Performance Analysis of Multi-Tier Hybrid Networks

5G, Heterogeneous networks, millimeter-wave, cell association, decoupling, uplink, downlink

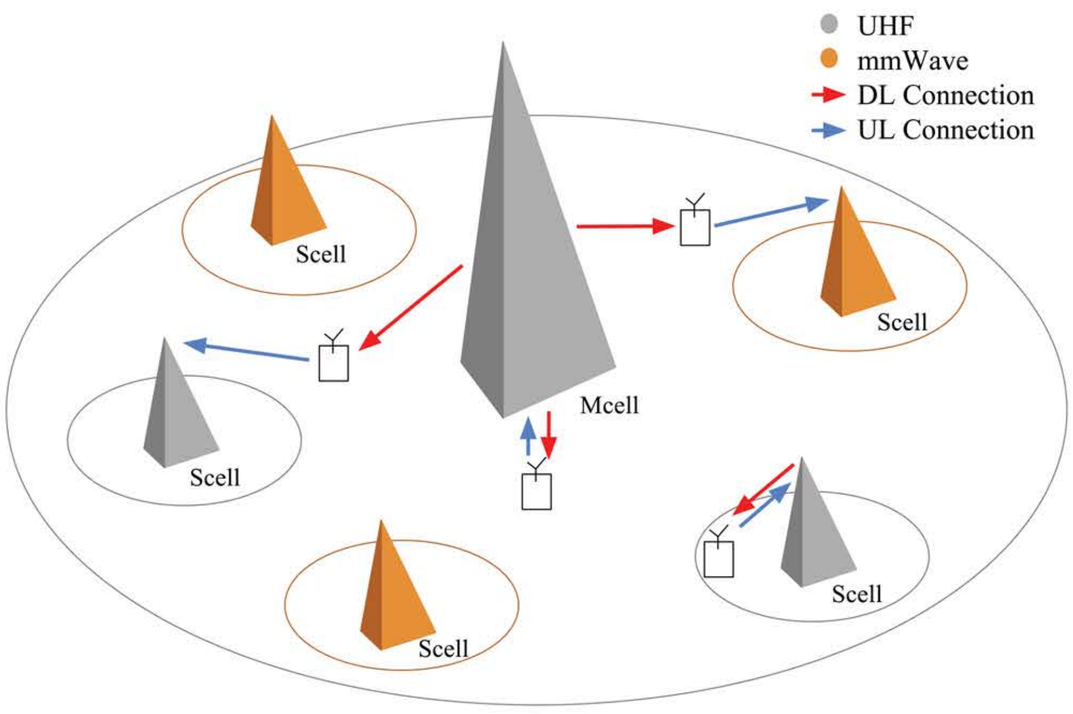
Introduction

Problem: Millimeter wave links provide high bandwidth and data rates, however they have a very high path loss

Solution: HetNets are used to address the problem as well as allow for Downlink and Uplink Decoupling (DUDe)

Results: Our simulation results show that DUDe can provide improvements in data rate and coverage

Realistic Channel Model: In order to simulate a realistic setting, our research incorporates a realistic 3D channel model and dual-slope path loss.



System model under consideration.

System Model

Three tier system :

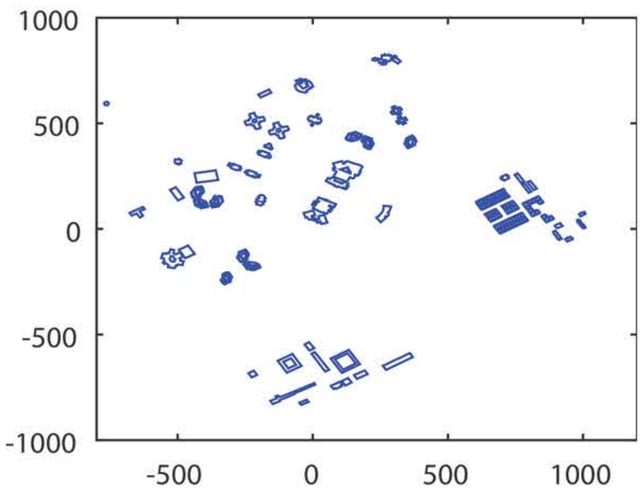
- Ultra High Frequency (UHF) macro cells (Mcells)
- UHF small cells (Scells)
- mmWave Scells

- *Realistic 2D and 3D blockage models :*
  - Building blockage data extracted via QGIS
  - Used a probabilistic LoS ball approximation of blockages

- *Channel Model :*
  - Dual slope path loss model
  - Ricean fading

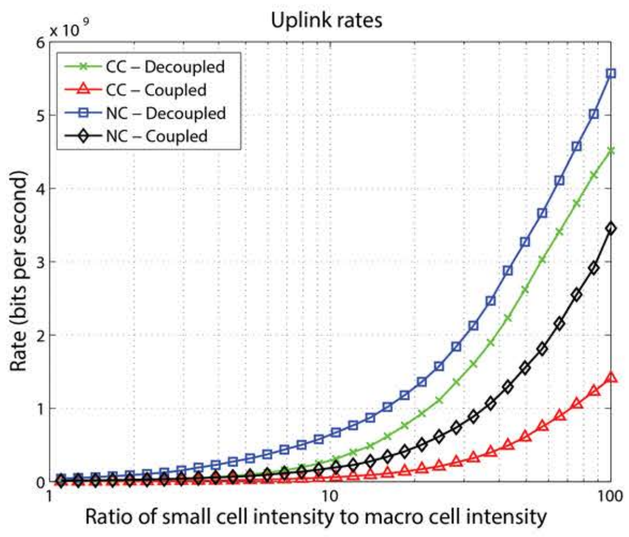
- *User Association :*
  - Open access.
  - DUDe allowed.

Google earth view of NUST Campus



Extracted building locations for NUST Campus

Results

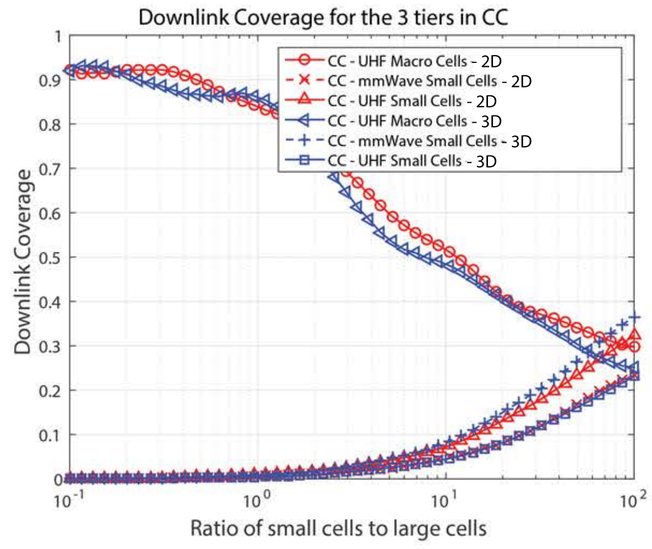


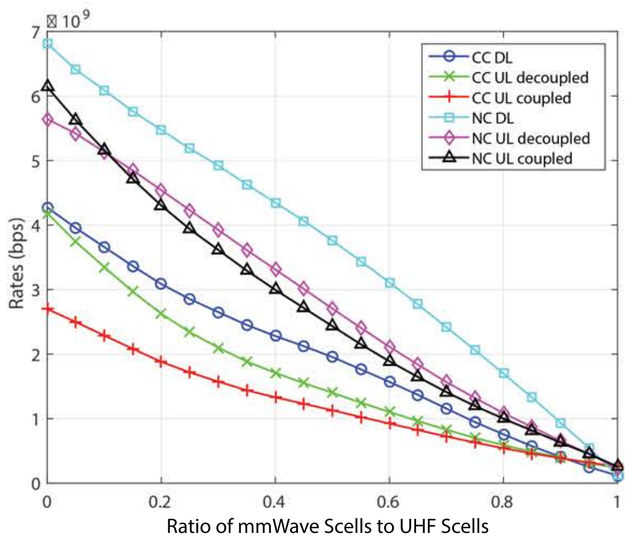
- DUDe considerably increases coverage and data rates

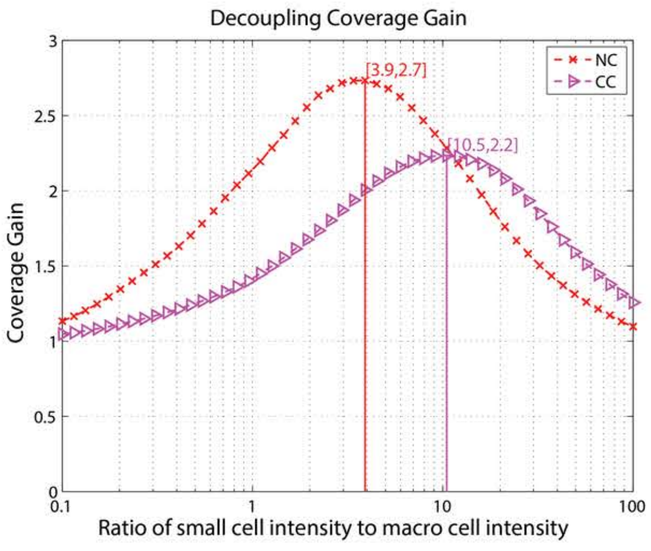
- Improvement due to DUDe is greater in high blockage environments

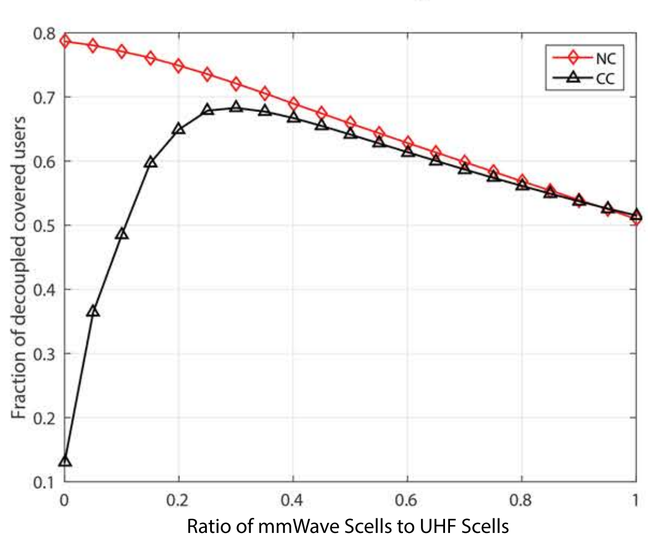
- 3D channel modeling improves coverage of small cell tiers, specifically mmWave

- Data rates show greater improvement in high blockage environments.









Future Work

Optimization of the network for data rates. Two possible strategies include:

- Game theoretic optimization approach.
- Reinforcement learning approach.

Conclusion

- Investigation on DUDe reveal that significant improvements in data rate and coverage is achieved

- The increase in complexity of realistic models is justified by the increase in accuracy

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