Modeling the 802.11 Protocol under Different Capture and Sensing Capabilities

Mathilde Durvy[1]   Olivier Dousse[2]   Patrick Thiran[1]

[1]EPFL, Switzerland
[2]Deutsche Telekom Laboratories, Germany

Introduction
Markov Chain Model
Results

Context and Goal
MAC Protocol
Carrier Sensing and Capture

Context

- Multi-hop ad hoc networks
- A single channel
- High traffic load (saturated traffic conditions)

- Decentralized MAC protocols
- Use a backoff mechanism to regulate the access to the channel
- E.g.: wifi protocol à la 802.11

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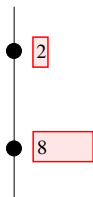
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Goal

- Investigate the performance and properties of protocols based on a backoff mechanism
- Show how the sensing and capture capabilities of the network nodes affect the performance of such protocols

- Explain why these protocols can organize the transmissions in a network but also lead to the starvation of some of the network links

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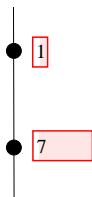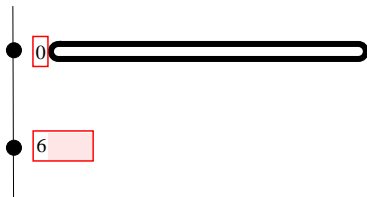MAC Protocol
Carrier Sensing and Capture

MAC protocols under study (1)

- Average exchange time: $1/\mu$
- Average backoff time: $1/\lambda$
- $\rho = \lambda/\mu$
- Continuous backoff distribution $\rightarrow$ no collision

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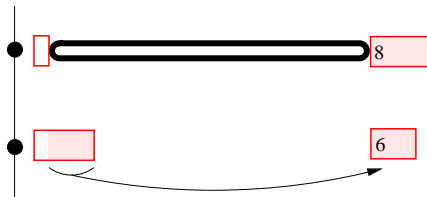MAC Protocol
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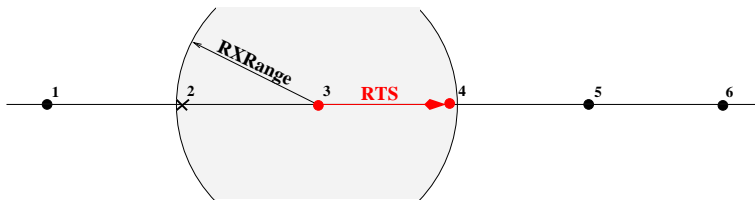- Continuous backoff distribution $\rightarrow$ no collision

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MAC protocols under study (2)

- Request-To-Send (RTS)
- Clear-To-Send (CTS)

- DATA packet

- ACKnowledgement

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Exclusion domain

- Symmetric exclusion domain
- Asymmetric exclusion domain

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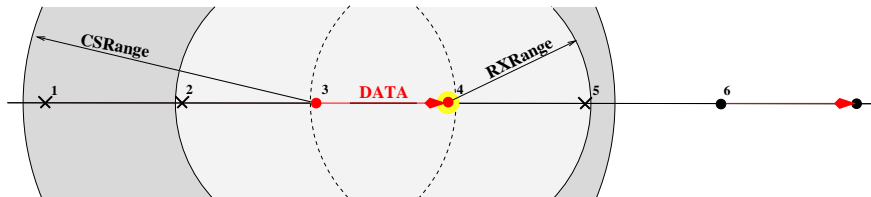
Context and Goal
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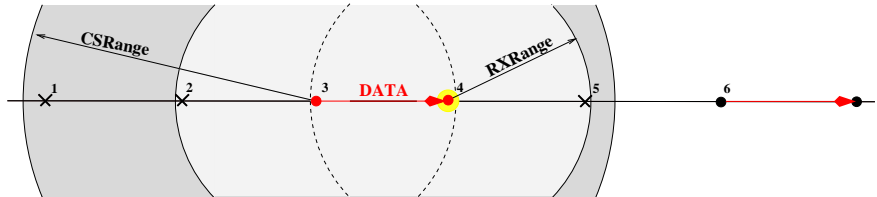# Capture effect

- The strongest signal arrives first
- There is capture at Node 4 ($P_3/P_6 >$ thr)
- Node 4 can continue to decode the packet from Node 3

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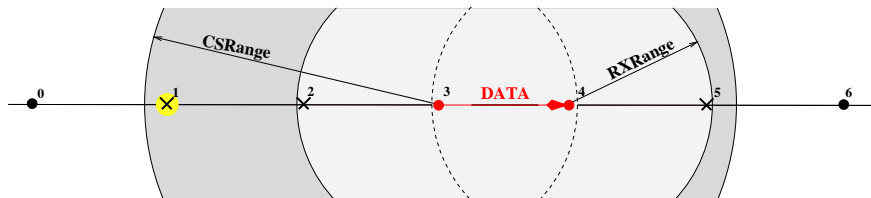Context and Goal
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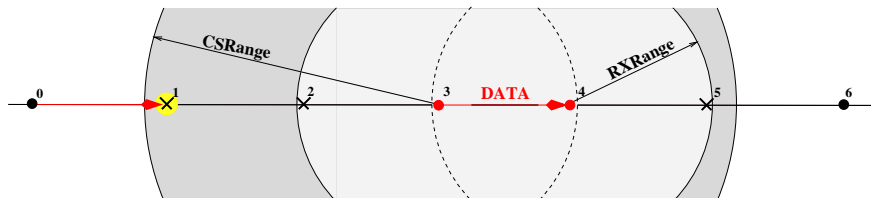Introduction
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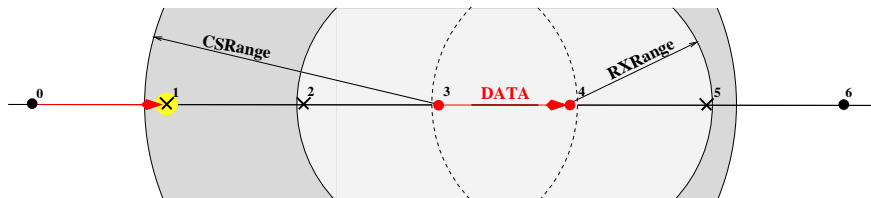MAC Protocol
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Capture models

- The strongest signal arrives in second position
- Full capture: Node 1 can resynchronize on the strongest signal (the DATA transmission can take place)
- Limited capture: Node 1 can *not* resynchronize on the strongest signal

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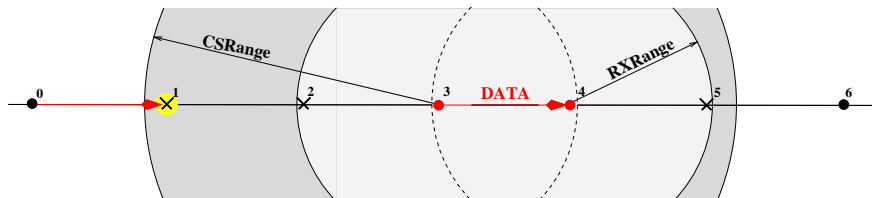MAC Protocol
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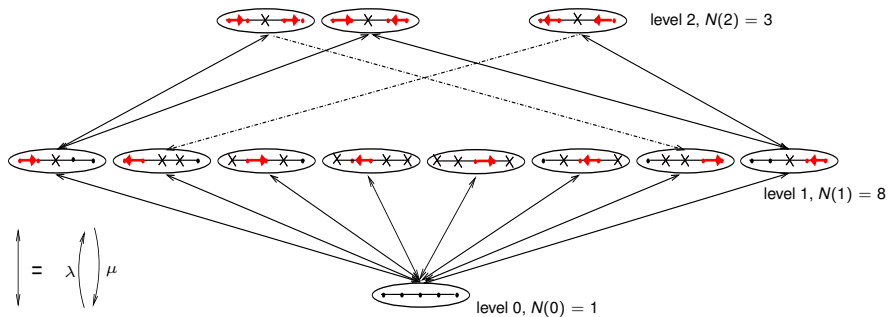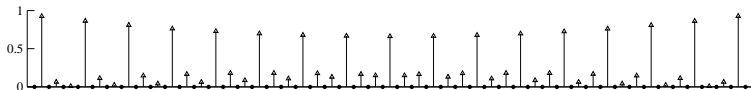
Symmetric case
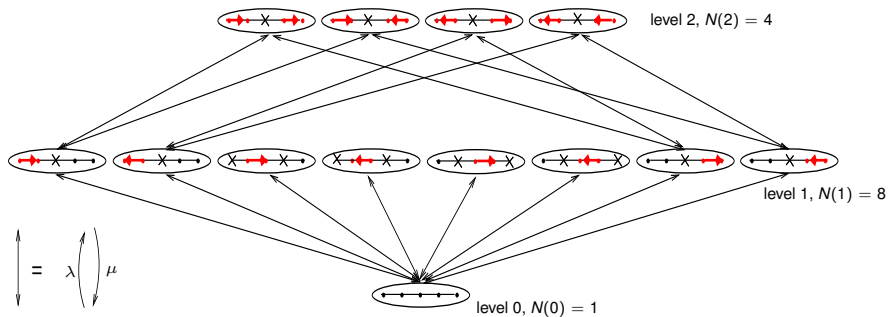
Asymmetric case - full capture

level 2, $N(2) = 3$

level 1, $N(1) = 8$
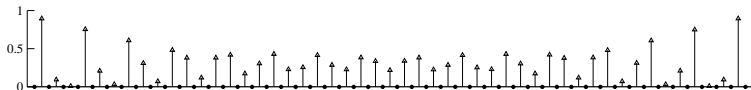
$= \lambda \mu$

level 0, $N(0) = 1$
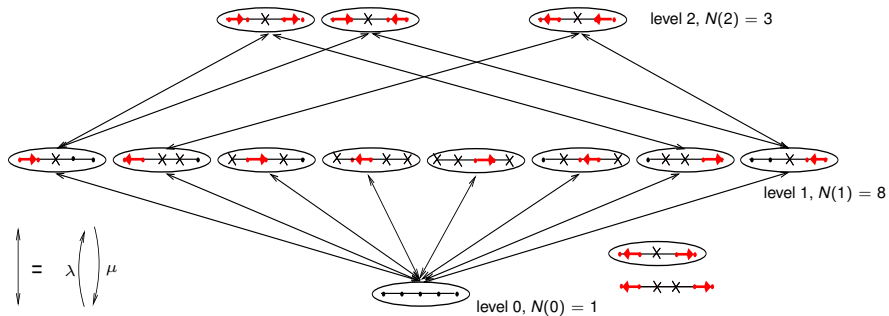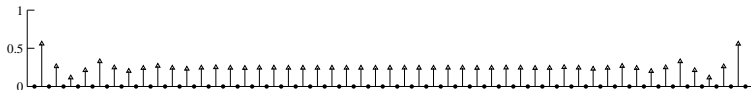
Asymmetric case - limited capture

Example, $\rho = 620$

symmetric: fraction of active links=0.34, fairness=0.53

asymmetric, full capture: fraction of active links=0.32, fairness=0.70

asymmetric, limited capture: fraction of active links=0.25, fairness=0.93