Collaborative Setting of RTS/CTS in Multi-Rate Multi-BSS IEEE 802.11 WLANs.

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IEEE LANMAN 2008, Cluj-Napoca, Romania

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Outline

- **Problem Statement and State of the art.**
- **Paper Contribution.**
- **Criteria for Controlling RTS/CTS**
- **Performance Evaluation and Results.**
- **Conclusions.**

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Problem Statement ad State of the ART

- **RTS/CTS has been shown to be effective:**
  - **If hidden nodes exist in the network.**
  - **Large packets.**

- **So far, the focus has been on the impact of RTS/CTS on total users throughput with *homogenous physical rates.***

- **Contradicting conclusions do exist:**
  - **RTS/CTS shall be always disabled.**
  - **RTS/CTS shall be always enabled.**
  - **RTS/CTS shall be enabled if Packet Size > Threshold (for example 700Bytes).**
  - **RTS/CTS shall be enabled if number of users > Threshold**

The question is how to set the RTS/CTS ??

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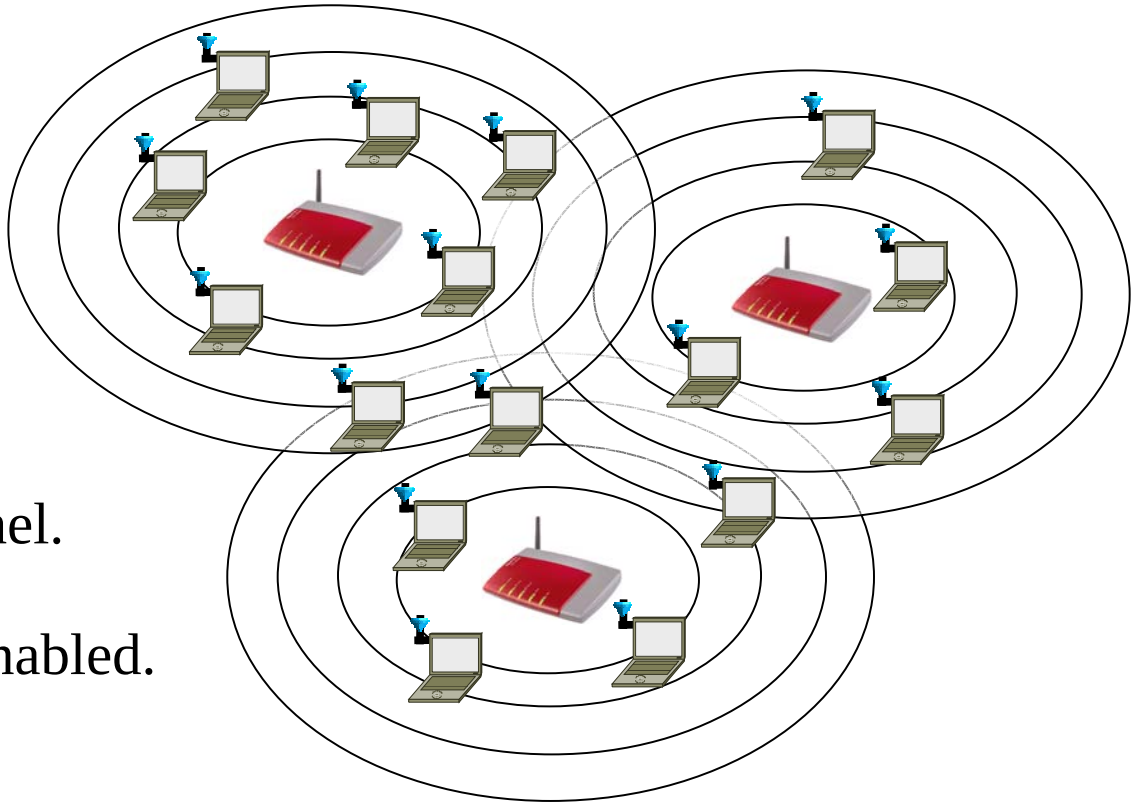
Paper Contributions

- **Propose two Criteria for Controlling RTS/CTS in Multi-Rate Multi-Cell WLANs:**
  - Controlling RTS/CTS based on number of hidden node pairs.
  - Collaborative criterion for Setting RTS/CTS

Controlling RTS/CTS

Configuration

- ESS 802.11 WLAN.
- Heterogeneous Rates .
- Some APs use the same channel.
- STAs and APs are 802.11k enabled.



Controlling RTS/CTS

Introduction

- Different recommendations are due to the differences in the scenarios considered.

- Performance depends on correlated factors: Rates, number of users, traffic characteristics, location of users in the BSSs, and interference from neighboring BSS.

- The intuition of using size as a threshold is that a retransmission or a collision of large packets is time consuming. **But,** the time Depends on the **RATE.**

Intuitively, reducing the collisions and consequently re- ransmissions at low physical rates improves the performance of high rate users which can not be observed when all users employ the same transmission rate.

Controlling RTS/CTS- Criterion 1

Each Node:

- Monitors transmissions in the BSS.
- Reports the received power from each node to AP.

Each AP:

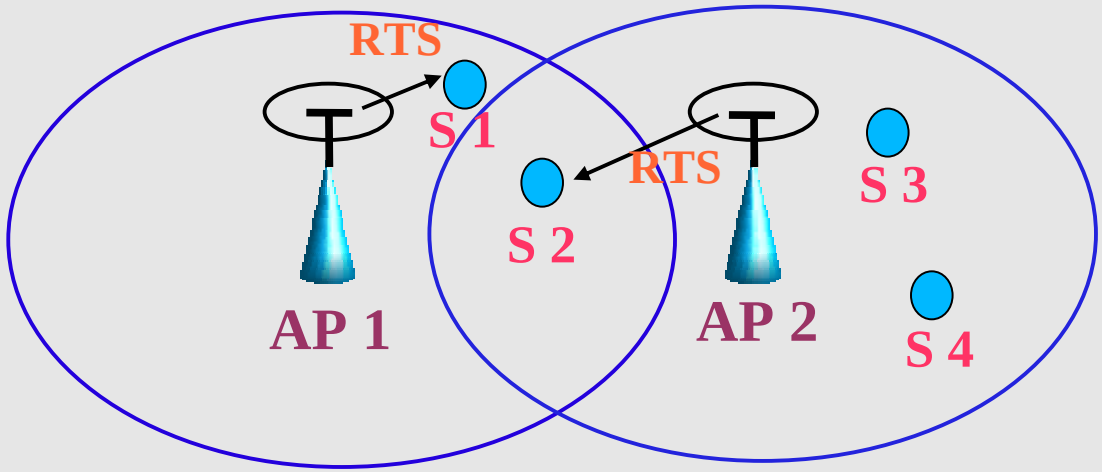
- Determines the set of of hidden node pairs.

  Hidden Pair: both nodes do not hear each other.

- Instructs hidden node pairs to use RTS/CTS.

Collaborative Settings of RTS/CTS (Criterion 2)

Motivation Example



* S2 will not be able to respond to the RTS sent by AP 2 until the exchange data and ACK between user S1 and AP 1 completes.

* RTS from AP 2 will mislead users S3 and S4 which think that a data transmission is taking place and hence prevented from accessing the channel.

Collaborative Settings of RTS/CTS (Criterion 2)

- Each AP instructs its nodes to **disable** RTS/CTS, **measure** and **quantify** their current QoS for some time period.
- Then, all nodes shall **enable** RTS/CTS prior to data packets and start to observe their QoS over a testing phase.
- Nodes **report measurements** to their APs.
- APs **share** measurement information.
- One AP **processes measurements** and decides whether RTS/CTS shall be used based on probable improvement in the QoS after using the RTS/CTS mechanism. The decision is then signalled to other BSSs which distribute it to the users.

Collaborative Settings of RTS/CTS (Criterion 2)

- After some time period, the current status of RTS/CTS is inverted and the testing takes place.

- The potential metrics for the decision are: Throughput, fairness or both.

Potential Improvement:

- It may not be necessary to instruct all nodes either to ENABLE or DISABLE RTS/CTS. If APs share hidden node pair measurement, it is possible to instruct only those hidden pairs to use RTS/CTS

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Performance Evaluation

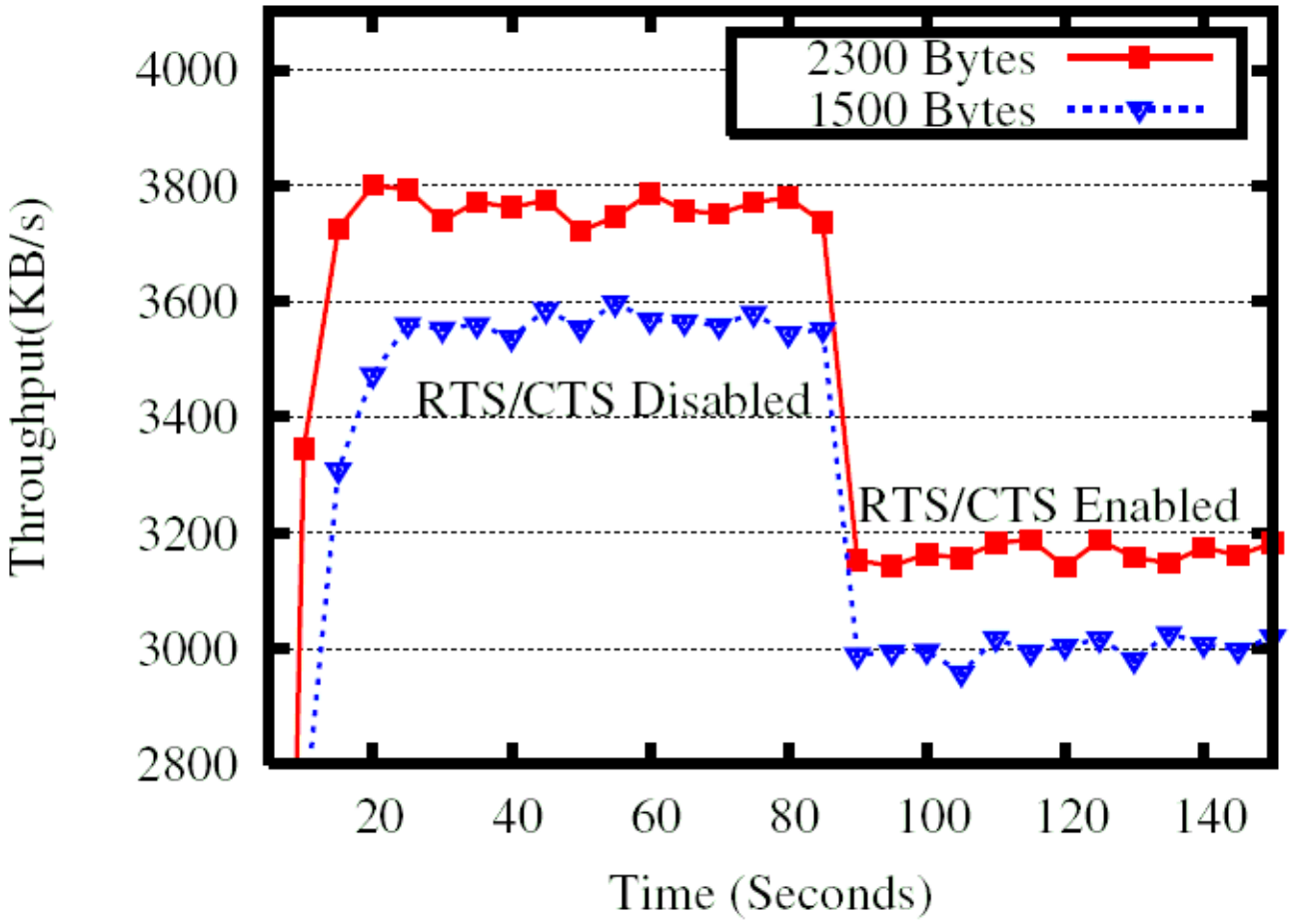
- Simulation with Synthetic and Real WLAN traffic.
- Real Experiments.

Evaluation Metrics: **Throughput and Fairness**

Simulation Setup:

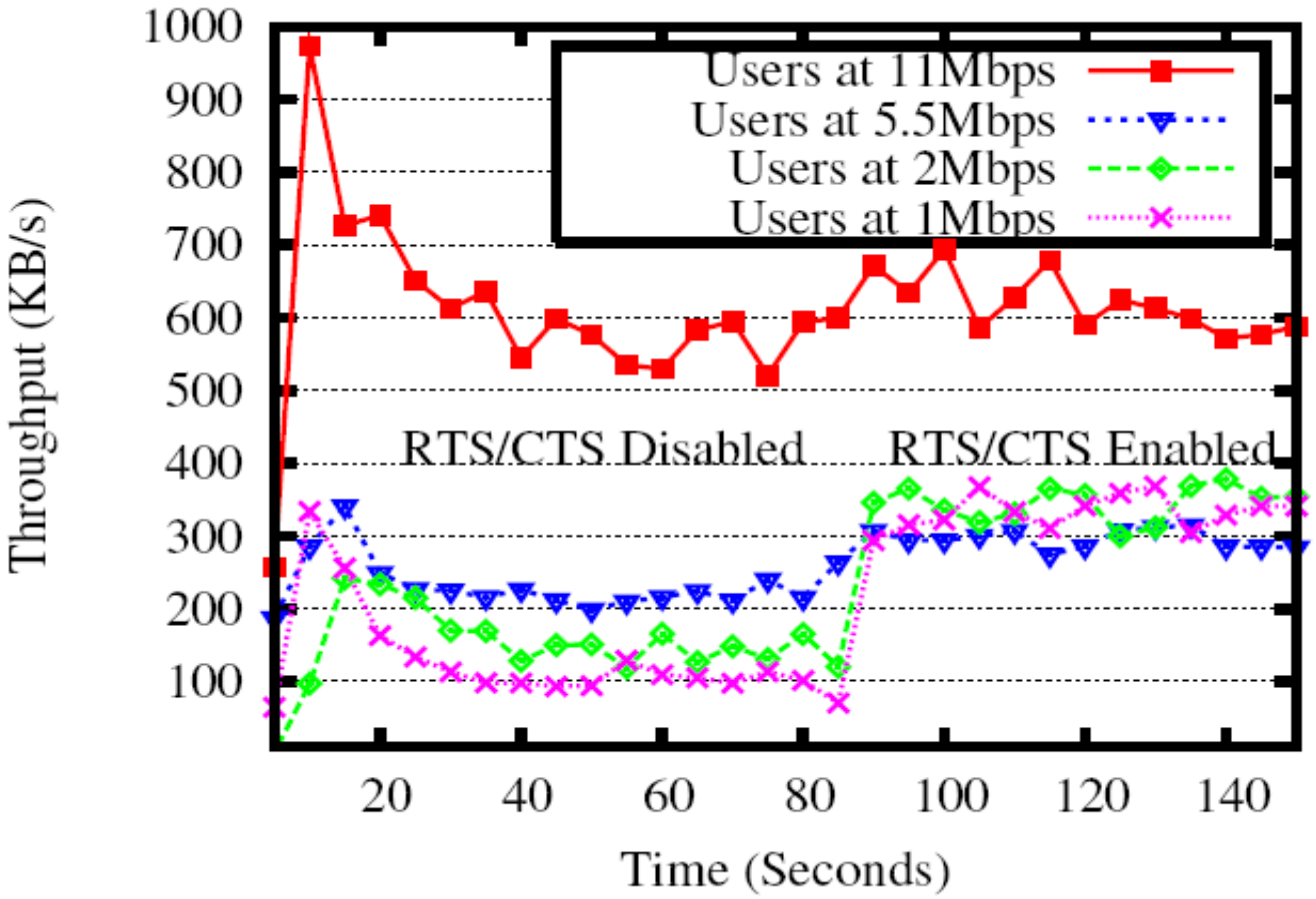
- **10 APs.**
- **100 Users.**
- **No mobility.**
- **802.11b.**
- **Cells overlapp.**
- **NCTUns Simulation Package.**
- **All nodes use 15dB transmission power.**
- **Fading: Rayleigh Fading.**
- **Path loss: two-Ray gound reflection model.**

Simulation Results



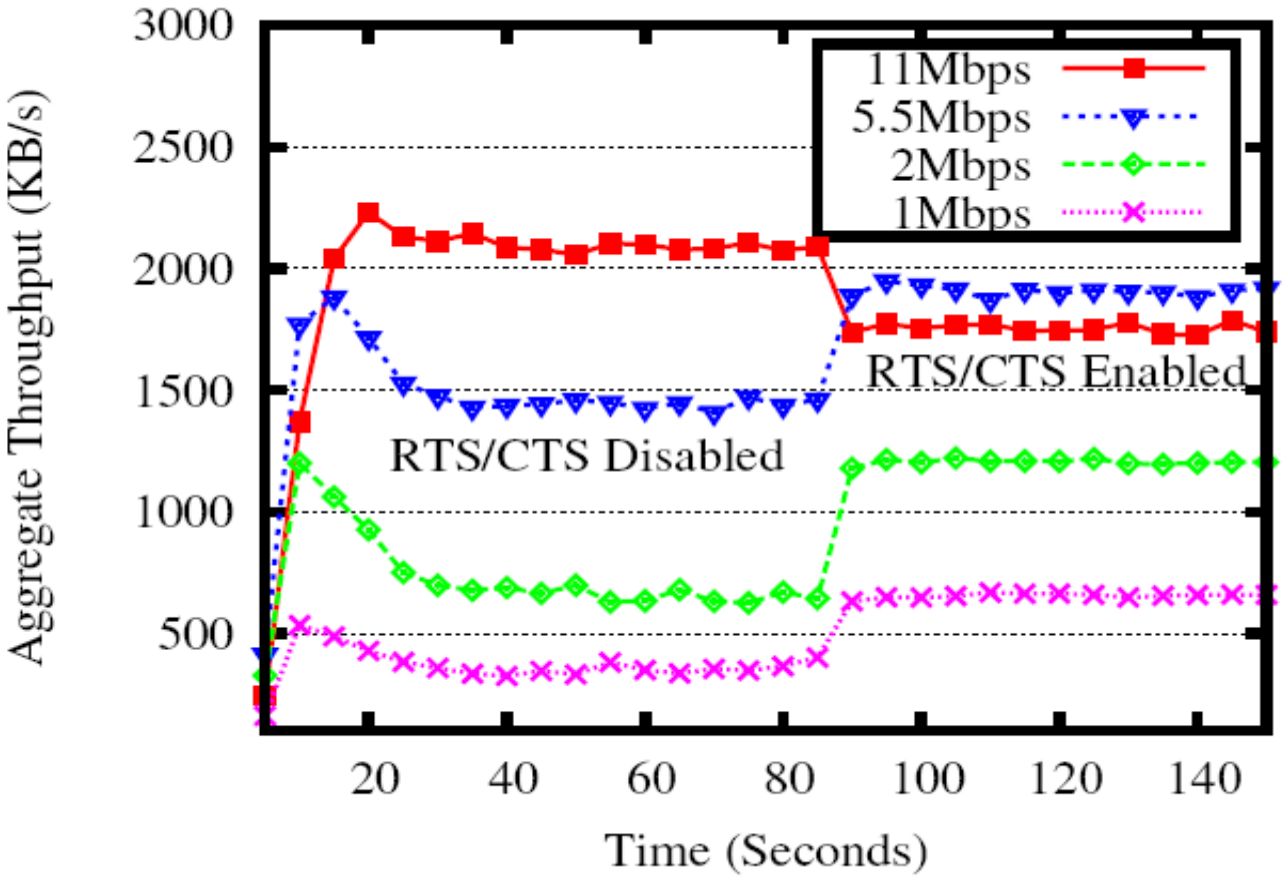
Aggregate Throughput Performance of all users for large packets and 0.01 seconds inter-arrival time.

Simulation Results (cont.)



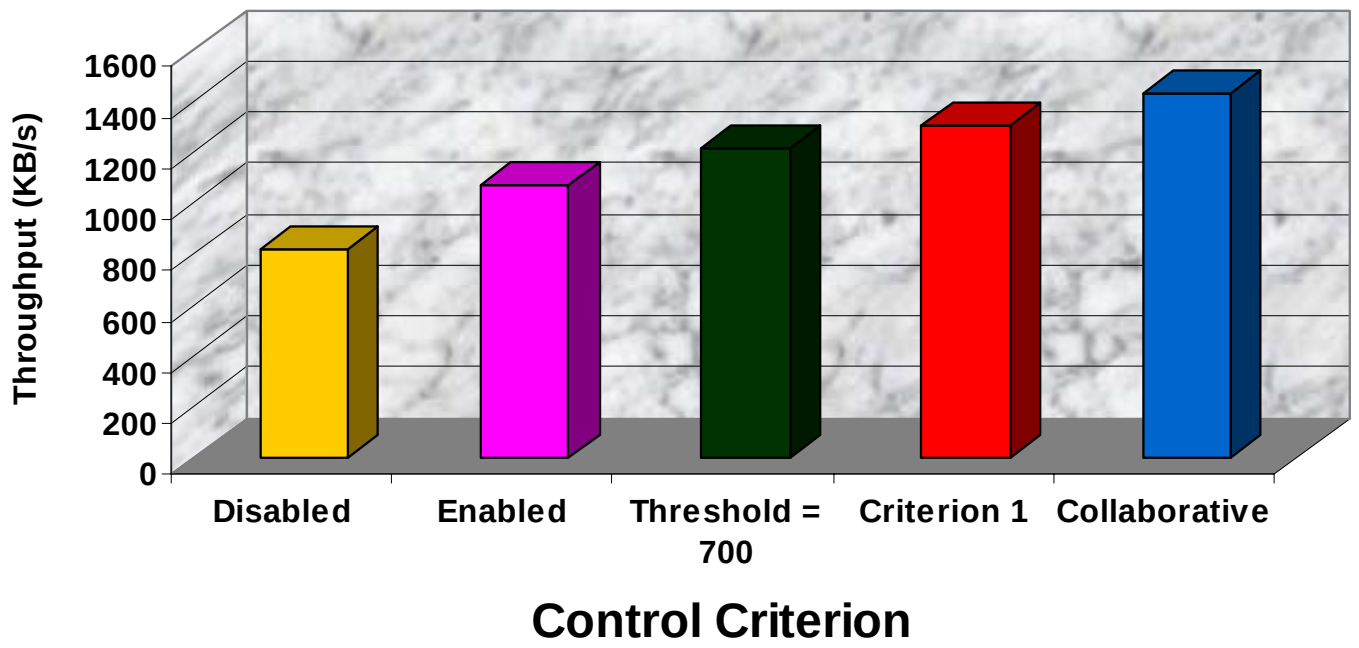
Impact of RTS/CTS on Throughput of Heterogeneous Rate Users with 1500 Bytes packets and 0.01 seconds inter-arrival time.

Simulation Results (cont.)



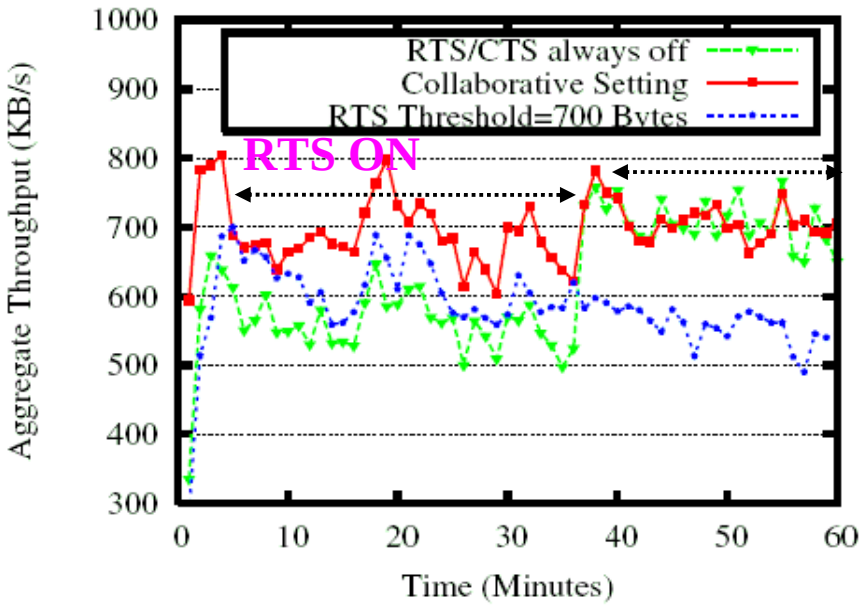
Impact of RTS/CTS on Throughput of Homogeneous Rate Users with 1500 Bytes packets and 0.01 inter-arrival time.

Simulation Results (cont.)

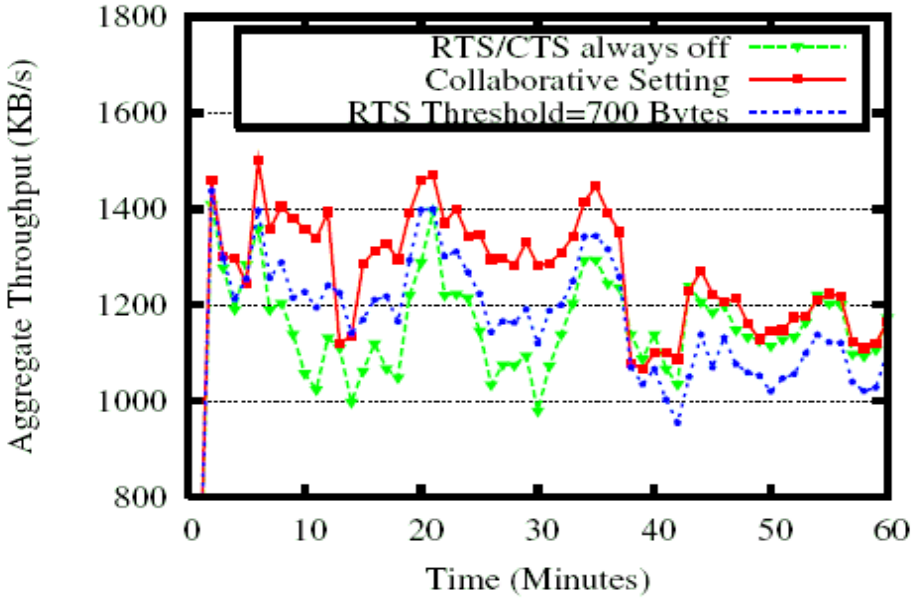


Comparison between our dynamic RTS/CTS setting and some common approaches.

Simulation Results (cont.)

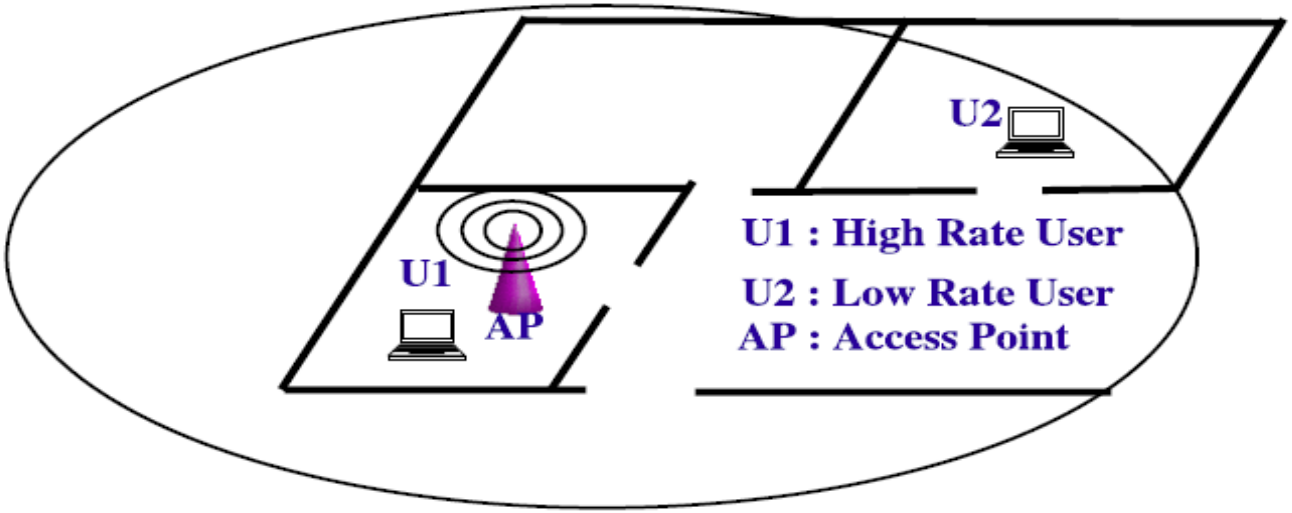


Performance of Collaborative Criterion with Real WLAN Traces from SigComm2001.



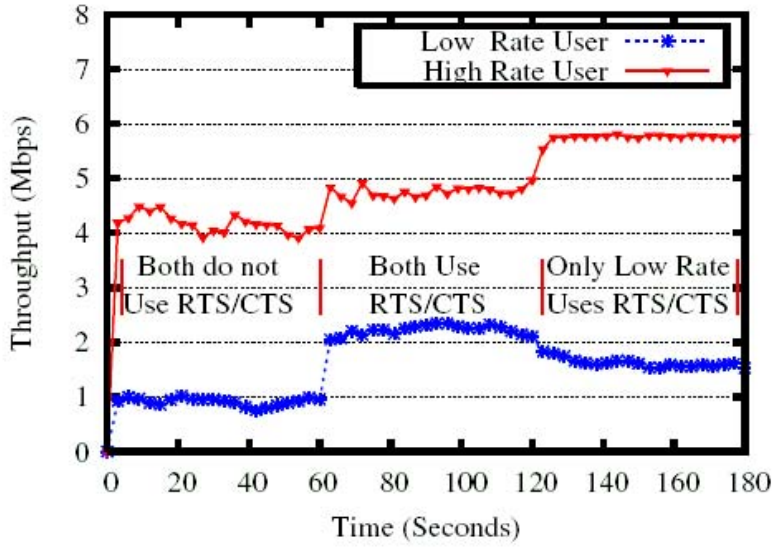
Performance of Collaborative Criterion with Real WLAN Traces from SigComm2004.

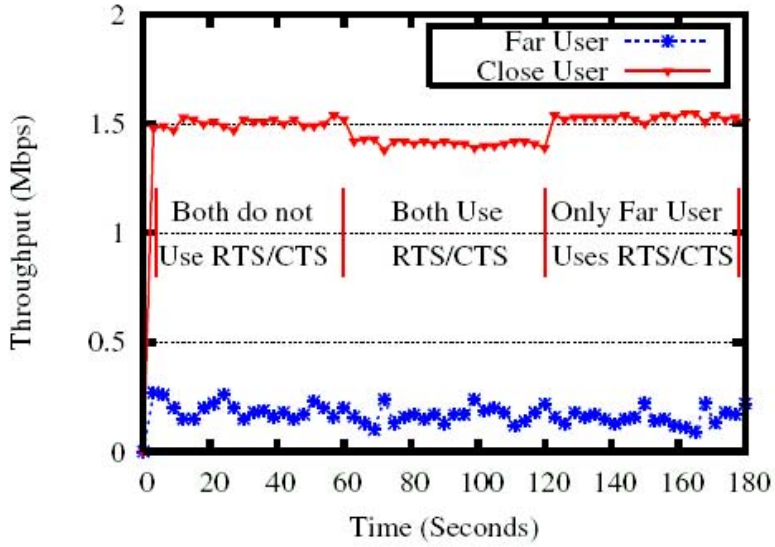
Set-up of Real Experimental



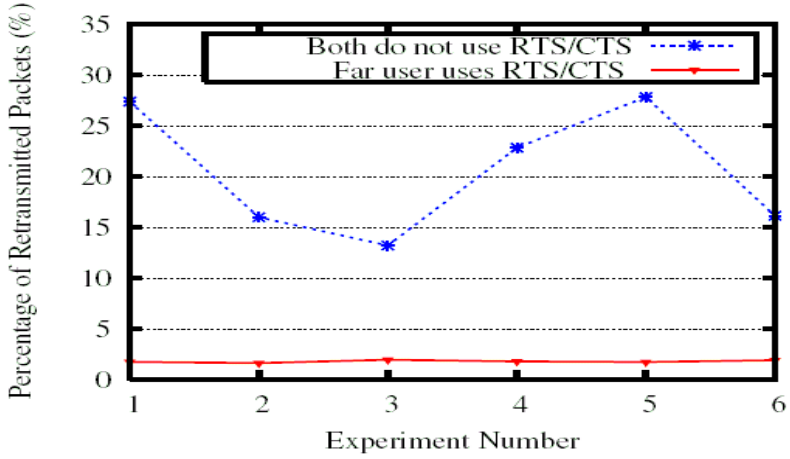
- 4 Laptops - **WPN511 RangeMax WLAN Adapters**.
- MADWIFI.
- NetCat + Ethereal

Real Experimental Results





Impact of RTS/CTS in Heterogeneous and Homogeneous Rate Scenarios.



Impact of RTS/CTS on the TCP Retransmission for real file transfer in heterogeneous rate scenario.

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Conclusions

- Through simulation and small real experiments, we have shown that RTS/CTS control algorithms have to be evaluated in a multi- rate environment.
- Two Criteria for RTS/CTS Setting are proposed.
- The Collaborative approach has shown good improvement.

Thank You