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

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Introduction to Spatial Reuse

Data rate used to be the fuel

- Up to 802.11ac data rate increase was the main goal

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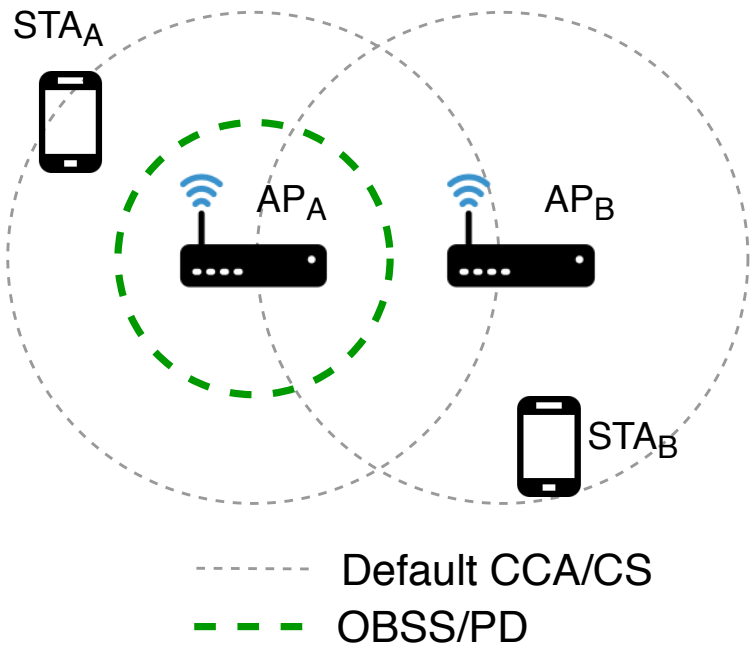
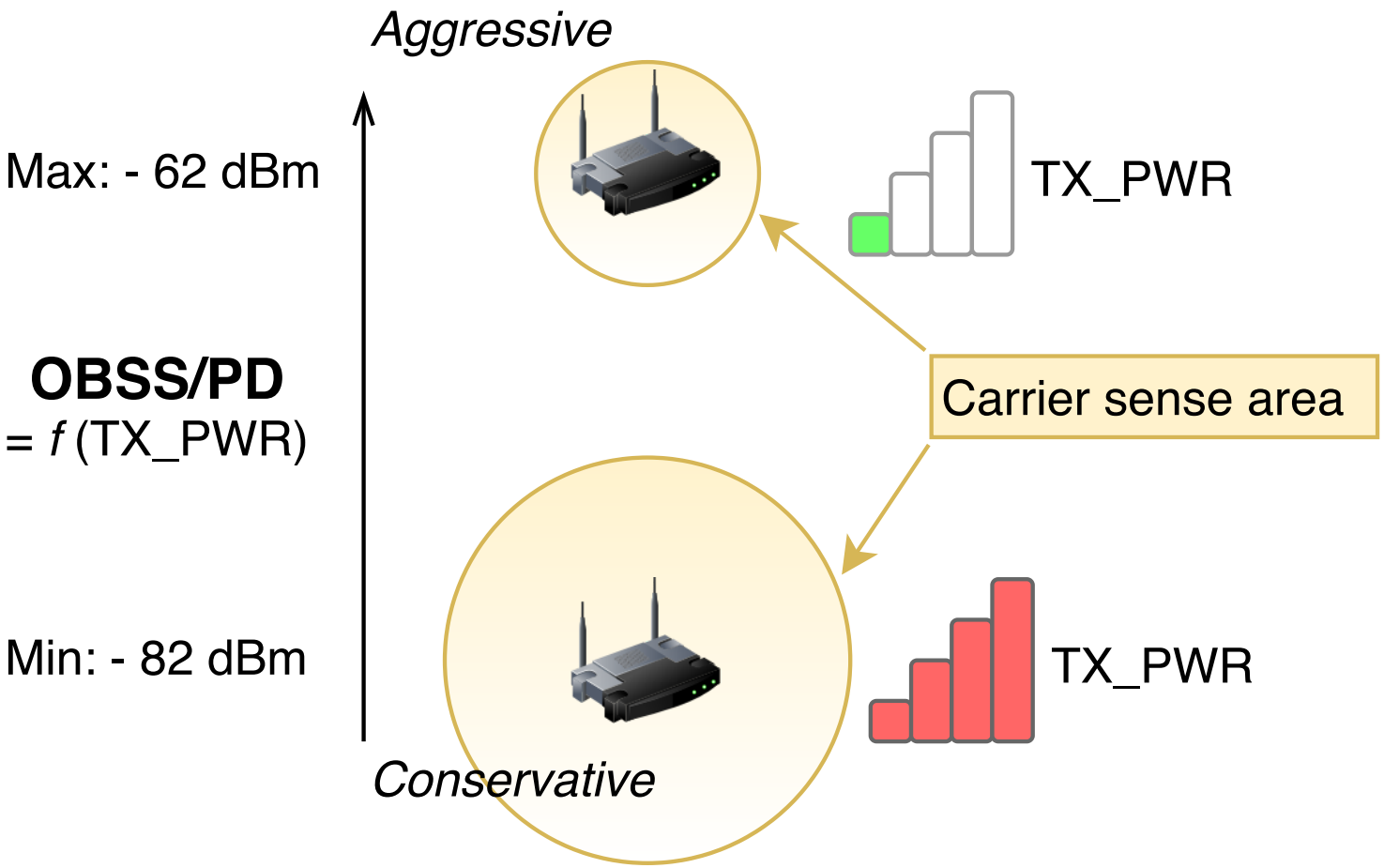
The SR approach

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



OBSS/PD and TX_PWR tradeoff



OBSS/PD based SR in a Nutshell

Early packet source detection

- BSS Color included in MAC headers (unique for an OBSS)
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- Only min and max values are provided in the amendment

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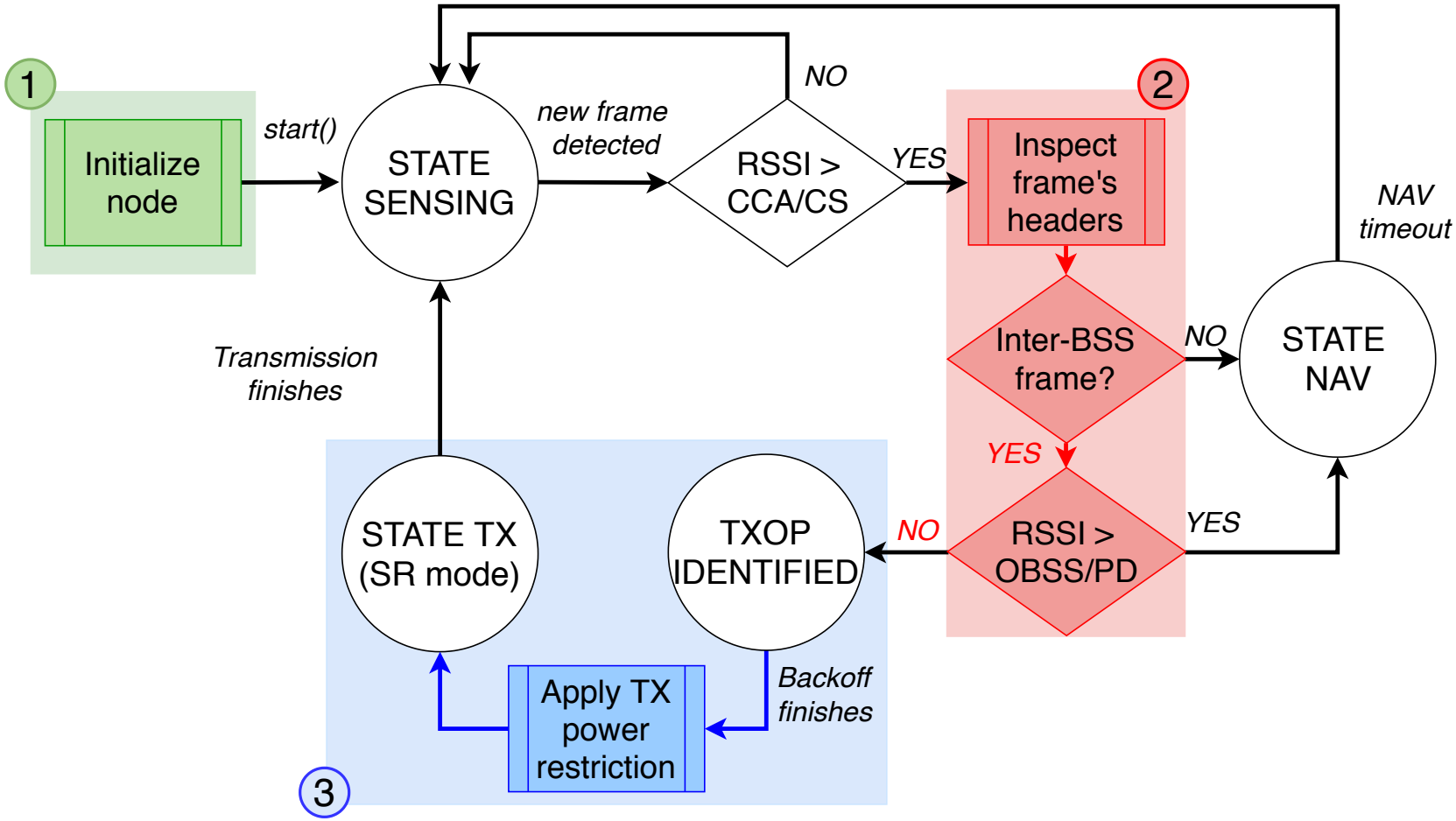
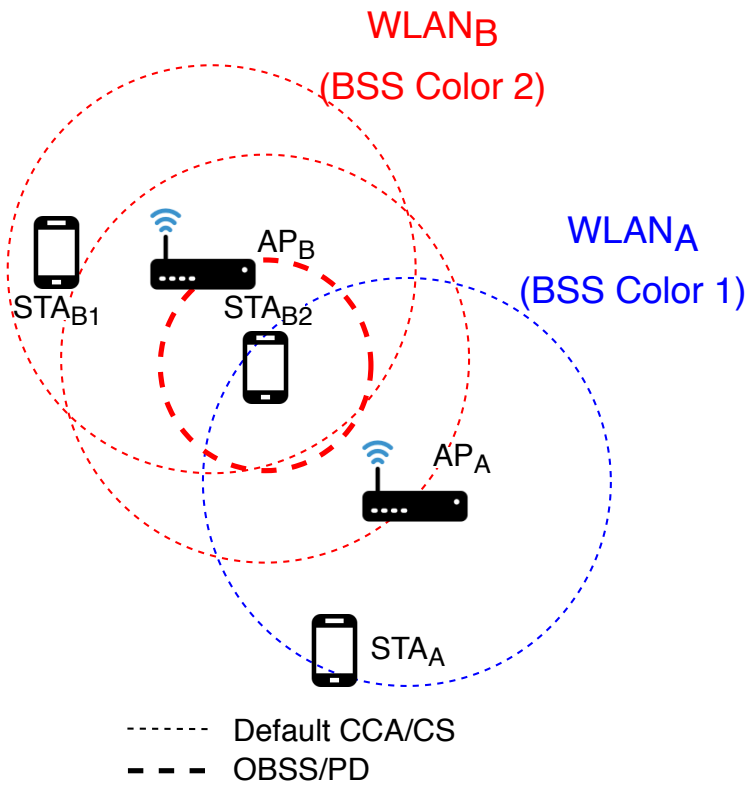
Constrained transmit power

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

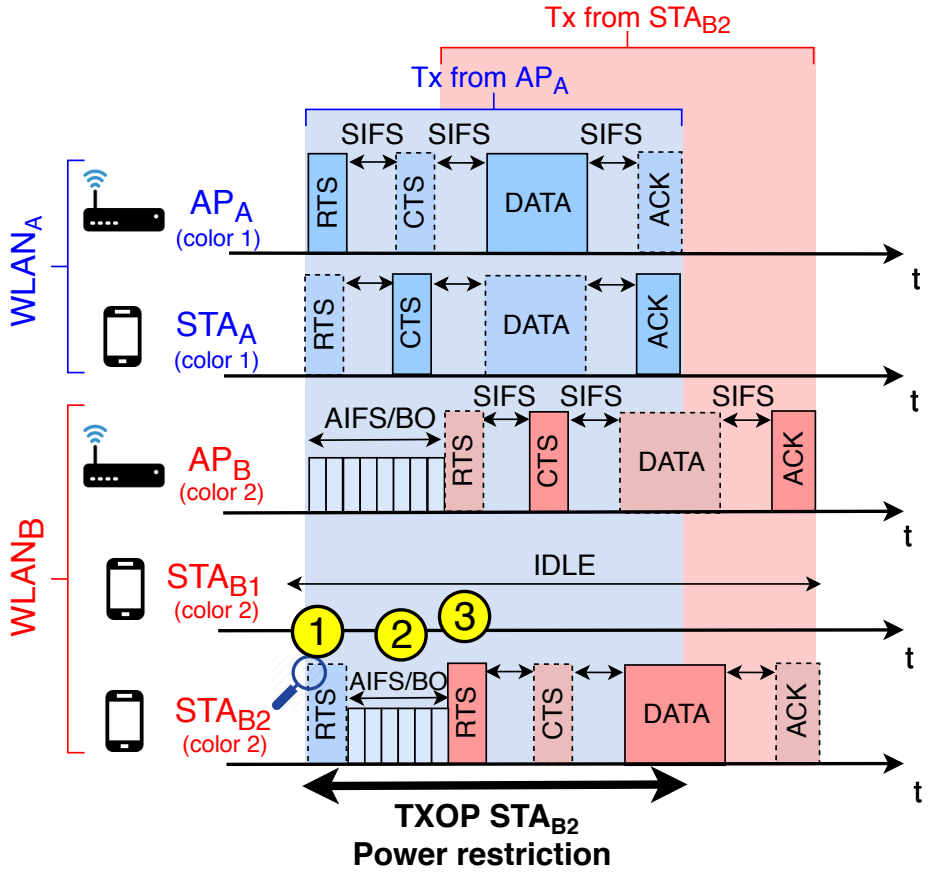
Implementation in Komondor - Flowchart



Example of the OBSS/PD SR operation

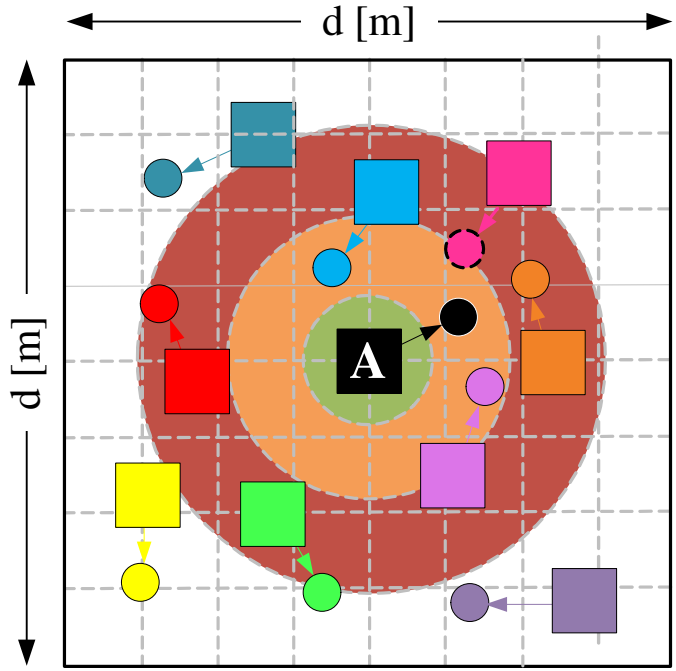


(a) Scenario



(b) Packets exchange

Simulation scenarios



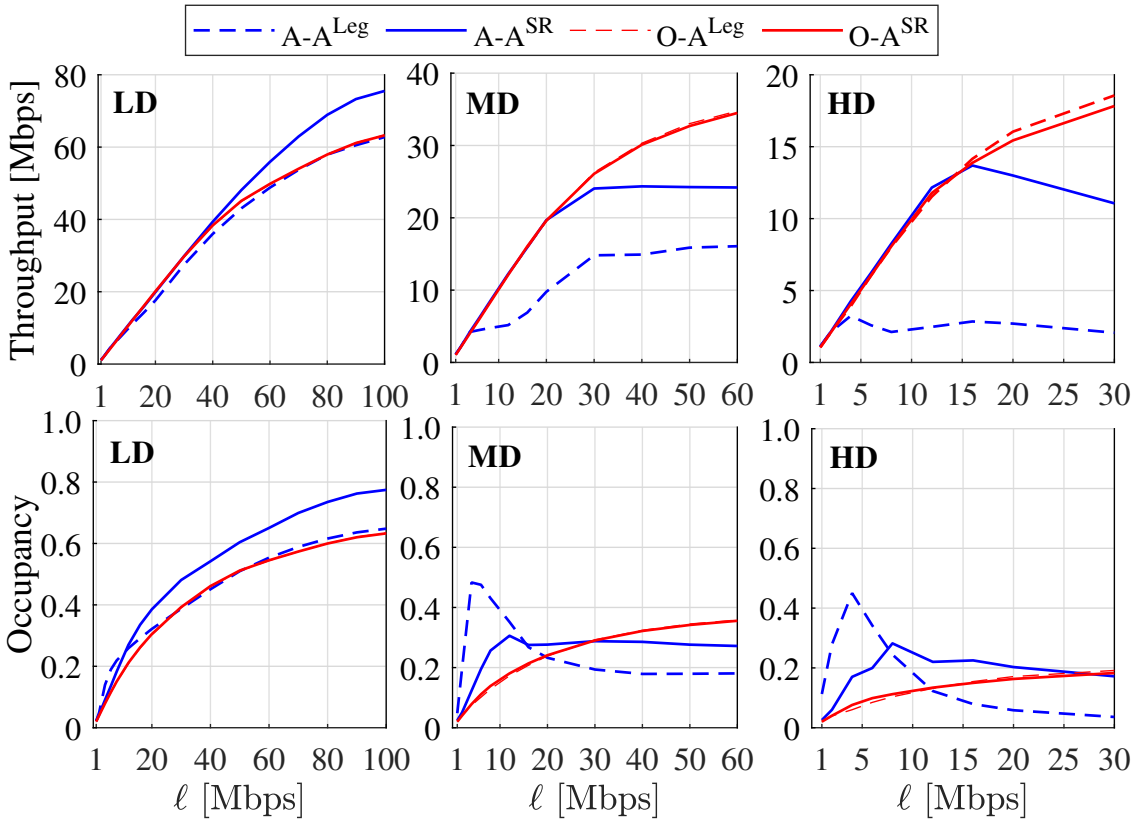
Simulation setup

- Low, medium and high density
- Traffic load (l) up to 100 Mbps
- 50 random deployments

Max. performance analysis

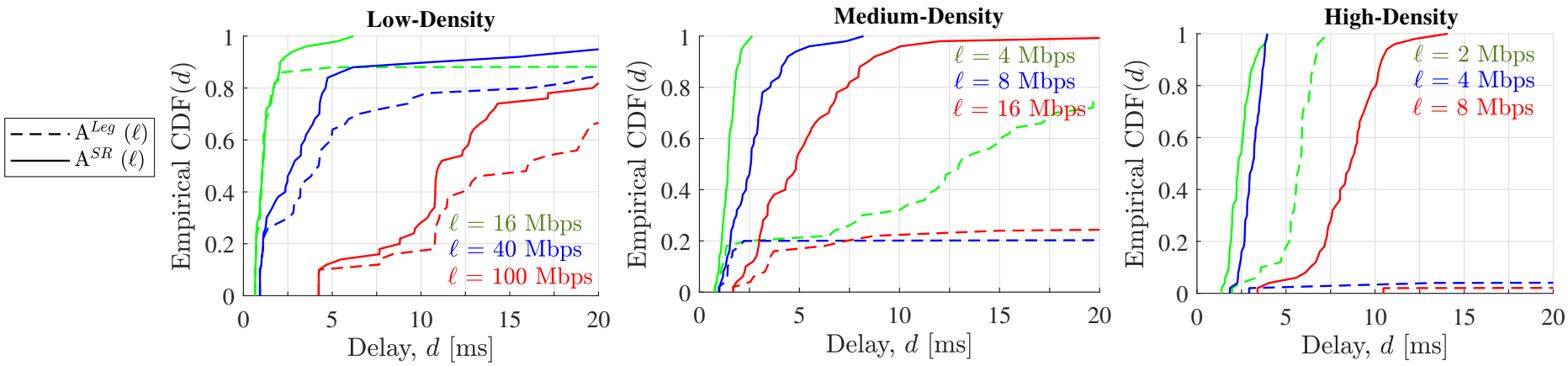
- Only WLAN_A applies the SR operation (higher interference)
- Throughput Γ and delay d of the $\text{argmax}_{\text{OBSS/PD}}(\Gamma)$
- Brute force computation

Results (Throughput and Channel Occupancy)



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)



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.

Conclusions & Future work

Conclusions

- We describe the OBSS/PD-based SR in IEEE 802.11ax
- Implementation of SR in Komondor → test novel algorithms
- Simulations show that SR enhances the performance (throughput and delay) of WLANs; specially, in dense scenarios

Future work

- Extend the analysis to scenarios where multiple WLANs apply SR
- Synergies of SR with other IEEE 802.11 features (scheduling, OFDMA, beamforming...)
- Algorithm for setting up an *optimal* OBSS/PD threshold

Any questions?

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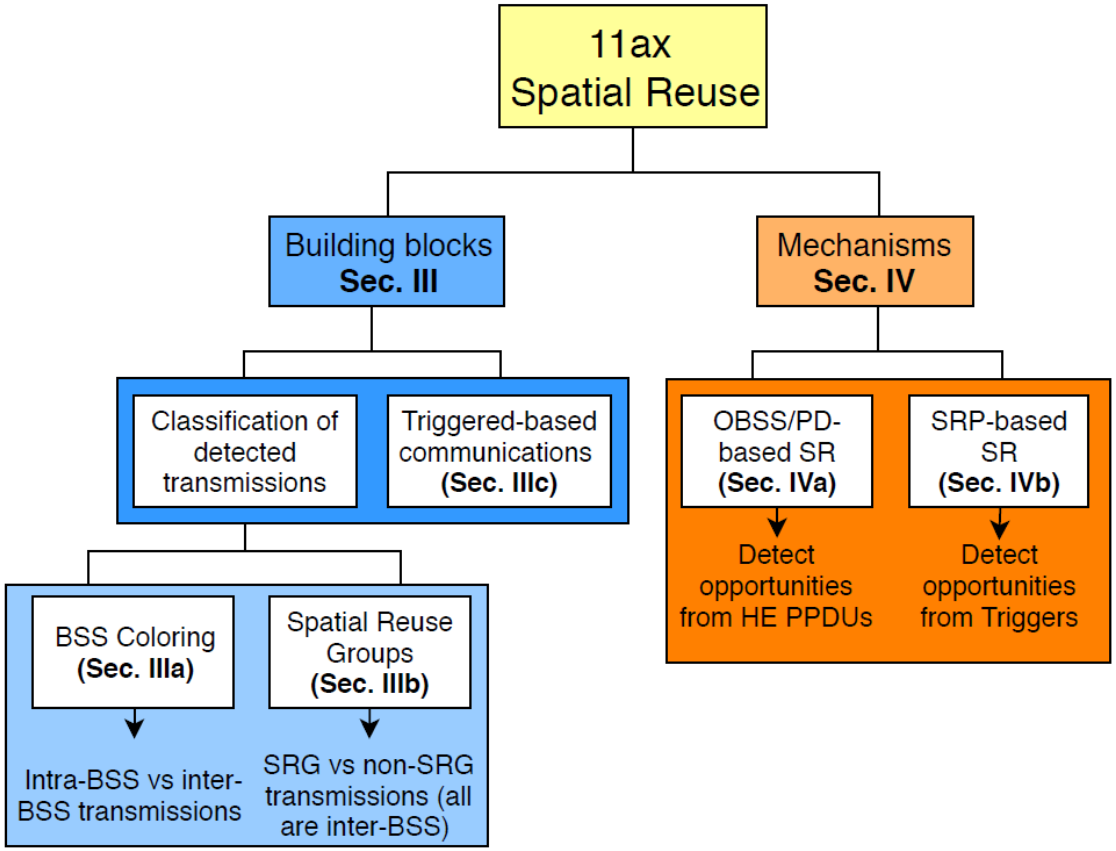
IEEE 802.11 SR operation



* Tutorial on 11ax SR: *Wilhelmi et. al. "Spatial Reuse in IEEE 802.11ax WLANs." preprint*

OBSS/PD equation

Maximum OBSS/PD threshold:

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

Maximum transmit power:

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