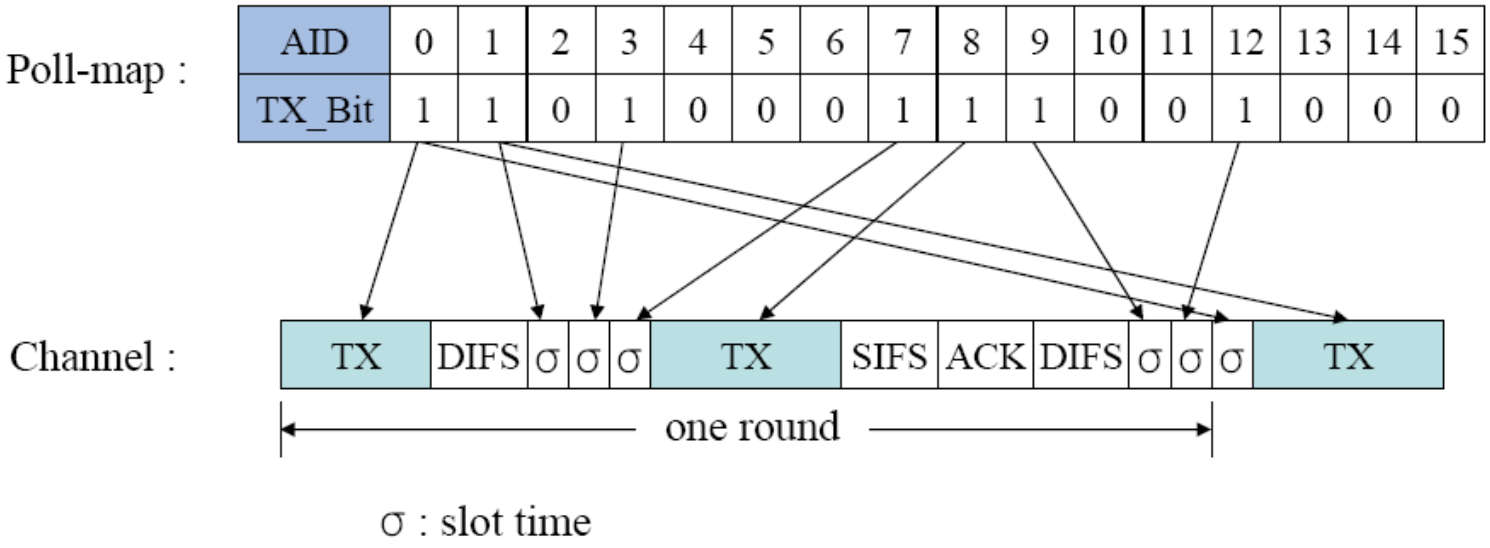
Block-poll frame format

Protocol Design – BCF (2/6)

- Block-poll based coordination function
  - Each STA whose Tx bit is 1 is allowed a time slot in the order in the poll-map
  - A station receives Block-poll
    - If Tx bit is set to 1,
      - if frames to send, set backoff counter to # of preceding 1s in the poll-map
        - » Decrease the backoff counter after an idle slot or DIFS (according to the medium status) and TX at zero backoff counter
      - If no frame to send, stay idle for its time slot
    - If Tx bit is set to 0,
      - stay idle

Protocol Design – BCF (3/6)

- An example of BCF operation



Protocol Design – BCF (4/6)

- Chunk-based poll-map
  - Drawback of block-poll
    - Poll-map introduces a fixed overhead
  - On the assumption of temporal locality
    - Divide the poll-map into several (251) chunks
      - A chunk has a chunk ID (8 bytes) and 8 AIDs
    - Transmit only the changed chunks
      - Can reduce the polling overhead

[Example of the chunk-based poll-map]

Chunk #	AID	1	2	3	4
0	TX_Bit	1	1	0	0

…

Chunk #	AID	2000	…	2006	2007
251	TX_Bit	1	…	0	0

Protocol Design – BCF (5/6)

- To participate in the poll-map
  - AP broadcasts Join-Solicitation frame periodically
    - Includes join-solicitation map
      - Inverse form of the poll-map
  - STA whose bit has been 0 gets chance to Tx
    - If has frames to send,
      - TX the frame
      - AP marks the STA in the poll-map afterwards
    - else,
      - Stay idle in its time slot

Poll control field of the Block-poll frame

BP	JS	Ch	Meaning
1	0	0	Block-poll frame with full Poll-map
1	0	1	Block-poll frame with Chunks
0	1	0	Join-Solicitation frame

Protocol Design – BCF (6/6)

- To leave from the poll-map
  - STA gives up n consecutive time slots (rounds)
  - By temporal locality
    - AP sets the corresponding Tx bit to 0
    - Next block-poll frame reflects the result

Discussion

- Poll-map synchronization
  - Damaged poll-map, Clock drift, Collision due to overlapping BSS, Channel error, etc.
  - Periodic Tx of the entire poll-map (every M rounds)
- Association / Probe request
  - No contention period
  - Additional bits after the poll-map (exceeding max AID)
    - Association / Probe request can use these slots

Simulation environment

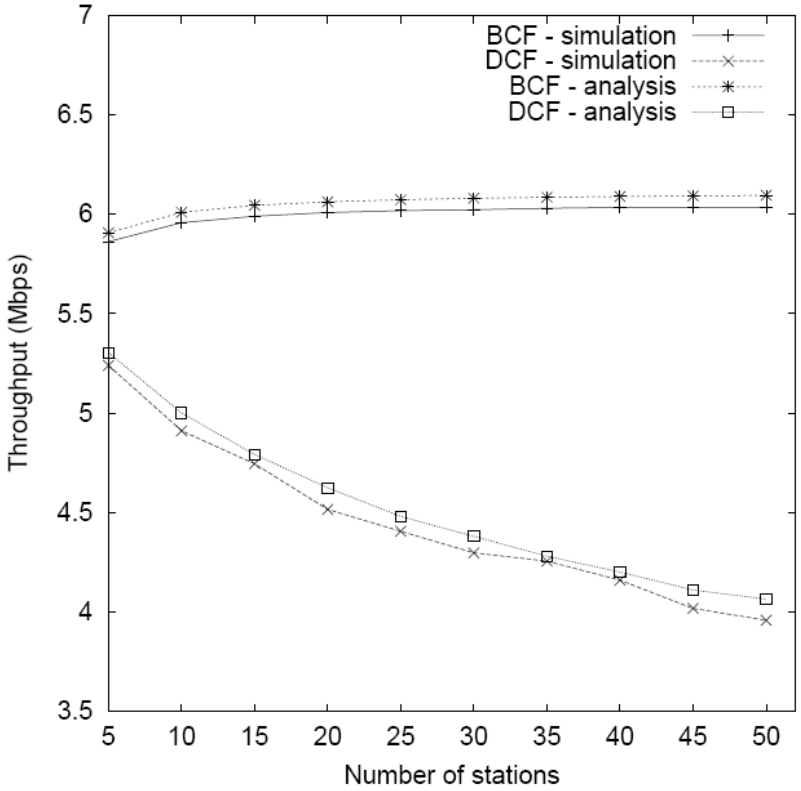
- Using NS-2.28
- Traffic pattern
  - Saturated/bursty/sporadic traffic
- Measured aggregated throughput/delay/delay jitter

Simulation parameters (IEEE 802.11b)

SIFS	10 us
DIFS, EIFS	50 us, 364us
slot time	20 us
BasicRate, DataRate	2 Mbps, 11 Mbps
PLCP length	192 bits @ 1 Mbps
MAC header (RTS, CTS, ACK, DATA)	(20, 14, 14, 28) @ Basic Rate
default payload size	1000 bytes
(CW_{min}, CW_{max})	(31, 1023)
Number of rounds per whole Block-poll Tx (M)	10
Number of rounds per changed chunk Tx (n)	5
Numebr of stations in a Chunk (K)	8

Simulation results (1/3)

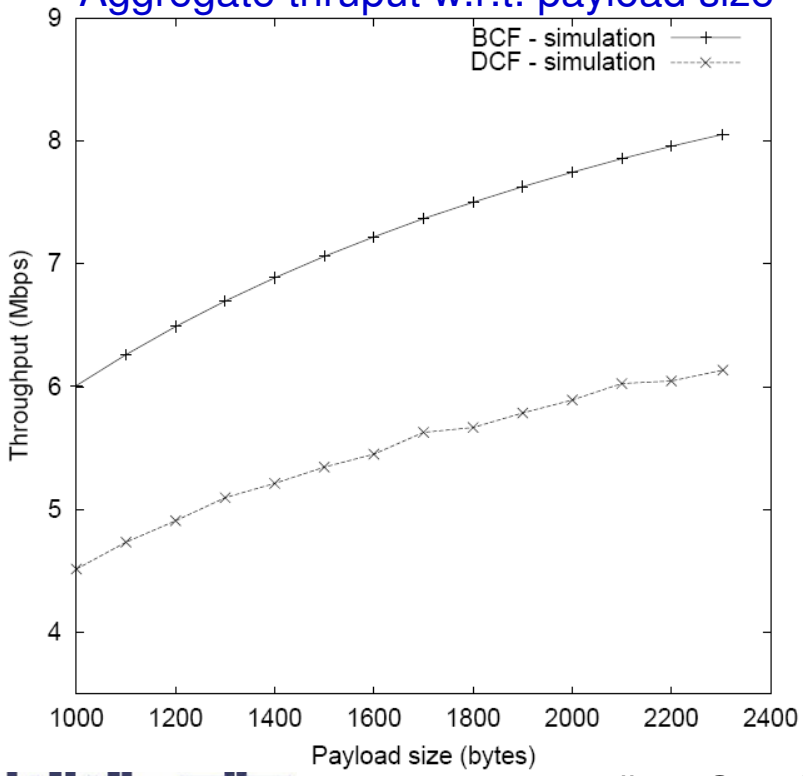
- Saturated traffic
  - Aggregate throughput
  - payload size = 1000 bytes



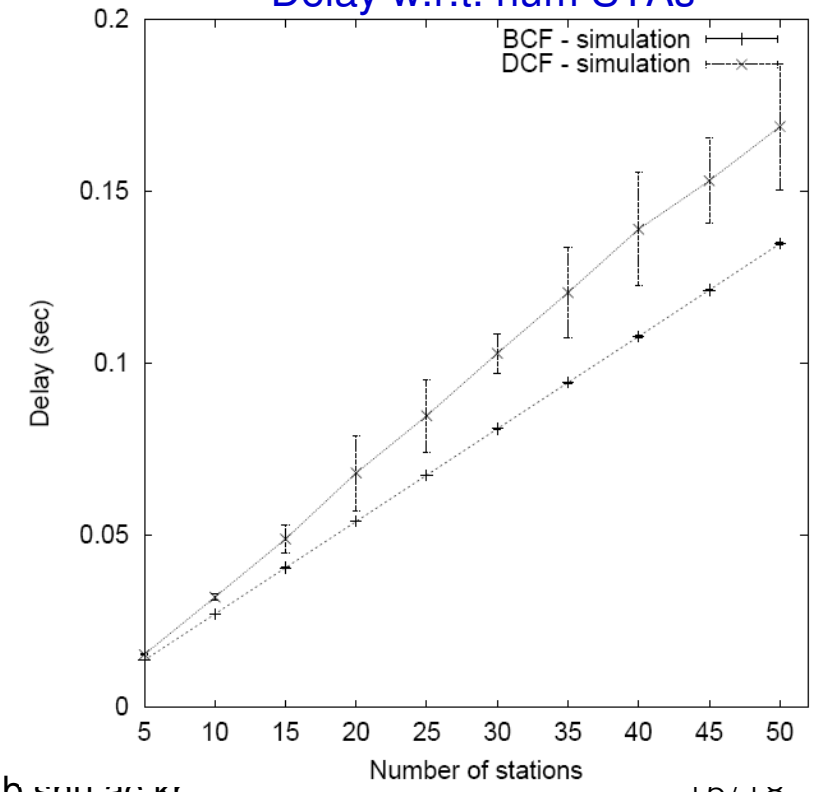
Simulation results (2/3)

- Saturated traffic
  - Aggregated throughput
  - Num of stations: 20
  - Delay
  - w.r.t. num STAs

Aggregate thruput w.r.t. payload size



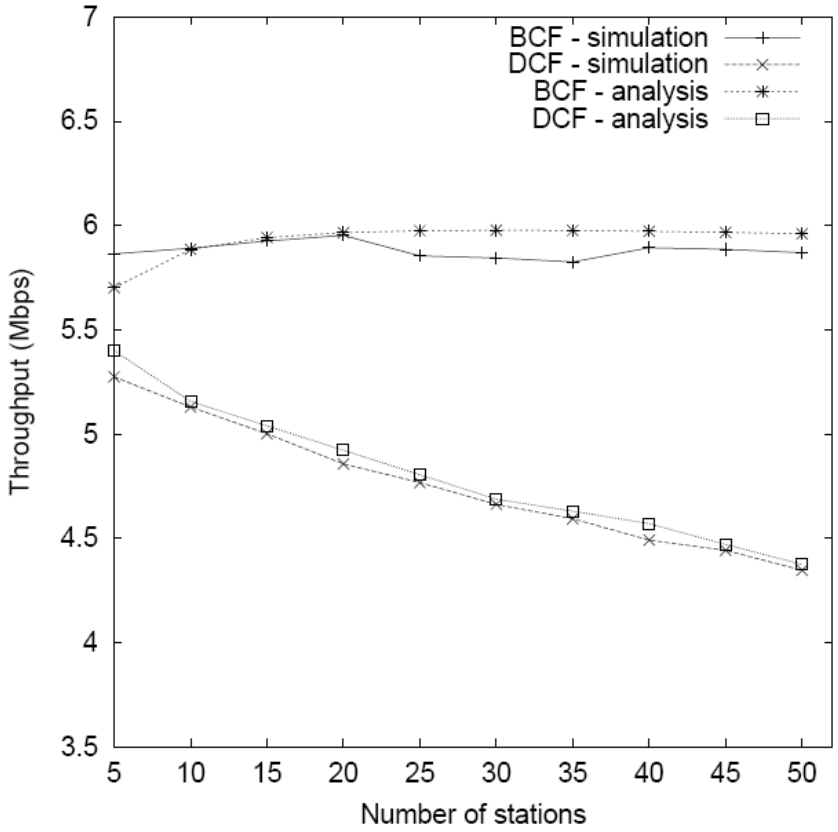
Delay w.r.t. num STAs



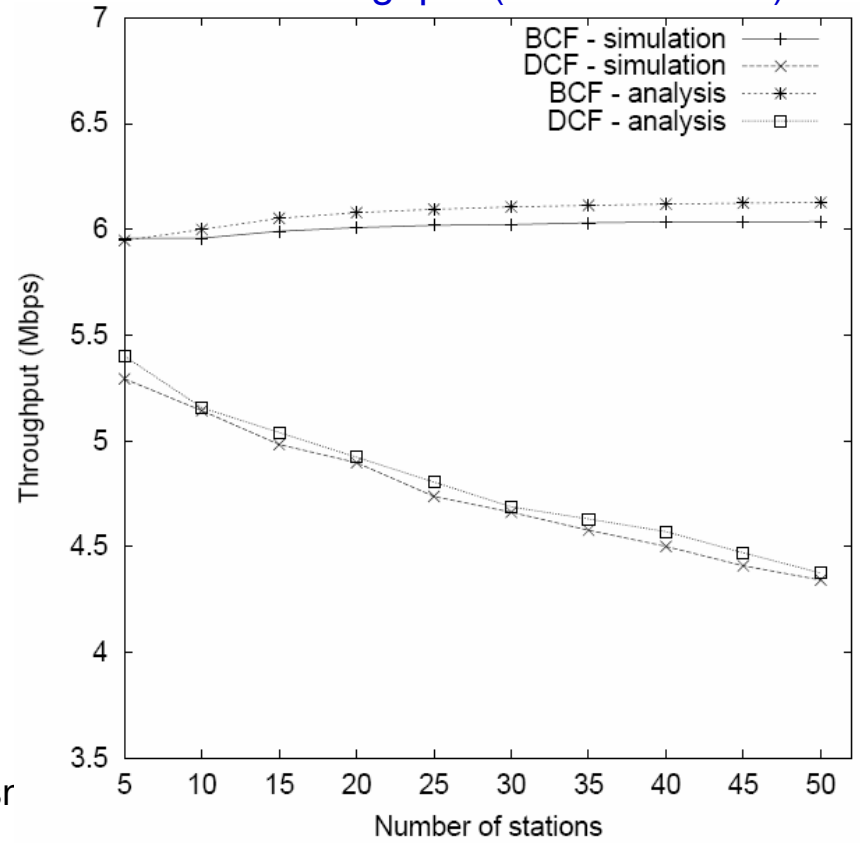
Simulation results (3/3)

- Burst traffic
  - payload size = 1000 bytes, TA: active time, TI: idle time
  - TA = TI (10ms and 1.0 sec)

Throughput (TA=TI=10ms)



Throughput (TA=TI=1.0sec)



Conclusion

- BCF
  - Outperforms DCF in terms of aggregate throughput, delay, and delay jitter
    - Almost w/o regard to the number of stations
    - In saturated and burst traffic
  - In lightly-loaded situation
    - Does not show better performance than DCF
- Future work
  - More various scenarios
    - Reflecting the real world
    - association and channel error situation
    - more accurate analysis
  - QoS and scheduling

Q&A

60th Anniversary
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