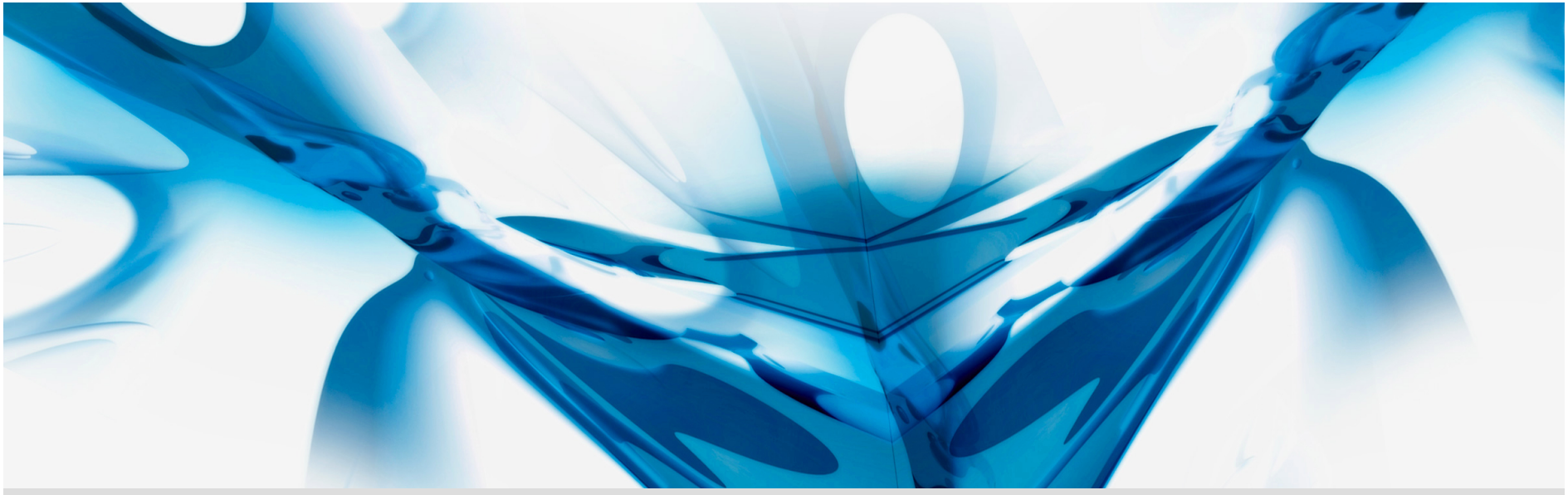
大学共同利用機関法人 情報・システム研究機構
国立情報学研究所
National Institute of Informatics

Information Systems
Architecture Science
Research Division



Neuron inspired collaborative transmission in WSNs

Mobiquitous 2011, 06.12.–09.12., Copenhagen, Denmark

Stephan Sigg, Predrag Jakimovski, Florian Becker, Hedda R. Schmidtke, Alexander Neumann, Yusheng Ji, Michael Beigl

The 8th International ICST Conference on Mobile and Ubiquitous Systems: Computing, Networking and Services, MobiQuitous 2012, 06.12.–09.12.2011, Copenhagen, Denmark

Smart Spaces

Smart Spaces

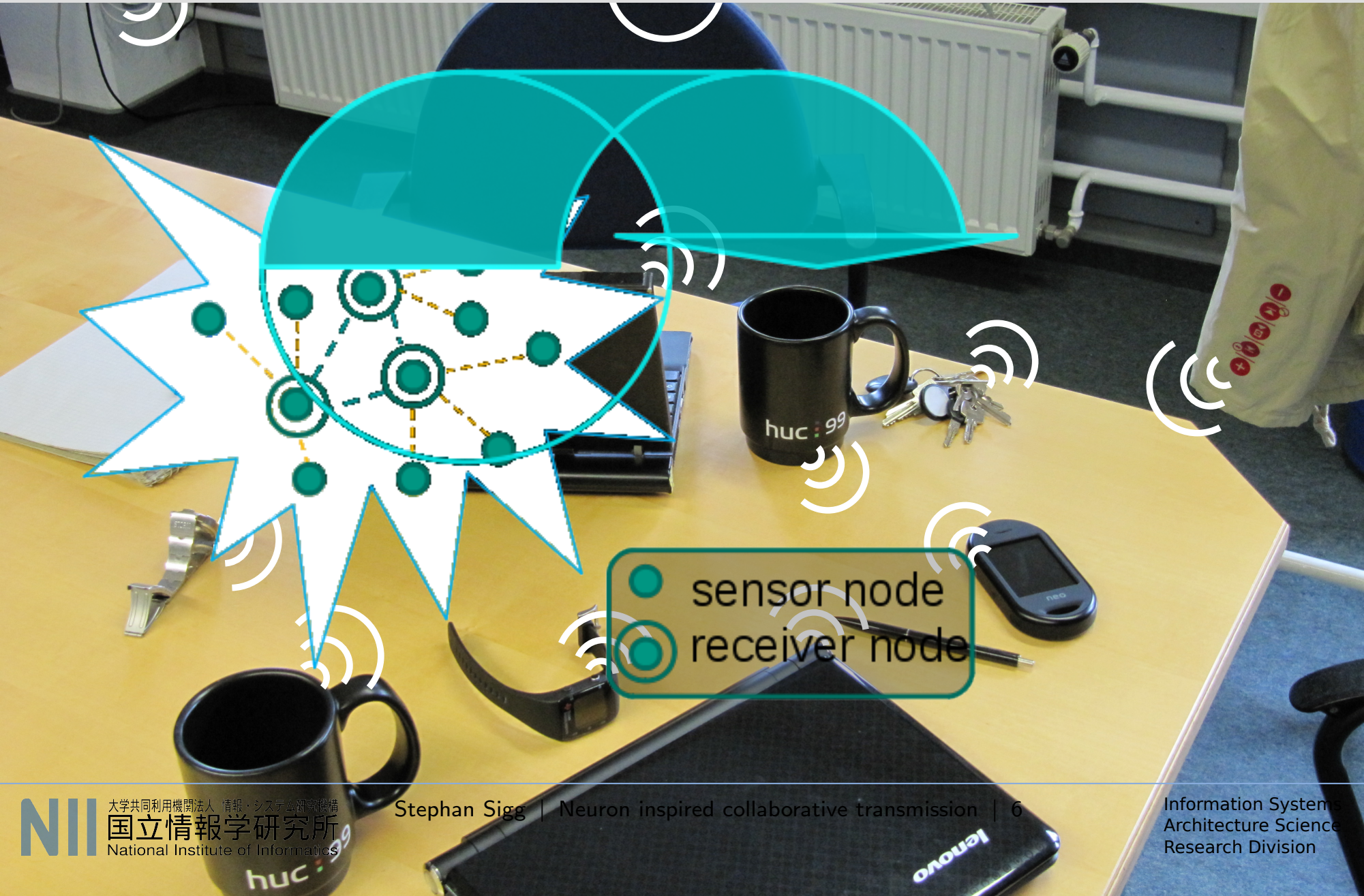
Smart Spaces are ...

- Sensing environment
- Traditionally visual and audio system
- Sensing and acting as a living being

Smart Spaces

Smart Spaces

Smart Spaces

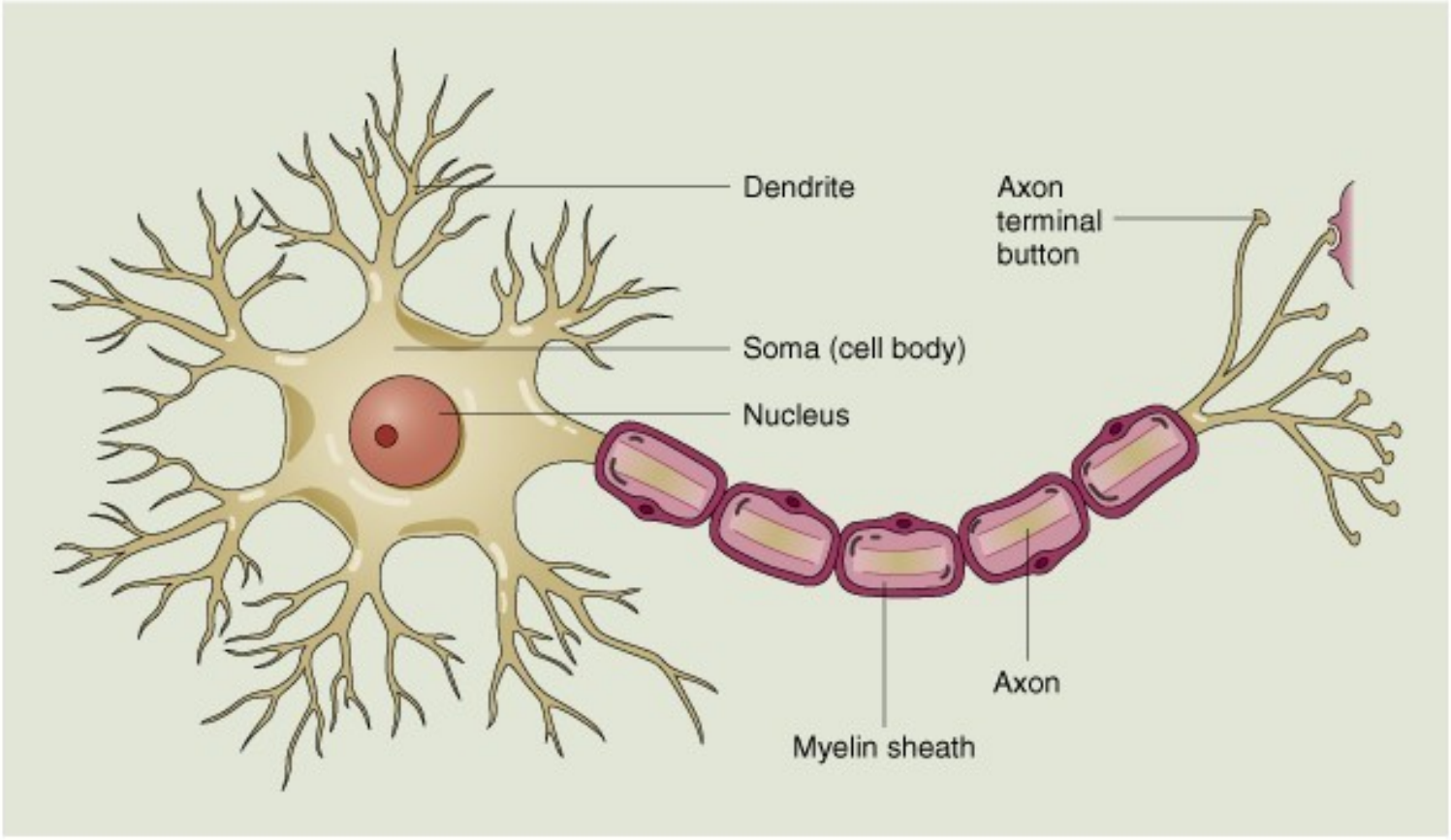


Smart Spaces

Smart Spaces

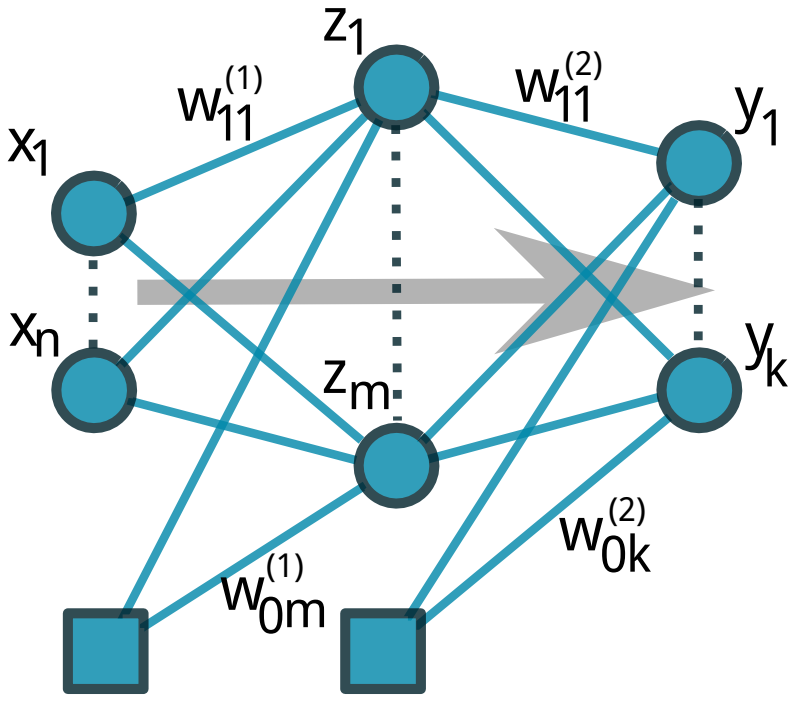
Motivation

Motivation



Outline

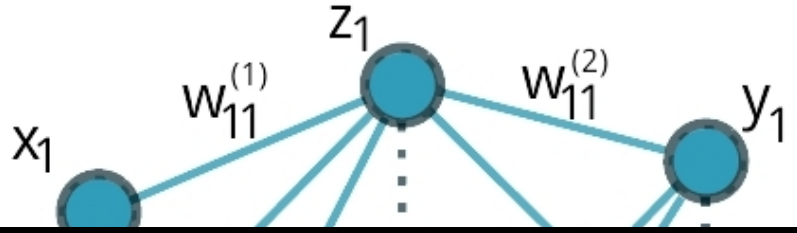
Neuron systems in WSNs



Neural network with one hidden layer:

$$y_k(\vec{x}, \vec{w}) = \sigma\left(\sum_{j=1}^{M} w_{jk}^{(2)} h\left(\sum_{i=1}^{D} w_{ij}^{(1)} x_i + w_{0j}^{(1)}\right) + w_{0k}^{(2)}\right)$$

Neuron systems in WSNs



No straightforward mapping to wireless networks

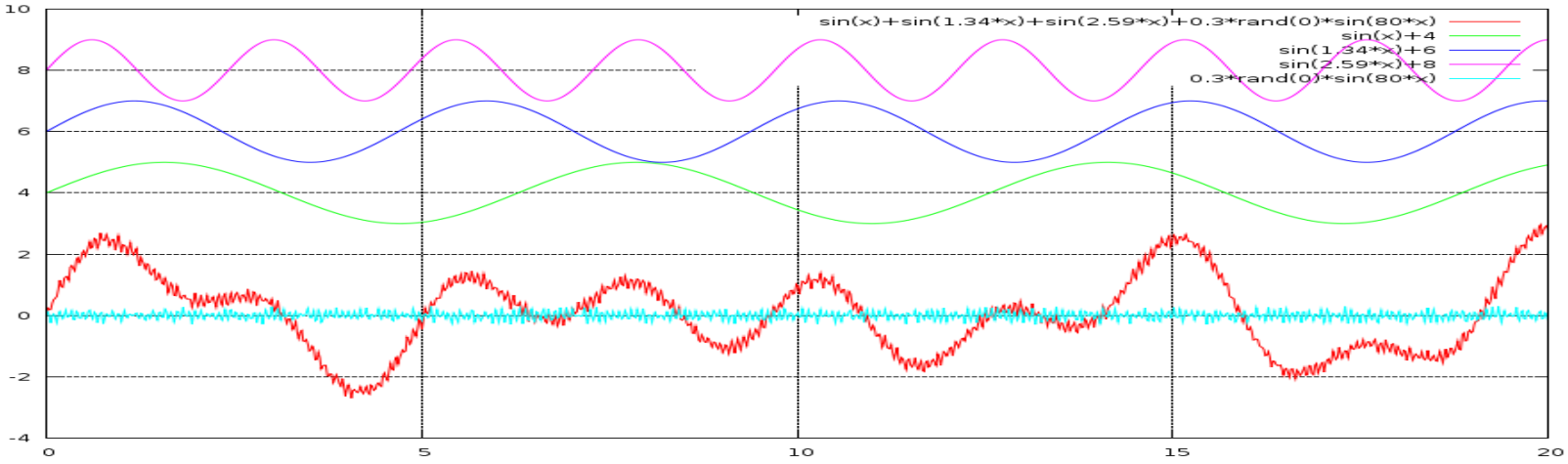
- **NN are inherently clocked**
- **Noise and interference due to wireless communication**

Neural network with one hidden layer:

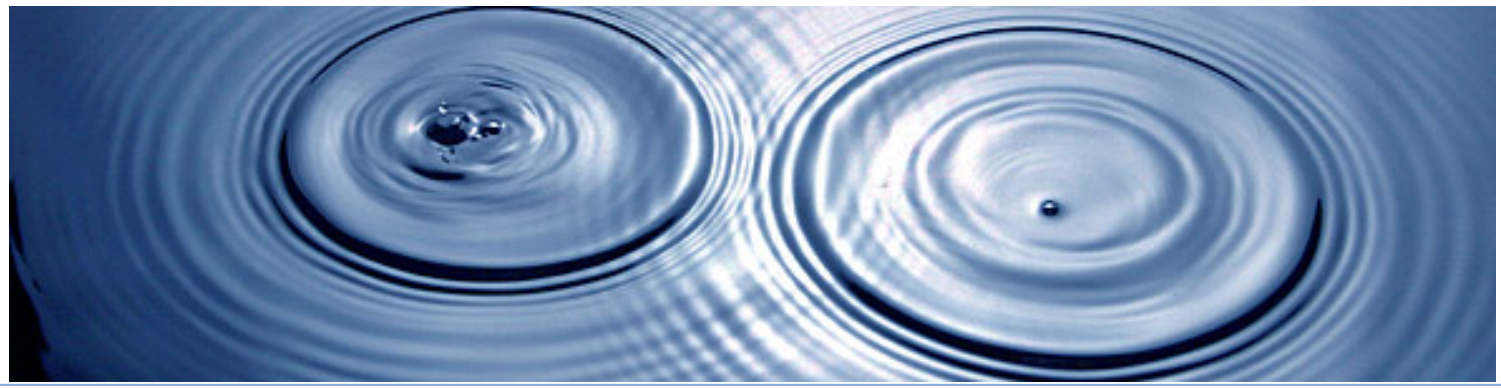
$$y_k(\vec{x}, \vec{w}) = \sigma\left(\sum_{j=1}^{M} w_{jk}^{(2)} h\left(\sum_{i=1}^{D} w_{ij}^{(1)} x_i + w_{0j}^{(1)}\right) + w_{0k}^{(2)}\right)$$

Outline

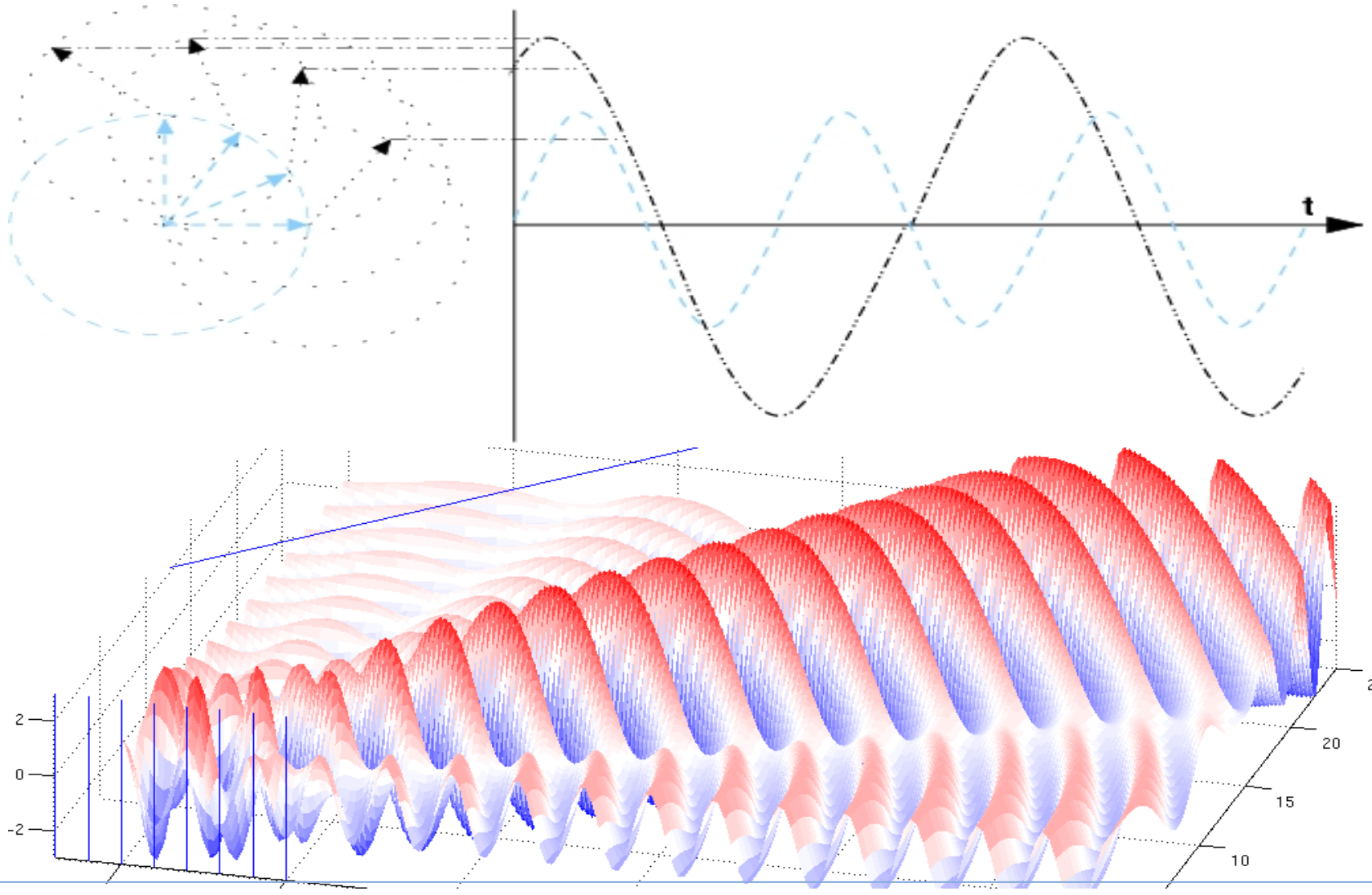
Collaborative transmission for neuronal structures



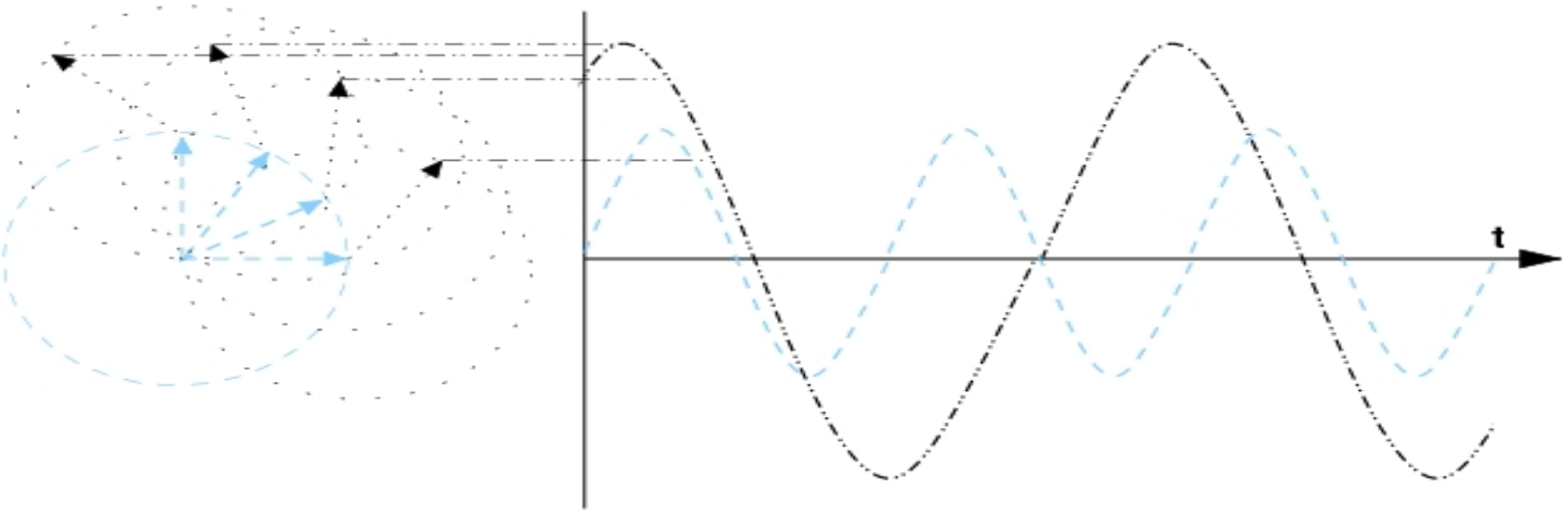
$$\zeta_{\text{sum}} = \sum_{i=1}^{\iota} \Re\left(e^{j(f_i t+\gamma_i)}\right)$$

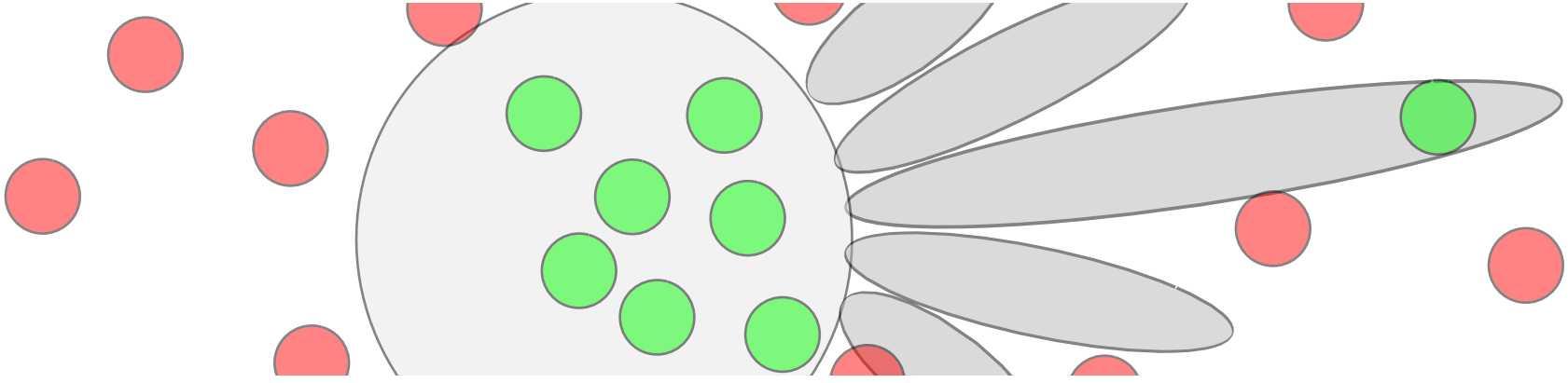


Collaborative transmission for neuronal structures

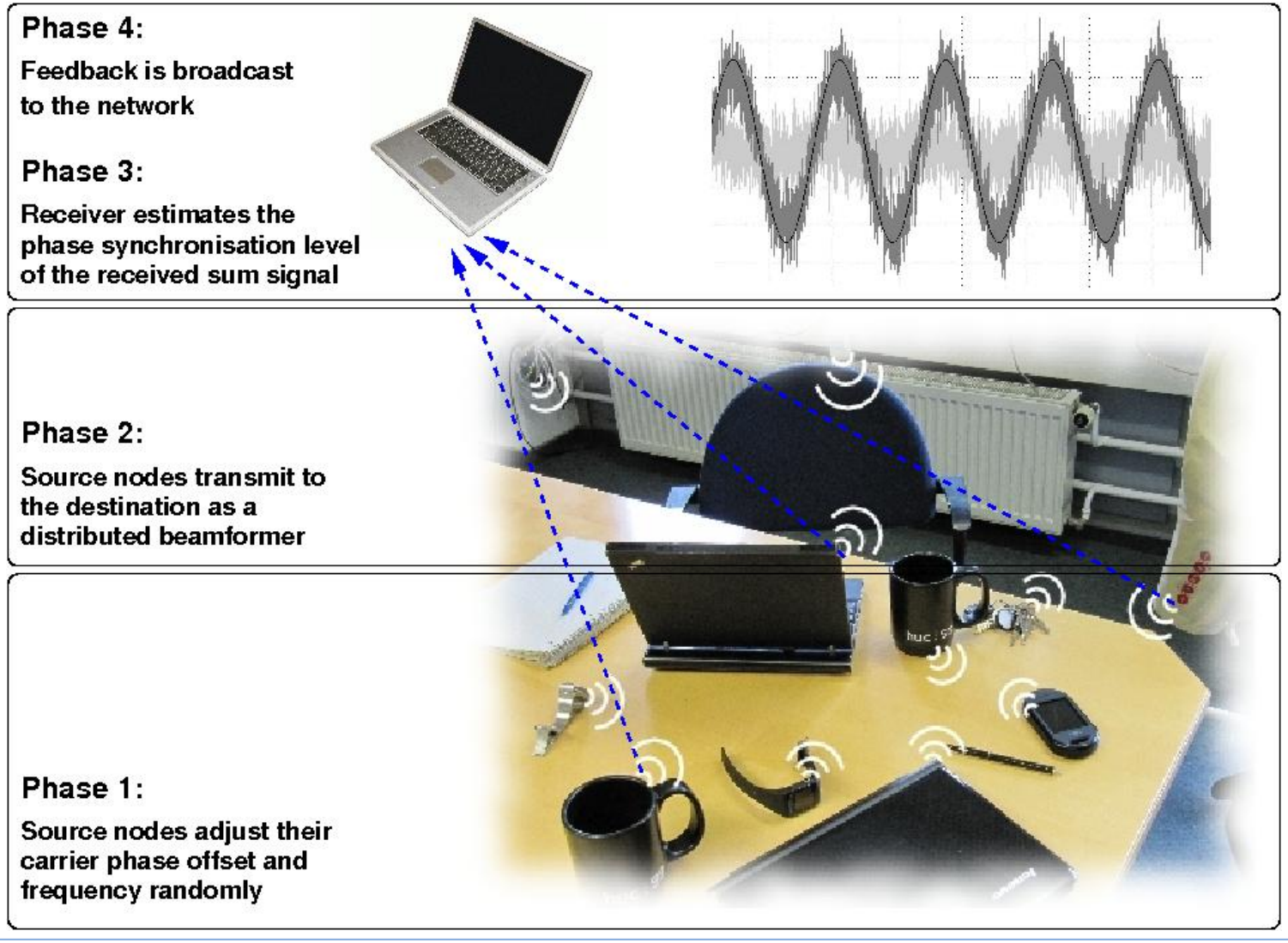


Collaborative transmission for neuronal structures

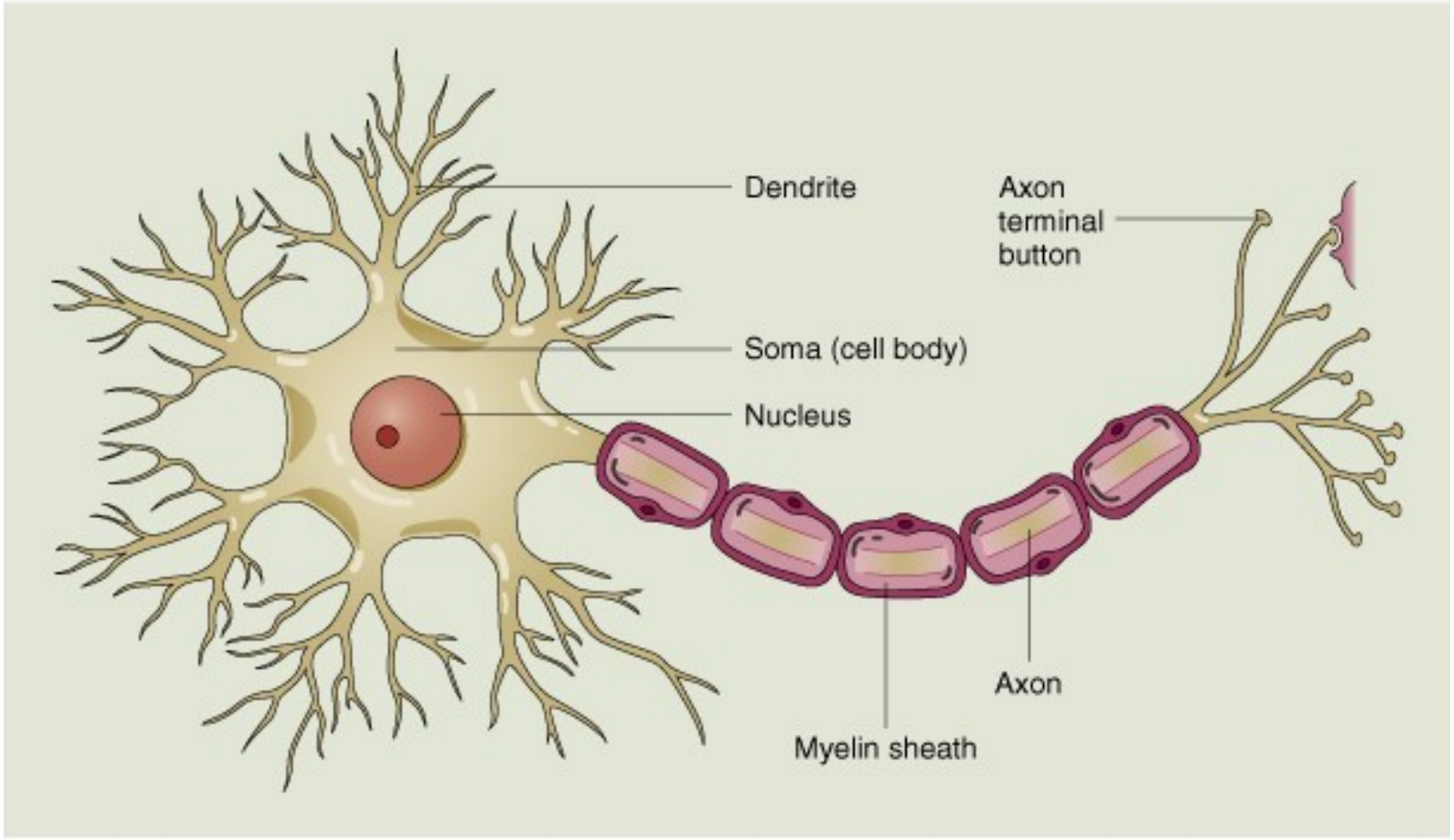




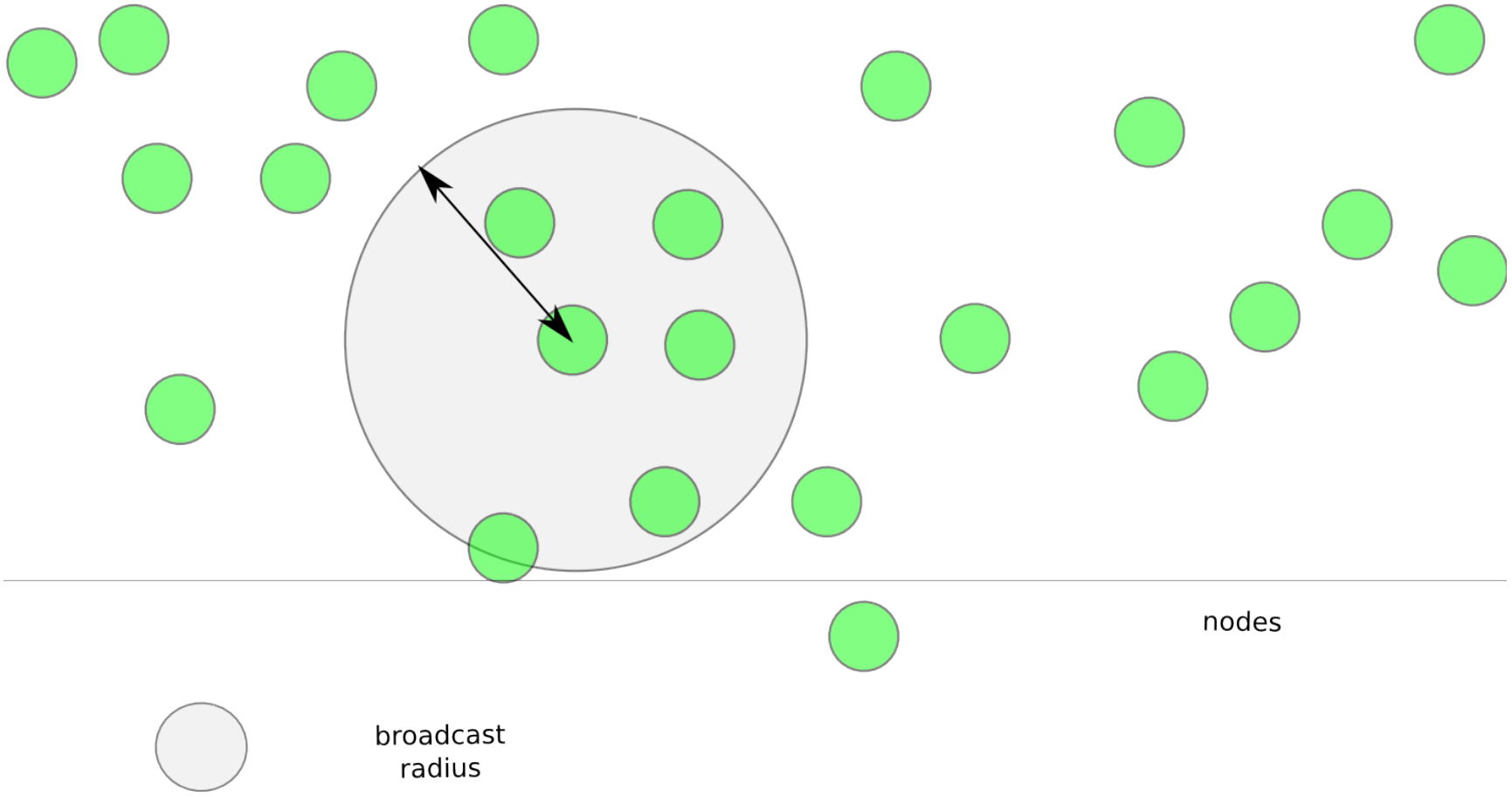
Collaborative transmission for neuronal structures



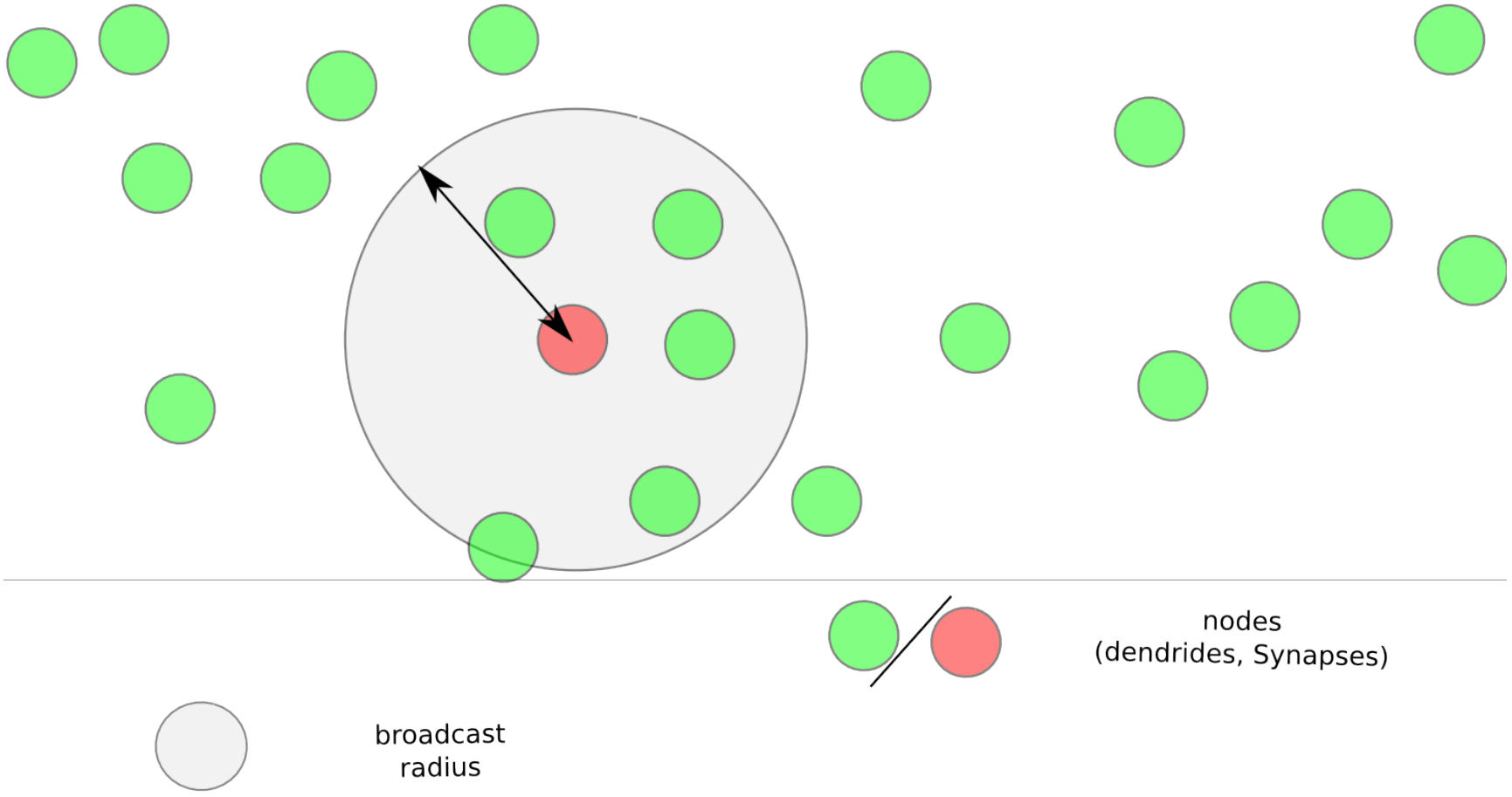
Collaborative transmission for neuronal structures



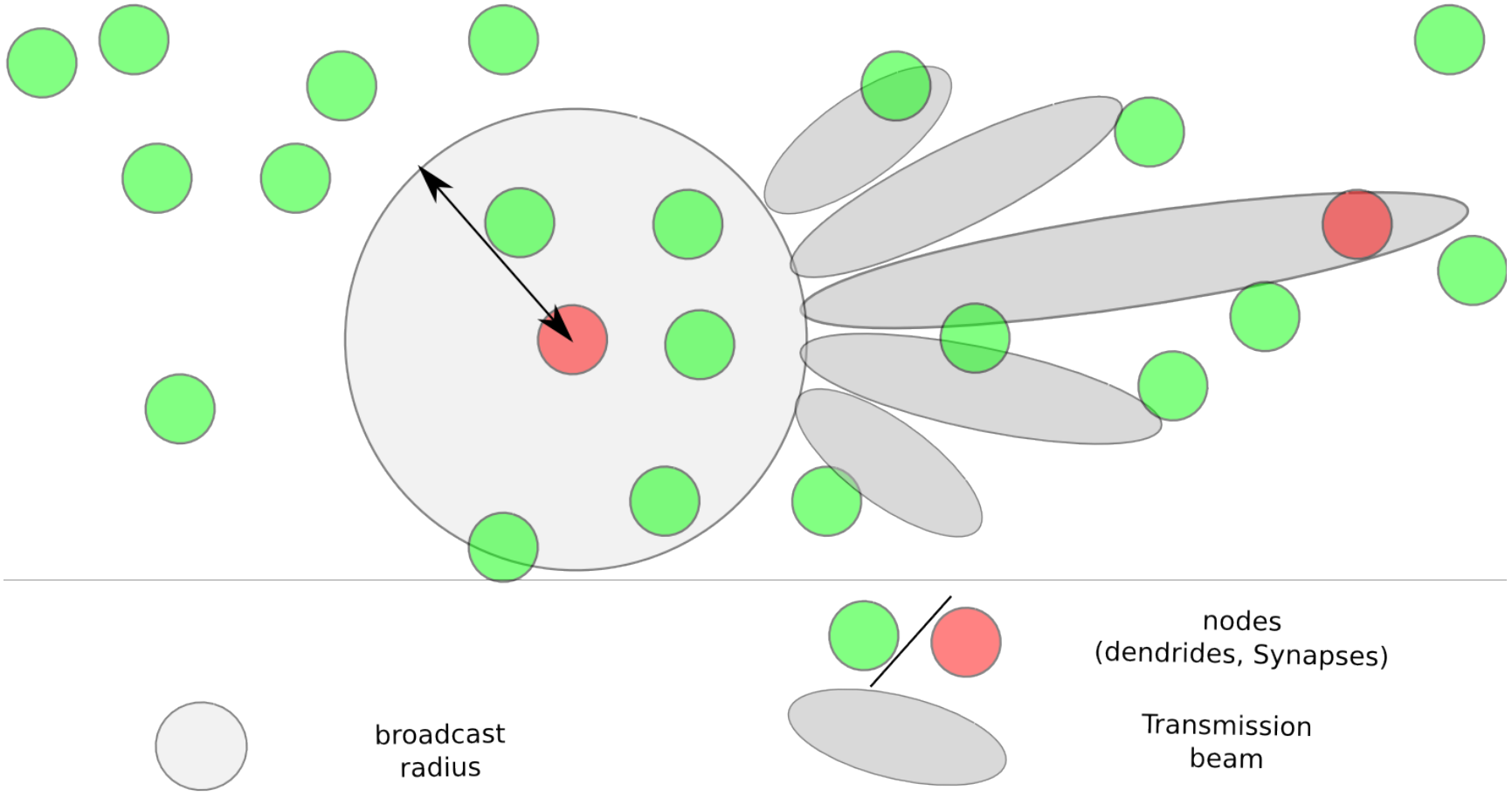
Collaborative transmission for neuronal structures



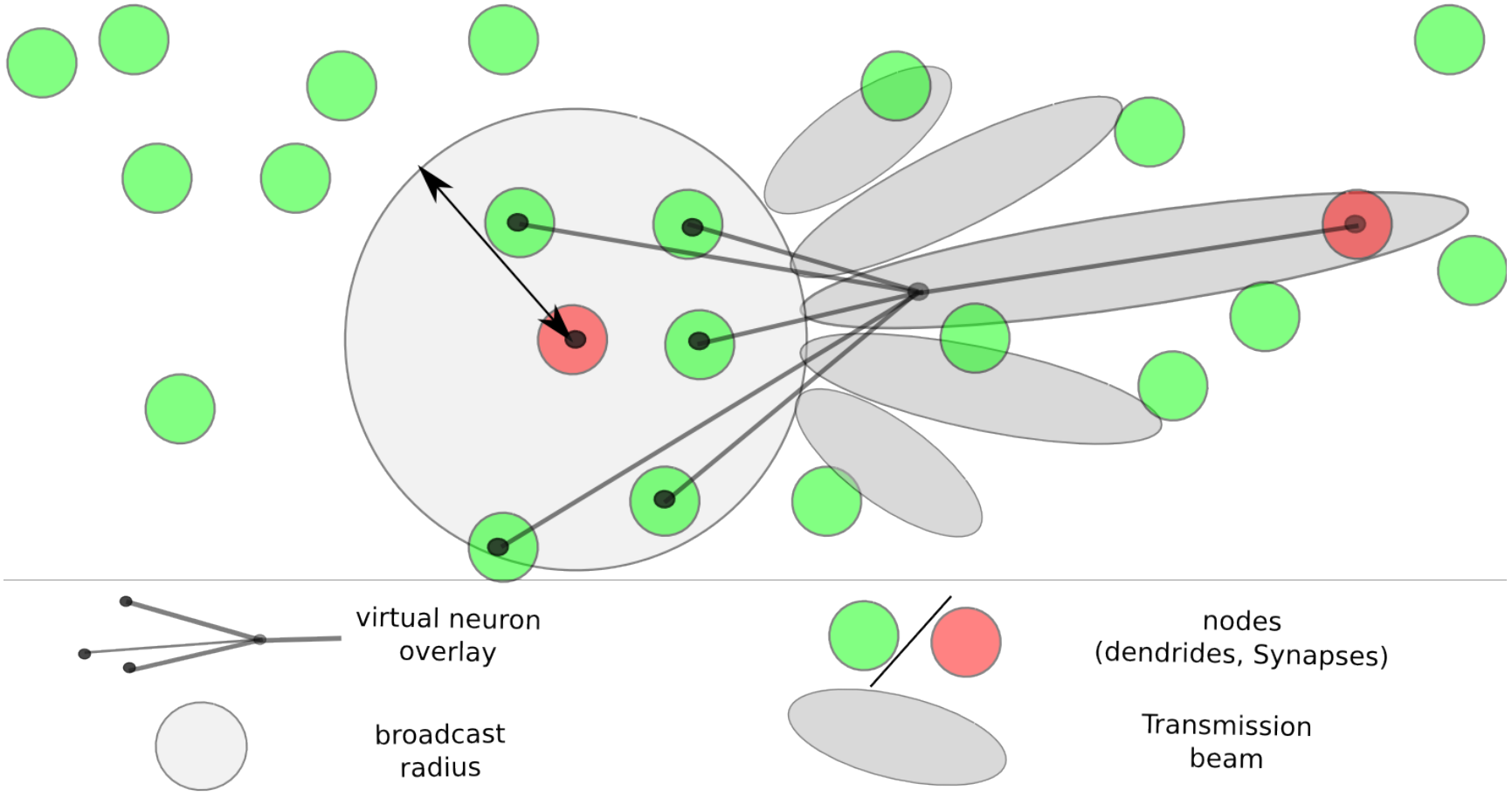
Collaborative transmission for neuronal structures



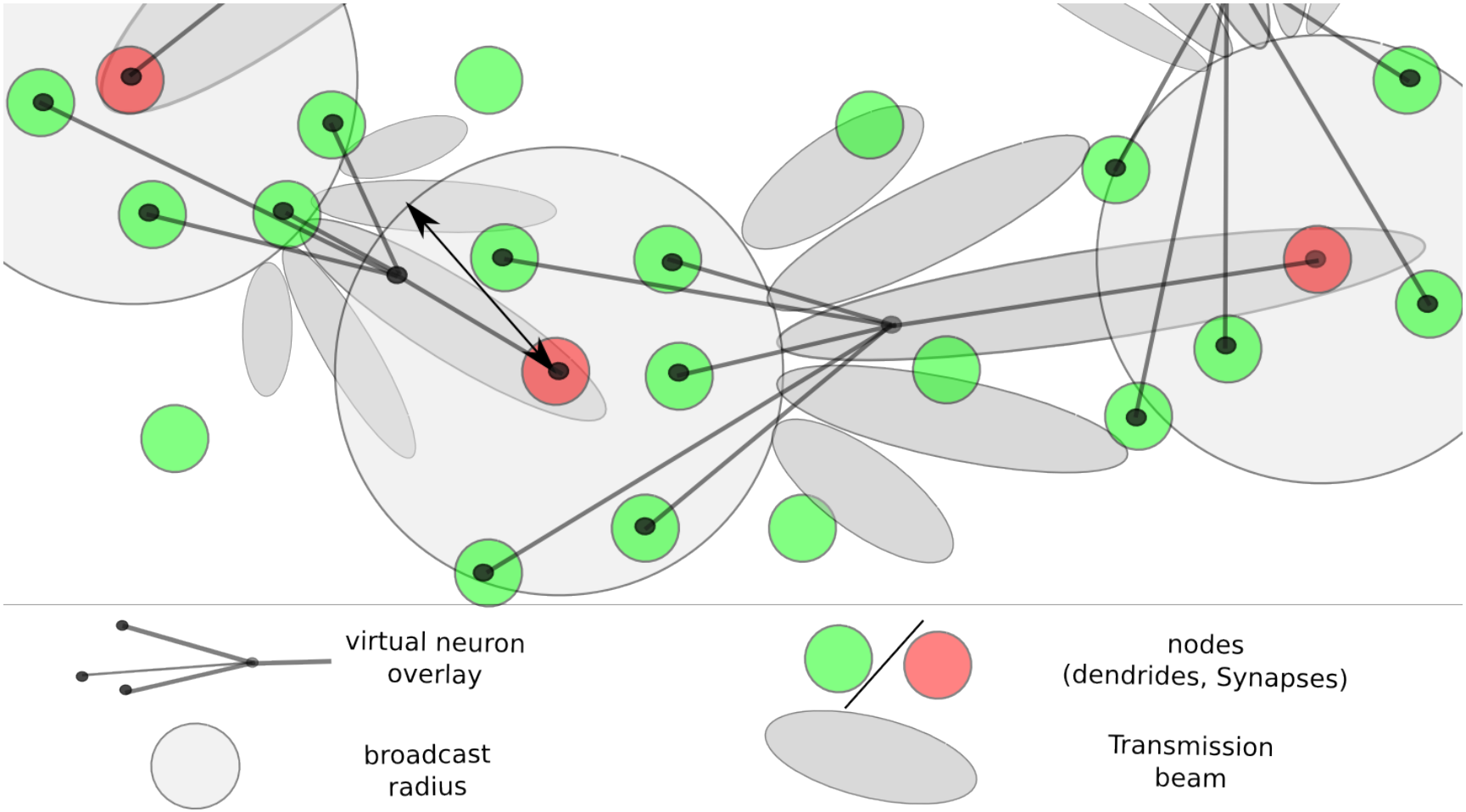
Collaborative transmission for neuronal structures



Collaborative transmission for neuronal structures

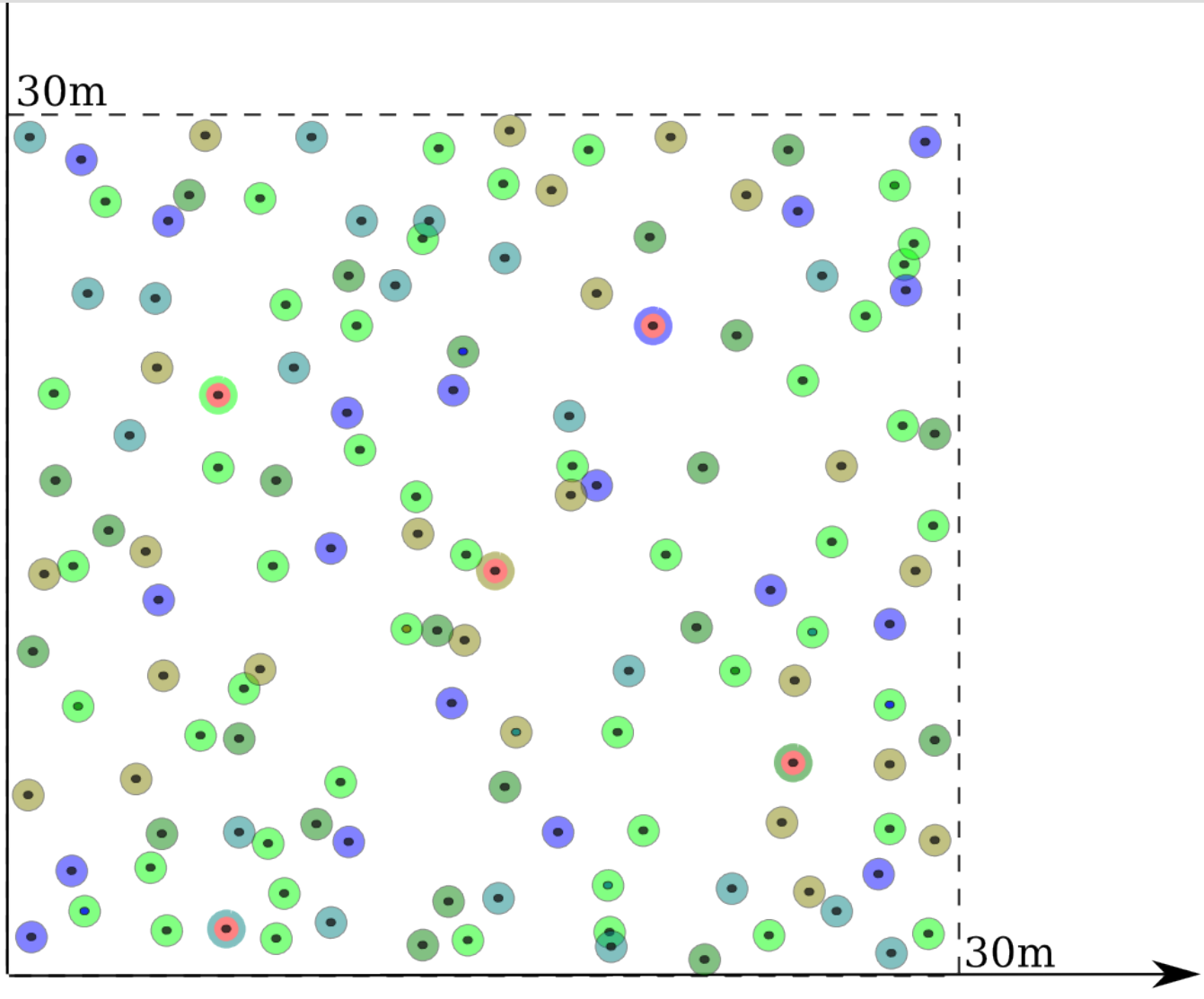


Collaborative transmission for neuronal structures

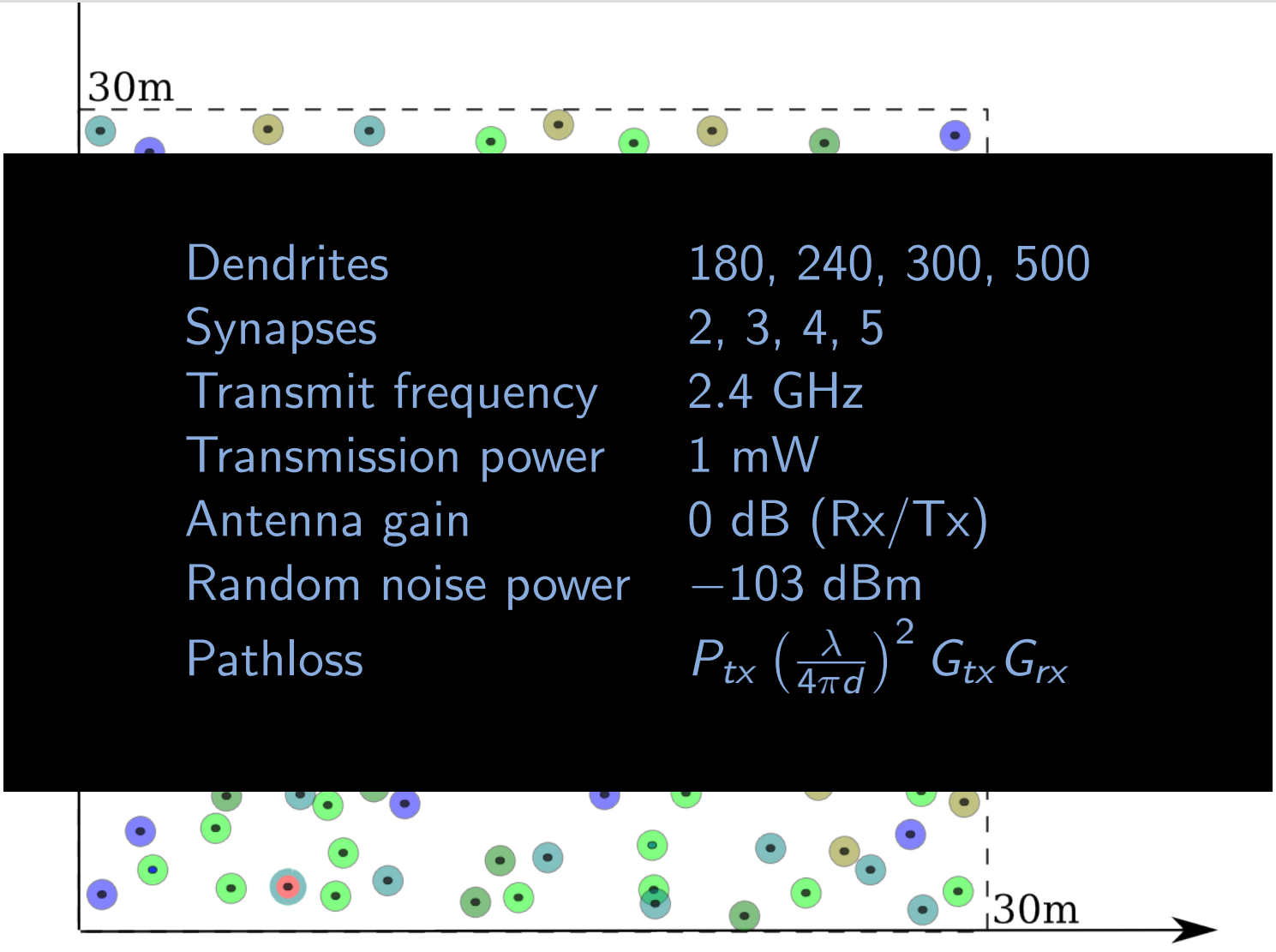


Outline

Results

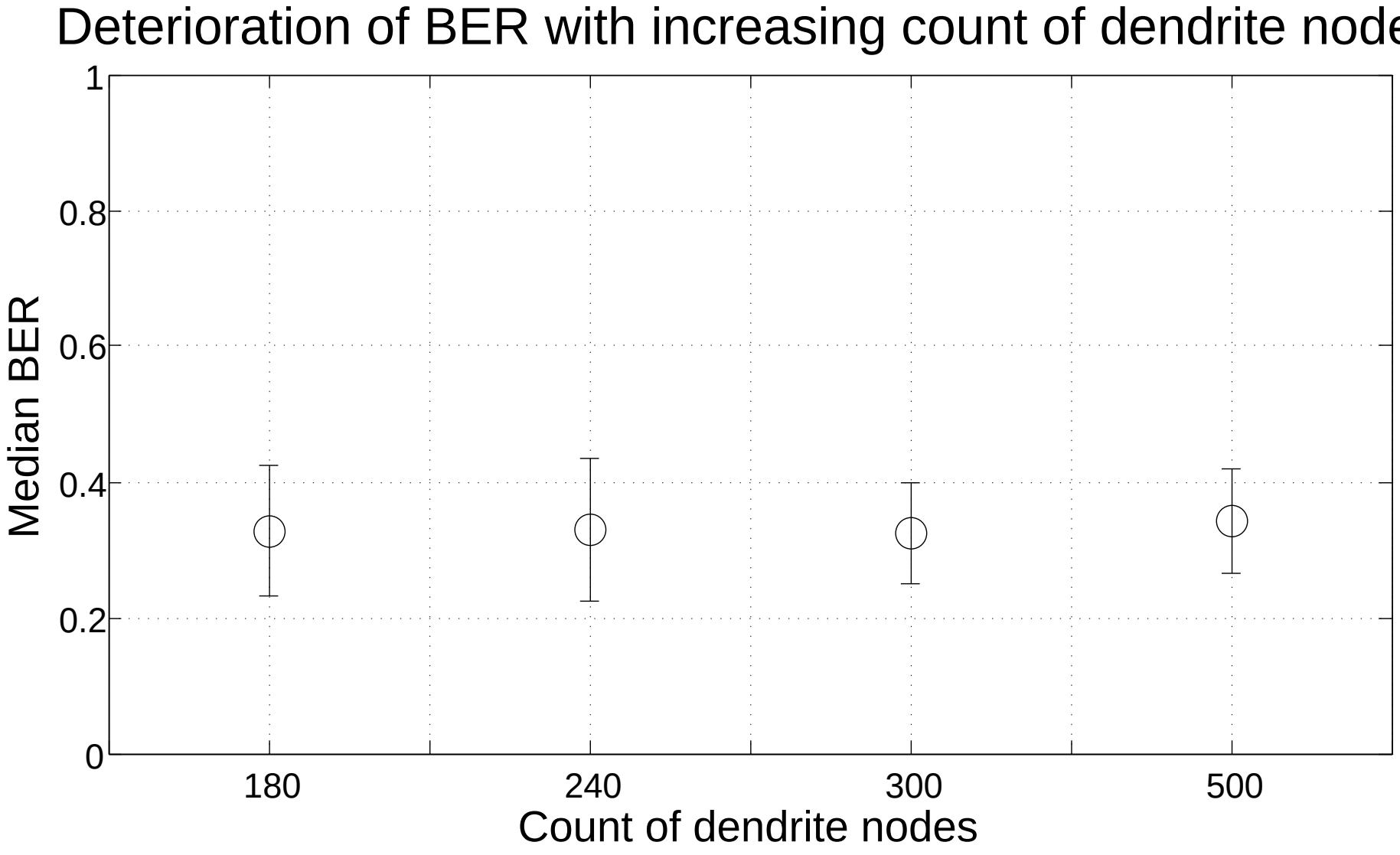


Results

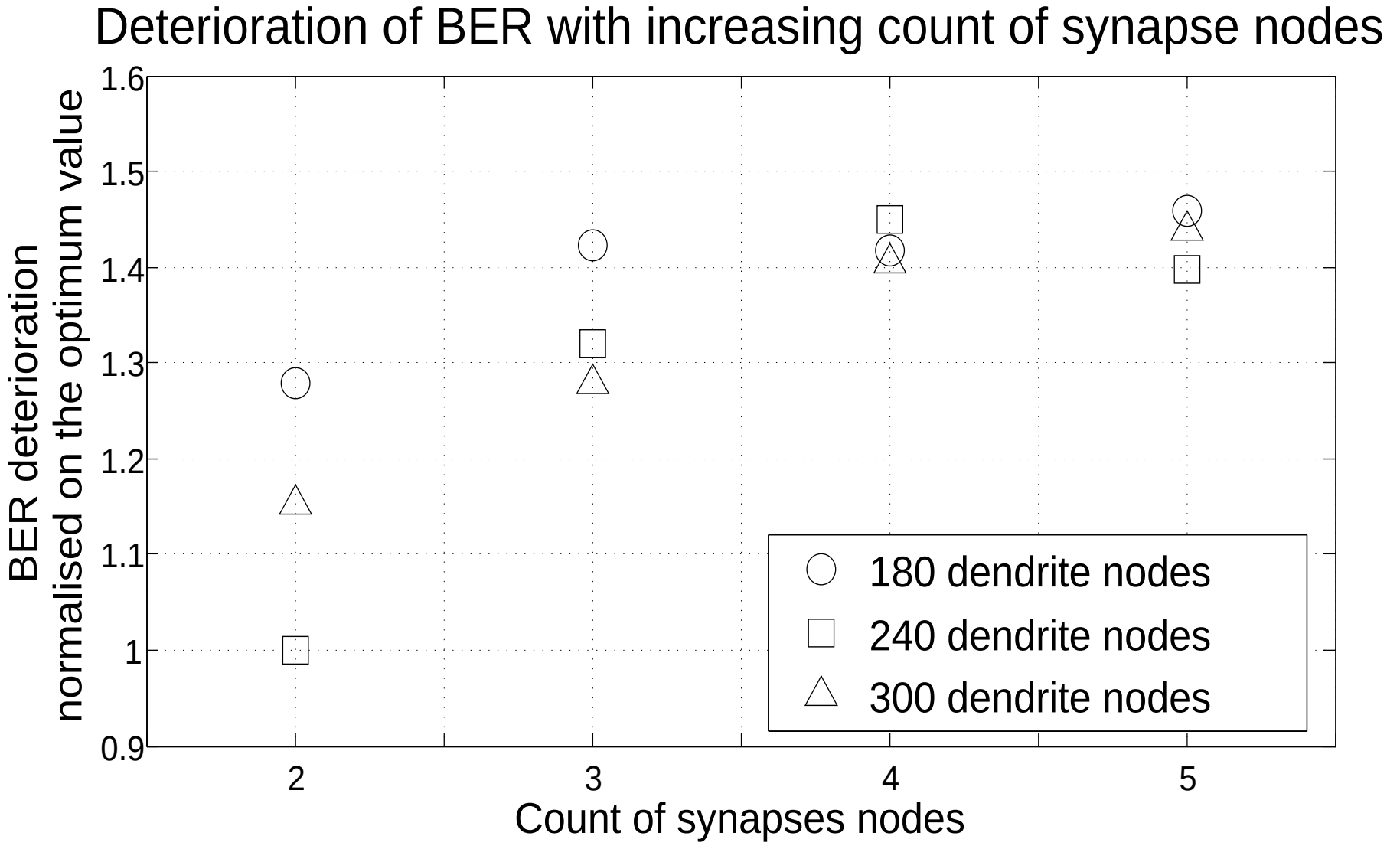


Dendrites	180, 240, 300, 500
Synapses	2, 3, 4, 5
Transmit frequency	2.4 GHz
Transmission power	1 mW
Antenna gain	0 dB (Rx/Tx)
Random noise power	-103 dBm
Pathloss	$P_{tx}\left(\frac{\lambda}{4\pi d}\right)^2 G_{tx} G_{rx}$

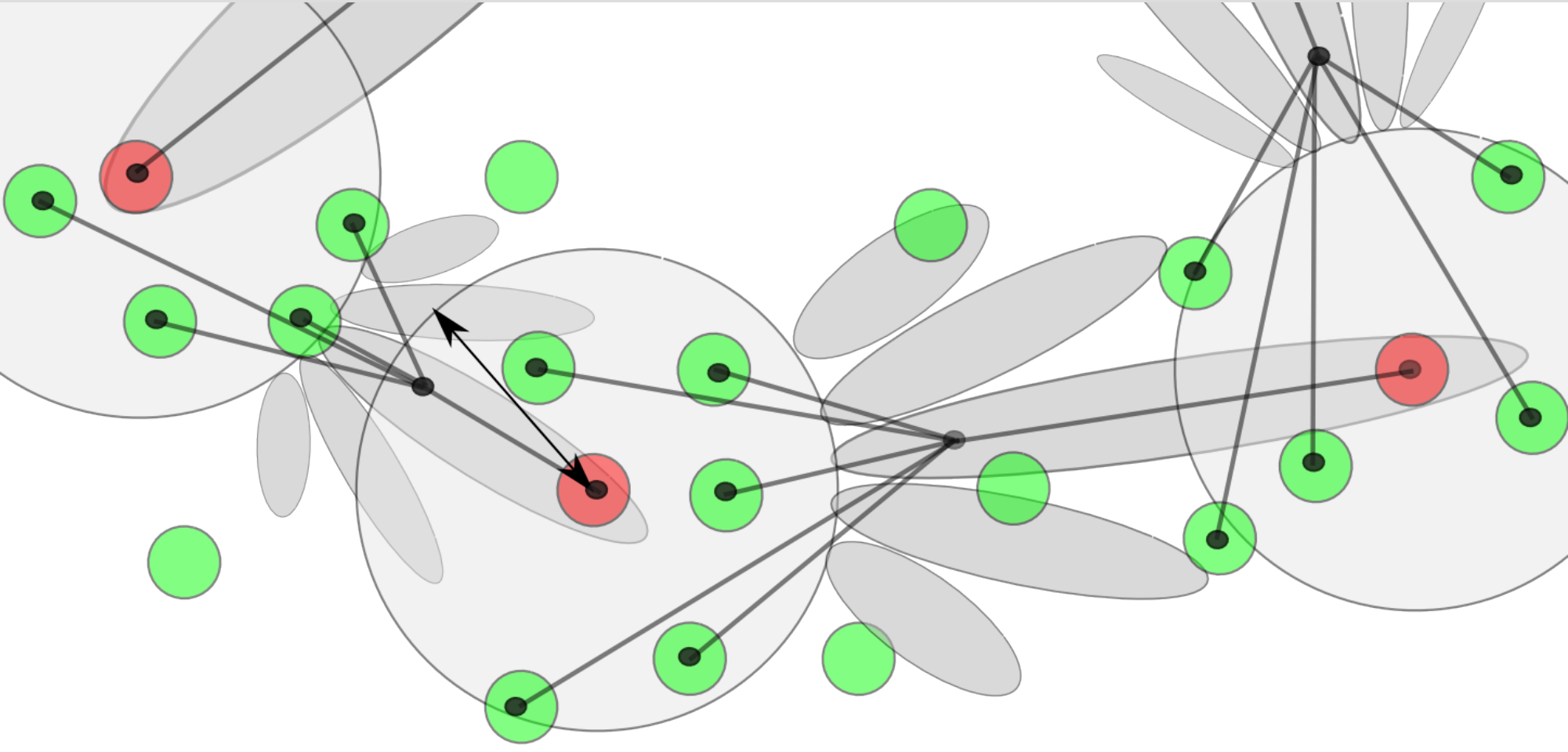
Results


Deterioration of BER with increasing count of dendrite nodes
Median BER
1
0.8
0.6
0.4
0.2
0
180
240
300
500
Count of dendrite nodes

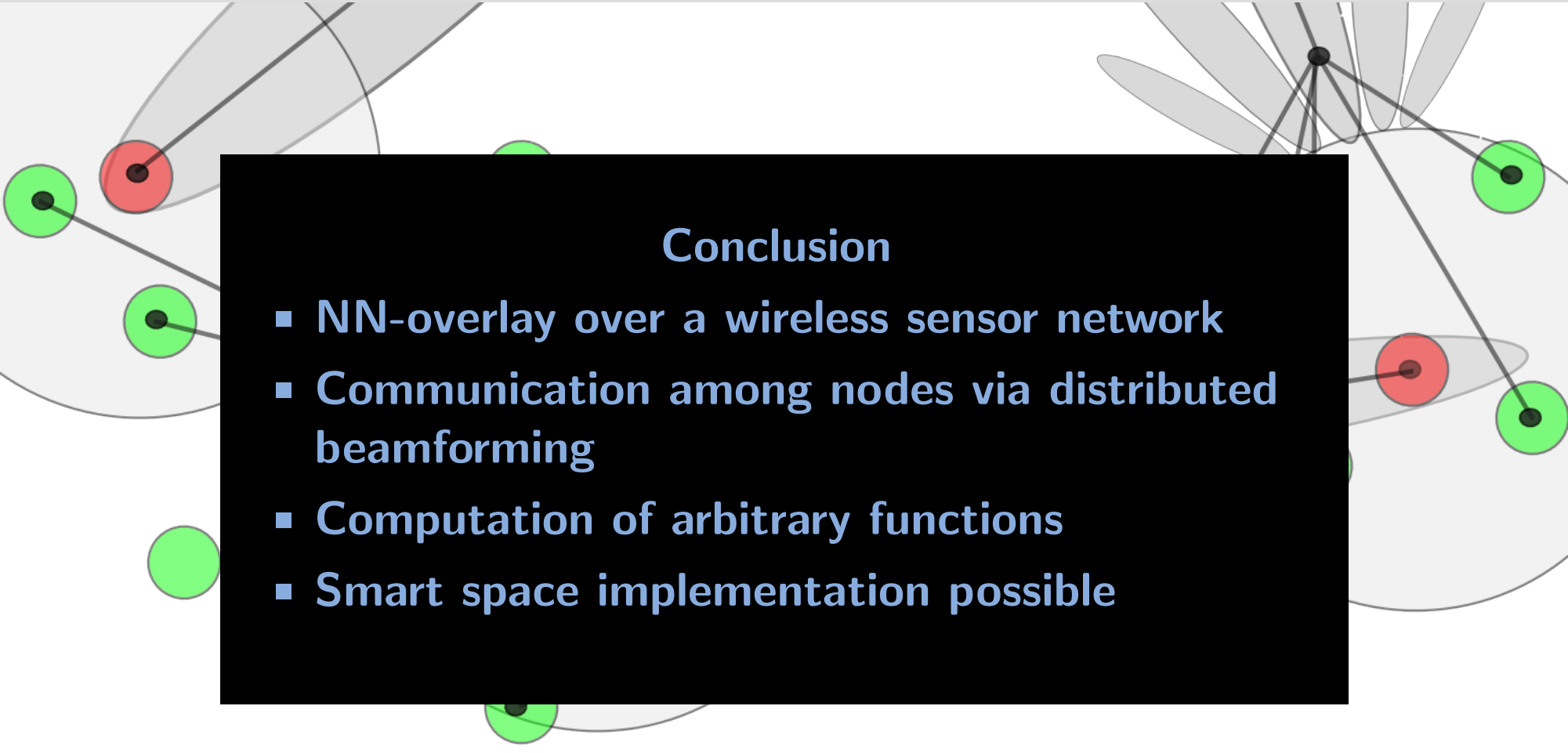
Results


Deterioration of BER with increasing count of synapse nodes
BER deterioration
normalised on the optimum value
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
2
3
4
5
Count of synapses nodes
180 dendrite nodes
240 dendrite nodes
300 dendrite nodes

Conclusion and future work



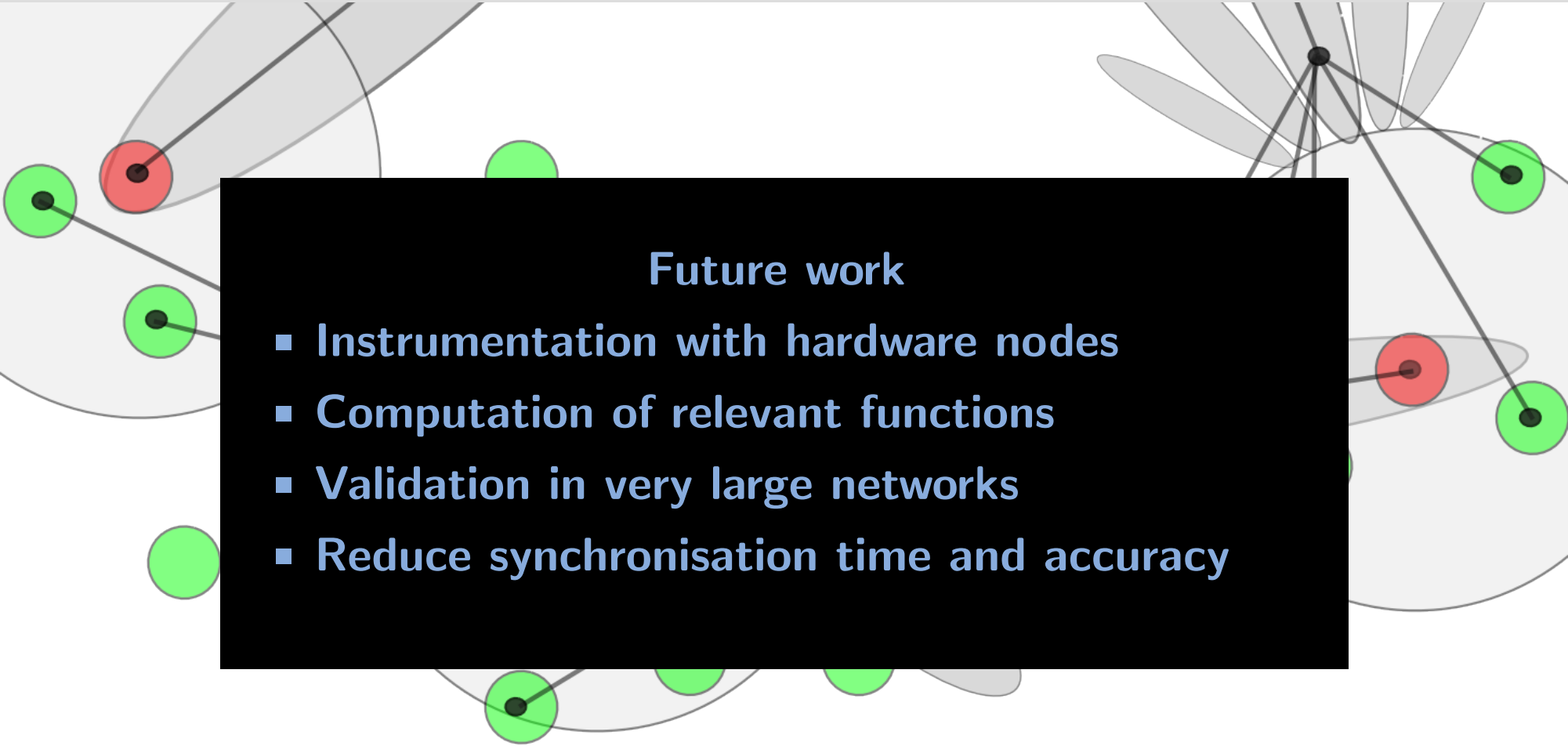
Conclusion and future work



Conclusion

- NN-overlay over a wireless sensor network
- Communication among nodes via distributed beamforming
- Computation of arbitrary functions
- Smart space implementation possible

Conclusion and future work



Future work

- Instrumentation with hardware nodes
- Computation of relevant functions
- Validation in very large networks
- Reduce synchronisation time and accuracy

Questions?

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