

# Juhyung Lee

[[LinkedIn](#)] [[GitHub](#)] [[Google Scholar](#)] [[Website](#)]

Email: juhyung.lee@usc.edu

Mobile: +1-213-245-9356

Los Angeles, CA, United States

## RESEARCH INTERESTS

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- Wireless communication systems
- Protocol design for LEO satellite networks
- AI for PHY/MAC layer, site-specific channel model, and RAN optimization

## EXPERIENCE

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- **University of Southern California** Los Angeles, USA  
*Postdoctoral Researcher, Wireless Devices and Systems Group (Head: Prof. Andreas Molisch)* Apr. 2022 - Present
  - ML-based Site-Specific Channel Modeling (Digital Twin Network) for RAN Optimization** [[GitHub](#)]
    - Developed an ML-based city map-scale pathloss map (*e.g.*, Digital Twin Network) prediction framework [1, 2]
    - Designed RAN network (*e.g.*, O-RAN) optimization frameworks for beam management, localization [3], and base station (*e.g.*, O-RU) deployment, based on the Digital Twin Network
    - Tested/Compared with 3GPP-38.901-UMi and site-specific RT (**WirelessInsite**, **NVIDIA-Sionna**) channels
  - On-Device AI (Distributed AI-to-AI) Communication** [[GitHub](#)]
    - Fine-tuned and validated a pre-trained Large Language Model (BART) as a neural lossy source coder in end-to-end Link-Level Simulation, integrating with 5G-NR PHY layer functions [4, 5]
    - Evaluated its compression efficiency within a 5G-NR end-to-end Link-Level Simulation (**NVIDIA-Sionna**)
- **Samsung Research America** Dallas, USA  
*AI/Wireless Senior Research Engineer* Dec. 2023 - Jan. 2024 (Seasonal)
  - NR-mMIMO Channel Estimation/Prediction**
    - Developed a low-complexity generative model-based channel estimation/prediction for massive MIMO systems
    - Designed a channel feedback (*e.g.*, DMRS, SRS) compression scheme; Tested via Link-Level Simulation (**MATLAB-5G**)
- **Korea University** Seoul, Korea  
*Research Professor, Research Institute for Information & Communication* Sep. 2021 - Feb. 2023
  - PHY/MAC Protocol Design for LEO Satellite Networks**
    - Designed 3GPP-compatible handover & contention-based random access (*e.g.*, RACH) protocols for LEO satellites, using satellite positional information (*e.g.*, GNSS ephemeris data) [6, 7, 8]
    - Tested/Debugged the designed PHY/MAC protocol in end-to-end System-Level Simulation

## SKILLS

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- **Tool & Library:** Link-Level & System-Level Simulation (**MATLAB-5G**, **NVIDIA-Sionna**), O-RAN (**MATLAB-5G**), Modeling (**Simulink**, **Quartus2**), GIS (**OpenStreetMap**), Ray-Tracing (**WirelessInSite**, **SionnaRT**)
- **ML Methodologies:** Generative Model (**Diffusion-DDPM**, **VQ-VAE**), Language Model (**BART**, **LLaMA**), Computer Vision (**ViT**, **ConvNext**, **DeepLapV3+**), Time Series (**Transformer**, **LSTM**), Reinforcement (**PPO**, **SAC**, **DQN**)
- **Programming:** Python, C/C++, **MATLAB**, Verilog, PyTorch, Tensorflow, Tensorflow Lite
- **HW:** SDR (**USRP**), FPGA (**Altera**)

## EDUCATION

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- **Korea University** Seoul, Korea  
*Ph.D. in Electrical and Computer Eng. (Awarded by Research Excellence)* Mar. 2016 – Aug. 2021
  - [**Demo**] **Radio-over-FSO (RoFSO):** Built a RoFSO system, integrating 802.11 WLAN (WiFi) USRP system and laser-based optical transceivers; Demonstrated the RoFSO system in high-speed (*e.g.*, Gbps) transmission [9, 10]
  - **DRL-based RAN Optimization:** Developed novel radio resource scheduling [11, 12, 13, 14], initial access [7], handover [6], and beam management [15] schemes for networks with high-mobility
- **Korea University** Seoul, Korea  
*B. Eng. in Electrical and Electronic Eng. (National Sci. & Tech. Scholarship - Full Tuition)* Mar. 2011 – Feb. 2016

## PROJECTS

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- **Site-Specific Channel Modeling (Digital Twin Networks)** [[GitHub](#)]
  - Built a channel measurement dataset using ray-tracing simulations (*WirelessInsite*, *Sionna-RT*) on real maps (*e.g.*, USC, UCLA, and Boston area)
  - Implemented a supervised-learning framework, using Computer Vision techniques, to predict radio maps in mmWave/THz Communications [1, 16]
  - **1st-rank in ML competition** (*Radio-Map Prediction Challenge @ IEEE ICASSP* [2]), achieving the highest accuracy (RMSE  $\sim -14$  [dB])
  - Developed a transfer learning method to adapt models to new, unseen network scenarios/environments
  - Achieved  $\sim 31$  [dB] RMSE gain compared to 3GPP channel model (*e.g.*, 3GPP-38.901-UMi)
  - **AutoBS**: Developed Digital Twin Network-based frameworks to optimize RAN network operations, including beam management and placement for O-RU.
- **Generative Model-based Channel Feedback Compression**
  - Designed a novel low complexity Generative Model-based scheme for channel feedback compression
  - Demonstrated high channel feedback compression efficiency ( $\sim \frac{1}{1000}$ ), retaining up to NMSE  $\sim -15$  [dB]
- **On-Device AI/LLM Communication Systems** [[GitHub](#)]
  - Built a framework integrating large language model (LLM, *e.g.*, BART) with 5G-NR link-level simulator (LLS, *e.g.*, NVIDIA Sionna), utilizing a compression technique (VQ-VAE)
  - Demonstrated the framework in realistic 5G-NR communication scenario (Modules: LDPC/Polar Coding, QAM, OFDM, and MIMO; Channels: 3GPP CDL- $\{A\sim E\}$ ) [5]
  - Achieved  $\sim 50\%$  compression in source data, retaining high robustness under 3GPP-CDL channel models.

## HONORS AND AWARDS

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- 1st-Rank, *IEEE ICASSP Signal Processing Grand Challenges*, Jun. 2023 [2]
- Best Paper Award, *IEEE ICTC*, Oct. 2022 [17]
- Best Paper Award, *IEEE ICTC*, Oct. 2021 [18]
- Grand Prize, *Graduate Research Excellence Award*, Korea University, Feb. 2021
- Travel Grant, *IEEE GLOBECOM*, Dec. 2020;
- Bronze Prize, *IEEE Seoul Section Student Paper Award*, Dec. 2020
- Best Paper Award, *Korea Institute of Commun., and Info. Sciences*, Feb. 2020
- Full Tuition Scholarship (B. Eng.), *National Science & Technology Scholarship*, Korea, 2011

## PATENTS

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- [USA #2 - pending] **J.-H. Lee** and Y.-C. Ko, “Deep reinforcement learning-based random access method for low earth orbit satellite network and terminal for the operation”, US20230189353A1 (06/15/2023)
- [USA #1 - pending] J.-M. Kim, **J.-H. Lee**, and Y.-C. Ko, “Apparatus based on wireless optical communication”, US20230083544A1 (03/16/2022)
- [Korea #3] B.-H. Lee, **J.-H. Lee**, and Y.-C. Ko, “Minimum transmission rate maximization using power control and association in ground base station-to-UAV communication”, 10-2508442 (03/06/2023)
- [Korea #2] J.-M. Kim, **J.-H. Lee**, and Y.-C. Ko, “Apparatus based on wireless optical communication”, 10-2506809 (03/02/2023)
- [Korea #1] **J.-H. Lee**, J. Lee, ”Method and apparatus for uploading or downloading file based on tag,” 10-2014-0128406 (01/26/2016)

## PROFESSIONAL REFERENCES

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- **Prof. Andreas F. Molisch** : Professor (IEEE Fellow, AAAS Fellow), University of Southern California, molisch@usc.edu
- **Dr. Hao Chen** : Manager, Samsung Research America, hao.chen1@samsung.com
- **Prof. Young-Chai Ko** : Professor, Korea University, koyc@korea.ac.kr

## SELECTED PUBLICATIONS [[LINK FOR FULL-LIST](#)]

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- [1] J.-H. Lee\* and A. F. Molisch, “A scalable and generalizable pathloss map prediction,” *arXiv preprint arXiv:2312.03950*, 2024. [[arXiv](#)] [[GitHub](#)].
- [2] J.-H. Lee\*, A. F. Molisch, and et al., “PMNet: Large-scale channel prediction system for radio map prediction challenge,” in *IEEE International Conf. on Acoustics, Speech and Signal Processing (ICASSP)*, Jun. 2023. [**1st-Rank in ML Competition**] [[GitHub](#)].
- [3] O. G. Serbetci, J.-H. Lee\*, D. Burghal, and A. F. Molisch, “Simple and effective augmentation methods for CSI based indoor localization,” in *Proc. IEEE Global Commun. Conf. (GLOBECOM)*, pp. 1–6, 2023.
- [4] J.-H. Lee\*, D.-H. Lee, J. Lee, and J. Pujara, “Integrating pre-trained language model with physical layer communications,” *arXiv preprint arXiv:2402.11656*, 2024. [[arXiv](#)] [[GitHub](#)].
- [5] J.-H. Lee\*, D.-H. Lee, E. Sheen, T. Choi, and J. Pujara, “Seq2seq-sc: End-to-end semantic communication systems with pre-trained language model,” in *Asilomar Conf. on Signals, Systems, and Computers*, pp. 1–4, 2023. [[arXiv](#)] [[GitHub](#)].
- [6] J.-H. Lee\*, A. F. Molisch, and et al., “Handover protocol learning for LEO satellite networks: Access delay and collision minimization,” *IEEE Trans. Wireless Commun.*, 2024. [[arXiv](#)].
- [7] J.-H. Lee\*, H. Seo, J. Park, M. Bennis, and Y.-C. Ko, “Learning emergent random access protocol for LEO satellite networks,” *IEEE Trans. Wireless Commun.*, vol. 22, no. 1, pp. 257–269, 2023. [[arXiv](#)].
- [8] J.-H. Lee\*, H. Seo, J. Park, M. Bennis, Y.-C. Ko, and J. Kim, “Random access protocol learning in LEO satellite networks via reinforcement learning,” in *Proc. IEEE Vehicular Technology Conf. (VTC)*, pp. 1–5, 2022. [**Invited Paper**].
- [9] J.-M. Kim, J.-H. Lee\*, and et al., “Experimental demonstration of RoFSO transmission combining WLAN standard and WDM-FSO over 100m distance,” in *IEEE Conf. on Comput. Commun. Workshop (INFOCOM-Demo)*, May 2022. [**Demo**].
- [10] J.-M. Kim, J.-H. Lee\*, and Y.-C. Ko, “WLAN standard-based Non-Coherent FSO transmission over 100m indoor and outdoor environments,” in *IEEE Conf. on Comput. Commun. Workshop (INFOCOM-Demo)*, May 2021. [**Demo**].
- [11] J.-H. Lee\*, J. Park, M. Bennis, and Y.-C. Ko, “Integrating LEO satellites and multi-UAV reinforcement learning for hybrid FSO/RF non-terrestrial networks,” *IEEE Trans. Veh. Technol.*, pp. 1–16, 2022.
- [12] J.-H. Lee\*, J. Park, M. Bennis, and Y.-C. Ko, “Integrating LEO satellite and UAV relaying via reinforcement learning for non-terrestrial networks,” in *Proc. IEEE Global Commun. Conf. (GLOBECOM)*, (Taipei, Taiwan), pp. 1–6, 2020. [**Travel Grant**].
- [13] J.-H. Lee\*, K.-H. Park, Y.-C. Ko, and M.-S. Alouini, “Spectral-efficient network design for high-altitude platform station networks with mixed rf/fso system,” *IEEE Trans. Wireless Commun.*, vol. 21, no. 9, pp. 7072–7087, 2022.
- [14] J.-H. Lee\*, K.-H. Park, Y.-C. Ko, and M.-S. Alouini, “Throughput maximization of mixed FSO/RF UAV-aided mobile relaying with a buffer,” *IEEE Trans. Wireless Commun.*, vol. 20, no. 1, pp. 683–694, 2021.
- [15] Y. Lee, J.-H. Lee\*, and Y.-C. Ko, “Beamforming optimization for IRS-assisted mmWave V2I communication systems via reinforcement learning,” *IEEE Access*, Jun. 2022.
- [16] J.-H. Lee\*, A. F. Molisch, and et al., “PMNet: Robust pathloss map prediction via supervised learning,” in *Proc. IEEE Global Commun. Conf. (GLOBECOM)*, pp. 1–6, 2023.
- [17] J.-H. Lee\*, A. F. Molisch, and et al., “Reinforcement learning empowered massive IoT access in LEO-based non-terrestrial networks,” in *Proc. IEEE Int. Conf. on Inf. and Commun. Techn. Conv.*, Oct. 2022. [**Best Paper Award**].
- [18] J.-H. Lee\* and Y.-C. Ko, “Optimization for LEO satellite-ground integrated networks via deep reinforcement learning,” in *Proc. IEEE Int. Conf. on Inf. and Commun. Techn. Conv.*, Oct. 2021. [**Best Paper Award**].