

IEEE ICUS 2022

Invited Session Summary

Title of Session

Cooperative Communication and Computing of
6G-Oriented Unmanned Swarm Systems

Name, Salutation and Affiliation of Organizers

1. Prof. Daxin Tian

Beihang University, China

2. Dr. Jianshan Zhou

Beihang University, China

Biosketches of Organizers



Daxin Tian (Senior Member, IEEE) received the Ph.D. degree in Technology of Computer Application from Jilin University, China, in 2007. He is currently a Professor with the School of Transportation Science and Engineering, Beihang University, Beijing, China. His current research interests include mobile computing, intelligent transportation systems, vehicular ad hoc networks, and swarm intelligence. Prof. Tian leads about 11 research projects such as the projects funded by the National Natural Science Foundation and the National Key Research and Development Program. He has authored/co-authored about 213 journal/conference papers, published 7 monographs and 2 translations, authorized 34 invention patents. He was the recipient of the Second Prize of the National Science and Technology Award in 2015 and 2018, the First Prize of the Technical Invention Award of the Ministry of Education in 2017, the First Prize of the Science and Technology Award from the China Intelligent Transportation Association in 2017, the First Prize of the Innovation and Development Award from the China Association of Productivity Promotion Centers in 2020, and seven other ministerial and provincial science and technology awards. He also received the Changjiang Youth Scholars Program of China in 2018 and the Outstanding Youth Fund from the National Natural Science Foundation of China in 2019, the Forum Keynote Award from the 2019 Cyberspace Congress, the Outstanding Invited Speaker from the 2020 International Conference on Blockchain and Trustworthy Systems, and the Distinguished Young Investigator of China Frontiers of Engineering from Chinese

Academy of Engineering in 2018. He was also awarded the Exemplary Reviewer for IEEE Wireless Communications Letters. He is a senior member of IEEE, CCF, and ITSC, and was or is the Editor-in-Chief of International Journal of Vehicular Telematics and Infotainment Systems, the Associate Editor of IEEE Transactions on Intelligent Vehicles, IEEE Internet of Things Journal, Complex System Modeling and Simulation, and Journal of Intelligent and Connected Vehicles.



Jianshan Zhou received the B.Sc., M.Sc., and Ph.D. degrees in traffic information engineering and control from Beihang University, Beijing, China, in 2013, 2016 and 2020, respectively. From 2017 to 2018, he was a Visiting Research Fellow with the School of Informatics and Engineering, University of Sussex, Brighton, U.K. He is currently a Postdoctoral Research Fellow

supported by the Zhuoyue Program of Beihang University and the National Postdoctoral Program for Innovative Talents, and is or was the Technical Program Session Chair with the IEEE EDGE 2020, the TPC member with the IEEE VTC2021-Fall track, and the Youth Editorial Board Member of the Unmanned Systems Technology. He is the author or coauthor of more than 20 international scientific publications. His research interests include the modeling and optimization of vehicular communication networks and air-ground cooperative networks, the analysis and control of connected autonomous vehicles, and intelligent transportation systems. He was the recipient of the First Prize in the Science and Technology Award from the China Intelligent Transportation Systems Association in 2017, the First Prize in the Innovation and Development Award from the China Association of Productivity Promotion Centers in 2020, the National Scholarships in 2017 and 2019, the Outstanding Top-Ten Ph.D. Candidate Prize from Beihang University in 2018, the Outstanding China-SAE Doctoral Dissertation Award in 2020, and the Excellent Doctoral Dissertation Award from Beihang University in 2021.

Details of Session

Recently, as a new-round evolution of information communication technologies (ICT) and industries is accelerated around the world, the Internet of Things based on cellular communications and wireless local area networks have been significantly advanced. However, there are several great limitations to the information interaction and processing performance of existing connected and unmanned swarm systems (e.g., autonomous vehicle platoons, unmanned aerial vehicles, etc.). For example,

cellular communications heavily rely on base stations, which will not meet the transmission demands of unmanned swarm systems in some infrastructure-less areas. Due to resource constraints, the physical nodes of an unmanned swarm system alone cannot meet the increasing computing and storage demands of various emerging applications efficiently. Besides, massive smart sensors are envisioned to be integrated with end nodes and infrastructures to realize the autonomy and intelligence of large-scale unmanned swarm systems, which requires ultra-reliable low-latency wireless communication networks with ubiquitous coverage. Therefore, to tackle the emerging demands and challenges, it is needed to investigate and develop 6G-oriented communication and computing technologies for enabling existing and envisioned unmanned swarm systems. The novel system architectures and technical paradigms will combine as well as extend existing 5G technologies. Advanced unmanned swarm systems will incorporate a wide range of radio access technologies, such as cellular communications, satellite communications, unmanned aerial vehicle-assisted communications, to form heterogeneous networks. They also depend on a space-air-ground integrated framework to provision more ubiquitous wireless connectivity and comprehensive performance enhancement in terms of transmission data rate, end-to-end latency, connection reliability, spectral efficiency, and other metrics. In addition, joining artificial intelligence (AI), swarm intelligence, and mobile edge computing into unmanned systems can achieve an elegant breakthrough in the cooperation of communication and computing and the integration of cyber and physical components in the systems. At this point, the 6G-oriented unmanned swarm systems receive more and more attention from both academia and industries.

The scope of this session is to present and highlight the potential challenges, the theoretical and technical advances, the latest implementations and applications in the field of 6G-oriented unmanned swarm systems such that the theoretical and practical frontiers can be moved forward for a deeper understanding from both academic and industrial viewpoints. We particularly have an interest in the submissions on joining emerging communication and computing solutions together to dramatically improve the performance of existing and envisioned unmanned swarm systems. Possible topics include but are not limited to:

- Swarm intelligence (SI) models and high-reliability and low-latency mechanisms for large-scale wireless ad hoc networks
- AI-driven system architectures and resource optimization for space-air-

ground integrated ubiquitous networks

- High-efficiency data transmission theories, methods, and key technologies for software-defined unmanned swarm systems
- Spatial-temporal perception and fusion methods of multi-dimensional multi-scale information for 6G-oriented unmanned swarm systems
- Cyber security-guaranteed edge computing and blockchain technologies for 6G-oriented unmanned swarm systems