On the Performance of the Spatial Reuse Operation in IEEE 802.11ax WLANs

Francesc Wilhelmi, Sergio Barrachina-Muñoz & Boris Bellalta

Presenter: sergio.barrachina@upf.edu

CSCN 2019

Outline

Summarized Contributions

1. Summary of the IEEE 802.11ax OBSS/PD-based SR operation
2. Performance evaluation of the SR operation through simulations
3. Newest (and stable) D4.0 version is considered

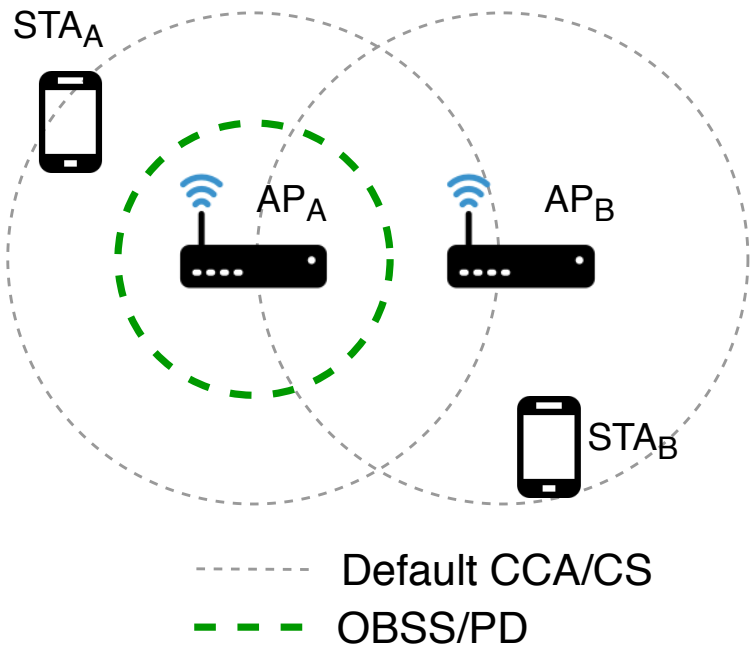
Introduction to Spatial Reuse

Goal

- Increase channel utilization
- Allow multiple simultaneous transmissions

Approach

- Ignore inter-BSS transmissions through OBSS/PD adjustment
- Constrained transmit power



Implications

	Data rate	Channel access probability	Hidden-node probability	Exposed-node probability
OBSS/PD ↑ (Tx Power ↓)	↓	↑	↑	↓

Table 1: Effects of increasing the OBSS/PD threshold (decrease the transmission power).

Outline

Spatial Reuse in a Nutshell

Early packet source detection

- BSS Color included in MAC headers (unique for an OBSS)
- SRGs can be formed among different BSS

Sensitivity adjustment mechanism

- No mechanism exists for selecting the OBSS/PD threshold
- Only lower/upper bounds are provided in the amendment

Constrained transmit power

- The maximum transmission power as function of the selected OBSS/PD threshold

Implementation in Komondor - Flowchart

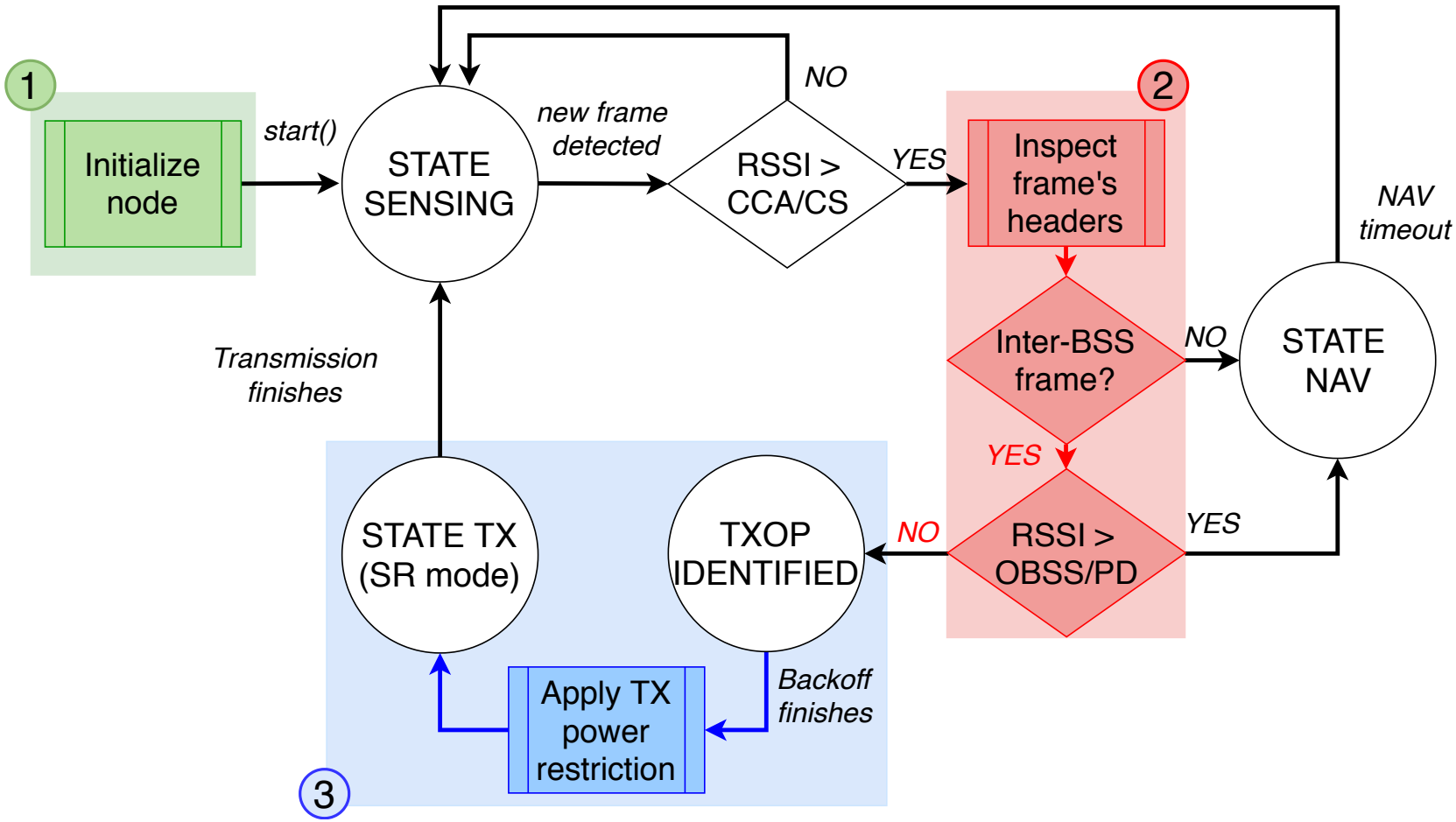
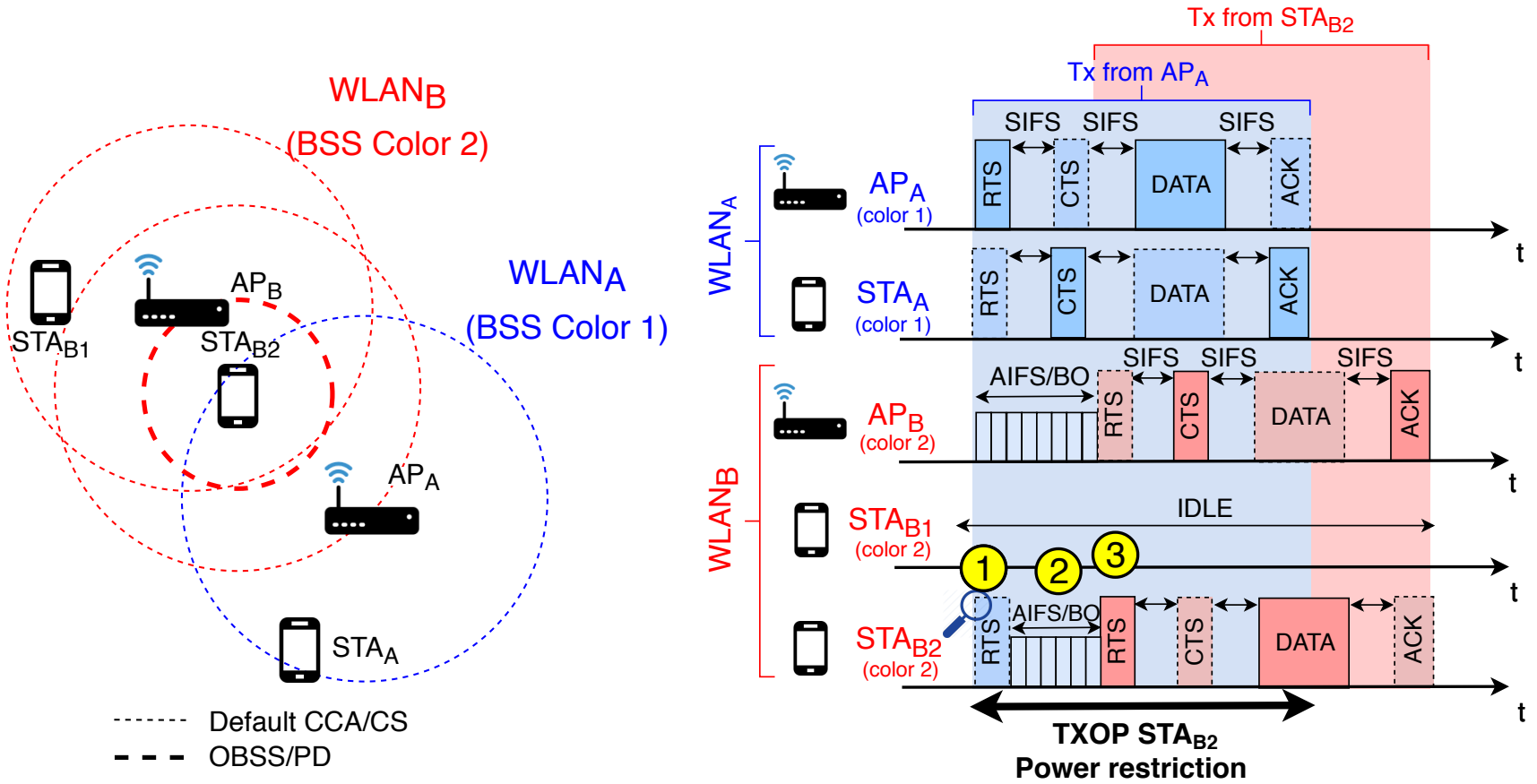


Figure 1: Implementation of the 11ax SR operation in Komondor.

Example



(a) Scenario (b) Packets exchange

Figure 2: Reduction of the contention time in a STA applying the 11ax SR operation.

Outline

Simulation Scenario

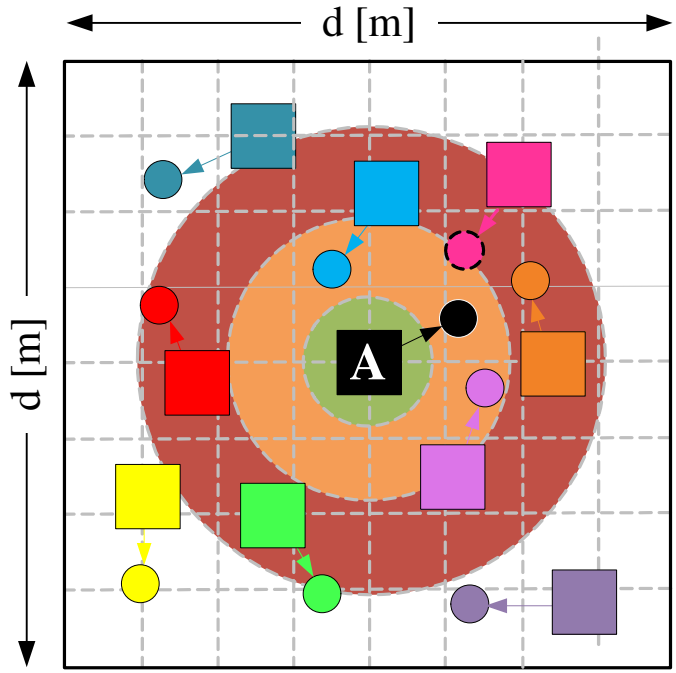


Figure 3: Random deployment with WLAN_A placed in the center.

Deployment

- 3 different map sizes (LD, MD and HD)
- 16 different traffic loads (l)
- 50 random deployments (averaging purposes)

Analysis

- Only WLAN_A applies the SR operation (higher interference)
- 21 possible OBSS/PD thresholds computed by brute force

Results (Throughput and Channel Occupancy)

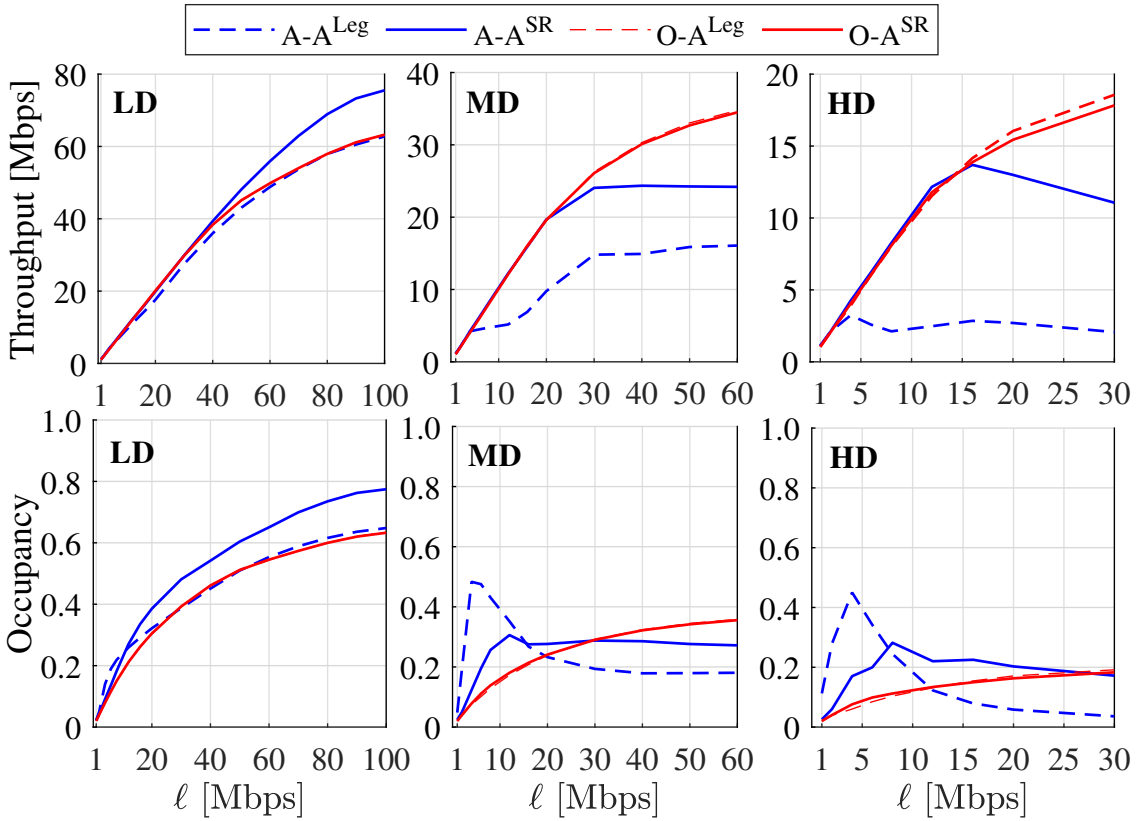


Figure 4: Throughput and channel occupancy experienced by WLAN_A (A) and the other WLANs (O) in low (LD), medium (MD) and high density (HD) deployments. Each curve is named in the legend in the format X-A^{m}, where A^{m} represents whether WLAN_A uses spatial reuse (SR) or not (Leg).

Results (Delay)

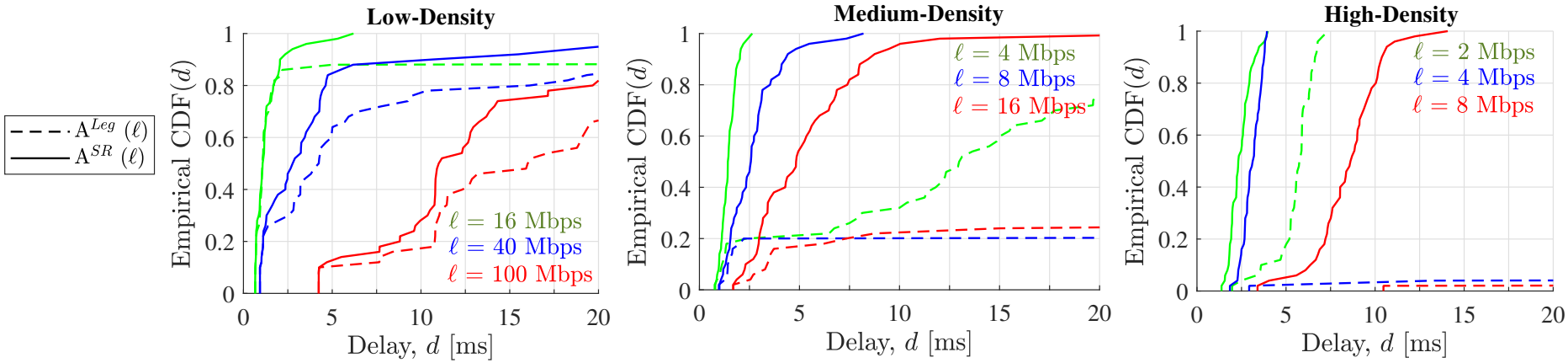


Figure 5: Empirical cumulative distribution function of the average packet delay experienced by WLAN_A. Different network densities and traffic loads are considered. Solid and dashed lines indicate whether WLAN_A uses spatial reuse (SR) or not (Leg), respectively.

Outline

Conclusions & Future work

Work done

- The SR operation allows to enhance the performance of WLANs in dense scenarios
- While gains in the throughput are moderate, significant delay improvements are noticed
  - Good for voice/video

Future work

- Extend the analysis to scenarios where multiple WLANs apply the SR operation
  - Also, consider the formation of SRGs to further enhance SR
- Synergies of SR with other IEEE 802.11 features (scheduling, OFDMA, beamforming...)

Any questions?

Sergio Barrachina Muñoz, Ph.D. candidate
sergio.barrachina@upf.edu
Department of Communication and Information Technologies
Universitat Pompeu Fabra (Barcelona, Spain)

S

Backup 1: Equations

Maximum OBSS/PD threshold:

$$\text{OBSS/PD} \leq \max\Big(\text{OBSS/PD}_{\text{min}}, \min\left(\text{OBSS/PD}_{\text{max}}, \text{OBSS/PD}_{\text{min}} + (\text{TX\_PWR}_{\text{ref}} - \text{TX\_PWR})\right)\Big)$$

Maximum transmit power:

$$\text{TX\_PWR}_{\text{max}} = \text{TX\_PWR}_{\text{ref}} - (\text{OBSS/PD} - \text{OBSS/PD}_{\text{min}})$$