Diagnosing Wireless Packet Losses in 802.11 Separating Collision from Weak Signal

Infocom2008

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Outline

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2. COLLIE
3. FEEDBACK-BASED COLLISION INFERENCE
4. USING COLLIE FOR LINK ADAPTATION
5. CONCLUSION

INTRODUCTION

- CSMA/CA - the lack of ACK upon timeout gives an indirect indication of a collision.
- A packet loss could also be due to weak signal.
- The problem of determining the cause of a packet loss to collision versus weak signal, as *loss diagnosis.*

Motivation

1. By analyzing the bit-level error patterns in other physical layer metrics can we determine the loss diagnosis.

2. Further, can we do this based on a single packet loss in real-time?

INTRODUCTION

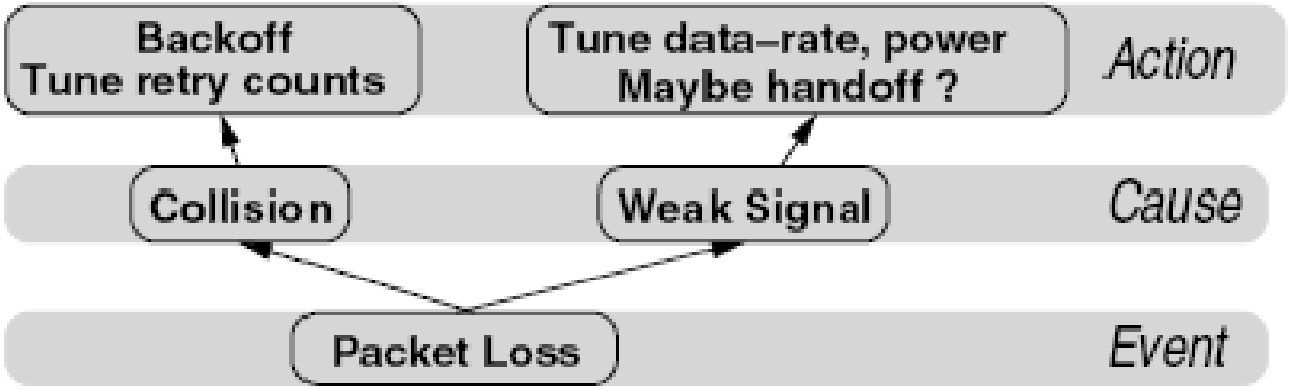


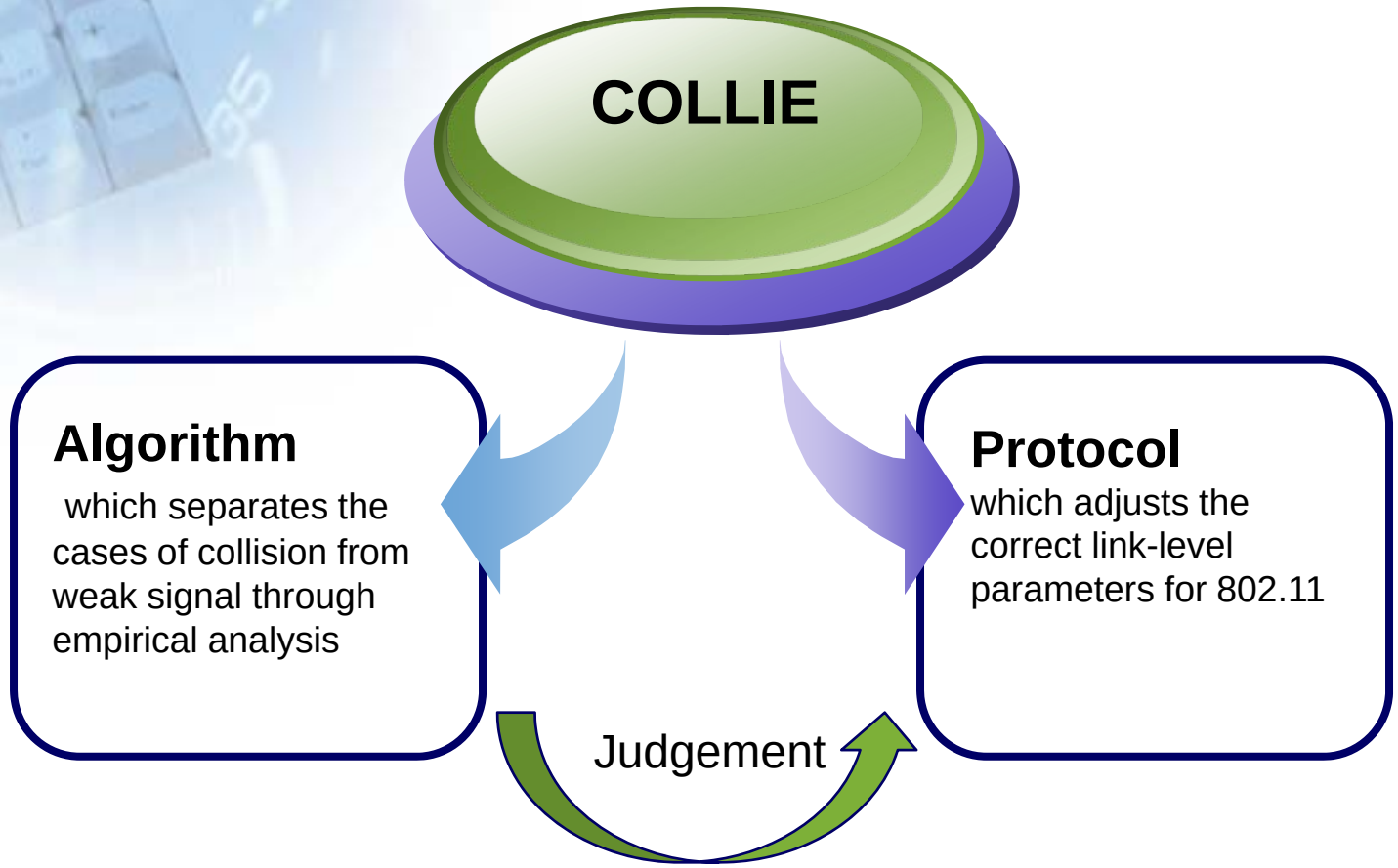
Fig. 1. What link parameters to adapt and how depends on the cause for a packet loss.

Comparison

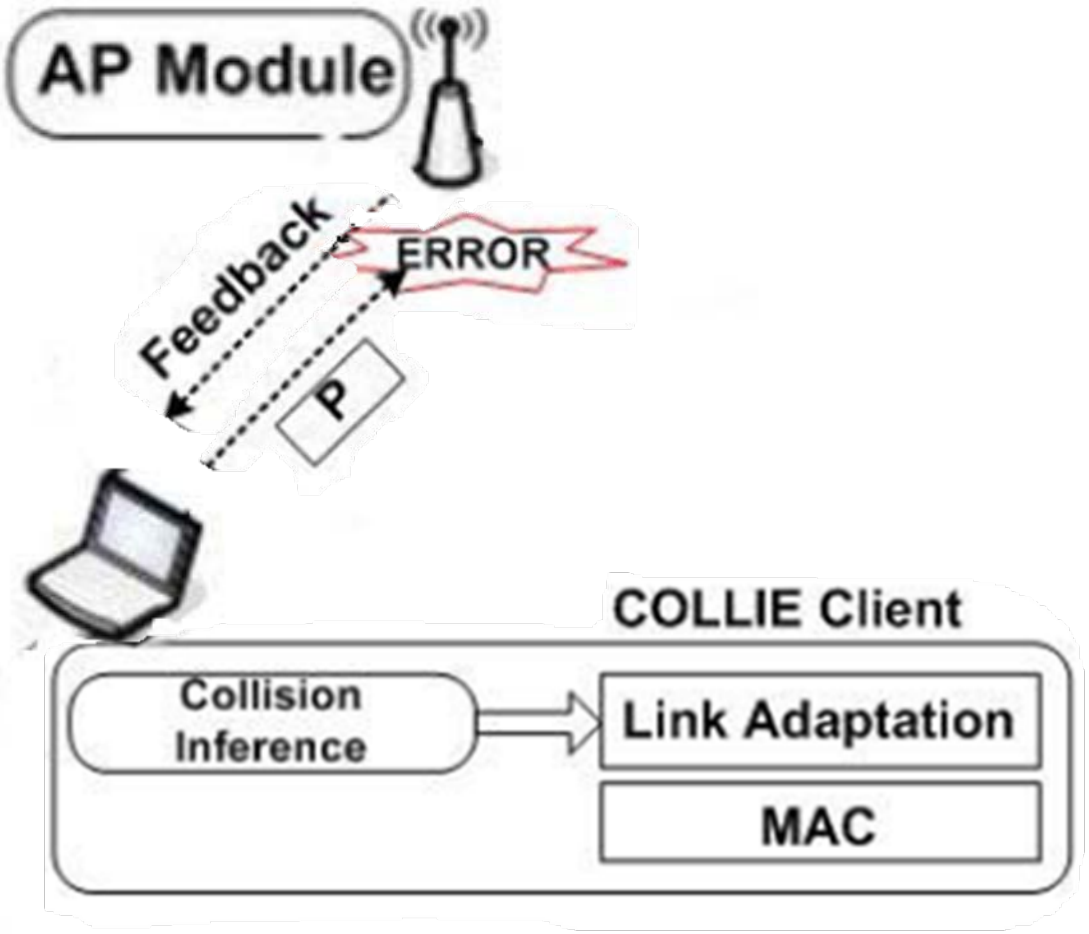
	Additional transmission	Real time	Analysis packet
Direct	x	O	O
Indirect	O	x	x

COLLIE

Collision Inferencing Engine

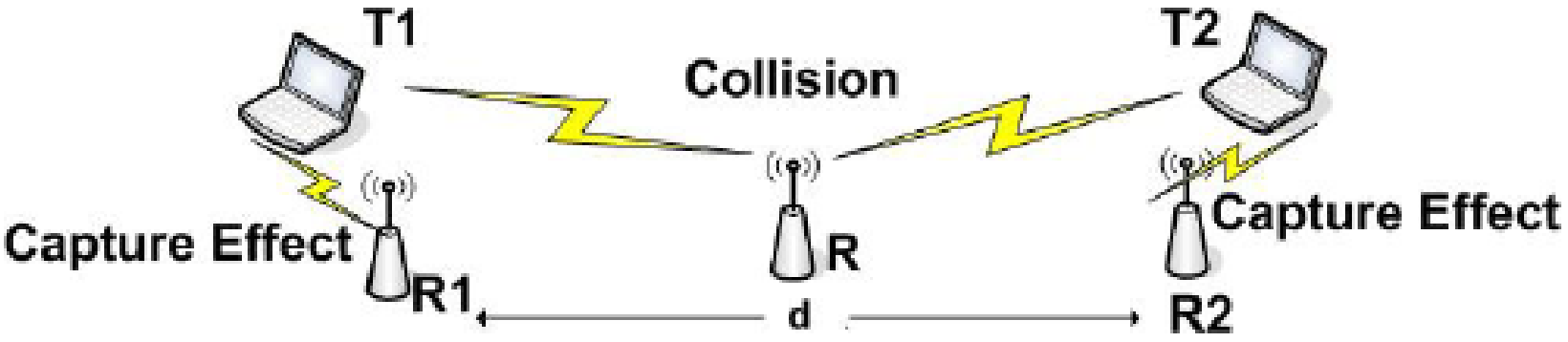


COLLIE system

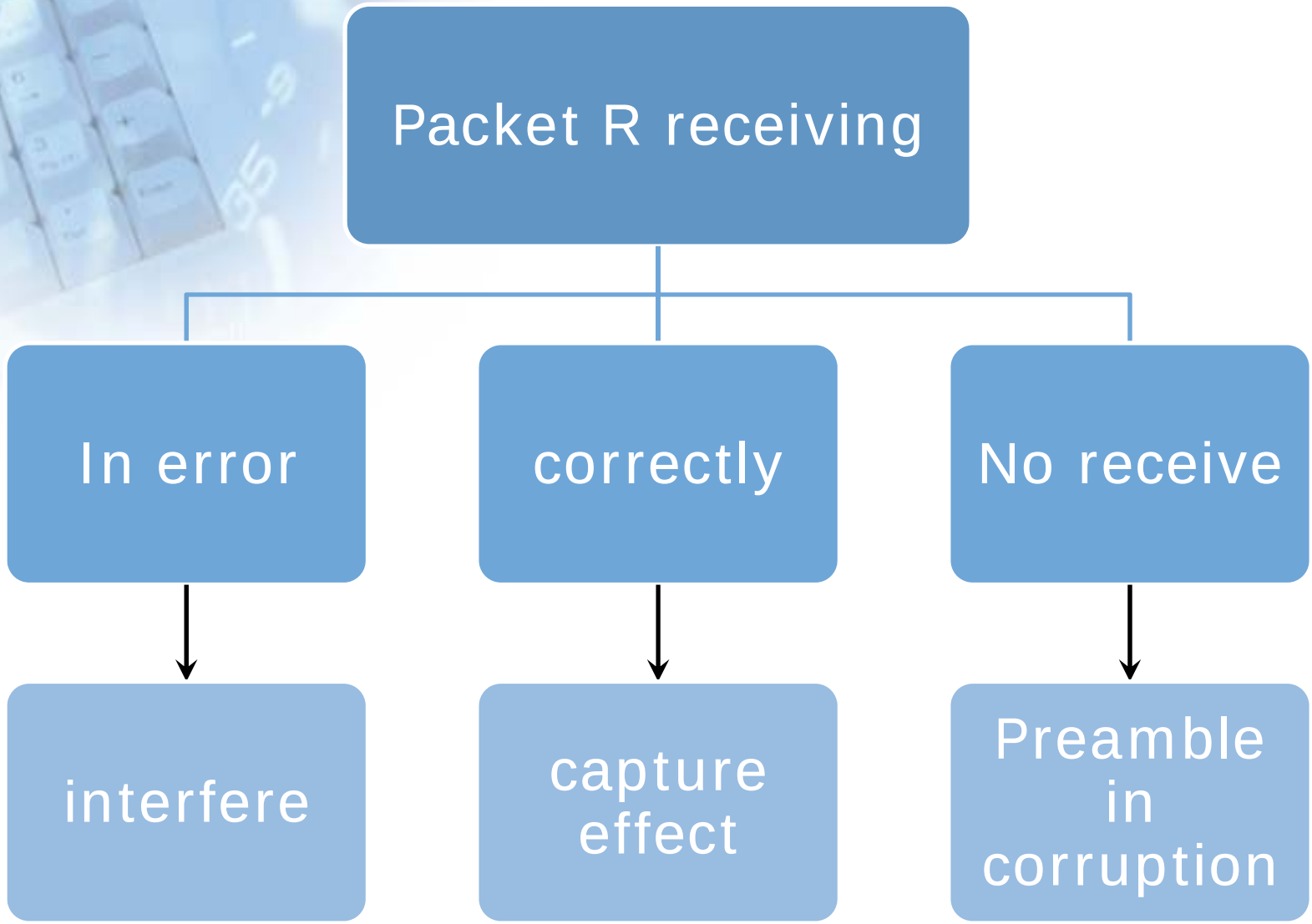


feedback based collision inference

Experiment Design for Detecting Collisions



Result


Packet R receiving
In error
correctly
No receive
interfere
capture effect
Preamble in corruption

Empirical Analysis

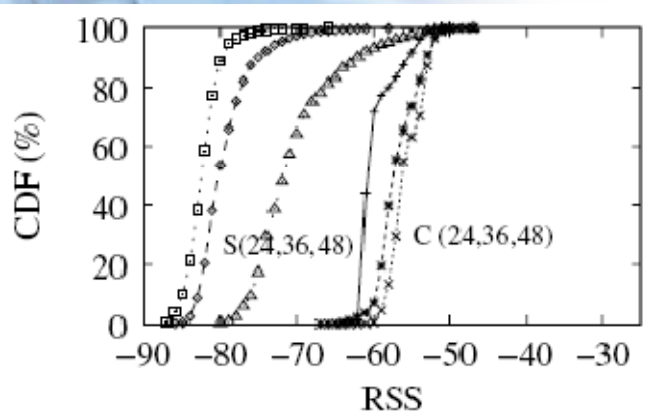


Fig. 4. CDF of Received Signal Strength (RSS)

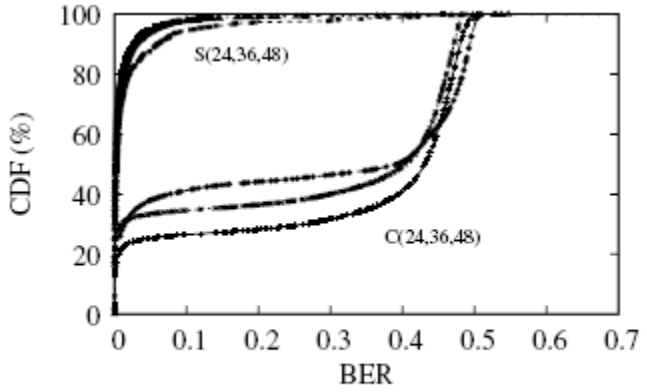


Fig. 5. CDF of Bit-Error Rate (BER)

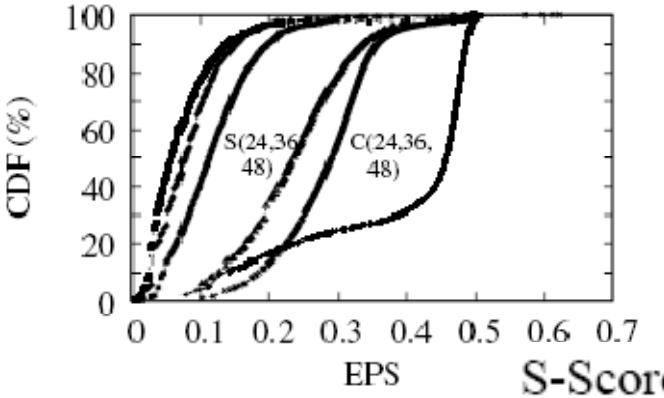


Fig. 6. CDF of Error Rate Per Symbol (EPS)

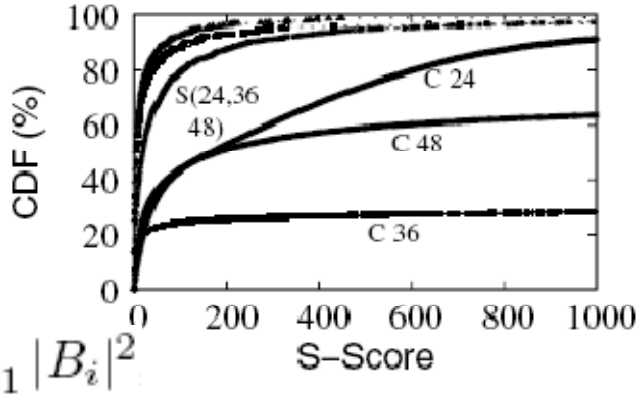


Fig. 7. CDF of S-Score

S-Score as $= \sum_{i=1}^{n} |B_i|^2$

$|B_i|$:the length of the symbol-error bursts for burst number i.

Collision Inferencing Algorithm

- **RSS observation:**
  - Estimating a ’cut-off’ value also becomes harder.
  - receiver sensitivity

TABLE I
COLLISION DETECTION ACCURACY AND FALSE POSITIVE RATES

	BER	EPS	S-Score	Metric-Vote
Accuracy	0.550	0.524	0.441	0.597
False Positives	0.0057	0.022	0.0126	0.024

Packet size

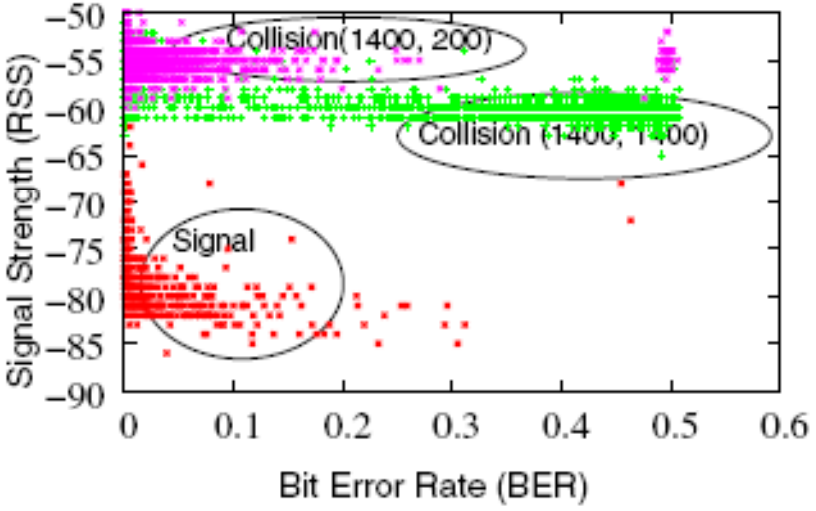


Fig. 9. Scatter-plot of BER vs RSS.

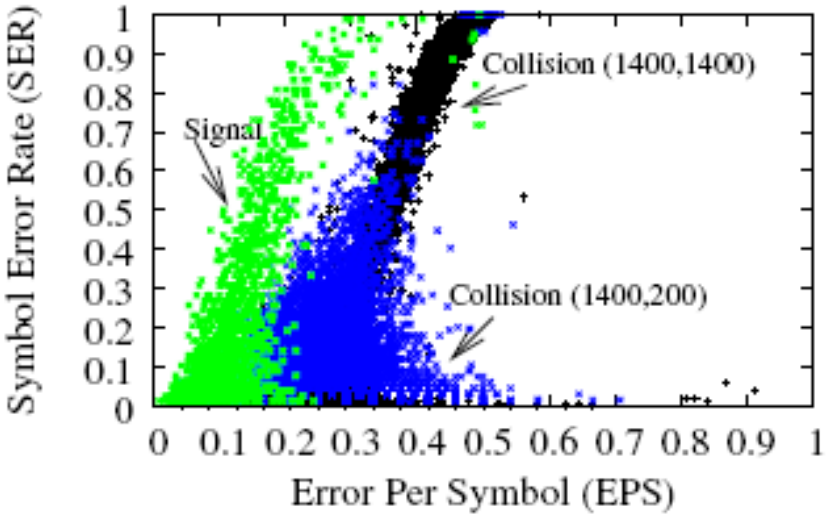
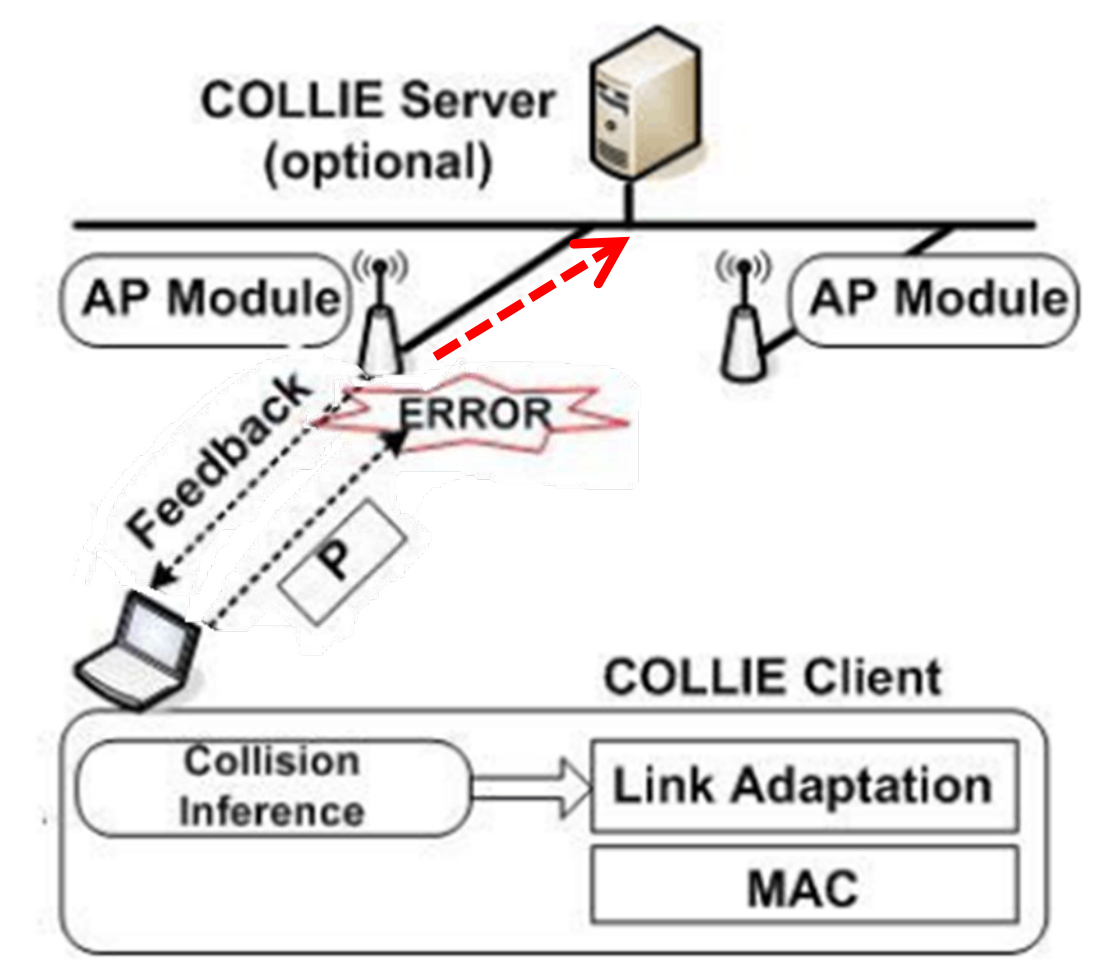


Fig. 8. Scatter-plot of SER Vs EPS

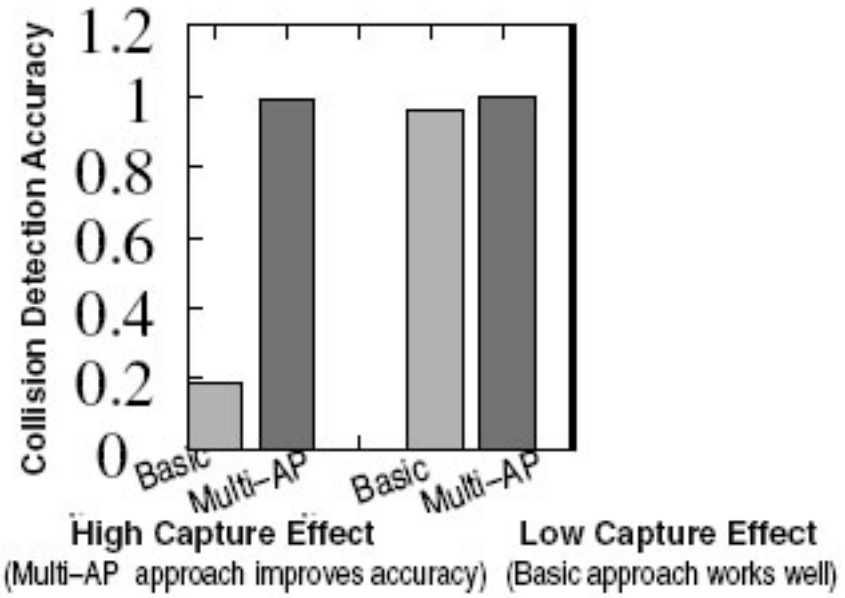
Multi-AP assisted enhancements

- **Component**
  - aggregating such feedback at a central COLLIE server.
  - The APs implement two functionalities:
    - Synchronize among each APs
    - send a message to the server with the additional following:
      - Time
      - Source and destination MAC address
      - Data rate information

Multi-AP assisted enhancements



Basic versus multi-AP



COLLIE FOR LINK ADAPTATION

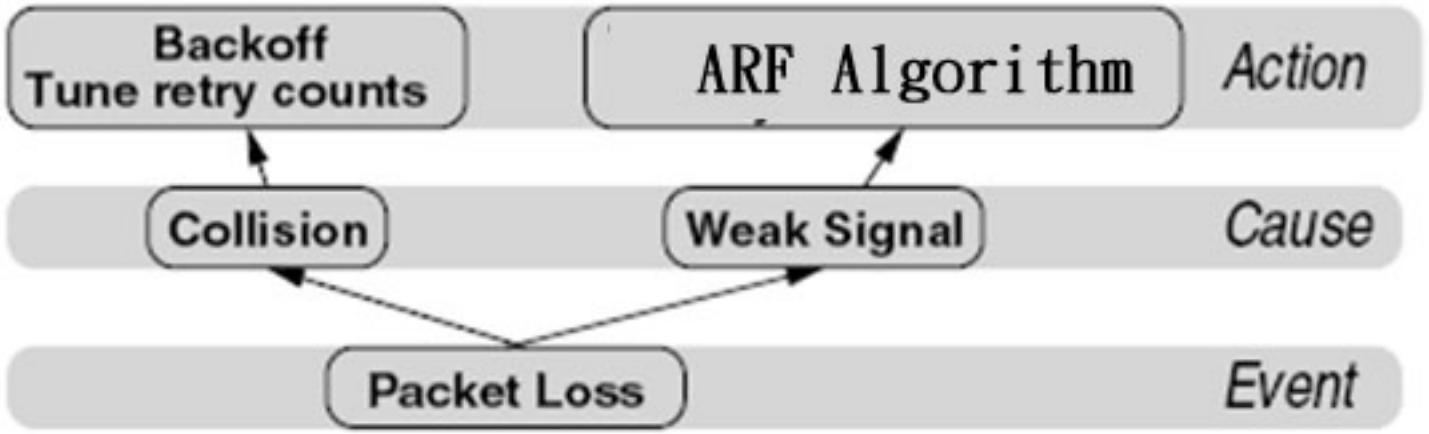
- The motivation :

  How can COLLIE be effective in a link adaptation leading to improvements in throughput?

- COLLIE-based link adaptation protocol
  - Goal: utilize COLLIE result in deciding how to react.

COLLIE-based link adaptation protocol

- In our implementation, we augment the ARF algorithm with COLLIE to make it collision-aware.



Experiment
Static scenario

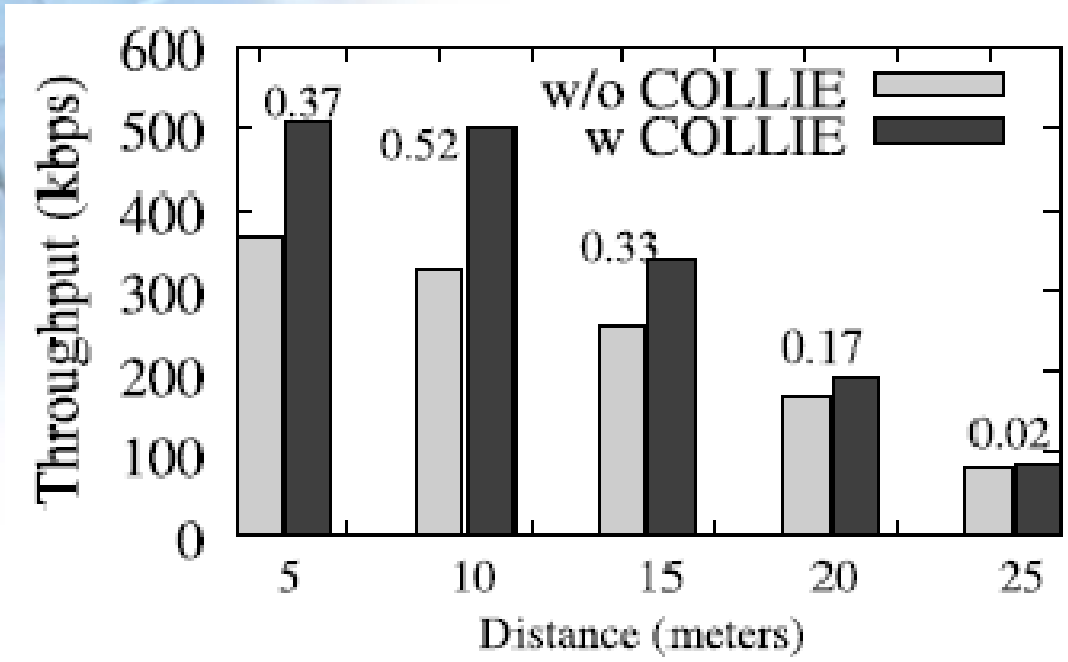


Fig. 11. Throughput gains for static scenario

COLLIE : the lack of feedback.

Experiment
Static scenario

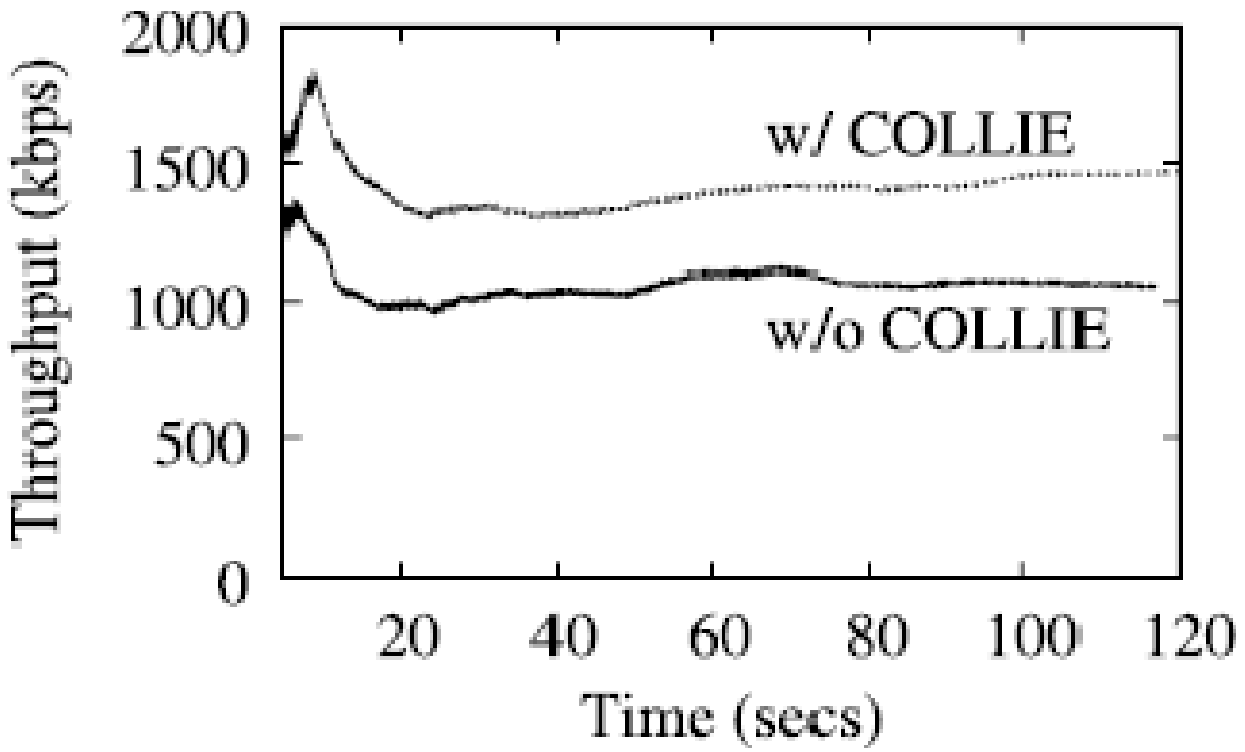


Fig. 12. Throughput variation over time

Experiment
Additional collision sources

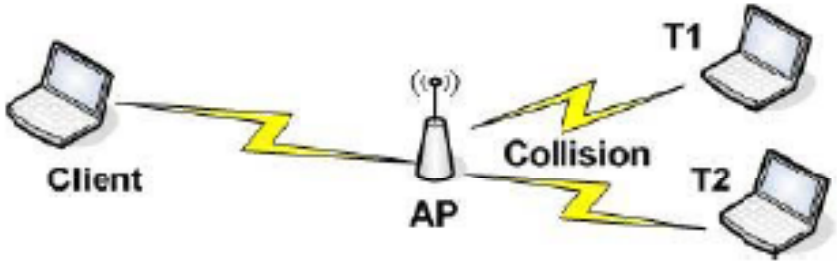


Fig. 13. Setup for inducing collisions

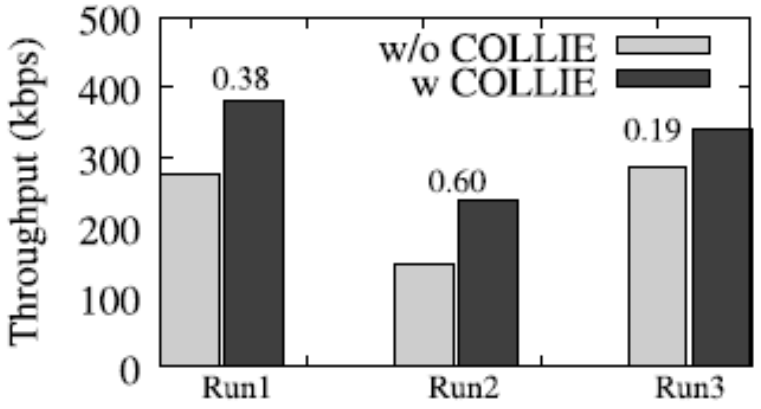


Fig. 14. Throughput gains of COLLIE in presence of collision sources

Experiment - Mobile scenario

Mobile : client position was continuously varied.

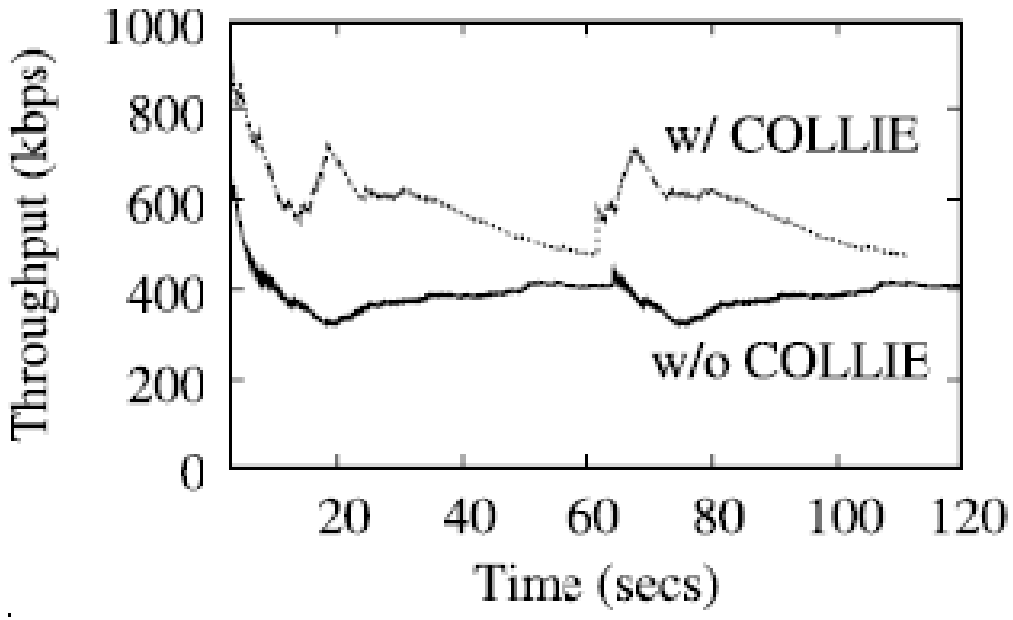


Fig. 15. Observed throughput for mobile scenario

COLLIE : real-time

Emulating a voice call

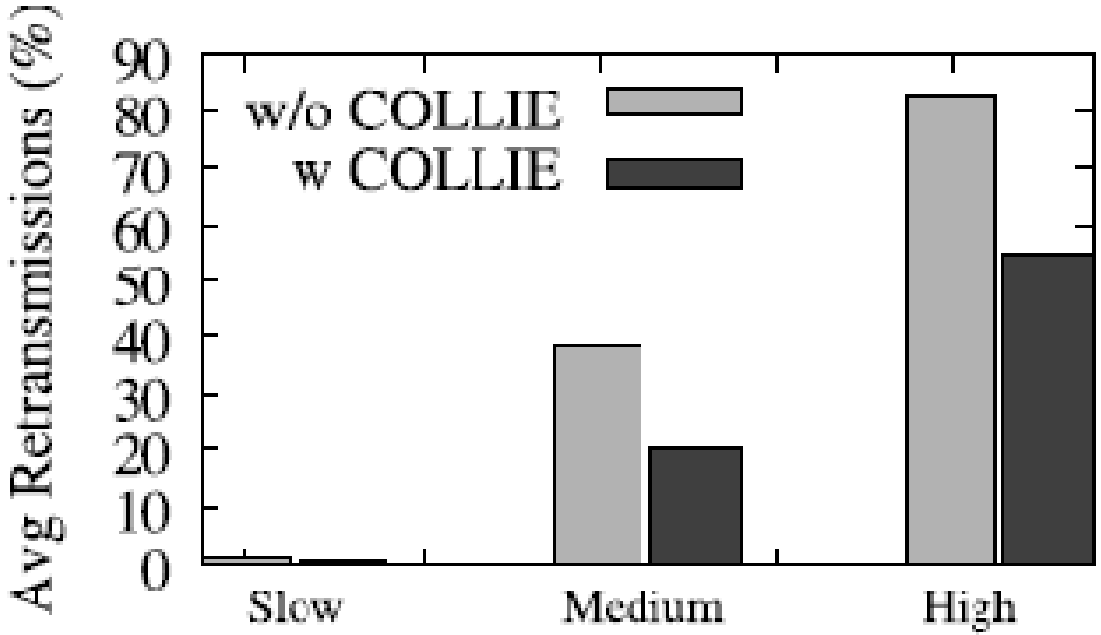


Fig. 16. Wasted (re)-transmission as a function of channel variability induced through node mobility.

CONCLUSION

- We have identified the cause of an erroneous packet reception by physical layer metric in 802.11 systems.
- It make link adaption more efficient by Using the COLLIE system.

Thank You !