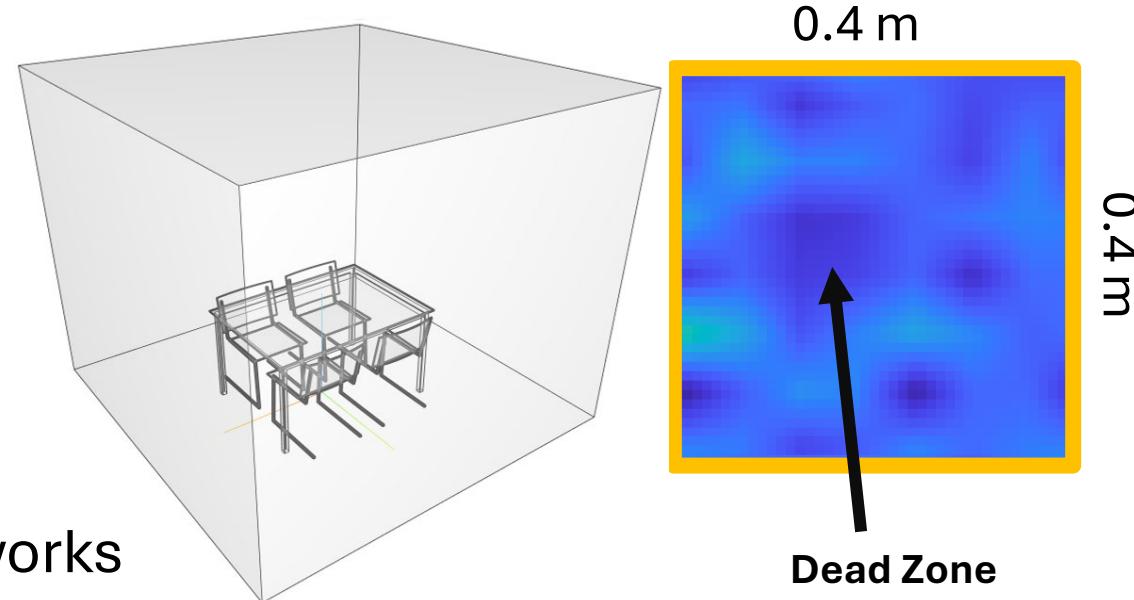


NeWRF: A Deep Learning Framework for Wireless Radiation Field Reconstruction and Channel Prediction

Haofan Lu, Christopher Vattheuer, Baharan Mirzasoleiman, Omid Abari

Dead Zones in Wireless Networks

- Dead zone: areas with bad signal quality
→ sudden outage and low quality of service
- Causes: blockage, interference, etc.
- More severe in next generation wireless networks



How can we identify the dead zones?

How can we identify the dead zones?

Naïve Solution:



Our Solution:

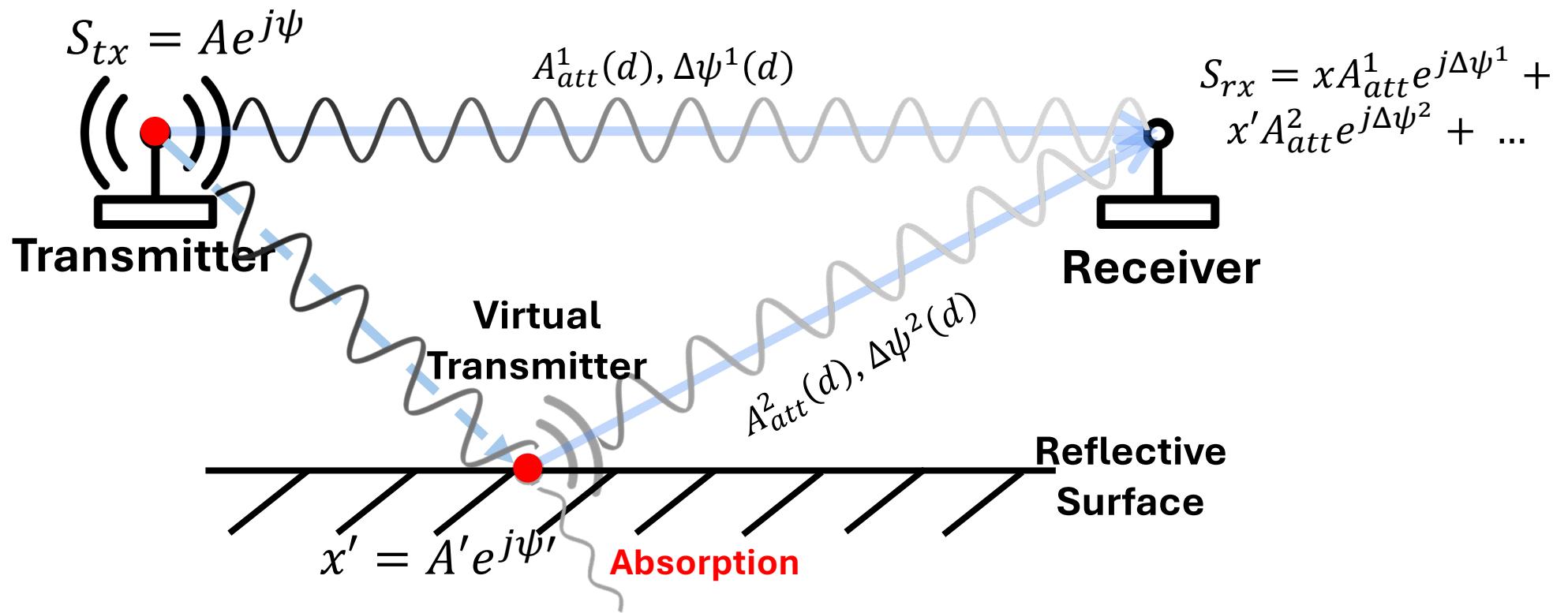


Can we predict the wireless signal quality at any locations with only a sparse set of measurements?

NeWRF: Neural Wireless Radiation Fields

- First wireless channel prediction framework for sparse measurements
- Adapt Neural Radiance Fields (NeRF) to wireless domain and solve the following challenges:
 - Distinct propagation model
 - Large room-scale scenes
 - Direction-of-arrival (DoA) ambiguity
- First unsupervised learning-based DoA-finding algorithm for inferencing at unvisited locations
- Achieve high prediction accuracy with orders of lower measurement density

Modeling Wireless Scenes



A wireless scene can be represented by the location of transmitters and the signals they transmit

Representing a Wireless Scene with Neural Network

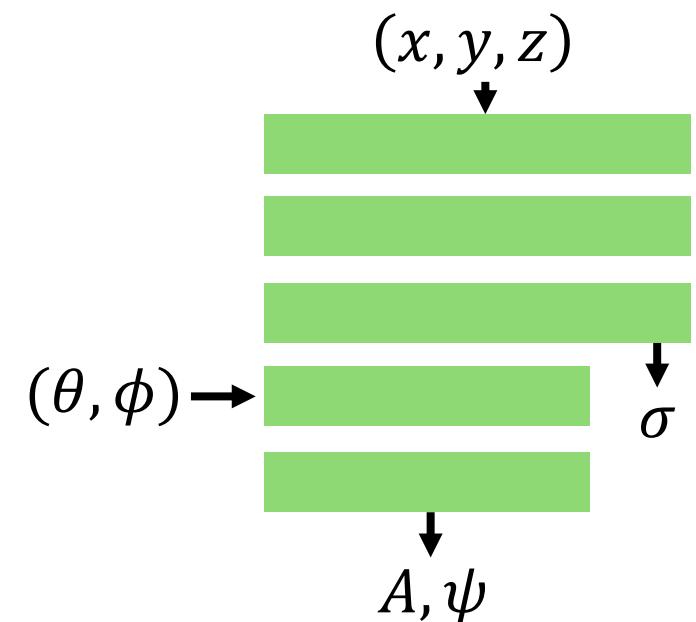
$$f_{\Theta}: (x, y, z, \theta, \phi) \rightarrow (A, \psi, \sigma)$$

(x, y, z) : spatial coordinates of the sample point

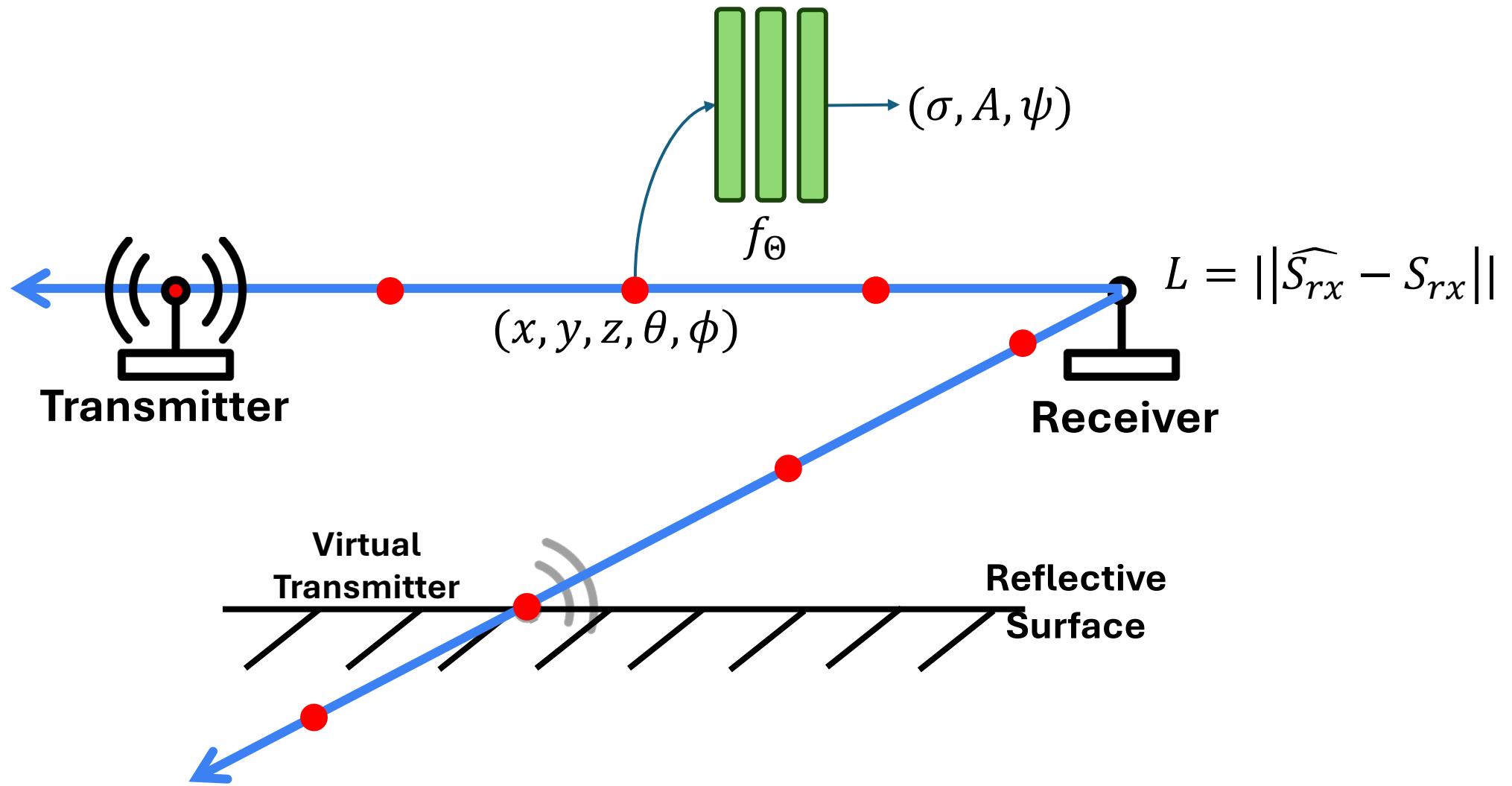
(θ, ϕ) : view direction coordinates

(A, ψ) : amplitude and phase of the signal

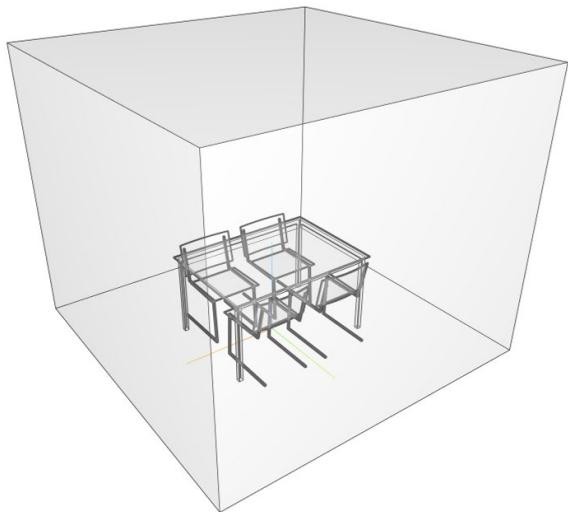
σ : indicator of the presence of transmitter



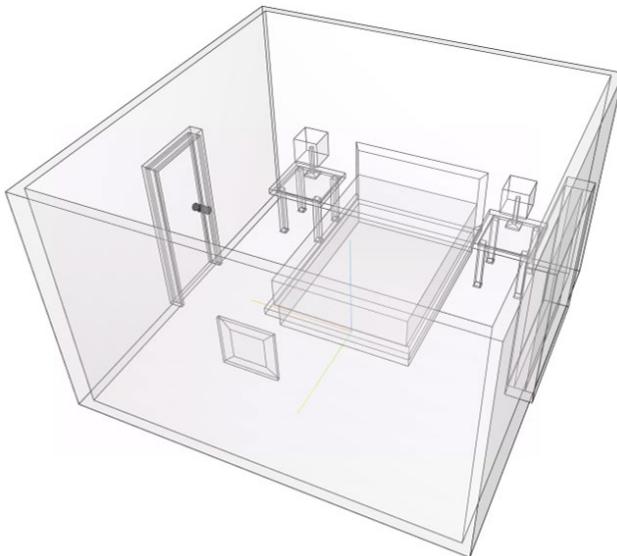
Neural Channel Synthesis



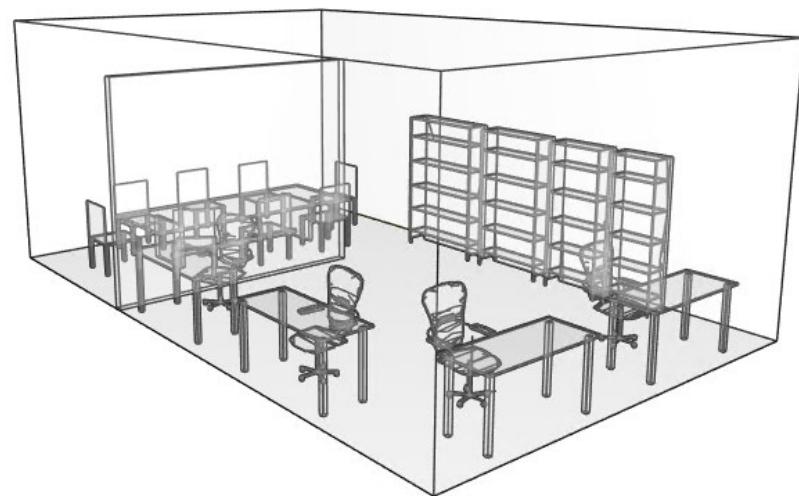
Experiment



Conference Room
 $(9.8ft \times 9.8ft \times 8.2ft)$
Measurements: 433

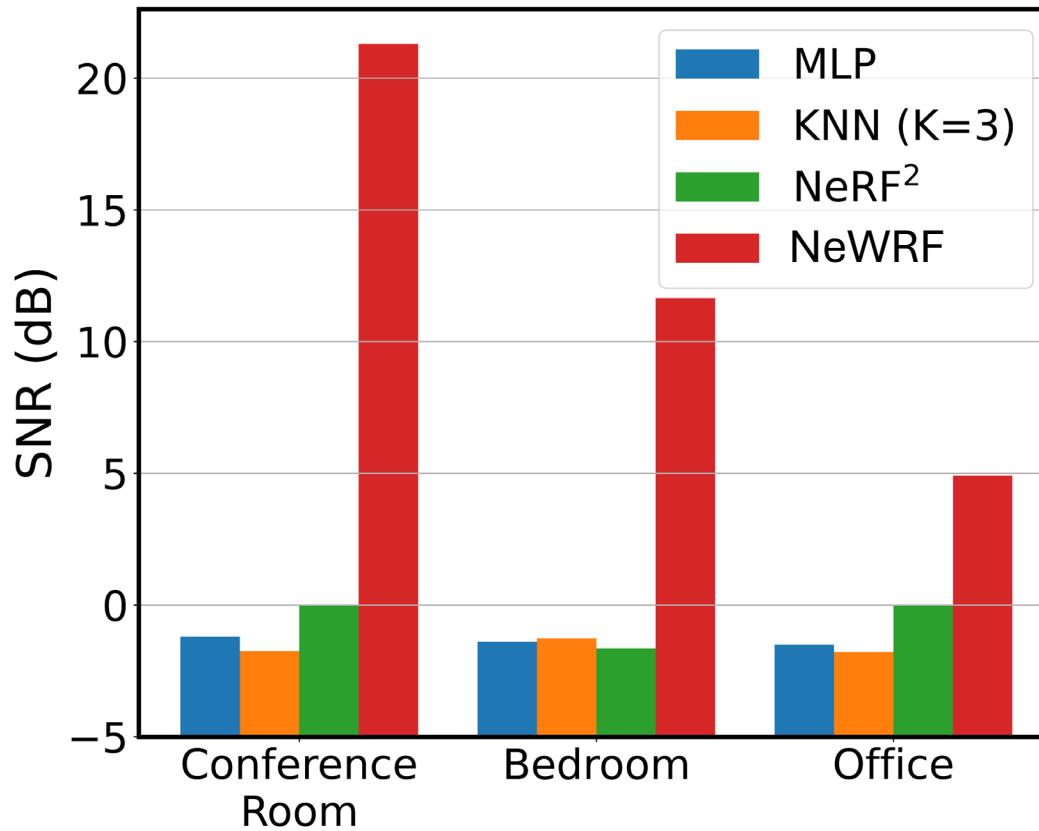


Bedroom
 $(16.4ft \times 15.7ft \times 9.8ft)$
Measurements: 975



Office
 $(26.2ft \times 16.4ft \times 9.8ft)$
Measurements: 1907

Experiment



$$SNR = -10 \log_{10} \frac{\sum |\hat{h} - h|^2}{\sum |h|^2}$$

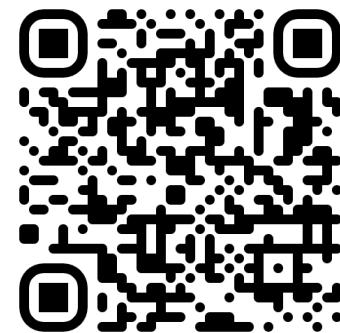
Higher SNR → Higher Accuracy

NeWRF outperforms all baseline methods in all three environments

Thank you!

For more results,
please refer to our paper:

Paper



Code & Datasets

