

Special topic on user-centric intelligent networking*

With the rapid development of artificial intelligence, edge computing, satellite Internet, and programmable networking, communication networks are evolving from being primarily connection- and resource-centric toward placing greater emphasis on user requirements, service experience, and intelligent service provisioning. How to better accommodate user and service demands and leverage intelligent methods to improve network services, resource management, and system design has become an important research topic in intelligent networking.

To explore recent advances in this direction, *SCIENCE CHINA Information Sciences* has organized the special topic on “User-centric intelligent networking”. The special topic received 34 submissions. After a rigorous peer-review process, 6 research papers and 5 letters were accepted. The authors of the accepted articles are from the United States, Canada, the United Kingdom, Sweden, Singapore, Australia, and China. These studies start from concrete user and application requirements in areas such as emergency communications, indoor localization, mobile augmented reality, and satellite networks, and further investigate intent understanding, network deployment, resource scheduling, data-plane processing, and security analysis, covering different aspects of user-centric intelligent networking from network services and intelligent control to system implementation.

The research article, “*NameShield*: secure and dynamic group communication for first responders in emergency management” investigates group communication in public safety and emergency response. To address frequent membership changes, communication disruptions, and confidentiality requirements faced by first responders, the paper proposes *NameShield*, which combines role-based publish/subscribe communication with attribute-based encryption to support dynamic group communication and fine-grained access control while avoiding frequent group rekeying.

The research article, “Self-supervised resource-efficient indoor tracking with adaptive anchor scheduling” studies indoor localization and target tracking under resource constraints. The paper proposes a self-supervised framework that jointly performs tracking and anchor scheduling. A physics-guided deep state-space model is used to estimate target positions and uncertainty, while reinforcement learning is employed to select anchors for subsequent ranging. Experiments show that the proposed method maintains favorable localization accuracy while using only 3 out of 8 anchors, significantly reducing ranging and communication overhead.

The research article, “Empowering a lightweight large language model agent for intent-based networking: harnessing curriculum learning and LoRA fine-tuning” studies user-intent understanding and network configuration in intent-based networking. The paper develops a lightweight agent based on an open-source medium-scale language model by combining curriculum learning with LoRA fine-tuning and constructing an expert-verified dataset for network topology deployment. Experimental results show that the proposed approach achieves favorable task success and explainability with relatively low inference cost.

The research article, “LLM-enhanced-EA-driven automated optimization framework for joint indoor deployment of multiple BSs and RISs” investigates the joint indoor deployment of multiple base stations and reconfigurable intelligent surfaces. The paper uses a large language model to assist NSGA-II in exploring the optimization space and develops an automated module that generates optimization prompts from user descriptions, templates, and reference materials. Simulation results demonstrate an improved tradeoff between network coverage and deployment cost.

The research article, “Learning to schedule: interference-aware optimization for edge AI inference on shared GPUs” addresses resource scheduling when multiple deep neural networks share GPUs at the network edge. Based on real-system measurements, the paper models interference-induced inference latency and develops online scheduling algorithms that jointly consider inference latency, inference error, communication overhead, and energy consumption. Experiments show that the proposed method can reduce the overall operating cost of edge AI inference systems.

The research article, “SmartFEC: adaptive SmartNIC-enabled forward error correction for low-latency video services” considers reliable transmission for low-latency video services such as live streaming, cloud gaming, and video conferencing. The paper proposes SmartFEC, an adaptive forward-error-correction framework based on

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SmartNICs, which offloads part of the video transmission and error-correction functions to programmable network interface cards and combines bandwidth prediction with adaptive redundancy configuration. Prototype experiments on an NVIDIA BlueField-2 SmartNIC show that SmartFEC improves bandwidth utilization and packet-loss recovery while reducing end-to-end latency.

The letter “Freesat: enabling user-centric multi-satellite cooperative networks via AI-RAN” studies service continuity for users in low-Earth-orbit satellite networks. The article proposes Freesat, a user-centric multi-satellite cooperative AI-RAN system that mitigates service interruptions caused by frequent handovers through dynamic task decomposition and satellite selection. Simulations based on real constellation data demonstrate improvements in user-side quality of service.

The letter “Service agent for user-centric QoE-aware communication service provision in mobile AR” investigates user experience modeling and communication service provisioning for mobile augmented reality. The article proposes an LLM-powered MAR service agent to enable information exchange between the application and network domains and develops a personalized model relating communication resource allocation to user-perceived quality of experience, thereby supporting user-centric resource provisioning.

The letter “Role-customized cross-domain task orchestration in satellite-terrestrial integrated networks” studies cross-domain task orchestration in satellite-terrestrial integrated networks. The article develops a role-customized multi-agent cooperative learning approach in which agents are deployed at base stations and low-Earth-orbit satellites and coordinate their decisions through state exchange and reward information. Simulation results show that the proposed approach improves task orchestration efficiency and reduces task completion time.

The letter “B-CUBE: a burst-aware 5G-TSN architecture and its large-scale mixed-flow scheduling” investigates mixed-flow scheduling in integrated 5G and time-sensitive networking systems. The article proposes B-CUBE, an architecture supporting wired, wireless, and dual-mode transmission, together with dedicated wired and wireless scheduling algorithms. Experimental results show that the proposed approach improves scheduling success rates in large-scale scenarios and alleviates tail latency.

The letter “Honey Insight: the interpretable reasoning engine for dynamic TTP inference” investigates attack-behavior inference for deception defense. Based on the MITRE ATT&CK framework, the article proposes Honey Insight, an interpretable reasoning engine that maps unstructured logs to system behaviors and further infers attacker tactics, techniques, and procedures, providing a traceable analysis path from logs to TTPs. Experiments validate its identification performance and cross-domain generalization capability.

These are the articles included in this special topic. We sincerely thank all the authors for their contributions and all the anonymous reviewers for their careful and timely reviews. We also thank the readers for their interest in and support of this special topic.

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