Qiang Liu ***Assistant Professor*** **Last update: May 23, 2022**

CONTACT INFORMATION
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RESEARCH INTERESTS
Wireless Communication, Computer Networking, Machine Learning, Edge Computing, Augmented Reality, Internet of Things

EDUCATION

The University of North Carolina at Charlotte, Charlotte, NC 2016–2020

- Ph.D. in Electrical Engineering
- Advisor: Prof. Tao Han.

University of Electronic Science and Technology of China, Chengdu, China 2013–2016

- M.S. in Communication and Information System
- Advisor: Prof. Gang Wu

HONORS AND AWARDS

◇ ***Best Paper Award***, IEEE International Conference on Communications (ICC) 2022

◇ ***Best Paper Award***, IEEE ComSoc on Transmission, Access, and Optical Systems (TAOS) 2019

◇ ***Best Paper Award***, IEEE International Conference on Communications (ICC) 2019

◇ ***Outstanding Graduate Student Award***, UNC-Charlotte 2019

◇ ***Graduate and Professional Student Government Travel Award***, UNC-Charlotte 2019

◇ ***Student Travel Grant Award***, IEEE International Conference on Network Protocols (ICNP) 2018

◇ ***Student Travel Grant Award***, ACM/IEEE Symposiumon Edge Computing (SEC) 2017

◇ ***Excellent Graduate Student Award***, University of Electronic Science and Technology of China (UESTC) 2016

• ***Bronze Medal Award***, 5G Algorithm Innovation Competition 2015

PUBLICATIONS

Conferences

19. Q. Liu, Y. Zhang, H. Wang, "EdgeMap: CrowdSourcing High Definition Map in Automotive Edge Computing", in *IEEE International Conference on Communications* (**ICC**), Virtual, May. 2022

18. T. Hu, Q. Liao, Q. Liu, D. Wellington, G. Carle, "Inter-Cell Slicing Resource Partitioning via Coordinated Multi-Agent Deep Reinforcement Learning", in *IEEE International Conference on Communications* (**ICC**), Virtual, May. 2022 (**Best Paper Award**)

17. Q. Liu, N. Choi, T. Han, "OnSlicing: Online End-to-End Network Slicing with Reinforcement Learning", *The 17th International Conference on emerging Networking EXperiments and Technologies* (**CoNEXT**), Virtual, Dec. 2021 (acceptance rate: **22%**)

16. Q. Liu, N. Choi, T. Han, "Constraint-Aware Deep Reinforcement Learning for End-to-End Resource Orchestration in Mobile Networks", *IEEE International Conference on Network Protocols* (**ICNP**), Virtual, Nov. 2021 (acceptance rate: **24%**)

15. Q. Liu, T. Han, L. Xie, B. Kim, "LiveMap: Real-Time Dynamic Map in Automotive Edge Computing", *IEEE International Conference on Computer Communications* (**INFOCOM**), Virtual, May 2021 (acceptance rate: **19.9%**)

14. Q. Liu, T. Han, E. Moges, "EdgeSlice: Slicing Wireless Edge Computing Network with Decentralized Deep Reinforcement Learning", in *IEEE International Conference on Distributed Computing Systems* (**ICDCS**), Singapore, Dec. 2020 (acceptance rate: **18%**)

13. Q. Liu, T. Han, N. Zhang, Y. Wang, "DeepSlicing: Deep Reinforcement Learning Assisted Resource Allocation for Network Slicing", in *IEEE Global Communications Conference* (**GLOBECOM**), Taipei, Taiwan, Dec. 2020

12. Q. Liu, T. Han, "DIRECT: Distributed Cross-Domain Resource Orchestration in Cellular Edge Computing", in *ACM International Symposium on Mobile Ad Hoc Networking and Computing* (**MOBIHOC**), Catania, Italy, Jul. 2019 (acceptance rate: **23.7%**)

11. Q. Liu, T. Han, "VirtualEdge: Multi-Domain Resource Orchestration and Virtualization in Cellular Edge Computing", in *IEEE International Conference on Distributed Computing Systems* (**ICDCS**), Dallas, TX, Jul. 2019 (acceptance rate: **19.6%**)

10. Q. Liu, T. Han, "DARE: Dynamic Adaptive Mobile Augmented Reality with Edge Computing", in *IEEE International Conference on Network Protocols* (**ICNP**), Cambridge, UK, Sep. 2018 (acceptance rate: **17.8%**)

9. Q. Liu, S. Huang, J. Opadere, T. Han, "An Edge Network Orchestrator for Mobile Augmented Reality", in *IEEE International Conference on Computer Communications* (**INFOCOM**), Honolulu, HI, Apr. 2018 (acceptance rate: **19.2%**)

8. J. Opadere, Q. Liu, N. Zhang, T. Han, "Joint Computation and Communication Resource Allocation for Energy-Efficient Mobile Edge Networks", in *IEEE International Conference on Communications* (**ICC**), Shanghai, China, May 2019 **(Best Paper Award)**

7. Q. Liu, T. Han, "Energy-Efficient On-demand Cloud Radio Access Networks Virtualization", in *IEEE Global Communications Conference* (**GLOBECOM**), Abu Dhabi, UAE, Dec. 2018

6. Q. Liu, T. Han, N. Ansari, "Joint Radio and Computation Resource Management for Low Latency Mobile Edge Computing", in *IEEE Global Communications Conference* (**GLOBECOM**), Abu Dhabi, UAE, Dec. 2018

5. J. Opadere, Q. Liu, T. Han, "Energy-Efficient RRH Sleep Mode for Virtual Radio Access Networks", in *IEEE Global Communications Conference* (**GLOBECOM**), Singapore, Dec. 2017

4. S. Huang, Q. Liu, T. Han, N. Ansari, "Data-Driven Network Optimization in Ultra-Dense Radio Access Networks", in *IEEE Global Communications Conference* (**GLOBECOM**), Singapore, Dec. 2017

3. Q. Liu, G. Wu, Y. Guo, Y. Zhang, S. Hu, "Energy Efficient Resource Allocation for Control Data Separated Heterogeneous-CRAN", in *IEEE Global Communications Conference* (**GLOBECOM**), Washington DC, Dec. 2016

2. Q. Liu, T. Han, G. Wu, "Computing Resource Aware Energy Saving Scheme for Cloud Radio Access Networks", in *IEEE Sustainable Computing and Communications* (**SustainCom**), Atlanta, GA, Oct. 2016

1. Y. Guo, Q. Liu, G. Wu, S. Li, "On the Impact of Power Amplifier Efficiency on the Energy Efficiency in a Massive MIMO System", *WiCOM*, Shanghai, China, 2015

Journal and Magazines

5. F. Salahdine, J. Opadere, Q. Liu, T. Han, N. Zhang, S. Wu, "A survey on sleep mode techniques for ultra-dense networks in 5G and beyond", in *Computer Networks*, vol. 201, pp.108567, 2021.

4. Q. Liu, T. Han, N. Ansari, "Learning-Assisted Secure End-to-End Network Slicing for Cyber-Physical Systems", in *IEEE Network Magazine*, vol. 34, no. 3, pp. 37-43, May 2020

3. J. Opadere, Q. Liu, T. Han, N. Ansari, "Energy-efficient Virtual Radio Access Networks for Multi-Operators Cooperative Cellular Networks", in *IEEE Transactions on Green Communications and Networking* (**TGCN**), vol. 3, no. 3, pp. 603-614, Sep. 2019

2. Q. Liu, T. Han, N. Ansari, "Energy-Efficient On-demand Resource Provisioning in Cloud Radio Access Networks", in *IEEE Transactions on Green Communications and Networking* (**TGCN**), vol. 3, no. 4, pp. 1142-1151, Jul. 2019

1. Q. Liu, T. Han, N. Ansari, G. Wu, "On Designing Energy-Efficient Heterogeneous Cloud Radio Access Networks", in *IEEE Transactions on Green Communications and Networking* (**TGCN**), vol. 2, no. 3, pp. 721-734, May 2018

Workshops and Demos

4. Q. Liu, T. Han, "When Network Slicing meets Deep Reinforcement Learning", in *ACM International Conference on emerging Networking EXperiments and Technologies* (**CoNEXT**) Student Workshop, Orlando, FL, Dec. 2019

3. Q. Liu, T. Han, "Demo Abstract: Themis: Cross-Domain Resource Orchestration and Virtualization in Cellular Computing Networks", in *IEEE International Conference on Network Protocols* (**ICNP**), Cambridge, UK, Sep. 2018

2. Q. Liu, S. Huang, T. Han, "Demo Abstract: Fast and Accurate Object Analysis at the Edge for Mobile Augmented Reality", in *ACM/IEEE Symposium on Edge Computing* (**SEC**), San Jose, CA, Oct. 2017

1. Q. Liu, S. Huang, Y. Deng, T. Han, "Demo Abstract: MExR: Mobile Edge Resource Management for Mixed Reality Applications", in *IEEE International Conference on Computer Communications* (**INFOCOM**), Atlanta, GA, Apr. 2017

Academic Experience

- **University of Nebraska-Lincoln** Aug. 2021–Present
  Assistant Professor

- **University of North Carolina at Charlotte** Aug. 2016–Dec. 2020
  Research, Teaching Assistant
  - Designed cross-domain resource orchestration frameworks with machine learning techniques, e.g., Bayesian optimization, Gaussian process regression, and DRL, that enable model-free and dynamic orchestration of virtual radio, transport and computing resources for network slices.
  - Developed and implemented dynamic end-to-end network slicing system with our designed resource virtualization solutions on OpenAirInterface LTE platform, OpenDayLight-based software defined network (SDN), and CUDA GPU parallel computing platform. The system allows real-time virtual resource management for network slicing in cellular edge computing networks.
  - Designed cross-layer dynamic adaptive protocol for mobile augmented reality (MAR) that allows MAR users to adjust their AR configurations, e.g., frame rate, frame resolution, and computation model, according to availability of networking and computing resources under dynamic cellular edge computing networks.
  - Developed and implemented edge-assisted MAR system with computation offloading, Mininet network simulator, and GPU computing platform in hierarchical edge cloud computing networks.

- **University of Electronic Science and Technology of China** Aug. 2013–Jun. 2016
  Research Assistant
  - Designed energy-efficient resource managements, e.g., user scheduling, cell sleep mode, and cooperative beamforming, for heterogeneous cellular networks (HetNets), cloud radio access networks (C-RAN) and mobile edge computing (MEC).

Industry Experience

- **Nokia Bell Labs** Jan. 2021–Aug. 2021
  Research Scientist
  - Design and research on critical challenges and problems in end-to-end network systems, i.e., access network, transport network, core network, and edge/cloud computing, with open-source platforms, e.g., OAI, ODL, OMEC, and network devices, e.g., SDR and SDN.

- **Nokia Bell Labs** Jun. 2020–Aug. 2020
  Research Intern
  - Developed and implemented end-to-end network slicing platform that integrates domain managers in RAN, TN, and CN, with open-source platforms, e.g., OAI, ODL, OMEC.

- **Toyota InfoTech Labs** Jan. 2020–Jun. 2020
  Research Intern
  - Designed and implemented edge-assisted real-time dynamic layer for high-definition map that allows connected vehicles to cooperatively sense, detect, and track surrounding objects, e.g. pedestrians and vehicles, in subseconds.
  - Developed end-to-end simulation platform that integrates on-vehicle processing, 5G uplink transmission, server computation, and downlink broadcasting, that enables large-scale evaluations in automotive edge computing.

- **Facebook Reality Labs** May. 2019–Nov. 2019
  Research Intern
  - Designed and implemented mobile-edge-cloud computing simulator with realistic deployment of cellular networks and Facebook computing infrastructure, which allows nation-wide evaluation of edge computing deployment in terms of momentary costs, QoS, and service coverage.
  - Evaluated and profiled the performance of Facebook AR/VR algorithms and applications, e.g., computer vision and LiveMaps, on Facebook infrastructure production tiers.

Teaching

- ◇ Instructor, CSCE 464/864: Internet System and Programming, Spring 2022, UNL
- ◇ Instructor, CSCE 990: Multi-Access Edge Computing, Fall 2021, UNL
- ◇ Teaching Assistant, Power Electronics I, Fall 2018, UNCC
- ◇ Teaching Assistant, Computer Utilization in C++, Spring 2018, UNCC
- ◇ Teaching Assistant, Data Communications and Networking, Spring 2018, UNCC
- ◇ Teaching Assistant, Signals and Systems II, Fall 2017, UNCC
- ◇ Teaching Assistant, Logic and Networks, Spring 2017, UNCC
- ◇ Teaching Assistant, Signals and Systems I, Fall 2016, UNCC

Service

- Technical Program Committee Member for The International Conference on Networking and Services (ICNS)
- Reviewer for IEEE Open Journal of the Computer Society
- Reviewer for IEEE System Journal
- Reviewer for IEEE Journal on Selected Areas in Communications
- Reviewer for IEEE Transactions on Cognitive Communications and Networking
- Reviewer for Elsevier Measurement
- Reviewer for Digital Communication and Networks
- Reviewer for IEEE Transactions on Communications
- Reviewer for IEEE Access
- Reviewer for IEEE Communication Letters
- Reviewer for IEEE Transactions on Green Communications and Networking
- Reviewer for Elsevier Computer Communications
- Reviewer for Elsevier Computer Networks
- Reviewer for IEEE Global Communications Conference
- Reviewer for IEEE International Conference on Communications