

Validation of the IEEE 802.11 WiFi implementation for OFDM-based communication

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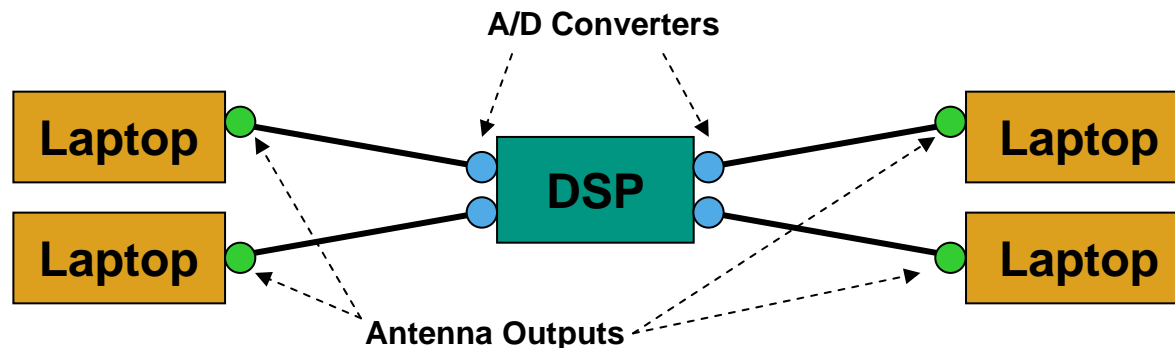
Motivation

■ Last NS-3 workshop in Rome

- Many discussions on 802.11 physical layer modeling approaches
- We couldn't say for sure whether they are right or not
 - Is the cumulative noise assumption valid?
 - Is the reception process modeled accurately enough?
- Core question: how can we validate our models?

■ Our proposal

- Let's use the network emulator testbed of the CMU Pittsburgh



Outline

- **Validation overview**
- **Validation experiments**
- **Results**
- **Conclusions**

Validation overview

■ What did we validate?

- **Question 1a:** Packet reception without fading w.r.t.
 - Data rate
 - Packet size
- **Question 1b:** Packet reception with Rayleigh fading w.r.t.
 - Data rate
 - Packet size
 - Fading speed
- **Question 2:** Packet reception with interference w.r.t.
 - Sender/Interferer SNR
 - Rayleigh fading/No Rayleigh fading

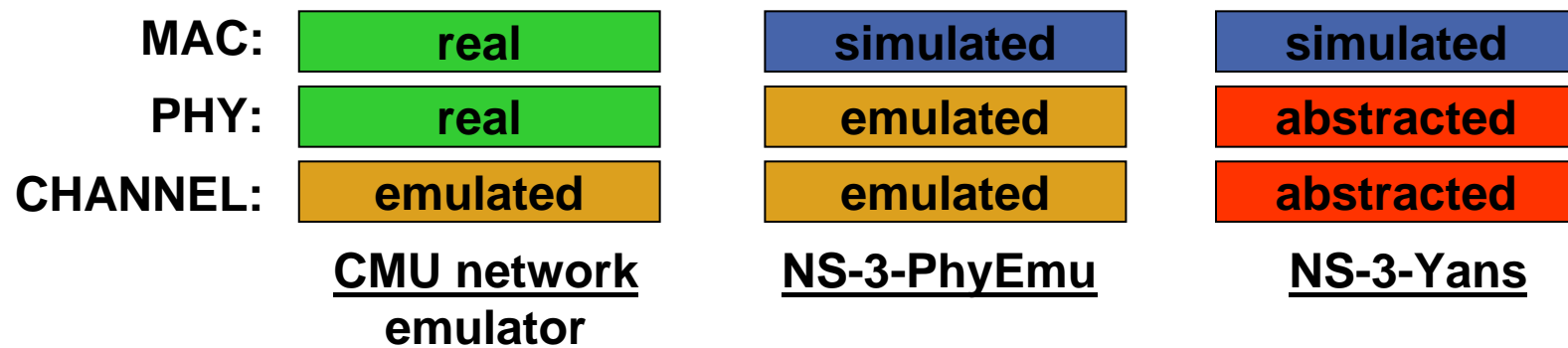
Validation overview

■ IEEE 802.11 configuration

- OFDM mode in 2.4 GHz frequency band
- 20 MHz channel width
- 6-54 Mbps data rates

■ We used 3 systems / simulation environments

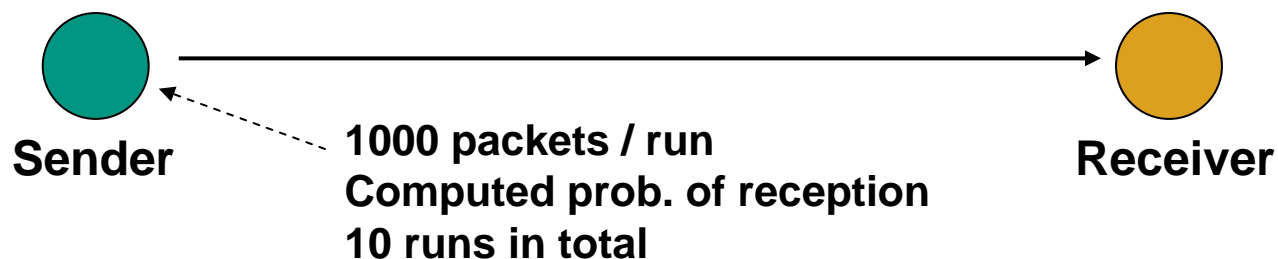
- CMU network emulator testbed (CMU Emulator)
- NS-3 with an emulated PHY layer (NS-3-PhyEmu)
- NS-3 with its traditional PHY layer model (NS-3-Yans)



Validation experiments

■ Experiment 1: No interference

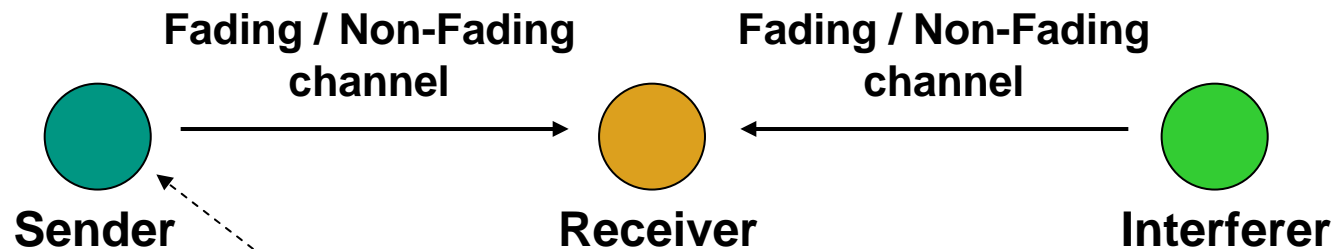
- a) Packet reception performance in non-fading channel
 - 1 sender / 1 receiver
 - No interference
 - Variation of
 - Pathloss
 - Payload
 - Data rate
- b) Packet reception performance in Rayleigh fading channel
 - Different Rayleigh fading speeds



Validation experiments

■ Experiment 2: one sending and one interfering node

- Interfering node sends 1400 byte packets continuously
- Sender does not hear interfering node
- Variation of
 - Channels between interferer/sender to receiver
 - SNR of sender and interfering node

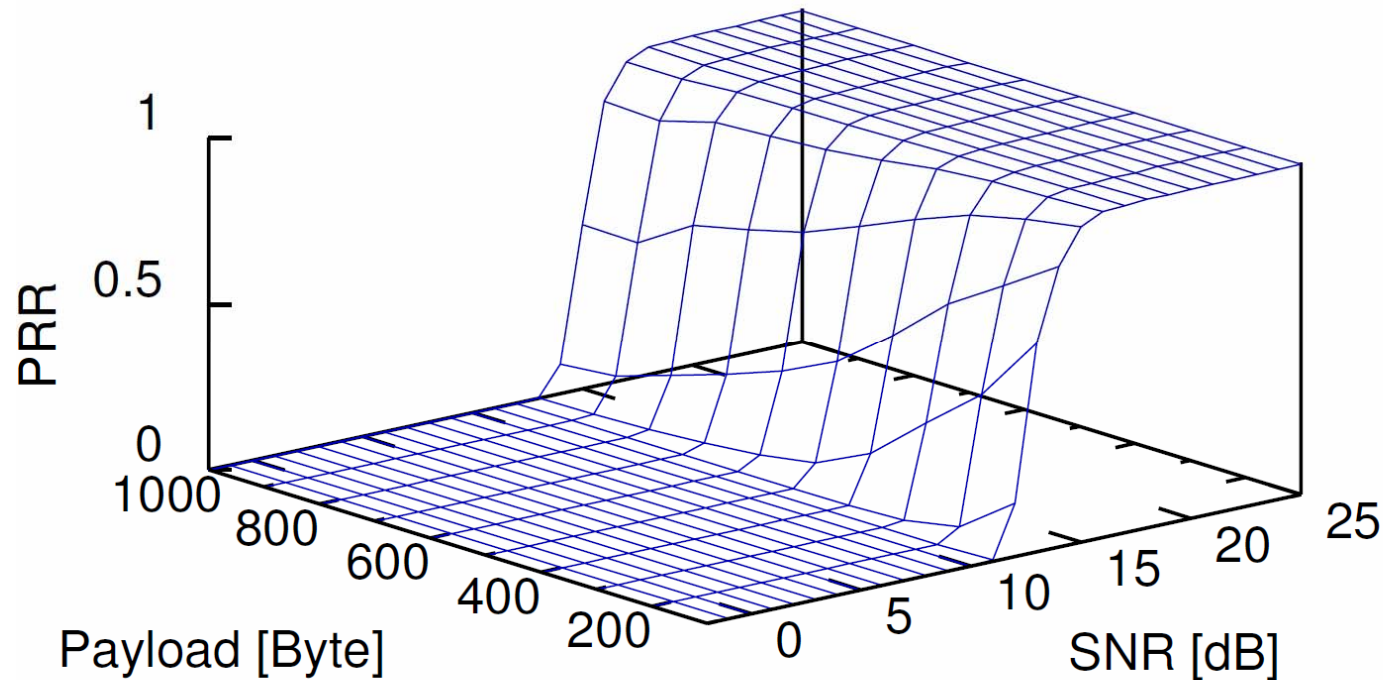


1000 packets / run
 Computed prob. of reception
 10 runs in total

Results

■ Experiment 1a: no fading

- CMU Emulator testbed with a datarate of 18 Mbps

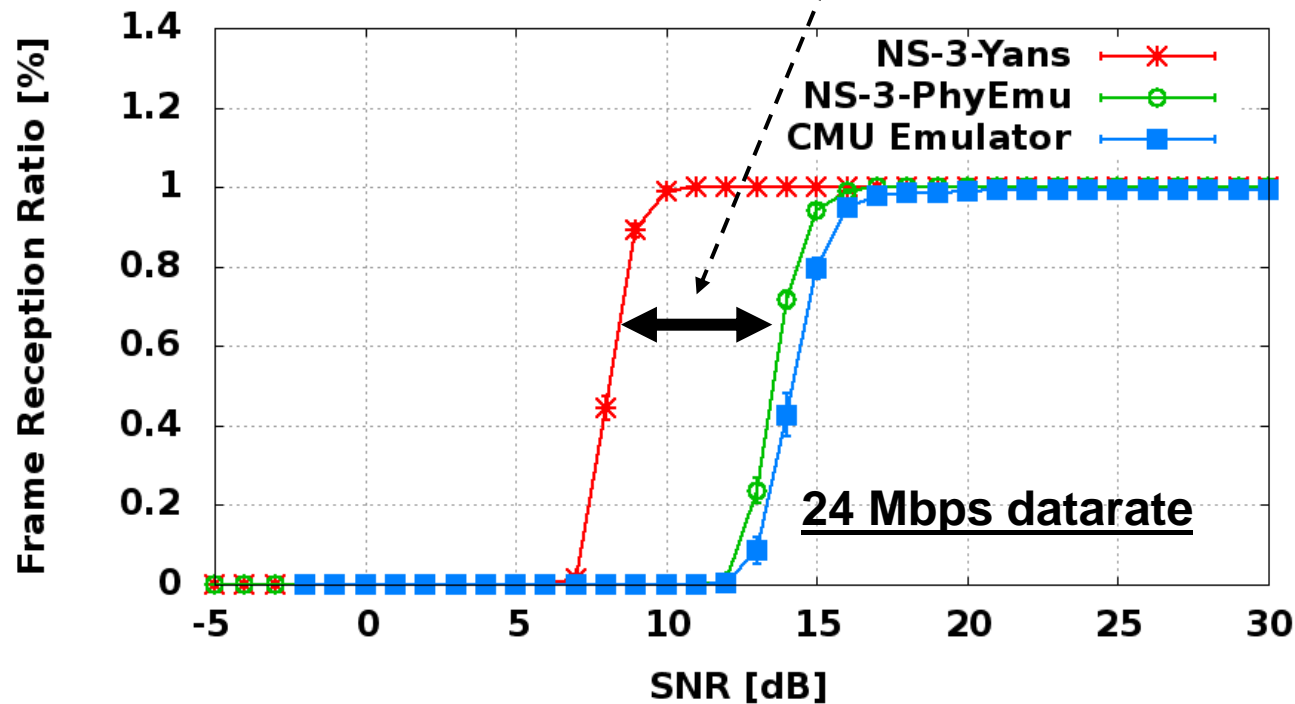


Results

■ Experiment 1a: no fading

- 500 byte packets
- all 3 systems

Observable ~5 dB offset
Between NS-3-Yans and
the other two Systems.

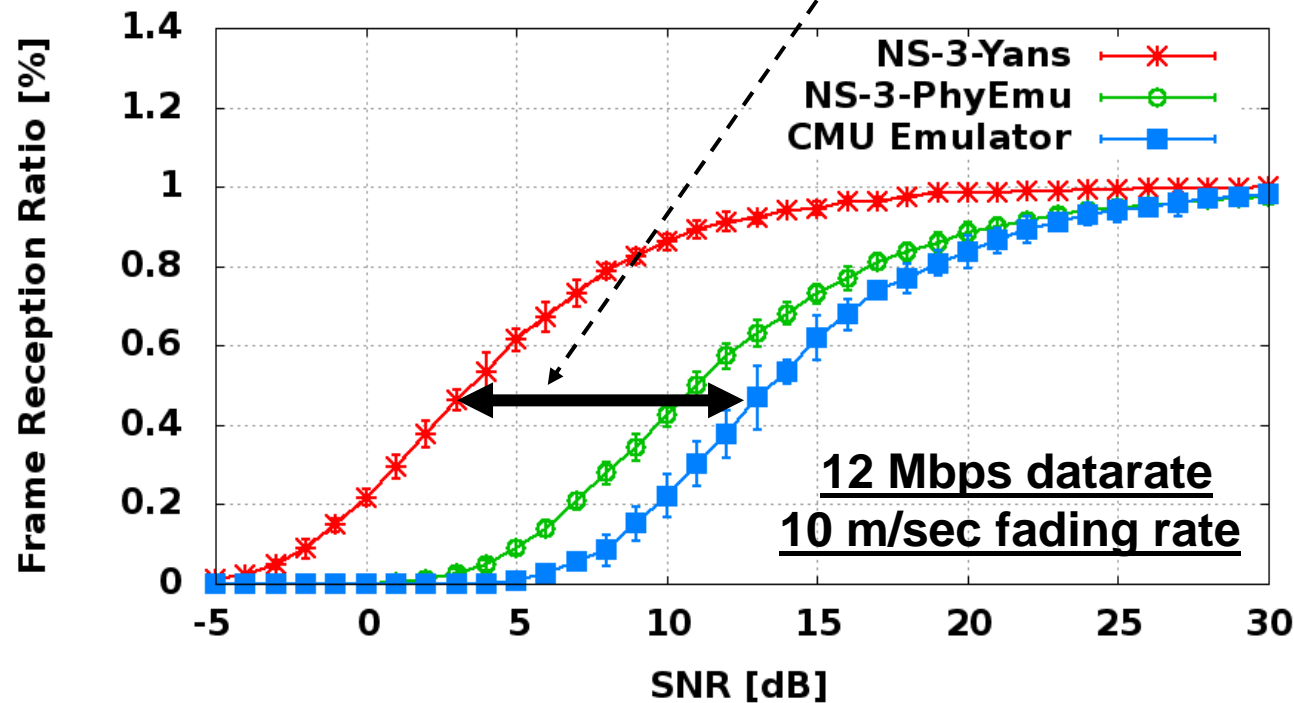


Results

■ Experiment 1b: Rayleigh fading (flat)

- 500 byte packets
- all 3 systems

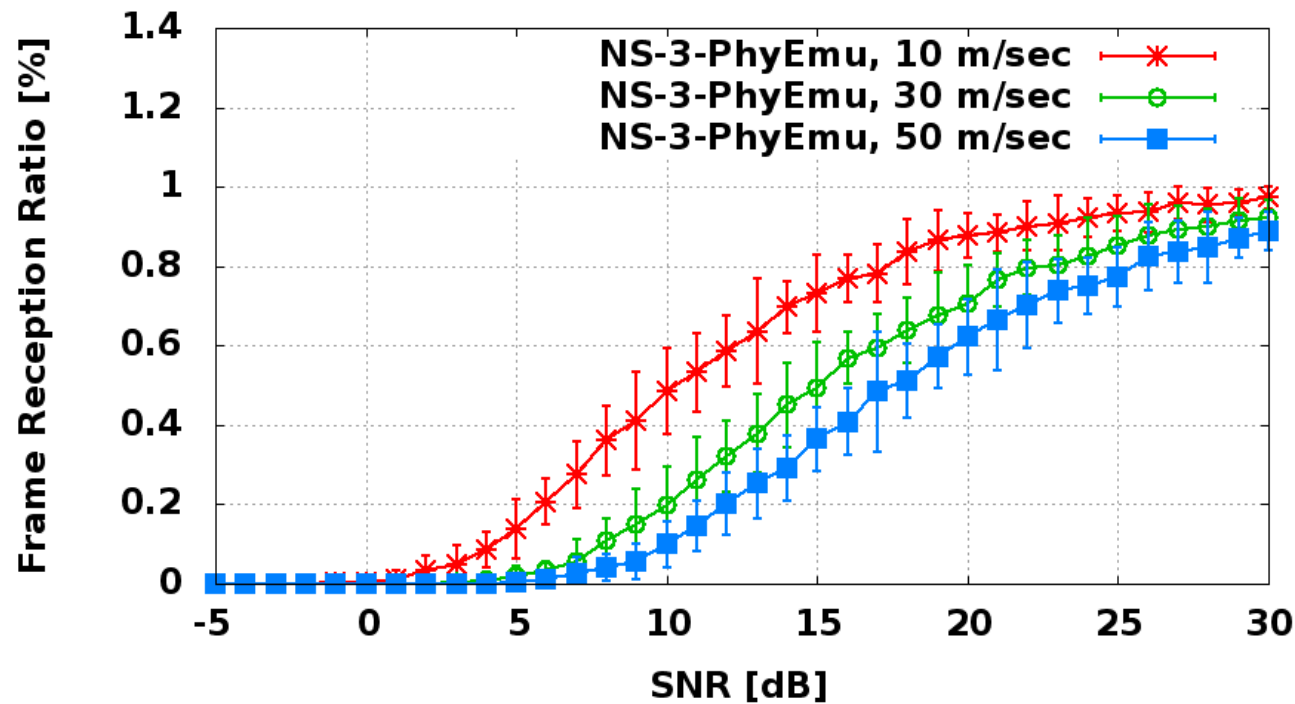
Again, an offset is observable.
This time it is ~10 dB.



Results

■ Experiment 1b: Rayleigh fading (flat)

- 500 byte packets, 6 Mbps datarate
- NS-3-PhyEmu

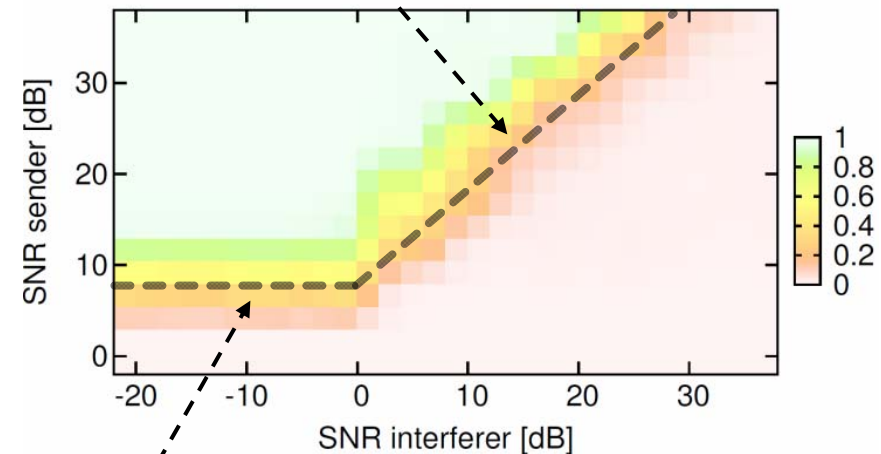
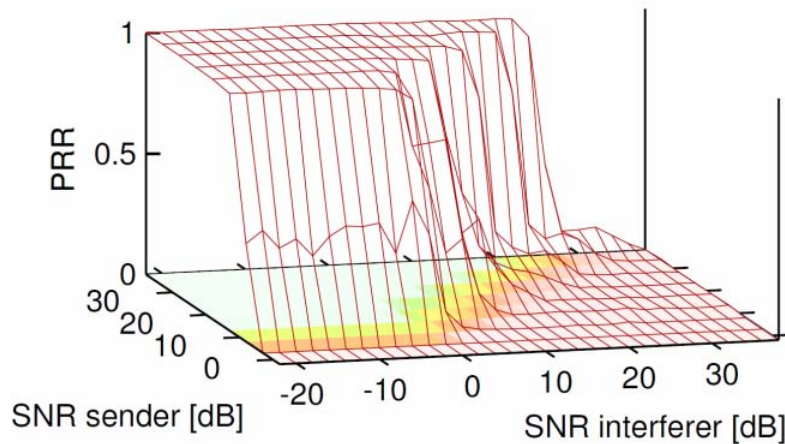


Results

■ Experiment 2: with Interference

- Sender vs. Interferer SNR
- CMU network emulator testbed with datarate of 24 Mbps

**Interference with SNR above 0
has impact on packet reception rate,
similar to background noise**



**Interference with SNR below 0
has no impact on packet reception rate**

Conclusions

■ Without interference

- Reception curves share very similar shapes
- Linear offset of ~5 dB observable in non-fading conditions
- Linear offset of ~10 dB observable in flat Rayleigh fading conditions
- Fading intensity has an impact on lower datarates

■ With interference

- Interference shows impact if its SINR is positive
- Interference shows to have same impact as background noise

■ Why is there an offset?

- Performance depends heavily on channel estimation of the chipset
- Results in [1] with different chipset match the ones with NS-3

[1] [*An Experimental Study on the Capture Effect in 802.11a Networks;*](#)
[Lee et. al; WINTECH Workshop 2007, Montreal](#)