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XI'AN, CHINA | JULY 5-7, 2024

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中国通信学会 China Institute of Communications

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飞博光电 fiber-photonics

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Fuhui Zhou, Nanjing University of Aeronautics and Astronautics

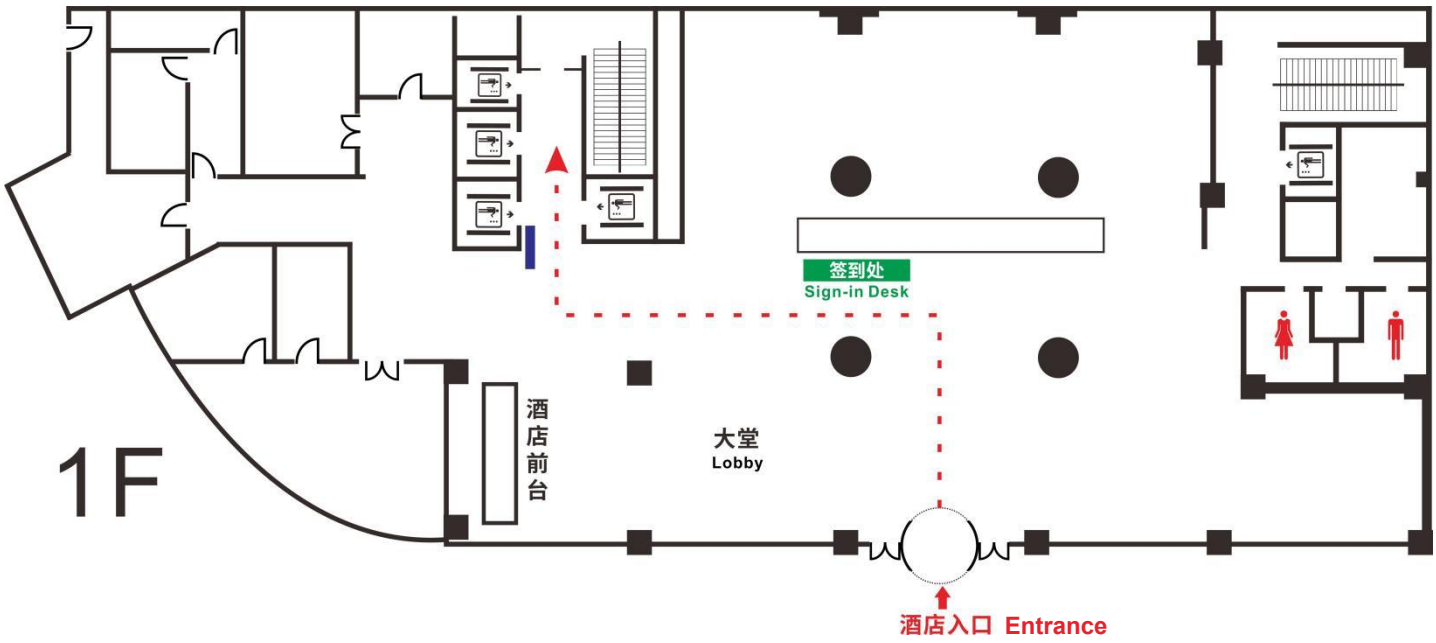
Haibo Zhou, Nanjing University

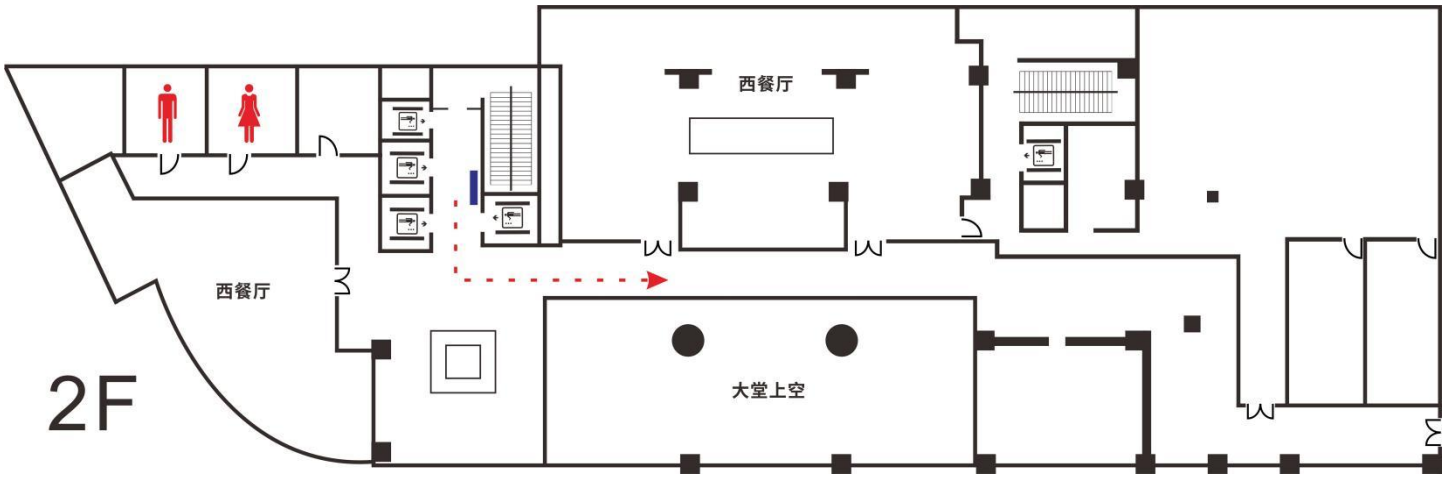
Conference Venue

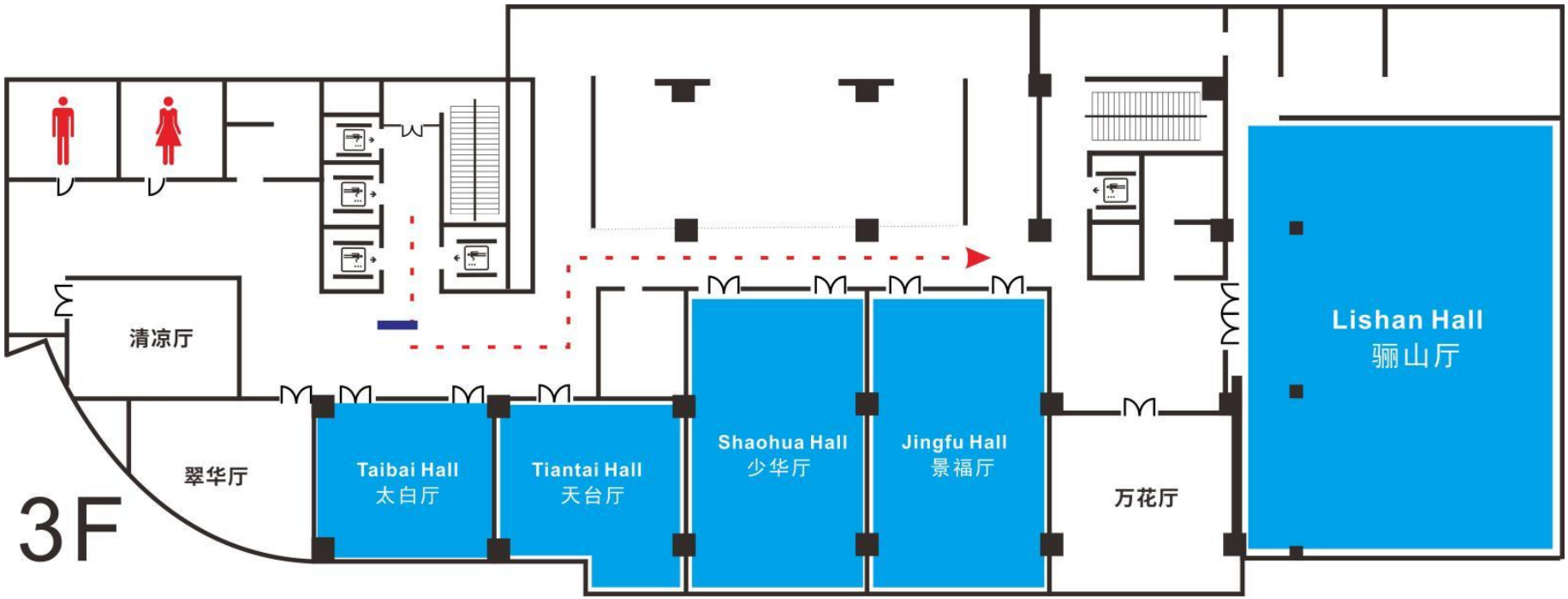
Grand Barony Xi'an / 西安天骊君廷酒店

Address: No.198 Taibai South Road, Xi'an, 710065, Shaanxi, China / 陕西省西安市雁塔区太白南路 198 号

Floor Plan






3F
清凉厅
翠华厅
Taibai Hall
太白厅
Tiantai Hall
天台厅
Shaohua Hall
少华厅
Jingfu Hall
景福厅
万花厅
Lishan Hall
骊山厅


4F
君廷宴会厅
Grand Barony Ballroom
休息室
电梯
Conference Backboard
合影背景板

Agenda Overview

July 5, 2024

Time	Activities	Venue
10:00-20:00	Sign-in	Lobby @1F

July 6, 2024-Morning

Opening Ceremony		
Host: Zan Li, Vice President of Xidian University		
08:40-09:10	Opening Remarks & Awards Ceremony	Grand Barony Ballroom @4F
Keynote Speech		
Host: Zan Li, Vice President of Xidian University		
09:10-09:40	**Hongke Zhang,** Academician of the Chinese Academy of Engineering, IEEE Fellow, Beijing Jiaotong University, China **Speech Title: Research and Exploration of Emerging Network**	Grand Barony Ballroom @4F
09:40-10:00 | Group Photo & Break		
Keynote Speech		
Host: Yunsong Li, Executive Dean of School of Telecommunications Engineering, Xidian University		
10:00-10:30	**Jianxin Liao,** Fellow of the Chinese Institute of Electronics, Beijing University of Posts and Telecommunications, China **Speech Title: 6G Intelligent Service Network: Vision, Architecture, and Key Technologies**	Grand Barony Ballroom @4F
10:30-11:00	**Tony Q.S. Quek,** Fellow of Academy of Engineering Singapore, IEEE Fellow, Singapore University of Technology and Design, Singapore **Speech Title: A Pathway Towards Future Network Intelligence: RAN Intelligent Controller Meets Semantic Communications**	
11:00-11:30	**Fumiyuki Adachi,** IEEE Life Fellow, Tohoku University, Japan **Speech Title: Distributed MIMO-based Radio Access Network for 6G Cellular Communications**	
11:30-12:00	**Bo Ai,** IEEE Fellow, IET Fellow, Beijing Jiaotong University, China **Speech Title: MIMO Channel Measurement and Modeling**	

July 6, 2024-Afternoon

Time	Activities	Venue
14:00-15:30	Young Scientist Forum	Shaohua Hall @3F
14:00-17:30	Experiencing China • International Academic Exchange Conference	Lishan Hall @3F
13:30-15:30	Parallel Session 01: Communication Theory and Techniques	Taibai Hall @3F
13:30-15:15	Parallel Session 02: Signal Processing & Image Processing	Tiantai Hall @3F
15:30-15:50 | Break		
16:00-17:15	Young Scientist Forum	Shaohua Hall @3F
15:50-18:05	Parallel Session 03: Communication Theory and Techniques	Taibai Hall @3F
	Parallel Session 04: Machine Learning & Optimization for Wireless Systems	Tiantai Hall @3F

July 7, 2024-Morning

Time	Activities	Venue
08:00-10:30	Parallel Session 05: Networking	Shaohua Hall @3F
08:30-10:30	Parallel Session 06: Signal Processing & Image Processing	Jingfu Hall @3F
10:30-10:50 | Break		
10:50-12:20	Parallel Session 07: Workshop on Joint Communication, Sensing and Computing for Next Generation Network	Shaohua Hall @3F
10:50-12:05	Parallel Session 08: Signal Processing & Image Processing	Jingfu Hall @3F

July 7, 2024-Afternoon

Time	Activities	Venue
13:30-15:45	Parallel Session 09: Machine Learning & Optimization for Wireless Systems	Shaohua Hall @3F
	Parallel Session 10: Communication Theory and Techniques	Jingfu Hall @3F
15:45-16:00 | Break		
16:00-18:30	Parallel Session 11: Emerging Technologies, Standards, and Applications	Shaohua Hall @3F
16:00-18:15	Parallel Session 12: Communication Theory and Techniques	Jingfu Hall @3F

Keynote Speech

09:10-09:40 @Grand Barony Ballroom

Hongke Zhang

Academician of the Chinese Academy of Engineering, IEEE Fellow
Beijing Jiaotong University, China

Hongke Zhang, IEEE Fellow, received the M.S. and Ph.D. degrees in electrical and communication systems from the University of Electronic Science and Technology of China, Chengdu, China, in 1988 and 1992, respectively. He is currently a Professor with the School of Electronic and Information Engineering, Beijing Jiaotong University, the Director of a National Engineering Lab on Next Generation Internet Technologies. He is also with the Department of New Networks, Peng Cheng Laboratory, Shenzhen, China. His research has resulted in many papers, books, patents, systems, and equipment in the areas of communications and computer networks. He has won two national technological invention of China and has authored of more than ten books and the holder of more than 100 patents. Prof. Zhang is the Chief Scientist of a National Basic Research Program of China (973 Program) and the Fellow of Chinese Academy of Engineering (CAE).

[Speech Title] Research and Exploration of Emerging Network

Abstract: Traditional Internet technologies have achieved tremendous success, but they are also facing new demands and challenges brought by special industry applications, such as high mobility, high security, and determinism. There is an urgent need for technological innovation to meet the industry's pressing needs. This report will introduce the research and exploration of the National Engineering Research Center team in emerging network technologies, focusing on the evolution and application prospects of emerging network technology achievements represented by the Smart Integration Identifier Network in specialized network engineering.

Keynote Speech

10:00-10:30 @Grand Barony Ballroom

Jianxin Liao

Fellow of the Chinese Institute of Electronics
Beijing University of Posts and Telecommunications, China

Deputy Director of the National Key Laboratory of Network and Switching, Director of Network Intelligence Research Center, Fellow of the Chinese Institute of Electronics, National Jieqing Youth, Head of the National Key R&D Program, and Head of the Ministry of Education's Innovation Team. He has long been devoted to the theoretical and engineering research of service network, won the Third National Innovation and Pioneering Certificate, won the Second Prize of National Scientific and Technological Progress for three times as the first complete person, won the major technological invention of the Ministry of Information and Industry, and published more than 60 academic papers in top international journals and conferences. His research achievements in service networks have been widely applied nationwide.

[Speech Title] 6G Intelligent Service Network: Vision, Architecture, and Key Technologies

Abstract: The mobile communication service network is responsible for the adaptation between the fundamental network and service applications. In the 6G era, the access network will exhibit complex ubiquitous connections across air, space, land, and sea. For the comprehensive coverage and full-scenario requirements, "scenario-driven" will become the main evolutionary paradigm for mobile communication developing, so that the importance of service networks increases.

This report reviews the evolution of service networks from the 2G to 5G eras. Based on current 6G application scenarios, we will talk about the challenges of on-demand services in 6G networks, the vision and overall architectural design of the 6G intelligent service network. It introduces three key technologies: resource access, intrinsic intelligence, and collaborative sharing, along with the technical routes to achieve fine-grained intelligent control and management for the global resources.

Keynote Speech

10:30-11:00 @Grand Barony Ballroom

Tony Q.S. Quek

Fellow of Academy of Engineering Singapore, IEEE Fellow
Singapore University of Technology and Design, Singapore

Tony Q.S. Quek received the B.E. and M.E. degrees in Electrical and Electronics Engineering from Tokyo Institute of Technology, respectively. At Massachusetts Institute of Technology, he earned the Ph.D. in Electrical Engineering and Computer Science. Currently, he is the Cheng Tsang Man Chair Professor with Singapore University of Technology and Design (SUTD) and ST Engineering Distinguished Professor. He also serves as the Head of ISTD Pillar, Director for Future Communications R&D Programme, Sector Lead for SUTD AI Program, and the Deputy Director of SUTD-ZJU IDEA. His current research topics include wireless communications and networking, 6G, network intelligence, non-terrestrial networks, and open radio access network.

Dr. Quek is currently serving as an Area Editor for the IEEE Transactions on Wireless Communications. He was an Executive Editorial Committee Member of the IEEE Transactions on Wireless Communications, an Editor of the IEEE Transactions on Communications, and an Editor of the IEEE Wireless Communications Letters. He received the 2008 Philip Yeo Prize for Outstanding Achievement in Research, the 2012 IEEE William R. Bennett Prize, the 2016 IEEE Signal Processing Society Young Author Best Paper Award, the 2017 CTTC Early Achievement Award, the 2017 IEEE ComSoc AP Outstanding Paper Award, the 2020 IEEE Communications Society Young Author Best Paper Award, the 2020 IEEE Stephen O. Rice Prize, the 2020 Nokia Visiting Professorship, and the the 2022 IEEE Signal Processing Society Best Paper Award. He is a Fellow of IEEE and a Fellow of the Academy of Engineering Singapore.

[Speech Title] A Pathway Towards Future Network Intelligence: RAN Intelligent Controller Meets Semantic Communications

Abstract: The RAN intelligent controller (RIC) is cloud native and a central component of an open and virtualized RAN network. The RIC enables to deployment of machine learning and AI techniques to optimize resources and services in the RAN. Thus, it is an important component that brings intelligence, agility, and programmability to the radio access network. On the other hand, semantic communication has emerged as a new communication paradigm that aims at the successful transmission of semantic information conveyed by the transmitter rather than the accurate reception of each single bit regardless of the meaning. With semantic communication, it is likely that some form of intelligence is needed at the RAN to enable such a paradigm. In this talk, we will share how RIC is going to enable semantic communications to become reality. Furthermore, we will also share some initial work in this area through Singapore's first national Future Communications Research and Development Programme (FCP).

Keynote Speech

11:00-11:30 @Grand Barony Ballroom

Fumiyuki Adachi

IEEE Life Fellow
Tohoku University, Japan

Fumiyuki Adachi received the B.S. and Dr. Eng. degrees in electrical engineering from Tohoku University, Sendai, Japan, in 1973 and 1984, respectively. In April 1973, he joined the Electrical Communications Laboratories of NTT and started mobile communications research. From July 1992 to December 1999, he was with NTT DOCOMO, leading a research group on wideband/broadband wireless access for 3G and beyond. He contributed to developing 3G air interface standard, known as W-CDMA. Since January 2000, he has been with Tohoku University, Sendai, Japan. Currently, he is leading a resilient wireless communication research group with the aim of realizing beyond 5G/6G systems at the International Research Institute of Disaster Science (IRIDeS), Tohoku University. His research interests are in the area of wireless signal processing and networking, including multi-access, equalization, antenna diversity, cooperative transmission, channel coding, radio resource management, etc. He is an IEEE Life Fellow and an IEICE Life Fellow.

[Speech Title] Distributed MIMO-based Radio Access Network for 6G Cellular Communications

Abstract: This talk will cover the history of mobile cellular communication systems from 1G to 5G and the ongoing research toward 6G systems. Mobile data traffic will not stop growing. 6G systems require more effective utilization of the mmWave band than 5G systems, but there is a major problem. The mmWave signals have significant propagation losses and can often be blocked. The cell-free/distributed MIMO technology may play an important role to effectively utilize the mmWave. However, the large-scale cell-free/distributed MIMO to cover wide communication service areas is prohibitively expensive in terms of computational complexity. One possible solution is to keep the cellular structure and divide the communication service area into many cells based on distributed antenna location information and then form user clusters (or virtual small-cells) within each cell based on user location information for performing small-scale distributed MIMO. This solution can improve the spectrum efficiency and enable the scalable and flexible radio access network (RAN). However, inter-cell and inter-cluster interference may limit the improvement in spectrum efficiency. The RAN intelligent controller (RIC) can take the role of interference coordination as well as system parameters optimization while providing various AI related communication services. This talk will introduce the concept of such distributed MIMO-based RAN for 6G communications.

Keynote Speech

11:30-12:00 @Grand Barony Ballroom

Bo Ai

IEEE Fellow, IET Fellow
Beijing Jiaotong University, China

Prof. Bo Ai (IEEE Fellow, IET Fellow) is the professor and doctoral supervisor of Beijing Jiaotong University. He is the Dean of School of Electronic and Information Engineering.

Prof. Bo Ai has published 6 Chinese academic books, 3 English books, over 180 IEEE journal articles. He has obtained 13 international paper awards include IEEE VTS Neil Shepherd Memorial Best Propagation Award and IEEE GLOBECOM 2018 Best Paper Award, 36 invention patents; 32 proposals adopted by the ITU, 3GPP, etc., and 9 provincial and ministerial-level science and technology awards. His research results have been involved in 6 national standards. He is mainly engaged in the research and application of the theory and core technology of broadband mobile communication and rail transit dedicated mobile communication systems (GSM-R, LTE-R, 5G-R, LTE-M).

Prof. Bo Ai is the Fellow of Chinese Institute of Electronics, Fellow of China Institute of Communications, Chair of IEEE BTS Xi'an Branch, Vice Chair of IEEE VTS Beijing Branch, IEEE VTS distinguished lecturer, an expert of the 5G Industry Expert Group of the China Mobile Group Technical Advisory Committee, and an expert of the 6G Group in China.

[Speech Title] MIMO Channel Measurement and Modeling

Abstract: The future of wireless communication is set to be more diverse and dynamic, with a wider range of scenarios and services. The emergence of satellite internet, smart railways, maritime communications, and unmanned aerial vehicles has expanded the communication demands. The wireless channel is the medium through which communication occurs and is one of the fundamental factors determining wireless communication capacity and system performance. Consequently, the evolution of wireless communication technologies also presents new challenges and demands for channel modeling. This report, based on our team's research achievements in the field of wireless channel measurement and modeling, highlights the latest advancements and findings in three typical scenarios: massive MIMO, high-speed mobility, and millimeter-wave integrated communication and sensing. The report covers specific content such as channel measurement methods, analysis of measured results, channel modeling, and simulation methods. Finally, the report offers a perspective on the research prospects and development directions for channel modeling in future wireless systems.

Young Scientist Forum

Session Chair: Dr. Yue Zhao, Xidian University, China

Date: July 6 **Venue:** Shaohua Hall

14:00-14:15

Chongwen Huang, Zhejiang University, China

Toward 6G Wireless Communications with Holographic MIMO

Abstract: In this talk, I will not only introduce the past, present, and future of this emerging technology named Holographic MIMO Surfaces (HMIMOS), but also explain fundamentals of this new technology by building up a basic channel modeling, demonstrate available hardware fabrication methodologies and their characteristics, and deliver some recent research results. Then, I would like to discuss the prospects of the technology, including a variety of potential use cases, the AI-based beamforming design issues, and how it integrates with the THz technology to combat the propagation loss, how we leverage the HMIMOS to realize the sensing, imaging, etc.

14:15-14:30

Qingqing Wu, Shanghai Jiao Tong University, China

How to Deploy Intelligent Reflecting Surfaces (IRSs) in Wireless Networks?

Abstract: In this talk, we introduce a new wireless research paradigm by employing a massive number of low-cost passive reflecting elements with controllable phase, named intelligent reflecting surface (IRS), which is able to smartly change the wireless signal propagation to enable various functions such as beamforming and interference nulling/cancelation. We illustrate how to deploy IRSs in wireless networks and offer insights for a point-to-point system, multiuser SISO system, and multiuser MISO system. We also highlight important directions for future research.

14:30-14:45

Zhaohui Yang, Zhejiang University, China

A Joint Communication and Computation Design for Probabilistic Semantic Communication System

Abstract: Traditional wireless communication networks face huge power consumption, separate scheduling of communication and computation resources, and lack of joint communication and computation design. There is an urgent need to develop new communication theory methods to reduce the performance gap between the theory of joint allocation of communication and computation and the overall performance of the network. In order to deal with the resource sharing interference and massive data transmission requirements caused by the integrated communication and computation network, this presentation will be carried out from three aspects: probabilistic semantic communication system model, joint communication and computation resource allocation, and the integration of probabilistic semantic communication system and emerging technologies.

14:45-15:00

Kun Guo, East China Normal University, China

Accelerating Wireless Distributed Learning with Multiple Learning Modes Coexistence

Abstract: The proliferation of mobile devices has led to an unprecedented surge in data generation, advancing the

pace of wireless distributed learning. A key feature of wireless distributed learning is that data samples are non-independent and identically distributed (non-IID) among devices. To fully leverage these data, federated learning (FL) and split learning (SL) are regarded as two promising distributed learning modes over wireless networks, each with its own pros and cons. FL allows for parallel training but demands significant computational resources on devices to train deep neural network models. Conversely, SL reduces the computational burden on devices and can enhance learning performance, though it often leads to longer training time due to its sequential nature. In this talk, we introduce a novel distributed learning framework, Hybrid Split and Federated Learning (HSFL), which integrates the benefits of both FL and SL. Firstly, we demonstrate the impact of learning mode selection on learning performance through convergence analysis. Based on these insights, we then jointly optimize learning mode selection and heterogeneous resource allocation to reduce the training time to minimize the global loss of HSFL over wireless networks. Finally, experimental results validate that the coexistence of SL and FL offers the potential for wireless distributed learning acceleration.

15:00-15:15

Chenxi Liu, Beijing University of Posts and Telecommunications, China

Impacts of Jittering on UAV mmWave Systems: From Communication and Sensing Perspectives

Abstract: Unmanned aerial vehicle (UAV) has been recognized as a cost-efficient platform for communication and sensing in the sixth generation (6G) and beyond era, due to its advantages such as strong line-of-sight link probability, controlled mobility, and on-demand deployment. As the spectrum shifts from sub-6GHz to millimeter wave (mmWave) band, the performances of the UAV-enabled communication and sensing are expected to be further enhanced, by exploiting the large bandwidth and high spatial resolution of the mmWave band. This will facilitate various novel applications such as emergency assistance, real-time video streaming, target monitoring, etc. However, we note that, the UAV's jittering, as a key feature of the UAV systems, its impacts on communication and sensing are significant, while so far have drawn little attention in the literature. In this talk, I will briefly introduce our recent research advances of the impacts of jittering on UAV mmWave communication and those on UAV mmWave sensing, respectively, focusing on performance analysis, hybrid beamforming, and sensing estimator design. Moreover, I will discuss some open issues for achieving the integrated sensing and communications in the UAV mmWave systems under jittering effects.

15:15-15:30

Hao (Howard) Yang, Zhejiang University - University of Illinois Urbana-Champaign Institute, China

Federated Learning Over the Air: A Tale of Interference

Abstract: This talk aims to present the current research efforts on the development of implementing distributed machine learning algorithms in wireless systems. Specifically, we provide a comprehensive coverage of a distributed learning paradigm based on over-the-air computing, a.k.a. over-the-air federated learning (OTA-FL). We will present an analytical framework that quantifies the convergence rate of OTA-FL. Then, we discuss the system enhancements from an algorithmic perspective, i.e., adopting adaptive optimizations to accelerate the model training. We also introduce model pruning schemes that reduce the computation and communication overheads for OTA-FL. Finally, we will elaborate on the analysis of generalization error of the statistical models trained by OTA-FL, which shows that wireless interference has the positive potential of improving the generalization capability.

16:00-16:15

Bodong Shang, Eastern Institute of Technology, Ningbo, China

Cooperative Communications in Non-Terrestrial Networks (NTN)

Abstract: Communicating in a non-terrestrial network (NTN) has recently emerged as a promising technology that provides seamless global connectivity. Although low earth orbit (LEO) satellites in an NTN have been employed for providing ubiquitous coverage and high data rates for ground users, especially in emergent outdoor scenarios, NTN has not been fully integrated into the design of cooperation in a terrestrial network (TN) and NTN. This talk will discuss several potential key technologies for cooperative communications in NTN. We will introduce the multi-connectivity technology between TN and NTN multiple-input and multiple-output (MIMO) systems, cooperative multi-satellite communications, cell-free massive MIMO-enabled LEO satellite networks, and cooperative optical inter-satellite link (OISL) in NTN.

16:15-16:30

Xiaoyang Li, Shenzhen Research Institute of Big Data, China

Exploiting the Signal Functionalities: Sensing, Communication, Computation and Power Transfer

Abstract: As electromagnetic waves transmitted in space, the functions of wireless signals are not only limited to communication, but also include sensing, computation and energy transmission. In order to fully utilize the limited spectrum resources, the multiple functions of wireless signals are expected to be integrated. The integration of communication and sensing has received extensive attention, which also triggered the academic community to further think about the integration of sensing, communication, and computation. If the sensing, communication and computation processes of data can be jointly designed based on the task requirements, the utilization of spectrum and computation resources will be significantly improved, and more efficient data processing will be realized to support smarter applications. However, since most of the computation schemes are not executed at the physical layer, it is difficult to combine computation with sensing and communication at the physical layer. To overcome this difficulty, this study focuses on the emerging computation scheme in the physical layer called over-the-air computing, and uses it as a breakthrough point to conduct an in-depth exploration of the integrated sensing, communication, and computation. In order to further enhance the utilization efficiency of wireless resources, the wireless power transfer is also expected to be integrated with the sensing, communication, and computation functionalities.

16:30-16:45

Meng Li, Hefei University of Technology, China

Data Security and Privacy Preservation for Vehicular Communications

Abstract: The Internet of Vehicles (IoV) has been enjoying extensive attention and development given the growing predicament between data sharing and privacy preservation. However, current privacy-preserving model and techniques of IoV cannot meet vehicular users'new requirements, leading to severe challenges for location privacy, identity privacy, and data privacy. In this presentation, I will first give a brief introduction to my education background, work experience, and academic achievements and services. Then, I will give an overview of my research basis of data security and privacy preservation for vehicular communications. Finally, I will look ahead to the future work, which resides in secure and credible circulation of data elements atop blockchain.

16:45-17:00

Weigang Hou, Chongqing University of Posts and Telecommunications, China

Research on Optical Data Center Networks: Achievements and Prospects

Abstract: As a critical information infrastructures for Chinese “East Data, West Computing” and “East Inference, West Training” national key projects, the optical data center network can provide efficient communication and computing services via cloud-network integration. The aggregated terminal data is transmitted to edge servers via fiber links, or relayed hop-by-hop through optical cross-connects to the remote cloud, thus ensuring the determinism of optical pipelines from end to edge, from end to cloud, and interconnected clouds. Moreover, this approach not only reduces the high latency of centralized cloud computing but also facilitates full process control of the cloud. It plays an indispensable and crucial role in application fields such as CPS. This report firstly introduces the innovative achievements made by the applicant and his team in the past 20 years, which have led both international academia and domestic industry from three aspects: intrinsic co-optimization mechanism of communication and computation, optimization technology of optical transmission between data centers, and optimization technology of optical computing within data centers. This report also highlights the application of the above achievements in national key engineering construction and top enterprises, along with their extensive international influence. Subsequently, this report will introduce how to achieve the evolution of endogenous synergy from “communication + computing” to “sensing + communication + computing”, the optimization evolution of optical transmission from algorithms to cross-layer designs, and the optimization evolution of optical computing from single-modal to multi-modal in the future, under the funding of the Excellent Young Scientist Project of the National Natural Science Foundation of China (NSFC).

17:00-17:15

Ruijin Sun, Xidian University, China

Knowledge-Driven On-Demand Resource Management in Wireless Networks

Abstract: With the increasing three-dimensionality of network coverage, the diversification of application scenarios, and the personalization of service demands, 6G networks face numerous challenges, such as high resource dimensionality, strong network dynamics, and the complexity of resource allocation. Traditional model-based theoretical methods, although interpretable in decision-making, require long iteration time and involve high complexity in online processing. Data-driven neural network methods, while possessing strong fitting capabilities and fast inference, heavily rely on vast amounts of data and stable environments. To address these challenges, this report introduces a knowledge-driven method for on-demand resource management in wireless networks. This approach deeply integrates theoretical model knowledge with neural network methods, leveraging the interpretability of theoretical models and the rapid online decision-making capabilities of neural networks, ensuring the precision and timeliness of 6G network resource management.

Parallel Sessions

Parallel Session 01: Communication Theory and Techniques

Session Chair: Assoc. Prof. Wen-Jing Wang, Xi'an University of Posts & Telecommunications, China

Date: July 6

Venue: Taibai Hall

13:30-13:45	**Paper ID:** 531 **Paper Title:** Hybrid Visible Light Positioning Algorithm of RSS/TDOA Based on Kalman Filter **Author(s):** Yao Nie, Yinghui Sun, Xianglin Fan, and Huan Wu **Presenter:** Yao Nie **Affiliation:** West Anhui University, China **Abstract:** To improve the positioning accuracy performance of indoor visible light positioning, a novel hybrid positioning algorithm combining RSS and TDOA based on Kalman filter (CRTK) is proposed. Firstly, TDOA is utilized to obtain local optimal coordinates as an initial solution based on the Chan algorithm. Secondly, an offline stage involves constructing a fingerprint database by RSS signal data. Then, the acquired signal strength is matched with the fingerprint database to determine coordinate information for unknown positions in the online stage. Moreover, Kalman filtering is employed to refine the obtained coordinates and define a matching interval for fingerprint comparison. Finally, local optimal solution into the defined interval is calculated distances between the local optimal solution and coordinates in the fingerprint database, and we can derive a final mixed positioning coordinate. The simulation results show the CRTK reduces error values and achieves 30% improvement over algorithms without Kalman filtering.
13:45-14:00	**Paper ID:** 849 **Paper Title:** Performance Analysis of Overlay Cognitive Cooperative Communication Based on RSMA **Author(s):** Linlin Liang, Zongkai Tian, Haiyan Huang, Nina Zhang, Dehua Zhang, and Yue Li **Presenter:** Zongkai Tian **Affiliation:** Xidian University, China **Abstract:** Rate-Splitting Multiple Access (RSMA) technology emerges as a pivotal innovation for the sixth generation (6G) of mobile communication networks, significantly contributing to the efficient management of signals and the enhanced utilization of wireless resources. This paper delves into RSMA communication technology, with a specific emphasis on addressing performance challenges within overlay cognitive cooperative communication networks. A comprehensive analysis is conducted on the reception outage performance of both primary and secondary users, culminating in the derivation of closed-form expressions for the outage probabilities across these networks. The accuracy of these theoretical derivations is corroborated through simulation experiments. Experimental findings reveal that RSMA technology substantially enhances the performance of cognitive cooperative communication networks, thereby optimizing the reliability and efficiency of information transmission.
14:00-14:15	**Paper ID:** 1703 **Paper Title:** Path Loss Prediction Based on Deep Neural Networks Considering Fresnel Zone **Author(s):** Shirui Wang, Ruisi He, Tong Wu, Jingya Yang, Mi Yang, Shun Zhou, Chenlong Wang, and Bo Ai

	Presenter: Shirui Wang **Affiliation:** Beijing Jiaotong University, China **Abstract:** Improving accuracy of path loss prediction is crucial for development of future communication networks. Although deep learning provides promising solutions, further research is still needed on how to effectively utilize environmental features. This paper integrates the first Fresnel zone features into path loss prediction and uses a deep neural network model to filter and fuse environmental information, enabling the model to learn the relationship between feature parameters and path loss. The comparison and validation results demonstrate that integrating the first Fresnel zone can effectively enhance line-of-sight information for path loss prediction in building shading scenarios. Prediction accuracy can be well enhanced, especially for relatively high frequency bands with a root mean square error as low as 1.97 dB.
14:15-14:30	**Paper ID:** 1643 **Paper Title:** Rate Maximization for RIS-Assisted OAM Multiuser Wireless Communications **Author(s):** Jun Lan, Liping Liang, Wenchi Cheng, and Wei Zhang **Presenter:** Jun Lan **Affiliation:** Xidian University, China **Abstract:** Conventional multiple-input multiple-out (MIMO) technologies have encountered bottlenecks of significantly increasing spectrum efficiencies of wireless communications due to the low degrees of freedom in practical line-of-sight scenarios and severe path loss of high-frequency carriers. Orbital angular momentum (OAM) has shown the potential for high spectrum efficiencies in radio frequency domains. To investigate the advantage of OAM in multiuser communications, in this paper we propose the reconfigurable intelligence surface (RIS) assisted OAM multiuser (MU) wireless communication schemes, where RIS is deployed to establish the direct links blocked by obstacles between the OAM transmitter and users, to significantly increase the achievable sum rate (ASR) of MU systems. To maximize the ASR, we develop the alternative optimization algorithm to jointly optimize the transmit power and phase shifts of RIS. The numerical outcomes demonstrate the superiority of our proposed scheme compared to existing methods in terms of ASR.
14:30-14:45	**Paper ID:** 4128 **Paper Title:** Performance Analysis of Intelligent Reflecting Surface Aided Wireless Reconnaissance in Mountain Areas **Author(s):** Yongxin Guo, Gui Fang, Yunfei Long, Yuxuan Zhang, Quanrui Wang, and Xinrong Guan **Presenter:** Xinrong Guan **Affiliation:** Army Engineering University of PLA, China **Abstract:** Due to the unfavorable signal propagation environments, the performance of wireless reconnaissance in mountain areas usually suffers from deep fading and large path loss. Therefore, in this paper an intelligent reflecting surface (IRS) aided wireless reconnaissance framework is proposed, which is expected to improve the reconnaissance performance by exploiting the line of sight (LoS) transmission link provided by the IRS. Specifically, we first analyzed the path loss model to show the performance gain brought by the IRS. Then, we evaluated the wireless reconnaissance performance of the proposed design in terms of the minimal detectable power and the maximal detectable distance. Simulation results validate the effectiveness of the proposed design. In particular, the minimal detectable power is significantly decreased and the maximal detection distance is largely extended, such that the signal source with lower transmission power even located farther away can be detected.

14:45-15:00	**Paper ID:** 1022 **Paper Title:** Multi-Beam Symbol-Level Secure Communication for Hybrid Near-and Far-Field Communications **Author(s):** Wensheng Deng, Bin Qiu, and Wenchi Cheng **Presenter:** Wensheng Deng **Affiliation:** Xidian University, China **Abstract:** This paper introduces a multi-beam secure communication scheme for mixed near-field and far-field (hNF) scenarios, primarily designed to address the challenges faced by sixth-generation (6G) networks in simultaneously managing near-field and far-field communications. This method significantly reduces the signal quality at eavesdroppers while ensuring high-quality reception for legitimate users, effectively enhancing communication security. At the transmitter, this study employs multi-beam symbol-level directional modulation to ensure secure and reliable transmission in a mixed eaves dropping environment. Given the uncertainty about eavesdropper information, the transmission beamforming vectors are specially designed to meet specific symbol-level constraints, thereby ensuring effective reception for legitimate users. Experimental and simulation results demonstrate the effectiveness of our approach in improving secrecy performance, reducing transmission power, and enhancing energy efficiency, offering a practical solution to the security challenges faced by future wireless networks.
15:00-15:15	**Paper ID:** 5283 **Paper Title:** Experimental Research of Blind Source Separation Anti-Jamming Based on Spread Spectrum Communication **Author(s):** Xiongfei Li, Hang Zhang, Xiangyang Meng, Xiaoyu Zhang, and Yangming Guo **Presenter:** Xiongfei Li **Affiliation:** Northwestern Polytechnical University, China **Abstract:** Spread spectrum communication (SSC) is a widely used anti-jamming communication technology, and blind source separation (BSS) is a novel signal processing approach. The application of BSS to SSC system has emerged as a current research hotspot, aiming to enhance their anti-jamming capabilities. Addressing the challenges faced by SSC system and the bottlenecks in improving their anti-jamming capabilities, a BSS anti-jamming communication model based on SSC system has been established. Experimental scheme has been developed based on this model, and results have been provided. Experimental research reveals that BSS can further enhance anti-jamming ability of SSC and has excellent prospects for application.
15:15-15:30	**Paper ID:** 3047 **Paper Title:** Orbital Angular Momentum Active Anti-Jamming in Radio Wireless Communications **Author(s):** Kexin Zheng, Wenchi Cheng, and Liping Liang **Presenter:** Kexin Zheng **Affiliation:** Xidian University, China **Abstract:** This paper proposed a novel anti-jamming scheme for Orbital Angular Momentum (OAM) based on a triangular transmission system model, aimed at enhancing interference resistance in wireless communications. The OAM modes in the transmitter node (TN) that are affected by jamming signals are identified firstly. Subsequently, to acieve active anti-jamming, the jamming signal is utilized as a carrier, re-modulating the signal via a Programmable Gain Amplifier (PGA) to ensure continuous and reliable communication from the TN to the receiver node (RN). For modes that are not affected by jamming signal, the system is simplified to a model involving two parallel-aligned Uniform Circular

	Arrays (UCA) between the TN and RN. Through simulation analysis, the channel capacity of this anti-jamming scheme is evaluated. The results demonstrate that the new scheme significantly enhances the system's channel capacity. This research not only optimizes the anti-jamming performance of OAM communication system but also utilizes the jamming signal sufficiently.

Parallel Session 02: Signal Processing & Image Processing

Session Chair: Assoc. Prof. Jian Xue, Xi'an University of Posts and Telecommunications, China

Date: July 6 **Venue:** Tiantai Hall

13:30-13:45	**Paper ID:** 334 **Paper Title:** Wireless Sensing Using Off-the-Shelf WiFi 6E Card **Author(s):** Xuanhong Liang, Howard H. Yang, Kun Guo, and Tony Q. S. Quek **Presenter:** Xuanhong Liang **Affiliation:** Zhejiang University, China **Abstract:** Recent years have witnessed the evolution of WiFi technologies, accompanied by the emergence and progress of WiFi-based sensing applications. However, the advancement of the IEEE 802.11 standards has brought along new features to mainstream commodity WiFi devices that may invalidate existing state-of-the-art methods, which has become one of the main challenges for real-life adoption of WiFi sensing. Therefore, it is essential to ensure WiFi sensing keep in step with the latest WiFi standards. In this paper, we uncover the new features on commodity WiFi 6E devices dissimilar from legacy IEEE 802.11n/ac/ax devices that most existing work focus on. We conduct a benchmark experiment to find the reason and behavior pattern of the new features and propose our solutions accordingly. We take the fine-grained respiration sensing as a demonstration, and experimental results verify the effectiveness of our approach. We believe our approach could also benefit other sensing applications.
13:45-14:00	**Paper ID:** 3102 **Paper Title:** Cramér-Rao Bound Analysis for MUSIC-Like Source Number Estimation in Indoor Sound Source Localization **Author(s):** Xiyu Song, Qingsheng Qin, Shiqi Wang, Fangzhi Yao, Mei Wang, and Hongbing Qiu **Presenter:** Qingsheng Qin **Affiliation:** Guilin University of Electronic Technology, China **Abstract:** In indoor sound source localization (ISSL), the direction of arrival (DOA) of the sound source can be observed to a certain extent from multiple peaks through parameter spectral estimation of the received signal of the array. Among many spectral based algorithms used for DOA estimation, an algorithm called Multiple Signal Classification (MUSIC) is one of the most well-known that has super resolution performance. However, its dependency on the source number estimation can lead to performance degradation especially for high reverberation and low signal-noise-ratio (SNR) environment like ISSL application and this is due to physical spatial proximity of sound sources and subspaces (signal subspace and noise subspace) non orthogonal. In this paper, the relationship between source numbers, physical spatial proximity of sound sources, linear correlation of spherical harmonic order decomposition and eigenvalues of the covariance matrix are explored. An improved second-order statistic of eigenvalues (SORTE) method for estimating the source number which utilizes the linear correlation of spherical harmonic order decomposition then satisfy the above-mentioned source number dependency is proposed for ISSL application. It can be applied to MUSIC-like algorithms, including MUSIC, spherical harmonic domain MUSIC (SHD-MUSIC) and spherical harmonic domain beam-space MUSIC (SHD-BMUSIC), and has undergone well Cramér-Rao Bound (CRB) analysis as well as experimental verification. Worthy emphasizing that this article derives the CRB of the MUSIC-like algorithm in the physical space adjacent multi-source

	localization scenario, which not only improves the theoretical boundary analysis of the MUSIC-like algorithm, verifies the reliability of the MUSIC-like algorithm in the physical space multi-source ISSL application, but also provides a theoretical reference for the engineering application of the MUSIC-like algorithm.
14:00-14:15	**Paper ID:** 759 **Paper Title:** Trapezoidal Gradient Descent for Effective Reinforcement Learning in Spiking Networks **Author(s):** Yuhao Pan, Xiucheng Wang, Nan Cheng, and Qi Qiu **Presenter:** Xiucheng Wang **Affiliation:** Xidian University, China **Abstract:** With the rapid development of artificial intelligence technology, the field of reinforcement learning has continuously achieved breakthroughs in both theory and practice. However, traditional reinforcement learning algorithms often entail high energy consumption during interactions with the environment. Spiking Neural Network (SNN), with their low energy consumption characteristics and performance comparable to deep neural networks, have garnered widespread attention. To reduce the energy consumption of practical applications of reinforcement learning, researchers have successively proposed the Pop-SAN and MDC-SAN algorithms. Nonetheless, these algorithms use rectangular functions to approximate the spike network during the training process, resulting in low sensitivity, thus indicating room for improvement in the training effectiveness of SNN. Based on this, we propose a trapezoidal approximation gradient method to replace the spike network, which not only preserves the original stable learning state but also enhances the model's adaptability and response sensitivity under various signal dynamics. Simulation results show that the improved algorithm, using the trapezoidal approximation gradient to replace the spike network, achieves better convergence speed and performance compared to the original algorithm and demonstrates good training stability.
14:15-14:30	**Paper ID:** 2107 **Paper Title:** Parameter-Efficient Transformer Network for Radar Anti-Jamming Strategy Design **Author(s):** Liangqi Liu, Tianpeng Pan, Wenqiang Pu, Bo Jiu, and Junkun Yan **Presenter:** Liangqi Liu **Affiliation:** The Chinese University of Hong Kong, Shenzhen, China **Abstract:** In modern electronic warfare (EW), the competition between radar and jammer systems is presenting a critical challenge. Recently, active countermeasures employ frequency agile technique and conceptualize anti-jamming as an online decision-making process. However, most traditional online methods suffer from poor sample efficiency and struggle with the real-world, large-scale scenarios. This paper addresses the limitations by introducing a transformer-based neural network tailored for radar anti-jamming strategy design. Our approach utilizes the transformer architecture's capabilities in representing large-scale scenarios, and incorporates prior knowledge of the jamming systems to significantly enhance sample efficiency. A parameter-efficient fine-tuning approach is further employed to optimize computational demands. Moreover, a signal-level simulation platform is developed to facilitate an in-depth evaluation of our approach against a range of established online algorithms and various jamming strategies. Rigorous experiments on this platform confirms our method's superiority in both sample efficiency and computational performance.
14:30-14:45	**Paper ID:** 2380 **Paper Title:** Fast CU Inter Partitioning Method for VVC Based on the Optimal Prediction Residual Maps

	Author(s): Chenxi Ma, Mingyi Yang, and Fuzheng Yang **Presenter:** Chenxi Ma **Affiliation:** Xidian University, China **Abstract:** The Versatile Video Coding (VVC) stands as the latest generation video coding standard developed by the Joint Video Experts Team. Compared to the previous standard, VVC improves coding efficiency by 40% but incurs an eightfold increase in coding complexity, especially for inter coding. To reduce the inter coding complexity of VVC, we propose a learning-based fast method to predict the Coding Unit (CU) partition mode in inter coding, thereby reducing the traversal count of CU partitioning modes during the Rate Distortion Optimization (RDO) process. Considering the strong correlation between residual information and inter partition, we propose to employ two kinds of optimal prediction residual maps as features to predict the CU partitioning mode. These optimal prediction residual maps are derived through motion searches conducted at the CU-level and sub-CU-level, respectively. In order to predict the partitioning mode accurately from the two kinds of optimal prediction residual maps, we propose a learning-based partition prediction network based on asymmetric convolution and quantization parameter (QP) adaptive modules to better extract texture information from the input optimal prediction residual maps. For network training, we employ loss functions based on ratedistortion cost correction and partitioning quantity correction, to address the imbalance between the proportions of various VVC partitioning modes and maintain the rate-distortion performance. Experimental results show that our method achieves a 36.64% time saving on VTM12.0, with a negligible BD-BR loss of only 2.5%.
14:45-15:00	**Paper ID:** 530 **Paper Title:** Reconfigurable Intelligent Surface-Assisted Wireless Powered Sensing and Communication Networks **Author(s):** Zhengyu Zhu, Kaixuan Guo, Zheng Chu, De Mi, Yuanwei Liu, and Sami Muhaidat **Presenter:** Kaixuan Guo **Affiliation:** Zhengzhou University, China **Abstract:** A novel idea of wireless powered sensing and communication networks (WPSCN) is proposed. Specifically, a multi-antenna transmitter utilizes a radar signal for sensing targets while enabling multiple Internet of Things (IoT) devices to harvest energy from the signal, each of which employs the collected energy to upload information to an access point (AP). We deploy a reconfigurable intelligent surface (RIS) to assist sensing and improve wireless energy transfer (WET) and wireless information transfer (WIT). This paper aims to maximize the weighted sum of the communication throughput and the beampattern gain by jointly designing the transmitter beamforming, transmission time scheduling and RIS phase shifts. We initially derive a closed-form expression of the optimal RIS phase shifts in the WIT phase. Then, an alternating optimization (AO) algorithm is proposed to solve the trade-off problem. Additionally, we introduce a low-complexity AO algorithm that derives the optimal solutions for transmitter beamforming, transmission time scheduling, and sensing/WET phase shift. Simulation results demonstrate the effectiveness of the proposed algorithms.
15:00-15:15	**Paper ID:** 3136 **Paper Title:** Density-Adaptive Octree-Based Point Cloud Geometry Compression **Author(s):** Ren Huang, Guiqi Wang, and Wei Zhang **Presenter:** Ren Huang **Affiliation:** Xidian University, China

Abstract: Point clouds are a widely used format for representing 3D objects and scenes. With the aim of enhancing the streamlined transfer and storage of such data, extensive attention has been directed towards point cloud compression (PCC). This has led to a significant research emphasis on advancing PCC methods. Audio Video coding Standard workgroup (AVS) of China have launched a PCC project, which employs the octree representation to compress the geometry information of point cloud data. This paper aims to improve the coding efficiency of AVS PCC. Specifically, the neighbouring occupancy information is used in various ways to construct efficient context driving geometry entropy coding. To reduce the memory footprint in context construction, a context reduction mechanism is proposed utilizing the historical coding information. Moreover, an adaptive context switching method is proposed to fit the diversity of point cloud distribution. Experimental results show that the proposed octree coding method achieves coding gains over 3.0% and 8.0% for lossless and lossy coding conditions, respectively without runtime increase. Due to the superiority of the proposed method, it has been recently adopted as the geometry coding method in AVS PCC.

Parallel Session 03: Communication Theory and Techniques

Session Chair: Assoc. Prof. Yinghui Ye, Xi'an University of Posts and Telecommunications, China

Date: July 6

Venue: Taibai Hall

15:50-16:05	**Paper ID:** 6404 **Paper Title:** Joint Optimization Method for Simulation Parameters and Hardware Latency in High-Precision Navigation Channel Emulators **Author(s):** Pengpeng Li, Shuibin Zhong, Zhicheng Lv, and Weihua Mou **Presenter:** Pengpeng Li **Affiliation:** National University of Defence Technology, China **Abstract:** In order to construct a navigation channel test scenario and reproduce the influence of environmental channel characteristics on the high-precision reception of navigation signals, this paper proposes a joint optimisation design method of simulation parameters and hardware delay for the realisation of a high-precision navigation channel emulator, which changes the limitation of traditional research and realisation that only focuses on improving the accuracy of mathematical models, and combines the control of the model simulation accuracy with the calibration of the hardware simulation error, and effectively improves the physical realisation of the channel emulator with reasonable constraints and joint optimisation design. By combining the model simulation accuracy control and hardware simulation error calibration with reasonable constraints and joint optimisation design, the physical realisation accuracy of the channel emulator is effectively improved. The test results show that, under the test scenario of multi-satellite and multi-site physical docking, the delay consistency error of the multi-channel dynamic simulation of the navigation channel is less than 0.3ns, which meets the demand for the simulation accuracy of sub-nanosecond signal transmission delay of the navigation channel emulator.
16:05-16:20	**Paper ID:** 4234 **Paper Title:** Lightweight Detection of UAV Communication Activity with A Finite Blocklength **Author(s):** Jianqi Peng, Xiaoling Hu, Shihao Yan, Chunshan Liu, and Ran Yan **Presenter:** Jianqi Peng **Affiliation:** University of Electronic Science and Technology of China, China **Abstract:** In this work, we consider the detection of communication activity from unmmand aerial vehicles (UAVs). For the first time, we design the detector from the protection perspective of a radio frequency (RF)-based detector at ground to detect malicious UAV communication activity with a finite blocklength. Specifically, we derive a closed-form expression for the detector's detection error probability with the prior probabilities to evaluate the detection performance. Then, we propose a lightweight threshold-based (LTB) scheme based on an average received power test to minimize the blocklength subject to a detection performance requirement. To mitigate the sensitivity of the LTB scheme, we further propose a lightweight naive Bayes (LNB) scheme based on the continuity of the UAV communication activity at the cost of a slight increase of the blocklength, where the derived detection performance can be used to leave out the collection of the training dataset. Meanwhile, numerical results demonstrate the advantages of the proposed two schemes over the naive Bayes scheme, in terms of achieving a lower detection error probability and a lower computational complexity.

16:20-16:35	**Paper ID:** 3122 **Paper Title:** Determining Pseudo-Random Chaotic Sequences Complexity Using Refined Fuzzy Entropy **Author(s):** Yujie Ling, Chenxi Li, Chuan Zhang, Lei Guan, Wenting Wei, and Yue Zhao **Presenter:** Yujie Ling **Affiliation:** Xidian University, China **Abstract:** The secure transmission of communication systems is a current hot topic of research both domestically and internationally. Within this context, the communication transmission scheme based on dynamic spectrum control emerges as a secure transmission approach suited for contemporary complex dynamic scenarios. The dynamic spectrum control sequence family, serving as the linchpin of this scheme, has assumed a crucial role in safeguarding the security of communication systems. Pseudo-random chaotic sequences as the most commonly used sequences have universality in analyzing the complexity of sequences. While established complexity metrics are commonly employed for accurate calculation and analysis, errors persist when observing sequences over short periods. To address this, the paper proposes a new complexity metric to evaluate the unpredictability of pseudo-random chaotic sequences based on refined fuzzy entropy. Simulation and analysis results demonstrate that R-FuzzyEn effectively characterizes the complexity of various pseudo-random chaotic sequences, outperforming existing algorithms.
16:35-16:50	**Paper ID:** 4462 **Paper Title:** UAV-Terrestrial RSMA Communication Suffering Terrestrial Interference **Author(s):** Jiarui Liang, Hang Deng, Yuanyuan Peng, Jinpeng Song, Shuai Wang, and Gaofeng Pan **Presenter:** Hang Deng **Affiliation:** Beijing Institute of Technology, China **Abstract:** Rate-splitting multiple access (RSMA) has emerged as a prospective technique for integrating and generalizing existing multiple access schemes. Meanwhile, unmanned aerial vehicles (UAVs) have been widely deployed for communication enhancement. This work analyzes a UAV-terrestrial RSMA communication system with uniformly distributed users and an interfering base station. Analytical expressions and numerical results are provided to give insights into the outage performance of this scenario. It is concluded that the power allocation proportion between common and private signals and the fading parameters can significantly affect the outage performance.
16:50-17:05	**Paper ID:** 4673 **Paper Title:** Precoding and Power Control Design for Cell-Free XL-MIMO: From Far-Field to Near-Field **Author(s):** Jiayao Yang, Jiayi Zhang, Bokai Xu, Huahua Xiao, and Bo Ai **Presenter:** Jiayao Yang **Affiliation:** Beijing Jiaotong University, China **Abstract:** Cell-free massive multiple-input multiple-output (CF-MIMO) and extremely large-scale MIMO (XL-MIMO) are considered the core technologies of the sixth-generation (6G) wireless communication. Combining the above technologies, we aim to explore an enhanced paradigm, called cell-free XL-MIMO. As the number of antennas increases, the propagation characteristics of the electromagnetic field undergo significant changes, and the communication environment shifts from far-field to near-field. We utilize the characteristics of near-field spherical waves to design codebooks and power control algorithms tailored explicitly to multiple base station (BS) scenarios. Numerical results show that our proposed multi-BS near-field codebook design and power control algorithms

	based on the alternating direction method of multipliers (ADMM) aided block coordinate descent (BCD) algorithm have a significant increase in spectral efficiency (SE) of the cell-free XL-MIMO system.
17:05-17:20	**Paper ID:** 4874 **Paper Title:** Transmit Power Minimization in a Mutualistic Symbiotic Radio with Hybrid Active-Passive Communication Network **Author(s):** Hailong Zhang, Bo Li, Ruixuan Mi, Xi Song, Kan Feng, and Wenhui Li **Presenter:** Hailong Zhang **Affiliation:** State Grid Pingliang Electric Power Company, China **Abstract:** The mutualistic symbiotic radio (SR) with hybrid active-passive communications (HAPC) enables Internet of Things (IoT) devices to share the energy and spectrum resources with the primary transmitter (PT), thus overcoming the spectrum and energy limitations of the IoT devices. However, the minimization problem of primary transmitter's (PT's) transmit power, which can reduce operational costs from the network operator's perspective, has not been addressed. In this paper, we propose to minimize the PT's transmit power in a mutualistic SR network with HAPC. Specifically, we formulate a non-convex problem to jointly optimize several variables, including the PT's transmitpower, the operation time of pure energy harvesting (EH), backscatter communications (BC) and active communications (AC) phases, as well as the reflection coefficient and AC's transmit power of each IoT device, and solve it by the following two steps. First, we employ successive convex approximation (SCA) and introduce auxiliary variables to transform the formulated problem into a convex one at a given the PT's transmit power. Second, an iterative algorithm, which combines the bisection and SCA, is proposed to determine the optimal PT's transmit power. The simulation results prove the fast convergence of our proposed algorithm, and show that our proposed scheme achieves a lower PT's transmit power compared to the baseline schemes.
17:20-17:35	**Paper ID:** 4911 **Paper Title:** Covert Communications Against UAV Surveillance via Probabilistic Transmission **Author(s):** Ting Yin, Sheng Wang, Yida Wang, and Shusen Zhang **Presenter:** Ting Yin **Affiliation:** Academy of Military Science of PLA, China **Abstract:** In this work, we investigate covert communications against UAV surveillance, where a sensor tries to transmit information to its receiver covertly by exploiting the noise uncertainty at the UAV. Specifically, the sensor can adjust its transmit power and transmit probability to make a balance between the communication covertness and quality. To measure the communication covertness and quality, we analytically derive the detection error probability and the effective covert rate, respectively. It is interesting to find that the optimal transmit probability is a moderate value rather than 1/2 to maximize the communication covertness. Then, we formulate an optimization problem to maximize the communication covertness under the requirement of the communication quality. At last, we give the optimization solution of the transmit power and probability at the sensor, which can be used as the guidance of the parameter setting in practice.
17:35-17:50	**Paper ID:** 5242 **Paper Title:** MUSIC-Based Residual Uniform Frequency Offsets Mitigation Method for Underwater Acoustic Differential OFDM Communications **Author(s):** Qilong Xiong, and Yuzhou Li **Presenter:** Qilong Xiong

	Affiliation: Huazhong University of Science and Technology, China **Abstract:** The inherently violent frequency offsets caused by Doppler shifts in underwater acoustic (UWA) channels severely disrupt the orthogonality among subcarriers in differential orthogonal frequency division multiplexing (DOFDM) systems, making precise signal detection quite challenging. Although the passband resampling can efficiently alleviate the non-uniform frequency offsets, it still leaves residual uniform frequency offsets. In this paper, we interestingly find that the residual uniform frequency offsets mitigation is similar to the direction of arrival (DOA) estimation, and thus can be well addressed by the multiple signal classification (MUSIC) algorithm. To meet the two prerequisites of applying the MUSIC, we derive the vectorized form of the resampled signal and propose the uniform null subcarriers insertion to ensure the column full-rank. The verification results based on the realistic UWA channel dataset show that, compared with the channel-adaptive estimation and the F-FFT, our proposed method reduces the mean squared error (MSE) of signal detection by approximately 3 dB and 6 dB (i.e., 50% and 75%) at a Doppler factor of 0.001, a subcarrier number of 1024, and a signal-to-noise ratio (SNR) of 15 dB, respectively.
17:50-18:05	**Paper ID:** 2203 **Paper Title:** RIS-Assisted Coverage Enhancement in mmWave Integrated Sensing and Communication Networks **Author(s):** Xu Gan, Chongwen Huang, Zhaohui Yang, Xiaoming Chen, Faouzi Bader, Zhaoyang Zhang, Chau Yuen, Yongliang Guan, and Merouane Debbah **Presenter:** Chongwen Huang **Affiliation:** Zhejiang University, China **Abstract:** Integrated sensing and communication (ISAC) has emerged as a promising technology to facilitate high-rate communications and super-resolution sensing, particularly operating in the millimeter wave (mmWave) band. However, the vulnerability of mmWave signals to blockages severely impairs ISAC capabilities and coverage. To tackle this, an efficient and low-cost solution is to deploy distributed reconfigurable intelligent surfaces (RISs) to construct virtual links between the base stations (BSs) and users in a controllable fashion. In this paper, we investigate the generalized RIS-assisted mmWave ISAC networks considering the blockage effect, and examine the beneficial impact of RISs on the coverage rate utilizing stochastic geometry. Specifically, taking into account the coupling effect of ISAC dual functions within the same network topology, we derive the conditional coverage probability of ISAC performance for two association cases, based on the proposed beam pattern model and user association policies. Then, the marginal coverage rate is calculated by combining these two cases through the distance-dependent thinning method. Simulation results verify the accuracy of derived theoretical formulations and provide valuable guidelines for the practical network deployment. Specifically, our results indicate the superiority of the RIS deployment with the density of 40 km^{-2} BSs, and that the joint coverage rate of ISAC performance exhibits potential growth from 67.1% to 92.2% with the deployment of RISs.

Parallel Session 04: Machine Learning & Optimization for Wireless Systems

Session Chair: Assoc. Prof. Jianbo Du, Xi'an University of Posts and Telecommunications, China

Date: July 6

Venue: Tiantai Hall

15:50-16:05	**Paper ID:** 296 **Paper Title:** Collaborative Radio Frequency Fingerprint Identification Using Dual-Channel Parallel CNN **Author(s):** Hanbo Wang, and Jian Wang **Presenter:** Hanbo Wang **Affiliation:** Nanjing University, China **Abstract:** The majority of current research in radio frequency (RF) fingerprint identification is conducted based on deep learning. In many existing RF fingerprint identification systems, a single receiver is typically utilized to collect data and perform RF sensing independently. This design can streamline the hardware structure of the system and reduce energy consumption and cost, but concurrently, it can also constrain the performance of the RF fingerprint identification system in terms of accuracy and robustness. Consequently, we propose a collaborative RF fing-erprint identification method based on a dual-channel parallel convolutional neural network (CNN), which employs dual receivers to collect data collaboratively and extracts RF fing-erprint features through a dual-channel parallel convolutional neural network to finalize RF fingerprint identification. The experimental results demonstrate that the RF fingerprint identification scheme proposed in this paper exhibits superior identification accuracy with the same amount of data compared to the RF fingerprint identification scheme with single-receiver independent identification.
16:05-16:20	**Paper ID:** 2826 **Paper Title:** Root Cause Localization of Wireless Communication Network Faults Based on 1DCNN-Att Network **Author(s):** Yuehua Han, Wei Liu, and Lei Wang **Presenter:** Wei Liu **Affiliation:** Xidian University, China **Abstract:** Locating the root cause of wireless network failures is critical to wireless network operations and maintenance. The introduction of new technology architecture in 5G and the rapid development of 6G technology have led to the emergence of diverse new scene services. Consequently, these services pose challenges in locating the root cause of wireless communication network faults. However, existing root cause localization schemes suffer from issues such as low accuracy and complex models. In this paper, we propose a scheme based on 1DCNN and attention mechanism to address these problems. Our scheme involves selecting, filling, and compressing the original data for efficient time series feature engineering. Then, we utilize the 1DCNN network to capturing the nonlinear relationships of different key performance indicators to overcome the low accuracy of the existing schemes. Additionally, this scheme has the advantages of a simple structure and short processing time. Finally, we conduct experiments and analysis using a dataset from real-world 5G business scenarios, and the results demonstrate the superior performance of our proposed scheme.
16:20-16:35	**Paper ID:** 1247 **Paper Title:** Multi-Hop UAV Relay Covert Communication: A Multi-Agent Reinforcement Learning Approach

	Author(s): Hengzhi Bai, Haichao Wang, Jiatao Du, Rongrong He, Guoxin Li, and Yuhua Xu **Presenter:** Hengzhi Bai **Affiliation:** Army Engineering University of PLA, China **Abstract:** The unmanned aerial vehicle (UAV) network, due to its line-of-sight (LoS) communication characteristics, is highly susceptible to be eavesdropped. Covert communication is studied to protect the communication behaviour. This paper explores the joint optimization problem of trajectory and transmission power in a multi-hop UAV relay covert communication system.Considering the communication covertness, power constraints, and trajectory limitations, an algorithm based on multi-agent proximal policy optimization (MAPPO), named covert-MAPPO (C-MAPPO), is proposed. Leveraging the advantages of multi-agent reinforcement learning (MARL), this method optimizes a collaborative strategy for multiple UAVs regarding transmission power and flight trajectory to maximize system throughput while meeting covert constraints. Simulation results demonstrate that this algorithm outperforms benchmark algorithms in terms of throughput and reward convergence speed.
16:35-16:50	**Paper ID:** 2897 **Paper Title:** Multi-Label Behavior Cloning for Full-Area Exploration in IoT-Enabled Unstructured Unknown Environments **Author(s):** Lijuan Xu, Qinghai Yang, and Meng Qin **Presenter:** Lijuan Xu **Affiliation:** Xidian University, China **Abstract:** The widespread application of Internet of Things (IoT) technology provides connectivity and intelligence to mobile terminals, which supports their independent exploration in unknown environments. This paper focuses on the full-area exploration in unstructured unknown environment. Considering the dynamics and complexity of unknown environments, we propose a full-area exploration method based on multi-label behavior cloning (MBC). The MBC utilizes behavior-related rewards as weights for labels to enhance the ability of the model to learn effective behaviors. We develop a lightweight neural network model that employs multiple attention mechanisms to fit the mapping from state to action in the behavior cloning process. This model incorporates three types of attention mechanisms including normalization-based attention module (NAM), simple attention module (SimAM), and decoupled fully connected (DFC) attention module. Additionally, the incorporation of the Ghost module significantly reduces the computational load of the model, making it suitable for deployment on terminal devices with limited computational resources. We perform interpolation on the perceived states to standardize the input data dimensions for the neural network model. The effectiveness of the proposed exploration algorithm is verified through a series of experiments.
16:50-17:05	**Paper ID:** 2995 **Paper Title:** Adaptable Semantic Compression and Transmission Resource Allocation for Intelligent Image Classification **Author(s):** Qian Wang, Jiaqi Ye, Qianqian Yang, Liping Qian, and Huijie Zhu **Presenter:** Qian Wang **Affiliation:** Zhejiang University of Technology, China **Abstract:** With the development of artificial intelligence, task-oriented semantic communication with low latency and high accuracy is a new communication mode for edge-aided Internet of Things (IoT). In this paper, we propose an image classification-oriented semantic communication method for multi-user IoT system, which aims to implement the adaptable semantic compression (ASC) and optimize the transmission resource allocations based on the semantic relationships. Specifically, to

	satisfy the low-latency requirement, the semantic entropy of the transmitted image multiplied by the success transmission probability is considered as the success probability of classification tasks, which is to be maximized given fixed total transmission power and bandwidth. In order to solve this maximization issue, we use the particle swarm optimization algorithm to jointly optimize the compression ratio and the allocation of power and bandwidth for each user. Simulation results show that the proposed ASC-based semantic scheme has much better performance in image transmission and classification, and is more robust under different channel conditions. Compared with the standard semantic communication and traditional communication methods, the proposed method can reduce the size of the transmitted data by 40% ~ 80% without compromising the task success probability. It is verified that a reasonable selection of compression ratio and intelligent allocations of communication resources for different users not only guarantee the high accuracy of the image classification, but also further reduce the transmission delay, which is of great practical interest.
17:05-17:20	**Paper ID:** 3319 **Paper Title:** Decoupled Online Learning Network Method for Analog Beamforming with Antenna Selection **Author(s):** Weijie Xiong, Yuhan Zhang, Jingran Lin, Kai Zhong, and Jinfeng Hu **Presenter:** Weijie Xiong **Affiliation:** University of Electronic Science and Technology of China, China **Abstract:** The analog beamforming design with antenna selection from a beampattern matching perspective is a key technology in large-scale antenna arrays (LSAAs) wireless communication systems. Currently, most existing methods use the scaled analog beamforming (SAB) architecture with phase shifters (PS) at the transmitter side, leading to constrained degrees of freedom. To enhance performance, we leverage the phase-corrected analog beamforming (PCAB) architecture with PS both at the transmitter side and the receiver side. We further formulate the problem as a mixed-integer least-squares problem with both constant modulus constraints (CMCs) and binary constraints (BCs). Due to the CMCs and BCs, the problem is non-convex. Additionally, the coupling effect between variables further aggravates the difficulty. To handle the problem, a decoupled online learning network is proposed. In the network, we address the BCs by transforming them into a continuously differentiable function with different biases. Simultaneously, we maintain parameters under CMCs by representing them in exponential form and leveraging their phases. By transforming the biases and the phases into learnable parameters, the loss function is minimized by the deep learning optimizer.
17:20-17:35	**Paper ID:** 4702 **Paper Title:** DDQN Based Beamwidth and Subcarrier Allocation Strategy for LEO Satellite Communication System with Multi-beam Capability **Author(s):** Jia Shi, Jinglan Ma, Qing Wei, and Wentao Sun **Presenter:** Jinglan Ma **Affiliation:** Xidian University, China **Abstract:** Broadband LEO satellites will play a key role in future mobile networks, due to its advantages of low delay, wide coverage and low cost. With the increasing demand for data rate and access amount, it has become an important trend to study dynamic and flexible resource allocation mechanism in LEO satellite systems. In this paper, we conceive a multi-beam scene of LEO satellite communication system, and formulate a resource allocation problem of compromising the data rate and beam coverage by optimizing the beamwidth, transmit power and subcarrier allocation. Based on

	decoupling the problem, we utilize the water injection algorithm to carry out the transmit power allocation. Then, by modeling decoupled resource allocation problem as markov decision processes (MDP), we propose a DDQN based beamwidth and subcarrier allocation algorithm. The simulation results show that the proposed algorithm has good adaptability to the scene where users appear randomly, and can realize the comprehensive optimization of coverage and propagation rate, and optimize the quality of user network service.
17:35-17:50	**Paper ID:** 5493 **Paper Title:** Minimization of Completion Time for Dynamic and Reliable Data Collection with Multiple UAVs **Author(s):** Xueli Guo, Xinyi Liu, Jiaqi Zhou, Mengmeng Shi, Xuerui Zhu, and Ziyao Zhu **Presenter:** Xueli Guo **Affiliation:** Chang'an University, China **Abstract:** Unmanned Aerial Vehicles (UAVs), with their deployment flexibility, superior line-of-sight (LOS), and cost-effectiveness, have emerged as a promising solution for Internet of Things (IoT) data collection. However, their application is often constrained by limited battery capacity. In this paper, we aim to minimize the maximum completion time of all UAVs by jointly optimizing the scheduling of ground IoT devices and the UAVs' trajectories in a large geographic area, while ensuring fairness in UAV service and the reliability of data collection tasks. The problem is a challenging non-convex one. To address it, we propose a hovering data collection scheme that guarantees a certain coverage ratio over a large geographic area. The approach divides the problem into two sub-problems: First, we introduce a novel method for calculating the optimal hovering height of UAVs based on the concept of outage probability, thus achieving the maximum coverage radius with a sufficiently low outage probability. Subsequently, we present an Affinity Propagation (AP)-based clustering algorithm that partitions the geographic area into an optimal number of clusters. Based on this clustering, a layered dynamic path planning algorithm using virtual UAV nodes is further proposed. Simulation results indicate that our multi-UAV data collection scheme, utilizing cluster-based dynamic path planning, significantly outperforms baseline methods.
17:50-18:05	**Paper ID:** 6235 **Paper Title:** Joint UAV Trajectory and Power Optimization in Cell-Free mMIMO Systems With Deep Q-Network **Author(s):** Xianghua Zhang, Zhilong Liu, Jiayi Zhang, and Bo Ai **Presenter:** Xianghua Zhang **Affiliation:** Beijing Jiaotong University, China **Abstract:** With the dominant spatial multiplexing and macro-diversity gain provided by the network densification, cell-free massive multiple-input multiple-output (CF-mMIMO) represents the critical technology in covering a wider range. However, limited by the cost and geographical limitations, it is hard to realize the all-dimensional access across the world. In this paper, we investigate the unmanned aerial vehicle (UAV)-aided CF-mMIMO systems. First, we analyze the closed-form expression of energy efficiency (EE) from the perspective of realistic power consumption. Then we propose an access point (AP) selection approach based on the quality of the channel and the inter-user interference. To reduce energy consumption, we jointly design an effective UAV trajectory and power optimization algorithm based on the multi-agent deep Q-network. Last, simulation results demonstrate that the EE of our design has been averagely improved by 42% than the all-connection APs and equal power allocation scheme.

Parallel Session 05: Networking

Session Chair: Prof. Bodong Shang, Eastern Institute of Technology, Ningbo, China

Date: July 7 **Venue:** Shaohua Hall

08:00-08:15	**Paper ID:** 101 **Paper Title:** An Architectural Design of Network Scenario Cognitive Engine Based on Metacognitive Core **Author(s):** Lei Chen, Lifeng Wang, and Dianxiong Liu **Presenter:** Lei Chen **Affiliation:** Academy of Military Science, PLA, China **Abstract:** Cognitive engine is the core component to promote the development of cognitive communication. However,most of the current cognitive engine is designed for a single decision algorithm, which is difficult to meet the needs of a variety of complex tasks, and it is difficult to adapt to the battlefield environment of the communication environment which is complex and changeable. This paper modularly designs an architecture of network scenario cognitive engine based on metacognitive core from a system perspective, and elaborates on the specific concepts of each module of the architecture, the realization technology and the recommendation method. The architecture is able to perceive user requirements, wireless environment and network environment, and recognize network scenarios including unknown scenarios by extracting scenario features. With the network scenario as the core, by applying the concept of metacognition, the system has the ability to select the most suitable decision algorithm for the current scenario to make decisions. Combined with cross-layer parameter information interaction, it intelligently optimizes the communication strategies and parameters of the physical layer, link layer, network layer, and higher layers. And it has the characteristics of strong adaptability to the scenario, strong accommodation to the decision algorithm, and autonomous learning of both cognition and metacognition.
08:15-08:30	**Paper ID:** 655 **Paper Title:** A Credit Based Abnormal Traffic Filtering Method for Time Sensitive Network in Substations **Author(s):** Huibin Jia, Yanyan Liu, Kun Wu, Jiahe Li, and Zhihua Wang **Presenter:** Huibin Jia **Affiliation:** North China Electric Power University, China **Abstract:** Time Sensitive Networking (TSN) offers deterministic latency, meeting the stringent real-time and high-reliability communication requirements of substation automation systems. To solve the issue of filtering abnormal traffic in these networks, we propose a credit-based method using an enhanced Per Stream Filtering and Policing (PSFP) structure at the switch's input. This structure progressively eliminates abnormal traffic in the input stream based on criteria such as frame length exceeding a threshold, frames not arriving at specified times, and frames exceeding predefined bandwidth limits. Furthermore, we introduce a credit-based flow limiting algorithm that adjusts parameters like idle slope, send slope, and maximum credit according to the bandwidth and maximum burst size of the network traffic. This algorithm efficiently filters out abnormal traffic by managing credit values. We validated our approach by building a multi-bay substation communication network model and conducting simulation experiments. The results show that our method effectively frees up bandwidth resources, reduces delay and jitter in business flows, and ensures reliable transmission

	during network storms.
08:30-08:45	**Paper ID:** 1089 **Paper Title:** Error Correction for SDN Routing and Forwarding **Author(s):** Xufang Wang, and Feng Lin **Presenter:** Xufang Wang **Affiliation:** Fujian Normal University, China **Abstract:** Multicast routing has attracted increasing attention because of the huge bandwidth consumption of various Software Defined Networking (SDN)-based applications. A new approach called Scalar-pair and Vectors Routing and Forwarding (SVRF) uses an efficient way to construct and query group memberships either hardware or software based on Chinese Remainder Theorem (CRT). However, the scalar-pairs of SVRF stored may suffer bit errors. Current soft error detection methods cannot meet the stringent error detection requirements of SVRF. In this paper, the bit error impact of scalar-pairs on SVRF is analyzed theoretically and the Redundant Key Detection and Correction (RKDC) scheme is proposed to efficiently detect and correct memory errors in scalars of SVRF. Simulation Results show that the RKDC scheme can achieve higher probability of error detection than traditional scheme such as ECC.
08:45-09:00	**Paper ID:** 2870 **Paper Title:** Active Intelligent Reflecting Surface Aided Secure Communication with Covert Constraint **Author(s):** Changjun Liu, Jia Shi, Zhusong Yin, and Yongchao Wang **Presenter:** Changjun Liu **Affiliation:** Xidian University, China **Abstract:** This work we investigate the use of active intelligent reflecting surface (IRS) for secure communications with covert constraint. Specially, Alice transmits private message to Bob with the help of active IRS, while two malicious users Eve and Willie, one is trying to intercept the private message and the other is trying to detect the communication behavior occurs or not. Based on this, we proposed an optimization problem to maximize the secrecy rate via joint design the transmission beamformer vector of Alice and reflecting phase shift vector of active IRS. To overcome the nonconvexity, an efficient alternating optimization (AO) based algorithm is proposed to solve the optimization problem. Numerical results shows that the active IRS is outperforms passive IRS for our proposed wireless communication system, since the active IRS can provide a higher power amplify for the incident signal.
09:00-09:15	**Paper ID:** 3681 **Paper Title:** Inter-Satellite Links-Enabled Cooperative Satellite Edge Computing **Author(s):** Caiguo Li, and Bodong Shang **Presenter:** Bodong Shang **Affiliation:** Eastern Institute of Technology, Ningbo, China **Abstract:** Satellite edge computing (SEC) has become a research hotspot in academia because of its enormous potential to enhance the performance of satellite communication systems, increase data processing capabilities, and address the growing data demand. However, ground users are typically unevenly distributed. When the data processing demand in a particular area suddenly surges, one satellite connected to these users may not have adequate computing capabilities to process a large amount of data simultaneously, resulting in a drop in edge computing system performance. This paper considers the possibility of inter-satellite cooperation, where a satellite directly connected to the ground user equipment (UE) not only offloads UE's task but also transmits partial tasks to other

	satellites via an inter-satellite link for cooperative offloading. In particular, offloading tasks through inter-satellite cooperation can alleviate the computational burden in areas with high traffic distribution. We consider computing resources and task partition to minimize the system weighted-sum energy consumption. In this study, we employ a rigorous methodology. Specifically, we develop an iterative algorithm by decomposing the original non-convex problem into several sub-problems. Each sub-problem is then transformed into a convex problem and solved by the Lagrange dual method, ensuring the robustness of our approach. Simulation results demonstrate that our scheme can efficiently utilize satellite computing resources.
09:15-09:30	**Paper ID:** 4209 **Paper Title:** A Predictiveness-Enhanced PRoPHET Based on Triple Exponential Smoothing In Mobile Opportunistic Networks **Author(s):** Demin Peng, Yanan Chang, Xingzhuo Duan, and Jianqun Cui **Presenter:** Xianglong Yan **Affiliation:** Central China Normal University, China **Abstract:** With the advancement in communication technologies in the last decade, mobile opportunistic networks (MONs) have received significant attention in facilitating spontaneous communication. Due to the intermittent connectivity and implicit end-to end routing paths in MONs, one of the most challenging problems is the development of reliable routing algorithms for delivering more messages to their destinations faster and at a reduced cost. This paper primarily focuses on enhancing the traditional Probability Routing Protocol using History of Encounters and Transitivity (PRoPHET) which utilizes the history of transitivity and encounters. Here, we propose a predictiveness-enhanced PRoPHET based on triple exponential smoothing (TES-PRoPHET). We incorporate triple exponential smoothing, a nonlinear analytical prediction method, to smooth and adjust the delivery predictability time series data that exhibits nonlinear tendencies in traditional PRoPHET, so as to compute the adaptive delivery predictability (ADP) of messages. Then, during message propagation, we choose relay nodes with exceptional ADP values, which aim to make more accurate routing decisions. The simulation results demonstrate that TES-PRoPHET not only significantly improves the delivery rate and reduces the average delay, but it also shows good performance in network overhead and average hop count compared to PRoPHET, PRoPHETV2 and AR-PRoPHET.
09:30-09:45	**Paper ID:** 6317 **Paper Title:** Resource Allocation for Vehicle-Satellite-Cloud Empowered Vehicular Edge Metaverse **Author(s):** Caiguo Li, Bodong Shang, and Yanhui Wu **Presenter:** Bodong Shang **Affiliation:** Eastern Institute of Technology, Ningbo, China **Abstract:** Combining the metaverse and vehicular edge computing (VEC) as two cutting-edge technological fields shows multiple new applications and creations. However, the existing vehicular metaverse edge computing schemes may not guarantee the quality of experience (QoE) of vehicular metaverse users (VMU) due to the limitations of terrestrial network coverage and computing resources. This paper introduces a novel vehicular metaverse edge computing scheme based on a three-tier vehicle-satellite-cloud integrated network. This innovative approach offloads VMU's task and transmits a portion of the task to the ground cloud server (CS) for cooperative offloading, thereby enhancing the overall system performance. By leveraging the real-time data transmission capabilities of satellites and the robust processing power of CS, our proposed scheme holds the promise of

	significantly improving real-time performance and reliability in vehicular metaverse edge computing. Specifically, we consider task partition and computing resources to maximize VMUs' total QoE. Moreover, we study an iterative algorithm by decomposing the original problem into several sub-problems, and we solve each sub-problem using the optimization tool and the Lagrange dual method. Simulation results demonstrate that our scheme is efficient regarding VMUs' QoE.
09:45-10:00	**Paper ID:** 6535 **Paper Title:** SMT-Based Traffic Scheduling Algorithm for TSN **Author(s):** Chunlong Liu, Wei Huangfu, Jiahao Huo, and Xiaolong Cui **Presenter:** Chunlong Liu **Affiliation:** University of Science and Technology Beijing, China **Abstract:** Globally, the trend of industrialization, informatization and intelligence is profoundly affecting various industries, among which the automotive, avionics, and industrial automation fields, which have stringent latency requirements, are in urgent need of network communications with deterministic low-latency characteristics. In this context, the Time Sensitive Networking (TSN) standard proposed by the IEEE 802.1 Working Group is considered to be the most promising solution. Although the application of TSN in traffic scheduling algorithms shows diverse and innovative features, it still lacks deep integration with the core mechanism of TSN system architecture. In this paper, we innovatively combine the time-aware shaper standard in the time-sensitive network protocol cluster with existing theories, and this pioneering integration aims to deeply explore the core potential of the TSN architecture.Ultimately, experiments demonstrate that the schedulability of this method is significantly improved compared to the standard time-triggered message scheduling approach.
10:00-10:15	**Paper ID:** 7593 **Paper Title:** A Data Collection Scheme Using Transformer Autoencoder in Wireless Sensor Networks **Author(s):** Jiahui Xu, and Cuiran Li **Presenter:** Jiahui Xu **Affiliation:** Lanzhou Jiaotong University, China **Abstract:** Data collection is one of the key operations in wireless sensor networks (WSNs). an efficient data collection scheme is designed using a transformer autoencoder for WSNs. During the model training stage, the model is trained using historical monitoring data to obtain optimized measurement matrix and reconstruction matrix. In the data collection stage, sensor nodes compress the data using the measurement matrix and achieve efficient data transmission by selecting the optimal transmission path through tree-based routing. Finally, the sink node utilizes the reconstruction matrix to restore the original data. Simulation and verification analysis shows that the proposed data reconstruction algorithm outperforms existing algorithms such as OMP, DAE, SSDAE-CS, and ISTA-1DNet in terms of reconstruction accuracy and reconstruction efficiency at a compression ratio of 30%.
10:15-10:30	**Paper ID:** 9837 **Paper Title:** Relay Assisted Covert Communications in Underlay Cognitive Radio Networks **Author(s):** Hongbin Fan, Weiwei Yang, Wenqiang Feng, and Chuanzhen Rong **Presenter:** Hongbin Fan **Affiliation:** Army Engineering University of PLA, China **Abstract:** In this work, we investigated relay-assisted covert communication. In phase 1, the secondary source (SS) sends covert messages to Relay, and relay sends interference signals to Willie. In phase 2, Relay decodes and forwards the covert information received in phase 1, and SS

	sends interference signals to Willie to ensure covert transmission. The average detection error probability, the transmission outage probability and the maximum effective covert rate of the system are derived. The simulation results show that the average minimum detection error probability in phase 1 and the transmission outage probability decrease with the increase of the maximum interference tolerance of primary destination (PD), and the maximum effective covert rate increases with the increase of the maximum interference tolerance of PD.

Parallel Session 06: Signal Processing & Image Processing

Session Chair: Assoc. Prof. Tianming Ma, Shanghai University of Engineering Science, China

Date: July 7 **Venue:** Jingfu Hall

08:30-08:45	**Paper ID:** 4267 **Paper Title:** Enhancing Mesh Parameterization Efficiency: A Study on Patch Generation Optimization in V-DMC Standard **Author(s):** Haidi Huang, Zhe Sun, Wenjie Zou, and Zhuoyi Lv **Presenter:** Haidi Huang **Affiliation:** Xidian University, China **Abstract:** In recent years, rapid advancements in multimedia technology have led to the emergence of immersive video concepts like the Metaverse. As a typical representation of 3D models, 3D meshes are widely used in many fields such as immersive video, holding a progressively significant role. Given that 3D mesh compression facilitates storing and transmitting a large amount of data from 3D meshes, it is a crucial aspect of their application. The Moving Picture Experts Group (MPEG) is developing a standard known as Video-based Dynamic Mesh Coding (V-DMC), aimed at dynamic meshes with high-precision attribute information. As a type of information representing surface texture or material properties of 3D meshes, the attribute information significantly influences the subjective quality of the 3D model. In the V-DMC framework, the encoding of attribute information involves mesh parameterization, which is used to regenerate texture coordinates. One of the adopted mesh parameterization methods, i.e., OrthoAtlas, has the advantage of low time complexity. It can be implemented at the decoder side to generate texture coordinates, resulting in significant bit savings for encoding. In this paper, an optimization scheme is proposed for OrthoAtlas. Specially, considering the issue of inaccurate projection planes for patches, the optimal projection planes are determined by recalculating the normal vectors of the patches. Furthermore, to enhance coding efficiency, it is integrated with rate-distortion optimization to decide whether to merge patches. The experimental results show that the proposed methods can improve the performance in terms of BD-Rate. The proposed methods have been adopted by the V-DMC standard and integrated into the MPEG V-DMC reference software.
08:45-09:00	**Paper ID:** 6494 **Paper Title:** Blind Reconstruction of Binary Primitive BCH Code Based on Error Codeword Correction **Author(s):** Haochen Mu, Yunzhi Wu, and Li Li **Presenter:** Haochen Mu **Affiliation:** Southwest Jiaotong University, China **Abstract:** In this paper, a blind reconstruction method of binary primitive BCH code is proposed, which can identify the generator polynomial of BCH code from received noisy bitstreams. Firstly, error codewords are exposed according to the fact that correct codeword polynomials shall have consecutive roots. Secondly, the recovery of error codewords will be fast completed by leveraging the parity-check matrix of BCH code. Then, the consecutive roots of BCH code are determined by measuring the discrepancy between their experimental occurring probability and their theoretical occurring probability. Finally, the generator polynomial of BCH code are reconstructed based on the detected roots. Simulation results show that for the BCH codes whose error correction capability exceed 2 bits, the proposed method outperforms the reconstruction method using single-error

	correction.
09:00-09:15	**Paper ID:** 4768 **Paper Title:** A Reference Frame Compression Scheme via AVS Perceptual Lossless Compression in Video Coding **Author(s):** Meng Wu, Huanbang Chen, Fuzheng Yang, Haitao Yang, and Junkai Feng **Presenter:** Meng Wu **Affiliation:** Xidian University, China **Abstract:** Video coding systems have enormous external memory bandwidth requirements, especially for ultra-high-definition (UHD) applications. However, due to cost and power constraints, the available bandwidth in video devices is limited.Consequently, reducing the required memory bandwidth is of paramount importance. In this paper, a lossy reference frame compression scheme is proposed to address this challenge. It includes two core technologies: 1) an address table storage scheme for random accessibility and 2) low complexity AVSPerceptual Lossless Compression (PLC) compression algorithm. Under fixed compression ratios of 2:1 and 1.5:1, the proposed scheme achieves a 64×4 block-level random access. Rigorous subjective and objective quality assessments verify the feasibility of the proposed solution. Experimental results demonstrate that the BD-Rate of luma is 0.81% and 0.2% for the 2:1 and 1.5:1 compression ratios, respectively, indicating a negligible impact on compression efficiency. This significant reduction in memory bandwidth requirements is achieved while preserving the video quality.
09:15-09:30	**Paper ID:** 1774 **Paper Title:** UAV Object Detection Based on Joint YOLO and Transformer **Author(s):** Yifan Gao, Rui Ding, Fuhui Zhou, and Qihui Wu **Presenter:** Yifan Gao **Affiliation:** Nanjing University of Aeronautics and Astronautics, China **Abstract:** With the gradual expansion of computer vision application fields, the demand for object detection based on unmanned aerial vehicle (UAV) aerial images continues to grow.Traditional methods have limitations in handling scale changes, motion blur, and complex backgrounds. We propose a novel approach that combines the model You Only Look Once version 5 based on convolutional neural network with the sequence modeling technology Transformer to better capture long-range dependencies and contextual information, thereby improving detection performance. Experimental results on the VisDrone dataset show that the proposed method has comparable performance to existing methods, demonstrating its effectiveness in UAV object detection.
09:30-09:45	**Paper ID:** 5510 **Paper Title:** Cloud Gaming Video Coding Algorithm Assisted by Pixel-level Motion Vector Predition Utilizing Camera Information **Author(s):** Haonan Sun, Yuan Chen, Yifan Wang, Fuzheng Yang, Kun Yang, and Gaoxing Chen **Presenter:** Haonan Sun **Affiliation:** Xidian University, China **Abstract:** The rapid development of cloud gaming putstremendous pressure on network bandwidth, highlighting the crucial role of video coding technology. Considering substantial disparities in video generation between natural recordings and those from video games, with game videos often characterized by frequent and rapid camera rotations, directly applying conventional video compression technologies to gaming videos is inadequate. Therefore, we propose a novel cloud gaming video coding algorithm assisted by pixel-level motion vector prediction. By meticulously

	analyzing the coordinate mapping process within the game rendering pipeline, we present an efficient pixel-level motion vector prediction method leveraging camera information, which is integrated in the H.266/VVC standard test model (VTM) as an additional inter-frame mode to compete with existing modes for rate-distortion optimization. Experimental results demonstrate the superiority of our algorithm, achieving a significant reduction of 11.1% in the average BD-Rate across various game scenes provided by SteamVR.
09:45-10:00	**Paper ID:** 6939 **Paper Title:** An Integrated Communication and Navigation Waveform Design Based on OFDM with Index Modulation **Author(s):** Yinjie Ma, Lifeng Wang, Supeng Leng, and Dianxiong Liu **Presenter:** Yinjie Ma **Affiliation:** University of Electronic Science and Technology of China, China **Abstract:** Aiming at the challenge of anti-interference and stable operation in navigation denial scenarios, we design an Integrated communication and navigation waveform for distributed swarm systems. The traditional integrated waveforms based on orthogonal frequency division multiplexing have some problems such as high peak-to-average ratio, sensitive frequency bias and weak anti-narrow-band interference ability, resulting in low robustness and reliability in denial and interference scenarios. Against this background, this paper proposes an innovative integrated communication and navigation waveform design that combines index modulation with orthogonal frequency division multiplexing technology. This design improves the system's anti-frequency offset and anti-interference performance. Information bits are transmitted through constellation mapping on the active subcarriers and implicitly transmitted by the index combination of the active subcarriers. At the same time, navigation and positioning are achieved through the time of arrival measured by code synchronization and loop tracking. The simulation results demonstrate that the designed waveform has more advantages in frequency offset and peak-to-average ratio performance compared to traditional integrated waveforms.
10:00-10:15	**Paper ID:** 4781 **Paper Title:** Assessing Wireless Screen-Casting Services: A Comprehensive Quality of Experience Model **Author(s):** Zhicheng Zhang, Tianyu Zhang, and Jiarun Song **Presenter:** Zhicheng Zhang **Affiliation:** Xidian University, China **Abstract:** Wireless Screen-casting service becomes popular due to its simple and convenient features. However, the quality of experience (QoE) is easily affected by encoding, transmission, and display. Currently, there is relatively little research on end-to-end systematic wireless screen projection quality evaluation methods. With this regard, this paper conducts a series of subjective experiments to explore the impact of end-side and network factors on user’s QoE, where the video encoding damage and video display attenuation are mainly considered for the end-side factors, while the screen-casting stalling and transmission delay are considered for the network factors. A complete QoE evaluation model is further proposed combining both factors. Experimental results showed that the proposed model can accurately predict user’s QoE of wireless screen-casting services. This work can be served as a guideline for device and network operators to improve their services.

10:15-10:30	**Paper ID:** 4330 **Paper Title:** Asymmetric Multi-Scale Dilated Attention Based Network for Remote Sensing Image Compression **Author(s):** Haoyi Ma, Peicheng Zhou, Jia Jia, Ran Tang, Keyan Wang, and Yunsong Li **Presenter:** Haoyi Ma **Affiliation:** Xidian University, China **Abstract:** Recently, there has been rapid development in learned image compression techniques. However, deep learning-based remote sensing image compression algorithms has limitations such as incomplete feature extraction and poor fitting of information entropy distribution. To alleviate these limitations, we propose a remote sensing image compression network based on a multiscale asymmetric codec. Based on hyperprior architecture, we incorporate a multiscale asymmetric codec to extract multiscale features and fit the distribution of latent features through an adaptive context entropy model. The experimental results on DIOR dataset demonstrate that our method can effectively enhance the visual quality of reconstructed images and achieve high-fidelity at a lower bitrate.

Parallel Session 07: Workshop on Joint Communication, Sensing and Computing for Next Generation Network

Session Chair: Dr. Chao Ren, University of Science and Technology Beijing, China

Date: July 7

Venue: Shaohua Hall

10:50-11:05	**Paper ID:** 2095 **Paper Title:** Channel State Estimation and Noise Source Location Based on Ambient Backscatter Communication in Substation Scenario **Author(s):** Qingqing Wu, Wei Bai, Yang Lu, Yan Ma, and Fei Chen **Presenter:** Yan Ma **Affiliation:** University of Science and Technology Beijing, China **Abstract:** With the development of power system, it is increasingly important to build a reliable, efficient, and safe substation communication system. However, due to the complex environment of the substation and the presence of high-voltage power equipment, the communication system is susceptible to a variety of interferences and noises.In this paper, channel state estimation and noise source localization techniques based on ambient backscatter communication are introduced. We employ the Prony algorithm to obtain the characteristic parameters of the received signal, accurately estimate the quality and characteristics of the channel, and provide a basis for the optimization of the communication system. Meanwhile, the MUSIC algorithm is utilized to accurately locate the noise sources in the substation, which further helps the operation and maintenance personnel establish the wireless map of the substation so as to carry out abnormal maintenance and analyze the operation status of some key switches. In addition, in order to reduce the interference of multiple scattering signals, the effectiveness of the communication system is improved by identifying and separating the multiple scattering paths to avoid receiving the same signal repeatedly.Experimental results show that this technology can effectively improve the reliability and performance of the substation communication system, and provide important support for the safe and stable operation of the power system.
11:05-11:20	**Paper ID:** 2171 **Paper Title:** Secure Design for RIS-Assisted Multi-Target ISAC Systems **Author(s):** Xinji Wang, Xin Chen, Haiyang Cao, Zenebe Melesew Yetneberk, Chaowen Liu, and Tongxing Zheng **Presenter:** Xinji Wang **Affiliation:** Xi'an Jiaotong University, China **Abstract:** This paper investigates a multi-objective secure integrated sensing and communication (ISAC) communication system based on reconfigurable intelligent surface (RIS), a multi-antenna dual-functional radar and communication base station serves a multi-antenna communication user and detects malicious eavesdropping targets simultaneously. The paper firstly establishes the system model, including the signal models for communication and radar target detection. Next, an optimization problem is proposed to maximize the secrecy rate, involving the joint optimization of the transmission matrix and the phase matrix of the RIS. In order to address the non-convex constraint problem, an approximation approach is employed, transforming the problem into an alternating optimization problem. Specifically, auxiliary variables are introduced, and a block coordinate descent algorithm is used to optimize the variables in each block. Simulation results demonstrate that the proposed algorithm effectively improves the secrecy rate of the system and achieves excellent target

	detection performance.
11:20-11:35	**Paper ID:** 2766 **Paper Title:** Sensing Processing Method for Integrated Sensing and Communication in Smart Home Linkage **Author(s):** Chao Gong **Presenter:** Chao Gong **Affiliation:** Nanyang Technological University, Singapore **Abstract:** In order to enhance the effectiveness of smart home linkage, this paper proposes methods for task-oriented modeling of linkage and the processing of heterogeneous data, as well as the fusion of communication-aware information. We present a diverse multi-source information processing system that utilizes heterogeneous data processing and interaction with historical information to improve the intelligence and reliability of smart home systems. These methods contribute to improving the performance and user experience of smart home systems, enabling personalized services and experiences.
11:35-11:50	**Paper ID:** 7207 **Paper Title:** Exploring Adversarial Attacks in Semantic Communication Systems Across Diverse Channel Environments **Author(s):** Mingjia Shi, Yandie Yang, and Yun Lin **Presenter:** Mingjia Shi **Affiliation:** Harbin Engineering University, China **Abstract:** Semantic communication systems are considered to be an innovative paradigm for future communications. However, adversarial attacks pose significant obstacles to the practical application of semantic communication. Unfortunately, research on this issue is still limited. To address this challenge, we firstly implement an image semantic communication system and conduct a comparative analysis under high and low compression rate. Numerical experiments show that this system enables efficient transmission with low resource requirements, achieving a loss rate of less than 5%. Secondly, we subject the implemented semantic communication system to two location-based attacks. Our research reveals the high sensitivity of semantic communication systems to wireless adversarial attacks, with the effectiveness being dependent on the attack location. Additionally, we account for realistic channel effects such as Gaussian noise, Rayleigh fading, Rician fading with path loss, and shadowing. Through comprehensive experiments, we investigate the system's vulnerability under various conditions including attack location, perturbation intensity, signal-to-noise ratio, and channel characteristics, thereby exploring the impact of the channel on adversarial perturbations.
11:50-12:05	**Paper ID:** 8030 **Paper Title:** Intelligent Positioning Polarity Testing of Space Engine Based on Joint Communication, Sensing and Computing **Author(s):** Zhongqiang Ren, Maosen Zhang, Hongxia Zhang, Bingbing Ma, Jianzhong Cao, and Kun Liu **Presenter:** Zhongqiang Ren **Affiliation:** Beijing Aerospace Propulsion Institute, China **Abstract:** As the frequency of spacecraft launches increases and the number of aerospace engine assemblies grows, the demand for engine assembly polarity testing has surged. However, conventional manual operations are inefficient, susceptible to errors, and lack data traceability. Furthermore, there is a risk of polarity inconsistency. To ensure the precision of engine polarity during

	assembly, an intelligent polarity tester system has been developed through the integration of communication, sensing, and computing technologies. Key technologies, including the synchronous acquisition of loop current, electromagnetic valve magnetic field strength, and small air pressure at the nozzle, are employed to achieve a consistent interpretation of sensor fusion data. The implementation of this intelligent space engine polarity testing system enhances engine safety, optimizes performance, reduces maintenance costs, and promotes design improvements, thereby providing robust support for high-frequency spacecraft launches.
12:05-12:20	**Paper ID:** 8839 **Paper Title:** Efficient Network Resource Management Based on Near-Zero Power Wireless Iot Communication **Author(s):** Weijun Zheng,Ying Wang, Zheng Wang, and Chen Xu **Presenter:** Weijun Zheng **Affiliation:** Jiaxing Power Supply Company State Grid Zhejiang lectric Power Co., Ltd., China **Abstract:** With the continuous development of Internet of things (Iot) technology, Internet of things technology has achieved the goal of low cost and low power consumption, which can basically satisfy the requirements of diverse scenarios. However, traditional wireless Internet of things systems face challenges such as high energy consumption, limited spectrum resources and network congestion, which affect their widespread deployment and application. In this paper, the wireless iot communication system model is first constructed. Then, based on the user association and spectrum allocation problems of the system model, the two problems were optimized respectively. By comprehensively considering the channel conditions, user location, and other factors, the reasonable association between users and base stations and the efficient allocation of spectrum resources were realized.

Parallel Session 08: Signal Processing & Image Processing

Session Chair: Dr. Xiaoyang Li, Shenzhen Research Institute of Big Data, China

Date: July 7 **Venue:** Jingfu Hall

10:50-11:05	**Paper ID:** 4243 **Paper Title:** Convolutional Neural Networks for Fiber-Bending Eavesdropping Attacks Detection in Coherent Optical Communication Systems **Author(s):** Wenshuai Qin, Qihan Zhang, Weigang Hou, Xu Zhang, and Xiaoxue Gong **Presenter:** Wenshuai Qin **Affiliation:** Chongqing University of Posts and Telecommunications, China **Abstract:** We propose a convolutional neural networks based scheme for detecting fiber bending eavesdropping in 16QAM coherent optical communication systems. Numerical results show 99.1%, 99%, and 98.5% detection accuracy at bending radii of 10.8 mm, 12.1 mm, and 15 mm, respectively.
11:05-11:20	**Paper ID:** 9407 **Paper Title:** Inter-Layer Link Allocation in Multilayer LEO Optical Satellite Networks **Author(s):** Yulong Fan, Yongli Zhao, Wei Wang, Yinji Jing, Yuanjian Zhang, and Zhang Jie **Presenter:** Yulong Fan **Affiliation:** Beijing University of Posts and Telecommunications, China **Abstract:** In the future, integrated terrestrial and space communication networks will need to simultaneously meet the high-reliability and high-quality transmission of massive satellite services and the global coverage of billions of terminals. Single-layer low earth orbit satellite optical networks (SONs) suffer from low ground coverage density, earlier network congestion, and they cannot balance global coverage with the prioritized coverage of traffic-intensive areas. Therefore, multilayer SONs have become a hot topic of research for various countries. Unlike single-layer satellite networks, multilayer networks emphasize spatial integration between layers, and the deployment of inter-layer links (ILLs) can reduce the number of hops in service paths and the blocking rate of satellite networks under high loads. Therefore, the deployment location of inter-layer links is particularly important. In this study, we first establish a multilayer satellite network inter-layer link model, define the inter-layer link planning problem, and propose a comprehensive weighted allocation strategy for inter-layer links in multilayer low Earth orbit satellite optical networks, considering factors such as ILLs duration, satellite ground links (GSLs) constraints, and ILLs distance. Simulation results show that this strategy can reduce the blocking rate by about 6% compared to the other three allocation strategies and can reduce the average service delay by up to 10%.
11:20-11:35	**Paper ID:** 6675 **Paper Title:** A Perceptual-Driven Adaptive Reference Picture Resampling Method in VVC **Author(s):** Jianxiang Sun, Mingyi Yang, and Fuzheng Yang **Presenter:** Jianxiang Sun **Affiliation:** Xidian University, China **Abstract:** In the latest H.266/VVC video coding standard, Reference Picture Resampling (RPR) is employed to enable variable resolution coding. Based on RPR technology, this paper proposes a perceptual-driven adaptive RPR approch. In order to determine the optimal timing to activate RPR, we design a subjective experiment to explore the just perceptible distortion for different videos, and the coding parameter (QP) corresponding to the just perceptible distortion is regraded as the parameter to

	activate RPR. In order to further determine the down-sampling ratio after RPR is activated, a subjective experiment is designed to explore the the optimal down-sampling ratio model for perceptual quality at different QP. Finally, based on the results of two subjective experiments, an adaptive downsampling method for RPR driven by perceptual quality is designed, which can adaptively adjust the coding resolution according to the video content in the coding process. The experiment results show that the proposed adaptive RPR method can save 14.66% bitrate and 21.82% coding time, while maintaining equivalent subjective quality levels, thus effectively improve the perceptual quality of high-resolution video under low-bit-rate video transmission.
11:35-11:50	**Paper ID:** 7765 **Paper Title:** Optimization Strategy for 3D Mesh Displacement Coding in the V-DMC Standard **Author(s):** Xuanrui Zhang, Wenjie Zou, and Zhuoyi Lv **Presenter:** Xuanrui Zhang **Affiliation:** Xidian University, China **Abstract:** Recent years have witnessed significant advancements in 3D model capture, modeling, and rendering technologies, propelling 3D mesh to the forefront as an effective representation of 3D models across various platforms and industries. As the quest for enhanced 3D mesh accuracy intensifies, the volume and complexity of 3D mesh data have escalated, challenging the storage and transmission of 3D meshes. In response, the Moving Pictures Experts Group (MPEG) has established the Video-based Dynamic Mesh Compression Standard (VDMC), wherein displacement data serves as a crucial component of mesh geometry. Following transformation and quantization, a substantial portion of this data comprises zero values, which hampers encoding efficiency. This paper presents a detailed analysis of the displacement data coding process within the VDMC codec framework and introduces an innovative zero-detection-based optimization algorithm for displacement encoding. This algorithm selectively encodes critical displacement data for transmission, seamlessly integrating with the VDMC framework to enhance BD-Rate performance and simplify codec complexity.
11:50-12:05	**Paper ID:** 8525 **Paper Title:** Nonstationary Jammer Excision Based on Sparse Reconstruction and Support Vector Regression **Author(s):** Jiangbo Si, Zeyu Wang, Naofal Al-Dhahir, and Hang Hu **Presenter:** Zeyu Wang **Affiliation:** Xidian University, China **Abstract:** As a typical jammer type, nonstationary jammers degrade the wideband communications and navigation signal performance significantly. Moreover, due to the channel fluctuations and receiver movement some received signal samples can be missing. For this scenario, traditional anti-jamming algorithms do not work well. We propose a novel jammer excision algorithm, which uses both model and data driven methods to realize jammer excision. Specifically, the nonstationary jammer signal is reconstructed by exploiting the jammer sparsity in the time-frequency domain. Then, support vector regression (SVR) is used to 'clean' and correct the imperfectly reconstructed jammer. Finally, a waveform projection technique is applied to eliminate the nonstationary jammer effect on the communication or navigation signal. Simulations results show the efficacy of our proposed algorithm.

Parallel Session 09: Machine Learning & Optimization for Wireless Systems

Session Chair: Dr. Zhaohui Yang, Zhejiang Univerisity, China

Date: July 7

Venue: Shaohua Hall

13:30-13:45	**Paper ID:** 6539 **Paper Title:** UAV-RIS Assisted AoI Minimization in IoT Networks: A Reinforcement Learning Approach **Author(s):** Zihui Gao, Xulong Li, Jiahao Huo, and Wei Huangfu **Presenter:** Zihui Gao **Affiliation:** University of Science and Technology Beijing, China **Abstract:** Unmanned aerial vehicles (UAV) and reconfigurable intelligent surfaces (RIS) have made significant contributions to assisting wireless network communication. Recently, the integration of UAV and RIS has also garnered widespread researchattention. The age of information (AoI) is an important evaluation metric for time-sensitive applications in the Internet of Things (IoT). This study investigates typical scenarios of UAV-RIS-assisted IoT communication, considering the high coupling between UAV trajectories and RIS phase-shift variables. The RIS phase shift is solved first, followed by joint optimization of UAV trajectories and IoT devices scheduling using the soft actor-critic (SAC) algorithm. Simulation results demonstrate that the optimization performance of this algorithm surpasses that of baseline algorithms.
13:45-14:00	**Paper ID:** 6650 **Paper Title:** OSMR: Open-Set Modulation Recognition Based on Information Enhancement **Author(s):** Yuxuan Ling, Linan Wang, Yuqing Wang, Chaoqun Hou, Jianxiong Pan, and Neng Ye **Presenter:** Neng Ye **Affiliation:** Beijing Institute of Technology, China **Abstract:** Modulation recognition is a vital component of communication systems. With the emergence of neural networks, many researches have used IQ signal as the input for various learning algorithms in hopes of improving the recognition performances. However, it has been neglected that IQ signal contains the information of modulation characteristics, source characteristics, and other influencing factors. Besides, the modulation characteristics are scattered across various dimensions where modulation occurs, such as frequency domain, phase domain, and amplitude domain. Therefore, the modulation characteristic information of the raw IQ signal is difficult to be fully extracted. To solve this problem, it is necessary to enhance the modulation characteristic information and effectively extract its specific features. In this paper, we propose an open-set modulation recognition (OSMR) framework, which exploits the joint enhancement of modulation characteristic information, residual network, spatial attention mechanism and openmax layer. Specifically, we enhance the modulation characteristic information by calculating instantaneous features of frequency, phase and amplitude, and utilize spatial attention mechanism to further extract the specific features. OSMR can improve the performance of inter-class and intra-class recognition. Simulation results of the proposed method demonstrate an open-set recognition accuracy of 81% on the RadioML2018.01A dataset.
14:00-14:15	**Paper ID:** 9262 **Paper Title:** Toward Embodied Intelligence: An Autonomous Exploration System for Multimodal UAV **Author(s):** Zihan Hu, Weikai Yang, Meng Zhang, Chengdong Lei, Hongtao Liang, Fuhui zhou, and Qihui Wu **Presenter:** Zihan Hu

	Affiliation: Nanjing University of Aeronautics and Astronautics, China **Abstract:** Unmanned Aerial Vehicles (UAVs) embodied intelligence is of increasingly important since UAVs are well suited to perform tasks that are dangerous or impractical for humans. Numerous model-based approaches for autonomous UAV exploration have been proposed, yet they predominantly rely on a single sensor. This reliance limits the range of information obtained and diminishes the success rate in search missions. In this paper, in order to tackle those issues, a multimodal UAV autonomous exploration system is proposed. A pioneering method is introduced that harnesses deep reinforcement learning to synergize spectral data with LiDAR information, thereby significantly enhancing the navigation capabilities of UAVs in complex environments. A novel UAV equipped with spectral sensing and conducted extensive experiments is developed on a virtual simulation platform. Simulation results demonstrate that the proposed method demonstrating increased robustness and a higher success rate in obstacle avoidance.
14:15-14:30	**Paper ID:** 7115 **Paper Title:** A Secure and Efficient Federated Learning Framework for Radio Frequency Fingerprint Recognition **Author(s):** Weicheng Liu, Yunsong Huang, and Hui-Ming Wang **Presenter:** Yunsong Huang **Affiliation:** Xi'an Jiaotong University, China **Abstract:** With the rapid development of cognitive radio networks, the number of terminal devices has exponentially increased, leading to the generation of a vast amount of privacy-sensitive data, particularly WiFi signals. Radio Frequency (RF) fingerprinting holds a significant advantage in device authentication within the Internet of Things (IoT) domain. To protect data privacy and enable RF fingerprint recognition without transmitting sensitive data, federated learning is necessary. In this paper, we apply hierarchical federated learning (HFL) for RF fingerprint recognition to reduce the communication overhead. Additionally, we conduct research on the vulnerability of federated learning to Byzantine attacks, and we propose a new defense method called Full-Krum to enhance the robustness of federated learning. Experimental results demonstrate the outstanding performance of our algorithm in safeguarding the security of federated learning.
14:30-14:45	**Paper ID:** 7261 **Paper Title:** Spectrum Map Construction Method Based on Spatially-Enhanced Channel Attention **Author(s):** Siqi Peng, Han Zhang. Congan Xu, Wei Zhang, and Yun Lin **Presenter:** Siqi Peng **Affiliation:** Harbin Engineering University, China **Abstract:** In sixth-generation (6G) wireless communication networks, spectrum map are crucial for network optimization and the intelligent management of electromagnetic spectrum. Spectrum map provide information on spatial power spectral density (PSD) distribution and spectrum resource occupancy. However, the complexities of urban environments and sparse PSD measurements pose challenges to accurately constructing high-resolution spectrum map. This paper introduces a Dual Attention Spectrum Cartography (DASC) method that utilizes channel features and spatial information through a joint spatial channel attention mechanism. This approach enhances the learning of propagation patterns and shadowing effects in complex environments, thereby improving the quality of spectrum map construction. Experimental results demonstrate that our method outperforms other deep learning models and interpolation algorithms in both performance and generalization capabilities.

14:45-15:00	**Paper ID:** 7429 **Paper Title:** PAPR-Aware Joint Waveform Design of UAV-Enabled Integrated Sensing and Communication **Author(s):** Meng Gu, Yaxi Liu, and Wei Huangfu **Presenter:** Meng Gu **Affiliation:** University of Science and Technology Beijing, China **Abstract:** Unmanned aerial vehicles (UAVs) can be regarded as reliable integrated sensing and communication (ISAC) transmitters due to their high mobility and strong line-of-sight links in upcoming sixth-generation wireless communications (6G). Since there exist inherent trade-offs between communication and sensing, their joint waveform design is an essential issue in UAV-enabled ISAC systems. However, the existing works for waveform design in UAV-enabled ISAC mainly neglect the peak-to-average power ratio (PAPR) of joint waveform designed for both communication and sensing. In this paper, we consider this signal characteristic and develop a nonconvex optimization problem to minimize the weighted sum of multiuser interference (MUI) for communication and beam pattern mismatch for sensing in UAV-enabled ISAC systems, subject to the constraints of PAPR of signal, transmit power, and ideal beam pattern approximation. To solve such a complex nonconvex problem, we propose a multivariate cyclic iterative alternating direction multiplier method (MCI-ADMM) where the original problem can be decomposed into multiple sub-problems with different variables. Experiment results show that the proposed algorithm is valid for waveform design of UAV-enabled ISAC considering PAPR.
15:00-15:15	**Paper ID:** 7910 **Paper Title:** Task Offloading and Trajectory Optimization for UAV-Assisted Mobile Edge Computing **Author(s):** Mengmeng Shi, Yanchao Xing, Xueli Guo, Xuerui Zhu, Ziyao Zhu, and Jiaqi Zhou **Presenter:** Mengmeng Shi **Affiliation:** Chang'an University, China **Abstract:** Recently, Unmanned Aerial Vehicles (UAVs) have been integrated into Mobile Edge Computing (MEC) systems to process substantial data tasks generated by distributed user devices (UDs). In UAV-MEC network architecture, UAV serve as primary MEC servers, significantly reducing the computational task latency and energy consumption of user devices, thereby enhancing Quality of Service (QoS). However, in providing computational services to numerous mobile devices, UAVs face dual challenges of limited computational capabilities and energy resources. To effectively confront these challenges, this paper effectively reduces the system's average latency and enhances energy efficiency through a joint optimization of user association, task allocation, and UAV dynamic trajectories. We developed a Markov Decision Process (MDP) for UAV-assisted MEC systems, applying the Twin Delayed Deep Deterministic Policy Gradient (TD3) algorithm in Deep Reinforcement Learning (DRL) due to the high continuity in the state spaces of UDs and UAV positions, as well as the action spaces of UAV flight speed and angles. Simulation results indicate that this algorithm outperforms other baseline algorithms in reducing the system's average delay.
15:15-15:30	**Paper ID:** 8938 **Paper Title:** FedsLLM: Federated Split Learning for Large Language Models over Communication Networks **Author(s):** Kai Zhao, Zhaohui Yang, Chongwen Huang, Xiaoming Chen, and Zhaoyang Zhang **Presenter:** Kai Zhao **Affiliation:** Zhejiang University, China

	Abstract: Addressing the challenges of deploying large language models in wireless communication networks, this paper combines low-rank adaptation technology (LoRA) with the splitfed learning framework to propose the federated split learning for large language models (FedsLLM) framework. The method introduced in this paper utilizes LoRA technology to reduce processing loads by dividing the network into client subnetworks and server subnetworks. It leverages a federated server to aggregate and update client models. As the training data are transmitted through a wireless network between clients and both main and federated servers, the training delay is determined by the learning accuracy and the allocation of communication bandwidth. This paper models the minimization of the training delay by integrating computation and communication optimization, simplifying the optimization problem into a convex problem to find the optimal solution. Additionally, it presents a lemma that describes the precise solutions to this problem. Simulation results demonstrate that the proposed optimization algorithm reduces delays by an average of 47.63% compared to unoptimized scenarios.
15:30-15:45	**Paper ID:** 6687 **Paper Title:** A Semisupervised Graph Convolutional Neural Network-Based Earth Station Network Planning Method **Author(s):** Honghua Zhao, Xuemiao Sun, Guyu Hu, and Ke Ding **Presenter:** Honghua Zhao **Affiliation:** Army Engineering University of PLA, China **Abstract:** Network planning is used for the rational allocation of satellite communication resources. In this paper, the low utilization and disorderly allocation problems of satellite communication network resources caused by the increasing demand for satellite communication are addressed. An algorithm based on a semisupervised graphical convolutional neural network for network planning is proposed to achieve a rational division of communication resources while improving the resource utilization rate. Based on the network management architectures of existing satellite communication systems, a system model is constructed based on the interoperability conditions of satellites and Earth stations, and the semisupervised graph convolution method is applied to Earth station network planning. Reasonable simulation parameters are set according to the characteristics of geosynchronous satellite networks, and simulation experiments are conducted on the Python platform. The simulation results show that the proposed method can rapidly group Earth stations according to the set optimization objectives and improve user experience and network resource utilization.

Parallel Session 10: Communication Theory and Techniques

Session Chair: Prof. Bodong Shang, Eastern Institute of Technology, Ningbo, China

Date: July 7 **Venue:** Jingfu Hall

13:30-13:45	**Paper ID:** 5285 **Paper Title:** Predictive Beamforming for ISAC-NOMA Enabled Vehicle Networks **Author(s):** Aoying Li, Yujie Wang, Wei Liang, Lixin Li, and Wensheng Lin **Presenter:** Aoying Li **Affiliation:** Northwestern Polytechnical University, China **Abstract:** As one of the important technologies of sixth generation mobile communication, integrated sensing and communication (ISAC) enables the vehicle networks to perform data transmission and target perception simultaneously. Aiming at solving the system congestion problem caused by the large number of communication devices and severe inter-user interference in 6G networks, this paper investigates a predictive beamforming scheme based on the non-orthogonal multiple access (NOMA) aided ISAC based on the historical channel space-time network (HCSTN) vehicle networks. A beamforming design problem is formulated to maximize the achievable communication rate under the constraint of sensing performance in the vehicle networks. To solve this problem, a penalty factor method is proposed to transform the original constrained optimization problem into an equivalent unconstrained optimization problem, and then a deep neural network (DNN) model is designed to optimize the system predictive beamforming matrix to maximize the system achievable communication rate. Simulation experiments show that the proposed the algorithm significantly improve the system communication rate while satisfying the perceived performance constraints, and the proposed HCSTN model has good robustness compare to other system influence factors.
13:45-14:00	**Paper ID:** 7629 **Paper Title:** Secrecy Rate Maximization for Active RIS Assisted Communication Systems with Transceivers Hardware Impairments **Author(s):** Zhanrong Huang, Yulong Zou, and Yulei Lou **Presenter:** Yulei Lou **Affiliation:** Nanjing University of Posts and Telecommunications, China **Abstract:** In this paper, we consider an active reconfigurable intelligent surface (ARIS)-assisted wireless communication system with transceiver hardware impairments, where a multi-antenna base station (BS) transmits information to a legitimate user (LU) with the assistance of an ARIS in the presence of a single-antenna eavesdropper (Eve). We propose the joint use of ARIS and artificial noise (AN) for the BS-LU transmissions against Eve, called ARIS-AN scheme, in which the ARIS is deployed to improve the BS-LU transmission and AN signal is emitted at BS to confuse Eve. We formulate an optimization problem aimed at maximizing the secrecy rate (SR) by jointly optimizing ARIS reflecting coefficients and transmit beamformming with AN. To solve the non-convex optimization problem, we present an efficient alternating optimization algorithm for obtain the suboptimal solution. Simulation results reveal that the proposed ARIS-AN scheme prevails passive reconfigurable intelligent surface (PRIS) and AN aided transmission scheme (PRIS-AN), PRIS aided transmission scheme without AN (PRIS-No-AN), ARIS-aided transmission scheme without AN (ARIS-No-AN), randomly phase-shifted PRIS and AN aided transmission scheme (RRIS-AN) in terms of the SR for the considered setup.

14:00-14:15	**Paper ID:** 3610 **Paper Title:** List Decoding of Binary Subspace Chirps **Author(s):** Pinmo Li, and Jianping Zheng **Presenter:** Pinmo Li **Affiliation:** Xidian University, China **Abstract:** Binary subspace chirps (BSSCs) have been proposed recently which can provide a larger codebook and slightly better performance than the binary chirps (BCs) in the deterministic compressed sensing and random multiple access. A BSSC is characterized by a rank r, an on-off pattern part, and a BC part. In general, the rich algebra structure of BSSCs can be employed to design the low-complexity decoding algorithm. Here, to further improve the performance, we first study the breadth-first list decoding of BSSCs in the single-user scenario, with emphasis on the determination of the candidate list of the on-off pattern. Moreover, we extend it to the random access scenario where the multipath matching pursuit algorithm is utilized. Finally, the effectiveness of the proposed list decoder is demonstrated by computer simulations.
14:15-14:30	**Paper ID:** 6782 **Paper Title:** Rotating Extremely Large-Scale MIMO with Generative AI for Vehicular Communications **Author(s):** Jiakang Zheng, Jiayi Zhang, Hongyang Du, Jiawen Kang, Dusit Niyato, and Bo Ai **Presenter:** Jiakang Zheng **Affiliation:** Beijing Jiaotong University, China **Abstract:** In this paper, we propose a novel concept of rotating extremely large-scale multiple-input multiple-output (XL-MIMO) systems based on a cell-free network, wherein the direction of each uniform planar array (UPA) is jointly controlled by a central processing unit to achieve full coverage for mobile user equipments (UEs) in vehicular communications. Using the near-field channel, we derive the expression for the achievable spectral efficiency (SE) of the considered systems for analysis. Furthermore, we formulate a joint optimization problem that maximizes the average SE of the rotating XL-MIMO system by optimizing the direction angle of each UPA. Then, we propose two low-complexity methods to enhance the SE performance of weak and strong UEs respectively. Moreover, we develop a method based on generative AI, employing a trained diffusion model to efficiently generate UPA direction angles in dynamic environments with mobile UEs.
14:30-14:45	**Paper ID:** 7083 **Paper Title:** Energy Efficiency Maximization for STAR-RIS Assisted Uplink NOMA Transmission Systems **Author(s):** Xiansheng Zeng, Yulong Zou, and Yulei Lou **Presenter:** Yulei Lou **Affiliation:** Nanjing University of Posts and Telecommunications, China **Abstract:** In this paper, we consider an uplink non-orthogonal multiple access (NOMA) transmission system and propose a simultaneously transmitting and reflecting reconfigurable intelligent surface (STAR-RIS) assisted uplink NOMA scheme denoted by STAR-NOMA, where multiple users transmit information to an access point (AP) assisted by the STAR-RIS. We formulate an energy efficiency (EE) maximization problem by jointly optimizing the transmit power of each user and the reflection and transmission coefficients of the STAR-RIS subject to the individual minimum transmission rate. To solve this problem, an alternating optimization (AO) method is employed to disentangle the problem into two distinct sub-problems, and the Dinkelbach and semidefinite relaxation (SDR) methods are employed to tackle it. Numerical results indicate that the proposed STAR-NOMA scheme surpasses

	the conventional reflecting/transmitting-only reconfigurable intelligent surface (CRIS)-based scheme and orthogonal multiple access (OMA)-based schemes in terms of the EE.
14:45-15:00	**Paper ID:** 9501 **Paper Title:** An Analytical Model for Coordinated Multi-Satellite Joint Transmission System **Author(s):** Xiangyu Li, and Bodong Shang **Presenter:** Bodong Shang **Affiliation:** Eastern Institute of Technology, Ningbo, China **Abstract:** Satellite communication is one of the key technologies that is enabling next-generation networks. However, nearest-satellite-supported downlink transmission may not meet a user's requirements due to limited signal strength, especially in emergent scenarios. In this paper, we investigate a coordinated multi-satellite joint transmission system from a system-level perspective, where a user can be served by multiple satellites to improve its quality-of-service (QoS). Furthermore, we analyze the coverage and rate of a typical user in the joint transmission system. Simulation and numerical results show that the introduced system achieves a higher coverage probability than the traditional nearest-satellite-supported network. Moreover, a user's ergodic rate can be maximized by selecting an appropriate number of serving satellites.
15:00-15:15	**Paper ID:** 7152 **Paper Title:** Movable Antenna Assisted OAM Wireless Communications with Misaligned Transceiver **Author(s):** Hongyun Jin, Wenchi Cheng, Haiyue Jing, and Jingqing Wang **Presenter:** Hongyun Jin **Affiliation:** Xidian University, China **Abstract:** The vortex electromagnetic wave carried by multiple orthogonal orbital angular momentum (OAM) modes in the same frequency band can be applied to the field of wireless communications, which greatly increases the spectrum efficiency. The uniform circular array (UCA) is the classical structure to generate and receive vortex electromagnetic waves with multiple OAM-modes. However, when the transmit and receive UCAs are misaligned, there will be interference among the OAM-modes and the signal cannot be recovered at the receiver. In order to solve this problem, we propose movable antenna (MA) assisted OAM wireless communications scheme. We estimate the rotation angle between transmit and receive UCAs and feed it back to the transmitter. Then, the MA at the transmitter adjusts the rotation angle to achieve alignment of the UCA at both the receiver and transmitter. Simulation results show that our scheme can significantly improve the spectrum efficiency.
15:15-15:30	**Paper ID:** 5969 **Paper Title:** Multi-Antenna Covert Communications with a BPP Field of Wardens **Author(s):** Hangmei Rao, Shihao Yan, Janquan Wang, Xi Peng, Sa Xiao, and Wanbin Tang **Presenter:** Hangmei Rao **Affiliation:** Nanjing University of Posts and Telecommunications, China **Abstract:** This paper considers a multi-antenna jamming to facilitate covert communications with multiple wardens. Specifically, the jammer generates artificial noise (AN) with random power to deliberately create interference to prevent a communication being detected by an adversarial warden (Willie), where Warden's location is modeled as a uniform binomial point process (BPP). The detection performance for each warden is analyzed under line-of-sight (LoS) channels i.e., the expressions for the false alarm (P_{FA}) and miss detection (P_{MD}) probabilities are analytically derived. Then, the communication performance of the covert communication in terms of the channel capacity is optimized

	following a stochastic spatial geometry framework. Numerical results show that the average detection error probability (i.e., $P_{FA}+P_{MD}$) decreases with the number of Willies and also decreases as the the jammer gradually parallel to the receiver's position relative to the transmitter, which leads to the reduction in the covert throughput.
15:30-15:45	**Paper ID:** 7412 **Paper Title:** Dynamic Beamforming Design for Near-Field MIMO Communications **Author(s):** Zheng Zhang, Yuanwei Liu, Zhaolin Wang, Jian Chen, and Long Yang **Presenter:** Zheng Zhang **Affiliation:** Xidian University, China **Abstract:** A novel dynamic hybrid beamforming architecture is proposed to achieve the spatial multiplexing-power consumption tradeoff for near-field multiple-input multiple-output (MIMO) networks, where a switch module is integrated between the baseband digital and analog phase-shift module to control the number of activated RF chains. Based on this architecture, an optimization problem is formulated that maximizes the sum of achievable rates while minimizing the hardware power consumption. A wavenumber-domain weighted minimum mean-square error (WD-WMMSE) algorithm is proposed, which exploits the sparsity of WD near-field channels to achieve the low-dimensional beamformer design. Simulation results demonstrate that the proposed dynamic beamforming architecture outperforms the conventional fixed hybrid beamforming architecture in terms of spatial multiplexing-power consumption tradeoff.

Parallel Session 11: Emerging Technologies, Standards, and Applications

Session Chair: Dr. Meaad Fadhel, Xidian University, China

Date: July 7

Venue: Shaohua Hall

16:00-16:15	**Paper ID:** 4264 **Paper Title:** Efficient Multi-Robot Cooperative Transportation Scheduling System **Author(s):** Xiaodong Li, Yangfei Lin, Zhaoyang Du, Rui Yin, and Celimuge Wu **Presenter:** Xiaodong Li **Affiliation:** The University of Electro-Communications, China **Abstract:** The efficiency of operations in complex environments such as factories increasingly relies on the coordinated efforts of multiple robots. This paper introduces a novel scheduling system designed for the effective coordination of robot fleets, directly addressing the challenges inherent in multi-robot collaborative transportation. Our system introduces a standardized data format for network communication, facilitating seamless interaction among robots, and incorporates a sophisticated collision avoidance strategy for safe simultaneous navigation. Additionally, we implement a visualization interface for real-time scheduling oversight, enhancing operational management and efficiency. Utilizing FastDDS for communication scheduling, QT for interface design, and ROS1 for robot control, our system is rigorously validated through extensive simulation experiments. These experiments demonstrate our system's capability to not only effectively manage multi-robot operations but also to execute tasks with a high degree of precision and reliability.
16:15-16:30	**Paper ID:** 4279 **Paper Title:** Coverage Analysis for Air-Ground Integrated-Sensing-and-Communication Networks **Author(s):** Yihang Jiang, Fanyi Meng, Xinhao Li, Xiaoyang Li, Guangxu Zhu, Kaifeng Han, and Qingjiang Shi **Presenter:** Xiaoyang Li **Affiliation:** Shenzhen Research Institute of Big Data, China **Abstract:** The analysis of network performance is an important guide for network deployment and design. In this work, the low-altitude integrated sensing and communication (ISAC) networks performance is studied in terms of communication coverage at the network level, where the ISAC base station (BS) serves the terrestrial communication users (CUs) while sensing the aerial targets. In contrast to previous works, the specific beamforming schemes rather than simple antenna beam gain is considered. As the interferences from other BSs during sensing are non-negligible, the cooperative beamforming design is necessary for effective sensing. The BSs, CUs and sensing targets are randomly distributed as two-dimensional homogeneous Poisson point processes (HPPP). By comparing HPPP model with the grid model and actual BS deployment, it can be observed that the presented analysis in HPPP model and ideal grid model are the lower and upper bounds of the actual deployments, respectively.
16:30-16:45	**Paper ID:** 5771 **Paper Title:** Fast Region-Adaptive Hierarchical Transform with Cross-Component Prediction and Coefficient Reordering **Author(s):** Xiaoyu Liu, Junjie Wang, and Wei zhang **Presenter:** Junjie Wang **Affiliation:** Xidian University, China

	Abstract: With the increasing applications of 3D point clouds in various systems, research into point cloud compression (PCC) has gained momentum in recent years. Among the point cloud attribute compression methods in the literature, Rate-Adaptive Hierarchical Transform (RAHT) in Geometry-based Point Cloud Compression (G-PCC) standard, currently undergoing standardization by MPEG, stands out as a promising scheme. This paper introduces several enhancements to RAHT. Firstly, a cross-component prediction technique is proposed to reduce the coefficient redundancy by leveraging correlations between chroma color components. Secondly, to improve the entropy coding efficiency, the distribution characteristics of RAHT coefficients are analysed, leading to a method for optimizing the coding order of transform coefficients. Additionally, the RAHT coding process is accelerated through early prediction termination based on node occupancy in the RAHT tree. Experimental results show that the proposed enhancements achieve approximately 1.0% coding gains on the Luma component and 7.0% on the Chroma component, while reducing the attribute coding time by approximately 20%.
16:45-17:00	**Paper ID:** 6168 **Paper Title:** Joint Visual and Haptic Signal Transmission for Immersive Interactions in Human Digital Twin **Author(s):** Kun Wu, Jiayuan Chen , Changyan Yi, Zili Liu, Xiaoping Lu, Junyi Wang, and Jun Cai **Presenter:** Kun Wu **Affiliation:** Nanjing University of Aeronautics and Astronautics, China **Abstract:** Human digital twin (HDT) is envisioned as a systematic platform interconnecting physical twins (PTs) in the real world with virtual twins (VTs) in the digital world, enabling advanced human-centric applications. In this paper, we study an optimization of quality of experience (QoE) aware multimodal signal transmission, particularly focusing on joint visual and haptic signal feedback transmissions from VT to its corresponding PT, for providing immersive interactions in HDT. To evaluate a synthesized performance of both visual and haptic experiences, we design a comprehensive QoE model, taking into account the video quality, continuous video quality switching rate and average haptic feedback error. Then, to maximize such QoE with a particular guarantee on synchronization between visual and haptic signal transmissions, we dynamically optimize the bandwidth allocation, bitrate and rendering mode of the video, and haptic signal's compression threshold. To this end, we propose a deep reinforcement learning based algorithm, called joint visual and haptic signal feedback transmission scheme (i.e., VisHap), which can produce an adaptive solution. Furthermore, we build a HDT multi-modal interactions platform for collecting an authentic dataset, and by using this dataset, we conduct experimental simulations, showing that the proposed VisHap is not only feasible but also outperform the counterparts.
17:00-17:15	**Paper ID:** 6320 **Paper Title:** Multi-Access Edge Computing Empowered Integrated Hybrid Sensing and Communication: A Computation-Efficient Design **Author(s):** Chenglong Dou, Xumin Huang, Yuan Wu, Liping Qian,, and Tony Q. S. Quek **Presenter:** Chenglong Dou **Affiliation:** University of Macau, China **Abstract:** Integrated sensing and communication (ISAC) system has been emerged as a crucial paradigm for addressing the growing demand of emerging wireless applications that require both ultra-reliable data transmission and high-precision sensing. However, due to the limited computation capability of ISAC devices, the large amount of collected sensing data is difficult to be processed in

	time. In this paper, we consider that the ISAC device can offload the sensing data to a group edge helper nodes via multi-access edge computing to improve the efficiency of sensing data processing. We propose a multi-access edge computing empowered ISAC with hybrid active and passive sensing, in which the ISAC device can perform passive sensing through the sensing reflected signal from the edge helper nodes while performing active sensing. To investigate this problem, we formulate a joint optimization of the transmit beamforming for active sensing, passive sensing and offloading, as well as the computation rates of both the ISAC device and the edge helper nodes, with the objective of maximizing the total computation rates for the sensing data. Despite the non-convexity of the formulated problem, we propose an efficient algorithm to obtain its solutions. Simulation results validate the performance advantages of our multi-access edge computing empowered integrated hybrid sensing and communication.
17:15-17:30	**Paper ID:** 6447 **Paper Title:** Design and Realization of Remote Real-Time Monitoring of Tower Concrete Curing Environment **Author(s):** Zhengfa Li, Desheng Zhou, Rui Wang, Haiyan Li, and Jian Yang **Presenter:** Zhengfa Li **Affiliation:** State Grid Gansu Electric Power Company Construction Branch, China **Abstract:** Aiming at the demand for remote real-time monitoring of the concrete curing environment during the construction of transmission line towers in remote areas, the digital intelligent real-time monitoring platform is constructed by organically integrating the Internet of Things (IoT) and the BeiDou short message communication. The monitoring platform is designed and realized. In order to verify the feasibility and advancement of the platform, a digital temperature and humidity sensor unit platform and a BeiDou short message communication platform based on the BeiDou BDM910 module were constructed to realize remote monitoring, real-time transmission and closed-loop optimization of the tower concrete curing environmental engineering. This paper provides a new solution to improve the real-time monitoring level of concrete curing environmental engineering in remote areas, and provides a solid foundation for the future research and platform development of intelligent concrete curing.
17:30-17:45	**Paper ID:** 6581 **Paper Title:** Constructing and Evaluating Digital Twins: An Intelligent Framework for DT Development **Author(s):** Longfei Ma, Nan Cheng, Xiucheng Wang, Jiong Chen, Yinjun Gao, Dongxiao Zhang, and Jun-Jie Zhang **Presenter:** Xiucheng Wang **Affiliation:** Xidian University, China **Abstract:** The development of Digital Twins (DTs) represents a transformative advance for simulating and optimizing complex systems in a controlled digital space. Despite their potential, the challenge of constructing DTs that accurately replicate and predict the dynamics of real-world systems remains substantial. This paper introduces an intelligent framework for the construction and evaluation of DTs, specifically designed to enhance the accuracy and utility of DTs in testing algorithmic performance. We propose a novel construction methodology that integrates deep learning-based policy gradient techniques to dynamically tune the DT parameters, ensuring high fidelity in the digital replication of physical systems. Moreover, the Mean STate Error (MSTE) is proposed as a robust metric for evaluating the performance of algorithms within these digital space. The efficacy of our framework is demonstrated through extensive simulations that show our DT not only accurately mirrors the physical

	reality but also provides a reliable platform for algorithm evaluation. This work lays a foundation for future research into DT technologies, highlighting pathways for both theoretical enhancements and practical implementations in various industries.
17:45-18:00	**Paper ID:** 8422 **Paper Title:** 3D Environment Reconstruction Based on ISAC Channels **Author(s):** Junzhe Song, Ruisi He, Zhengyu Zhang, Mi Yang, Bo Ai, Haoxiang Zhang, and Ruifeng Chen **Presenter:** Junzhe Song **Affiliation:** Beijing Jiaotong University, China **Abstract:** Integrated Sensing and Communication (ISAC) has emerged as a highly promising technology in 6G, attracting widespread attention. For ISAC, sensing echoes which provide knowledge of the surrounding environment, can be used for environment reconstruction to assist communications. However, different conditions of applications and systems result in different characterizations of ISAC channels, leading to varying reconstruction quality. Understanding influence of ISAC channel condition on reconstruction performance, such as frequency, bandwidth, and subcarrier spacing, is thus essential. This paper investigates 3D environment reconstructions based on ISAC channels, considering impacts of carrier frequencies (ranging from 3.5 GHz to 100 GHz), bandwidths (ranging from 40MHz to 400MHz), and subcarrier spacings (ranging from 60kHz to 360kHz). Additionally, Chamfer distance and F-score indicators are employed to analyze reconstruction performance in terms of accuracy and coverage range. The results in this paper can enrich the investigation of environment reconstruction baesd on ISAC channel and enable further designs of ISAC systems.
18:00-18:15	**Paper ID:** 8497 **Paper Title:** Design of a Spaceborne Earth-Coverage Scanning Phased Array Antenna Based on Mirror Beamforming Networks for MEO Satellite Communications **Author(s):** Muren Cai, Siyi Du, Xiaowei Shi, Wentao Li, Heng Liu, Qiaoshan Zhang, Yan Li, and Chunbang Wu **Presenter:** Muren Cai **Affiliation:** Xi'an Institute of Space Radio Technology, China **Abstract:** This paper proposes a spaceborne Earth-coverage scanning phased array (ECSPA) antenna based on shared subarray architecture for medium Earth orbit (MEO) satellite communications. A couple of mirror beamforming networks are utilized for shared subarray to obtain the Earth-coverage beam of MEO satellites in two symmetrical sections by mirror imaging, effectively reducing the optimization difficulty. An ECSPA consisting of 40 shared subarrays based on the mirror beamforming networks has been designed and analyzed. Numerical results indicate that the scanning gain variation of the ECSPA can well match the space loss variation during beam scanning, and adaptively compensate for the path loss variation between the satellite and ground users at different locations, demonstrating excellent Earth-coverage scanning characteristics. Additionally, the ECSPA exhibits grating lobe suppression, further improving the anti-interference performance of the satellite system.
18:15-18:30	**Paper ID:** 9856 **Paper Title:** Improved Trisoup Geometry Reconstruction in Geometry-Based Point Cloud Compression (G-PCC) **Author(s):** Kai Yao, Yimo Cao, and Wei Zhang

Presenter: Kai Yao
Affiliation: Xidian University, China
Abstract: Point clouds serve as a widely employed format for representing 3D objects and scenes. In recent years, to facilitate the efficient transmission and storage of point cloud data, point cloud compression (PCC) has become a highly regarded research focus. The ongoing G-PCC standardization project, launched by the Moving Picture Experts Group (MPEG) of ISO/ITU, employs a method termed as Trisoup to compress the geometry information of point cloud data. This paper aims to improve both the coding efficiency of Trisoup and the visual quality of reconstructed point clouds using Trisoup. Specifically, theoretical analyses are conducted towards the redundancy of Trisoup vertex. Then, a straightforward method is proposed to remove unnecessary vertices in the Trisoup point reconstruction pipeline. Experimental results show that the proposed method can improve the coding performance of Trisoup by 2% on average. Moreover, both the subjective and objective visual quality of the reconstructed point clouds are significantly enhanced.

Parallel Session 12: Communication Theory and Techniques

Session Chair: Prof. Weigang Hou, Chongqing University of Posts and Telecommunications, China

Date: July 7 **Venue:** Jingfu Hall

16:00-16:15	**Paper ID:** 8079 **Paper Title:** Intelligent Reflecting Surface Assisted Anti-Jamming for Multi-User Wireless Communications **Author(s):** Yunfei Long, Wendong Yang, Xinrong Guan, and Yangyi Zhang **Presenter:** Yunfei Long **Affiliation:** Army Engineering University of PLA, China **Abstract:** In this paper, we investigate an anti-jamming communication method for multi-user wireless communication system assisted by intelligent reflecting surface (IRS). Specifically, we aim to maximize the minimum signal to interference plus noise ratio (SINR) among all users via optimizing the IRS passive beamforming. However, the formulated problem is difficult to solve due to the complex objective function. Thus, we introduce a slack variable to transform the original problem into a convex problem and use the method of semidefinite program (SDP) to solve it. Simulation results show that deploying IRS to assist multi-user communication can significantly improve anti-jamming performance. Moreover, with the number of reflecting elements increase, the proposed scheme can effectively suppress the performance degradation caused by the increase in the number of users.
16:15-16:30	**Paper ID:** 8322 **Paper Title:** Multi-Frequency Resonant Circuit Based Multi-User Emergency Through-the-Earth Communication with Magnetic Induction **Author(s):** Zhenyu Wang, Jianyu Wang, and Wenchi Cheng **Presenter:** Zhenyu Wang **Affiliation:** Xidian University, China **Abstract:** Magnetic induction (MI) communication is an effective technique in emergency through-the-earth communications due to the higher penetration efficiency and lower propagation loss as compared with electromagnetic wave communication. How to cancel the interference between different users and enhance the effectiveness of multi-user transmissions is imperative for the practical application of MI communication. In this paper, we use multi-frequency resonant circuit to establish multiple resonant frequencies for MI communication. The transmissions corresponding to different users operate at different resonant frequencies and multi-user interferences can be naturally mitigated. Numerical results verify our theoretical analyses and show that the proposed system can significantly enhance the performance.
16:30-16:45	**Paper ID:** 6776 **Paper Title:** Impacts of Imperfect SIC and Hardware Impairment on Cooperative NOMA Networks with Spectrum Sharing **Author(s):** Haiyan Huang, Yuhao Wei, and Linlin Liang **Presenter:** Yuhao Wei **Affiliation:** Lanzhou Jiaotong University, China **Abstract:** Undertaking hardware impairment and imperfect successive interference cancellation (imp-SIC), this paper proposes an incremental non-orthogonal multiple access (NOMA) transmission scheme to optimize cooperative diversity for spectrum sharing cognitive radio network. In order to

	make full use of limited wireless resource, the primary transmitter communicates to the primary receiver directly or by the aid of the secondary source, namely, when the direct transmission between the primary transmitter and primary receiver is successful, the secondary source only transmits its own signal to the secondary destination. However, if the direct transmission is unsuccessful, the secondary source employs NOMA technique to superimpose its signal with that of the primary user and simultaneously transmit it to the secondary destination and the primary receiver. By deploying the selection combining (SC) scheme to combine the signals received at the primary receiver, exact closed and asymptotic form expressions for the outage probability and throughput of the primary and secondary networks are derived over Rayleigh fading channels. Finally, the correctness of the theoretical analysis is verified by the numerical simulation. The results show that the outage performance is decreased with the increase of hardware impairment and the residual interference caused by imp-SIC, which means the investigation of the cognitive cooperative NOMA network is extremely significant under practical imperfect scenarios.
16:45-17:00	**Paper ID:** 9055 **Paper Title:** Intersymbol Interference Cancellation for Ultra-Wideband Sensing and Communication Systems **Author(s):** Xufang Wang, Feng Lin, and Yi Wu **Presenter:** Xufang Wang **Affiliation:** Fujian Normal University, China **Abstract:** This paper introduces a novel approach for mitigating intersymbol interference (ISI) in ultra-wideband (UWB) sensing and communication systems that employ impulse radio. Unlike traditional methods, our proposed scheme leverages wavelet transformation for ISI cancellation, without the need for prior channel knowledge. By analyzing the received pulses through wavelet transformation, we can accurately locate and differentiate the desired signal pulse from interference pulses. Theoretical analysis, along with derived closed-form expressions, demonstrates the efficacy of our approach, which is applicable across various UWB pulse waveforms. Simulation results show that our proposed ISI cancellation scheme significantly improves the detection performance of UWB systems compared to those without ISI cancellation.
17:00-17:15	**Paper ID:** 9111 **Paper Title:** Design of A Multi-Frequency Antenna Loaded with SRR Structure **Author(s):** Yuxuan Fang , Yang Liu, and Qiwei Li **Presenter:** Yang Liu **Affiliation:** Xidian University, China **Abstract:** Multifrequency antennas with miniaturization, high gain, and other functions can be realized by loading metamaterial structures. The open resonant ring structure has become one of the hot spots for multifrequency antenna design. In this article we will describe a method for designing a multi-frequency antenna that covers WLANs using SRR structure as a basis. It can work at 2.4GHz and 5.21GHz frequencies, covering the 2.4GHz and 5.2GHz frequency bands of the WLAN protocol and it has excellent return loss characteristics. Through the comparison of the results of physical antenna testing and simulations, it is possible to verify the performance of the multifrequency antenna structure proposed in this article.
17:15-17:30	**Paper ID:** 9576 **Paper Title:** Weighted Sum Rate Maximization for Smart Reflective Surfaces Based on Improved Lion Swarm Algorithm

	Author(s): Feng Wang, Mingyan Jiang, Keqin Jiang, and Ze Zhao **Presenter:** Feng Wang **Affiliation:** Shandong University, China **Abstract:** With the maturity and popularization of 5G communication network technology, research into next-generation (6G) communication technology has intensified to address the demands of data transmission in the big data era. Reflective Intelligent Surface (RIS) technology has emerged as a promising avenue for advancing 6G communication capabilities. The objective of utilizing intelligent reflective surfaces in wireless network transmission is to optimize the beamforming at the base station transmitter and the reflection coefficient of the RIS. This optimization aims to maximize the weighted sum-rate (WSR) at the user side, while adhering to constraints related to base station transmitter power and RIS unit modes. In this paper, we propose enhancements to the basic lion swarm algorithm by incorporating elements such as good point set, chaotic search, and the mining mechanism inspired by the honey badger algorithm. These modifications are intended to improve the algorithm's performance in optimizing the aforementioned parameters. Simulation results demonstrate that our enhanced lion swarm algorithm achieves significant improvements in weighting and rate maximization, thereby enhancing the efficiency of reflective intelligent surface-assisted wireless networks.
17:30-17:45	**Paper ID:** 8340 **Paper Title:** Channel Estimation of Uplink Extremely Large-Scale MIMO in Wideband Near-Field Communications **Author(s):** Qinxuan Ruan, and Jianping Zheng **Presenter:** Qinxuan Ruan **Affiliation:** Xidian University, China **Abstract:** In this paper, the channel estimation (CE) of uplink extremely large-scale multiple-input multiple-output in the nearfield communication is studied. Specifically, we consider the scenario that all users share the same scatterers other than the polar-domain codebook, which happens usually in the wideband multicarrier system. To utilize the same scatterer shared by allusers, two two-stage multiuser CE methods are proposed. In the first stage, the first method estimates the location of the scatterer for all users separately. The second method estimates the location of the scatterer only for one user, and the other users share this estimation. In the second stage, both the proposed methods introduce an additional processing through angular clustering to refine the location estimation and thus improve the performance.The effectiveness of the proposed methods is finally validated by computer simulations.
17:45-18:00	**Paper ID:** 9722 **Paper Title:** STAR-RIS Assisted Secure Wireless Powered Communications with Cooperative Jamming **Author(s):** Haolian Chi, Kunrui Cao, Beixiong Zheng, Jingyu Chen, Siwei Tang, Danyu Diao, and Haiyang Ding **Presenter:** Siwei Tang **Affiliation:** National University of Defense Technology, China **Abstract:** This paper investigates the simultaneously transmitting and reflecting reconfigurable intelligent surface (STARRIS)-assisted secure transmissions in wireless powered communication systems. According to conditions of communication links, two scenarios are considered, and corresponding four transmission schemes are proposed to enhance the security of information. To be specific, for the scenario-I with blocked energy harvesting links, the scenario-I based information

	transmission of outdoor-user and cooperative jamming of indooruser (IbTOJI) scheme, and cooperative jamming of outdoor-user and information transmission of indoor-user (IbJOTI) scheme are proposed, respectively. For the scenario-II with blocked information transmission links, scenario-II based information transmission of outdoor-user and cooperative jamming of indooruser (IIbTOJI) scheme, and cooperative jamming of outdooruser and information transmission of Indoor-user (IIbJOTI) scheme are proposed, respectively. Connection outage probability (COP) and secrecy outage probability (SOP) are analyzed to evaluate the system performance achieved by the proposed schemes. Theoretical analysis and simulation results demonstrate the effectiveness of the proposed schemes.
18:00-18:15	**Paper ID:** 8029 **Paper Title:** DCT Scheme in LOS Propagation Based on UCA **Author(s):** Ke Gao, Wenchi Cheng, and Jingqing Wang **Presenter:** Ke Gao **Affiliation:** Xidian University, China **Abstract:** As the demand for higher transmission rates in next-generation wireless communication continues to rise, the imminent challenge of spectrum resource scarcity becomes pronounced. Orbital angular momentum (OAM) has garnered significant attention due to their orthogonal beam structures. OAM introduces multiple topological charges or OAM modes, enabling the orthogonal multiplexing of beams without relying on traditional resources such as time and frequency. However, for space wireless communications, the paramount importance of reliability presents significant challenges to the deployment OAM wireless communications. In this paper, we propose the discrete cosine transform (DCT) scheme, which is a kind of highly reliable OAM based wireless communications. First, we build the system model of the DCT based UCA for light of sight (LOS) propagation. Then, we derive a formula expression for the DCT scheme. Subsequently, we analyze the corresponding capacity and received bit error rate. Simulation results validate that DCT scheme is more reliable than traditional multiple-inputs multiple-outputs (MIMO) and OAM.

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