1 Introduction: Special Issue on Terrestrial Communication Technology and Ultra-High-Speed Satellite Communications Technology

Naoto KADOWAKI

The use of information infrastructure has become an essential part of our daily lives today. Most of this infrastructure is accessed using wireless technology. Recent years have seen remarkable advances in wireless network technology and the world of mobile communications is in the process of evolving from fourth-generation (4G) technologies such as LTE to fifth-generation (5G) systems. Unlike 3G with CDMA and 4G with LTE/WiMAX, the term 5G does not indicate any particular technology, describing instead a new communications environment created by a diverse array of technologies that meet a wide range of user needs, so the scope of research and development is extremely broad.

On the other hand, in the realm of information use, IoT is undergoing rapid advances, with wireless technology essential to both the collection of sensing data and the control of device actions (actuation). In IoT, sensing and actuation in locations without a human presence is of great significance, so not only terrestrial wireless, but also satellite communications covering marine areas and airspace, and communication systems that use unmanned aerial vehicles (UAVs) and drones are vital.

Since the previous medium to long-term plan period, NICT's Wireless Networks Research Center has been conducting research and development focused on the wireless network technology and ultra-high-speed satellite communications technology that will need to be applied in 5G and IoT systems. This special issue presents the outcomes of that work.

Section **2** focuses mainly on terrestrial wireless network technology. The articles summarize the outcomes of research and development in the realm of the flexible architecture and spectrum sharing technologies required for 5G systems, massive device connectivity technology, and millimeter- and terahertz-wave transmission models. This section also describes the results of research and development focused on technologies for building large-scale mesh networks, which are effective for building sensing systems and power-saving grid communications systems for use in sensing in the agriculture and fisheries industries, where IoT offers promising possibilities, and also wireless communication stabilization technologies that can be effective in manufacturing sites. Moreover, it includes the findings from research into terminal-to-terminal communication systems for expanding wireless network usage environments; wireless technologies for use in extreme environments, such as underwater and in deep space; and wireless technologies that use small UAVs.

Section **3** summarizes the outcomes of an empirical study involving various demonstration experiments using the Wideband InterNetworking engineering test and Demonstration Satellite (WINDS). WINDS is a demonstration satellite developed in partnership with the Japan Aerospace Exploration Agency (JAXA) to facilitate ultra-high-speed satellite communications. It was launched in February 2008 and continues to be used for various experiments today. WINDS has succeeded in achieving a transmission speed of 3.2 Gbps, the world's fastest in fixed satellite communications. It is equipped with world-class ultra-high-speed satellite communications capabilities, with a 50-cm-diameter antenna that enables it to receive signals at speeds of up to 155 Mbps and on-board switching capabilities of up to 455 Mbps. For details of the satellite and network design and development, please see Journal of NICT vol.53 no.4.

As well as providing an overview of the WINDS fundamental experiments, this special issue reports on the results of a diverse array of other experiments conducted using WINDS in the areas of communication systems, trialing of applications, and on-board equipment integrity checks. These include rain attenuation compensation experiments; disaster countermeasures experiments; terrestrial network connection experiments; orthogonal frequency-division multiplexing modulation transmission experiments; ultra-high-definition television transmission experiments; APAA integrity check experiments; aircraft communications experiments; Ka-band multi-level modulated signal transmission experiments; marine communica-

tions experiments; land-based mobile communications experiments; and high-speed data transmission protocol experiments.

Many companies, universities, and other bodies are engaged in a wide range of technology development initiatives focused on 5G and IoT, so various technologies are expected to appear in due course. As well as working in partnership with these stakeholders to promote the utilization of 5G and IoT, NICT intends to conduct long-term research and development that looks even further into the future. In closing, I would like to express my gratitude to the Ministry of Internal Affairs and Communications, JAXA, and the many companies, universities, and other relevant organizations that provided cooperation and support in the course of the research and development of the diverse technologies showcased in this special issue, without whose assistance we would have been unable to achieve these results.

Naoto KADOWAKI, Ph.D.

Vice President, National Institute of Information and Communications Technology

Satellite communications, Wireless communications