Ray Tracing Analysis for Drone-assisted Integrated Access and Backhaul Millimeter Wave Networks

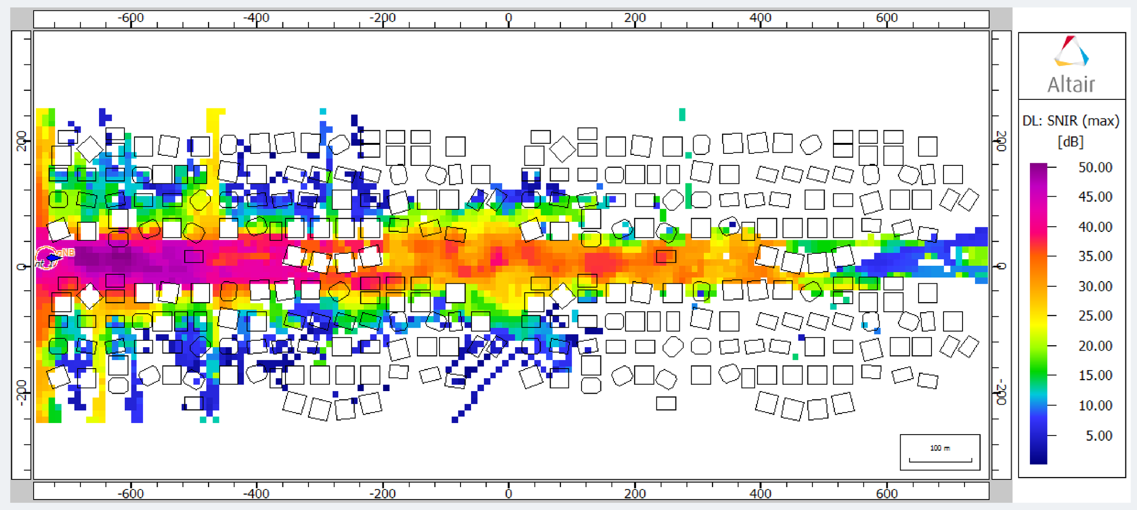
Alberto Perez, Abdurrahman Fouda, and Ahmed S. Ibrahim*
Department of Electrical and Computer Engineering, Florida International University, Miami, USA 33174

FIU FLORIDA INTERNATIONAL UNIVERSITY

5th NSF Millimeter-Wave RCN Workshop, Jan. 2019

Motivation & Problem Statement

- The **high-bandwidth** millimeter wave (mmWave) spectrum band can satisfy the need for large mobile **data demand**.
- However, the mmWave band experiences **short-range** communication, leading to coverage gaps.
- **Drones** can be utilized in a scalable and cost-effective way to dynamically **reduce** the coverage gaps.

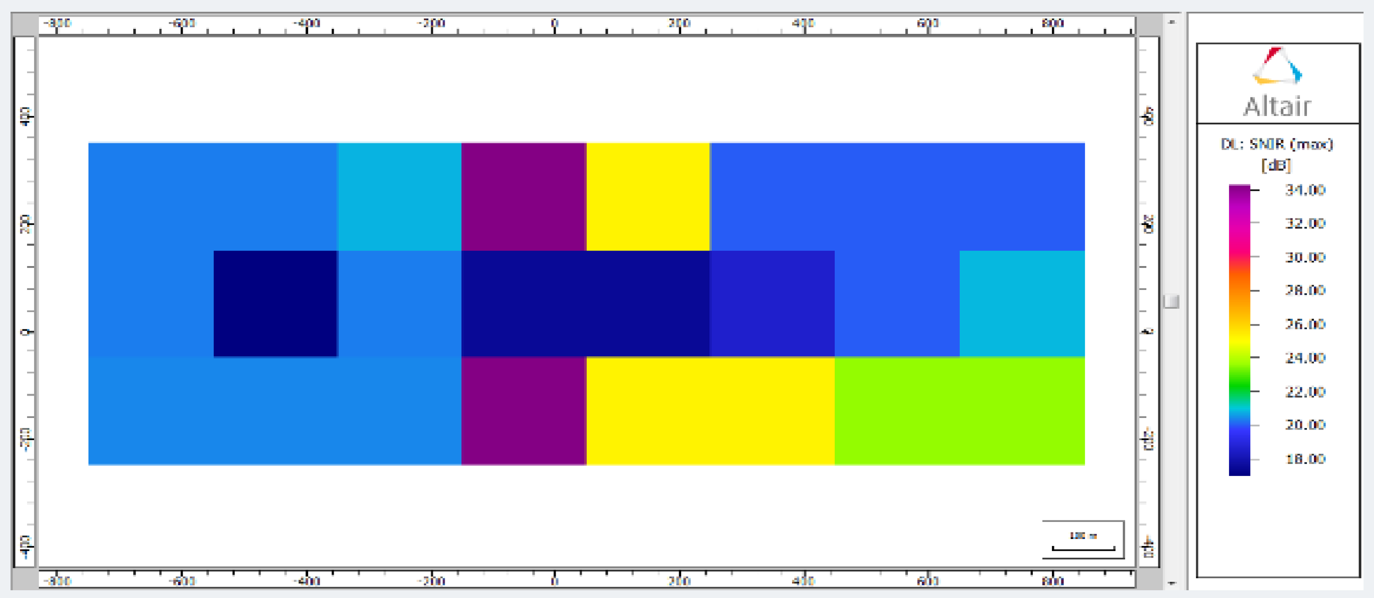


WinProp software package is exploited, with the aid of ray-tracing simulations, to show the coverage gap in the 1 $km \times 1$ km Manhattan environment (at 30 GHz)

How to utilize Unmanned Aerial Vehicles (UAVs) to reduce the coverage gaps, making use of the ray-tracing approach?

WinProp Implementation of UAV-based AF Relaying

- UAV **flying-relay** is modeled as a 3D transmitter site in WinProp
- UAV **initial positioning** is determined based on the good reception (SINR) regions at the UAV's altitude, received from the base station



- UAV AF **power mapping table**, which defines its transmission power, is constructed based on received SINR at the UAV and also taking into account the received SINR at user's level

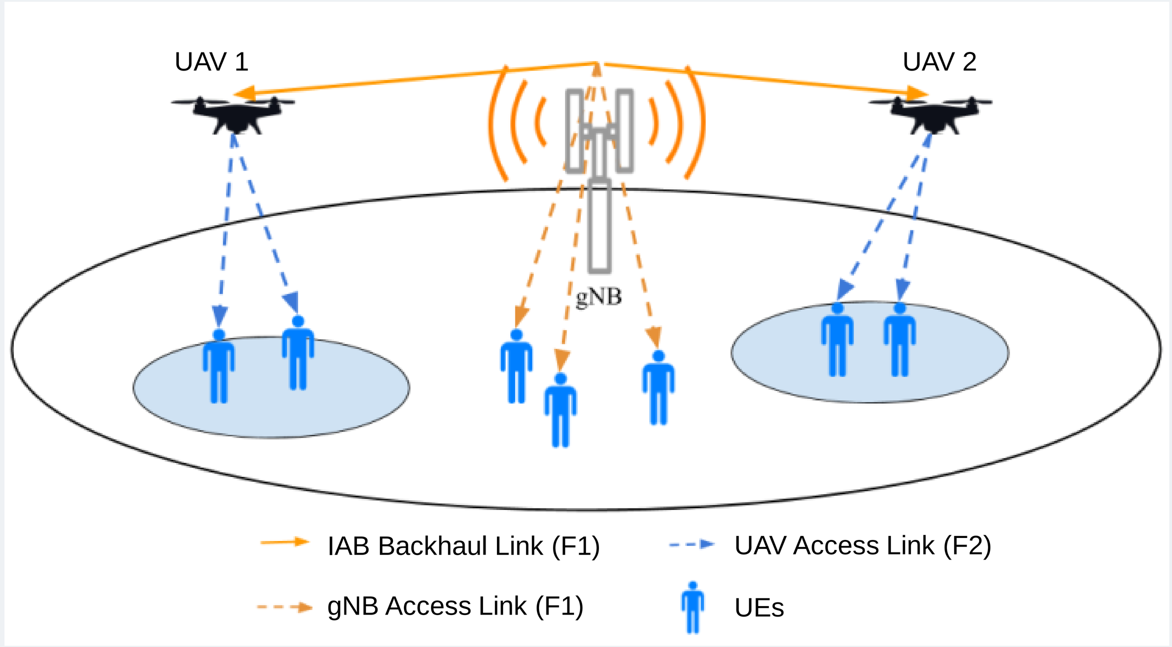
Received SINR (dB)	UAV Tx Power (dBm)	Received SINR (dB)	UAV Tx Power (dBm)
16.95	32.28	20.37	33.10
17.42	32.41	20.74	33.16
17.45	32.43	20.81	33.18
18.56	32.67	23.47	33.69
19.98	32.99	25.17	34.00
20	33.01	25.21	34.01
20.24	33.05	34.22	34.42
20.27	33.07	34.32	34.43

- **3D positioning** of UAVs is ultimately defined based on the received SINR at **UAVs' altitude**, such that the coverage at **ground users** is maximized and the interference is minimized.

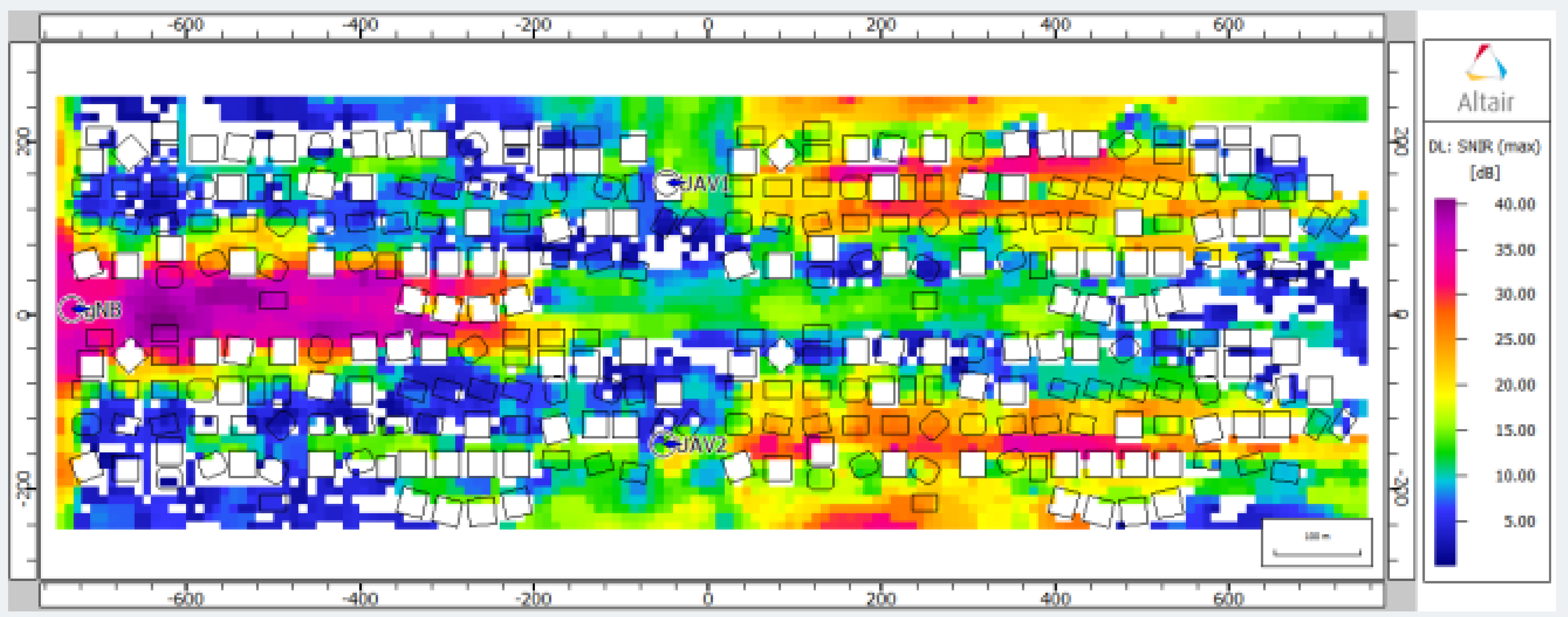
* This work is supported in part by the **National Science Foundation** under Award No. **CNS-1618692**. For further information, please contact Dr. Ahmed Ibrahim at **aibrahim@fiu.edu**.

Solution and Objectives

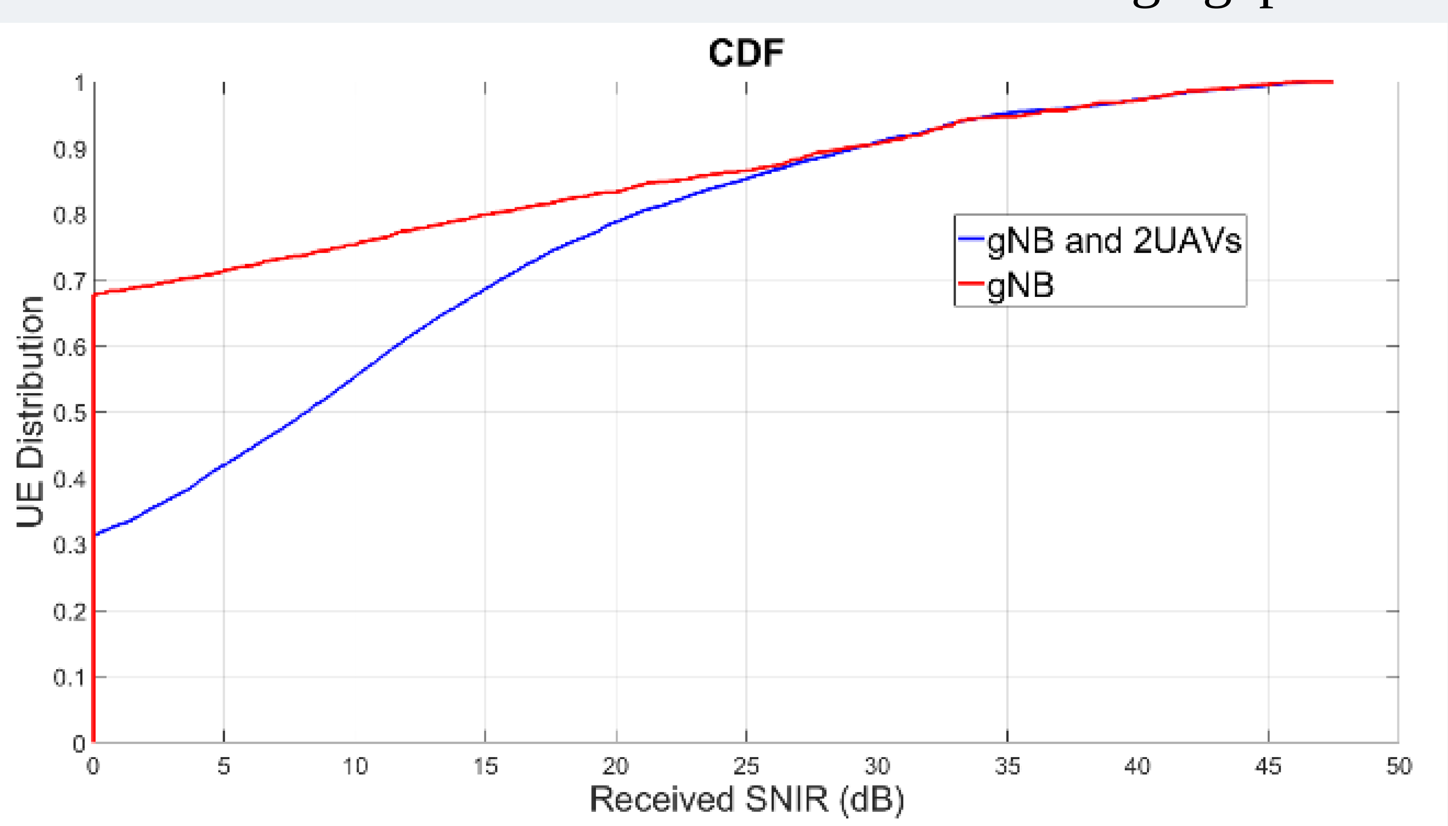
- **Solution**: UAVs can increase the coverage via **relaying** information from the base station, which leads to UAV-assisted Integrated Access and Backhaul (IAB) scenario
- **Objective**: Utilizing WinProp to implement Amplify-and-Forward (**AF**) relaying mode, and investigate potential performance improvements



Results



- **2** UAVs leverage their Line of Sight mmWave communication and fill in the coverage gaps
- ~ **70th** percentile coverage gaps is reduced to only **30th** percentile after deploying 2 UAVs



Conclusion

- Developed a ray tracing-based model for the UAV-assisted IAB scenario
- Coverage gaps are reduced from 70% to 30%, due to utilizing 2 amplify-and-forward relaying-based UAVs.