Wen Wu

Frontier Research Center
Peng Cheng Laboratory
2 Xingke No. 1 Street
Shenzhen, Guangdong, P. R. China

Email: wuw02@pcl.ac.cn,
w77wu@uwaterloo.ca
Homepage: https://wuwenustc.github.io/

RESEARCH INTEREST

- Holistic network virtualization: Digital twin, Network slicing, and AI-based slice management
- Artificial intelligence (AI) for networking: Edge intelligence, AI-driven networking, and hybrid data-model driven networking
- Networking for AI: Federated learning, split learning, connected intelligence, and AI service
- mmWave networking: mmWave medium access control, and beam alignment

EMPLOYMENT

- **Associate Researcher** **Nov. 2021 – Present**
  Frontier Research Center
  Peng Cheng Laboratory, Shenzhen, Guangdong, P. R. China

- **Postdoctoral Research Fellow** **Oct. 2019 – Aug. 2021**
  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, **1** US patent, **51** accepted/published papers (**29** journal papers and **22** conference papers), and **7** preprints
- **19** Chinese Academy of Sciences (CAS) Q1 papers, **9** CAS Q2 papers, **2** China Computer Federation (CCF) A paper, **5** CCF B papers, **1** ESI highly cited paper, and **8** popular articles
- Total number of citations: **846**, h-index: **15**, and i10-index: **21** (Source: Google Scholar, Date: Jan. 18, 2022)

Books

[B1] Peng Yang, **Wen Wu**, Ning Zhang, and Xuemin Shen, "Millimeter-Wave Networks: Beamforming Design and Performance Analysis," ISBN-10: 3030886298, ISBN-13: 9783030886295, 2021, 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.

Patent

[P1] Xuemin Shen, **Wen Wu**, Mushu Li, Kaige Qu, Conghao Zhou, Weihua Zhuang, and X. Li, "Systems and Methods for Cluster-Based Parallel Split Learning," United States, 2022. The proposed filing date is Apr. 8, 2022.

Preprints and Manuscripts

[P1] Ruijin Ding, Jiawei Chen, **Wen Wu**, Jun Liu, Feifei Gao, and Xuemin (Sherman) Shen, "Packet Routing in UAV Multi-Hop Network: A Multi-agent Deep Reinforcement Learning Approach," submitted to IEEE Transactions on Vehicular Technology (**TVT**).

[P2] 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**).

[P3] Jie Lin, Peng Yang, **Wen Wu**, Ning Zhang, Tao Han, and Li Yu, "Resource-Efficient Adaptive Query Scheduling for Low-Latency Edge Video Analytics," under revision, IEEE Transactions on Mobile Computing (**TMC**).

[P4] Haina Zheng, Ke Xiong, **Wen Wu**, Pingyi Fan, Zhangdui Zhong, and Xuemin Shen, "Age of Information-Based Efficiency Design in Point-to-Point Communication Link", submitted to Wireless Communications Letter.

[P5] Zhe Ma, **Wen Wu**, Feifei Gao, and Xuemin Shen, "Deep-Learned Non-Coherent Transmission for Massive Machine-Type Communications", manuscript.

[P6] Zhi Mao, Fengye Hu, **Wen Wu**, Huaqing Wu, Xuemin Shen, "Joint Distributed Beamforming and Backscatter Cooperation for UAV-Assisted WPSNs", manuscript.

[P7] Zhixuan Huang, Peng Yang, Ning Zhang, Feng Lyu, Qihao Li, **Wen Wu**, and Xuemin Shen, "Design and Analyze for Joint Framework of Viewpoint Prediction and Tile Selection", manuscript.

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," IEEE Communications Surveys and Tutorials (**COMST**), to appear, 2021. (**Editor-in-Chief Invited Paper, IF: 23.7, Q1**)

[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: 100)**

[J3] **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**), to appear, 2021. **(IF: 11.391, Q1)**

[J4] **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, Q1, Cited: 26)**

[J5] **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, Q1, Cited: 10)**

[J6] **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, Q2, Cited: 10)**

[J7] **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, Q1, Cited: 47)**

[J8] **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, Q2, Cited: 49)**

[J9] Dairu Han, Wenhe Liao, Haixia Peng, Huaqing Wu, **Wen Wu**, and Xuemin Shen, "Edge Caching with Cooperative Multicast Beamforming in Integrated Satellite-Terrestrial Networks," IEEE Transactions on Vehicular Technology (**TVT**), to appear, 2021. **(IF: 5.379, Q2)**

[J10] 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," to appear, IEEE Network Magazine (**Network**). **(IF: 8.808, Q1)**

[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**), vol. 39, no. 12, pp. 3688–3703, Dec. 2021. **(IF: 11.42, CCF A, Q1, Popular Article)**

[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**), to appear. **(IF: 6.779, CCF B, Q1)**

[J13] 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, vol. 8, no. 22, pp. 16207–16218, Nov. 2021. **(IF: 9.936, Q1)**

[J14] 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, Q1)**.

[J15] 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, Q2)**.

[J16] 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, Q1)**

[J17] 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, Q1, Popular Article)**

[J18] 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, Q2, Popular Article)**

[J19] 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, Q2)**

[J20] 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, Q1, Cited: 12)**

[J21] 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, Q1)**

[J22] 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, Q1)**

[J23] 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, Q2)**

[J24] 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, Q1, Cited: 11)**

[J25] 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, Q2, Popular Article, Cited: 73)**

[J26] 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, Q1, ESI Highly Cited Paper, Cited: 42)**

[J27] 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, Q2)**

[J28] 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**), vol. 9, no. 3, pp. 1050–1060, Jul. 2021. **(IF: 4.714, CCF C, Q1, Popular Article, Cited: 101)**

[J29] 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**), vol. 9, no. 4, pp. 1634–1644, Oct. 2021. **(IF: 4.714, CCF C, Q1, Cited: 49)**

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: 10)**

[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: 15)**

[C3] **Wen Wu**, X. Li, H. Yin, C. Zhang, and G. Wei,"A Joint Real Grassmannian Quantization Strategy for SISO IA with Limited Feedback," in Proc. IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (**PIMRC**), Washington, USA, Sep. 2–5, 2014.

[C4] **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.

[C5] Jiawei Chen, Ruijin Ding, **Wen Wu**, Jun Liu, Feifei Gao, and Xuemin (Sherman) Shen, "Multi-Agent Learning Based Packet Routing in Multi-Hop UAV Relay Network", in Proc. IEEE International Conference on Communications (**ICC**), Seoul, South Korea, May 16–20, 2022. **(CCF C)**

[C6] Enfang Cui, Weiting Zhang, Dong Yang, **Wen Wu**, and Feng Lyu, "Resource-Efficient DNN Training and Inference for Heterogeneous Edge Intelligence in 6G," in Proc. IEEE International Conference on High Performance Computing and Communications Workshop (**HPCC Workshop**), 2021.

[C7] 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)**

[C8] 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)**

[C9] 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)**

[C10] 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.

[C11] Zhe Ma, **Wen Wu**, Feifei Gao, and Xuemin Shen,"Multi-Task Learning Aided Joint Constellation Design and Multiuser Detection for GF-NOMA", in Proc. IEEE International Conference on Communications **(ICC)**, 2021. **(CCF C)**

[C12] 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.

[C13] 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)**

[C14] 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)**

[C15] 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)**

[C16] 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)**

[C17] 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)**

[C18] 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)**

[C19] 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))

[C20] 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)**

[C21] 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.

[C22] 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] Network Slicing for Service-Oriented Vehicular Networks,
International Workshop on Mobile Edge Computing and Security – Peng Cheng Laboratory & University of Electronic Science and Technology of China, Jan. 8-9, 2022.

[P2] 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.

[P3] 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.

[P4] AI-assisted Next Generation Wireless Networks,
UW & Huawei Workshop – Department of Electrical and Computer Engineering, University of Waterloo, Jul. 25, 2019.

[P5] Design and Analysis of Beamforming in mmWave Networks,
ECE PhD Seminar – Department of Electrical and Computer Engineering, University of Waterloo, Jul. 22, 2019.

[P6] Design and Analysis of Beamforming in mmWave Networks,
BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Jul. 15, 2019.

[P7] Design and Analysis of mmWave Edge Networks,
Graduate Research Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Sept. 26, 2018.

[P8] Design and Analysis of mmWave Edge Networks,
BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Sept. 4, 2018.

[P9] 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.

[P10] Advanced Beamforming in Millimeter-Wave WLAN,
BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Sept. 19, 2017.

[P11] Dynamic Beamforming in Millimeter-Wave Networks,
Graduate Research Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Aug. 9, 2017.

[P12] Dynamic Beamforming in Millimeter-Wave Networks,
BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Jul. 19, 2017.

[P13] Performance Analysis of IEEE 802.11ad Downlink Hybrid Beamforming,
IEEE ICC – IEEE International Conference on Communications, Paris, France, May 21–25, 2017.

[P14] Millimeter Wave Communications: A Survey,
BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Feb. 9, 2016.

[P15] Interference Alignment with Limited Feedback in Multiuser Interference Networks,
Graduate Research Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Dec. 2, 2015.

[P16] Interference Alignment with Limited Feedback in Multiuser Interference Networks,
BBCR Seminars – Department of Electrical and Computer Engineering, University of Waterloo, Oct. 15, 2015.

[P17] 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 – Oct. 2021**
  - 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 – Oct. 2021**
  - 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

- 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
- Conghao Zhou, PhD student at University of Waterloo Sept. 2018 – Oct. 2021
  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 – Aug. 2021
  Mentoring on federated learning algorithm design for wireless networks
  Project: Implementation and design of a federated learning algorithm design for wireless networks.
- 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 (10 members)** **Mar. 2019 – Oct. 2021**
  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
- Lead Guest Editor, Wireless Communications and Mobile Computing, special issue on "AI-Empowered Resource Orchestration for QoS Provisioning in 6G", 2022
- Guest Editor, China Communications, special issue on "IoT Intelligence Empowered by End-Edge-Cloud Orchestration", 2022
- Editorial Board, Frontiers in Internet of Things, Special Section on IoT Services and Applications

Conference Organization
- Workshop TPC Co-Chair, IEEE INFOCOM 2022 Workshop on Pervasive Network Intelligence for 6G Networks (PerAI-6G)
- Workshop TPC Co-Chair, IEEE HPCC 2021
- Track Co-Chair, EAI CollaborateCom 2021
- Workshop Co-Chair, IEEE IPCCC 2021

Technical Program Committee
- IEEE ICC 2022
- IEEE ICC 2022 Workshop
- IEEE ICNC 2019
- IEEE WCSP 2019
- IEEE VTC-Fall 2020, 2021
- IEEE VTC-Fall 2020 Workshop

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 (NET)
- 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
- Information Processing and Management
- 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

- **Xuemin (Sherman) Shen**
  University Professor, IEEE Fellow, EIC Fellow, CAE Fellow, RSC Fellow
  Chinese Academy of Engineering Foreign Member
  Department of Electrical and Computer Engineering
  University of Waterloo
  200 University Ave. West
  Waterloo, Ontario, Canada, N2L 3G1
  Email: sshen@uwaterloo.ca
  Homepage: `http://bbcr.uwaterloo.ca/~xshen/`
  Tel: +1 (519) 888-4567 ext. 32691

- **Xianbin Wang**
  Professor, IEEE Fellow, CAE Fellow
  Tier-I Canada Research Chair
  Department of Electrical and Computer Engineering
  Western University
  1151 Richmond St
  London, Ontario, Canada, N6A 3K7
  Email: xianbin.wang@uwo.ca
  Homepage: `https://www.eng.uwo.ca/electrical/faculty/wang_x/`
  Tel: +1 (519) 661-2111 ext. 81298

- **Ning Zhang**
  Associate Professor, IEEE Senior Member
  Tier-2 Canada Research Chair
  Department of Electrical and Computer Engineering
  University of Windsor
  401 Sunset Ave
  Windsor, Ontario, Canada, N9B 3P4
  E-mail: ning.zhang@uwindsor.ca
  Homepage: `https://ningece.wordpress.com/`
  Tel: +1 (519) 253-3000 ext. 5954

- **Xu Li**
  Senior Principal Engineer
  Huawei Technologies, Ottawa, Canada
  303 Terry Fox Dr
  Kanata, Ontario, Canada, K2K 3J1
  Email: xu.lica@huawei.com
  Homepage: `https://sites.google.com/site/easylix/`
  Tel: +1 (613) 408-1918