Enhancements of IEEE 802.11p Protocol for Access Control on a VANET Control Channel

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IEEE International Conference on Communications
Kyoto - 06 June 2011

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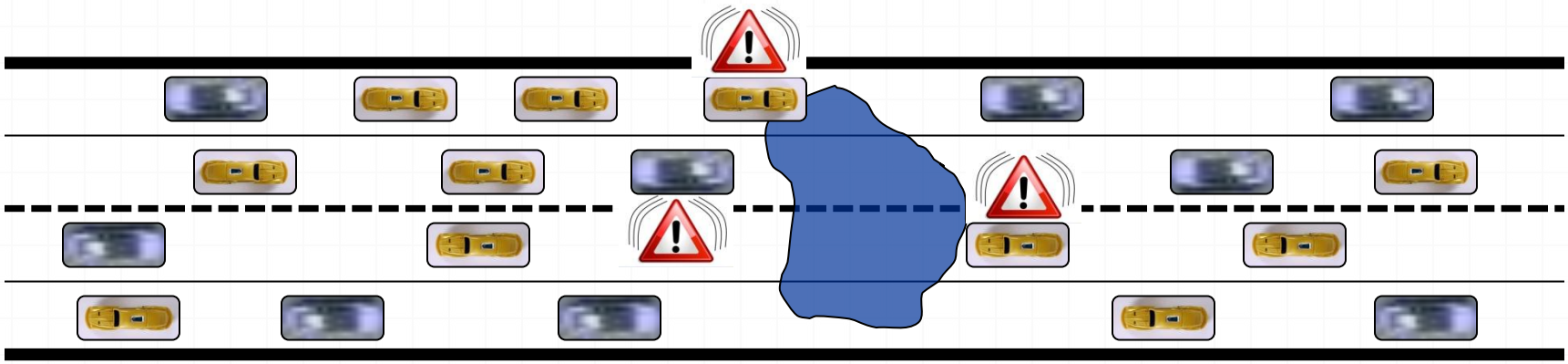
- Safety Communication in Vehicular Networks
- Congestion Control using IEEE 802.11p
- Influence of the Minimum Contention Window
- Decrementing Contention Window

VANET objective: Building an accurate image of the exterior world



- Cooperative Awareness Message (CAM)
- Decentralised Environmental Notification (DEN)

USA Spectrum Allocation

CH172	CH174	CH176	CH178	CH180	CH182	CH184
5.860	5.870	5.880	5.890	5.900	5.910	5.920
G5SC4	G5SC3	G5SC1	G5SC2	G5CC		

Europe Spectrum Allocation

- Service channels (SCH) – non-safety (usually IP-based) applications
- Control channel (CCH) – safety applications

IEEE 802.11p

- Amendment to the IEEE 802.11-2007 standard
- Published in June 2010
- Based on an OFDM PHY at 5.9GHz
- Included in both WAVE and ETSI ITS architectures
- MAC layer follows the IEEE 802.11e EDCA function
- STAs can communicate without belonging to the same BSS

Congestion Control

- Reduce Beaconing Frequency

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  - Strict requirements from applications

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- ❑ Reduce Beaconing Frequency
  - Strict requirements from applications
- ❑ Decrease Transmission Power
  - Minimal coverage area
- ❑ Increase Data Rate

Congestion Control

- Reduce Beaconing Frequency
  - Strict requirements from applications
- Decrease Transmission Power
  - Minimal coverage area
- Increase Data Rate
  - Noisy channel, reduced reception probability

Contention Window in unicast IEEE 802.11

- If channel free – send directly
- If channel busy – back off for n idle slots
- n= random (0, CW)
- Initially CW= CW_{min}
- If collision – CW= CW*2

broadcast
Contention Window in ~~unicast~~ IEEE 802.11

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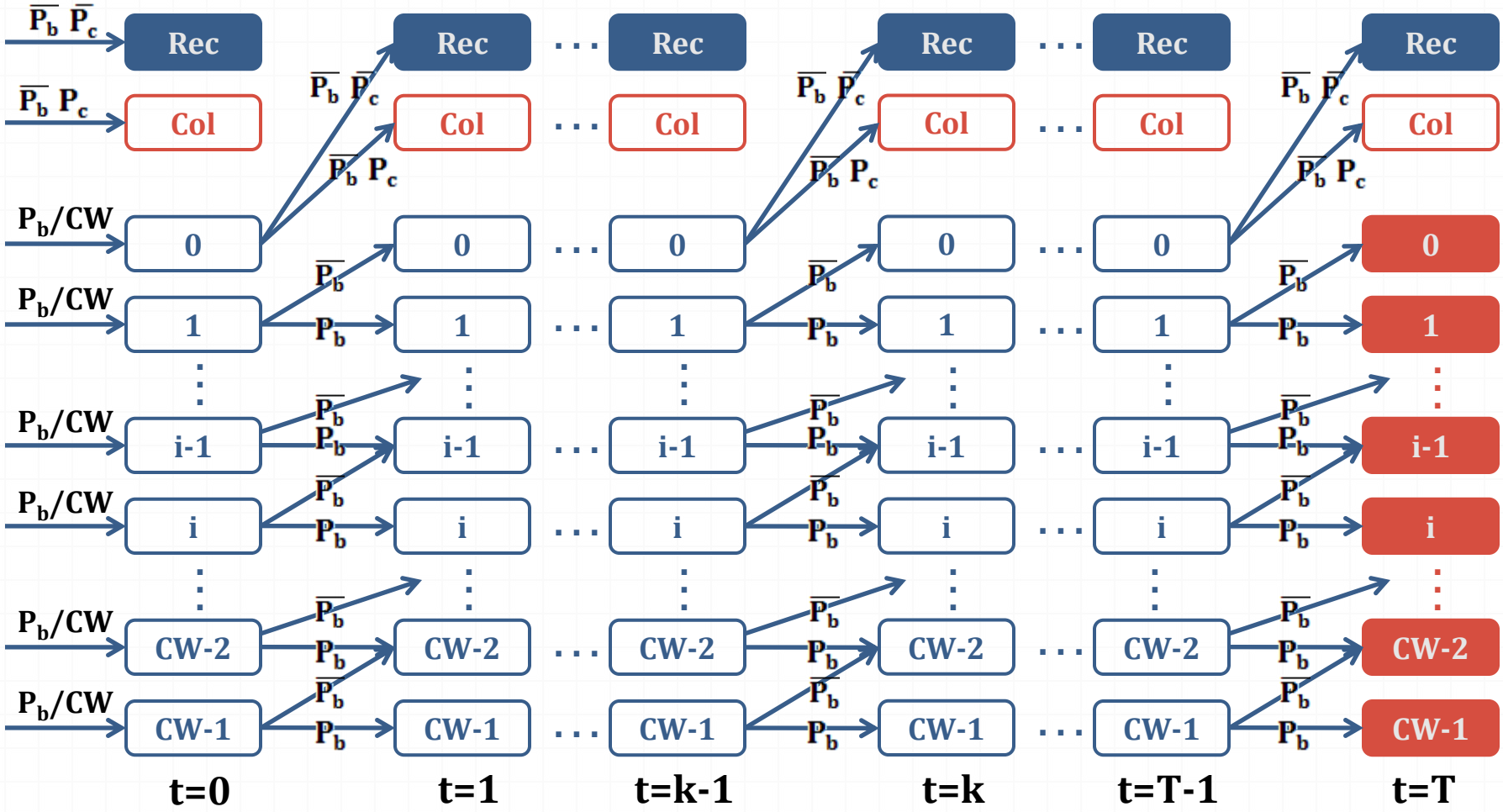
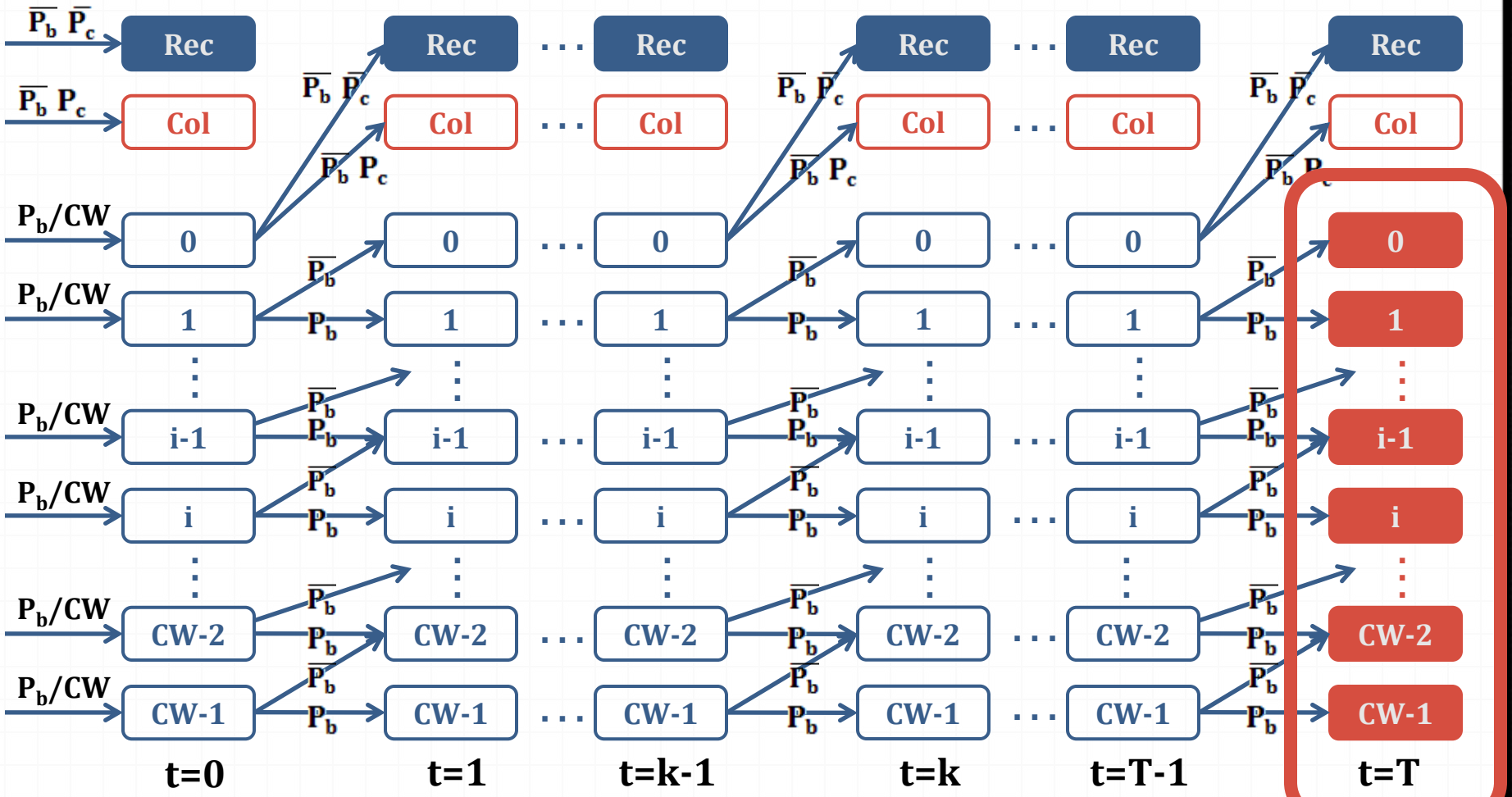

Rec
Col
0
1
i-1
i
CW-2
CW-1
P_b/CW
$\overline{P_b}\,\overline{P_c}$
$\overline{P_b}\,P_c$
$\overline{P_b}$
P_b
t=0
t=1
t=k-1
t=k
t=T-1
t=T


Rec
Col
0
1
i-1
i
CW-2
CW-1
P_b/CW
$\overline{P_b}\,\overline{P_c}$
$\overline{P_b}\,P_c$
$\overline{P_b}$
P_b
t=0
t=1
t=k-1
t=k
t=T-1
t=T

Impact of the Minimum Contention Window

- Small CW – increased number of collisions
- High CW – increased number of expired beacons
- Beware: an expired beacon is lost for all the neighbours

New Back-off Mechanism

- Can not detect collisions

New Back-off Mechanism

- Can not detect collisions
- We can detect expired beacons

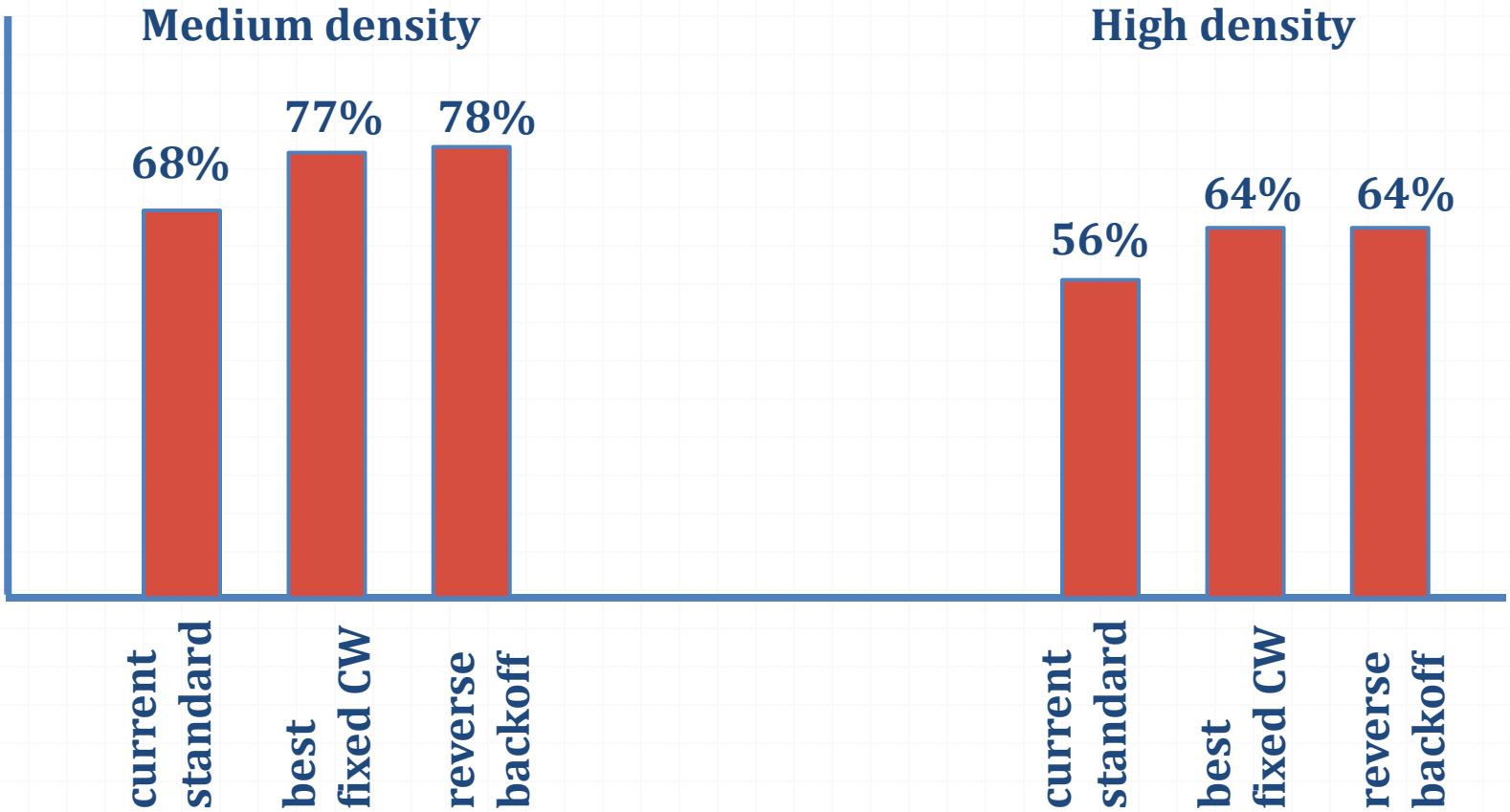
New Back-off Mechanism

- Can not detect collisions
- We can detect expired beacons
- Relatively high initial CW= 60
- CW = CW/2 after every expired beacon
- CW goes back to the initial value after N beacons

Simulation scenario

- JiST/SWANS framework
- Street Random Waypoint Mobility Model
- Beaconing frequency 10 Hz (beacons can expire)
- Different road topologies
- Medium and high density

Beaconing reception probability at less than 200m from the source



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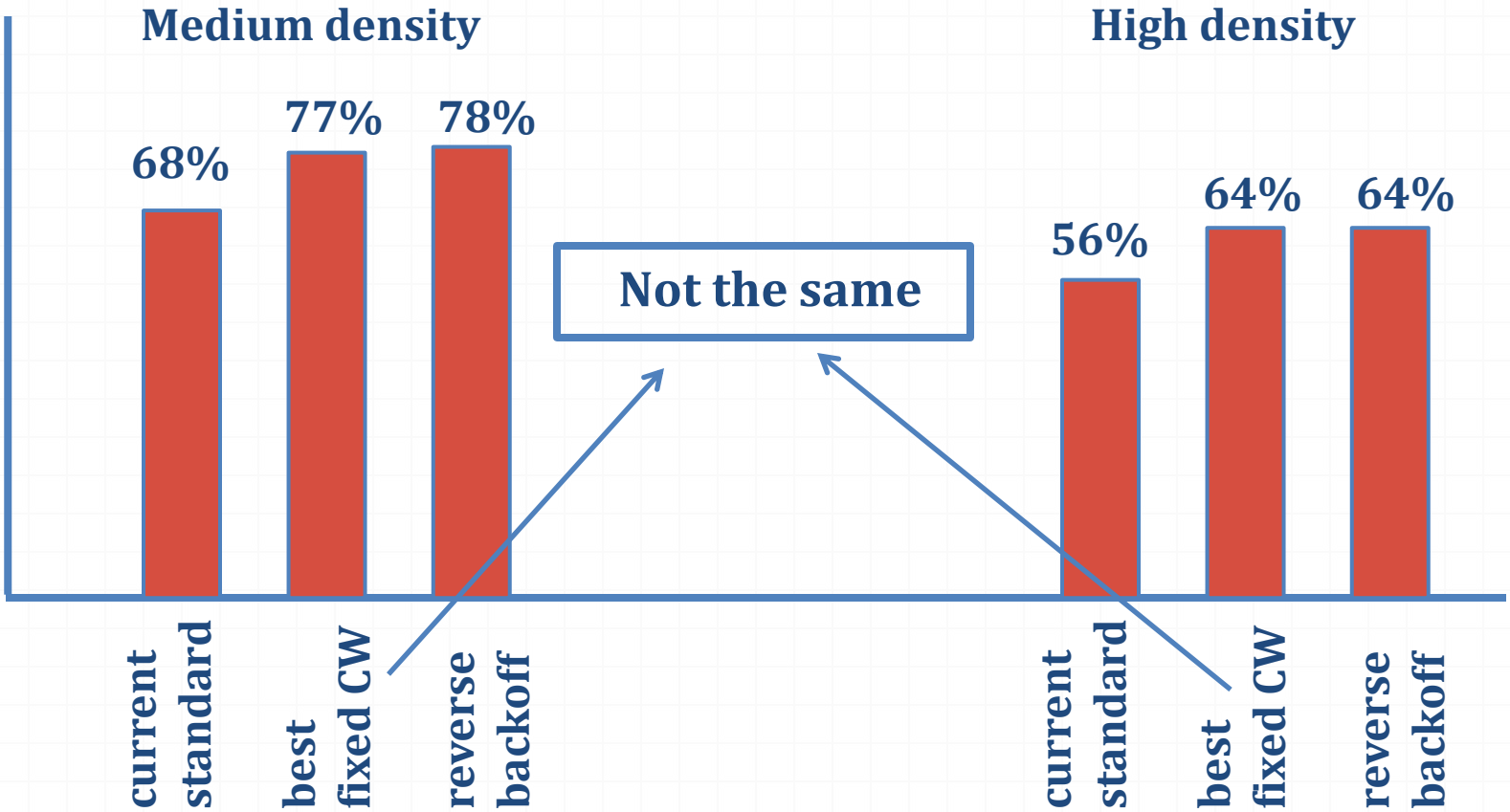
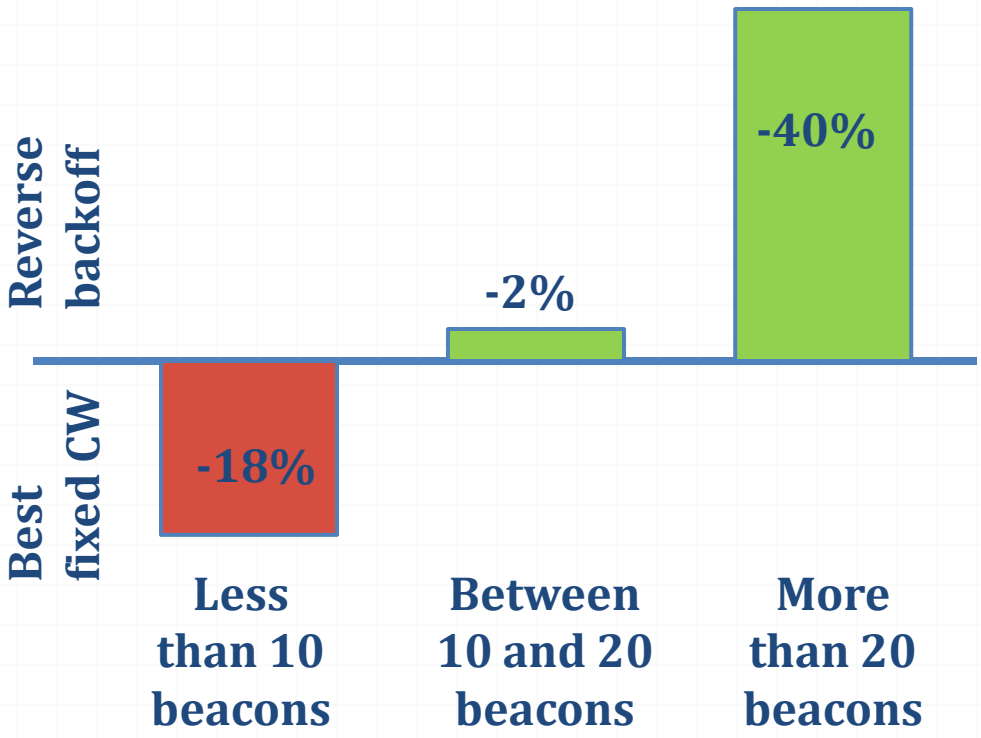


Impact on the number of consecutive lost beacons



- ❑ alleviate the "ghost node" problem
- ❑ can be used to give priority to DENs over CAMs

Conclusion

- Contention window: very important in IEEE 802.11
- IEEE 802.11p – many amendments at the physical layer
- MAC layer (IEEE 802.11e) – good for multimedia applications in WLAN
- VANET safety applications should be considered

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