Wen Wu

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RESEARCH INTEREST

- Artificial intelligence (AI) for networking: Edge intelligence, AI-driven networking, and hybrid data-model driven networking
- Networking for AI: Federated learning and split learning for wireless networks, and AI slice
- Network virtualization: Network slicing, AI-based slice management, and slicing-based vehicular networks
- mmWave networking: mmWave medium access control, anti-blockage design, and beam alignment

EMPLOYMENT

- **Postdoctoral Research Fellow**   **Oct. 2019 − Present**
  Department of Electrical and Computer Engineering
  University of Waterloo, Waterloo, Ontario, Canada
  Supervisor: Professor Xuemin (Sherman) Shen

EDUCATION

- **Doctor of Philosophy, Electrical and Computer Engineering**   **Sept. 2015 − Aug. 2019**
  University of Waterloo, Waterloo, Ontario, Canada
  Supervisor: Professor Xuemin (Sherman) Shen
  Thesis: Design and Analysis of Beamforming in mmWave Networks

- **Master of Engineering, Communication and Information Systems**   **Sept. 2012 − Jun. 2015**
  University of Science and Technology of China, Hefei, P. R. China
  Supervisor: Professor Guo Wei
  Thesis: Interference Alignment with Limited Feedback for Multiuser Interference Networks

- **Bachelor of Engineering, Information Engineering**   **Sept. 2008 − Jun. 2012**
  South China University of Technology, Guangzhou, P. R. China
  Advisors: Professor Yuli Fu and Professor Wenyi Zhang
  Final Year Project: Performance Analysis of Monobit Digital Receivers

HONORS and AWARDS

- Faculty of Engineering Graduate Scholarship Award, University of Waterloo   2019
- Graduate Scholarship, University of Waterloo   2015 − 2019
- International Doctoral Student Award, University of Waterloo   2015 − 2019
- Best Speaker Award, ECE Graduate Seminar Series, University of Waterloo   2015
- Guorui Scholarship, China Electronics Technology Corporation 14th Research Institute   2014
- China Scholarship for Encouragement, Ministry of Education of P. R. China   2010
- First Prize of South China University of Technology,
  Guangdong Province Undergraduate Contest in Physics Experiments Design   2010

PUBLICATION

Publication Statistics
- **1** book, **3** book chapters, **42** accepted/published papers (**23** journal papers and **17** conference papers), and **9** submitted
- **13** 中科院 1 区 papers, **9** 中科院 2 区 papers, **1** CCF A paper, **4** CCF B papers, **14** CCF C papers, **1** ESI highly cited paper, and **7** popular articles
- Total number of citations: **588**, and h-index: **11** (Source: Google Scholar, Date: Aug. 16, 2021)

Books

[B1] Peng Yang, **Wen Wu***, Ning Zhang, and Xuemin Shen, "Millimeter-Wave Networks: Beamforming Design and Performance Analysis," Springer Book Series on Wireless Networks. (**Around 170 pages**)

Book Chapters

[BC1] **Wen Wu**, Yujie Tang, Peng Yang, Weiting Zhang, and Ning Zhang, "Collaborative Deep Neural Network Inference via Mobile Edge Computing," in "Broadband Communications, Computing, and Control for Ubiquitous Intelligence," Springer Book Series on Wireless Networks.

[BC2] Qiang Ye and **Wen Wu**, "Network Slicing for 5G Networks and Beyond," in "Broadband Communications, Computing, and Control for Ubiquitous Intelligence," Springer Book Series on Wireless Networks.

[BC3] Yujie Tang and **Wen Wu**, "Routing Algorithms for Heterogeneous Vehicular Networks," in "Broadband Communications, Computing, and Control for Ubiquitous Intelligence," Springer Book Series on Wireless Networks.

Refereed Journal Papers

[J1] Xuemin Shen, Jie Gao, **Wen Wu**, Mushu Li, Conghao Zhou, and Weihua Zhuang, "Holistic Network Virtualization and Pervasive Network Intelligence for 6G," submitted to IEEE Communications Surveys and Tutorials (**COMST**). (**IF: 23.7, 中科院 1 区, Editor-in-Chief Invited Paper**)

[J2] Xuemin Shen, Jie Gao, **Wen Wu**, Kangjia Lyu, Mushu Li, Weihua Zhuang, Xu Li, and Jaya Rao, "AI-assisted Network-slicing based Next-generation Wireless Networks," IEEE Open Journal of Vehicular Technology (**OJVT**), vol. 1, no. 1, pp. 45–66, Jan. 2020. (**Editor-in-Chief Invited Paper, Popular Article, Cited: 55**)

[J3] **Wen Wu**, Nan Chen, Conghao Zhou, Mushu Li, Xuemin Shen, Weihua Zhuang, and Xu Li, "Dynamic RAN Slicing for Service-Oriented Vehicular Networks via Constrained Learning," IEEE Journal on Selected Areas in Communications (**JSAC**), vol. 39 no. 7, pp. 2076–2089, July 2021. (**IF: 11.42, CCF A, 中科院 1 区, Cited: 6**)

[J4] **Wen Wu**, Peng Yang, Weiting Zhang, Conghao Zhou, and Xuemin Shen, "Accuracy-Guaranteed Collaborative DNN Inference in Industrial IoT via Deep Reinforcement Learning," IEEE Transactions on Industrial Informatics (**TII**), vol. 17, no. 7, pp. 4988–4998, July 2021. (**IF: 9.112, 中科院 1 区, Cited: 1**)

[J5] **Wen Wu**, Nan Cheng, Ning Zhang, Peng Yang, Khalid Aldubaikhy, and Xuemin Shen, "Performance Analysis and Enhancement of Beamforming Training in 802.11ad," IEEE Transactions on Vehicular Technology (**TVT**), vol. 69, no. 5, pp. 5293–5306, May 2020. (**IF: 5.379, 中科院 2 区, Cited: 2**)

[J6] **Wen Wu**, Nan Cheng, Ning Zhang, Peng Yang, Weihua Zhuang, and Xuemin Shen, "Fast mmwave Beam Alignment via Correlated Bandit Learning," IEEE Transactions on Wireless Communications (**TWC**), vol. 18, no. 12, pp. 5894–5908, Dec. 2019. (**IF: 6.779, CCF B, 中科院 1 区, Cited: 20**)

[J7] **Wen Wu**, Ning Zhang, Nan Cheng, Yujie Tang, Khalid Aldubaikhy, and Xuemin Shen, "Beef up mmWave Dense Cellular Networks with D2D-Assisted Cooperative Edge Caching," IEEE Transactions on Vehicular Technology (**TVT**), vol. 68, no. 4, pp. 3890–3904, Apr. 2019. (**IF: 5.379, 中科院 2 区, Cited: 40**)

[J8] **Wen Wu**, Conghao Zhou, Mushu Li, Huaqing Wu, Haibo Zhou, Ning Zhang, Xuemin Shen, and Weihua Zhuang, "AI-Native Network Slicing for 6G Networks," IEEE Wireless Communications (**WCM**), under major revision , 2021.

[J9] Dong Yang, Kai Gong, Jie Ren, Weiting Zhang, **Wen Wu**, and Hongke Zhang, "TC-Flow: Chained Flow Scheduling for Advanced Industrial Applications in Time-Sensitive Networks," submitted to IEEE Network Magazine (**Network**), 2021.

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*Corresponding author

[J10] Ruijin Ding, Jiawei Chen, Jun Liu, Wen Wu, Feifei Gao, and Xuemin (Sherman) Shen, "Packet Routing in UAV Multi-Hop Network: A Multi-agent Deep Reinforcement Learning Approach," manuscript.

[J11] Weiting Zhang, Dong Yang, **Wen Wu**, Haixia Peng, Ning Zhang, Hongke Zhang, and Xuemin Shen, "Optimizing Federated Learning in Distributed Industrial IoT: A Multi-Agent Approach," IEEE Journal on Selected Areas in Communications (**JSAC**), major revision.

[J12] Zhe Ma, **Wen Wu**, Mengnan Jian, Feifei Gao, and Xuemin Shen, "Joint Constellation Design and Multiuser Detection for Grant-Free NOMA," IEEE Transactions on Wireless Communications (**TWC**), under minor revision.

[J13] Enfang Cui, Weiting Zhang, Dong Yang, **Wen Wu**, Jiawen Kang, and Hongke Zhang, "Resource-Efficient DNN Training and Inference for Heterogeneous Edge Intelligence in 6G," IEEE Network Magazine (**Network**), submission.

[J14] Qiong Liu, Peng Yang, **Wen Wu**, Ning Zhang, and Li Yu, "Intelligent In-Network Queue Control for Fair and Low-Latency Packet Transmission," submitted to IEEE Transactions on Cognitive Communications and Networking (**TCCN**).

[J15] Dairu Han, Wenhe Liao, Haixia Peng, Huaqing Wu, **Wen Wu**, and Xuemin Shen, "Edge Caching with Cooperative Multicast Beamforming in Integrated Satellite-Terrestrial Networks," submitted to IEEE Transactions on Vehicular Technology (**TVT**).

[J16] Chengxiao Yu, Wei Quan, Deyun Gao, Yuming Zhang, Kang Liu, **Wen Wu**, Hongke Zhang, and Xuemin Shen, "Reliable Cybertwin-Driven Concurrent Multipath Transfer with Deep Reinforcement Learning," IEEE Internet of Things Journal (**JIoT**), to appear, DOI: 10.1109/JIOT.2021.3101447, 2021. **(IF: 9.936, 中科院 1 区)**

[J17] Danyang Wang, Peihan Qi, Yue Zhao, Chenxi Li, **Wen Wu**, and Zan Li, "Covert Wireless Communication with Noise Uncertainty in Space-Air-Ground Integrated Vehicular Networks," IEEE Intelligent Transportation Systems Transactions (**TITS**), to appear, DOI: 10.1109/TITS.2021.3098790, 2021. **(IF: 6.492, CCF B, 中科院 2 区)**.

[J18] Weiting Zhang, Dong Yang, Haixia Peng, **Wen Wu**, Wei Quan, Hongke Zhang, and Xuemin Shen, "Deep Reinforcement Learning Based Resource Management for DNN Inference in Industrial IoT," IEEE Transactions on Vehicular Technology (**TVT**), to appear **(IF: 5.379, 中科院 2 区)**.

[J19] Ying Wang, Shaohua Wu, Jian Jiao, **Wen Wu**, Ye Wang, and Qinyu Zhang, "Age-Optimal Transmission Policy with HARQ for Freshness-Critical Vehicular Status Updates in Space-Air-Ground Integrated Networks," IEEE Internet of Things Journal (**JIoT**), early access, DOI: 10.1109/JIOT.2020.3047665, 2020. **(IF: 9.936, 中科院 1 区)**

[J20] Conghao Zhou, **Wen Wu**, Hongli He, Peng Yang, Feng Lyu, Nan Cheng, and Xuemin Shen, "Deep Reinforcement Learning for Delay-Oriented IoT Task Scheduling in Space-Air-Ground Integrated Network," IEEE Transactions on Wireless Communications (**TWC**), vol. 20, no. 2, pp. 911-925, Feb. 2021. **(IF: 6.779, CCF B, 中科院 1 区, Popular Article)**

[J21] Shushi Gu, Ye Wang, Niannian Wang, and **Wen Wu**, "Intelligent Optimization of Availability and Communication Cost in Satellite-UAV Mobile Edge Caching System with Fault-Tolerant Codes," IEEE Transactions on Cognitive Communications and Networking (**TCCN**), vol. 6, no. 4, pp. 1230-1241, Dec. 2020. **(IF: 4.574, 中科院 2 区, Popular Article)**

[J22] Meilin Gao, Bo Ai, Yong Niu, **Wen Wu**, Peng Yang, Feng Lyu, and Xuemin Shen, "Efficient Hybrid Beamforming with Anti-Blockage Design for High-Speed Railway Communications," IEEE Transactions on Vehicular Technology (**TVT**), vol. 69, no. 9, pp. 9643–9655, Sept. 2020. **(IF: 5.379, 中科院 2 区)**

[J23] Peng Yang, Feng Lyu, **Wen Wu**, Ning Zhang, Li Yu, and Xuemin Shen, "Edge Coordinated Query Configuration for Low-Latency and Accurate Video Analytics," IEEE Transactions on Industrial Informatics (**TII**), vol. 16, no. 7, pp. 4855–4864, Jul. 2020. **(IF: 9.112, 中科院 1 区, Cited: 12)**

[J24] Khalid Aldubaikhy, **Wen Wu**, Qiang Ye, and Xuemin Shen, "Low-Complexity User Selection Algorithm for Multiuser Transmission in mmWave WLANs," IEEE Transactions on Wireless Communications (**TWC**), vol. 19, no. 4, pp. 2397–2410, Apr. 2020. **(IF: 6.779, CCF B, 中科院 1 区)**

[J25] Khalid Aldubaikhy, **Wen Wu**, Ning Zhang, Nan Cheng, and Xuemin Shen, "mmWave IEEE 802.11ay for 5G Fixed Wireless Access," IEEE Wireless Communications (**WCM**), vol. 27, no. 2, pp. 88–85, Apr. 2020. **(IF: 11.391, 中科院 1 区)**

[J26] Yujie Tang, Peng Yang, **Wen Wu**, Jon W. Mark, and Xuemin Shen, "Interference Mitigation via Cross-Tier Cooperation in Heterogeneous Cloud Radio Access Networks," IEEE Transactions on Cognitive Communications and Networking (**TCCN**), vol. 6, no. 1, pp. 201–213, Mar. 2020. **(IF: 4.574, 中科院 2 区)**

[J27] Beixiong Zheng, Miaowen Wen, Shaoe Lin, **Wen Wu**, Fangjiong Chen, Fei Ji, and Hua Yu, "Design of Multi-Carrier LBT for LAA&WiFi Coexistence in Unlicensed Spectrum," **IEEE Network**, vol. 34, no. 1, pp. 76–83, Jan. 2020. **(IF: 8.808, 中科院 1 区, Cited: 11)**

[J28] Yujie Tang, Nan Cheng, **Wen Wu**, Yanpeng Dai, Miao Wang, and Xuemin Shen, "Delay-Minimization Routing for Heterogeneous VANETs with Machine Learning based Mobility Prediction," IEEE Transactions on Vehicular Technology (**TVT**), vol. 68, no. 4, pp. 3967–3979, Apr. 2019. **(IF: 5.379, 中科院 2 区, Popular Article, Cited: 73)**

[J29] Xiao Liu, Yuxin Liu, Ning Zhang, **Wen Wu**, and Anfeng Liu, "Trajectory of Unmanned Aerial Vehicles for Efficient Data Acquisition: A Matrix Filling Approach," IEEE Internet of Things Journal (**JIoT**), vol. 6, no. 2, pp. 1829–1840, Apr. 2019. **(IF: 9.936, 中科院 1 区, ESI Highly Cited Paper, Cited: 42)**

[J30] Ruijin Ding, Yadong Xu, Feifei Gao, Xuemin Shen, and **Wen Wu**, "Deep Reinforcement Learning for Router Selection in Network with Heavy Traffic," **IEEE Access**, vol. 7, pp. 37109–37120, 2019. **(IF: 3.745, 中科院 2 区)**

[J31] Ying Chen, Ning Zhang, Yongchao Zhang, Xin Chen, **Wen Wu**, and Xuemin Shen, "Energy Efficient Dynamic Offloading in Mobile Edge Computing for Internet of Things," IEEE Transactions on Cloud Computing (**TCC**), early access, DOI: 10.1109/TCC.2019.2898657, 2019. **(IF: 4.714, CCF C, 中科院 1 区, Popular Article, Cited: 92)**

[J32] Ying Chen, Ning Zhang, Yongchao Zhang, Xin Chen, **Wen Wu**, and Xuemin Shen, "TOFFEE: Task Offloading and Frequency Scaling for Energy Efficiency of Mobile Devices in Mobile Edge Computing," IEEE Transactions on Cloud Computing (**TCC**), early access, DOI: 10.1109/TCC.2019.2923692, 2019. **(IF: 4.714, CCF C, 中科院 1 区, Cited: 49)**

Refereed Conference Papers

[C1] **Wen Wu**, Qinghua Shen, Khalid Aldubaikhy, Nan Cheng, Ning Zhang, and Xuemin Shen, "Enhance the edge with beamforming: Performance analysis of beamforming-enabled WLAN", in Proc. International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks Workshop (**WiOpt Workshop**), Shanghai, China, May 7–11, 2018. **(Cited: 9)**

[C2] **Wen Wu**, Qinghua Shen, Miao Wang, and Xuemin Shen, "Performance Analysis of IEEE 802.11.ad Downlink Hybrid Beamforming", in Proc. IEEE International Conference on Communications (**ICC**), Paris, France, May 21–25, 2017. **(CCF C, Cited: 13)**

[C3] **Wen Wu**, Xu Li, Huarui Yin, Cheng Zhang, and Guo Wei, "A Joint Real Grassmannian Quantization Strategy for MIMO Interference Alignment with Limited Feedback", in Proc. International Conference on Computer Communications and Networks Workshop (**ICCCN Workshop**), Shanghai, China, Aug. 4–7, 2014.

[C4] Zhi Mao, Fengye Hu, Qihao Li, **Wen Wu**, and Xuemin Shen, "Joint Distributed Beamforming and Backscatter Cooperation for UAV-Assisted WPSNs", in Proc. IEEE Global Communications Conference (**Globecom**), 2021. **(CCF C)**

[C5] Conghao Zhou, Huaqing Wu, Mingcheng He, **Wen Wu**, Nan Cheng, and Xuemin Shen, "Adaptive Access Mode Selection in Space-Ground Integrated Vehicular Networks", in Proc. IEEE Global Communications Conference (**Globecom**) 2021. **(CCF C)**

[C6] Jie Lin, Peng Yang, **Wen Wu**, Ning Zhang, Tao Han, and Li Yu, "Edge Learning for Low-Latency Video Analytics: Query Scheduling and Resource Allocation", in Proc. IEEE International Conference on Mobile Ad-Hoc and Smart Systems (**MASS**), 2021. **(CCF C)**

[C7] Zhixuan Huang, Peng Yang, Ning Zhang, Feng Lyu, Qihao Li, **Wen Wu**, and Xuemin (Sherman) Shen, "QoE-driven Mobile 360 Video Streaming: Predictive View Generation and Dynamic Tile Selection", in Proc. IEEE/CIC International Conference on Communications in China (**ICCC**), 2021.

[C8] Zhe Ma, **Wen Wu**, Feifei Gao, and Xuemin Shen, "Multi-Task Learning Aided Joint Constellation Design and Multiuser Detection for GF-NOMA", IEEE International Conference on Communications (**ICC**), 2021. **(CCF C)**

[C9] Weiting Zhang, Dong Yang, **Wen Wu**, Haixia Peng, Wei Quan, Hongke Zhang, and Xuemin Shen, "Spectrum and computing resource management for federated learning in distributed industrial IoT", in Proc. IEEE International Conference on Communications Workshop (**ICC Workshop**), 2021.

[C10] Weiting Zhang, Dong Yang, Haixia Peng, **Wen Wu**, Wei Quan, Hongke Zhang, and Xuemin Shen, "Deep Reinforcement Learning Based Resource Management for DNN Inference in IIoT", in Proc. IEEE Global Communications Conference (**Globecom**), Virtual, Dec. 7–11, 2020. (**CCF C, Popular Article**)

[C11] Wei Wang, Conghao Zhou, Hongli He, **Wen Wu**, Weihua Zhuang, and Xuemin Shen, "Cellular Traffic Load Prediction with LSTM and Gaussian Process Regression", in Proc. IEEE International Conference on Communications (**ICC**), Virtual, Jun. 7–11, 2020. (**CCF C**)

[C12] Conghao Zhou, **Wen Wu**, Hongli He, Peng Yang, Feng Lyu, Nan Cheng, and Xuemin Shen, "Delay-aware IoT Task Scheduling in Space-air-ground Integrated Network", in Proc. IEEE Global Communications Conference (**Globecom**), Waikoloa, USA, Dec. 9–13, 2019. (**CCF C**)

[C13] Meilin Gao, Bo Ai, Yong Niu, **Wen Wu**, Peng Yang, Feng Lyu, and Xuemin Shen, "Edge Caching and Content Delivery with Minimized Delay for both High-Speed Train and Local Users", in Proc. IEEE Global Communications Conference (**Globecom**), Waikoloa, USA, Dec. 9–13, 2019. (**CCF C**)

[C14] Conghao Zhou, Hongli He, Peng Yang, Feng Lyu, Nan Cheng, **Wen Wu**, and Xuemin Shen, "Deep RL-based Trajectory Planning for AoI Minimization in UAV-assisted IoT", in Proc. IEEE International Conference on Wireless Communications and Signal Processing (**WCSP**), Xi'an, China, Oct. 23–25, 2019. (**Popular Article**)

[C15] Meilin Gao, Bo Ai, Yong Niu, **Wen Wu**, Peng Yang, Feng Lyu, and Xuemin Shen, "On Hybrid Beamforming of mmWave MU-MIMO System for High-Speed Railways", in Proc. IEEE International Conference on Communications (**ICC**), Shanghai, China, May 20–24, 2019. (**CCF C**)

[C16] Yujie Tang, Peng Yang, **Wen Wu**, Jon W. Mark, and Xuemin Shen, "Cooperation-based Interference Mitigation in Heterogeneous Cloud Radio Access Networks", in Proc. IEEE International Conference on Communications (**ICC**), Shanghai, China, May 20–24, 2019. (**CCF C, Invited for fast-track journal publication** in IEEE Transactions on Cognitive Communications and Networking (TCCN))

[C17] Feng Lyu, Peng Yang, Weisen Shi, Huaqing Wu, **Wen Wu**, Nan Cheng, and Xuemin Shen, "Online UAV Scheduling Towards Throughput QoS Guarantee for Dynamic IoVs", in Proc. IEEE International Conference on Communications (**ICC**), Shanghai, China, May 20–24, 2019. (**CCF C**)

[C18] Khalid Aldubaikhy, **Wen Wu**, and Xuemin Shen, "BF-PDVG: Hybrid Beamforming and User Selection for UL MU-MIMO mmWave Systems", in Proc. IEEE Global Communications Conference Workshop (**Globecom Workshop**), Abu Dhabi, UAE, Dec. 9-13, 2018.

[C19] Khalid Aldubaikhy, Qinghua Shen, Miao Wang, **Wen Wu**, Xuemin Shen, Osama Aboul-Magd, Yan Xin, Rob Sun, and Edward Au, "MAC layer design for concurrent transmissions in millimeter wave WLANs", in Proc. IEEE/CIC International Conference on Communications in China (**ICCC**), Qingdao, China, Oct. 22–24, 2017.

FUNDING APPLICATION ASSISTANCE

[F1] **Proactive User-centric Networking for Next Generation Wireless Communications**
Funded by NSERC Collaborative Research and Development Grant
PI: Professor Xuemin (Sherman) Shen
Industrial partner: Huawei Canada
My contributions: Milestone scheduling, activity planning, and monthly meeting with industrial cooperators.

[F2] **High Efficiency Wireless LAN MAC Layer Design**
Funded by NSERC Collaborative Research and Development Grant
PI: Professor Xuemin (Sherman) Shen
Industrial partner: Huawei Canada
My contributions: Milestone deliver and monthly meeting with industrial cooperators.

SELECTED SEMINARS AND PRESENTATIONS

[P1] RAN slicing for Vehicular Networks: Perspectives of AI and Optimization,
Huawei Workshop on Next Generation Networks: Theory and Technologies – Department of Electrical and Computer Engineering, University of Waterloo, Apr. 8, 2021.

[P2]   Dynamic RAN Slicing for Service-Oriented Vehicular Networks via Constrained Learning,
       BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Oct. 22, 2020.

[P3]   AI-assisted Next Generation Wireless Networks,
       UW & Huawei Workshop – Department of Electrical and Computer Engineering, University of Waterloo,
       Jul. 25, 2019.

[P4]   Design and Analysis of Beamforming in mmWave Networks,
       ECE PhD Seminar – Department of Electrical and Computer Engineering, University of Waterloo, Jul. 22, 2019.

[P5]   Design and Analysis of Beamforming in mmWave Networks,
       BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Jul. 15, 2019.

[P6]   Design and Analysis of mmWave Edge Networks,
       Graduate Research Seminars – Department of Electrical and Computer Engineering, University of Waterloo,
       Sept. 26, 2018.

[P7]   Design and Analysis of mmWave Edge Networks,
       BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Sept. 4, 2018.

[P8]   Enhance the Edge with Beamforming: Performance Analysis of Beamforming-Enabled WLAN,
       IEEE WiOpt Workshop – International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and
       Wireless Networks, Shanghai, China, May 7–11, 2018.

[P9]   Advanced Beamforming in Millimeter-Wave WLAN,
       BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Sept. 19,
       2017.

[P10] Dynamic Beamforming in Millimeter-Wave Networks,
       Graduate Research Seminars – Department of Electrical and Computer Engineering, University of Waterloo,
       Aug. 9, 2017.

[P11] Dynamic Beamforming in Millimeter-Wave Networks,
       BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Jul. 19, 2017.

[P12] Performance Analysis of IEEE 802.11ad Downlink Hybrid Beamforming,
       IEEE ICC – IEEE International Conference on Communications, Paris, France, May 21–25, 2017.

[P13] Millimeter Wave Communications: A Survey,
       BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Feb. 9, 2016.

[P14] Interference Alignment with Limited Feedback in Multiuser Interference Networks,
       Graduate Research Seminars – Department of Electrical and Computer Engineering, University of Waterloo,
       Dec. 2, 2015.

[P15] Interference Alignment with Limited Feedback in Multiuser Interference Networks,
       BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Oct. 15, 2015.

[P16] A Joint Real Grassmannian Quantization Strategy for MIMO Interference Alignment with Limited Feedback,
       ICCCN Workshop – IEEE International Conference on Computer Communications and Networks Workshop,
       Shanghai, China, Aug. 4–7, 2014.

RESEARCH EXPERIENCES

Department of Electrical and Computer Engineering, University of Waterloo, Canada
Postdoctoral Research Fellow, Broadband Communications Research (BBCR) Laboratory
■ **Artificial Intelligence for Next Generation Wireless Networks (1 JSAC, 1 TII, I WCM and 2 EIC invited papers)**
- *Edge Intelligence for Wireless Networking*   **Mar. 2020 – Present**
    - Design edge intelligence solutions for multi-dimensional resource management and differentiated service provisioning, especially in highly dynamic network environments
    - Develop edge intelligence protocols for large-scale wireless networks with distributed data storage, computing, and communication resources.

- *Intelligent Network Slicing for Vehicular Networks*   **Sept. 2019 – Present**
    - Cooperate with Huawei Canada Co. to investigate next generation vehicular networks
    - Design a dynamic radio access network (RAN) slicing framework to support Internet of vehicles services with different quality of service (QoS) requirements, adapting to spatial-temporally varying vehicle traffic

- Develop novel machine learning algorithms to make real-time RAN slicing decisions while satisfying multi-fold slice QoS requirements.

- ***Edge Inference for Industrial IoT*** **Sept. 2019 − Sept. 2020**
  - Designed a collaborative inference framework by leveraging on-board and edge computing resources to reduce deep neural network inference service delay
  - Designed a sampling rate adaption mechanism for IoT devices to reduce the amount of offloaded sensing data volume
  - Proposed a deep reinforcement learning based scheduling algorithm to make the optimal sampling rate adaption and resource allocation decisions.

Research Assistant, Broadband Communications Research (BBCR) Laboratory
- **Design and Analysis of Beamforming in mmWave Networks (1 TWC and 2 TVT papers)**
  - ***Beam Alignment for mmWave Communications*** **Sept. 2017 − Aug. 2019**
    - Proved that received signal strength among nearby beams in the beam alignment process is correlated in the multipath channel
    - Proposed a machine learning based fast beam alignment algorithm by leveraging correlation structure among beams and the prior knowledge on the channel fluctuation to reduce beam alignment latency
    - Analyzed theoretical performance to validate the proposed algorithm is asymptotically optimal.

  - ***Cooperative Edge Caching for mmWave Dense Networks*** **Sept. 2016 − Dec. 2018**
    - Proposed a device-to-device assisted cooperative edge caching policy by cooperatively utilizing cache resources of users and nearby small base stations to enhance caching performance
    - Derived closed-form expressions of backhaul offloading gain and content retrieval delay in mmWave dense networks based on stochastic network information
    - Analyzed the impacts of network density and practical directional antennas on the performance of the proposed caching policy.

  - ***Medium Access Control (MAC) Protocol for Beamforming Training*** **Sept. 2015 − Aug. 2019**
    - Collaborative research with Huawei Canada Co.
    - Proposed an analytical model to evaluate MAC performance of beamforming training protocol in IEEE 802.11ad standard
    - Derived the closed-form expressions of protocol performance, including successful training probability, network throughput and training latency
    - Developed an enhancement scheme to improve beamforming training efficiency by tuning protocol parameters with respect to user density.

University of Science and Technology of China, China
Research Assistant, Wireless Information Network Laboratory
- **Interference Alignment in Wireless Networks**
  - ***Interference Alignment with Limited Feedback*** **Mar. 2013 − Jun. 2015**
    - Analyzed the impact of limited feedback on interference alignment algorithms by deriving the average interference leakage in different wireless channels
    - Proposed a joint real Grassmannian quantization strategy to reduce the overhead of feedback information
    - Analyzed the theoretical performance of the proposed strategy based on chordal distance analysis
    - Analyzed the impact of channel estimation error on the interference alignment performance.

  - ***Performance Analysis of Monobit Digital Receivers*** **Feb. 2012 − Jun. 2012**
    - Analyzed the theoretical performance of optimal and suboptimal algorithms of the monobit digital receiver
    - Validated the theoretical results of two algorithms via simulations.

TEACHING AND MENTORING EXPERIENCES

Teaching Experiences

- **Teaching Assistant, University of Waterloo**   **Jan. 2017 – Apr. 2017**
  Undergraduate course: Numerical Methods (ECE 204A)
  Duties: Dealing with the problems students have during and after the classes, and marking assignments and final exam.

- **Certificate of ExpecTAtions Teaching Assistant (TA) Training Workshop**   **Sept. 2015**
  Department of Electrical and Computer Engineering, University of Waterloo
  The workshop involves:
    – Two short lectures consisting of surprise and prepared topics
    – A marking exercise under the guidance of two departmental mentors.

- **Teaching Assistant, University of Science and Technology of China**   **Sept. 2013 – Jan. 2014**
  Undergraduate course: Digital Signal Processing (00618701)
  Duties: Instructing students on group projects, preparing and delivering tutorials, answering students' questions, assisting in preparation and grading of exams.

Mentoring Experiences

- Conghao Zhou, PhD student at University of Waterloo   Sept. 2018 – Present
  Mentoring on machine learning based resource management for wireless networking
  Project: Deep reinforcement learning for delay-oriented IoT task scheduling in space-air-ground integrated network.
- Zehao Zhang, undergraduate co-op student at University of Waterloo   Apr. 2021 – Present
  Mentoring on federated learning algorithm design for wireless networks
  Project: Implementation and design of a federated learning algorithm design for wireless networks.
- Zhi Mao, visiting PhD student at University of Waterloo   Mar. 2021 – Present
  Mentoring on distributed beamforming design in UAV-assisted WPSNs
  Project: Joint distributed beamforming and backscatter cooperation for UAV-assisted WPSNs
- Dairu Han, visiting PhD student at University of Waterloo   Nov. 2019 – May 2021
  Mentoring on key techniques on beamforming design in satellite-terrestrial integrated networks
  Project: Joint cache placement and multicast beamforming design in integrated satellite-terrestrial networks.
- Weiting Zhang, visiting PhD student at University of Waterloo   Nov. 2019 – Nov. 2020
  Mentoring on machine learning based resource management algorithm design
  Project: Deep reinforcement learning based resource management for industrial IoT networks.
- Zhe Ma, visiting PhD student at University of Waterloo   Nov. 2019 – Nov. 2020
  Mentoring on deep learning based multiuser detection
  Project: Joint constellation design and multiuser detection for grant-free NOMA
- Meilin Gao, visiting PhD student at University of Waterloo   Sept. 2017 – Dec. 2019
  Mentoring on mmWave network architecture and key techniques on beamforming design
  Project: Efficient hybrid beamforming design for high-speed railway communications.
- Chuqing Hu, undergraduate co-op student at University of Waterloo   Jan. 2020 – Apr. 2020
  Mentoring on machine learning algorithm design for vehicular networks
  Project: Implementation of a learning based resource management algorithm for vehicular networks.

VOLUNTEER EXPERIENCES

- **Group Coordinator, BBCR AI Research Group (8 members)**   **Mar. 2019 – Present**
  Duties: Organizing group members to do advanced research, developing technologies for next generation wireless networks, discussing research ideas with group members, discussing with the researchers of industrial partner, Huawei, Canada about the project progress, organizing biweekly group meetings and backup meeting files, and collecting meeting notes and writing minutes.
- **IEEE Student Branch Chair,**
  University of Science and Technology of China   **May 2013 – May 2014**
  Duties: Organizing a number of IEEE on-campus events for undergraduate and graduate students, hosting research seminars on new technologies, inviting distinguished professors to share research experience, organizing volunteers for IEEE conferences, and attracting new IEEE student members.
- **Conference Volunteer, IEEE VTC-Fall 2017, Toronto, Canada**   **Sept. 24–27, 2017**

PROFESSIONAL SERVICES

Editor
- Guest Editor, *China Communications*, special issue on "IoT Intelligence Empowered by End-Edge-Cloud Orchestration", 2022

Conference Organization
- Workshop Co-chair, IEEE HPCC 2021 (CCF C), IEEE 23rd High Performance Computing and Communications Conference on "Distributed Intelligence for Future High Performance Unmanned Mobile Systems (DIFUS)"
- Track Co-chair, EAI CollaborateCom 2021 (CCF C), EAI 14th International Conference on Collaborative Computing Conference on "Internet of Things"
- Workshop Co-chair, IEEE IPCCC 2021 (CCF C), IEEE 40th International Performance Computing and Communications Conference on "Edge Intelligence for 6G Networks (EI)"

Technical Program Committee
- IEEE International Conference on Communications (ICC) 2021
- EAI International Conference on Collaborative Computing 2021
- IEEE International Performance Computing and Communications Conference Workshop (IPCCC Workshop) 2021
- IEEE International Conference on Computing, Networking and Communications (ICNC) 2019
- IEEE International Conference on Wireless Communications and Signal Processing (WCSP) 2019
- IEEE Vehicular Technology Conference Fall (VTC-Fall) 2020, 2021
- IEEE Vehicular Technology Conference Fall Workshop (VTC-Fall Workshop) 2020

Session Chair
- Heterogeneous Networks, VTC-Fall 2017, Toronto, Canada, Sept. 23–24, 2017

Reviewer of Refereed Journals and Conferences
- IEEE Communication Magazine (CM)
- IEEE Wireless Communications Magazine (WCM)
- IEEE Network Magazine
- ACM/IEEE Transactions on Networking (TON)
- IEEE Journal on Selected Areas in Communications (JSAC)
- IEEE Transactions on Mobile Computing (TMC)
- IEEE Transactions on Wireless Communications (TWC)
- IEEE Transactions on Communications (TCOM)
- IEEE Transactions on Industrial Informatics (TII)
- IEEE Internet of Thing Journal (IoTJ)
- IEEE Transactions on Vehicular Technology (TVT)
- IEEE Transactions on Cognitive Communications and Networking (TCCN)
- IEEE Communication Letters (CL)
- IEEE Wireless Communication Letters (WCL)
- IEEE Access
- Springer Wireless Networks (WN)
- Wiley ETRI Journal
- Wiley IET Communications
- Elsevier Computer Networks (CN)
- SAGE International Journal of Distributed Sensor Networks
- IEEE Global Communications Conference (GLOBECOM) 2020
- IEEE International Conference on Communications (ICC) 2021
- IEEE Vehicular Technology Conference (VTC) 2020
- IEEE International Conference on Computing, Networking and Communications (ICNC) 2019
- IEEE International Conference on Wireless Communications and Signal Processing (WCSP) 2014, 2019

CONTACT INFORMATION OF PROFESSIONAL REFERENCES

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