Efficient OFDM-based WLAN-Multicast with Feedback Aggregation and Power Control

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conclusion
OFDM feedback jamming (failure)
measurement results for fixed n
results for arbitrary n by monte-carlo simulation

why is it important?
jamming failure (n) determines the error floor of a class of multicast protocols

worst-case scenario
where header selection may be insufficient

power control helps
viable option as transmit power can be tuned (at some granularity)

outlook
- determine the error floor of this class of multicast protocols by simulation
- implement prototypes and measure

feedback jamming
monte-carlo

fading
measurement
reciprocity
interest in interference at the receiver

an analogy
what if we would reduce the ACK transmit power at the receiver?

focus on the...
Efficient OFDM-based WLAN-Multicast with Feedback Aggregation and Power Control

Jochen Miroll
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wireless multicast feedback
simulation & measurement
power control results
Why multicast?

- Efficiency
- Broadcast streaming

Multicast group

- One-to-many transmission over an erasure channel

Vs. simulcast using MIMO

Think of over 20 receivers for one stream
multicast group

some losses, medium distance

few losses, short distance

one-to-many transmission over an erasure channel

many losses, far away

some losses but quite near
think of over 20 receivers for one stream

"many" in 802.11:
   already more than 5
circumvent asking each one of our many receivers for an immediate ACKnowledgement
as opposed to opportunistic multicast scheduling
immediate

Source STA  \[\cdots\]  DATA \(n\)  \[\cdots\]  REQ\(_1\)  IFS  RX  \[\cdots\]  REQ\(_2\)  IFS

STA\(_1\)  RX  RX  IFS  ACK

STA\(_2\)  loss  \[\cdots\]  RX  IFS

STA\(_3\)  RX

**cf. P802.11aa**
an analogy

grasp the idea behind the multicast feedback protocol

- you are speaking to a crowd
- one leader (may be at the back)

- leader can only say "yes!"
- others can only say "no!"

- you ask: "can you hear me?"

if the leader says "yes" but some shout "no!"
you may overhear the "yes" (from the back)
feedback

about reception from all receivers whereas one has a special role

at the same time

aggregation in time
### Multicast Transmission

<table>
<thead>
<tr>
<th>Source STA</th>
<th>( \cdots )</th>
<th>DATA n</th>
<th>( \cdots )</th>
<th>REQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>STA_1 (Leader)</td>
<td>RX</td>
<td>RX</td>
<td>ACK</td>
<td></td>
</tr>
<tr>
<td>STA_2</td>
<td>RX</td>
<td>RX</td>
<td>NACK</td>
<td></td>
</tr>
<tr>
<td>STA_3</td>
<td>RX</td>
<td>RX</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Feedback Aggregation

- IFS
- Loss

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**OFDM**
- Frame Collision Feedback Jamming

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**Time**
帧碰撞 800ns GI
900ns Jitter

反馈干扰!
feedback

about reception

from all receivers whereas one has a special role

at the same time

aggregation in time
focus on the event of feedback jamming - do not care about the protocol itself

find the jamming probability for an arbitrary n non-leaders in some scenario
fading measurement
we captured the fading characteristics at the receivers

reciprocity
interested in the interference at the source

is this a worst-case scenario?

analysis
measurements

CDF

SNR (dB)
is this a worst-case scenario?

analysis

measurements

analysis
ACK-to-NACK ratio ("SIR")

\[ Z = \frac{X^2}{\sum_{i=1}^{n} Y_i^2} \]

random experiment

\(Z, X\) and \(Y\) are random processes
assume \(X^2\) and \(Y^2\) are power levels

monte-carlo \(n \not= 3\)

measurements \(n=3\)
ACK-to-NACK ratio ("SIR")

\[ Z = \frac{X^2}{\sum_{i=1}^{n} Y_i^2} \]

single ACK
1 leader

n NACKs
n non-leaders

random experiment

Z, X and Y are random processes
assume \(X^2\) and \(Y^2\) are power levels
jamming success

jamming failure

measurements $n=3$
feedback jamming

monte-carlo $n \leftrightarrow 3$ measurements $n=3$
monte-carlo $n \leftrightarrow 3$

measurements $n=3$
what if we would reduce the ACK transmit power at the leader?
power control

power control is a simple method for reducing the jamming failure rate.

example

by 8dB power reduction at the leader, the jamming failure rate is reduced from 1 in 100 to less than 1 per million (6 NACKs vs. the leader's ACK)
results
analytical, simulation, measurements?
optimistic, pessimistic, realistic?
Conclusion

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Why is it important?
jamming failure ($n$) determines the
error floor of a class of multicast protocols

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power control helps
viable option as transmit power
can be tuned (at some granularity)
outlook

- determine the error floor of this class of multicast protocols by simulation
  cf. follow-up IEEE CCNC'12 publication, tbp.
- implement protocols and measure
  compare with simulation
- with power control, stations could try to maintain a constant SIR
  => constant error floor achievable?

thank you!

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