- **IEEE 802.21 MEDIA INDEPENDENT HANDOVER**
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- Title:Performance Measurements for Link Going Down Trigger
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- Abstract: The objectives of this contribution are to discuss what PHY and MAC layer performance metrics can be used in order to generate a Link Going Down event in anticipation of a Link Down event. We focus on two measurements, namely the signal level at layer 1 and the number of packet retransmissions at layer 2 in order to generate a Link Going Down event. We develop algorithms using these metrics. Simulation results are discussed for two different case scenarios: (1) moving out of range, (2) varying interference level.

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Outline

- Objectives
  - Show what layer 1 and layer 2 performance metrics can be used in order to generate a *Link Going Down* event in anticipation of a handover.
- Performance measurements
  - Power level (at the receiver)
  - Number of MAC packet retransmissions (at the transmitter)
- *Link Going Down* trigger definition
- Simulation set-up
- Performance results for two handover anticipation scenarios
  - Moving out of range, varying mobile node speeds
  - Varying the level of interference, stationary node

Power level as a metric for *Link Going Down* trigger

Let P_t be the power level measured at the receiver at time t.

P_t can be computed according to a weighted window average:

$$P_{t+1} = \alpha P_{t+1} + (1 - \alpha) P_t \quad (3)$$

where $\alpha \in [0,1]$ is the averaging weight factor.

A *Link Going Down* trigger is generated when

$$P_{t+1} = \beta P_{Th} \quad (4)$$

where P_{Th} is the receiver power level threshold.

- P_{Th} depends on the coverage area and the receiver design
- β depends on the propagation path loss, speed, data rate

Number of packet retransmissions as metric for *Link Going Down* trigger

Let R_t be the number of packets retransmitted at the MAC layer.

R_t can be computed according to a weighted window average:

$$R_{t+1} = \alpha R_{t+1} + (1 - \alpha) R_t \quad (3)$$

where $\alpha \in [0,1]$ is the averaging weight factor.

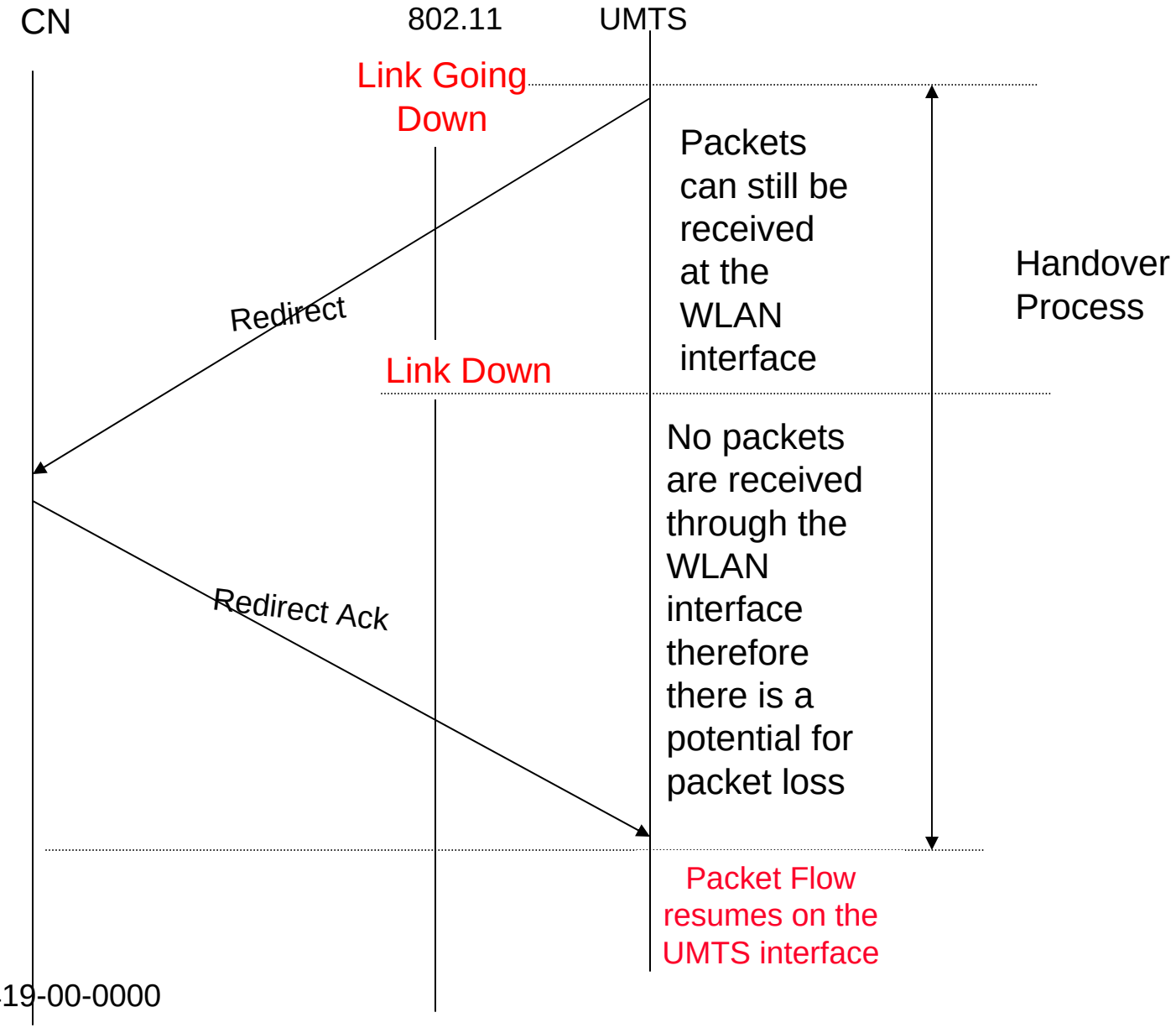
A *Link Going Down* trigger is generated when:

$$R_{t+1} = \theta R_{Th} \quad (4)$$

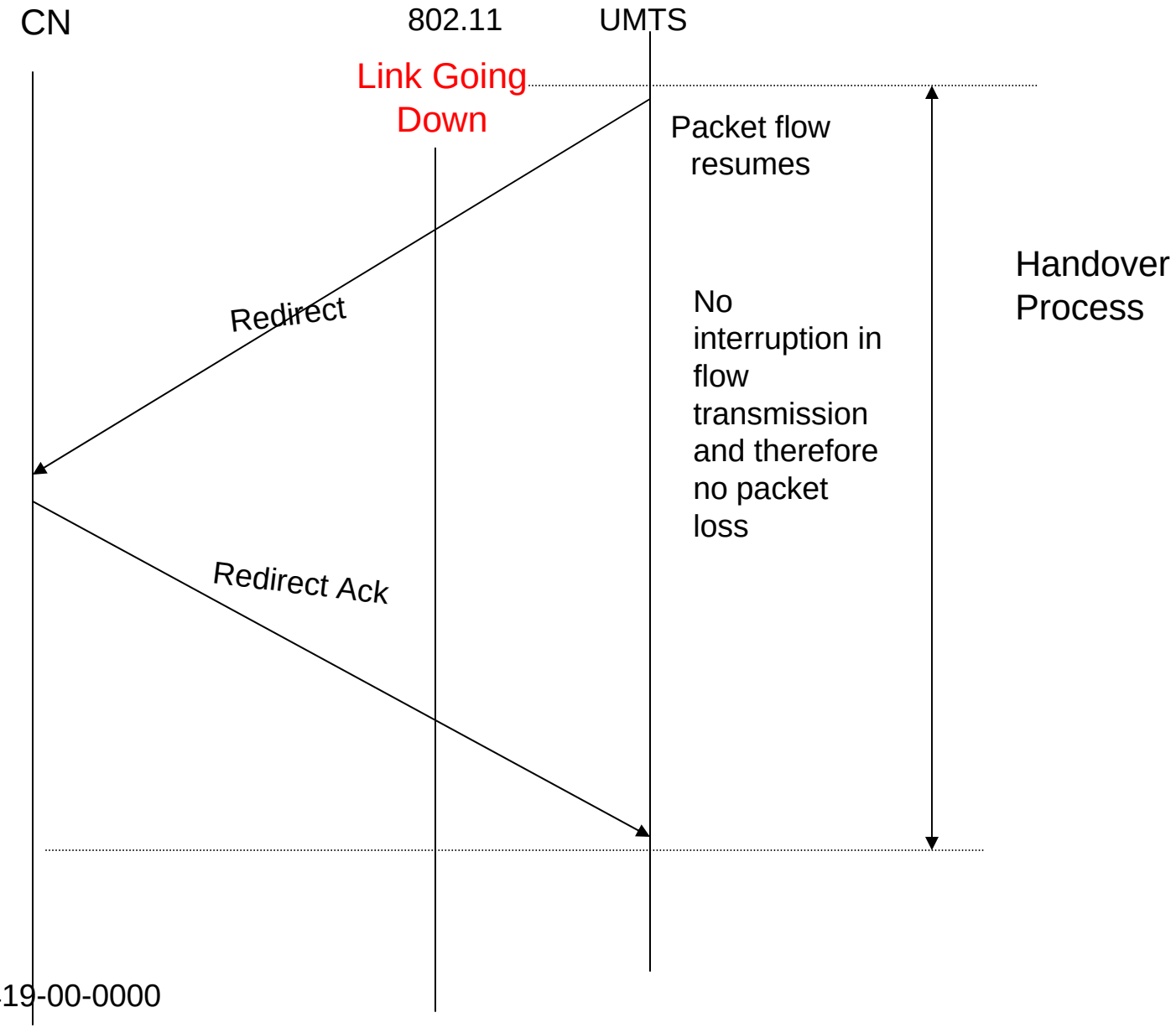
where R_{Th} is the retransmission threshold level.

- R_{Th} depends on the maximum retransmission threshold (eg. 7 in WLAN).
- θ depends on the propagation path loss, speed, data rate.

Link Going Down Flow Diagram
Mobile is receiving packets

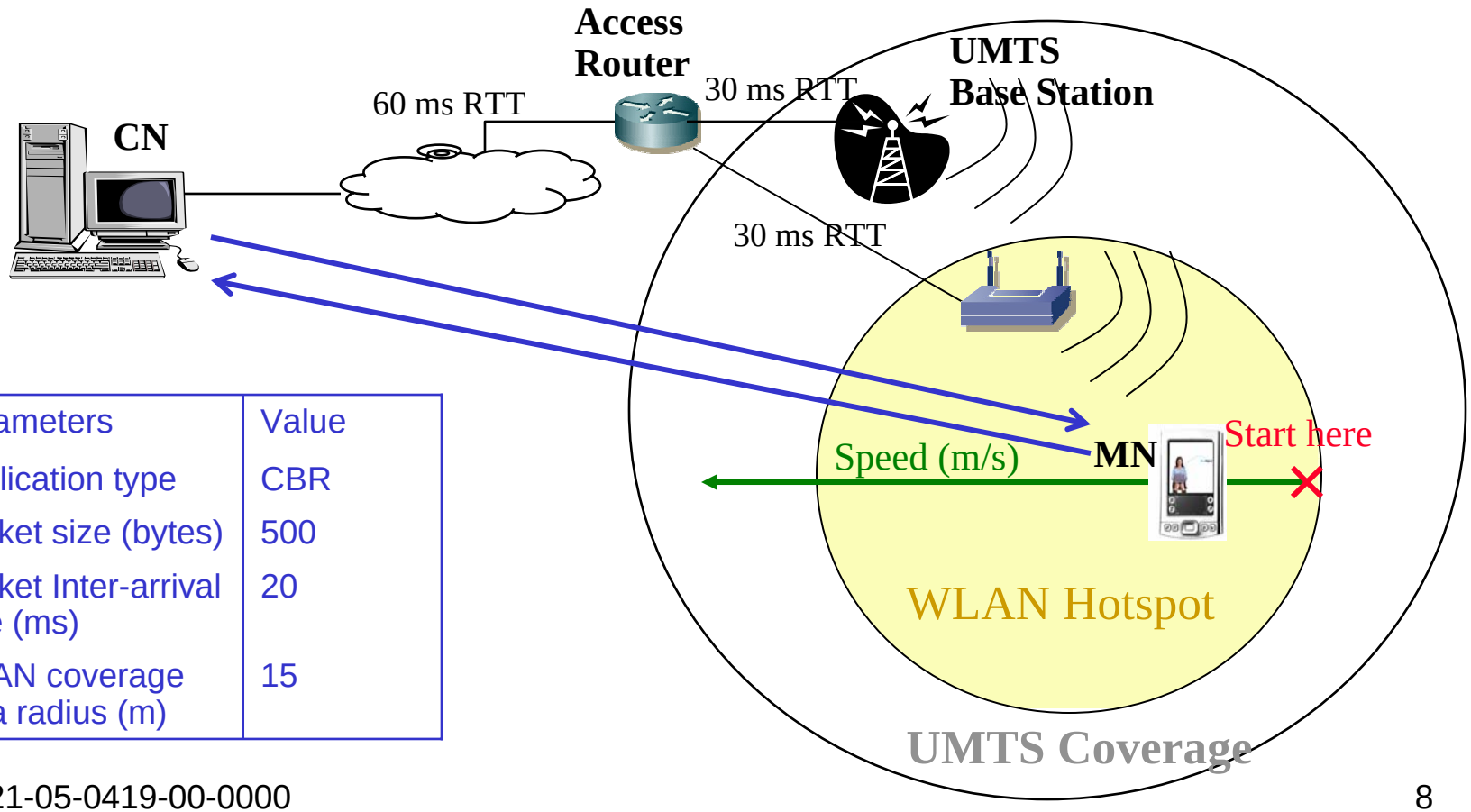


Link Going Down Flow Diagram
Mobile is sending packets



Simulation Set-up

- Experiment 1: Moving out of range
- Experiment 2: Varying interference level



Parameters	Value
Application type	CBR
Packet size (bytes)	500
Packet Inter-arrival time (ms)	20
WLAN coverage area radius (m)	15

Path loss model

The path loss model includes a free space component and a shadowing component :

$$\text{Path loss (dB)} = -10\,\varepsilon \log(d) + X_{dB}$$

where ε is the loss exponent, d is the distance traversed in meters.

X_{dB} is a Gaussian random variable with zero mean and standard deviation σ_{dB}.

$\varepsilon = 4$ for shadowed urban area

$\sigma_{dB} = 4$

Evaluating *Link Going Down* trigger performance

The objective of the *Link Going Down* trigger is to improve the handover performance:

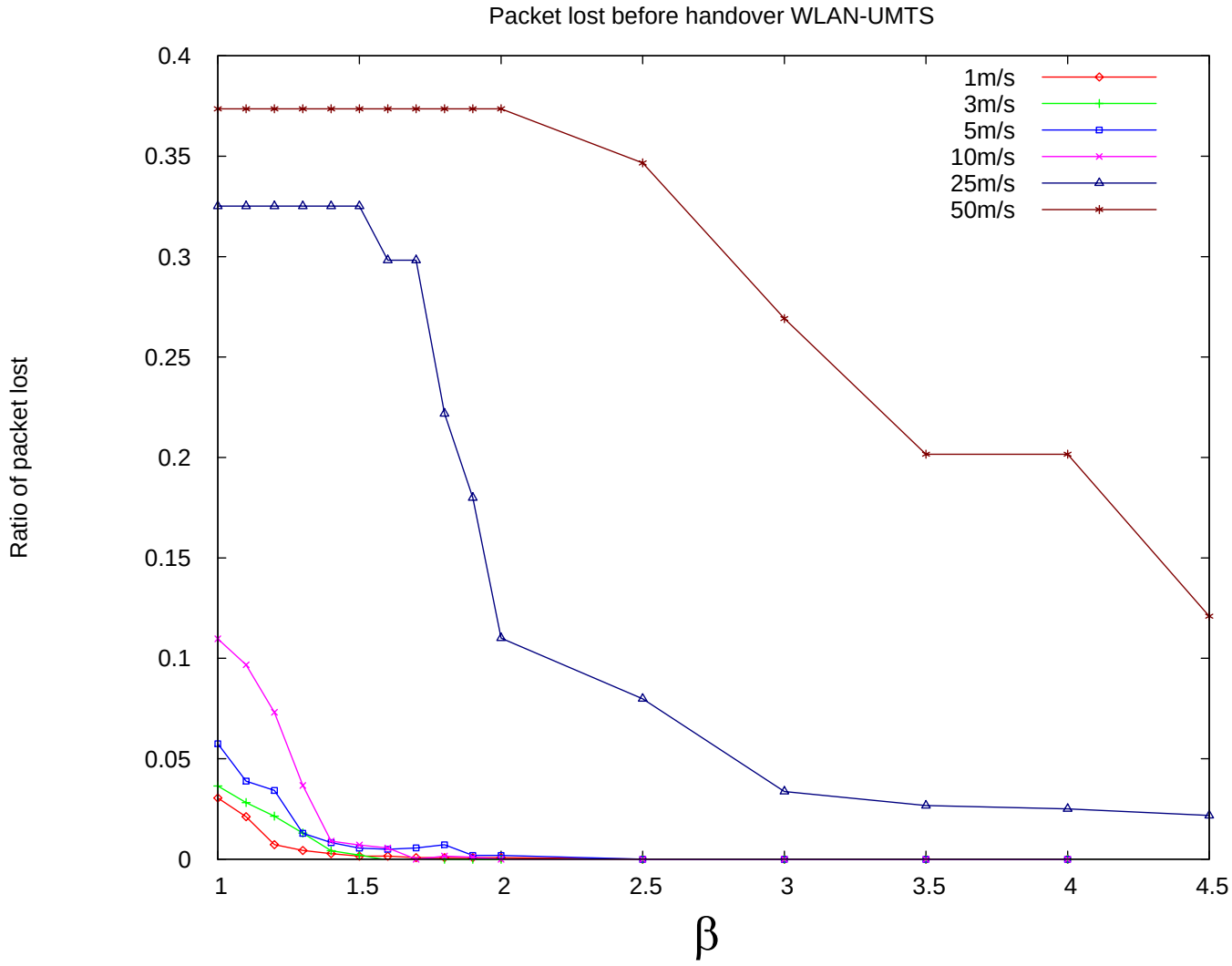
- reduce the handover latency
- reduce the handover packet loss

- Performance is measured in terms of packet loss as seen by the application in order to include losses (and retransmissions) at the lower layers.
- Packet Loss (PL) is defined as follows:

$$PL = \frac{\text{Number of packets lost during time T}}{\text{Number of packets expected during time T}}$$

Experiment 1: Moving out of range

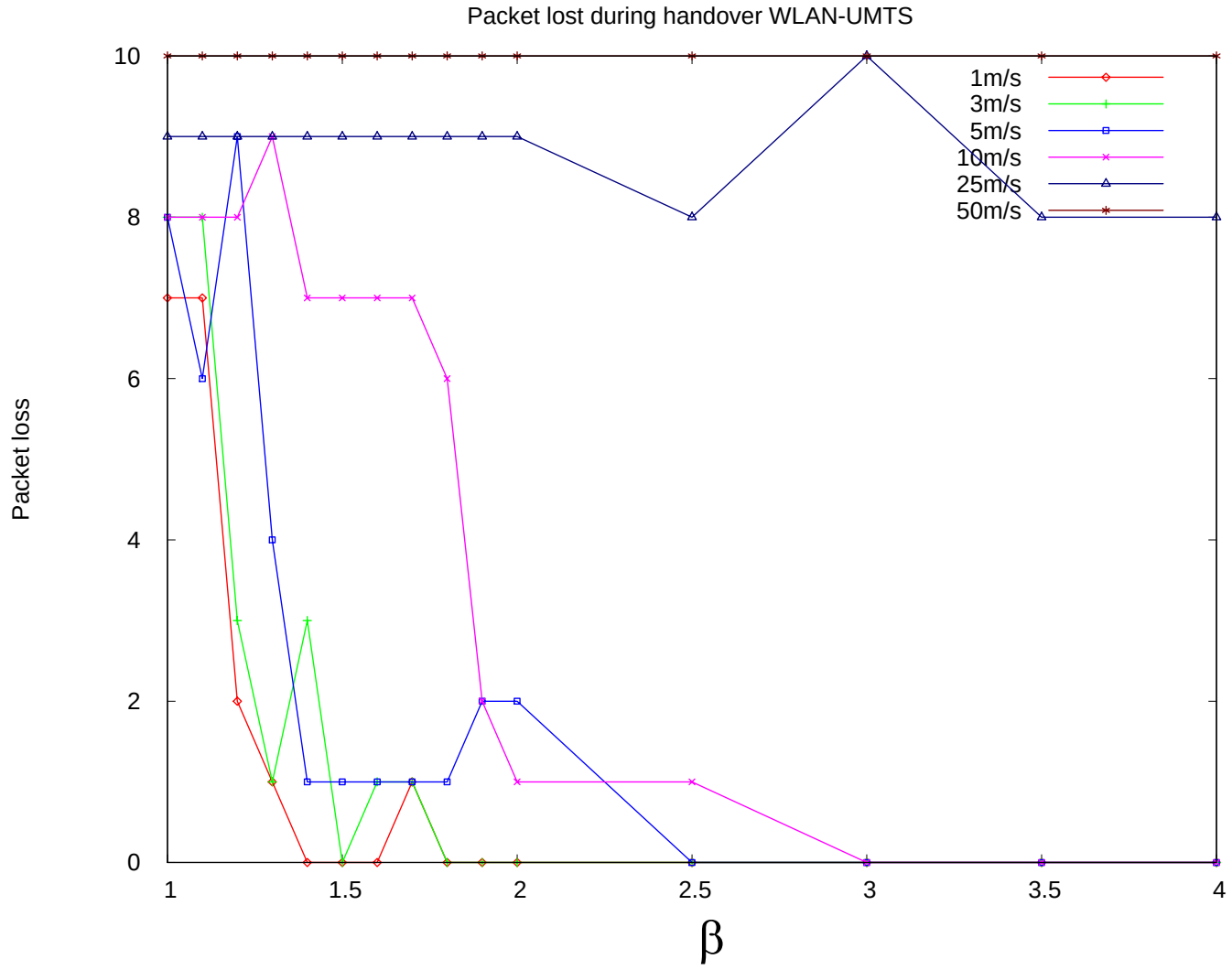
relying on the signal level at the receiver



P_{Th} = 3.162 x 10e-11W, α= 0.05

Experiment 1: Moving out of range

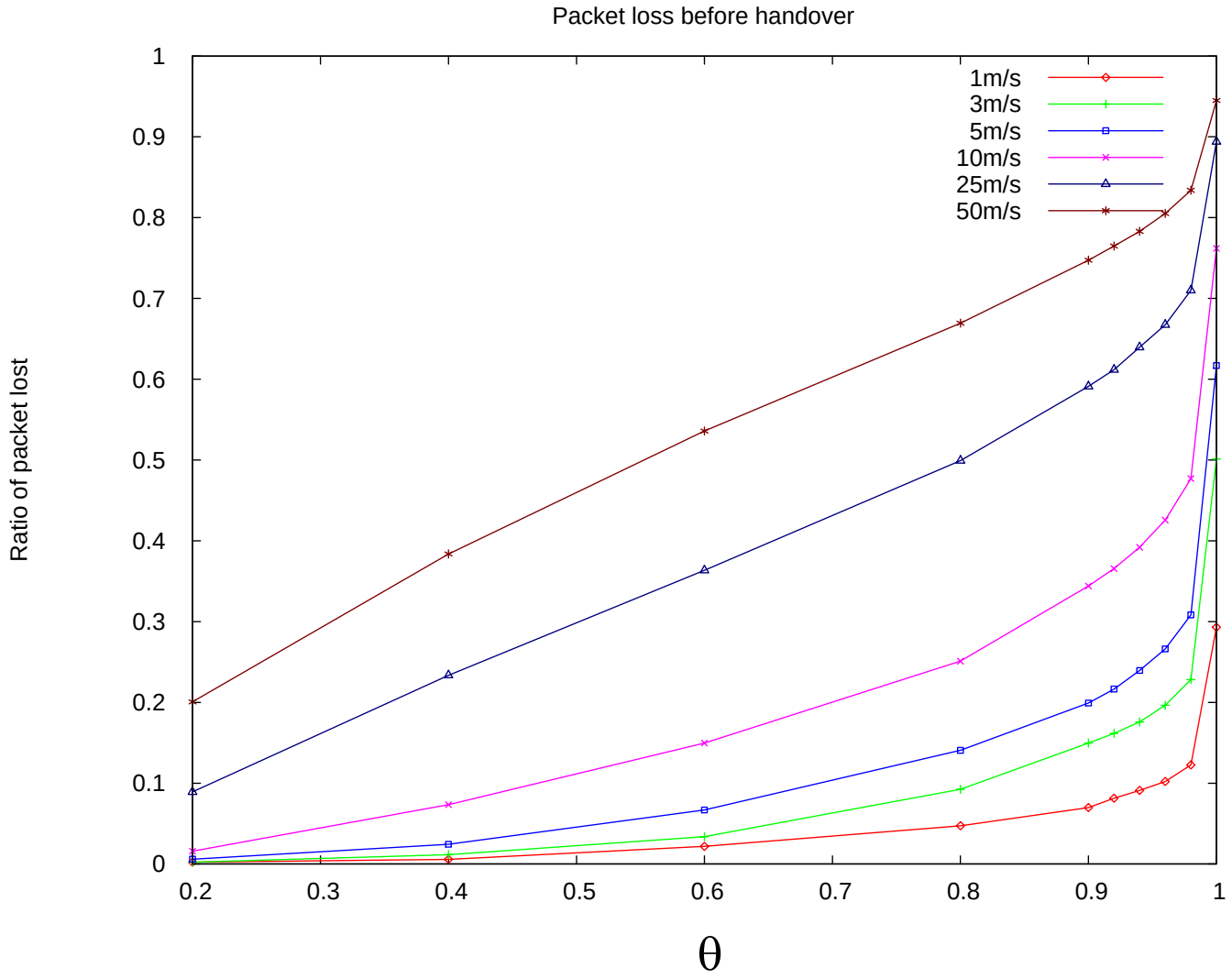
relying on the signal level at the receiver



P_{Th} = 3.162 x 10e-11W, α= 0.05

Experiment 1: Moving out of range

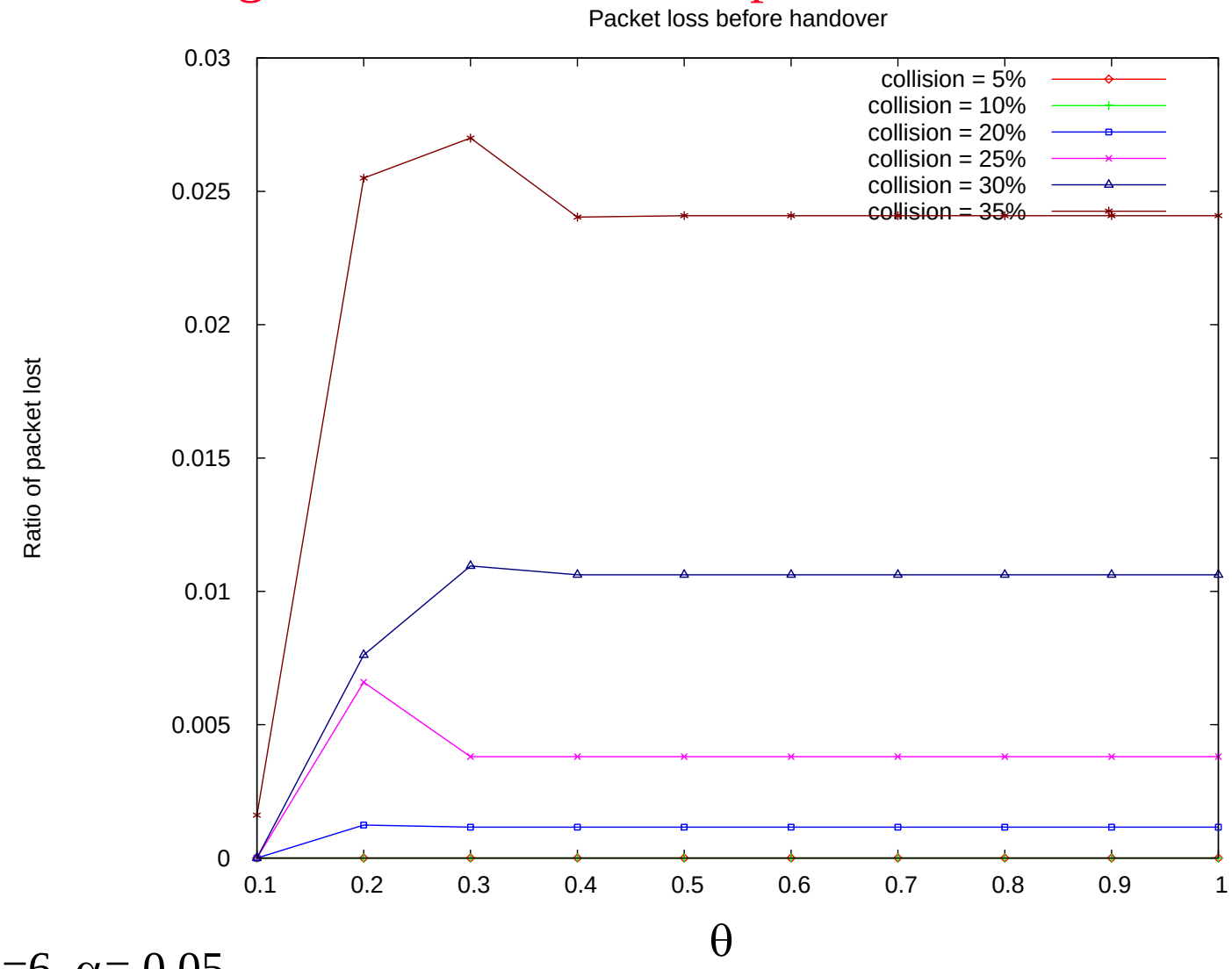
using the number of MAC packets retransmissions



R_{Th} =6, α= 0.05

Experiment 2: Varying the interference level

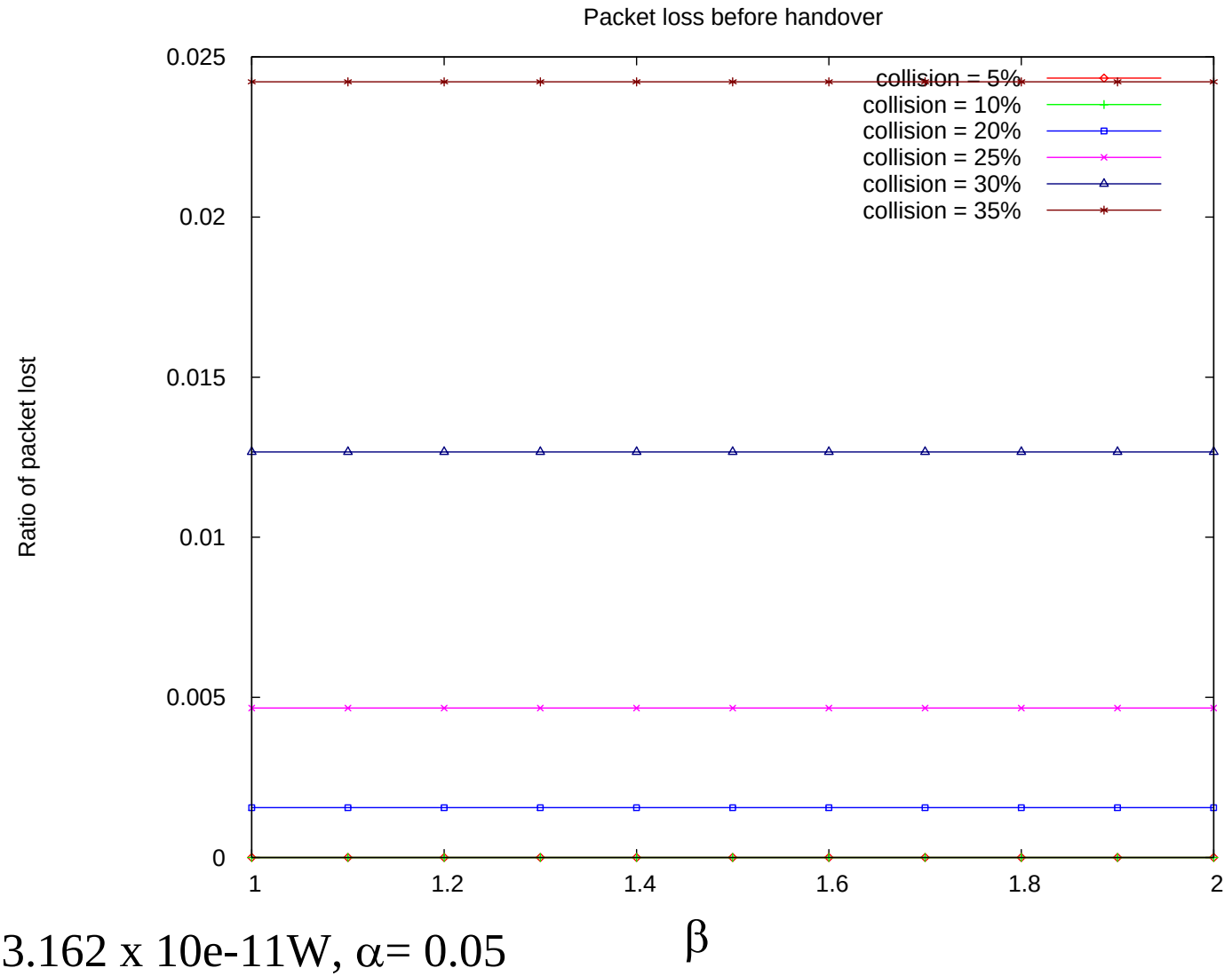
using the number of MAC packet retransmissions



R_{Th} =6, α= 0.05

Experiment 2: Varying the interference level

using the power level at the receiver



P_{Th} = 3.162 x 10e-11W, α= 0.05

Conclusions

1. Using the power level at the receiver is generally a good measure to trigger a Link Going Down for the case where the mobile node is moving out of range (signal level is degrading)
   - The power level threshold can be adjusted for different speeds:
     a Link Going Down should be triggered earlier for faster speeds.
   - The packet loss during the handover is not as significant as the packet loss incurred before a handover.
2. The packet retransmissions at the MAC layer transmitter could be used as an alternative (or in addition) to the power level.
   - Care in setting the retransmission level threshold:
     a lower retransmission threshold factor is needed for higher speeds.
3. Both metrics can be used interchangeably for moving out of range scenarios depending on the traffic directionality.
4. The packet retransmissions are mostly useful to trigger a Link Going Down for varying interference environments.