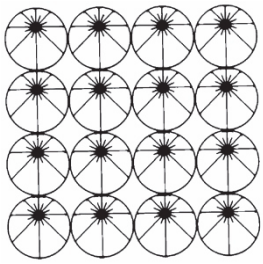
Anritsu Technical Review No.27 September 2019

Foreword



Dawn of 5G Mobile Communications Systems

Emeritus Professor, Nagoya Institute of Technology
Tetsuo Ikeda

1 Introduction

Communications and information are developing as the 21st century's leading-edge technology fields. In the broadcasting field, ultra-high-definition 4K and 8K television broadcasting has already started. In the communications field, IoT (Internet of Things) network, which is a new network connecting all devices, Artificial Intelligence (AI), self-driving automobiles, unmanned aerial drones, and 5G mobile communications systems, etc., are developing. It may be easy to visualize a future with 4K and 8K technologies and self-driving automobiles, but it can be hard to imagine how IoT technologies will be connected to our daily lives. In broad terms, 5G is an extension of previous high-speed, large-capacity technologies, but it will also play a key role in supporting IoT and self-driving automobile applications, while combination with AI will speed even more unforeseen developments.

2 Growth of Smartphones and Hopes for 5G

The first pocket-bell mobile call systems started about 10 years before the appearance of car telephones; salaried workers felt like they were on 24-hour call from the office and, despite the convenience, plenty of people complained about having no free time. It evolved from a simple caller to display numbers, and it was popular among many students to exchange messages by rhyming numbers, sometimes with up to 10 million participants at one time. However, the spread of mobile phones soon saw the decline of the pocket bell, which 50 years later is just a footnote in communications history.

The history of the cordless cell phone began with the announcement of the 1970 Osaka Expo. Conversations were made wirelessly over distances of a few meters to a dedicated leased line. In 1987, commercial analog cordless phone services were rolled-out and were soon to be followed by the introduction of digital technology in the mid-1990s; LTE services started from 2012, bringing us to today's 4G services.

Until 4G, mobile phones evolved as devices for direct person-to-person communications, but the advent of 5G service is focused on key social functions using IoT communications with various types of sensors, electrical and electronic equipment, self-driving automobiles, and more. With the widespread deployment of IoT and the growth of person-to-machine and machine-to-machine communication, the number of terminals is expected to reach 50 billion units in 10 or so years, finally reaching several trillion units.

3 Expanding to Large-Scale IoT

Using IoT, various electronic and electrical equipment and sensors, etc., exchange information via an Internet connection. Based on the characteristics of these devices and the volume of information, the following systems are assumed:

- Large-scale systems with extremely large numbers of terminals
- Systems for handling Big Data
- Ultra-stable systems requiring extreme reliability

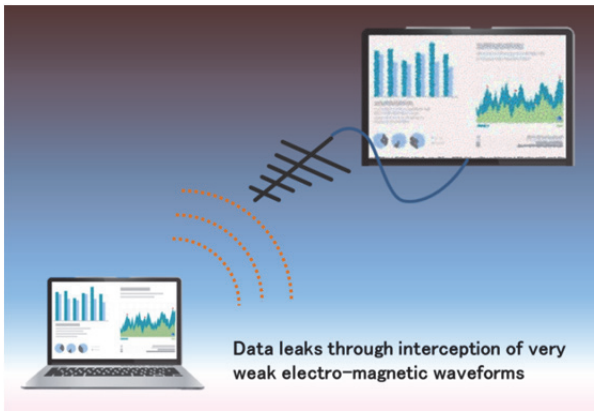
Examination and commercialization of IoT is progressing in

many fields. In the home, there are applications for door locks, healthcare, building management, scheduling, self-driving vehicles, home banking, home shopping, and more. The man-machine interface will not be limited to keyboard and touchscreen but will also use speech recognition and natural conversation; the home environment will be matched with human feelings and conversational interactions. Home automation was a key research interest of Professor Kotsukawa at Osaka University more than 20 years ago.

On the other hand, introduction of IoT to factories will help managers better understand operating conditions to optimize production lines, and improve quality, stability, and yield. Analysis of Big Data collected using IoT will help clarify cause and effect relationships that have been overlooked so far, helping to stabilize product quality and improve production efficiency.

4 Assuring Safety and Usability with EMC

Current statistics just for the Internet show there are 2 billion security threats each year. Wireless systems require ever greater safety assurance against intentional hacks, attacks, and data leaks. Since most common wooden house structures are not protected by electro-magnetic shielding, household information may leak outside unless countermeasures are taken. Heightened security is even more important for key infrastructure. “Tempest” is the name of crime exfiltration of sensitive data by intercepting the very low-level radio waves emitted from server and personal computer cables, monitors, etc. For example, electronic data leaks from power utilities, banks, government ministries, etc., can paralyze social infrastructure. In Europe and the United States, vigorous R&D into a tempest shield is being undertaken to stop leaks from information equipment, and Japan must also focus on this issue in future.



In addition, it is also necessary to push forward with protection against attacks using large electromagnetic fields such as EMP weapons. In other words, we need solutions for Electro Magnetic Compatibility (EMC) problems because disabled key infrastructure can only lead to nationwide disorder. The bright future foreseen with widespread introduction of IoT systems can become a problem and requires investigation of many matters.

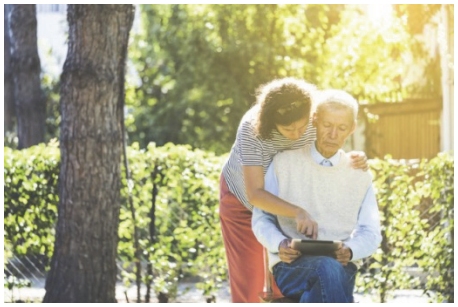
With the increasing number of base stations serving mobile phones, the mobile-phone average output power in the operating state is on the order of several mW. Regarding the effect of these power levels on the human body, the results of limited studies by several international cancer-related organizations suggest some possible increased risk for one type of brain cancer. The results of other epidemiological studies are said to suggest slightly elevated risk of cancer, but the future results of studies on the long-term use of mobile are still awaited. However, the power of radio waves used by household IoT devices is very much lower than that from mobile terminals; even if the number of terminals is n units, the increase in the field strength as a result of synergistic effects between terminals is on the order of $\sqrt{n}$, which is not thought to be a problem.

In addition to assuring safety, EMC technology is also critical to improving usability. EMC ensures that equipment and systems remain unaffected by radio interference from other electronic equipment by specifying operational tolerances when receiving such interference. The EMC standard is defined by the International Electrotechnical Commission (IEC) and the Comité international spécial des perturbations radioélectriques (CISPR). However, even if the television meet the EMC standard, unless it works it will not be accepted by users. Additionally, interrupted communications for self-driving vehicles and factory automation pre-

sent risks to life and added costs. For the future, compliance with EMC standards is obviously a matter of course, but it is also important to take countermeasures to unexpected circumstances, such as high concentrations of smartphones in sport stadiums, event spaces, etc., so users are satisfied with their products and services.

5 Conclusions

Many dream technologies are close at hand and although nobody can predict the future, it seems likely that development of unique systems will continue. With the one-by-one introduction of new technologies, such as mobile phones, personal computers, the Internet, etc., people who could manage these devices enjoyed their benefits. As operators roll-out 5G functions, our lives overall become more dependent on 5G and life cannot be lived without this technology in some cases. Construction of easy-to-use systems is indispensable for assuring benefits to as many people as possible, making education of information engineers an urgent task.



The shortage of information engineers is a serious problem for industry and will be a big problem in achieving an information-oriented society. Additionally, in the field of circuit technologies, the number of university classes teaching circuits and electromagnetism is decreasing, with almost no teaching time spared for studying transient phenomena and distributed constant circuits, the latter of which is a key technology for measuring and analyzing mmWave band circuits expected to be used by 5G. Moreover, the chances to learn from failure are reduced by fewer opportunities for hands-on soldering and experimentation. Learning more within limited time is a difficult task, but is something where I would like to see future improvements.

The move towards new technologies triggering an information-oriented society will help solve some modern social problems, promote better social lives, and lead towards new forms of community while revolutionizing industry as well.

Acknowledgments

I would like to express my thanks to the editors and authors for the opportunity to write this Foreword, and to the many other authors, reporters, and information organizations I referenced while writing for this journal covering recent developments in the active field of communications engineering. Many points of interest to readers still remain uncovered, due to my limited knowledge in this rapidly advancing field. Moreover, any errors are entirely my own responsibility and I appreciate readers' opinions and corrections.

Reference

1) Takeshi Hattori, Masanobu Fujioka (eds.): "5G TEXTBOOK", Impress Corporation (2018) (in Japanese)

About Tetsuo Ikeda

Emeritus Professor, Nagoya Institute of Technology

1961: Graduated in Communications Engineering, Faculty of Engineering, Tohoku University

1977: Professor in Department of Electrical Engineering, Nagoya Institute of Technology

2001: Retired Nagoya Institute of Technology

2016: Awarded the Order of the Sacred Treasure, Gold Rays with Neck Ribbon

1995 to 1997:
Appointed to Various Working Groups

Vice Chairman of Institute of Television Engineers of Japan

Publications

Network Theory, Maruzen, 1980, and other publications