
INTERVIEW WITH RESEARCH TEAM OF ATR WAVE ENGINEERING LABORATORIES, KYOTO, JAPAN

EDITOR: YAFEI HOU

Editor Note: As one famous research institute in Japan, Advanced Telecommunications Research Institute International (ATR) dedicates to the fundamental researches on computational neuroscience, deep interaction science, wireless and communications and life science. In this issue, the editor interviewed with the research team of Wave Engineering Laboratories (WEL), one Laboratories of ATR, to share how this famous research institute creates new wireless technology and trains the qualified wireless researchers.



Director, Dr. Yoshinori Suzuki

He received the B.E., M.E. and Ph.D. degrees from Tohoku University, Sendai, in 1993, 1995 and 2005 respectively. Currently, he is the director at ATR Wave Engineering Laboratories, Kyoto, Japan.



Vice Director, Dr. Toshikazu Sakano

He received Ph. D degree in electrical and communication engineering from Tohoku University in 1998. Currently, he is the vice director at Wave Engineering Laboratories and a director of Business Development Office, ATR.



Dept. Head, Dr. Kazuto Yano

He received Ph. D degree in communications and computer engineering from Kyoto University in 2005. Currently, he is the Head of Dept. Wireless Communication Systems at Wave Engineering Laboratories, ATR.



Principal Researcher,
Dr. Satoru Shimizu

He received Ph. D. from Chiba University in 1995. Currently, he is the principal researcher at Wave Engineering Laboratories ,ATR and a visiting professor of Doshisha University.

[Q1]What are the major missions and main research topics of ATR-WEL? What is important role of ATR-WEL in Japan?

[Dr. Suzuki] Our Laboratories will fulfill the following three missions.

- Creation of advanced technology to solve unexplored issues in the wireless field
- Providing new value by utilizing wireless technology in new areas
- Training of stubborn wireless researchers and technicians who strongly promote new R&D based on free and original ideas.

Therefore, our major research projects are aiming to improving communication quality such as large capacity, multiple connections and low latency, as major targets of 5G. Wireless has many issues to be solved and new roles to be expected. For example, there are wireless harnesses that never cause physical disconnection, monitoring technology that can easily observe the radio environment, and non-contact sensor

that grasps the state and properties of objects using radio waves, etc.

Our Laboratories aims to achieve pioneering and original research on wireless technologies and services for our future society. Most projects are supported from government, and R&D activities are operating with industry-academia-government collaboration as well as international collaboration.

[Q2] What are the main research directions of wireless technologies for the next decade from the views of ATR-WEL?

[Dr. Suzuki] From my view, ATR-WEL will focus on following research topics:

Wireless network control technology and frequency utilization technology: By switching the frequency and communication path according to noise, interference, time / frequency / polarization, and environment, it can improve the overall frequency efficiency and the convenience of communication.

Antenna control technology: It aims to improve communication quality by controlling the directivity and polarization of the antenna.

Wireless harness technology: We try to make wiring of information and power inside equipment wireless.

Radio environment monitoring and sensing technology: Interference waves that may affect communication are measured and analyzed, and the sources are identified. Radio waves sense without contact and provide correct information to networks and mechatronics equipment.

[Q3] Compared with the education provided from universities, what are the major advantages of training wireless researchers at ATR-WEL?

[Dr. Suzuki] Most of our research projects are from government, and R&D activities are operating with industry-academia-government collaboration. Therefore, we offer young wireless researchers the first-class, timely and practical research topics from many hot wireless fields such as IoT, AI, and 5G/6G. In addition, researchers and engineers with various experiences and achievements can provide appropriate advices for young wireless researchers.

From our training, we hope the young people can become a full-fledged researcher through daily practical research and development through joint research and contract research, and exchanges with many people in R&D, conference presentations, exhibitions, etc.

[Q4] Could you introduce the major research contents of Dept. of Wireless Communication Systems?

[Dr. Yano] We are engaging for research on wireless communication technologies in PHY and MAC layers to improve efficiency of radio spectrum utilization for improving quality-of-service (QoS) of users and for increasing the number of accommodatable uses number. For example, multiple-input multiple output (MIMO) transmission and interference suppression technique are our major research topics in PHY layer. Design of

efficient channel access protocol for unlicensed bands is a major research topic in MAC layer. Moreover, we are also engaging for research on prediction of wireless channel usage and QoS that will contribute to realizing efficient control/management of wireless communication systems/networks.

[Q5] In your opinion, which research topics are more important and practical for next 6G wireless communication systems?

[Dr. Yano] In 6G era, wireless communication networks need to support various applications which are important and critical in our social lives or in industries. To support such applications with severe QoS requirement, technologies to realize deterministic communications, especially in wireless communications, to guarantee QoS required by users/applications will become more and more important.

[Q6] For next decade, the technologies of AI and IoT will be definitely driving forces for future wireless system. In your opinion, how do you think these technologies will change the research directions of wireless communications and smart device of consumer electronics?

[Dr. Yano] The usage of wireless communications will become more and more complex because there is a variety of applications that have different traffic patterns and QoS requirements, even in IoT use cases. AI will be a key technology to provide automatic control/management of wireless communication networks, especially in such complex traffic situations. So, AI may free engineers/operators from finding sophisticated rules to efficiently control/management wireless communication networks in future. On the other hand, AI will not be omnipotent, and there will be some limitations of AI. So, researcher will be requested to analyzes the AI's limitations and explained them to the world.

[Q7] Could you introduce the major research contents of Dept. of wireless applications?

[Dr. Shimizu] I am researching robot control using millimeter-wave band communication and proximity sensors using changes in antenna characteristics.

[Q8] In your opinion, what the technology trends for the future wireless applications?

[Dr. Shimizu] I think that terahertz band communication for beyond 5G and non-contact sensing for COVID-19 countermeasures are technological trends.

[Q9] Could you provide some comments on the integration of wireless applications on smart devices or consumer electronic equipment for Society 5.0?

[Dr. Shimizu] In addition to communication and control, I think that application technologies that transmit electric power wirelessly will advance.

[Q10] Could you introduce the wireless COE project at ATR-WEL?

[Dr. Sakano] The Wireless COE R&D Program is a program in the Strategic Information and Communications R&D Promotion Program (SCOPE) of the Ministry of Internal Affairs and Communications (MIC). ATR, in collaboration with Kyoto University, proposed a project; "R & D on technologies for robust / flexible radio resource utilization and new applications, and its support program for training of radio experts," to the MIC's program and

was accepted (SCOPE No.196000002) in 2019.

Since then, we have run five R&D sub-projects related to the creation of advanced wireless technology and applications in the wireless technical field as joint projects with academia, industry and startup company. One of the main objectives of the program is to encourage young wireless talents and get them grow to top researchers/engineers through conducting the sub-projects as leaders. Other objectives of the project are to create advanced wireless technology and to develop new application areas for wireless technology.

To support the R&D sub-projects and to accelerate wireless related R&D nationwide, we installed two functions in the project. They are the assignment of mentors to facilitate and encourage talents and the release of a part of ATR's facilities to the leading wireless related R&Ds in and around the project.

The project assigned fourteen experts as mentors from wide variety of related technical fields like wireless network, communication protocol, radio-wave propagation, antennas, microwave circuit, semiconductor device, EMC, satellite communication, international standardization, and technical magazine editor. The mentors support the R&D sub-projects. They make presentations as mentors in technical seminars and workshops held in and around the project.

ATR originally owned facilities and equipment to conduct R&D on wireless technology. In the wireless COE project, we renewed them so that top researchers can use them for their leading R&D. The facilities are a large anechoic chamber, CAD for semiconductor design, 3D printer, Software defined radio equipment and various measurement equipment. After the start of the project, leading researchers from universities and companies often come to ATR to conduct their experiments using the facilities and equipment.

We hope that the COE project not only yields the technical outcome through the pre-project's R&D, but also create new talents for the future of this technical field. In addition, we expect ATR keep contributing to the evolution of this technical field as center of excellence even in 6G era and beyond.

[Q11] What are the advantages of wireless COE project?

[Dr. Sakano] An advantage of the wireless COE project run by ATR and Kyoto University is that we have abundant accumulating experience and outcome, and environment to run wireless related leading-edge R&D. A substantial human network in the researcher/engineer community has been formed through the R&D activities conducted for decades. This human network is another advantage we have. The network often makes it easy for us to reach industry, government and academia nationwide and global to form a collaborative R&D project, to get fund to run R&Ds and to deploy R&D outcome in real society. We believe the wireless COE project would be a good trigger to create an eco-system which keeps generating talents and also new technologies in the field of wireless technology.