COMMISSION C: Radiocommunication Systems and Signal Processing
(August 2021 – May 2023)

Edited by *Name* (*Affiliation*)
Noriharu Suematsu (25th Japan URSI-C Chair, Tohoku University)

1. Summary

5G, which began service in 2020, is now further upgrading as Beyond 5G toward 2025. In the 2030s, 6G is expected to be put into practical use. Cellular systems have been evolving significantly approximately every 10 years, and further evolution is expected for 6G/7G. It is expected that not only the evolution of base stations and terminals, but also wireless power transmission, sensing, and other hardware will be incorporated in the future. In this context, Commission C is to investigate and research the latest technologies in microwave, millimeter-wave, and sub-THz circuits and ICs, transmitters and receivers, and signal processing for various wireless applications, and to provide a open forum for technical discussions and exchanges. In the 25th period, we have held six open workshops. We collaborated in submitting technical papers to the 3rd URSI Atlantic and Asia Pacific Radio Science Meeting (AT-AP-RASC2022) held in the Grand Canary Islands and participated in the Commission meeting. We also contributed to organize the sessions and are to the paper submission, i.e., 1 invited paper and 10 technical papers for 2022 URSI-Japan Radio Science Meeting (JRASM2022). Currently, we actively contribute in the collection and submission of technical papers to the XXXVth General Assembly and Scientific Symposium of. the International Union of Radio Science (URSI-GASS2023).

2. Activity Report

Since the 25th committee started, we have held scientific workshops six times. This document reports summaries of the meetings/workshops.

– The 1st scientific workshop of the 25th URSI-C in Japan –
Session title: "Small antenna technologies in the IoT/5G era"
Convener: Dr. Kengo Nishimoto (Mitsubishi Electric Corporation)

Date/time: 13:30 - 17:20, November 2nd, 2021

Venue: Nonoichishi Koyusha, Kanazawa city, Ishikawa (Online participation was available)

Registration fee: Free

Listed attendees: 14 persons (local participation) , 31 persons (online participation)

Technical arrangement: Dr. Kengo Nishimoto (Mitsubishi Electric Corporation)

Local arrangement: Prof. Keisuke Noguchi (Kanazawa Institute of Technology)

Sponsors:

- IEEE MTT-S Nagoya Chapter
- IEEE AP-S Nagoya Chapter
- IEEE VT-S Tokyo/Japan Chapter
- IEEE SSCS Japan Chapter

Presentations:

- 13:30 - 13:40 Opening Remarks
  Prof. Noriharu Suematsu, Chair, Commission C of URSI-JNC
  (Tohoku University)
- 13:40 - 14:30 "Theoretical analysis of spherical and cylindrical helix antennas for IoT applications"
  Prof. Keisuke Fujita (Maebashi Institute of Technology)
- 14:30 - 15:20 "Small and dual-frequency decoupling circuits for two-element antennas"
  Dr. Kengo Nishimoto (Mitsubishi Electric Corporation)
- 15:20 - 15:40 Coffee Break (20 min.)
- 15:40 - 16:30 "Quality factor and broadbanding for solid or planar small antennas"
- 16:30 - 17:20 "A small antenna design with robustness to metal for installation on metal walls"
  Prof. Hisashi Morishita and Prof. Naobumi Michishita (National Defense Academy of Japan)
- 17:20 Closing

Reception: It held from 18:30 to 20:30 at Ekinokura in Kanazawa station, Kanazawa city, Ishikawa pref. The number of attendees was 13 persons.

The Steering committee meeting: It took place from 13:00 to 13:30 on November 2nd, 2021, at Nonoichishi Koyusha and on online.

Concluding Remarks: With the spread of IoT, many terminals are equipped with a wireless communication function, and as the terminals themselves become smaller, the demand for smaller antennas is increasing. In addition, 5G terminals are increasingly required to be equipped with multi-frequency, multi-element antennas to improve communication performance. On the other hand, there are theoretical limits to the miniaturization of antennas, and the gain and bandwidth decrease with miniaturization. Therefore, to meet the demand and approach the limit, the technological progress of small, wideband, and multi-element antennas is desired. At this meeting, we focused on small antenna

technologies in the IoT/5G era, discussed intensely the latest trends and issues through lectures, questions and answers, and deepened a common understanding of future prospects.

Prof. Keisuke Fujita (Maebashi Institute of Technology) gave a lecture on the theoretical analysis of spherical and cylindrical helix antennas for IoT applications. The analysis method of the spherical antenna, the maximum radiation efficiency and the Q value were shown. The theoretical limit was clarified, and it was validated that the antenna close to the theoretical limit can be realized by the spherical helix antenna and the cylindrical helix antenna.

Dr. Kengo Nishimoto (Mitsubishi Electric) gave a lecture on small and dual-frequency decoupling circuits for two-element antennas. A small decoupling circuit that can control the excitation distribution of the antenna and a small and low loss dual-frequency decoupling circuit that is integrated with the matching circuit were shown, and its effectiveness were verified by measurement and calculation. We deepened the common understanding about the effect of the decoupling circuit.

Prof. Keisuke Noguchi (Kanazawa Institute of Technology) gave a lecture on the quality factor and broadbanding for solid or planar small antennas. After reconsidering the Q value of the small antenna, the results of wideband design and evaluation by multi-mode resonance were shown and compared with the theoretical limit. In the future, it was shown that research to increase the degree of freedom of polarization with an eye on MIMO is an issue.

Prof. Hisashi Morishita (National Defense Academy of Japan) gave a lecture on the design of a small antenna design with robustness to metal for installation on metal walls. It was shown that the high impedance antenna improves the robustness depending on the direction in which the metal plate approaches. The antenna that can switch the input impedance according to the installation environment was also shown, and it was confirmed that the installation area with low VSWR is expanded.

This meeting greatly contributed to the miniaturization and higher performance of small antennas, and served as a place for participants to understand the actual state-of-the-art R&D situation and share awareness of technical issues and prospects for the future image envisioned by each participant.

– The 2nd scientific workshop of the 25th URSI-C in Japan –

Session title: "Latest Research and Development Activities on Machine Type Communications"

Convener: Prof. Yukitoshi Sanada (Keio University)

Date/time: 13:20 - 17:00, January 7th, 2022

Venue: Multi-purpose Room, Hotel Minoh Sanso Kazeno Mori (Minoh city, Osaka pref.) (Hybrid conference with web conference)

Registration fee: Free

Listed attendees: 15 persons (local participation) , 10 persons (online participation). **Local arrangement:** Prof. Yukitoshi Sanada (Keio University)

Presentations:

- 13:20 - 13:30 Opening Remarks
  Prof. Noriharu Suematsu, Chair, Commission C of URSI-JNC
  (Tohoku University)
- 13:30 - 14:15 "Flexible Factory Project - Towards Stable Wireless Communications in Manufacturing Sites -"
  Dr. Satoko Itaya (National Institute of Information and Communications Technology)
- 14:15 - 15:00 "Current Status and Future Perspectives of Local 5G System for Smart Factories ~ Semiconductor Development towards Post 5G"
  Dr. Hiroki Ikeda (ABIT Corporation)
- 15:00 - 15:15 Coffee Break (15 min.)
- 15:15 - 16:00 "Practical Experiments for Use Cases of 5G and 6G"
  Dr. Yuji Aburakawa (NTT DOCOMO)
- 16:00 - 16:45 "Standardization Activities of Industrial IoT/URLLC in 3GPP"
  Dr. Tetsuya Yamamoto (Panasonic)
- 16:45 Closing

Reception: It held from 18:30 to 20:30 at Room Momiji, Hotel Minoh Sanso Kazeno Mori in Minoh city, Osaka pref. The number of attendees was 13.

The Steering committee meeting: It took place from 8:30 to 9:30 on January 8th, 2022, at Room Akebi, Hotel Minoh Sanso Kazeno Mori.

Concluding Remarks: In recent years, technologies for direct wireless connection between machines, such as between industrial devices or self-driving cars, has attracted much attention. Standardization and technology developments for machine-type communications are also underway for 5G and wireless LAN systems. In machine-type communications, unlike high data rate communications, high reliability, small jitter characteristics, low cost, and low power consumption are important characteristics. This workshop was aimed to present and discuss latest research and development activities on machine type communications towards standardization and practical

applications for industrial use by researchers who are active at the forefront. We deeply discussed on wide aspects of the technological subjects, bottlenecks, solutions, and practical timelines in relation to the presentations given by four renowned leading researchers and questions to deepen our common understanding of prospects.

Dr. Satoko Itaya (NICT) talked about the applications of wireless communications at manufacturing sites, especially about the issues specific to manufacturing sites and the problems of using commercially available wireless devices. She also introduced Flexible Factory Project, a project to use wireless communications in manufacturing. Dr. Haruki Ikeda (ABIT Corporation) introduced the local 5G system developed by his company and its application experiments to smart factories, especially for vehicle base operations, remote heavy machinery operations, experiments at a baseball stadium, and smart city demonstration experiments. He also explained the development status of post-5G semiconductor chips for ultra-low latency.

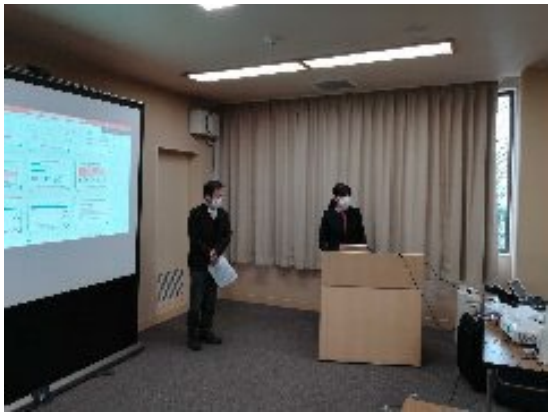
Dr. Haruki Ikeda (ABIT Corporation) introduced the local 5G system developed by his company and its application experiments to smart factories, especially for vehicle base operations, remote heavy machinery operations, experiments at a baseball stadium, and smart city demonstration experiments. He also explained the development status of post-5G semiconductor chips for ultra-low latency.

Dr. Yuji Aburakawa (NTT DOCOMO) explained the case studies of 5G solution co-creation projects. He also introduced 5G application experiments for use cases such as remote automated driving, remote operation of large construction machinery, telemedicine, and remote surgical support. He also gave an outlook on the technological development of 6G.

Dr. Tetsuya Yamamoto (Panasonic) spoke about the standardization issues of Industrial IoT/URLLC in 3GPP. He explained the issues to be considered in each release and reviewed the status of Industrial IoT/URLLC in those releases. In addition, he introduced the transmission technology to realize low latency and its numerical evaluation results.

All the speakers presented the results of the latest studies for practical use. Also the issues to be solved and the prospects for the industrial application of wireless communications were discussed in depth. This workshop was very useful to introduce the results of the latest demonstration experiments and to share the issues specific to machine-type communications with the participants since machine-type communication has become a major subject of discussion in the standardization bodies.






– The 3rd scientific workshop of the 25th URSI-C in Japan –

Session title: "Devices for over 100GHz band and Radio Systems"

Convener: Yasunori Suzuki (NTT DOCOMO, INC.)
Date/time: April 27th, 2022 / 13:20 - 16:00
Venue: Hakodate city convention center (meeting room #2), Hokkaido pref. (Hybrid conference with web conference)
Registration fee: Free
Listed attendees: On site: 19persons, Online: 20persons
Local arrangement: Prof. Nakatsugawa (National Institute of Technology, Hakodate College)
Session title: "Devices for over 100GHz band and Radio Systems"
Presentations:

- 13:20 - 13:30 Opening Remarks

Prof. Noriharu Suematsu, Chair, Commission C of URSI-JNC
(Tohoku University)

- 13:30 - 14:05 "Future Trend of Beyond 5G/6G mobile communication systems and Tera-Hertz Radio Communication Systems"

Dr. Iwao Hosako (National Institute of Information and Communications
Technology)

- 14:05 - 14:40 "Current Status and Future Trend of Optical Technology for millimeter- wave and Tera-Hertz Radio Communication Systems"

Prof. Tadao Nagatsuma (Osaka University)

- 14:40 - 14:50 Coffee Break (10 min.)
- 14:50 - 15:25 "Device Technology for 300 GHz Band Radio Communication Systems"
  Dr. Hiroyuki Takahashi (NTT Advanced Technology Corporation)
- 15:25 - 16:00 "THz Band On-Chip Array Antenna"
  Prof. Haruichi Kanaya (Kyushu University)
- 16:45 Closing

Reception: It held from 18:30 to 20:30 at KKR Hakodate in Hakodate , Hokkaido pref. The number of attendees was 18.
The Steering committee meeting: It took place from 8:30 to 9:30 on April 28th, 2022, at KKR Hakodate.
Concluding Remarks: Regarding research of radio communication systems and devices for operating more than 100 GHz band toward the six-generation mobile communication systems (6G), there are many research activities for realizing 6G such as publishing the white papers from research groups

and companies. This workshop provided to share the recent research results in Japan, which are radio communication systems and devices above 100 GHz band for 6G.

First, Dr. Iwao Hosako (NICT) presented the current status and future trend of tera-Hertz radio communication systems toward beyond the fifth-generation mobile communication systems (5G) and 6G. The presentation included the standardization status and use-case scenarios for beyond 5G and 6G.

Second, Prof. Tadao Nagatsuma (Osaka University) presented the research results and future perspective of optical technology for generating millimeter wave and tera Hertz wave. The practical use-case scenarios using tera Hertz wave were also introduced.

Third, Dr. Hiroyuki Takahashi (NTT Device Technology Laboratories) presented the research results of radio communication systems and devices for operating 300 GHz band. The filed experiment results confirmed that the 300 GHz band transmitter could send the transmitted signal to the receiver achieving sufficient transmission quality.

Finally, Prof. Haruichi Kanaya (Kyushu University) presented the research results of THz band on-chip array antennas. The presentation provided the design, fabrication, experimental results of THz band on-chip array antennas.

In the research activities toward 6G, this workshop shared the current status and future trend of radio communication systems and devices for operating millimeter wave band and THz band, while that provided deep and comprehensive discussions between attendees and speakers. From these discussions, this workshop was very useful to share the latest results, research trend, standardization trend, and technical issues for realizing 6G.

– The 4th scientific workshop of the 25th URSI-C in Japan –

Session title: "Introduction to recent research activities by young researchers"

Convener: Dr. Satoshi Yoshida (Kagoshima University)

Date/time: 13:20 - 16:30, September 22nd, 2022

¥Venue: Conference Room, Kyukamura Ibusuki (Ibusuki city, Kagoshima pref.)

(Hybrid conference with web conference)

Registration fee: Free

Listed attendees: 21 persons (local participation), 5 persons (online participation)

Local arrangement: Dr. Satoshi Yoshida (Kagoshima University)

Presentations:

- 13:20 - 13:30 Opening Remarks

Prof. Noriharu Suematsu, Chair, Commission C of URSI-JNC

(Tohoku University)

- 13:30 - 13:55 "Terminal location estimation method using VHF band radio big data and machine learning"

Dr. Keiichi Mizutani (Kyoto University)

- 13:55 - 14:20 "A PAPR Reduction Method of Multitone Signals by Optimizing Their Phases with Initial Values Using Algebra and High Autocorrelation Code"

Dr. Hiroto Sakaki (Mitsubishi Electric Corporation)

- 14:20 - 14:45 "Introduction to the Impedance Expansion Method:
  Application to Circuit Modeling of Wireless Power Transfer Systems"

Dr. Nozomi Haga (Gunma University)

- 14:45 - 14:55 Coffee Break (10 min.)
- 14:55 - 15:20 "Development of Ring Beam for Wireless Power Transfer to Drone"

Dr. Takayuki Matsumuro (Advanced Telecommunications Research Institute International)

- 15:20 - 15:45 "Enhancement of Antenna characteristics using Meta-surface"

Dr. Ryuji Kuse (Kumamoto University)

- 15:45 - 16:10 "Mode division multiplex transmission using shielded quad cable"

Dr. Tohlu Matsushima (Kyushu Institute of Technology)

- 16:10Closing
  Prof. Mitoshi Fujimoto, Vice chair, Commission C of URSI-JNC
  (Fukui University)

Reception: It was held from 17:00 to 19:30 at Eco-Camp site, Kyukamura Ibusuki, Ibusuki city, Kagoshima prefecture. The number of attendees was 18.

10. The Steering committee meeting:

It took place from 8:30 to 9:30 on September 23rd, 2022, at Kyukamura Ibusuki.

Concluding Remarks: In the past, presentations were given on the state-of-the-art research results in each field such as AP/MW/RCS/ED. This time, however, we asked young researchers who are active in radio-related R&D to give presentations without being restricted to a specific field, and the session was finally organized with presentations by six people. In the circumstances where the number of young researchers is decreasing, we asked all the speakers to be young people, and it was a very valuable opportunity to establish a good connection between well experienced researchers and young researchers. It would be very valuable to continue organizing young researchers' session in the future, even if it is an infrequent event, as it will surely be a very valuable opportunity for them.

Dr. Keiichi Mizutani (Kyoto University) explained the development of a system to estimate base station and terminal locations only by receiving VHF RF signals through machine learning of VHF RF big data. He showed that highly accurate terminal location estimation is possible by applying AI/Big Data, which has become a hot topic in recent years, to radio wave related systems.

Dr. Hiroto Sakaki (Mitsubishi Electric Corporation) proposed the necessity of low PAPR of multi-tone signals to compensate the frequency characteristics of RF front-ends, which have been broadened in recent years, and explained the results of quantitative evaluation by simulating the self-correlation and PAPR of four different codes.

Dr. Nozomi Haga (Gunma University) reported on his research results on circuit modeling methods for wireless power transmission systems using coils. The analytical results of the circuit model derived by the impedance expansion method proposed by Dr. Haga were in good agreement with the results of conventional electromagnetic field analysis, demonstrating the effectiveness of the proposed method.

Dr. Takayuki Matsumuro (Advanced Telecommunications Research Institute International) proposed a null-core beam that has a null at the beam center to solve the problem that the irradiation power to the mission equipment mounted in the center of a drone is maximized with a normal antenna beam when wireless power transmission using microwaves is applied to power supply to a drone, and proposed a new method to reduce the irradiation power to the drone. He reported the simulation results of the method to apply the Laguerre-Gaussian mode.

Dr. Ryuji Kuse (Kumamoto University) proposed the utilization of metasurfaces to improve antenna characteristics, and reported a case study of converting linearly polarized wave to circularly polarized wave and a case study of improving communication capacity in 2x2 LOS MIMO. In both cases, he reported that the edge part of the metasurface did not work as a unit cell. He also reported that the compensation method and its effectiveness were successfully verified.

Dr. Tohlu Matsushima (Kyushu Institute of Technology) proposed that mode-multiplexing transmission, in which signals are assigned to modes of electromagnetic fields, can in principle enable crosstalk-free communication, while conventional differential or single-ended transmission using

multi-wire cables cannot ignore crosstalk. He introduced a case study in which a transmitter/receiver system was constructed using a shielded 4-wire cable and the eye pattern was evaluated.

– The 5th scientific workshop of the 25th URSI-C in Japan –

Session title: "Latest Trends on Applications of Satellite and HAPS for Beyond 5G and 6G"

Convener: Prof. Yukitoshi Sanada (Keio University)

Date/time: 13:15 - 17:00, January 6th, 2023

Venue: Yonago Culture Hall Seminar Room 1 (Yonago city, Tottori pref.)

(Hybrid conference with web conference)

Registration fee: Free

Listed attendees: 19 attendees on site, 27 attendees on web conference

Local arrangement: Prof. Yukitoshi Sanada (Keio University)

Presentations:

- 13:00 - 13:15 Reception
- 13:15 - 13:20 Opening Remarks

Prof. Noriharu Suematsu, Chair, Commission C of URSI-JNC

(Tohoku University)

- 13:20 - 14:00 "Trends on Applications of Satellite in NTN for Beyond 5G and 6G"

Dr. Makio Tsuchiya (National Institute of Information and Communications Technology)

- 14:00 - 14:40 "Old and New HAPS"

Dr. Hiroyuki Tsuji (National Institute of Information and Communications Technology)

- 14:40 - 14:50 Coffee Break (10 min.)
- 14:50 - 15:20 "SKY Perfect JSAT's Approach to Future NTN Deployment

Dr. Nobuyuki Setoguchi (SKY Perfect JSAT Corporation)

- 15:20 - 16:00 "Trends on Developments of Satellite for Beyond 5G and 6G Network"
  Dr. Soichiro Inoue (Axelspace Corporation)
- 16:00 - 16:40 "Problems and Diversification Efforts of Backhaul Connections for IFC Services"
  Dr. Takayuki Sotoyama (Panasonic)
- 16:40 Closing

Reception: It held from 19:30 to 21:00 at Kaike Grand Hotel Tensui in Yonago city, Tottori pref. The number of attendees was 19.

The Steering committee meeting: It took place from 8:30 to 9:30 on January 7th, 2023, at Kaike Grand Hotel Tensui.

Concluding Remarks: In Beyond 5G and 6G, the use of satellites and HAPS with base stations and relay stations is being considered to extend coverage not only during disaster emergencies but also during normal times. It can cover mountainous and remote areas, the ocean, and even outer space. On the other hand, there are unique research and development issues such as propagation characteristics

that differ from those on terrestrial wireless links, linkage with terrestrial network systems, and beam control for space division. This workshop was aimed to present and discuss latest research and development activities on a non-terrestrial network (NTN) towards standardization and developments in all over the world by researchers who are active at the forefront. We deeply discussed on wide aspects of the NTN including the technological subjects, bottlenecks, solutions, and practical timelines in relation to the presentations given by five renowned leading researchers and questions to deepen our common understanding of prospects.

Dr. Makio Tsuchiya (NICT) talked about the global trend of NTN R&D. He also introduced the current statuses of the studies on the use of satellites, HAPS, and UAVs in wireless communication networks.

Dr. Hiroyuki Tsuji (NICT) introduced the advantages and development trends of HAPS. Then, He explained the technical developments of HAPS for wireless communications and optical communications at NICT and summarized the issues for their practical applications.

Dr. Nobuyuki Setoguchi (SKY Perfect JSAT Corporation) explained about expectations for NTN and SKY Perfect JSAT's efforts to realize NTN. He also introduced the company's demonstration experiments.

Dr. Soichiro Inoue (Axelspace Corporation) introduced satellite systems that AXELSPACE has developed. He also explained the company's low-cost and quick-delivery satellite platform called AxelLiner.

Dr. Takayuki Toyama (Panasonic Holdings) introduced the avionics business. He also spoke about the market for in-flight network connections and the technologies that will be needed for in-flight network in the future.

All the speakers presented the latest R&D and standardization trends, and the issues to be solved and future prospects for the commercial deployment of NTNs were discussed in depth. The workshop was very useful to share with the participants the specific challenges of satellite and HAPS utilization for Beyond 5G and 6G.

– The 6th scientific workshop of the 25th URSI-C in Japan –

Session title: "Microwave passive components toward 5G Evolution and 6G - Key technologies for transmitters of the future mobile communication systems -"

Convener: Yasunori Suzuki (NTT DOCOMO, INC.)

Date/time: April 21th, 2023 / 14:00 - 18:00

Venue: Kiboukan (meeting room), Wakayama pref. (Hybrid conference with web conference)

Registration fee: Free

Listed attendees: On site: 15 persons, Online: 21 persons

Local arrangement: Yuji Miyake (Mitsubishi Electric Corp.)

Presentations:

- 14:15 - 14:30 Opening Remarks
  Prof. Noriharu Suematsu, Chair, Commission C of URSI-JNC
  (Tohoku University)
- 14:30 - 15:20 "Design methods of compact and wideband / multiband microwave dividers and couplers for wireless communication system"
  Prof. Tadashi Kawai (University of Hyogo)
- 15:20 - 16:10 "Mobile communication system and transmitter for 5G evolution and 6G"
  Dr. Yasunori Suzuki (NTT DOCOMO, INC.)
- 16:10 - 16:20 Coffee Break (10 min.)
- 16:20 - 17:10 "Multilayer device technologies and applications employing liquid crystal polymer"
  Mr. Kuniaki Yosui (Murata Manufacturing Co., Ltd.)
- 17:10 Closing

Reception: It held from 18:30 to 20:30 at Kiboukan in Wakayama pref. The number of attendees was 14.

The Steering committee meeting: It took place from 8:30 to 9:30 on April 22th, 2023, at Kiboukan

Concluding Remarks: 5G mobile communication systems (5G) have just launched for commercial services from 2020. 5G will upgrade for attaining new functions and features in the future. Mobile communication systems have generally evolved every 10 years, and 6G mobile communication system (6G) will launch toward 2030s in the world. 6G will include new devices such as wireless power transformer, sensing technologies, and so on. In this background, microwave passive components will be key technologies for banding mobile communication system and hardware technologies of base stations and mobile terminals. This workshop provided to share the resent recent research results in Japan, which are microwave passive components for 5G evolution and 6G.

First, Prof. Tadashi Kawai (University of Hyogo) presented the current research results and future

research topics of compact microwave power dividers and couplers for operating wideband and multiband. The presentation included research topics of microwave power divider for operating sub-THz bands.

Second, Dr. Yasunori Suzuki (NTT DOCOMO) presented the current status and trend of 5G Evolution and 6G. The presentation provided the technical issues and key technologies for realizing mobile communication system and transmitter for sub-THz band operation.

Finally, Mr. Kuniaki Yosui (Murata Manufacturing Co., Ltd.) presented the multilayer device technologies using liquid crystal polymer for small antenna and front-end module of mobile terminal. The presentation included various use cases of the presented technologies.

In the research activities toward 6G, this workshop shared the current status and future trend of microwave passive components, while that provided deep and comprehensive discussions between attendees and speakers. From these discussions, this workshop was very useful to share the latest results, research trend, and technical issues for realizing 5G Evolution and 6G.

3. References

Below is a list of papers which were presented in 2022 URSI-Japan Radio Science Meeting (JRSM2022), Tokyo Japan, on Sep. 1-2, 2022.

Invited paper
Invited Lecture 7 (Commission C)
Noriharu Suematsu (Tohoku University, Japan)
"Direct digital RF transceiver technology for millimeter-wave DBF systems"

Regular Papers
C1-1 Communication Area Expansion Effect by Repeater in Polarized MIMO Transmission
Mitoshi Fujimoto (University of Fukui, Japan)
C1-2 User Scheduling at Base Station Cluster Boundary for Massive MIMO Downlink Transmission
Masahito Yata, Yukitoshi Sanada (Keio University, Japan)
C1-3 Enabling Synchronization between RSS data and Capture data for Wireless Resource Usage Monitoring
Morihiko Tamai, Akio Hasegawa, Hiroyuki Yokoyama (Advanced Telecommunications Research Institute International, Japan)
C1-4 Passive Indoor Localization Based on Propagation Delay Fingerprinting Extracted from Wi-Fi Channel State Information

Nopphon Keerativoranan, Yap Tee Ying, Jun-ichi Takada (Tokyo Institute of Technology, Japan)

C1-5 Design of High-impedance Antennas for Wireless Power Transfer Applications

Keisuke Noguchi (Kanazawa Institute of Technology, Japan)

Friday, September 2, 2022

C2-1 Single Carrier Transmission Scheme for Sub-THz band Power Amplifier toward 6G Mobile Communication System

Yasunori Suzuki, Hiroshi Okazaki, Satoshi Suyama (NTT Docomo, Inc., Japan)

C2-2 28GHz-Band 1-D and 2-D Beam Steering Network Based Broadside Coupled Stripline

Jean Temga, Tomoyuki Furuichi, Takashi Shiba, Noriharu Suematsu (Tohoku University, Japan)

C2-3 Experimental Verification of Adaptive Impedance Matching in a Small Card-Sized VHF-band Heartbeat Sensor Module

Kengo Nishimoto, Saki Wada, Yoshio Inasawa (Mitsubishi Electric Corporation, Japan)

C2-4 K-band Single-Shunt Rectifier Using Simple Layout Matching Circuit on PCB

Satoshi Yoshida, Kenjiro Nishikawa (Kagoshima University, Japan)

C2-5 Multi-band RF Spectrum Reconstruction from Multiple Direct RF Undersampled Signals

Tomoyuki Furuichi, Takashi Shiba, Noriharu Suematsu (Tohoku University, Japan)