



29<sup>th</sup> August 2020  
 Makoto Taromaru  
 24<sup>th</sup> URSI-C (Japan) Chair

## Activity Report of URSI-C Committee

Period: April 2019—August 2020

Since the 24<sup>th</sup> committee started, we have held scientific workshops seven times. This document reports the 5<sup>th</sup>, 6<sup>th</sup>, and 7<sup>th</sup> meetings/workshops held during the period; the former four workshops were described in our previous reports.

Remarks: The 8<sup>th</sup> workshop planned in April 2020 is postponed indefinitely this time, due to the COVID-19 disaster.

### – The 5<sup>th</sup> scientific workshop of the 24<sup>th</sup> URSI-C in Japan –

Session title: "Current status and issues of antenna propagation technology in V2X communications"

Convener: Prof. Takuji Arima (Tokyo University of Agriculture and Technology)

Date/time: 13:45—17:25, May 31st, 2019

Venue: Room "The meeting room 1 in the Tenbusu Naha" (Naha, Okinawa, Japan)

Registration fee: Free

Listed attendees: 20 persons

Local arrangement: Prof. Ryo Yamaguchi (Softbank)

#### Presentations:

- 14:10 - 14:20 Opening Remarks  
 Prof. Makoto Taromaru, Chair, Commission C of URSI-JNC (Fukuoka University)
- 14:20 - 15:10 "Analog OAM Multiplexing and Related Technologies"  
 Prof. Atsushi Sanada (Osaka University)
- 15:10 - 16:00 "Development of Millimeter-wave OAM Mode Multiplexing System for High Capacity Backhaul"  
 Mr. Eisaku Sasaki (NEC)
- 16:00 - 16:10 Coffee Break
- 16:10 - 17:00 "An experiment of 100 Gbps wireless transmission using OAM-MIMO multiplexing technology using 28 GHz frequency band"  
 Dr. Doohwan Lee (NTT Network Innovation Laboratories)



- 17:00 Closing

#### Reception

Held from 18:30 to 20:30 at the Niko in Naha City. The number of attendees is 15 persons.

#### The Steering committee meeting

It took place at the meeting room 1 in the Tenbusu Naha, from 13:00 to 13:30 on May 31st, 2019

#### Concluding Remarks

From the development of high-speed mobile communications, a lot of researchers are discussing the autonomous driving system. These systems must always be connected in terms of information. Communication technologies that cannot tolerate disconnection and large transmission delays are required.

This communication technology is called V2X communication in the sense of communication with a mobile object. Propagation and signal processing about V2X were widely discussed. Therefore, further development of V2X was expected.





– The 6<sup>th</sup> scientific workshop of the 24<sup>th</sup> URSI-C in Japan –

Session title: "Progress of Millimeter Wave Devices for Wireless Communications"

Convener: Atsushi Honda (Fujitsu Limited)

Date/time: 14:00—17:50, September 27th, 2019

Venue: Presentation Room, Shin-Kawasaki Technology Square, Fujitsu Limited  
(Saiwai-ku, Kawasaki, Kanagawa, Japan)

Registration fee: Free

Listed attendees: 39 persons

Local arrangement: Atsushi Honda (Fujitsu Limited)

Presentations:

- 14:00 - 14:10 Opening Remarks  
Prof. Makoto Taromaru, Chair, Commission C of URSI-JNC (Fukuoka University)
- 14:10 - 15:00 "Recent trends in GaN HEMTs for improved performance"  
Prof. Masaaki Kuzuhara (Fukui University)
- 15:00 - 15:50 "Millimeter wave GaN high power amplifier"  
Dr. Akira Inoue (Mitsubishi Electric Corp.)
- 15:50 - 16:00 Coffee Break (10 min.)
- 16:00 - 16:50 "Recent Trend of Millimeter-wave Band Pass Filter design"  
Dr. Shigemitsu Tomaki (TDK Corp.)
- 16:50 - 17:40 "ADI mmWave solution for 5th generation"  
Dr. Satoshi Baba (Analog Devices Inc.)
- 17:50 Closing

Reception

Held from 18:30 to 21:00 at "Kenko Chuka-an Seiren", Shin-Kawasaki Mitsui Building in Kawasaki city. The number of attendees was 13 persons.

The Steering committee meeting

It took place from 13:30-14:00 on September 27th, 2019 at the room for the scientific workshop.

Concluding Remarks

The technical standardization for high frequency bands including 24-30 GHz band are progressed to utilize the bands for 5th generation wireless communications. In addition, mobile communication services using these frequency bands will be started from 2020 in



Japan. Device manufactures are preparing their products for the market of the high frequency bands assuming the increase of demands of devices for wireless base stations or terminals of the frequency bands. Therefore, steering committee of URSI-C planned to have a workshop for reviewing the recent development of technologies such as high-power output power amplifiers or LTCC filters.

Prof. Kuzuhara (Fukui University) presented technology trends of GaN HEMT and the application examples utilizing the feature of the devices.

Dr. Inoue (Mitsubishi Electric Corp.) presented actual design examples of high-power amplifiers utilizing GaN devices and amplifier structures for hybrid beam-forming base stations.

Dr. Tomaki (TDK Corp.) presented examples of band pass filters at millimeter-wave band utilizing LTCC technologies, and application examples of antenna filters.

Dr. Baba (Analog Devices) presented examples of millimeter wave base station utilizing DAC/ADC and up/down converters, and he demonstrated beam-forming performance using the devices.

In this workshop, important device progress was reported in every presentation for the future utilization of high frequency bands. In addition, presenters and audiences had active discussion in the presentations. This workshop was very meaningful in the aspect of letting known the activities of URSI-C widely.





– The 7<sup>th</sup> scientific workshop of the 24<sup>th</sup> URSI-C in Japan –

Session title: "Semiconductor device technologies supporting high-speed big-capacity radio communications beyond 5G"

Convener: Prof. Taiichi Otsuji (Tohoku University)

Date/time: 13:30—17:25, December 6th, 2019

Venue: Room No. 23, EE-Bldg. 1F, Faculty of Eng., Koorimoto Campus,  
Kagoshima University, Kagoshima, Kagoshima pref.

Registration fee: Free

Listed attendees: 20 persons

Technical arrangement: Prof. Taiichi Otsuji (Tohoku University)

Local arrangement: Prof. Kenjiro Nishikawa (Kagoshima University)

Presentations:

- 13:45 - 13:55 Opening Remarks  
Prof. Makoto Taromaru, Chair, Commission C of URSI-JNC (Fukuoka University)
- 13:55 - 14:45 "Advances and future trends in 5G mobile communications systems"  
Prof. Fumiyuki Adachi (Tohoku University)
- 14:45 - 15:35 "Study on phase noise reduction in CMOS oscillators for use in 5G"  
Dr. Adel Barakat (Kyushu University)
- 15:35 - 15:45 Coffee Break (10 min.)
- 15:45 - 16:35 "Planar-antenna-integrated high-power-added-efficiency push-pull amplifier for 5G mobile communications systems"  
Prof. Takeshi Kuboki (Kyushu University)
- 16:35 - 17:25 "Control of THz waves by using semiconductor optical devices towards high-speed large-capacity wireless communications"  
Dr. Kazutoshi Kato (Kyushu University)
- 17:25 Closing

Reception

It was held from 18:30 to 20:30 at Juan, Kurobagoshima-Chuo Ten, Kagoshima city, Kagoshima pref. The number of attendees was 20 persons.

The Steering committee meeting:

It took place from 13:00 to 13:25 on December 6th, 2018, at Room No. 23, EE-Bldg. 1F, Faculty of Eng., Koorimoto Campus, Kagoshima University.



### Concluding Remarks

As mobile radio communication technology is increasing in speed and capacity, 5G releases are approaching next year, and research and development of the next generation beyond 5G or 6G are also emerging. This workshop focused on semiconductor device technology that supports high-speed, high-capacity wireless communications of and beyond 5G, attracting 20 attendees. Four leading researchers working at the forefront of a series of fields ranging from devices to circuits and systems presented the state-of-the-art technology and ideas. They stimulated deep discussions among attendees, helping deepen a common understanding of future prospects.

Dr. Fumiyuki Adachi (Tohoku Univ.) explained the technology roadmap up to and beyond the 5th generation (5G) mobile communication system. Efforts have been made to improve spectrum utilization efficiency up to 4G but improving energy utilization efficiency (Whr/bit) is also an important issue after 5G. Distributed MIMO radio is expected as a breakthrough. The impact and R&D issues beyond 5G-6G toward further advancement were addressed.

Dr. Baccarat Adele (Kyushu Univ.) gave a presentation on the latest achievements regarding 5G CMOS oscillators, specifically Ku-to-K band CMOS-VCO (Voltage Controlled Oscillator) phase noise reduction technology. By introducing LC series resonance on the low or high frequency side of the oscillation band, he proposed that the Q value of the oscillation band and the suppression ratio can be improved simultaneously. And in the 25 GHz band, low power consumption equivalent to the conventional one and low transport noise exceeding the conventional performance in a wide specific band have been realized.

Dr. Takeshi Kuboki (Kyushu Univ.) gave a presentation on the latest achievements regarding a planar antenna integrated high-efficiency push-pull amplifier for 5G radio. First, 5 GHz band high-efficiency planar slot antenna integrated CMOS push-pull power amplifier. Secondly, as a 300 GHz band integrated planar antenna technology for post 5G systems, impedance matching other than 50 ohms for amplifiers on board was proposed. By improving power load efficiency, a maximum PAE of 30.9% was achieved. The superiority of independent slot antenna was discussed.

Dr. Kazutoshi Kato (Kyushu Univ.) gave a presentation on the latest achievements regarding terahertz wave control by semiconductor optical devices for high-speed and high-capacity wireless communication. Photomixing diodes capable of generating coherent millimeter and submillimeter waves by mixing two laser lights can easily achieve phase modulation in the output of the terahertz waves by controlling the phase between the two light waves, but the remaining critical issue is the phase noise of laser





light. It has been shown that the problem can be solved by arraying a novel photonic phase modulator capable of chromatic dispersion control and a photonic integration with an antenna.

In summary, this meeting was very valuable opportunity to understand and share the status of R&D and technical issues and prospects towards beyond 5G and 6G.

