

Cooperative MAC

IEEE 802.11 MAC overview

- CSMA/CA
- Long term channel access fairness inherent in MAC design: In the long term, all nodes in the network will get equal number of access opportunities.
- Performance anomaly: Low data rate nodes (say 1 Mbps) will occupy the channel for longer duration for the same size frame leading to reduced overall network throughput.

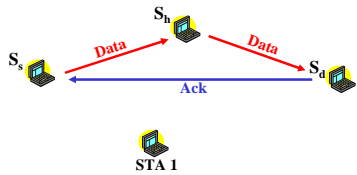


Fig 1: Cooperative MAC

Cooperative MAC

Cooperative MAC

- Our solution: Reduce the channel time for low data rate node by assisting its transmission.
- In Fig 1, the source station, instead of sending its data directly to the destination using a low data rate transmission, transmits the data in a two-hop manner, using the station S_h as a helper.

Helper selection

- Every station maintains a table, called CoopTable, with information about all the possible helpers.
- Once a station has a frame to transmit, it estimates the transmission time in a two hop basis, using every potential helper.
- Then, it selects the helper that provides the lowest transmission time

Cooperative MAC Implementation

Testbed settings

- The network consists of a source, a destination and a potential helper node.
- The CoopTable information is configured manually into the source node.
- Every station consists of a Linux laptop with an 802.11b wireless card, which is based on the Intersil Prism 3 chip-set.

Software

- We modify the functionality of the HostAP driver which is a Linux driver for Intersil Prism 2/2.5/3 chip-set.

Implementation details

- A new header is inserted between the 802.11 header and the payload of the frame.



Cooperative MAC Implementation

Challenges

- Controlling time critical tasks, like ACK transmission, is only possible by modifying the firmware of 802.11 cards.
- Thus, we could not:
 - Suppress the ACK frame sent by the helper.
 - Generate a new ACK, directly from the destination to the source.

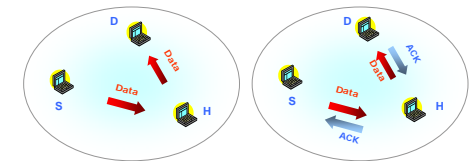
Solutions

Broadcast approach:

- Suppress undesirable Ack, losing the ACK from destination as well.

Unicast approach:

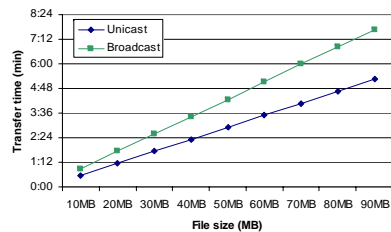
- Two ACKs:
 - destination to helper
 - helper to source



Implementation Results

Comparison between the two approaches

- Large file transfers via ftp.
- Both links have 11 Mbps transmission rate.



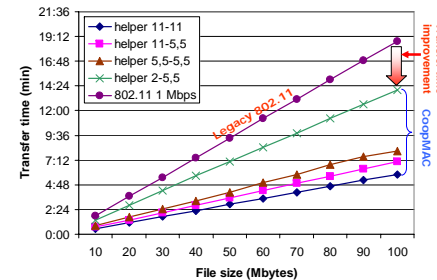
Conclusions

- We expected to have higher throughput in the case of broadcast transmissions as in this case we do not have the added overhead from the ACK transmission.
- Nevertheless, the scheme with the unicast transmissions performs better.
- This is due to the fact that in the broadcast transmission scheme, there is no ACK for the MAC transmissions. Thus, the communication in the MAC layer is not reliable, resulting in lost frames and subsequent reduction of TCP window size.

Implementation Results

Comparison between Cooperative MAC and 802.11

- The direct link between the source and the destination has 1 Mbps transfer rate.
- We run Cooperative MAC for several rate combinations for the two-hop transmissions.



Conclusions

- Cooperative MAC outperforms the legacy IEEE 802.11 protocol in terms of throughput, for several positions of potential helpers.

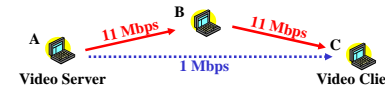
Cooperative MAC Demo

Demo settings

- Three Linux laptops with 802.11b wireless cards.
- We run a video streaming application (JMStudio) where the source station is the server and the destination station is the client.

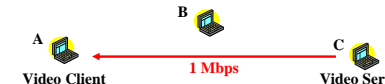
Two Demo setups

- **CoopMAC setup**
 - Laptop A is the source, laptop B is the helper, laptop C is the destination.
 - The transmission rates in the two hops are 11Mbps.



802.11 setup

- Laptop C is the source, laptop A is the destination.
- The transmission rate is 1 Mbps.



Cooperative MAC Demo

Video clip characteristics

- Type: mpeg
- Width: 352
- Height: 288
- Frame rate: 25 fps
- Bit rate: 1 Mbps

Demo results

CoopMAC setup

The video quality is good at the client, as the helper involvement provides higher transmission rates for the video frames and thus supporting the bit rate of the video clip.

802.11 setup

The video quality is not very good at the client (freezing of the video frames can be seen, as the transmission rate is not high enough to support the video bit rate.)