Wireless Networking project presentation
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Congestion Control and Rate Adaptation in IEEE 802.11 networks
Overview

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Problem Statement

- The IEEE 802.11 is a CSMA/CA-based medium access scheme.
- It is designed for small and medium sized networks.
- Has no built in congestion control scheme.
- Very poor performance when network size increases.
Rate Adaptation

• Because of mobility the SNR is not stable.
• The SNR depends on the distance between the mobile node and the Access Point (AP).

• When the SNR decreases, the Transmission Rate should also decrease, in order to cope with a worse BER.
How does Rate Adaptation works?

• The IEEE 802.11 adapts the transmission rate based on the lost packets.

• For example, 10 consecutive lost packets are interpreted as sign of lower SNR (the node has moved further away from the AP)

• If, on the other hand, 10 consecutive packets are successfully transmitted the SNR has been improved (closer to the AP)
Why this is a problem?

• In medium-load networks the Wi-Fi rate adaptation technique works fine.
• But, in heavy-loaded there are a lot of collisions which may be mis-interpreted as poor SNR.
• Increasing the air-time each packet occupies.
• This leads to reduction of throughput and capacity.
Air-time occupied from packets

1500 bytes frame

54 Mpbs

~0.2 ms

5 Mpbs

2.4 ms

• More than 10 times more air-time occupied
Motivation

• It is very important to develop a congestion control scheme which would work for large Wi-Fi networks.

• A survey conducted by the Pew Internet Project in Feb. 2007 shows that one third of users in USA access internet via wireless networks.

• Wide proliferation of Wi-Fi Hotspots.
Motivation

- Large increase of Wi-Fi in enterprises and academic environments.
- The dramatic increase of Smartphone devices, for which is cheaper and faster to access Internet by Wi-Fi than 3G.
- This all indicates that Wi-Fi protocol must be able to support large networks to.
Wireless cOngestion Optimized Fallback (WOOF)

- The WOOF protocol is designed so to distinguish packet loss due to collision and packet loss due to poor SNR.
- This way Transition Rate decrease due to collision would be avoided.
- It is designed so it can be implemented in all platforms.
- Uses Real-Time Measurements.
Benefits from WOOF

![Graph showing network throughput vs. offered load for StaticBest, WOOF, CARA, and SampleRate.]

- **StaticBest**: Solid line with circles.
- **WOOF**: Dashed line with crosses.
- **CARA**: Dotted line with squares.
- **SampleRate**: Dashed-dotted line with dots.

The graph depicts how network throughput changes with offered load for different protocols.
Proposal

• We propose an extension to the WOOF protocol.
• Congestion Control would be more effective if it take into account the packet size.
• In order to improve fairness and throughput we propose the adaptation of MTU (maximum transmission Unit) based on Transition rate.
Proposal

• Nodes with large SNR would have large-transmission unit.
Benefits

• Throughput would be improved, because low rate transitions would occupy much less the channel.

• It’s more fair for the nodes with good SNR because now they have more air-time.

• Low-rate nodes are motivated to find Access Points closer to them.
Experiments

• We conduct real-world experiments in order to show the benefits of the proposed schemes.

• We use wireshark and nttcp tools in Linux to perform the experiments.

• We use a simple topology with two mobile nodes, an Access Point and a Server.
First Experiment

- Both the tested node and the noise have good SNR, and therefore high transmission rate.
- They both use large packets.
• We can observe very effective communication.
Second Experiment

• The noise has poor SNR, and therefore low transmission rate.
• They both use large packets.
Time-SequenCe graph

- Efficiency decreases dramatically
Third Experiment

- The noise has poor SNR, and therefore low transmission rate.
- We use our proposal and reduce the size of the packet.
Proposal implemented

- We can see improvement
Fourth Experiment

- The noise has poor SNR, and therefore low transmission rate.
- The MTU of the node with low-SNR is even smaller.
Drawbacks of our proposal.

- If the packet becomes too small the performance decreases
Explaining the Results.

• Remember from the book that:

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RTS  CTS  DATA  ACK
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• The portion of control messages (RTS/CTS) increases and the portions of the data packets decreases.

• The Increase of the number RTS means increase in the number of collisions.
Conclusion

• Congestion Control for Wi-Fi networks is very important for the future and more can be done to improve existing mechanisms.

• We show that a congestion control based on the size of the packet has potential benefits.

• But, reducing the size of the packet may increase the number of collisions.

• Must be careful when we reduce the size of the packet.