https://doi.org/10.65091/icicset.v2i1.37

Keynote speech #3

A Hyper Connected Wireless Future with Immersive, AI Native, and Sustainable Communications

Himal A. Suraweera
University of Peradeniya
Sri Lanka
himal@eng.pdn.ac.lk

SUMMARY

The future of mobile connectivity will be defined by seamless hyper connection, where wireless networks intelligently link people, machines, and environments. In this context, 6G networks are envisioned to operate across terrestrial, underwater, and space domains, enabling ubiquitous connectivity and reliable service coverage even in the most remote parts of the world, such as dense forests, deep oceans, and polar areas. In this talk, we highlight how immersive communication experiences, powered by extended reality and multisensory interaction, will transform the way we live, work, and collaborate across both physical and digital spaces in the 6G era. Use cases in entertainment (e.g., extended reality and high-resolution 360-degree video streaming), personalized education, and digital healthcare are expected to benefit significantly from immersive communication. However, these applications impose unprecedented requirements on wireless networks, including gigabit-per-second data rates, ultra-low latency on the order of sub-millisecond levels, and near-perfect reliability. Meeting these stringent performance demands while supporting massive device density, seamless mobility, and energy efficiency poses major challenges for the design and operation of future 6G wireless networks. A major enabler of this transformation, which sets a new precedent for integrating multisensory human perception into digital communication systems, is the emergence of AI-native intelligent networks capable of real-time learning, adaptation, and self-optimization. AI-intelligent wireless networks will leverage on machine learning, deep learning, and reinforcement learning to embed AI models across the physical, MAC, and network layers of the communication stack. At the physical layer, beyond conventional digital signal processing and optimization, integration of intelligence will support advanced functionalities such as modulation recognition, channel estimation, intelligent waveform detection, and beamforming design. Our talk will also emphasize the growing importance of sustainability, with energy efficient architectures and green technologies guiding these future deployments. Modern wireless networks, including 4G LTE and 5G systems, are significant contributors to global energy consumption, as the continuous operation of base stations, cooling infrastructure, and computationally intensive technologies substantially increases both the CAPEX and OPEX costs associated with network deployment and maintenance. As a solution, green and sustainable communication techniques and practices seek to minimize energy consumption in emerging wireless network

paradigms by leveraging innovative solutions such as energy-harvesting communication systems, massive MIMO, AI/ML-optimized protocols, and low power hardware. Collectively, these advancements in immersive communications, AI-integrated paradigms, and energy-efficient transmission technologies will establish a highly connected, resilient, and sustainable communication ecosystem that forms the foundation for next-generation communication innovation.

Index Terms— Next Generation Wireless Systems, Immersive Communications, AI-Native 6G Networks, Semantic Communication, Energy-Efficient Wireless Networks, Energy Harvesting Communications, Machine Learning.

BIBLIOGRAPHY

J. G. Apostolopoulos, P. A. Chou, B. Culbertson, T. Kalker, M. D. Trott and S. Wee, "The Road to Immersive Communication," Proceedings of the IEEE, vol. 100, no. 4, pp.974-990, April 2012.

X. Shen, "Toward immersive communications in 6G," Frontiers Comput. Sci., vol. 4, Jan. 2023, Art. no. 1068478.

M. Z. Chowdhury, M. Shahjalal, S. Ahmed and Y. M. Jang, "6G Wireless Communication Systems: Applications, Requirements, Technologies, Challenges, and Research Directions," IEEE Open Journal of the Communications Society, vol. 1, pp.957-975, 2020.

W. Saad, M. Bennis and M. Chen, "A Vision of 6G Wireless Systems: Applications, Trends, Technologies, and Open Research Problems," IEEE Network, vol. 34, no. 3, pp. 134-142, May/June 2020.

J. Hoydis, F. A. Aoudia, A. Valcarce and H. Viswanathan, "Toward a 6G AI-Native Air Interface," in IEEE Communications Magazine, vol. 59, no. 5, pp. 76-81, May 2021.

P. Zhang et al., "Way to Build Native AI-Driven 6G Air Interface: Principles, Roadmap, and Outlook," arXiv, arXiv:2508.15277, Aug. 2025. [Online]. Available: https://arxiv.org/abs/2508.15277.

P. Gandotra, R. K. Jha and S. Jain, "Green Communication in Next Generation Cellular Networks: A Survey," IEEE Access, vol. 5, pp. 11727-11758, 2017.

H. A. Suraweera, J. Yang, A. Zappone, and J. S. Thompson, Eds., Green Communications for Energy-Efficient Wireless Systems and Networks. London, U.K.: The Institution of Engineering and Technology (IET), 2020.

Speaker's short biography:

Himal A. Suraweera received the B.Sc. Eng. (Hons.) degree from University of Peradeniya, Sri Lanka, in 2001, and the Ph.D. degree from Monash University, Australia, in 2007. He is currently a Senior Lecturer with the Department of Electrical and Electronic Engineering, University of Peradeniya. He was a recipient of the 2017 IEEE ComSoc Leonard G. Abraham Prize, the IEEE ComSoc Asia-Pacific Outstanding Young Researcher Award in 2011, the WCSP Best Paper Award in 2013, and the SigTelCom Best Paper Award in 2017. He served as an Editor of the IEEE Transactions on Wireless Communications (2014-2019), IEEE Transactions on Green Communications and Networking (2017-2021) and IEEE Communications Letters (2010-2015). Currently, he is serving as an Editor of the IEEE Transactions on Communications and the IEEE Open Journal of the Communications Society. His research interests include 5G/6G networks, multiple-input multiple-output systems, intelligent reflective surfaces, energy-efficient wireless communications, full-duplex wireless techniques, wireless security, integrated sensing and communication, visible light communication, signal processing for communications, and machine learning for wireless design.