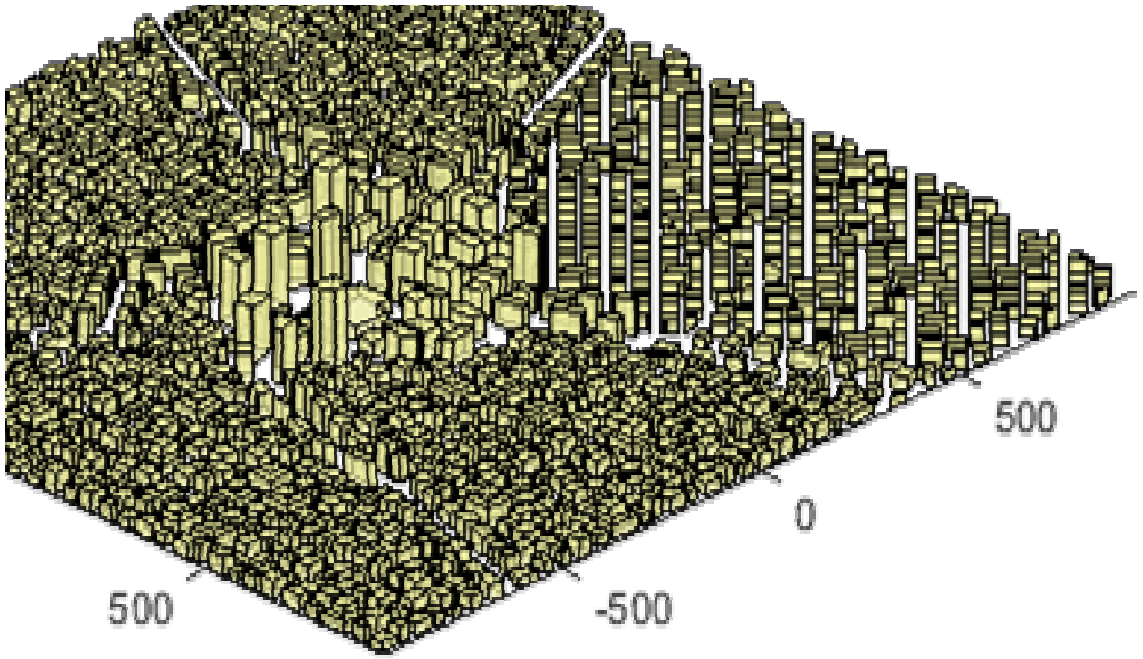

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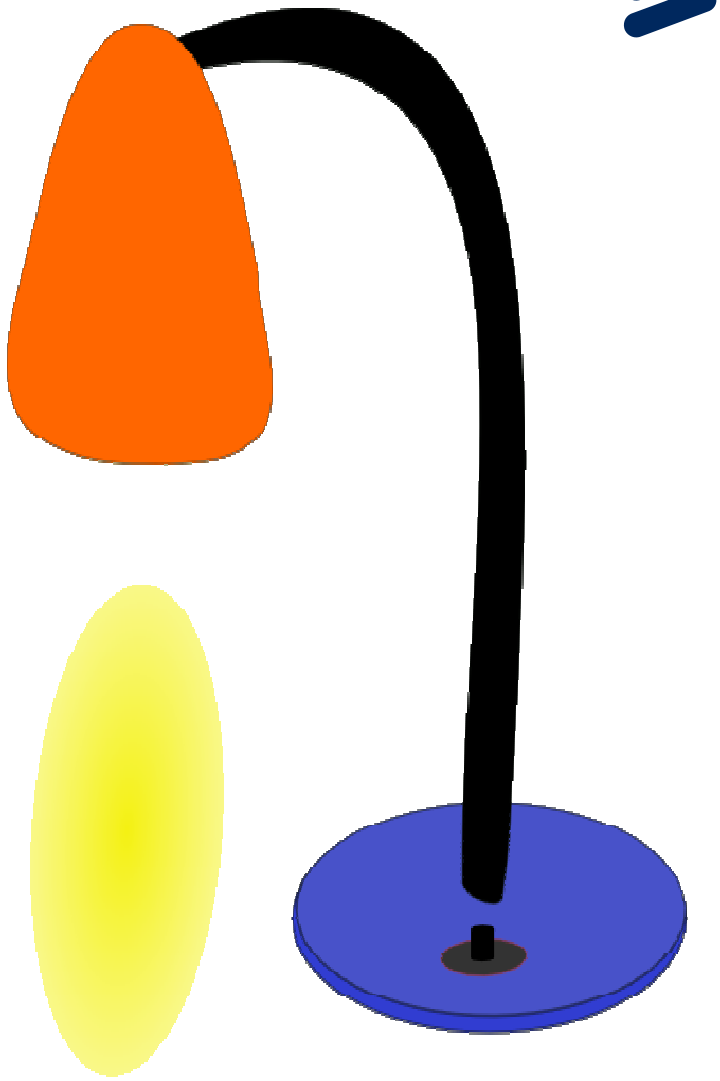
Energy Performance of Heterogeneous LTE Networks

Henrik Forssell, Gunther Auer, Daniel Dianat
Ericsson AB
Stockholm, Sweden

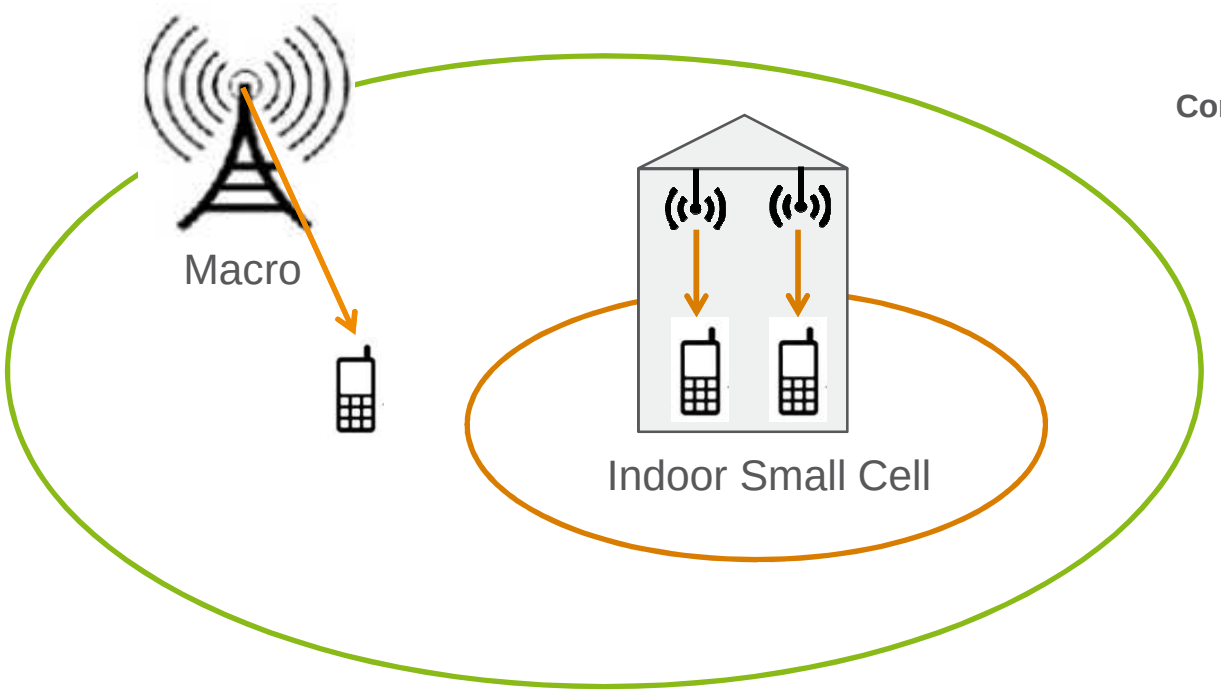
Third ETSI Workshop on ICT Energy Efficiency and Environmental Sustainability
3-5 June 2015
Sophia Antipolis

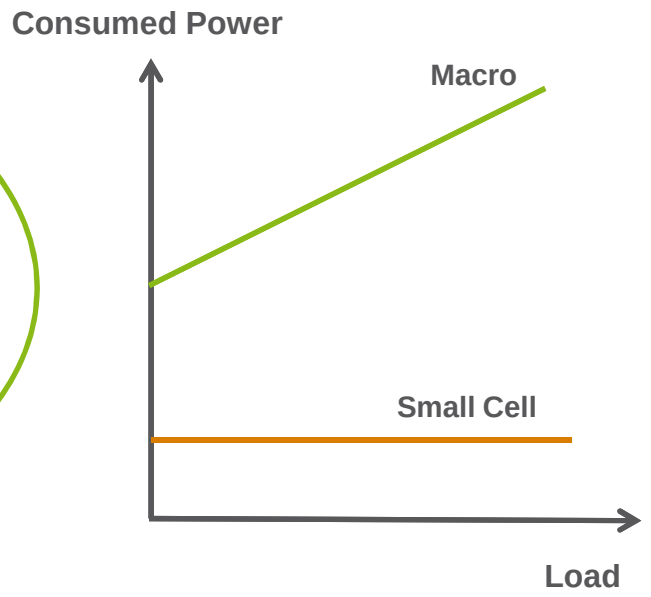
Outline

- Problem formulation
- EARTH base station power model
- Scenario
- Simulation results
- Conclusion



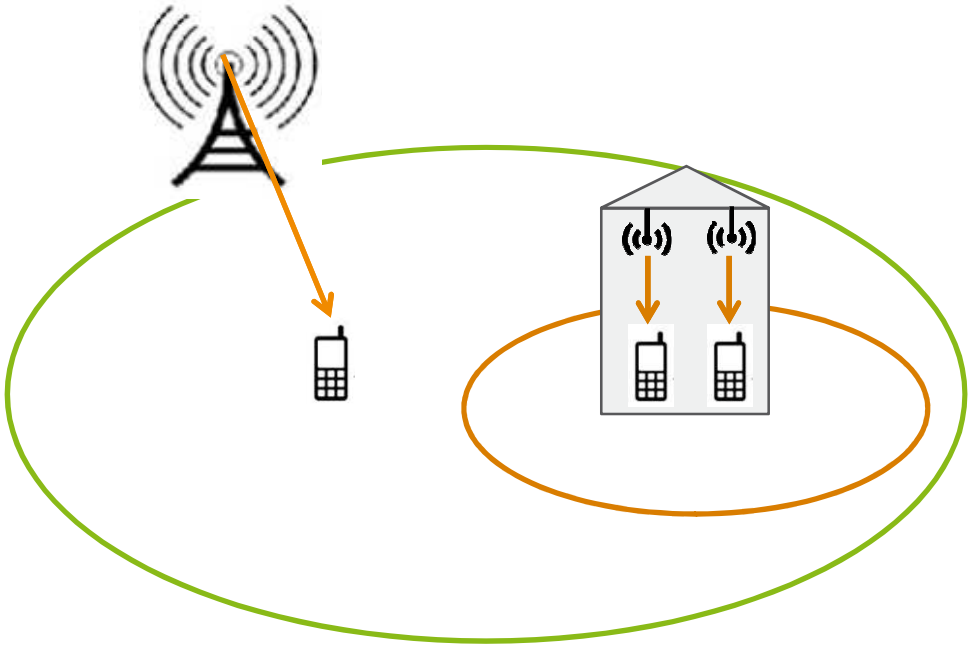
Het Net Scenario



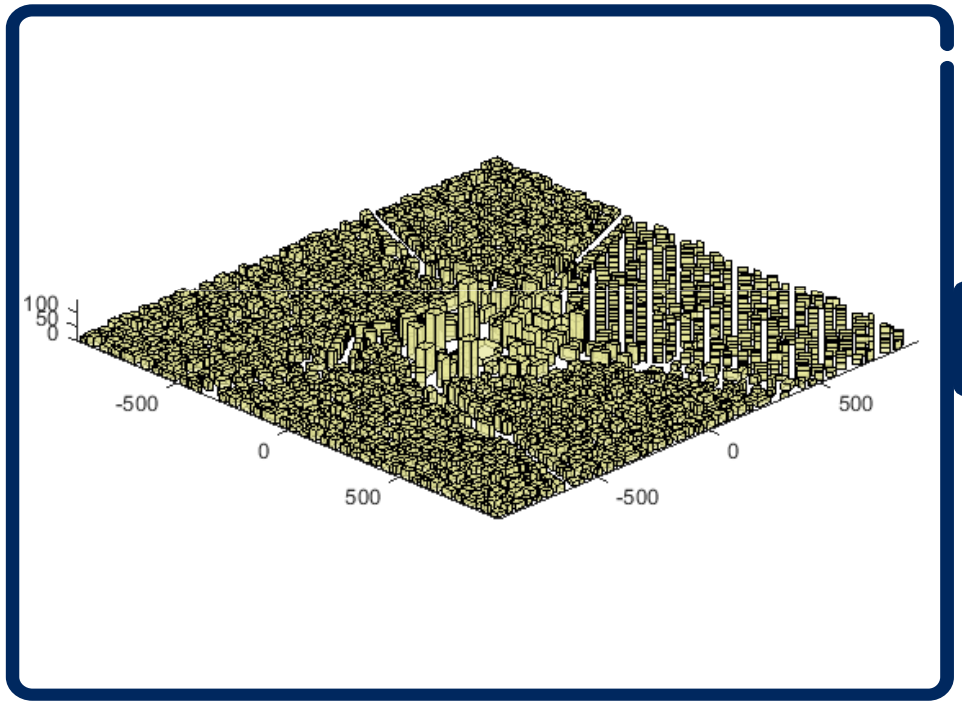


Problem Formulation

- How does het net deployment affect the energy performance?
- Elaborate trade-off between small cell transmit power and node density?
- What is the potential for energy savings using sleep modes?



Energy Performance
Assessment Methodology



Post Processing

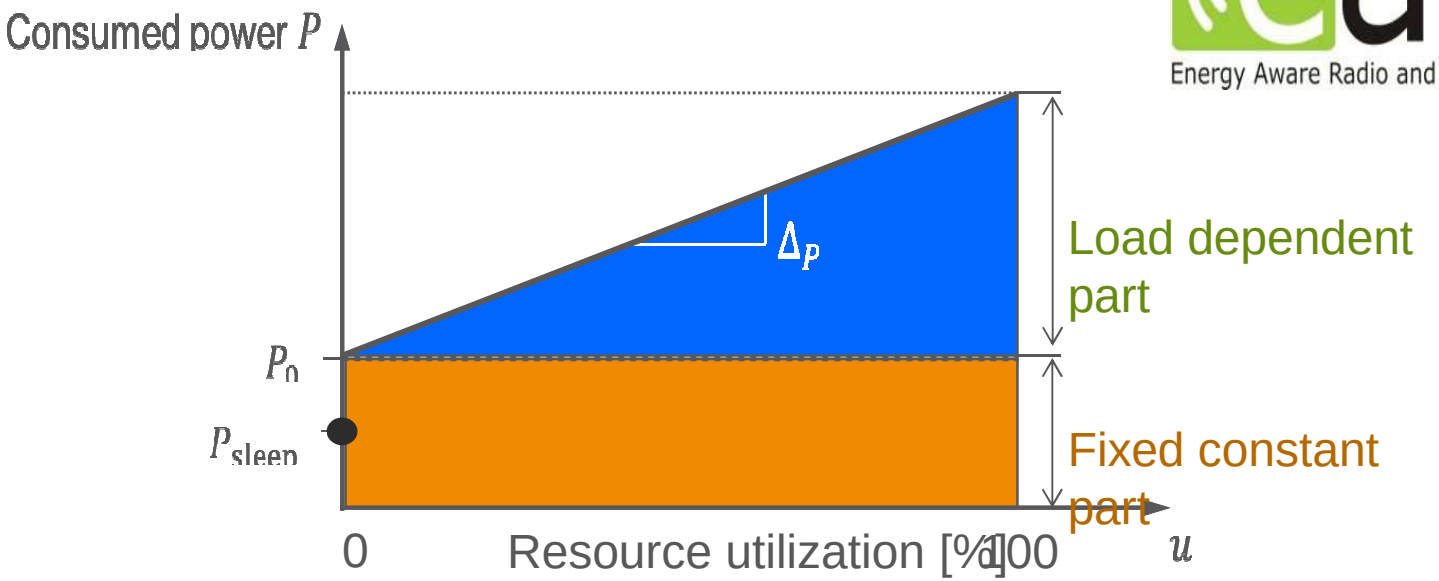
Power Consumption Models

Energy Saving techniques

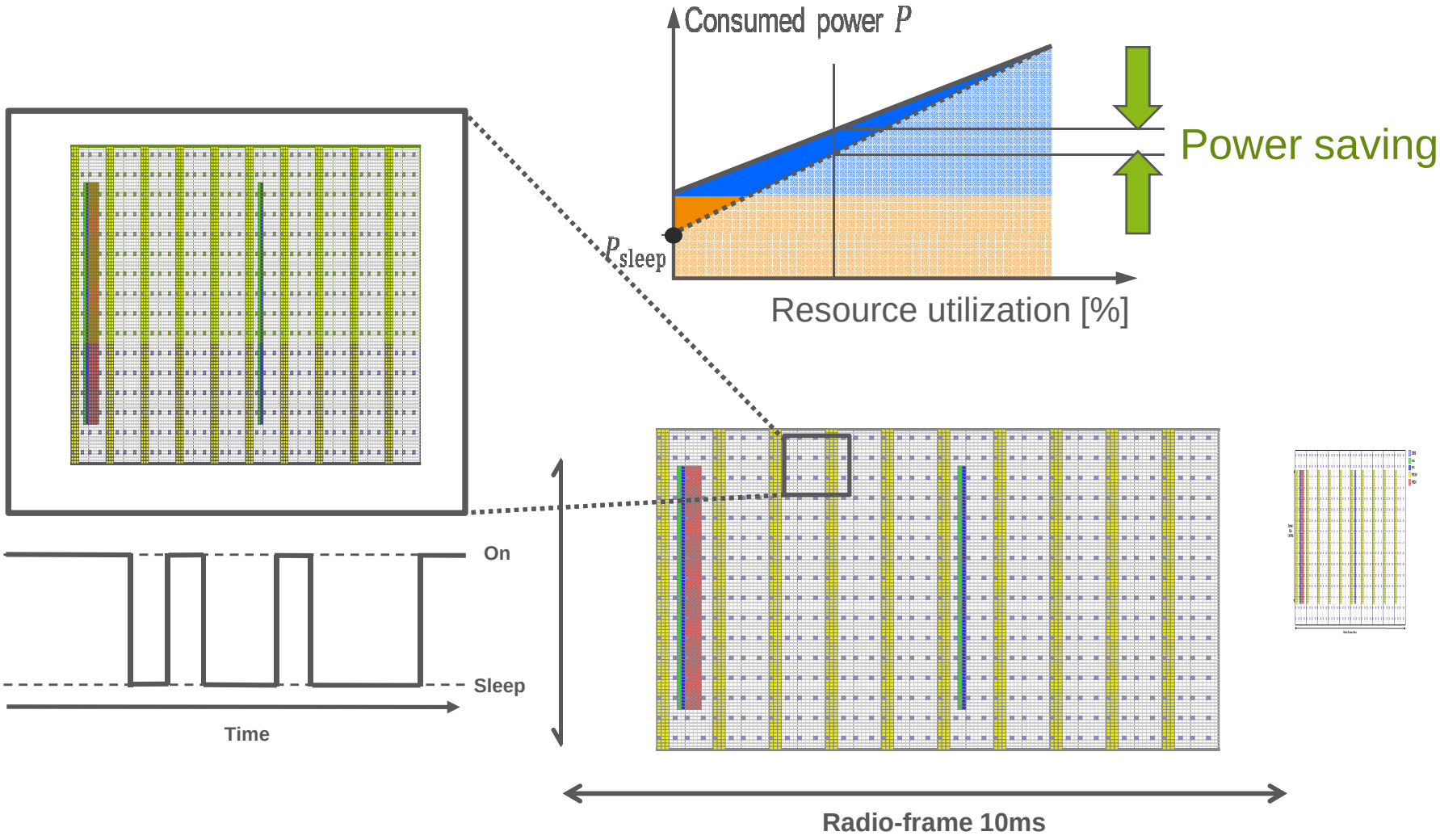
EARTH Base Station Power Model

- Linear power model: $P(u) = P_0 + \Delta_P \, P_{max} \, u$
  - $P_{\max}$ maximum transmit power (per transmit antenna)
  - P_0 consumed power at zero load
  - P_{sleep} consumed power when in sleep mode
  - Δ_P slope of load dependent power consumption

Energy Aware Radio and neTwork tecHnologies

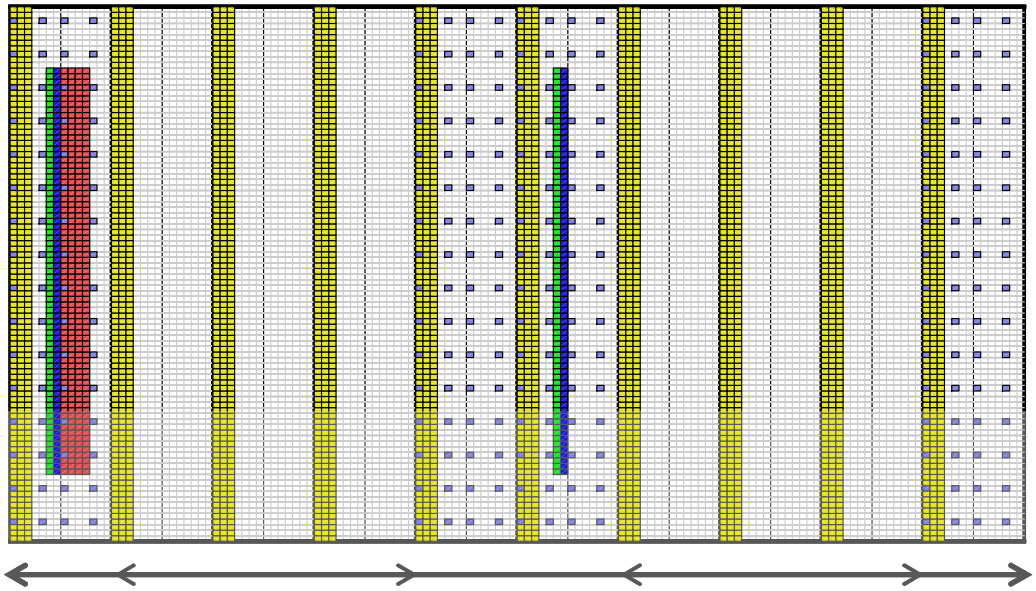


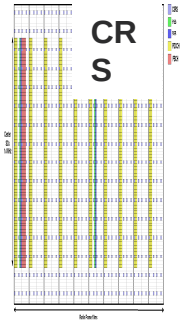
Discontinuous Transmission

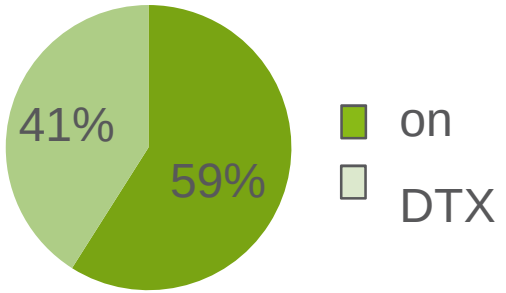


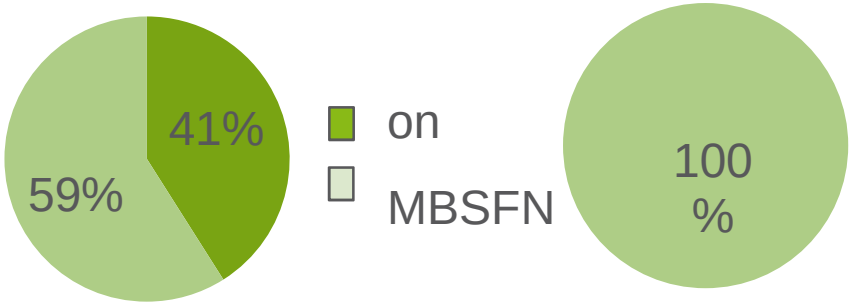
Discontinuous Transmission

- Micro DTX
- MBSFN DTX
- Lean Carrier DTX



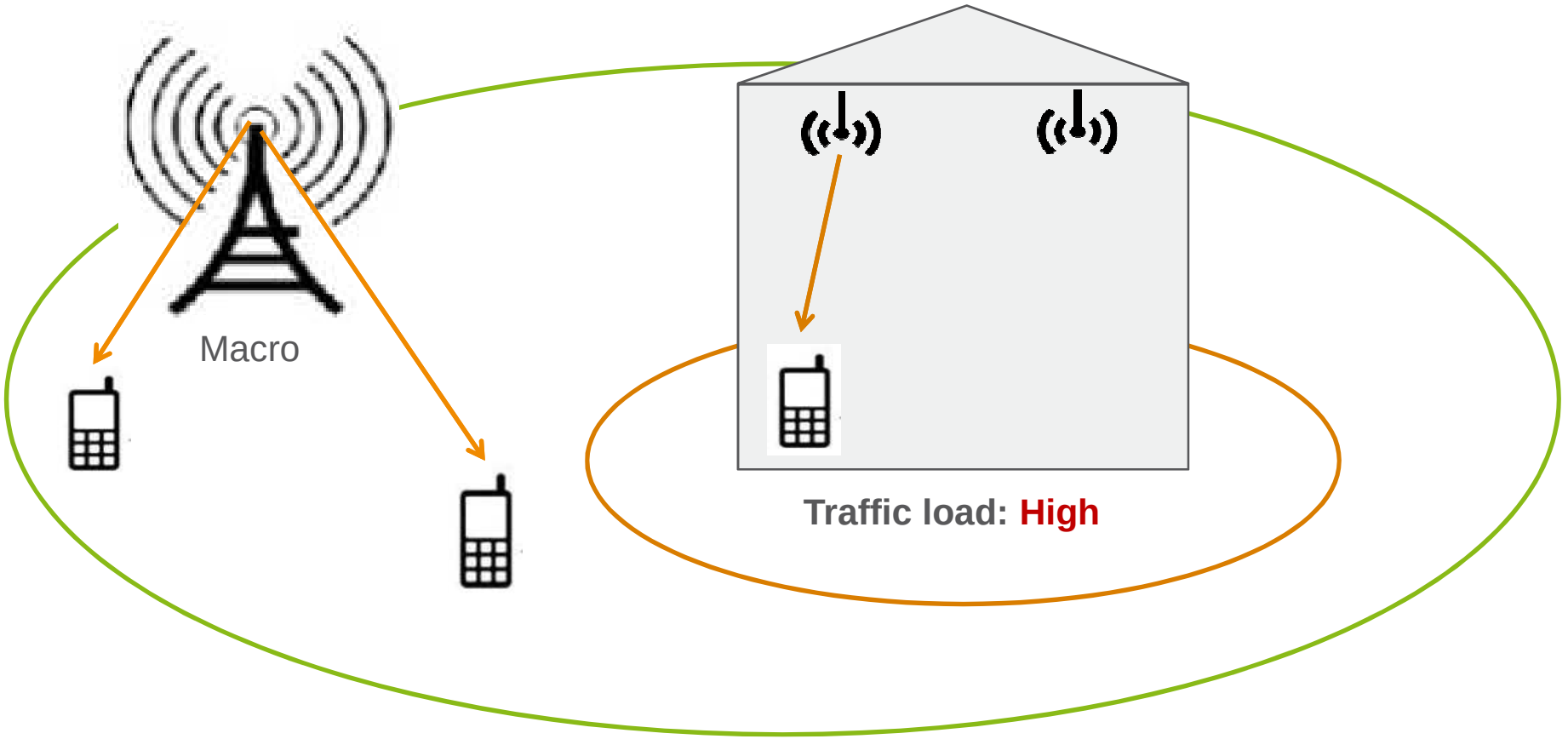




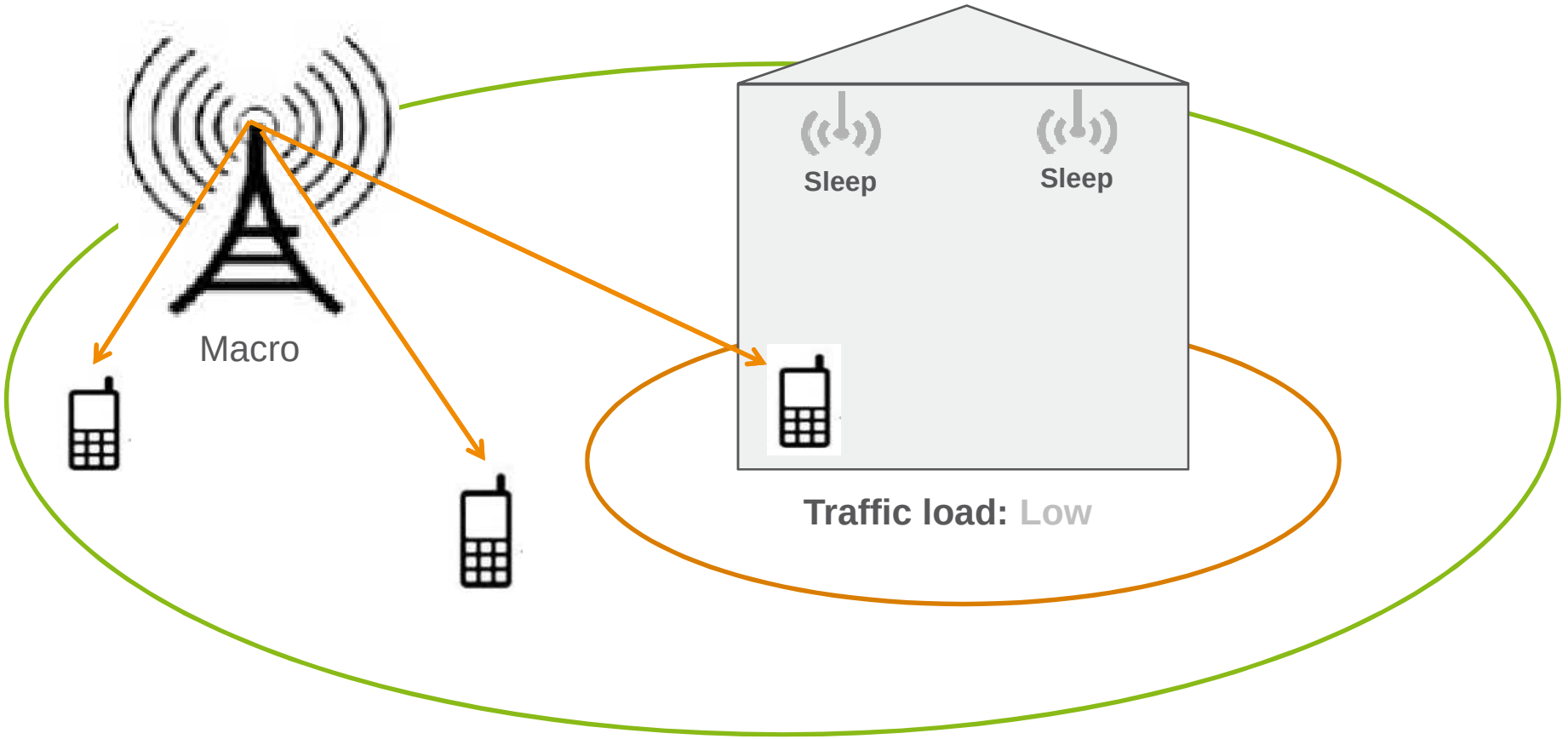


MBSFN: Multi-cast and Broadcast Single Frequency Network

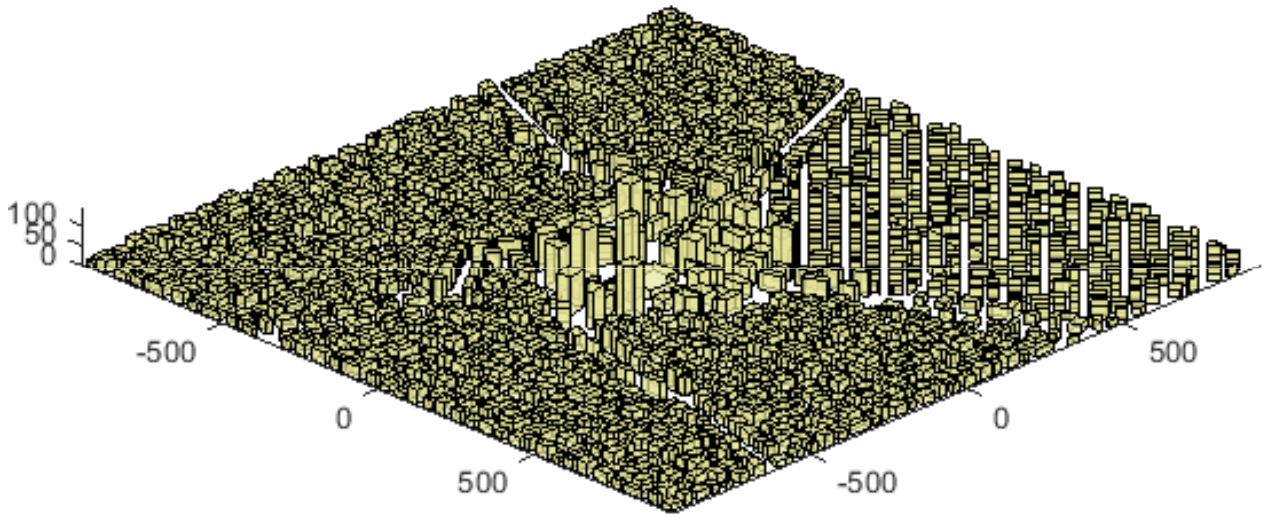
Small Cell Sleep Modes



Small Cell Sleep Modes



Simulation Scenario

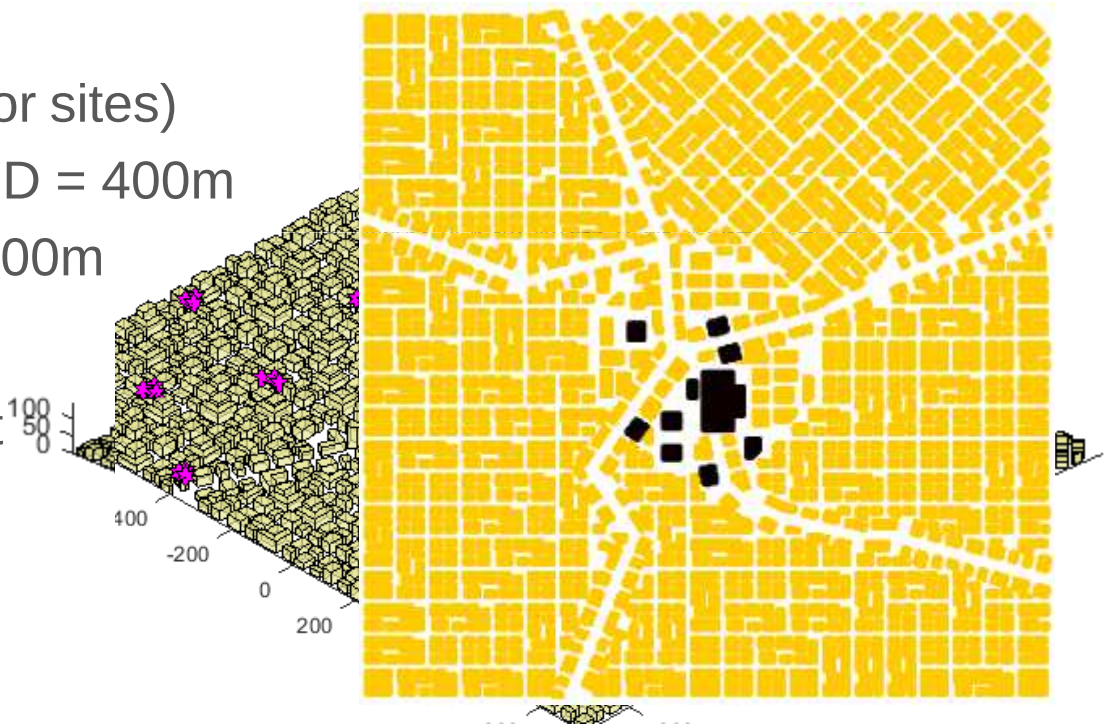


Simulation Scenario

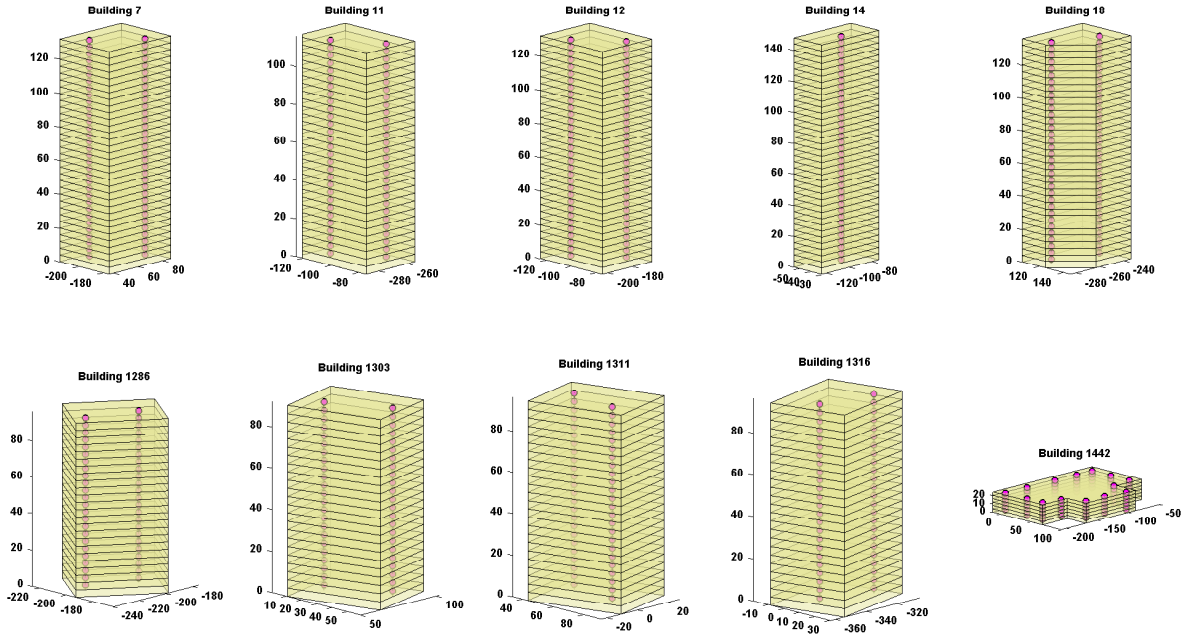
- Asian Scenario
  - Dense urban (inspired by Tokyo and Seoul)

Macro deployment (3-sector sites)

  - Surrounding macro ISD = 400m
  - Center macro ISD = 200m
- 10 largest buildings
  - Small cell deployment

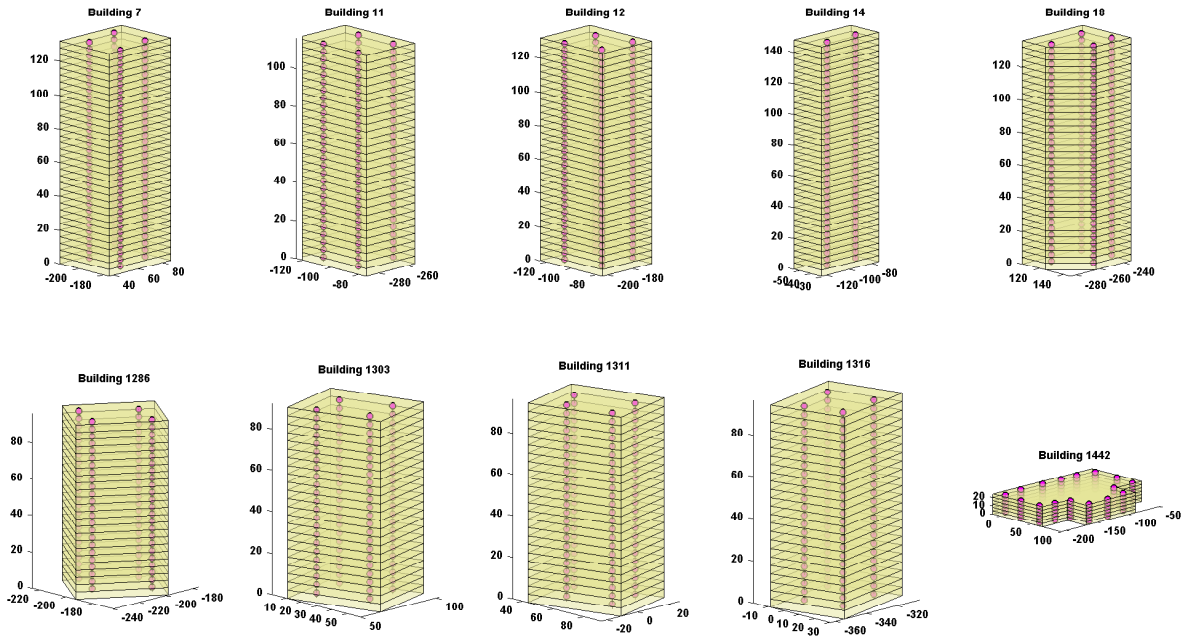


Small Cell Deployment



Deployment Type	Sparse
Coverage area per node	1000 m^2
Number of nodes	x

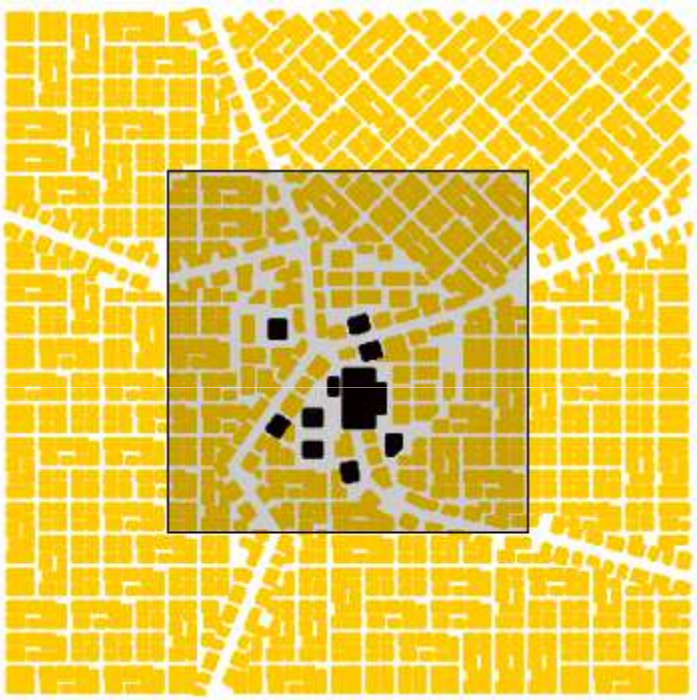
Small Cell Deployment



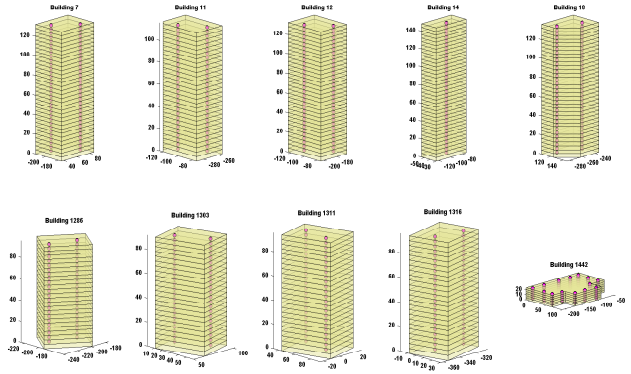
Deployment Type	Dense
Coverage area per node	600 m^2
Number of nodes	x

Result Evaluation

- Center area polygon
  - Area: 1 km^2
  - Contains high-rise center area

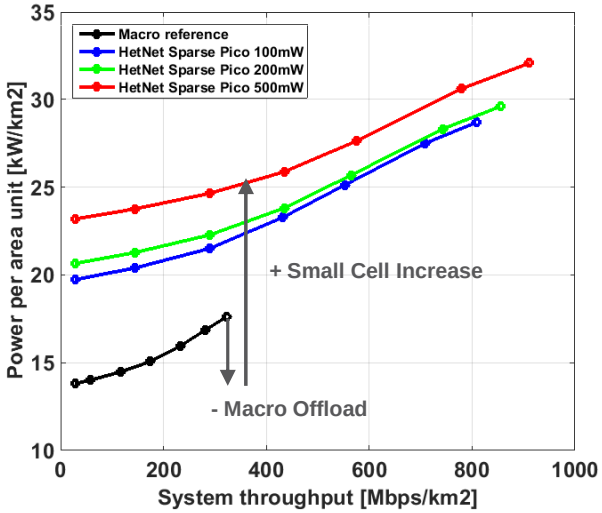


Simulation Results

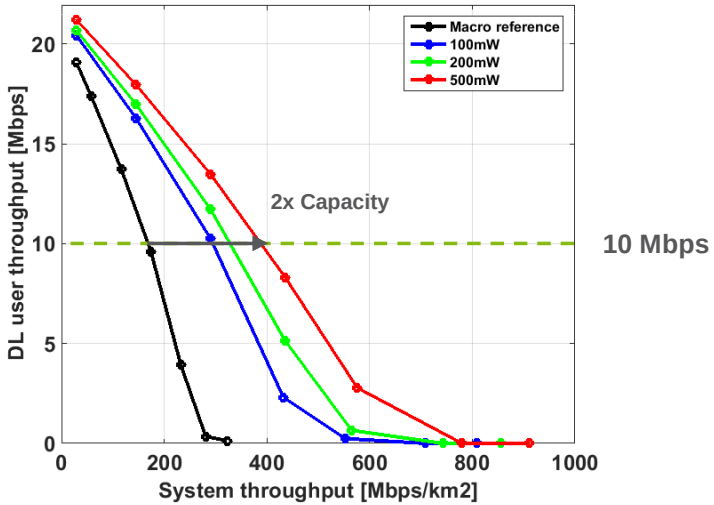


Deployment	Sparse Pico
Transmit power	100, 200 and 500mW
Capacity	285-388 Mbps

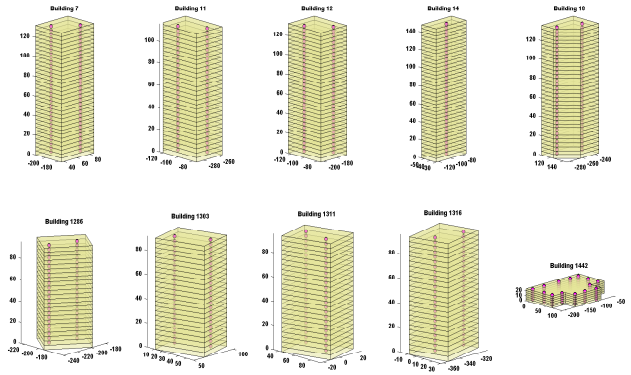
Total power consumption



10th percentile DL user throughput



Simulation Results



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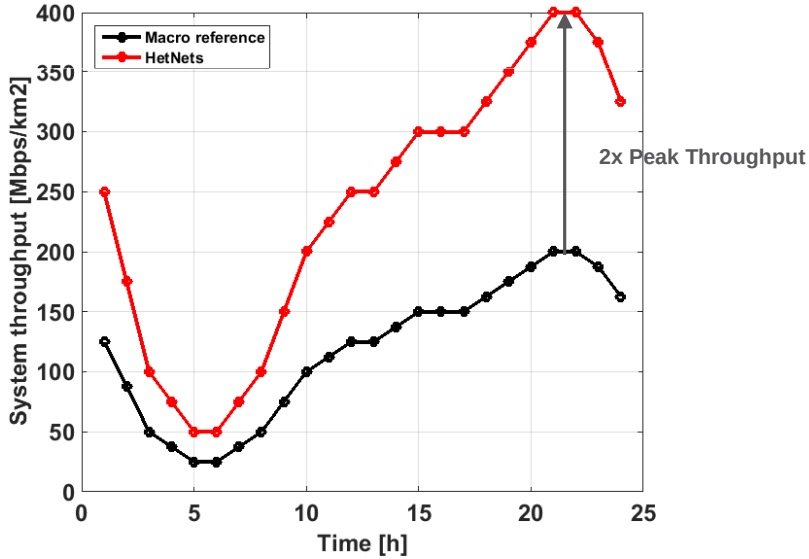
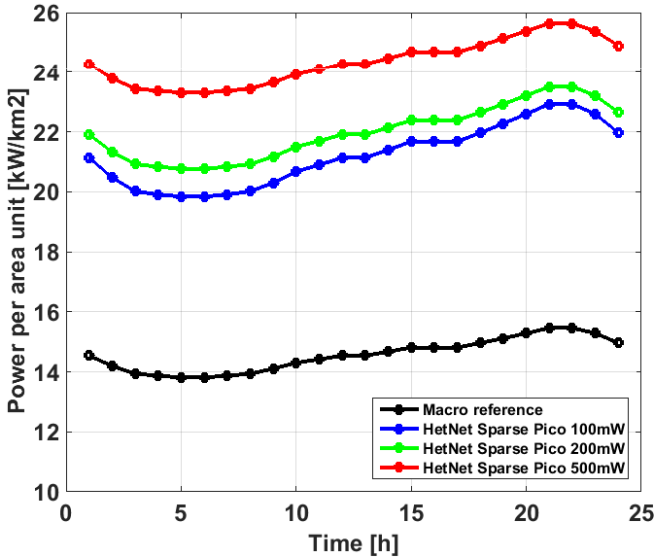
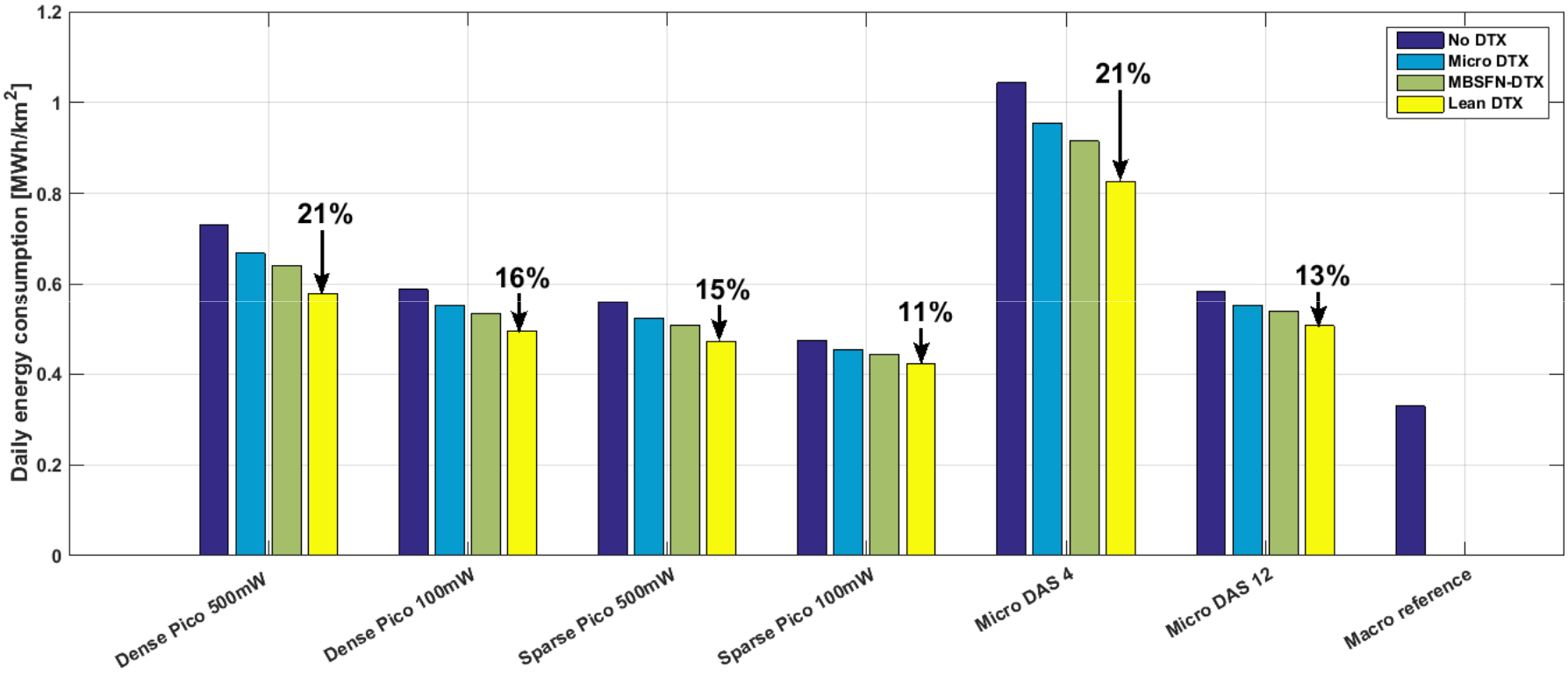
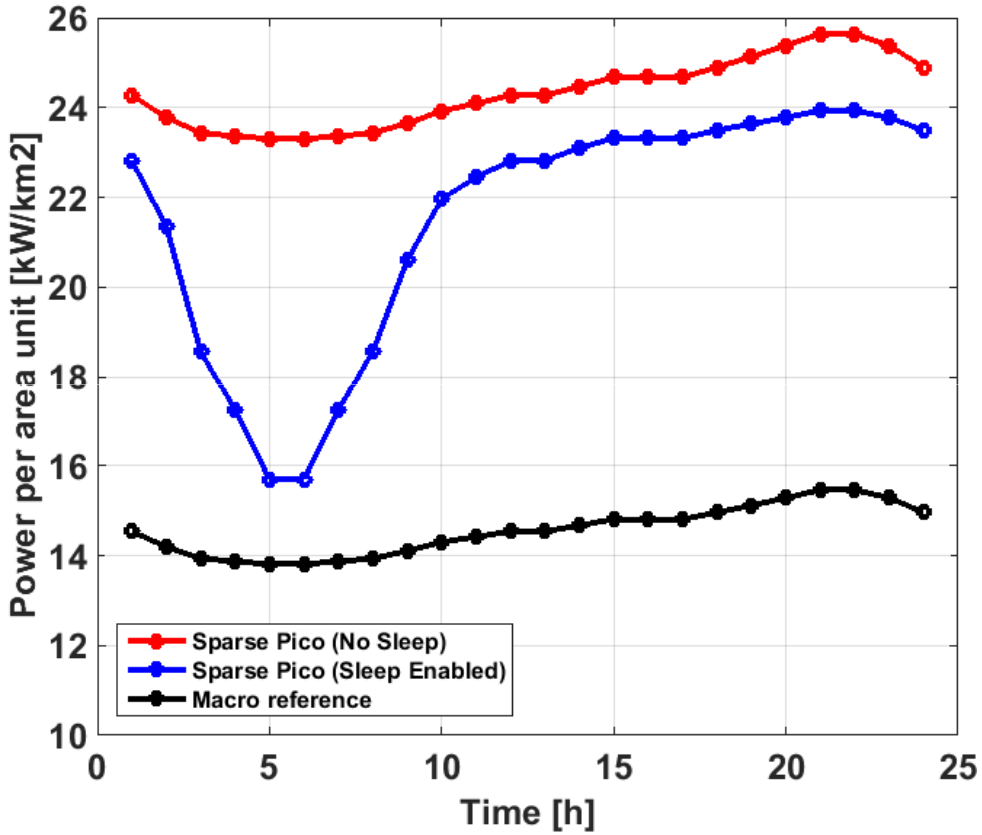




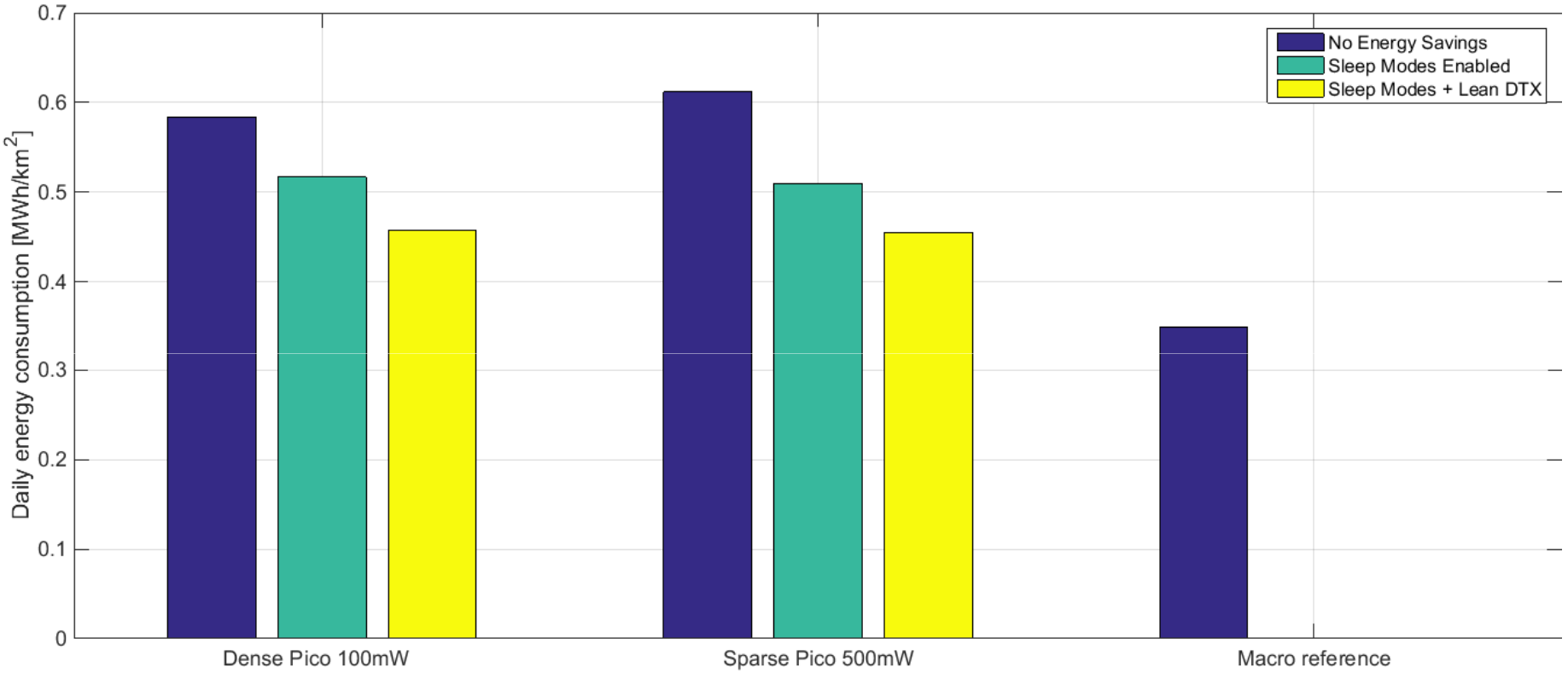
DTX Energy Savings



Sleep Mode Energy Savings



Sleep Mode Energy Savings



Conclusion

- The deployment of small cells increases the performance of the network, but without energy saving techniques the power consumption is up to 3x higher than that of the macro reference.
- With energy saving techniques such as DTX and small cell sleep modes, the energy consumption of the HetNets can be reduced.
- From an energy performance perspective, dense low power pico deployment vs a sparse high power pico deployment are equally efficient. Micro DAS however, have shown to be a deployment of poor energy efficiency due to high feeder losses in the cables

Conclusion

- The results also show that the total daily energy consumption of the HetNets can be reduced by 10-20% with DTX.
- Introducing longer sleep periods also show potential for energy savings. The result shows that with a sparse pico deployment, the power consumption at low traffic loads can be reduced by 33%.

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