ISWCS 2017, Bologna

Mobility-aware Handover Strategies in Smart Cities

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August 30, 2017

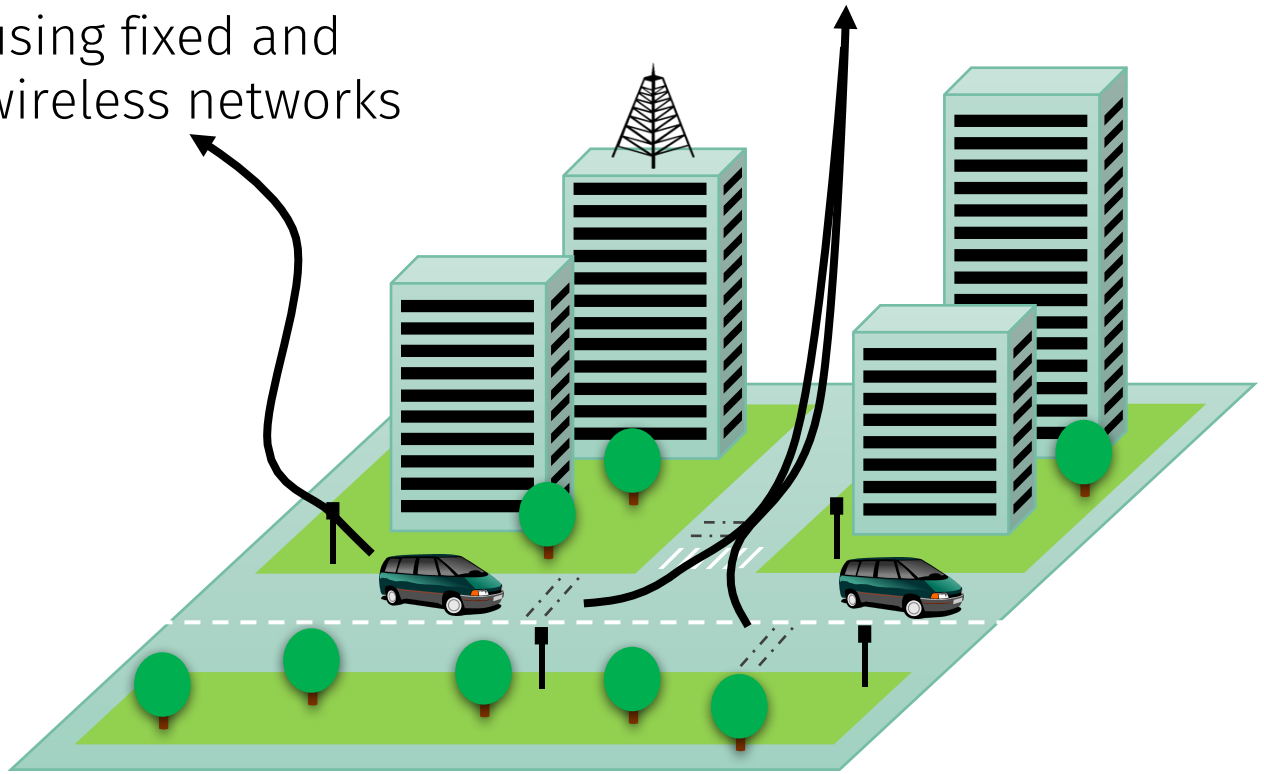
Outline

- Introduction
- Handover in HetNets
- Mobility data
- Asymmetrical Handover Bias
- Conclusions

IoT impacts the network

A Smart City gathers data from IoT sensors

using fixed and
wireless networks

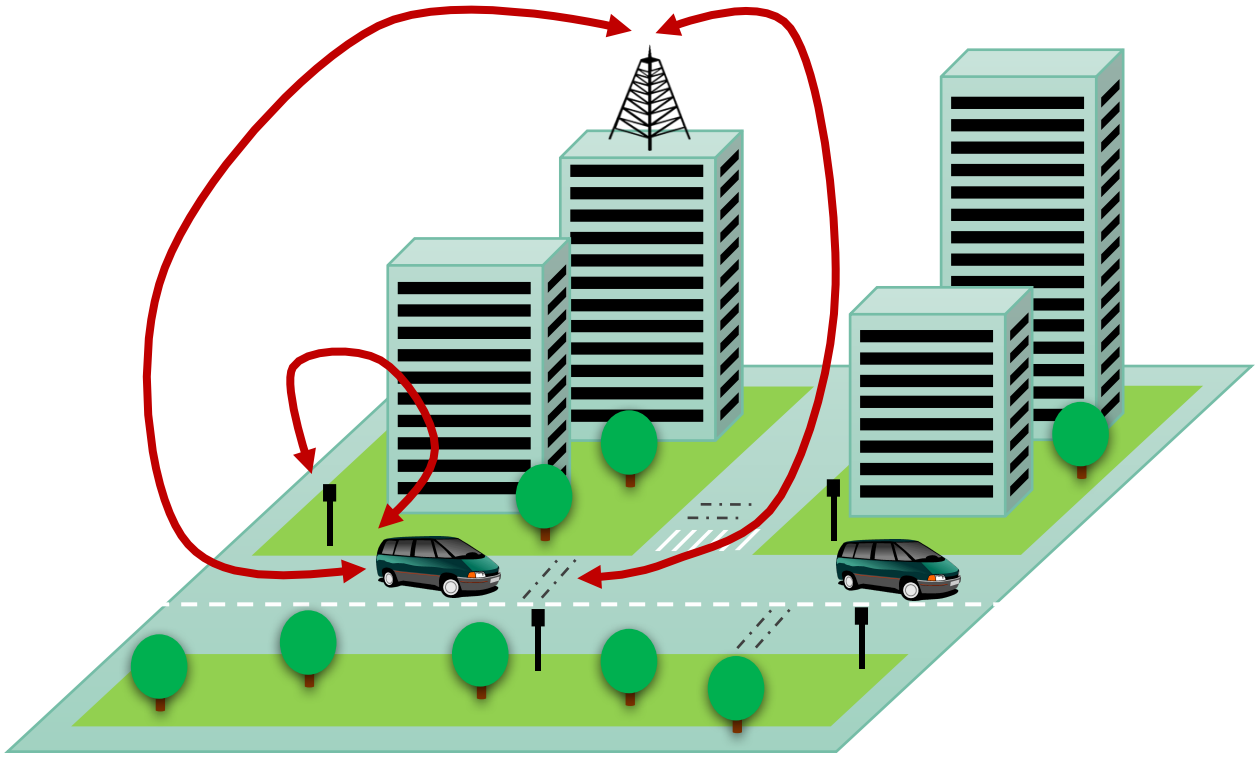


IoT introduces an additional load in the network

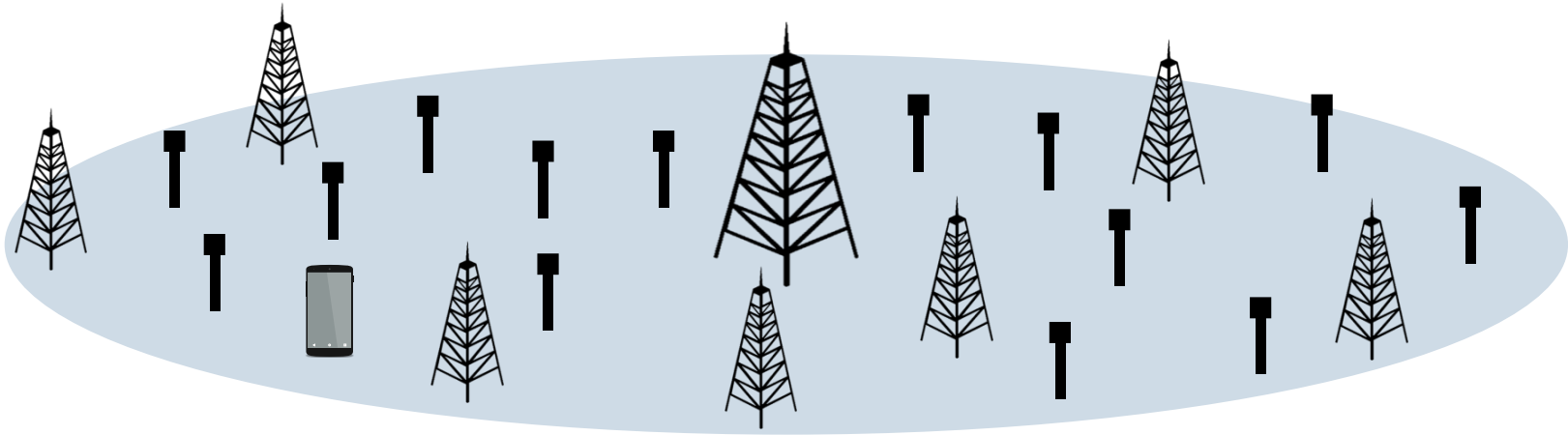
SymbioCity

Smart City data can be used by the network to increase its awareness

Smarter Self-Organizing Networks



Heterogeneous Networks

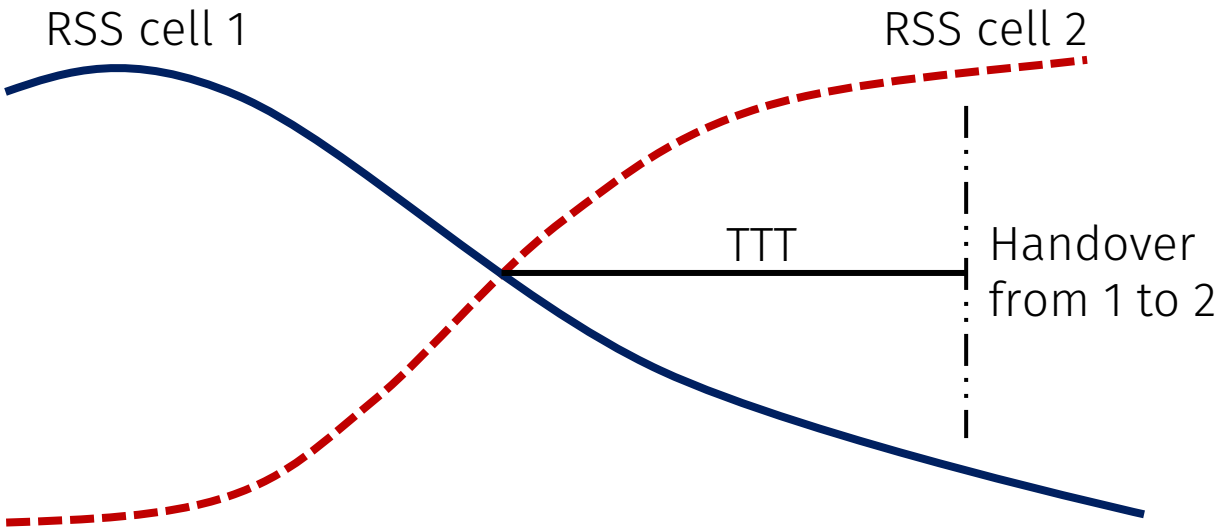


- Cells of different sizes and capabilities
- Tons of parameters to tune
- Perfect fit for SONs

Mobility procedures (handovers) are an issue

Handover in HetNets

- Frequent HO
  - Dense cells
  - Small cells
- RSS-based



Handover in HetNets

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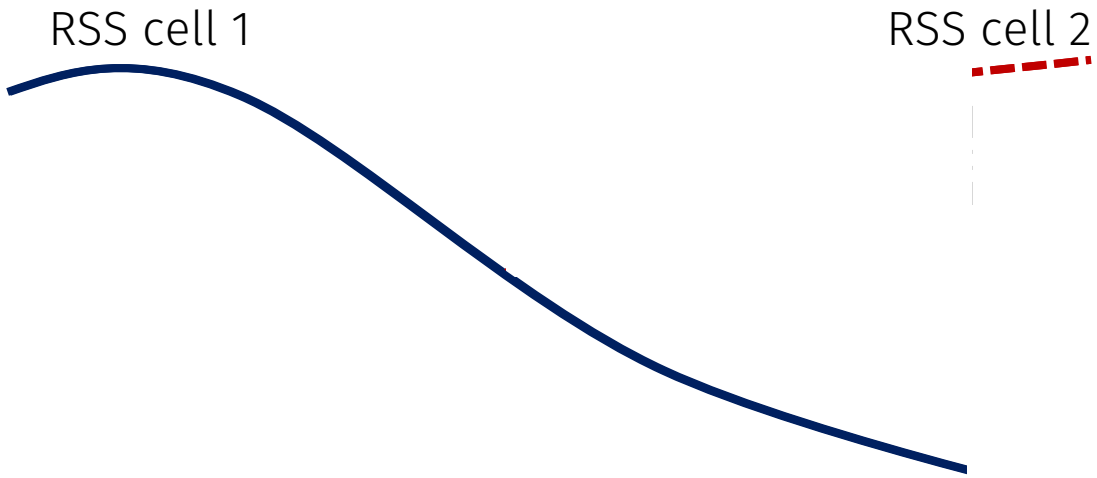

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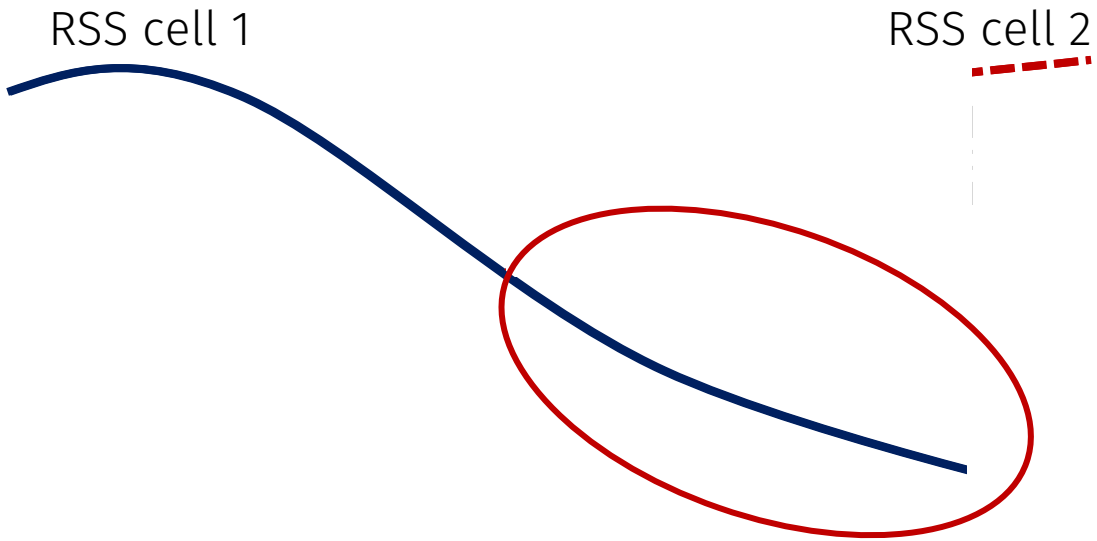

Handover in HetNets

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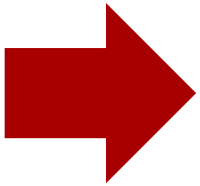
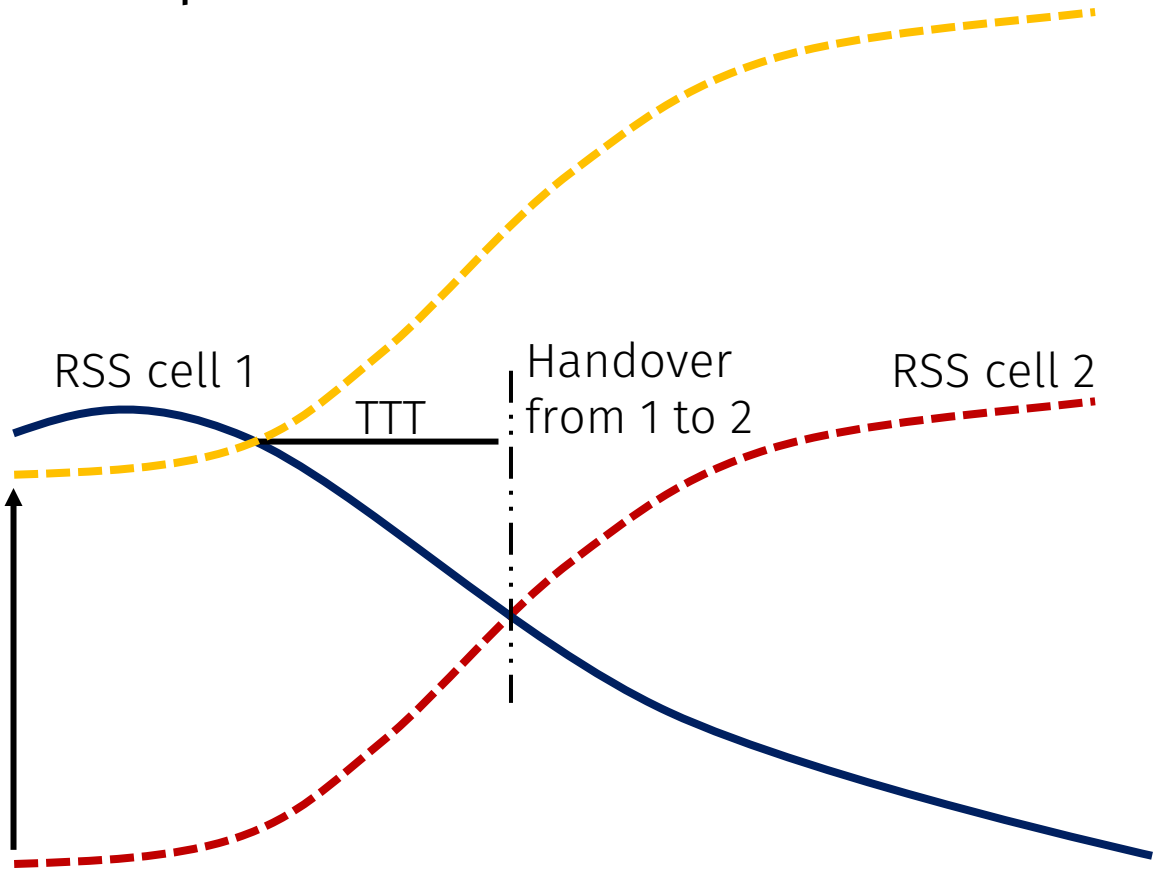


SymbioCity application: avoid ping-pong & increase capacity

Range Expansion Bias

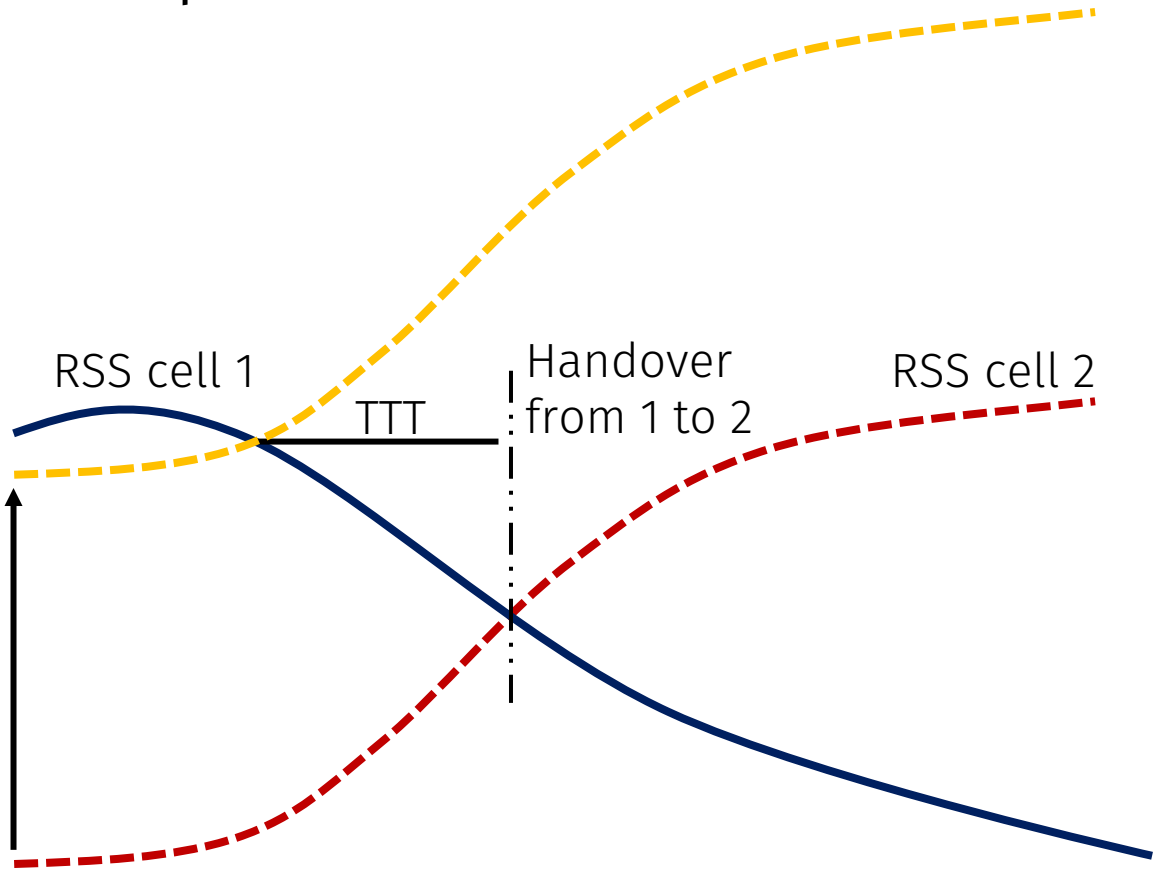
- Additive parameter



How to tune it?

Range Expansion Bias

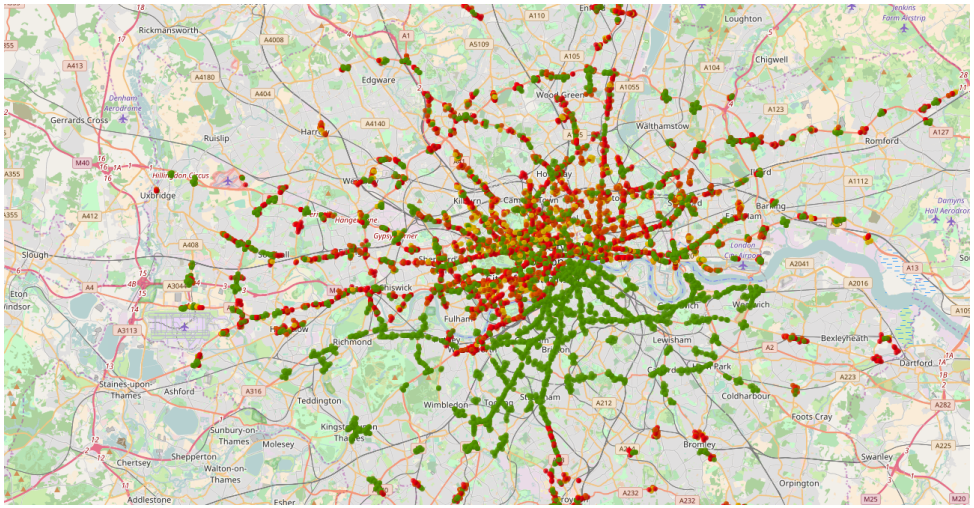
- Additive parameter



… we need data!

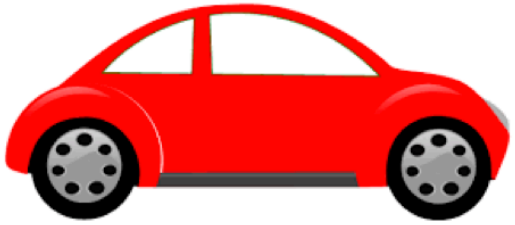
London UTC network

Traffic light timing optimization to reduce congestion

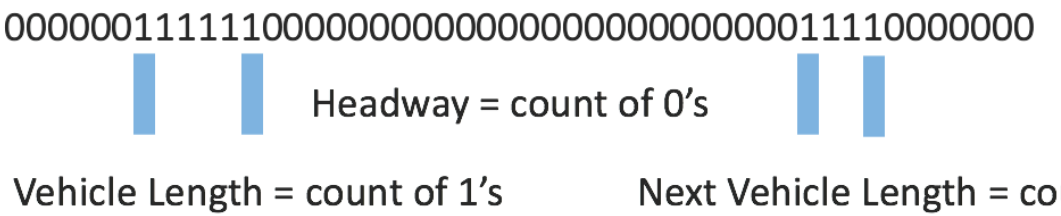


From: Traffic for London (TfL) – first quarter 2015

Speed estimation



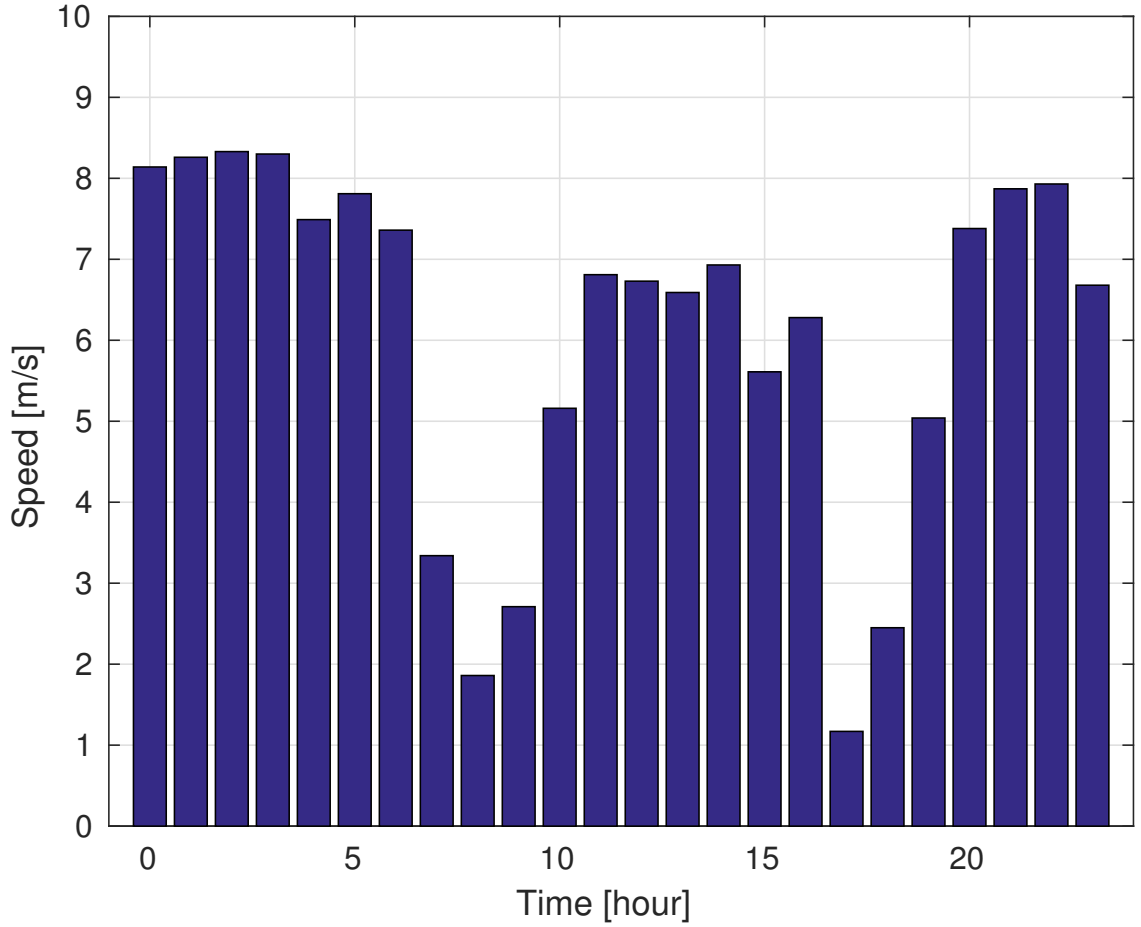
Detector



- $T_s = 250$ ms
- Vehicle length L (we assume $L = 4$ m)
- Number of 1's n

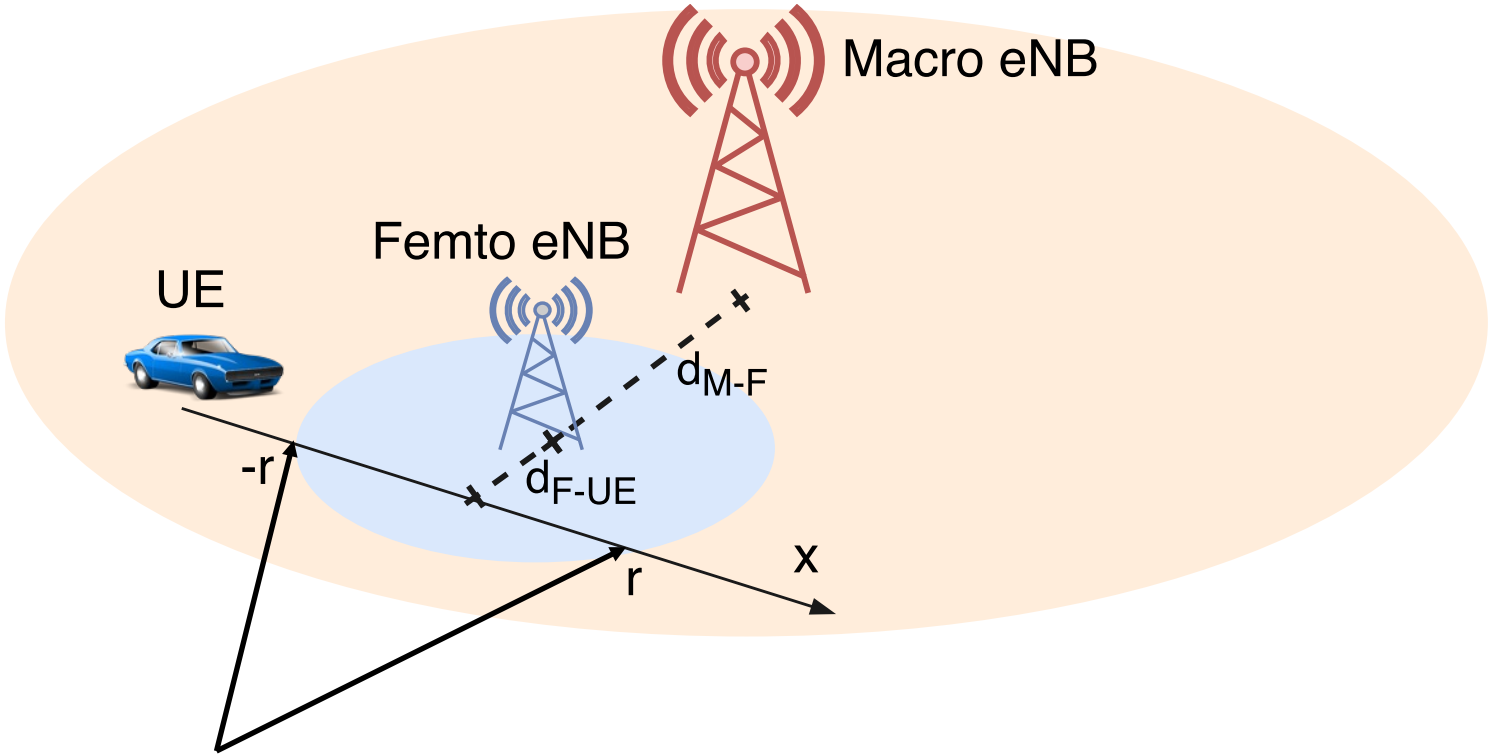
$$v = \frac{L}{nT_s}$$

Example



Hourly average, January 23, 2015. Intersection between Homerton High St. and Daubeney Rd.

Scenario



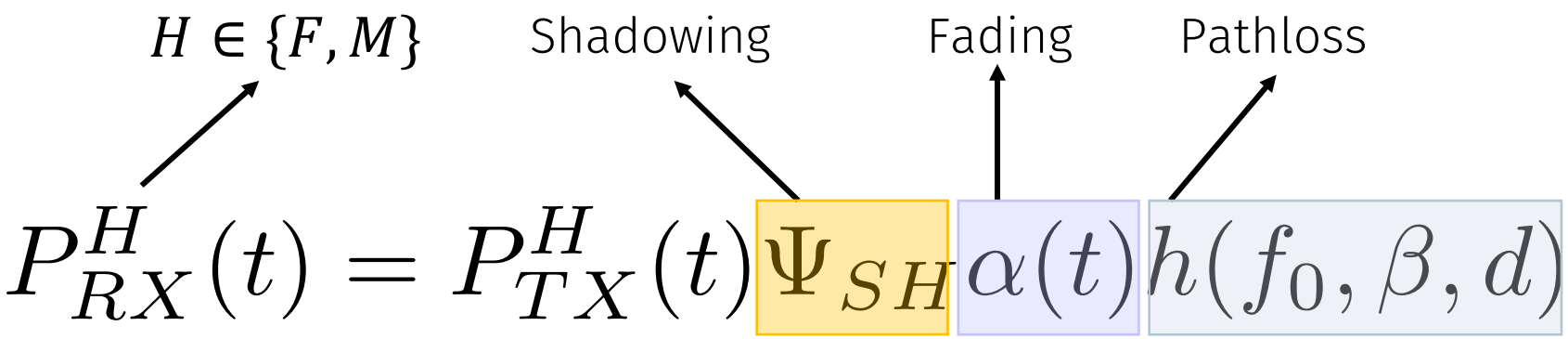
Optimal handover

- Speed-based
- Asymmetrical

Channel model

$$P_{RX}^{H}(t) = P_{TX}^{H}(t)\Psi_{SH}\alpha(t)h(f_0, \beta, d)$$

Channel model



Channel model

$$P_{RX}^{H}(t) = P_{TX}^{H}(t)\Psi_{SH}\alpha(t)h(f_0, \beta, d)$$

$$h(f_0, \beta, d) = A\left(\frac{c}{4\pi f_0}\right)^2\left(\frac{d}{d_0}\right)^{-\beta}$$

Channel model

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$$h(f_0, \beta, d) = A\left(\frac{c}{4\pi f_0}\right)^2 \left(\frac{d}{d_0}\right)^{-\beta}$$

Pathloss exponent

Carrier Frequency

Distance

Channel model

$$P_{RX}^{H}(t) = P_{TX}^{H}(t)\Psi_{SH}\alpha(t)h(f_0,\beta,d)$$

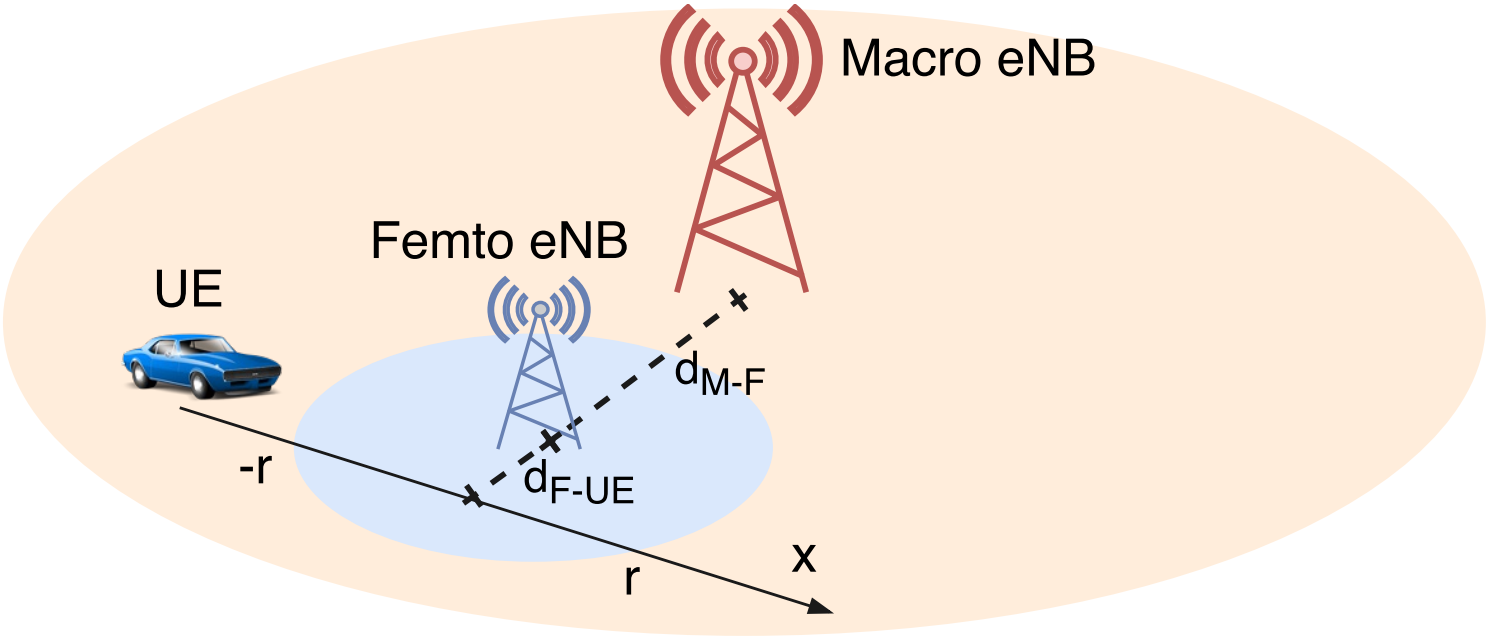
$$h(f_0,\beta,d) = A\left(\frac{c}{4\pi f_0}\right)^2\left(\frac{d}{d_0}\right)^{-\beta}$$

$$\gamma_H(t) = \frac{P_{RX}^{H}}{N_0 B}$$

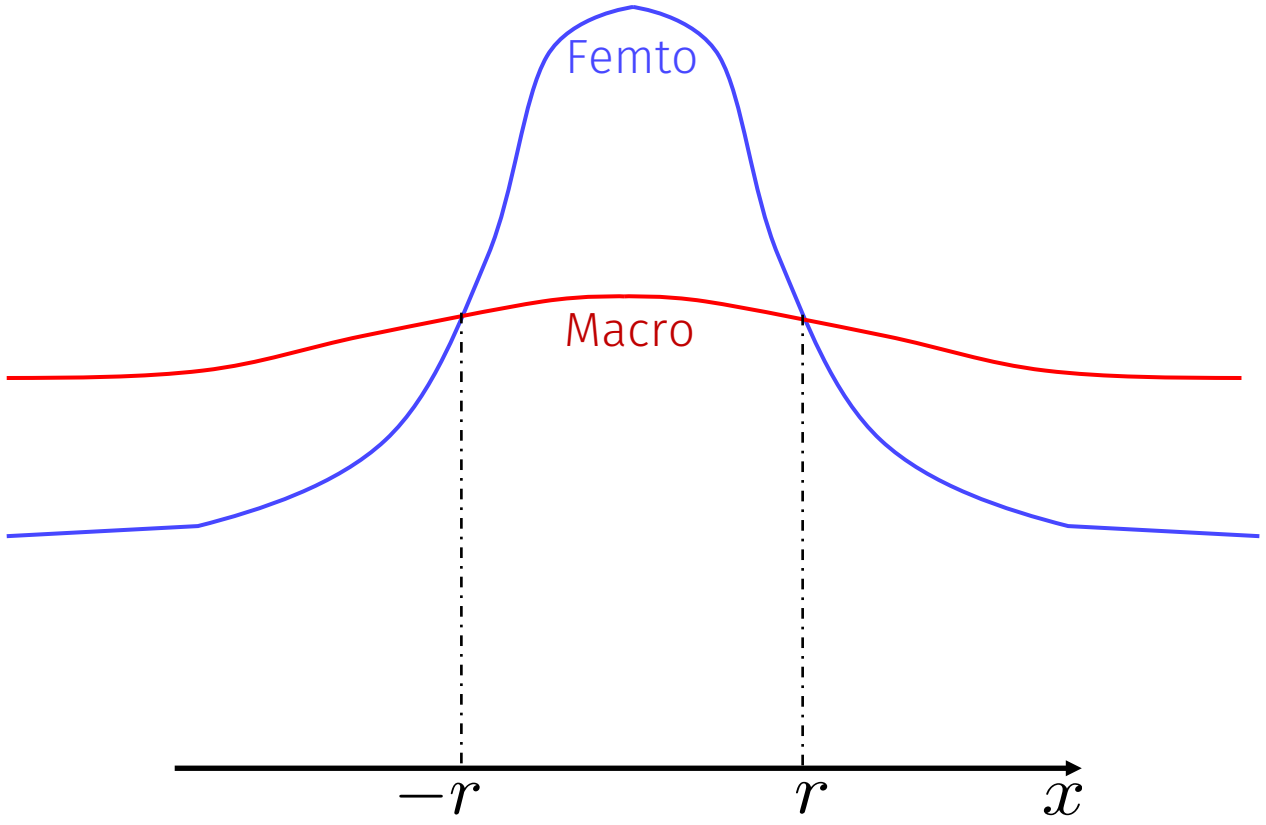
Parameters

Parameter	Value	Description
P_{TX}^{M}	46	MeNB transmission power [dBm]
P_{TX}^{F}	26	FeNB transmission power [dBm]
f_0^M	900	MeNB carrier frequency [MHz]
f_0^F	1800	FeNB carrier frequency [MHz]
B	20	Bandwidth [MHz]
d_{M-F}	40	Distance between MeNB and FeNB [m]
d_{F-UE}	10	Distance between FeNB and UE [m]
σ_M^2	8	MeNB log-normal shadowing variance
σ_F^2	4	FeNB log-normal shadowing variance
β_M	4.28	MeNB pathloss exponent (NLOS)
β_F	3.76	FeNB pathloss exponent (LOS)

Asymmetrical Bias

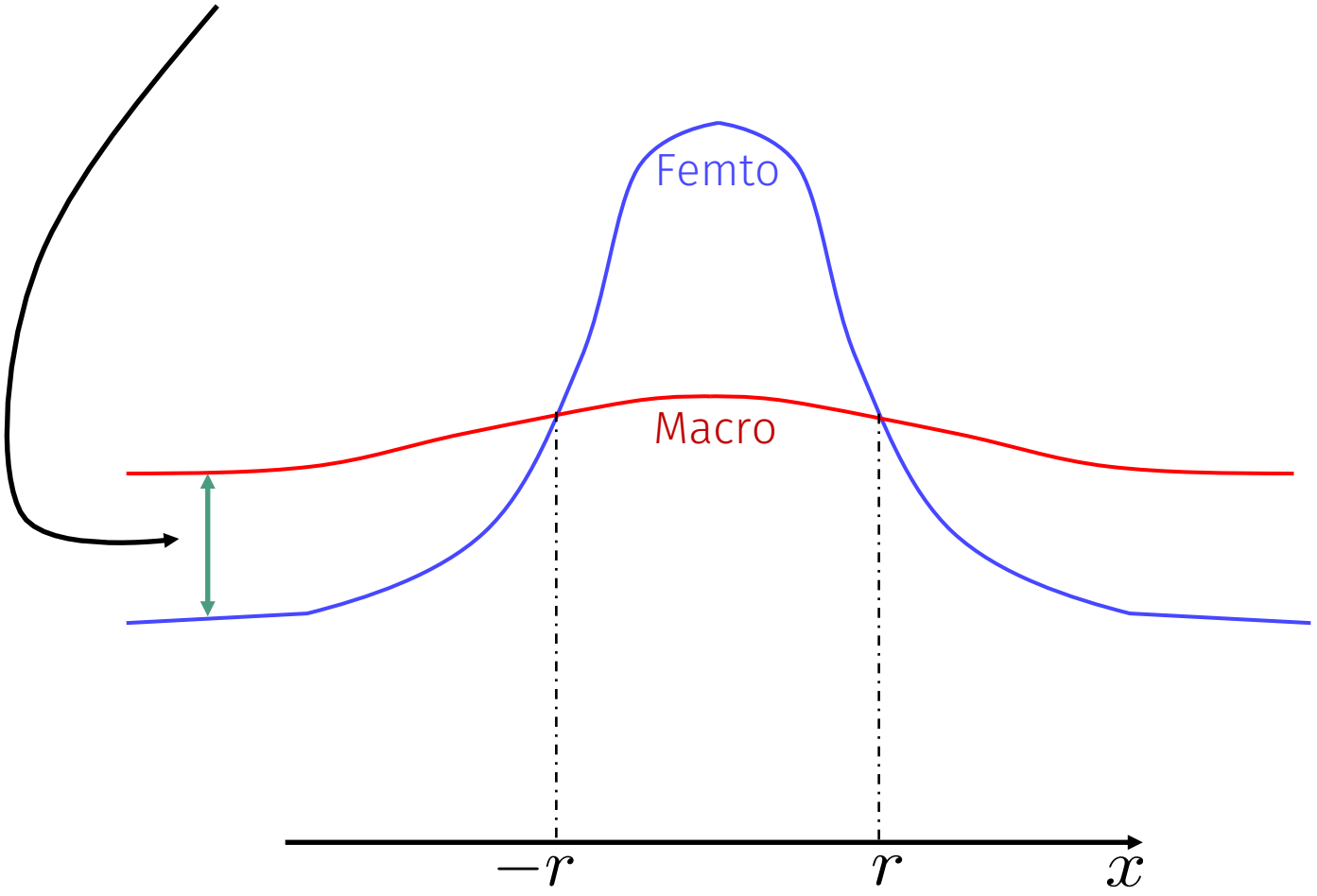


Asymmetrical Bias



Asymmetrical Bias

$$\Delta(x) = \bar{\gamma}_F(x) - \bar{\gamma}_M(x)$$



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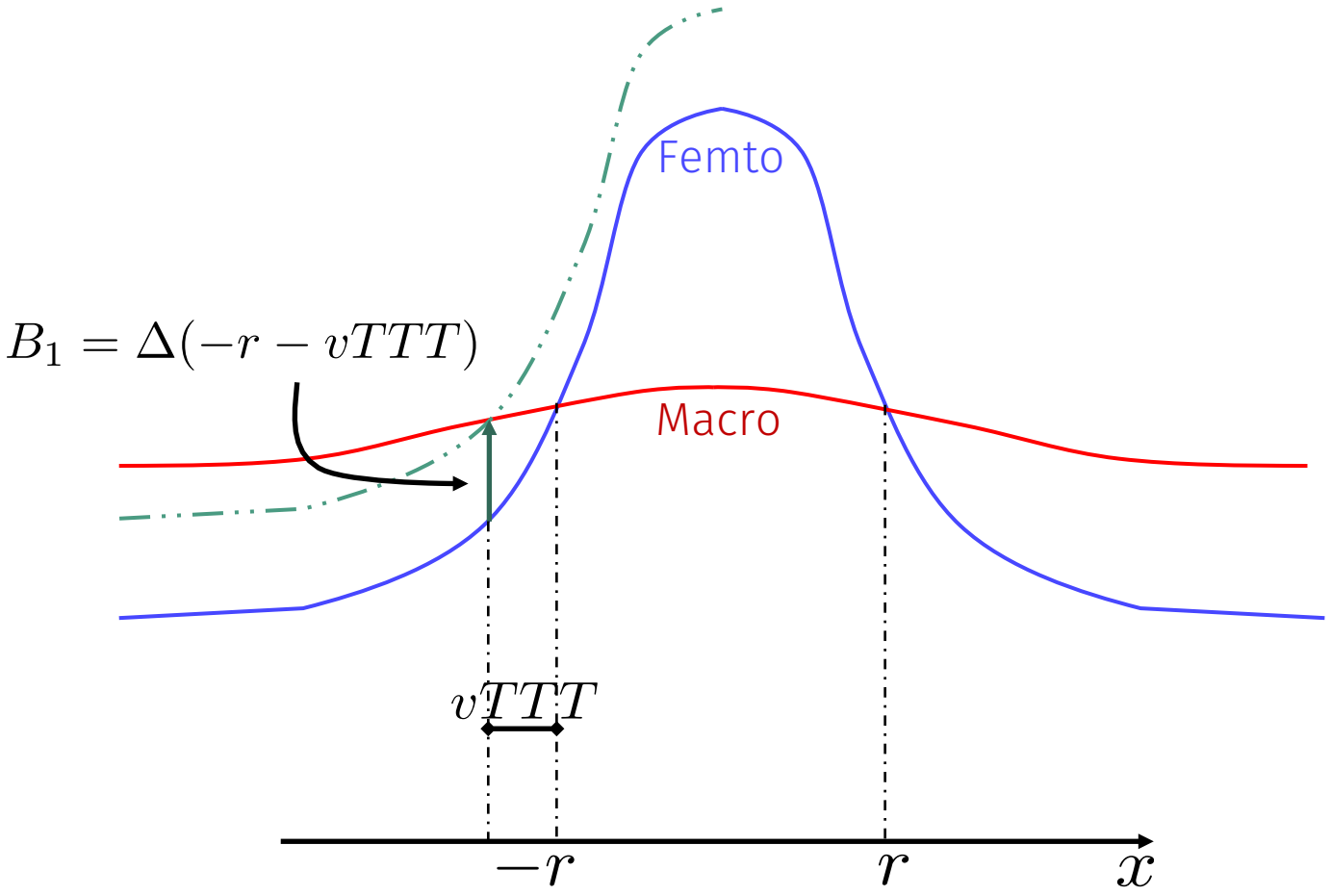
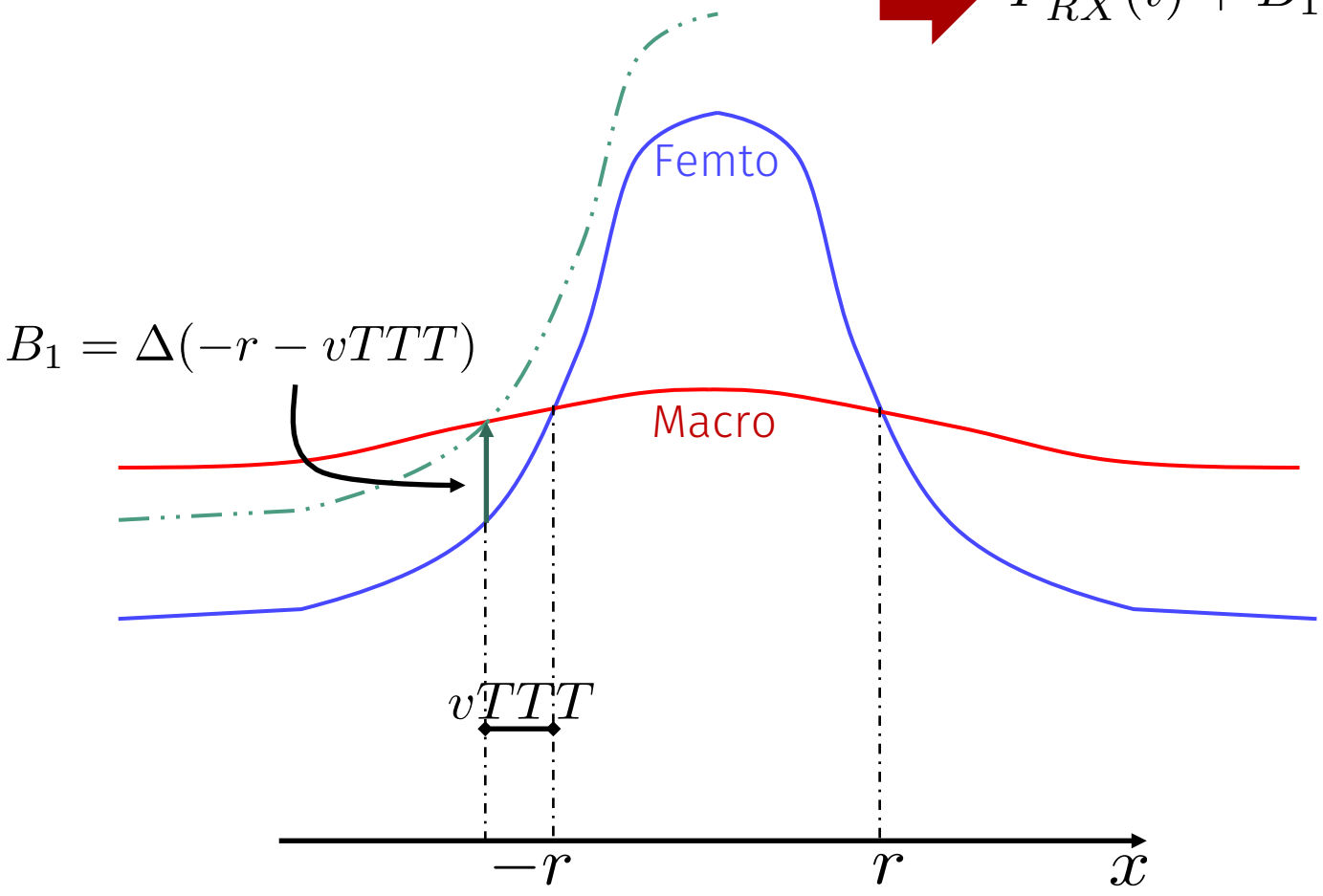
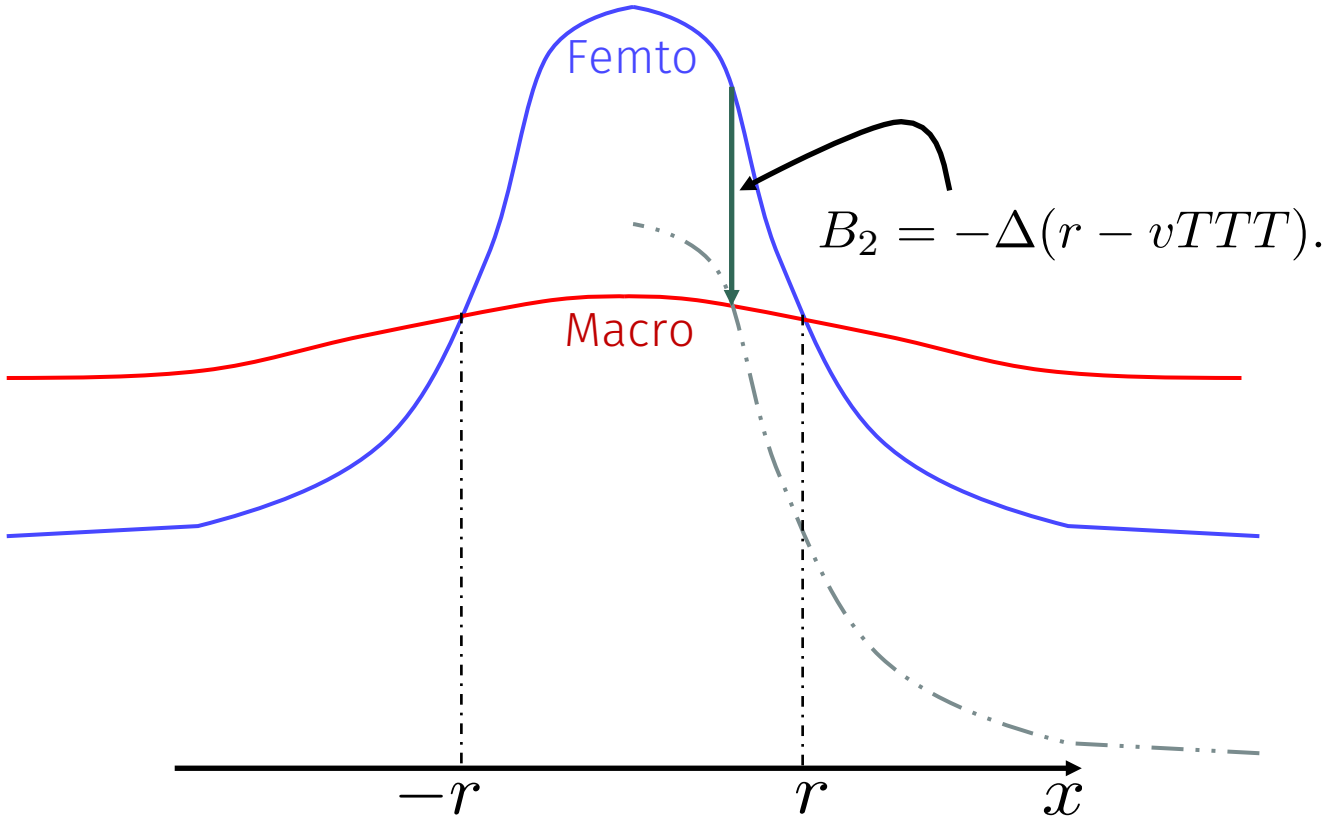


Asymmetrical Bias

$$P^F_{RX}(t) + B_1 > P^M_{RX}(t)$$

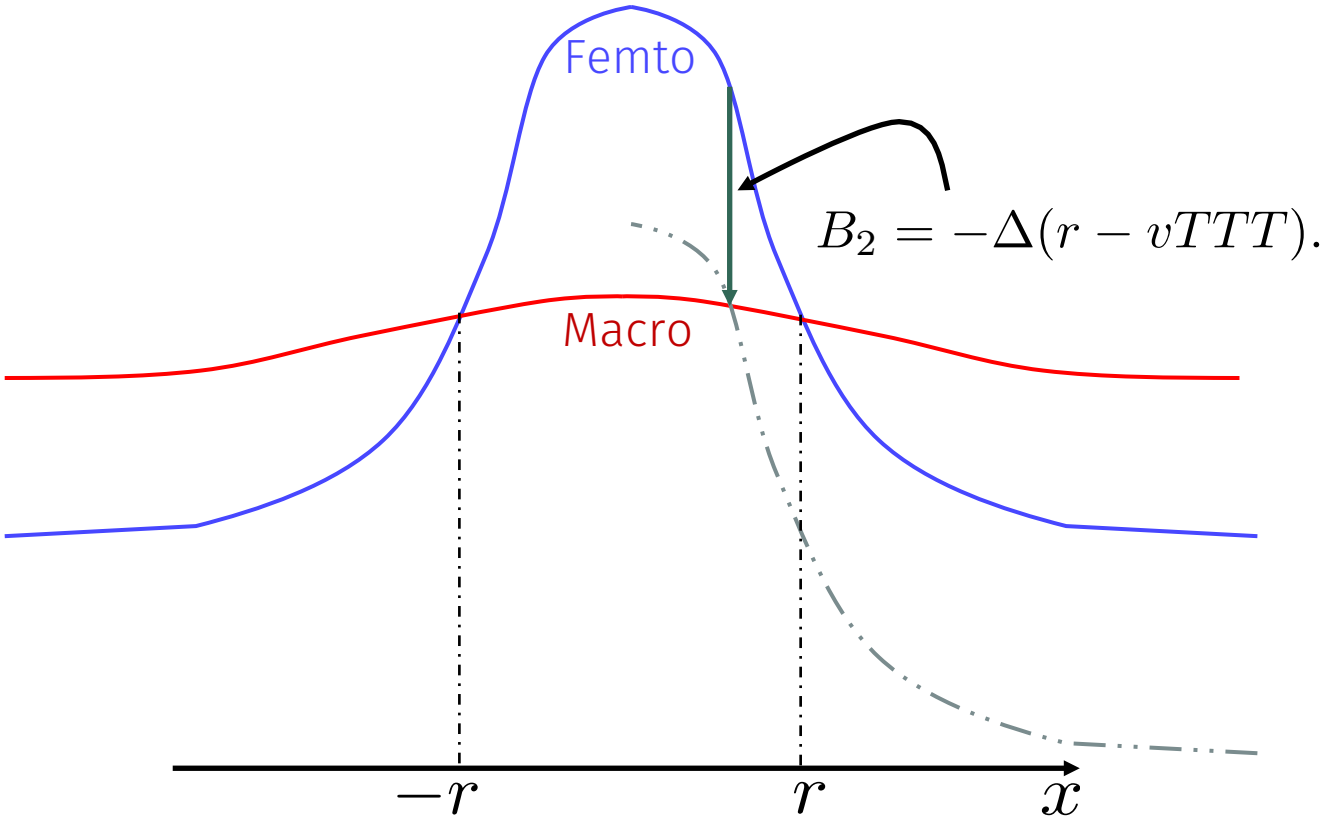


Asymmetrical Bias



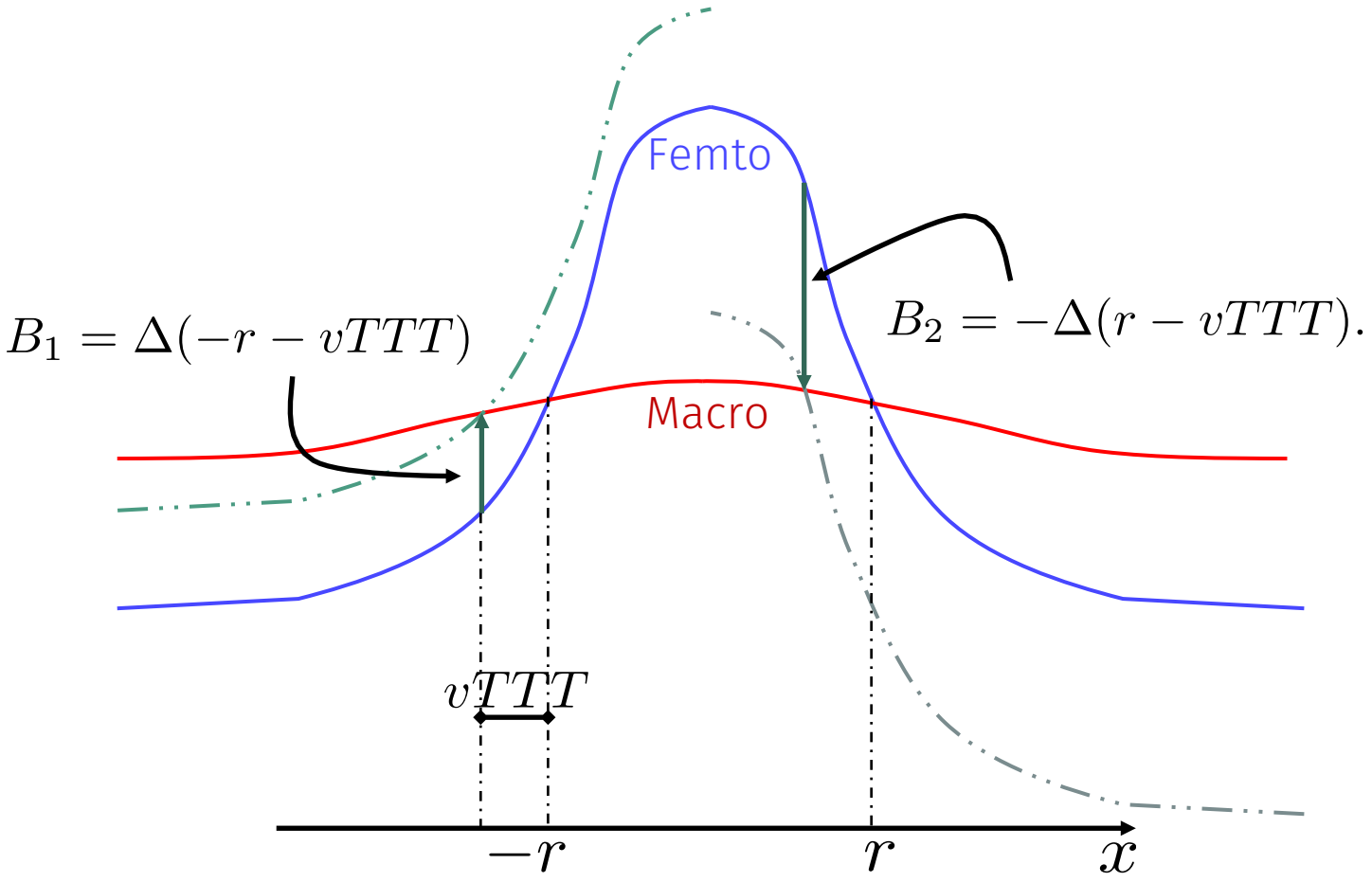
Asymmetrical Bias

$$P_{RX}^{M}(t) + B_2 > P_{RX}^{F}(t)$$

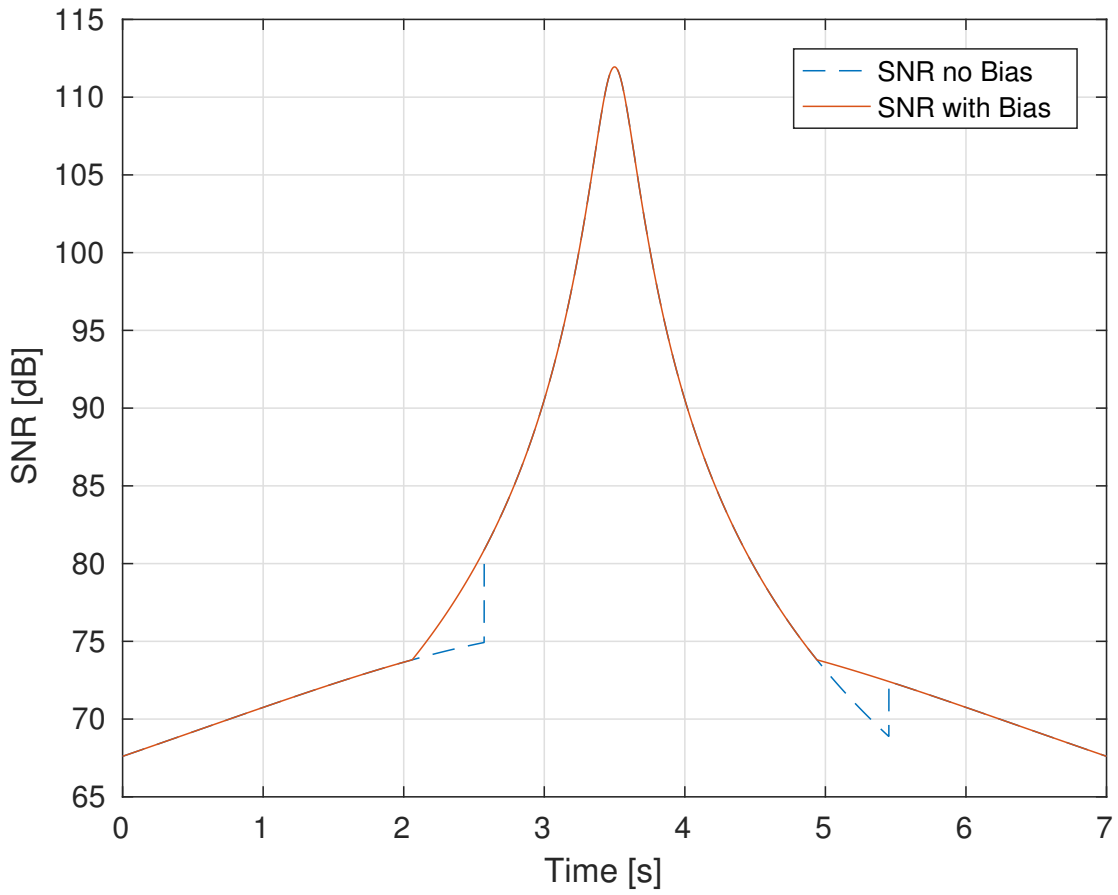


Asymmetrical Bias

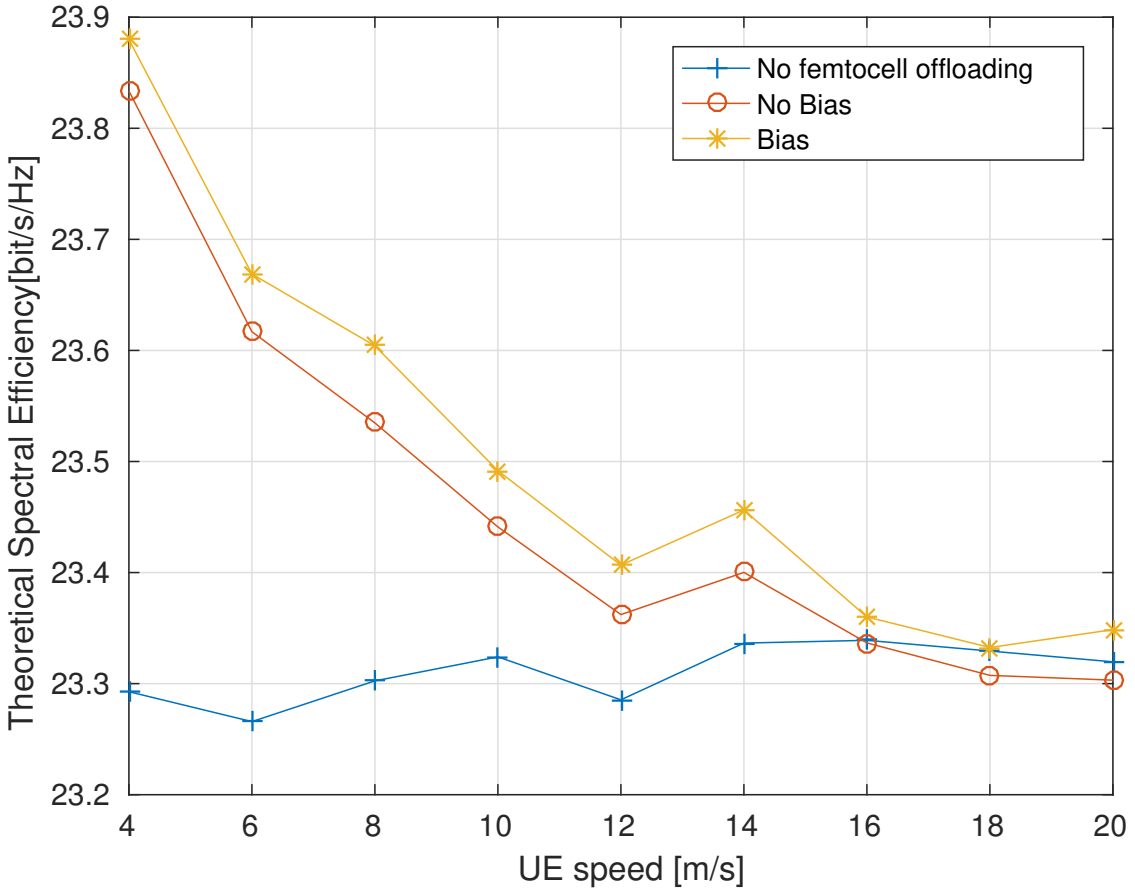
$$\Delta(x) = \bar{\gamma}_F(x) - \bar{\gamma}_M(x)$$



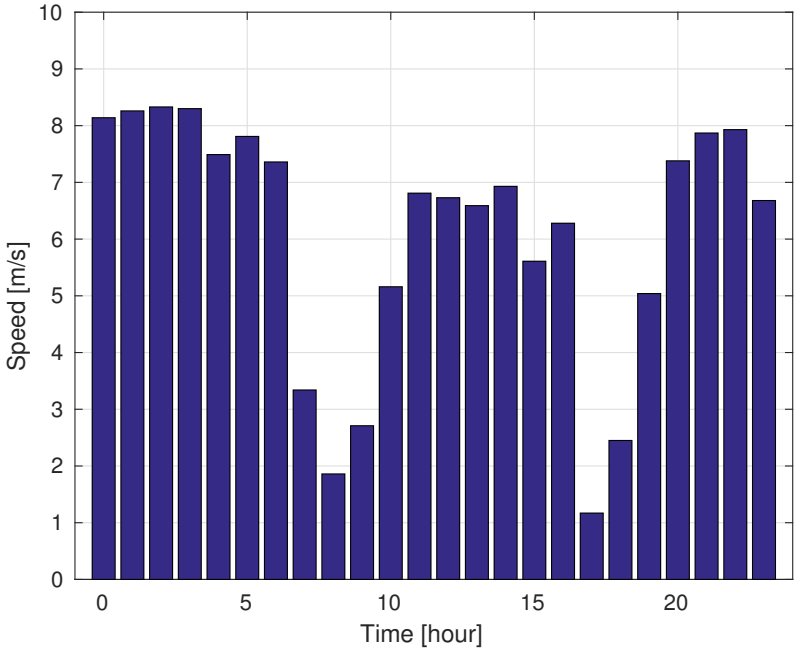
SNR with and without bias

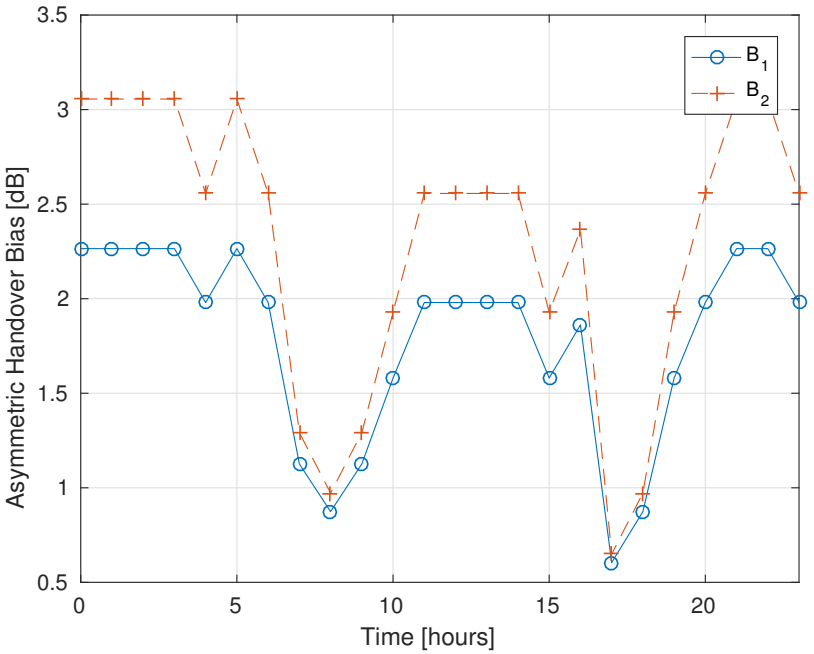


Spectral Efficiecy



Bias values


Speed [m/s]
Time [hour]
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20


Asymmetric Handover Bias [dB]
Time [hours]
B1
B2
0.5
1
1.5
2
2.5
3
3.5
0
5
10
15
20

Conclusions

- SymbioCity idea: smarter networks with Smart City data
- Application: handover in HetNets
  - Data from TfL
  - Range expansion bias
  - Increased efficiency without *ping pong*
- Future works
  - Dynamic vMME allocation
  - Integration with more data

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