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Source Coding and Transmission Technology of 4K/8K UHDTV Satellite Broadcasting

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1. Introduction

Direct satellite broadcasting service to the home was launched in Japan in 1984. Starting with test broadcasting of analog standard-definition television, it eventually shifted to the main service in 1989 and has since spread across the country, during which time it incorporated new broadcasting technologies such as high-definition television and digital broadcasting (Fig. 1). Meanwhile, NHK began research and development of Super Hi-Vision (8K) as a successor to high-definition television in 1995. 8K was internationally standardized as Ultra-High Definition Television (UHDTV) together with 4K, and it has been put to use as a next-generation broadcasting system.

The Ministry of Internal Affairs and Communications (MIC) had held the Study Group on Advanced Broadcasting Services since 2012 in order to realize next generation broadcasting services in 4K and 8K and published the "Roadmap for 4K/8K Promotion". The roadmap was revised in 2015, in which the goal was set of achieving "widespread use of 4K/8K broadcasting and the enjoyment of 4K/8K programs on commercial TV sets" by 2020, when the Tokyo Olympic and Paralympic Games were supposed to be held. Moreover, on the basis of this roadmap, satellite test broadcasts of 4K and 8K started in 2016, and commercial 4K/8K satellite broadcasting services started on December 1, 2018. Although the Tokyo 2020 Olympic and Paralympic Games have been postponed for one year due to COVID-19, the number of receivers ready for viewing 4K/8K satellite broadcasting had exceeded 6 million units by the end of October 2020, and it continues to grow steadily.

This article describes the features and technologies of information coding and transmission of 4K/8K UHDTV satellite broadcasting.

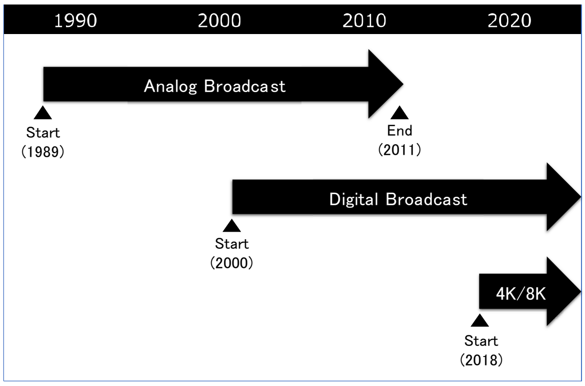

Fig. 1 History of Satellite Broadcasting (BS) in Japan.

2. Features of 4K/8K UHDTV Satellite Broadcasting

2.1 Video System

The 4K/8K satellite broadcast video system conforms to International Telecommunication Union Radiocommunication Sector (ITU-R) Recommendation's BT.2020 [1] and BT.2100 [2], which are high-quality video formats aiming to provide higher quality service than is possible with the current digital high-definition television broadcasting. These standards specify 4K video with 3840x2160 pixels and 8K video with 7680x4320 pixels. Whereas BT.2020 is capable of representing the same dynamic range as conventional video systems (i.e., standard dynamic range, or SDR), BT.2100 is capable of representing a wider dynamic range (i.e., high dynamic range, or HDR). The 4K and 8K video systems are both called UHDTV as opposed to HDTV. Although UHDTV tends to be thought of as being just a higher resolution version of HDTV, it is a progressive format that presents 59.94 (60P) or 119.88 (120P) frames per second, as well as high-resolution images. In addition, it enables new forms of video expression through its adoption of HDR and wide color gamut (WCG) that can reproduce virtually all of what can be seen by the naked eye.

Here, HDR and WCG are explained. HDR is a technology that widens the range of brightness that can be expressed in an image; it can display the range of dark to bright areas in images with unprecedented accuracy. For example, in conventional video systems, when shooting a person against the sun, the person is often blacked out when the amount of light that enters an image sensor is reduced to capture a clear background, whereas the background is often overexposed when the aperture is opened to capture the face of the person. This phenomenon is caused by the fact that the range of brightness of the subject (dynamic range) is wider the range of brightness that can be expressed. When one of the subjects is shot clearly, the other results in exceeding the expressible range. HDR

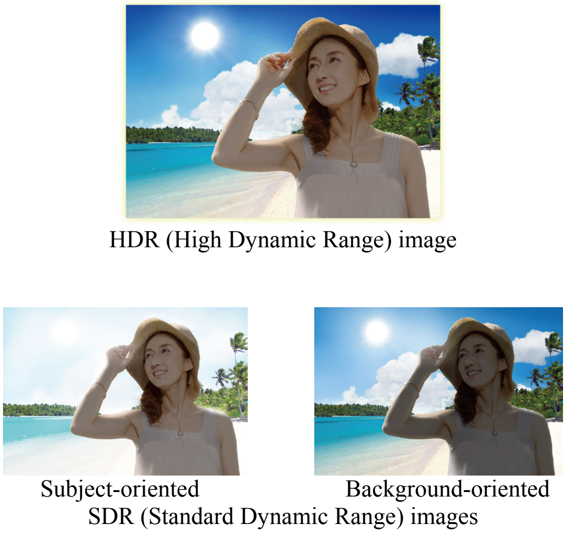

Fig. 2 Differences between SDR and HDR expression.

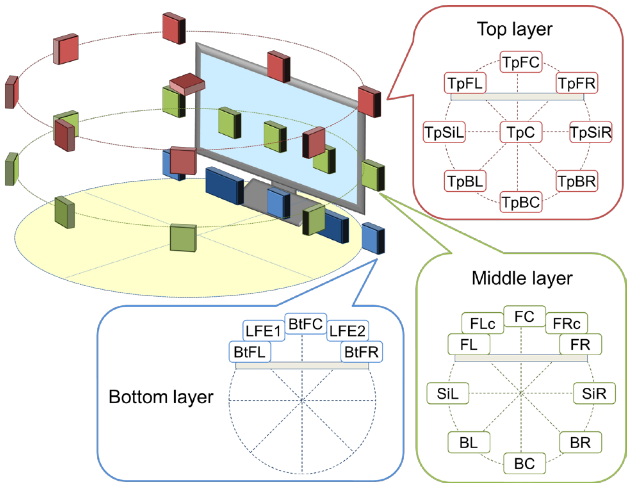

Fig. 3 Channel Arrangement and Channel Labeling for 22.2ch Sound.

can clearly represent the background and the subject at the same time (Fig. 2).

Wide color gamut, or WCG, is an extended range of color expression that enables reproduction of colors that can not be reproduced by a conventional video system. The result is color reproduction as close as possible (99.9% coverage of the object colors versus 74.4% on HDTV). In other words, HDR and WCG are expected to reproduce wide range of brightness and vivid colors that cannot be expressed by conventional video systems and to enable new forms of video expression. To achieve this, the video signal is extended to 12 bits, as opposed to the maximum bit depth of 10 bits for the conventional high-definition television signal.

The features of the new video format have been incorporated not only in UHDTV but also in the existing HDTV service. The multi-channel HDTV service can be offered as a low-layer service, to alleviate viewing difficulties caused by low received signal levels during rainfall. Since some HDTV programs are already produced in progressive mode and content down-converted from UHDTV to HDTV is expected to be broadcasted, progressive HDR and/or WCG HDTV services can also be provided.

2.2 Sound System

The 4K/8K UHDTV satellite broadcasting system has a 22.2 multi-channel sound system (22.2ch sound system). This is a high-presence sound system capable of providing audio services at a quality level beyond that of current digital HDTV broadcasting. The 22.2ch sound system is the largest among the three-dimensional sound systems specified in ITU-R recommendation BS.2051-1 [3], and it can reproduce a natural and high-quality three-dimensional sound field. The channel layout, shown in Fig. 3, consists of 24 channels arranged in three dimensions: 9 channels in the upper layer above the listening position, 10 channels in the middle layer corresponding to the height of the listener's ears, 3 channels in the lower layer below the listening position, and 2 low frequency effects (LFE) channels. The sound image can be localized anywhere on the screen, and sounds coming from all directions around the listening position can be reproduced. The system is capable of representing a natural, high-quality three-dimensional sound field and provides a high-quality acoustic experience, therefore it has been adopted for 4K/8K UHDTV satellite broadcasting.

3. Information Source Coding Technology [4]

3.1 Video Coding

Since the amount of data in a UHDTV signal is ten times that of an HDTV signal, due to not only the larger number of pixels, but also the faster frame rate and higher bit depth, highly efficient data compression techniques are required to transmit it. Here, it was decided to adopt the ISO/IEC 23008-2|ITU-T recommendation H.265 High Efficiency Video Coding (HEVC) [5][6], which is the latest international standard system for video coding. HEVC was standardized by ISO/IEC and ITU-T, which are international standardization organizations. HEVC was developed by the Joint Collaborative Team on Video Coding (JCT-VC), established by ISO/IEC JTC1/SC29/WG 11 (more commonly known as MPEG: Moving Picture Experts Group) and SG16/WP3/Q.6 (known as VCEG: Video Coding Experts Group) as a successor to MPEG-2 and MPEG-4 AVC|H.264 (AVC). It consists of block decomposition, prediction, orthogonal transformation of predicted residual signals, quantization, loop filter, and entropy coding, as well as conventional coding methods. One of the major differences between HEVC and existing coding schemes is that it has been developed in consideration of UHDTV from the beginning of the standardization. Especially for high resolution video, the coding block

Table 1 Comparison of Major Encoding Tools in Broadcasting.

	MPEG-2	AVC	HEVC
Encoding Block Size	16 x 16	16 x 16	64 x 64 to 8 x 8
Orthogonal Conversion	real number precision DCT (8 x 8)	integer precision DCT (8 × 8, 4 × 4)	integer precision DCT, DST and transform skipping (32 x 32 to 4 x 4)
In-screen Prediction	none	DC prediction + up to 9 directions	DC prediction + up to 33 directions + planar prediction
Motion Compensation Prediction	no vector prediction	median MV projection from adjacent blocks	optimal MV prediction from adjacent blocks + merge
In-loop Filter	none	deblocking filter	deblocking filter + SAO
Entropy Encoding	2D-VLC	CAVLC or CABAC	CABAC
HDR/WCG	×	×	○
Time-scalable Function	none	none	available

Table 2 Summary of the Video Coding specification.

Video Format	Spatial Resolution		1,920 × 1,080		3,480 × 2,160		7,680 × 4,320	
	Temporal Resolution		60/I	60/P	60/P	120/P	60/P	120/P
	SDR	Bit Depth	8.10 bit		10.12 bit			
		Colorimetry/Transfer Function	Rec. ITU-R BT.709, xvYCC		Rec. ITU-R BT.2020			
	HDR	Bit Depth	10 bit					
		Colorimetry	Rec. ITU-R BT.2020					
		Transfer Function	ARIB STD-B32. SMPTE ST-2084					
Encoding			ISO/IEC 23008-2 |Rec. ITU-T H.265 （HEVC）					
Profile	SDR		Main, Main10		Main10			
	HDR		Main10					
Tier			Main					
Level			4.1		5.1	5.2	6.1	6.2

size (macro block in MPEG-2 and AVC), which had been fixed in conventional coding schemes, was extended to allow the selection of variable coding blocks of up to 64x64. HEVC supports time scalability as a standard feature, so when 120P broadcasts become available in the future, it will remain backward compatible with 60P receivers. Because HEVC supports HDR and WCG and has many features such as 10-bit signal coding, it was selected as the coding for 4K/8K UHDTV satellite broadcasting. Table 1 shows the differences between MPEG-2, AVC, and HEVC coding tools used in HDTV digital broadcasting.

The Association of Radio Industries and Businesses (ARIB) is dedicated to studying standardization in the field of communication and broadcasting in Japan. ARIB has released ARIB STD-B32, which specifies the video format, coding levels, profiles, and restrictions on coding for 4K/8K UHDTV satellite broadcasting [7]. Table 2 is a summary of video coding specification.

Table 3 Summary of Audio Coding specification.

Sampling Frequency	48 kHz
Input Quantization Bits	16 bits or more
Maximum Number of Input Channels	22.2ch
Coding Method	MPEG-4 AAC, MPEG-4 ALS

3.2 Audio Coding

The MPEG-4 AAC LC (Advanced Audio Coding Low Complexity) profile was adopted as a new broadcasting coding format for transmitting audio data increased to a maximum of 22.2 channels. MPEG-4 AAC did not initially support 22.2 channels, so an extended technology was standardized to implement coding for each channel by combining SCE (Single Channel Element: compression coding for a single channel), CPE (Channel Pair Element: compression coding that treats two channels as a pair) and LFE

Table 4 Technical Specifications of ISDB-S3 (for UHDTV) and ISDB-S (for HDTV).

Standard	ISDB-S3	ISDB-S
Modulation Scheme	16APSK	TC8PSK
Bandwidth (99% Energy)	34.5 MHz	34.5 MHz
Symbol Rate	33.7561 Mbaud	28.86 Mbaud
Roll-off Rate	0.03	0.35
FEC	Outer FEC : BCH Inner FEC : LDPC (Coding Rate 7/9)	Outer FEC : Reed Solomon Inner FEC : Convolution (Coding Rate 2/3)
Transmission and Control Signal	TMCC signal （π/2shift BPSK）	TMCC signal （BPSK）
Information Rate per Transponder	99.9552 Mbps	52.17 Mbps
Multiplexing System	MMT･TLV	MPEG-2 TS

(LFE Element: compression coding for LFE channel), and it was decided to broadcast in accordance with this extended standard. In addition, by using MPEG-4 ALS (ALS stands for Audio Lossless), which enables lossless coding, it is possible to realize a distortion-free audio service. The summary of audio coding specification is shown in Table 3.

4. Satellite Broadcasting Technology

4.1 Transmission System

Integrated Services Digital Broadcasting - Satellite (ISDB-S) [8,9] has been used for many years as a transmission system for BS and 110-degree east longitude CS satellite broadcasting in Japan. It has many features, such as broadcasting two to three HDTV programs on a single satellite transponder, mixing high-definition and standard-definition programs, transmitting various types of data broadcasting by using Electronic Program Guide (EPG) or Broadcast Markup Language (BML), enabling multiple operators to independently provide services over a single satellite transponder, having a hierarchical transmission scheme to reduce service interruptions due to rain fade events, and notifying receivers of transmission parameters and program multiplexing configuration information by always sending transmission and multiplexing configuration control (TMCC) signals. However, the maximum rate of information that can be transmitted in a single transponder with ISDB-S is about 52 Mbps, and it is not possible to transmit high-capacity video services such as 8K. Therefore, a new broadcasting system, called the Advanced Broadband Satellite Digital Broadcasting System (ISDB-S3) [10,11], has been developed for transmitting such services. Table 4 shows the main technical specifications of ISDB-S3 (for UHDTV) and ISDB-S (for HDTV).

ISDB-S3 has the following features in addition to the ones of ISDB-S.

(1) It enables a single 8K program or three 4K programs to be broadcast over a single satellite transponder.
(2) By adopting the MPEG Media Transport (MMT) and Type Length Value (TLV) multiplexing method, integrated broadcasting and communication services can be flexibly provided.
(3) Introduction of a pilot signal enables optimal error correction and decoding even under the influence of the nonlinear characteristics of the satellite.

Regarding feature (1) above, a roll-off ratio of 0.03 (0.35 for ISDB-S) is adopted for the roll-off filter, which limits the bandwidth of the modulation signal during transmission, to make the spectral waveform of the modulation signal closer to a rectangle. The symbol rate can be increased to 33.7561 Mbaud while satisfying the bandwidth of 34.5 MHz per satellite transponder required by the Radio Regulation. This improves the frequency utilization efficiency by about 17% compared with the ISDB-S symbol rate of 28.86 Mbaud. The required carrier-to-noise (C/N) ratio, which is the minimum ratio of signal power to noise that can be transmitted error-free, is improved by employing amplitude phase shift keying (APSK) that optimizes the distance between modulation signal points of different amplitudes, and by employing low-density parity check (LDPC) code that has a strong error correction capability. The combination of modulation method 16APSK and error correction coding ratio 7/9 enable a broadcasting satellite to transmit an 8K program taking up a transmission capacity of about 100 Mbps through a single transponder to a standard parabolic antenna with a 45-cm diameter while ensuring a service time of 99.5% in

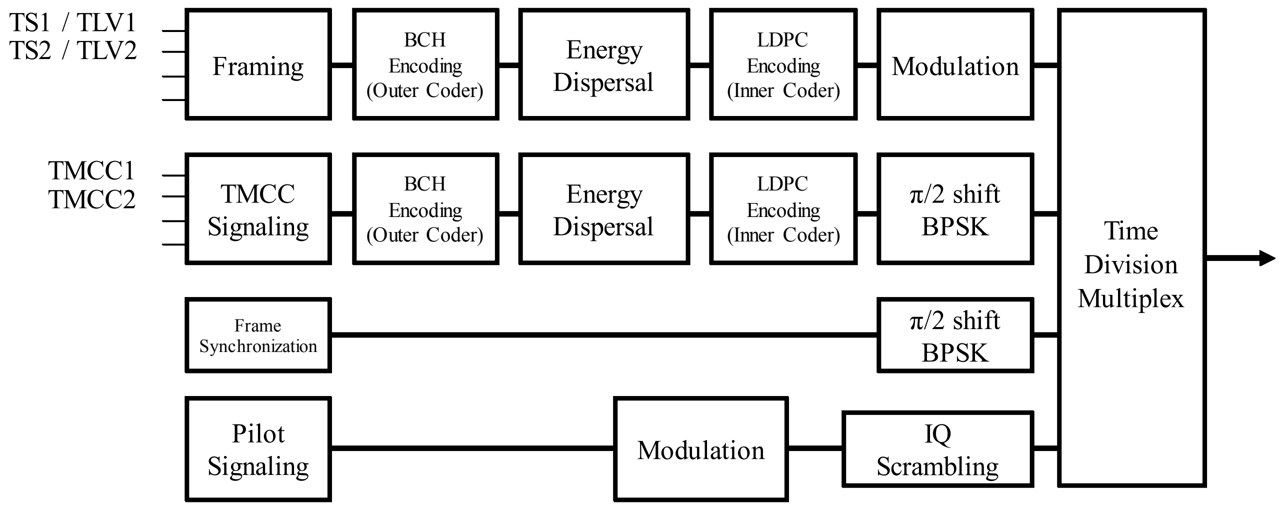

Fig. 4 Block Diagram of ISDB-S3.

the worst month (the month with the highest rainfall throughout the year) in Tokyo.

In ISDB-S3, a $\pi/2$ shift BPSK signal is periodically and intermittently inserted in the modulated signal to ensure stable synchronization even when the received C/N is less than 0 dB. In addition, the TMCC signal can be used as a synchronous reinforcement signal by transmitting the same $\pi/2$ shift BPSK signal as the transmission control signal.

ISDB-S3 supports hierarchical transmission using time division multiplexed combinations of modulations, for stable broadcasting services even during rainfall. By multiplexing part of the transmitted signal with a low C/N modulation scheme such as QPSK, it is possible to reduce the number of broadcast service interruptions during rain fade events.

Regarding feature (2), in addition to the conventional MPEG-2 TS multiplexing, ISDB-S3 supports MMT and TLV multiplexing, which enables transmission of variable-length data. MMT allows signals to be transmitted through multiple transmission channels, such as through broadcasting and communications together, and synchronized using common time information. This feature will enable the realization of advanced joint broadcasting and communications services. The encoded UHDTV and multi-channel audio components are packetized in MMT packets and transmitted in IP packets, and then multiplexed in TLV packet format. In ISDB-S3, as the positions of the first and last bytes of variable length packets are indicated in the TMCC signal as pointer information, the location of multiple variable-length packets in a transmitted frame can be identified.

Regarding feature (3), the effect of the nonlinear characteristics of the traveling wave tube amplifier (TWTA) of the satellite transponder is compensated for by introducing a pilot signal that periodically and intermittently transmits known signal points with the same modulation scheme as that of the main signal. Even if nonlinear distortion occurs in the transponder, the deviation from the ideal signal point caused by it can be measured by averaging this known signal at the receiver. This value is used in the log-likelihood ratio calculation for LDPC decoding of the error correction codes; i.e., it enables optimal LDPC decoding even in the case of nonlinear distortion.

Figure 4 shows the block diagram of ISDB-S3. ISDB-S3 was standardized by ARIB as a domestic satellite broadcasting system in 2014, and it was internationally standardized by ITU-R as Recommendation BO.2098 in December 2016 [12].

4.2 Reception Technology

Satellite broadcasting over BS and 110-degree east longitude CS uses circularly polarized radio waves, in which the electromagnetic field of the wave rotates with time. The 4K/8K UHDTV satellite broadcasting newly uses left-handed circularly polarized (LHCP) waves in addition to the right-handed circularly polarized (RHCP) waves that have been conventionally used (Fig. 5). LHCP and RHCP waves can be handled

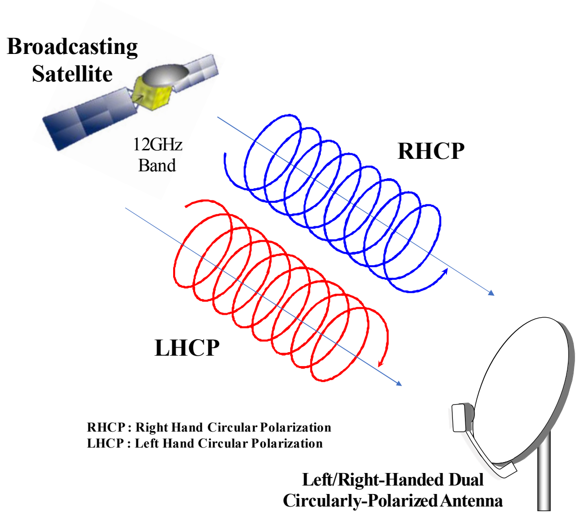

Fig. 5 LHCP and RHCP Waves.

independently of each other and are transmitted in the same frequency band. In order to receive both waves, a receiving antenna system capable of picking up RHCP and LHCP waves is required.

12-GHz signals received from the broadcast satellites are converted to intermediate frequency (IF) signals by the receiving antenna's low noise block converter (LNB). The conventional RHCP waves of the BS and 110-degree CS have IF frequencies between 1.0 GHz and 2.1 GHz, while the LHCP waves have ones between 2.2 GHz and 3.2 GHz. Therefore, to receive 4K/8K UHDTV satellite broadcasting, it is necessary to prepare a reception system with a parabolic antenna for both RHCP and LHCP waves, as well as amplifiers, splitters and distribution equipment corresponding to the IF band from 1.0 GHz to 3.2 GHz.

The IF band between 2.2 GHz and 3.2 GHz for LHCP wave is the same frequency band as the general-purpose ISM band that is used by low-power data transmission systems, satellite telephones, broadband wireless access (BWA), etc., so these waves affect the radio waves emitted by wireless LAN and microwave ovens. In case of improper installation of the satellite broadcasting receiver system, there is a possibility of interference with all systems using the same frequency as the IF frequency band; for this reason, power leakage from the receiver system should be less than or equal to -49.1 dBm (46.2 dBμV/m or less at 3m distance) / 33.7561 MHz, which is regulated by the Ordinance Regulating Radio Equipment. The MIC has compiled guidelines to be followed in the implementation of television reception facilities for satellite broadcasting [13].

5. Conclusion

The world’s first 4K/8K UHDTV satellite broadcasting began in 2018 in Japan, and a number of ultra-high definition programs have continued to be broadcast on many channels since then. In 2021, the year of the Tokyo Olympic and Paralympic Games, it is expected that many people will have UHDTV TVs on which they can enjoy the broadcasts of the events with highly realistic images and sound. 4K/8K UHDTV broadcast services will become more widespread in the future.

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Development of Automotive Millimeter Wave Radars

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1. Introduction

In recent years, many safety systems have been implemented in vehicles, such as adaptive cruise control, autonomous emergency braking, and blind spot monitoring. In the future, safety systems are expected to be able to perform the advanced functions necessary for autonomous mobility. To achieve these functions, various sensors are used to accurately perceive the environment around the vehicle. Several types of perception sensors are installed on vehicles, such as radars, cameras, lidars, and sonars. Compared with the other sensors, millimeter wave radars have the following advantages:

- a detection distance of 150 m or more can be easily achieved;
- the relative velocity of the target can be directly detected;
- they are not affected by sunlight;
- their permeability to rain and fog is high.

Owing to these features, millimeter wave radars are now installed on many cars, as they can accurately detect the location and movement of vehicles at a distance. Compared with those for aircraft and ships, automotive radars are required to detect relatively short distances with high accuracy. In addition, many innovations have been introduced to reduce the size and cost of these radars. In this work, the technical development of automotive millimeter wave radars is described, including the technical challenges required for such developments, the difficulties encountered from prototype design to product commercialization, and the future evolution of the technology.

2. Technology of Automotive Radars

2.1 Distance and Relative Velocity Detection

Many methods exist for distance and relative velocity detection; among these, the pulse method and frequency-modulated continuous wave (FMCW) method are widely used. The pulse method transmits pulsed radio waves and measures the time it takes for the reflected waves to return from an object. The FMCW method transmits a radio wave whose frequency varies with time and makes a beat signal by mixing of the transmitted and reflected wave signals (Fig. 1). For example, when the distance from the object is 5 m, the round-trip time of the radio wave is approximately 33 ns. In the pulse method, a fast counter is needed to directly measure this short time. The FMCW method detects the frequency of the beat signal generated using the frequency difference between the transmitted and received signals. Thus, this method is relatively easy to implement.

In the FMCW method, two types of linear frequency modulation signals, namely, a signal with increasing frequency and a signal with decreasing frequency are alternately transmitted. Here, these signals are called rising slope and falling slope, respectively. From the transmitted wave and reflected wave from the object, beat signals of frequencies f_{up} and f_{dn} are obtained at each slope (Fig. 2). The frequencies f_{up} and f_{dn} are the sum or difference between the frequency difference f_r caused by the propagation delay and the frequency shift f_d caused by the Doppler effect (Doppler frequency). Thus, they are expressed as:

$$f_{up} = f_r - f_d, \tag{1}$$

$$f_{dn} = f_r + f_d. \tag{2}$$

Here, f_r and f_d can be calculated from the following two equations:

$$f_r = (f_{dn} + f_{up})/2, \tag{3}$$

$$f_d = (f_{dn} - f_{up})/2. \tag{4}$$

Since f_r is proportional to the distance from the object and f_d is proportional to the relative velocity of the object, with the FMCW method it is possible to measure the distance and the relative velocity simultaneously. In the case that the relative velocity of the object is zero, both f_{up} and f_{dn} become the frequency f_r (they have different signs mathematically).

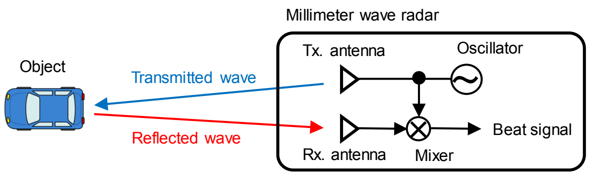

Fig. 1 Basic configuration of the FMCW method.

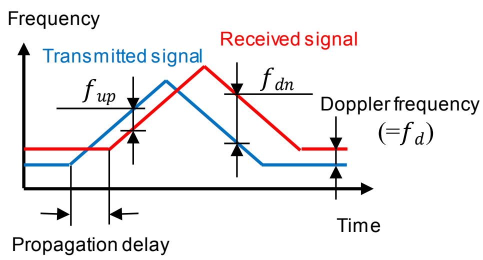

Fig. 2 Frequency of the beat signal that is obtained via the FMCW method.

2.2 Beam Scanning

Several different methods of beam scanning are used to detect the direction of an object. Receiving antenna systems are of three types: (i) mechanical scanning (Fig. 3), which is steered by mechanically deflecting the receiving antenna; (ii) lens beam scanning (Fig. 4), which uses lenses to switch multiple receiving antennas at different positions; (iii) electronic scanning (Fig. 5), which synthesizes the signals of multiple receiving antennas by shifting the phases using either hardware or software. Among these, the main advantages of the electronic scanning method consist in the fact that it has no driving mechanism and does not require a lens. However, the performance will be degraded if multiple antennas cannot receive the amplitude and phase accurately. This is a technical challenge for millimeter waves with a wavelength of approximately 4 mm. This work focuses on the possibility of achieving future miniaturization and cost reduction, as well as reliability and quietness, and thus challenges the development of electronic scanning with digital beamforming (DBF), which has not yet been achieved by other companies in the automotive millimeter wave radar field.

In DBF, a time difference exists to reach multiple receiving antennas depending on the angle of arrival θ of the reflected wave. The time difference is measured as the phase difference of the received signal. The angle is detected by adjusting the phase with a phase shifter, so that the amplitude of the combined output is maximized. A relationship exists between the phase difference φ and the angle of arrival θ between adjacent receiving antennas. θ can be calculated according to:

$$\theta = \sin^{-1}(\varphi\lambda/2\pi d). \quad (5)$$

The signal output from each antenna is digitized via an A/D converter and synthesized using signal processing to detect the angle.

Since there are signs, guardrails, etc., as well as vehicles on the road, multiple objects can exist at approximately the same distance. In equation (5), the calculation is not possible when multiple reflection waves return. However, all the angles can be calculated correctly by measuring the amplitude and phase of each receiving signal with multiple receiving antennas and by solving the simultaneous equations.

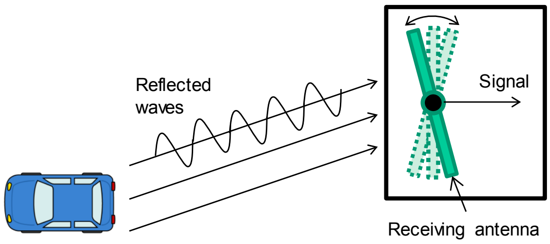

Fig. 3 Mechanical scanning.

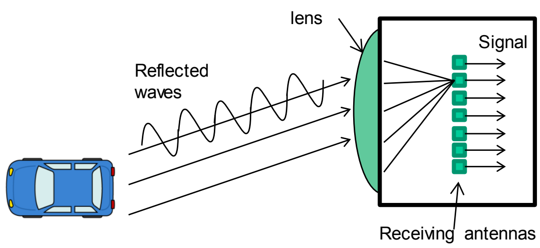

Fig. 4 Lens beam scanning.

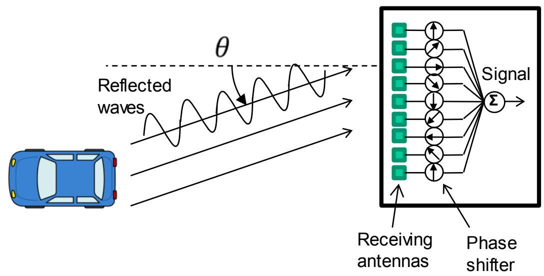

Fig. 5 Electronic scanning (beamforming).

3. Technical Development and Commercialization of Automotive Millimeter Wave Radars

3.1 Prototyping and Improvement of the Radar

We have been developing technologies to realize millimeter wave radars since the 1990s. At that time, DENSO and Toyota Central R&D Labs. (TCRDL) were working on their own prototypes. Fig. 6 shows the external appearance of the millimeter wave radar prototype developed by DENSO. This radar uses a DBF electronic scanning with nine channels of slot arrays arranged horizontally as the receiving antenna. A cylindrical lens is mounted in front of the receiving antenna to focus the beam in the vertical plane. Figure. 7 shows the detection results for the arrival angle using this prototype, with the target placed at angles of −5°, 0°, and +5°. It can be seen that the peak angle and directivity pattern agree well with the simulations, and the expected results were thus obtained.

Further, the appearance and configuration of the radar prototype developed by TCRDL are shown in Figs. 8 and 9, respectively [1,2]. To simplify the configuration and reduce the cost, a method for switching between three transmitting antennas and three receiving antennas with a single transmitter and receiver was attempted. By

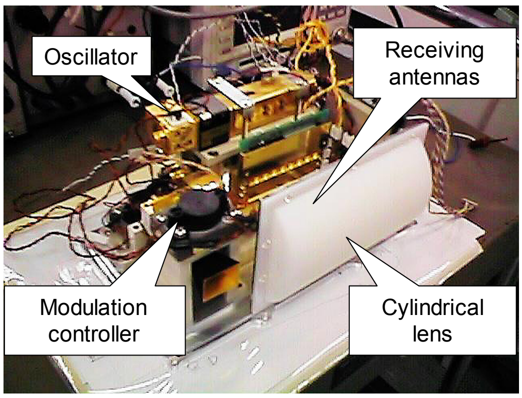

Fig. 6 Radar prototype (DENSO).

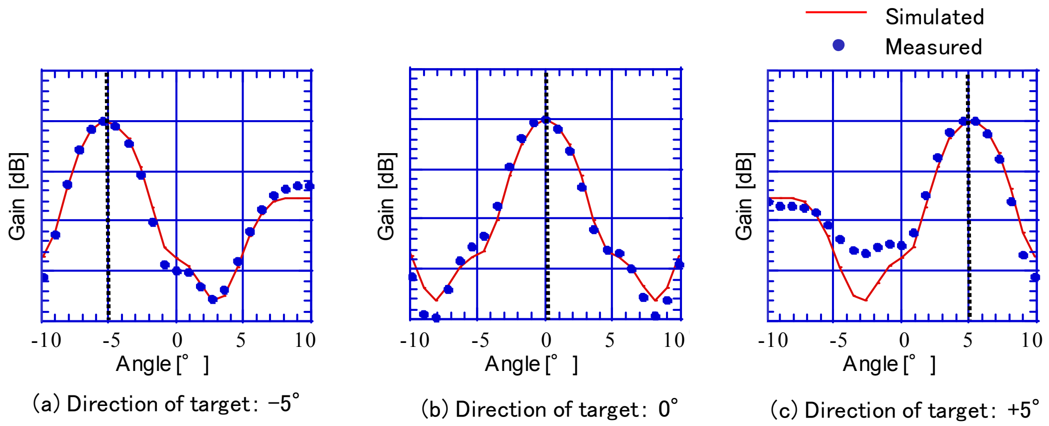

Fig. 7 Detection results of the arrival angle via the prototype.

setting the interval of the transmitting antennas to three times the interval of the receiving antennas and switching the antennas in a time-division manner, nine channels of the signal can be received. This reduces the number of channels and the number of switches by using only two three-channel switches. Both prototypes had dimensions of 20 × 30 cm^2, thus being very large to be installed on a vehicle. However, they enabled us to obtain the basic technology through various tests.

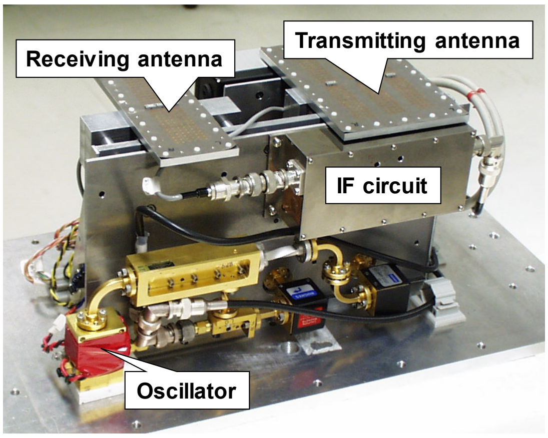

Fig. 8 Radar prototype (TCRDL).

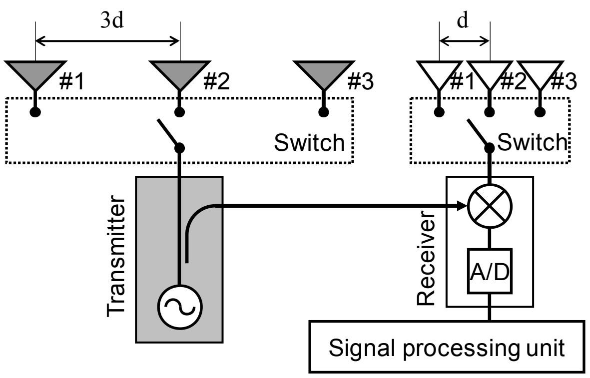

Fig. 9 Configuration of the radar prototype (TCRDL).

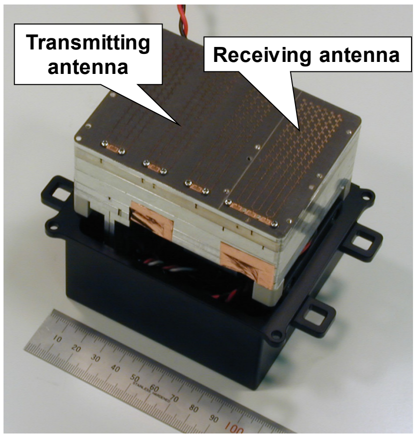

Fig. 10 Radar prototype in ca. 2000.

To further accelerate the research, DENSO and TCRDL decided to bring their technologies together and redesigned the antenna and circuits to realize a smaller radar. This attempt was successful at reducing the width to approximately 10 cm, in ca. 2000 (Fig. 10).

3.2 Important Technology

In DBF, when the phase difference of the received signal between adjacent antennas exceeds 2π, grating lobes are generated. Thus, the object's direction cannot be uniquely determined. To avoid ambiguity, the spacing between the receiving antennas was designed in such a way that the phase difference did not exceed 2π within the field of view (FoV) of the radar. In addition, the sensitivity was suppressed so that the reflected wave arriving from outside the FoV was not received by suppressing the side lobes.

Another challenge is to realize signal processing for stable object detection. The received signal of the radar varies in a complex manner, owing to not only various reflected waves generated by the objects on the road but also the reflections from the road surface and side walls. These depend on the type of object and its aspect angle. In particular, the signal intensity of millimeter wave radars fluctuates greatly because of the short wavelength. The multiple reflections generated simultaneously affect the accuracy of angle detection. Since radio waves are invisible, it is not easy to know the reflection points and each of the reflection intensity. Therefore, a method was established to measure the distribution of reflection intensity from an object with high resolution. This was achieved by measuring the received signal while moving the position of the radar and applying the synthetic aperture technology [3]. An example of the distribution of reflection intensity measured from the rear of a vehicle at different aspect angles is shown in Fig. 11. This method was used to measure vehicles and objects on the road under various conditions. Furthermore, a simulator was constructed to predict the detection results from the data during driving. This simulator was used for radar design and signal processing improvements.

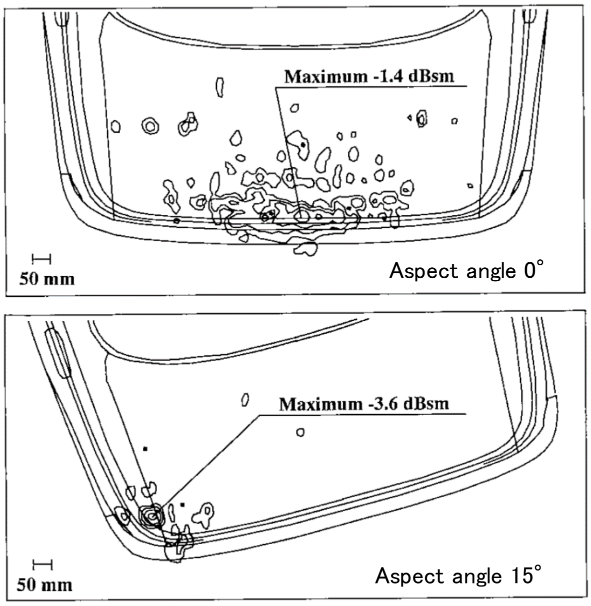

Fig. 11 Distribution of reflection intensity at the rear of the vehicle (top view).

3.3 Commercialization of Automotive Millimeter Wave Radars

After continuing to study prototypes, in 2003 DENSO finally commercialized the world's first automotive millimeter wave radar with electronic scanning using DBF. The appearance of the commercialized radar and its specifications are shown Fig. 12 and Table 1, respectively. A high-sensitivity triplate-type slot antenna was used. The antenna, the millimeter wave module, and the signal processing board are stacked on top of each other to reach an overall thickness of 60 mm. The beat signal is acquired in a time-division manner, while switching between multiple receiving antennas, is digitized via an A/D converter, and is finally imported into the signal processor (Fig. 13). The flowchart of the signal processing is shown in Fig. 14. The beat signals

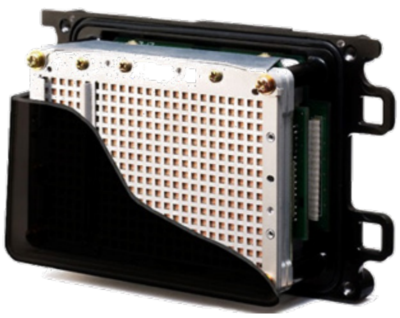

Fig. 12 Commercialized millimeter wave radar.

Table 1 Specifications of the radar (2003).

Parameter	Value
Maximum Distance	150 m
Relative Velocity	-200 ～ 100 km/h
Azimuth Angle Range	-10° ～ 10°
Processing Cycle Time	100 ms
Operating Frequency	76 ～ 77 GHz
Modulation Principle	FMCW
Beam Scanning	Electronic Scanning (DBF)
Average Output Power	2 mW

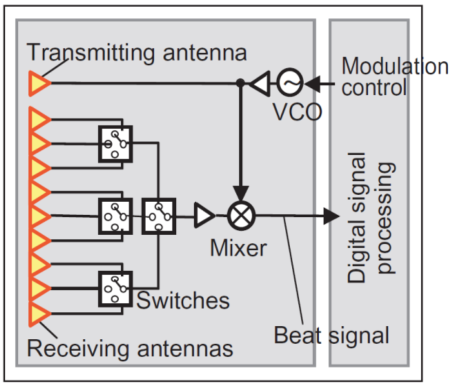

Fig. 13 Block diagram of the radar [4].

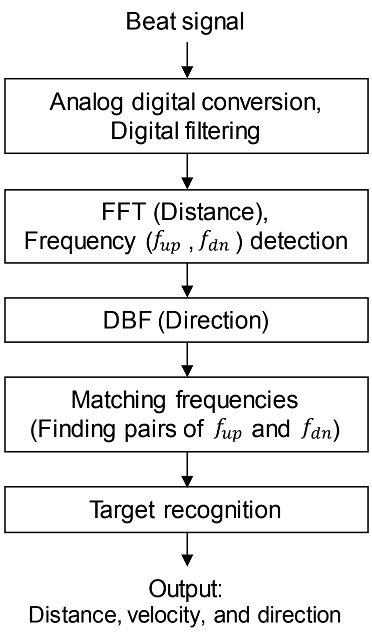

Fig. 14 Signal processing flowchart.

are obtained via multiple receiving antennas. The frequency of the beat signal is detected via Fourier transformations. In addition, beamforming is used to realize electronic scanning and calculate the angle of arrival. This radar calculates the distance, relative velocity, and direction of an object based on the information of the frequency of the beat signal and the angle. A PCS (Pre-Crash Safety) system using this radar has been developed by Toyota Motor Corporation. This was also a world's first.

4. Evolution of Automotive Millimeter Wave Radars

Research and development of the radar technology has continued even after the first commercialization of radar systems.

4.1 Improvement of the Angle Detection Method [4]

Although DBF is capable of high-speed calculation, its low resolution renders it difficult to distinguish between multiple objects in close proximity. To overcome this shortcoming, the well-known high-resolution signal processing technique, MUSIC [5], was applied. Fig. 15 compares the results of MUSIC detection and DBF detection of vehicles traveling beside guardrails. The result shows that, even in situations where it is difficult for DBF to distinguish between vehicle and guardrail, MUSIC can detect them separately. Although reducing the time required to perform complex calculations has been a technical challenge, this has been here achieved by not only improving the performance of the processing unit, but also by replacing complex number operations with real number operations. These technologies were awarded the "Arch T. Colwell Merit Award" by the Society of Automotive Engineers (SAE) in 2006 (Fig. 16).

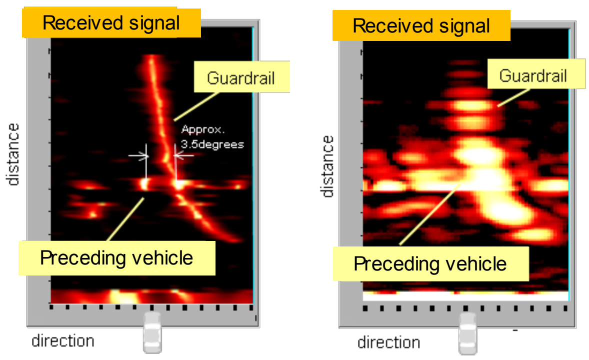

Fig. 15 High-resolution detection using MUSIC.

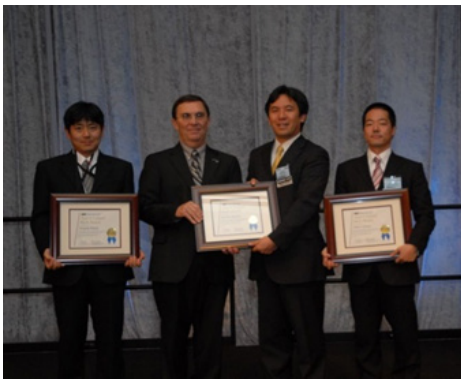
Fig. 16 Award ceremony (Author: Natsume, third from left).

4.2 Improved Distance and Relative Velocity Detection

As described above, the FMCW method calculates the distance and relative velocity of the object from the frequencies of the beat signals obtained in the rising and falling slopes. Therefore, when multiple objects are present and multiple beat signals are detected, if the distance and relative velocity are calculated from the frequencies of the beat signals generated by different objects, this will result in a false detection. Although it is possible to reduce false detections by improving the detection algorithm, a distance and relative velocity detection method has been realized using a pulse compression method. In this approach, one of the rising and falling slopes is repeated at high speed to fundamentally eliminate this false detection (Fig. 17). The distance is detected from the frequency of the beat signal, whereas the relative speed is detected from the time variation of the phases of multiple beat signals. The frequency of multiple beat signals is almost the same if they can be observed in a short period; thus, they cannot be mistaken for the beat signals of different objects. This technology was achieved by improving the performance of RF devices and signal processing equipment.

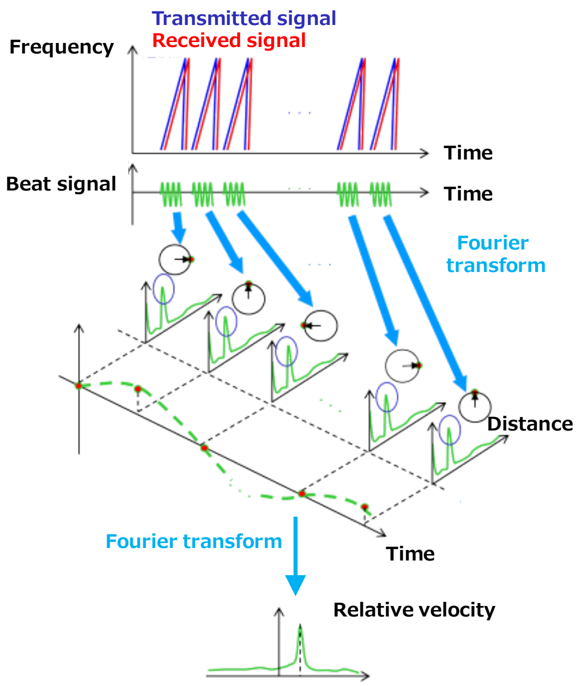

Fig. 17 Pulse compression method.

5. Conclusions

In this article, we have introduced the technical development of automotive millimeter wave radars, including the technical challenges required for such developments, the difficulties encountered from prototype design to product commercialization, and the future evolution of the technology. The needs for safety and comfort are expected to continue to increase in the future. We will continue to contribute to the realization of safe and comfortable mobility through the application of millimeter wave radars and other radio wave products.

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Report on the 2020 NS English Session Awards and Award Ceremony

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Masahiro YOSHIDA†††, Chuo University
†Chair, ††Vice Chair, †††Secretary, ††††Assistant Secretary

1. Introduction

In the 2020 IEICE General Conference that was held on March 17-20 2020, the IEICE Technical Committee on Network Systems (NS) provided the complete English Symposium Session entitled "In-Network Intelligence for Design, Management, and Control of Future Networks and Services". Due to concerns about COVID-19, the English session this year was held online via Zoom [1] on March 17. In this year, 23 papers were submitted to the English session, among which 6 papers were presented at the online conference. The submitted papers include a variety of interesting research topics related to "in-network intelligence", such as security/privacy, network virtualization technologies, Internet of Things (IoT) networks, wired/wireless networking, and machine learning [2].

The NS committee selected recipients of NS English Session Award among the 23 papers. The recipients won the award at an award ceremony and presented the progress of their awarded papers as an invited lecture at the NS technical meeting in October 2020.

2. Award Ceremony

The award ceremony was held in the NS technical meeting on October 9, 2020 online. Many participants attended the ceremony. Three distinguished papers won the NS English Session Award, and all the recipients received an award certificate and a plaque from NS technical committee chair (Fig. 1). (For the past recipients, please see our English home page. URL: http://www.ieice.org/cs/ns/eng/index.html)



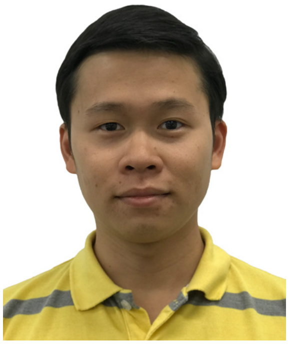
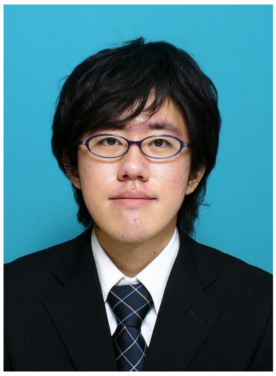

Fig. 1 English session award recipients
(Prof. Kimura: Top left [2],
Ms. Dinh: Top right [3],
Mr. Le: Bottom left [4]),
and secretary (Yoshida): Bottom right.

3. English Session Awards 2020

The abstracts of the three papers that won the 2020 NS English Session Award are as follows.

"Distributed Deployment of Unmanned Aerial Vehicle Base Stations for Maximizing Ground User QoS" [2]

Flying aerial base stations (ABSs) equipped with unmanned aerial vehicles (UAVs) are an emerging technology having the potential of significantly increasing the capacity of existing fixed networks in a more flexible and on-demand manner during temporary events, such as disaster and sports events. However, the dynamic optimization of 3D-deployment of ABSs is a significantly challenging problem due to the high degree of freedom in 3D space, the complicated air-to-ground channel characteristics, and an interference problem among multiple ABSs.

In this paper, we propose a novel distributed 3D-deployment method of ABSs that maximizes the quality of service (QoS) of ground users. In our method, each ABS dynamically updates its 3D-position by collaborating with neighboring ABSs so that the total QoS of ground users is maximized in an on-demand manner. Owing to this distributed nature and incremental updates, our method is applicable to dynamic network environments.

Since obtaining all the specific positions of ground users is computationally intensive and unrealistic in a dynamic network environment, we model the locations of users using a spatial point process. Under this model, we consider the maximization of the total expected data rate of ground users and formulate it as a distributed optimization problem. Furthermore, to solve the problem in a distributed manner, we utilize a distributed push-sum algorithm framework, in which each ABS dynamically optimizes its 3D-position considering interference among ABSs. By employing this framework, we also prove the convergence of our distributed algorithm. Simulation results demonstrate that our method can improve the overall QoS of ground users in an efficient manner, and it can be applied to a dynamic network in which the density of ground users varies temporally.

“Deep Reinforcement Learning-based User-to-Multiple Access Points Association Method for Heterogeneous Quality of Service Provision” [3]

Future wireless networks are predicted to become denser and denser owing to an increased amount of Access Points (AP) and mobile users. Moreover, Beyond 5G networks are expected to provide various applications to each user simultaneously. This raises inevitable challenges for enabling efficient wireless resource sharing while satisfying the diverse and stringent Quality of Service (QoS) constraints. In such a context, this work investigates the issue of user-to-multiple Access Points (AP) association, where a user requiring several applications may be served by several APs simultaneously. This problem is formulated as a network sum-rate maximization subject to the required QoS constraints for each user and application, and AP load constraints. To handle this problem in large-scale and dense future wireless systems, we propose a distributed association method based on deep reinforcement learning techniques, which allows each user to decide its association to multiple APs simultaneously using its locally available network information. Simulation results show that, compared to reference schemes, the proposed method enables large throughput enhancements while satisfying the QoS constraints and AP load limitations, thereby reducing user outage probabilities.

“Performance Evaluation on MAC Layer Protocol in Crash Warning Application using PC5-based Cellular-V2X mode4” [4]

Knowledge on the future traffic load in network links plays an important role in various networking problems such as traffic engineering, quality of service provisioning, etc. For estimating future traffic, Deep Learning techniques have been currently exploited and achieved much better performance compared with traditional regression-based approaches (e.g., ARIMA). However, predicting network traffic is still a challenging problem due to the complicated network behavior and the problem of missing data. Although the prediction accuracy largely depends on the amount of historical data, obtaining all the measured data at high monitoring frequency is impractical due to the monitoring resources constraints as well as the un-avoidable data loss. Thus, the existing approaches reveal poor performance regarding traffic inference when lacking historical data. In this paper, we address the prediction problem of traffic load in network links with partial monitoring information. We design a new prediction model by modifying the Diffusion Convolutional Recurrent Neural Network (DCRNN) to overcome the missing data problem. We also introduce a new graph-based structure to represent the dynamic relation among the links. Based on the proposed graph we present a novel DCRNN model that can capture the dynamic spatial relation among links to improve prediction accuracy. The experiment results show that our proposed approach achieve significantly high prediction accuracy compared to original DCRNN model.

4. Future Plans

In the 2021 IEICE General Conference, the English Session entitled “AI technologies and their applications for future network systems and services” will be held on March 9-12, 2021. Many interesting studies on “network” and “service” including “wireless” and “optical” will be presented. Please attend the IEICE General Conference and enjoy the NS English session during the four days.

5. Acknowledgement

We would like to give special thanks to Prof. Yoshiaki Tanaka for his great contributions.

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Report on the 34th Optical Communication Systems Symposium “What Optical Communication Systems will Support the Era of Communications Revolution?”


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1. Introduction

The 34th Optical Communication Systems (OCS) Symposium “What Optical Communication Systems will Support the Era of Communications Revolution?” was held online on Dec. 15–16, 2020. It was organized by the IEICE Technical Committee on OCS, in cooperation with the IEEE Photonics Society Tokyo Section Chapter, the Photonic Internet Forum (PIF), and the IEICE Technical Committee on Extremely Advanced Optical Transmission Technologies (EXAT). The coronavirus disease 2019 (COVID-19) crisis has fundamentally overturned communication styles and made online communication even more important in business and education. This year's symposium, with 20 exhibitors and more than 240 attendees, was held as an opportunity to explore the ideal state of optical communication systems in the era of communications revolution.

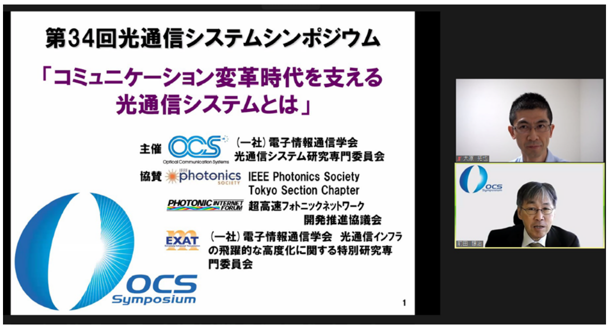

Fig. 1 Picture of online OCS symposium, from top, Mr. Takuya Ohara (Secretary of OCS), and Prof. Joji Maeda (OCS committee chair).

2. Technical Sessions

On Day 1 (Dec. 15), following the welcome address (Fig. 1) by Prof. Joji Maeda, the IEICE OCS committee chair, the symposium started with a keynote speech given by Prof. Hiroyuki Morikawa (The University of Tokyo) entitled “Digital management in the new normal era” (Fig. 2). He gave the examples of the digital transformations and introduced the important perspectives for value creation and productivity enhancement in the new normal era.

The award ceremony whose details described later was followed by an online exhibition, in which the 10 exhibitors introduced the latest optical communication devices and systems.

Fig. 2 Keynote speech by Prof. Morikawa.

After that, we had workshop entitled “Evolving communication for a new lifestyle.” It was contributed by the following four invited speakers (Fig. 3): Mr. Tatsuya Nomoto (Z-kai) describing changes in education under the COVID-19 crisis and on EdTech initiatives in the Z-kai group, Mr. Takashi Honda (Fujitsu Laboratories) presenting on gymnastics scoring support system using 3D sensing technology, Dr. Tetsushi Watanabe (MaaS Tech Japan) talking about Mobility as a Service (MaaS) and its relationship with beyond 5G, and Dr. Hidenori Sakanashi (AIST) providing recent progress on social infrastructure diagnosis and medical diagnosis technologies using machine learning. From these talks, it was afresh remined that further stable and high-speed optical communication systems will be necessary for the advanced online services such as EdTech, MaaS, and emerging applications.

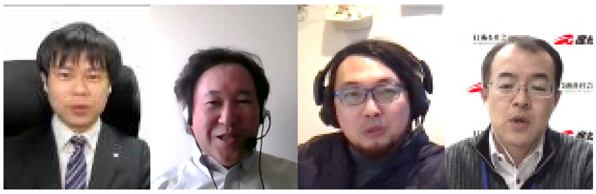

Fig. 3 The presenters of Workshop 1: from left, Mr. T. Nomoto, Mr. T. Honda, Dr. T. Watanabe, and Dr. H. Sakanashi.

There were totally 206 attendees on Day 1. Day 1 of the symposium was closed with an online get-together, where 40 people participated and free discussions on the changes in work and lifestyles under COVID-19 crisis were held.

Day 2 (Dec. 16) started with three invited talks (Fig. 4). The first invited talk was presented by Dr. Shuto Yamamoto (NTT) on “Standardization trends for Ethernet and 200G/λ class short-reach optical transmission by applying advanced digital signal processing." He described the standardization activities of Ethernet such as 400 GbE and introduced the 200 G/λ next-generation short-reach optical communication technologies using advanced digital signal processing for realization of 800 GbE/1.6 TbE. The second invited talk was given by Prof. Hidetoshi Katori (The University of Tokyo) and entitled "New space and time information infrastructure created by optical lattice clocks." He introduced the advances of optical lattice clock and its application to measurement systems. Furthermore, he described future prospects for the social implementation of optical lattice clock. Finally, Prof. Tomoyuki Miyamoto (Tokyo Institute of Technology) gave an invited talk entitled "Optical wireless power supply, its features, latest trends and future perspectives." He introduced the advantages and issues of optical wireless power transmission technologies and the research trends in power transmission systems and devices.

After that, an invited lecture, organized by the IEEE Photonics Society Tokyo Section Chapter, was given by Prof. Mitsuru Takenaka (The University of Tokyo). His lecture was entitled "Dissimilar material integrated silicon optical circuit and optical neural network application." He presented the latest research results on an III-V/Si hybrid MOS optical phase shifter for programmable optical circuit applications. He also lectured on a micro-ring resonator crossbar array technology and its application to deep learning.

Fig. 4 The presenters of invited talks and lecture: from left, Dr. S. Yamamoto, Prof. H. Katori, Prof. T. Miyamoto, and Prof. M. Takenaka.

The invited lecture was followed by an online exhibition, where the research results of five national research projects were reported

In the afternoon session, we had another workshop entitled "Optical communication technologies that support the era of communications revolution." Invited talks were given by Dr. Kenichi Suzuki (Trimatiz) on underwater LiDAR and underwater optical wireless communication technologies, Dr. Kazuhiro Ikeda (AIST) on the latest technology of silicon photonics switch, Mr. Osamu Kurokawa (NTT Communications)

Fig. 5 The presenters of Workshop 2: from left, Dr. K. Suzuki, Dr. K. Ikeda, Mr. O. Kurokawa, and Prof. T. Morioka.

on advanced transmission system between data centers that will support the new normal era, and Prof. Toshio Morioka (Technical University of Denmark) on the current status and future prospects of spatial-division multiplexed optical transmission technologies (Fig. 5). It is strongly expected that the leading-edge technologies presented in the session will open the way to the realization of optical fiber communication systems that can handle the increasing traffic in the new normal era. There were totally 242 attendees on Day 2.

3. Award Ceremony

During the technical sessions, we celebrated this year's OCS award winners at the award ceremony (Fig. 6). The OCS Technical Committee presented the awards to the following winners:

- OCS Best Paper Award: "402.7-Tb/s weakly-coupled 10-mode-multiplexed transmission," by Mr. Daiki Soma (KDDI Research) et al.
- OCS Young Researchers Award: Mr. Shota Ishimura (KDDI Research) for "Analog radio-over-fiber transmission technology for mobile fronthaul networks."
- OCS Young Researchers Award: Mr. Tsubasa Ishikawa (Kagawa University) for "Core Selective Switch for Spatial Channel Networks."

Fig. 6 OCS award-winners: Mr. D. Soma (middle left), Mr. S. Ishimura (lower middle), and Mr. T. Ishikawa (middle right).

4. Conclusion

In this year, the OCS symposium was held online, in a different style from conventional ones due to COVID-19. The OCS technical committee would like to express gratitude to all the speakers, exhibitors, and audiences, for their contributions to the successful symposium. We hope that this symposium impressed on all participants an unforgettable memory during "communications revolution."

Publicized March 1, 2021.

Report on OECC 2020

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1. Introduction

OECC 2020 conference was held from 4th through 8th October 2020 at Huanan Bank International Conference Center (HNBK ICC), Taipei, Taiwan (Fig. 1). The conference was postponed from the original schedule in July due to COVID-19 pandemic. The conference brought together international leading researchers, scientists and engineers who have been actively working in optical devices and modules, optical transmission and optical networking, optical fibers, optical switching and computing systems, and related technologies.

The conference was held on hybrid basis; onsite and online (physical and virtual) participation considering safety and conveniences for attendees.

The conference was cosponsored by the IEEE, Taiwan Tech, Chunghwa Telecom, the Ministry of Economic Affairs, Taipei City, MDPI, and technically cosponsored by the IEEE Photonics Society Taipei Chapter, PIDA, TPS, the IEEE Taipei Section, Ministry of Science and Technology, the IEICE Communications Society, the IEICE Electronics Society, and the Optical Society.

The conference was also industrial supported by Chunghwa Telecom, JPC, Mediatek, FOCI, uSenlight, Anritsu, INOPTICALS, EXFO, santec, Synchronous Communication, Realtek, Alpha Networks and Hwacom.

Fig. 1 Entrance signage at Huanan Bank International Convention Center (HNBK ICC).

2. Outline and Results of the Conference

The conference was intended to include two aspects that are historical views and the latest technological views as per the conventional scopes T.1- T.5, plus on growing areas T.6-T.8 as below, all based on the hybrid presentations and discussions.

Statistics of the conference are; 293 papers were submitted to the conference from all over the world (18 countries/areas), and each contributed paper (227) was reviewed by each category expert researchers. After the review, total 206 papers were accepted for the oral (110) and poster presentation (96), hence the total acceptance ratio of the conference was 90.8%. The accepted oral and poster papers were categorized into 8 technical scopes as;

Fig. 2 Opening and Plenary session in HNBK ICC, started by General chairs.

T1. Core/Access Networks and Switching Systems
T2. Transmission Systems and Subsystems
T3. Optical Fibers, Cables, Devices and Modules
T4. Optical Active Devices and Modules
T5. Optical Passive Devices and Modules
T6. Integrated Photonics and Nanophotonics
T7. Biomedical and Optical Sensing
T8. Machine Learning/ AI, Quantum Communication/ Computing, and others

The conference was started with three workshops in the afternoon of 4th October: **WS1**. AI in Optical Networks - the Opportunities and Challenges, **WS2**. Towards Photonic Integrated Circuits: Present and Future of Design and Fabrication, and **WS3**. Challenging beyond 5G of Optical Access & Transport Technology - Optics Transport Domain. More than 250 online attendees in total enjoyed these workshops.

The opening session was started with opening addresses by Dr. Yuan-Kuang Tu and Prof. San-Liang Lee (General Chairs), and Prof. Shien-Kuei Liaw (Program Chairs) on 5th October (Fig. 2), then two plenary talks given as follows; Prof. Masataka Nakazawa, Tohoku University, addressed Odyssey on Ultrahigh-speed optical communication over 30 Years, and Dr. Hey-Chyi Young, Vice President, Telecommunication Laboratories, Chunghwa Telecom, addressed the 5G new era – Future network and applications. On 6th October, two plenary talks were also given as; Prof. Rajeev Ram, Massachusetts Institute of Technology, addressed Tera-scale CMOS photonics, and Prof. Ian White, University of Bath, addressed Advances and trends in optical data communications.

Fig. 3 Oral session (left: onsite; right: online).

In the technical sessions, there were 293 presentations (Fig. 3) in 38 technical sessions (4 days 5 parallel tracks) with including 1 poster sessions (Fig. 4), and 3 special symposia (**S1**. The 60th Laser Anniversary Symposium**, S2.** Special Symposium of Silicon and Photonic Integration in Taiwan**, S3.** Historical Review Symposium of Optical Communications-25th anniversary of OECC and 50th anniversary of Optical Fiber Communications).

In **S1**, Prof. John Dudley Université Bourgogne Franche-Comté-CNRS Light, Lasers and the Nobel Prize; Prof. Masataka Nakazawa, Tohoku University, Advanced Fiber Laser Technology for Achieving Extremes of Ultrahigh-speed Optical Communication; Prof. Fumio Koyama, Tokyo Institute of Technology, VCSEL Photonics for Communications and Sensing; Prof. Jyhpyng Wang, National Central University, Generating Hard X-Ray and Relativistic Single-Cycle Long-Wavelength Infrared Pulse in a Laser Wakefield Accelerator; Prof. Federico Capasso, Harvard University, Resuscitating molecular lasers: compact widely tunable sources to span the Terahertz gap; Prof. David Payne, University of Southampton, Making and Breaking Things with New Lasers

In **S2**, Prof. Ming Chang Lee, National Tsing Hua University, Silicon Photonics mm Wave-over-Fiber Phased Array Antenna; Dr. Herbert Chen, Browave Corporation, PIC Packaging for Datacenter applications; Prof. Shih-Hsiang Hsu, NTUST, Silicon Photonics based Rapid Multi-module Medical Sensing through Interferometry; Prof. Hsuen Li Chen, National Taiwan University, Nanomaterials and micro-nano hybrid structures for silicon based optoelectronic devices; Prof. Tien-Tsorng Shih, National Kaohsiung University of Science and Technology, 1.6Tb/s Silicon Photonics Transmitting Chip and Receiving Chip.

In **S3**, six talks of historical views addressed by Prof. C. Kao's video presentation, Background of future networks; Prof. Tetsuya Miki, UEC, The History of OECC and my Research and Development; Dr. Shyue Ching Lu, Former Chunghwa Telecom, Major Development of Telecom Infrastructures in Taiwan; Prof. Sigeyuki Akiba, Tokyo Institute of Technology, Optical Submarine Cables -Artery of Global Communications; Prof. Benjamin Eggleton, University of Sydney, A Renaissance in Brillouin scattering; Prof. Fumio Koyama, 40 Years Evolution of VCSEL.

Industrial exhibition was done from 5th through 8th October in the exhibition hall, in which coffee served. Seven companies exhibited their products/services as follows; santec, Anritsu, uSenlight, EXFO (Trust Measurement Technology), Chunghwa Telecom, INOPTICALS, JPC.

On 5th October, after all sessions closed, the reception with small Taiwan snacks welcomed participants in the open space in front of the registration desk.

On 6th October, we enjoyed the banquet (Fig. 5) at the DingXian restaurant with Taiwanese seafood cuisine and nice panorama scenery of Taipei city from the 86th floor of the Taipei101.

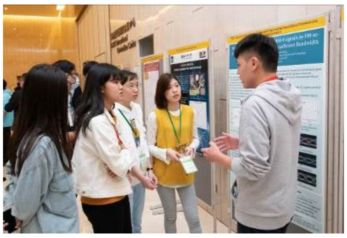


Fig. 4 Poster session.

Fig. 5 Group Photo at Banquet.

Fig. 6 Awarding Ceremony in the Closing ceremony.

Fig. 7 Coffee break in Exhibition area.

The post deadline papers (PDP) submitted to the conference from all over the world and each paper was reviewed by the technical committee members. After the review, total five papers were accepted for oral, and presented on 8th October.

In the Closing ceremony on 8th October, the best paper awards, the best student paper awards, the best poster paper awards (eight papers for each category, one per each track) and the best on-site presentation awards (four papers, one per each day) were introduced and gave the award to onsite awardee (Fig. 6). Then, the next OECC2021 was promoted by Prof. Alex Wai (General chair; Hong Kong Polytech Univ.) and video clips. Finally, Prof. San-Liang Lee (General Chairs) addressed special thanks for all participants regardless of onsite or online, all sponsors, all supporters and all students assisted, and then closed.

3. Conclusion

OECC 2020 was closed with great success with hybrid mode even under severe circumstances. Finally, 435 participants (registrations) including 252 online participants (about 58%) and 206 students (about 47%) have enjoyed 325 presentations and discussion in this conference. The next OECC 2021 is announced to be held at Hong Kong, from 3rd through 7th July 2021.

Report on 21st Asia-Pacific Network Operations and Management Symposium (APNOMS 2020)

Shinji Yamashita* and Kazuhiko Kinoshita**
* Secretary of APNOMS 2020 and Fujitsu Labs.
** Vice Chair of APNOMS 2020 and Tokushima Univ.

1. Overview

The 21st Asia-Pacific Network Operations and Management Symposium (APNOMS 2020) was held from September 22nd to 25th as a hybrid event in Daegu, Korea and online under the influence of COVID-19. It is organized by Technical Committee on Information and Communication Management, the Institute of Electronics, Information and Communication Engineers (IEICE ICM) and the committee on Korean Network Operations and Management, the Korean Information and Communications Society (KICS KNOM), and is technically co-sponsored by the IEEE Communications Society.

APNOMS 2020, with its theme being "Towards Service and Networking Intelligence for Humanity," consists of 3 keynote speeches, a distinguished expert panel, a special session, 4 tutorial sessions, 10 technical sessions, 4 poster sessions, and 2 innovation sessions. Over the 150 people from seven countries participated in the conference (onsite participants were only from Korea).

2. Highlights

Three executives delivered keynote speeches from each perspective. Prof. Jyh-Cheng Chen from National Chiao Tung University gave a speech on "Free 5GC - Free the Cellular Core Network," Dr. Hiroaki Harai from National Institute of Information and Communication Technology introduced "AI-Support Network Control and Management towards Beyond 5G Era," and Dr. Lee Young Ro gave a speech on "5G + MEC Deployment for the Public Administration."

In the distinguished expert panel session, Prof. Ji-Woong Choi from Daegu Gyeongbuk Institute of Science and Technology, Prof. Shiao-Li Tsao from National Chiao Tung University, Dr. Takayuki Kuroda from NEC Corporation and Dr. Taesang Choi from the Electronics and Telecommunications Research Institute discussed various emerging topics about network operations and management with chair and audiences.

The special session covered the topics of "Multi-access Edge Computing (MEC) - 5G and Beyond" and "Government Policies and Standardization Activities on Telecommunication."

A total of 119 papers, including 21 papers from Japan, were submitted to APNOMS 2020, among which 38 papers (9 from Japan) were accepted to be

Fig. 1 Welcome address by General Chair, Prof. Hongtaek Ju.

Fig. 2 Reception desk with a thermometer and free masks.

Fig. 3 Group photo of APNOMS2020 OC members and staff (local participants in Korea).

presented in the technical sessions. Besides, 50 papers (3 from Japan) were accepted to be presented in poster sessions. All presentations were pre-recorded and followed by live Q&A sessions. These papers are to be included in the IEICE Proceeding Series, the KICS Proceedings Series, and the IEEE Xplore.

The technical program committee and organizing committee selected the top four papers and the top four students with the highest overall scores from technical sessions as “Best Paper Award” and “Best Student Paper Award,” respectively. One of the awardees of “Best Paper Award” is “A Design of Port Scan Detection Method Based on the Characteristics of Packet-In Messages in OpenFlow Networks” presented by Mr. Daichi Ono from Tohoku University. And one of the awardees of “Best Student Paper Award” is “Topic-based Allocation of Distributed Message Processors on Edge-Servers for Real-time Notification Service” presented by Mr. Tomoya Tanaka from Kobe University.

3. Summary

APNOMS 2020 was closed with great success against the pandemic of COVID-19. On behalf of all organizing committee members, we would like to express our appreciation to all parties involved in this conference.

The next APNOMS will be held in Tainan, Taiwan in 2021.

Report on the 23rd International Symposium on Wireless Personal Multimedia Communications (WPMC 2020)

Kiyoshi Hamaguchi
Publication Committee Chair of WPMC 2020,
National Institute of Information and Communications Technology

1. Introduction

The 23rd International Symposium on Wireless Personal Multimedia Communications (WPMC 2020) was held as a web-based event during the 19th to the 26th of October 2020 (WPMC's website opened during the 19th to the 31st of October) [1]. Although it was originally planned to be held at Okayama Convention Center in Japan, it had been changed to virtual conference due to the influence of COVID-19. WPMC 2020, co-hosted by Okayama University, the National Institute of Information and Communications Technology (NICT), the YRP R&D Promotion Committee, and the CTIF Global Capsule (CGC), was technically supported by the IEICE Communications Society (CS), the IEEE Hiroshima Section, the IEEE Vehicular Technology Society Tokyo/Japan Chapter, and the Institute of Telecommunications, Portugal.

2. Organization

The organizing committee of WPMC 2020 was formed under Honorary Chair, Prof. Hirofumi Makino (Okayama University, Japan), and General Chair, Dr. Hideyuki Tokuda (NICT, Japan). Co-chair of the WPMC steering board, Dr. Shingo Ohmori (YRP R&D Promotion Committee, Japan) supervised a local organizing committee with his excellent leadership. The Technical Program Committee (TPC) was formed with Co-chairs, Prof. Satoshi Denno (Okayama University, Japan), Prof. Yukitoshi Sanada (Keio University, Japan), Prof. Pavlos Lazaridi (University of Huddersfield, UK), and Prof. Stavros Kalafatis (Texas A&M University, USA). Also, Financial Chair, Publication Chair, Conference Operation Chair, and General Secretary were Mr. Tetsuya Yasui (YRP R&D Promotion Committee, Japan), Dr. Kiyoshi Hamaguchi (NICT, Japan), Prof. Kazuhiro Uehara (Okayama University, Japan), and Mr. Yasuhiro Koyama (NICT, Japan), respectively.

3. Conference Program

The theme of this year's conference was "Bridging Wireless and Business Worlds." Not only technical papers but also business-related papers have been widely collected for the WPMC. The WPMC started with the opening remarks and was followed by the two keynote speeches on "Towards the 6th Generation Mobile Communication System" by Dr. Iwao Hosako (NICT, Japan) and "Toward Quantum Photonic Wireless Communications and Computing" by Prof. Kwang-Cheng Chen (University of South Florida, USA). Five special sessions such as Security, Trust and Connectivity, Enabling Beyond 5G Systems, Digital Technologies and Humanity for Quality of Life, Recent R&D Activities on Further Enhancement of 5G in Japan, and NICT's R&D and Promotion Activities toward the Future Diversified Radio Systems were held, followed by 16 regular sessions. When attendees wanted to ask questions to an author regarding her or his presentation, they could text on the website, then the author replied the answer on the page as shown in Fig. 1. Because all attendees remotely joined the conference, there were no social events such as welcome party, award banquet, etc.

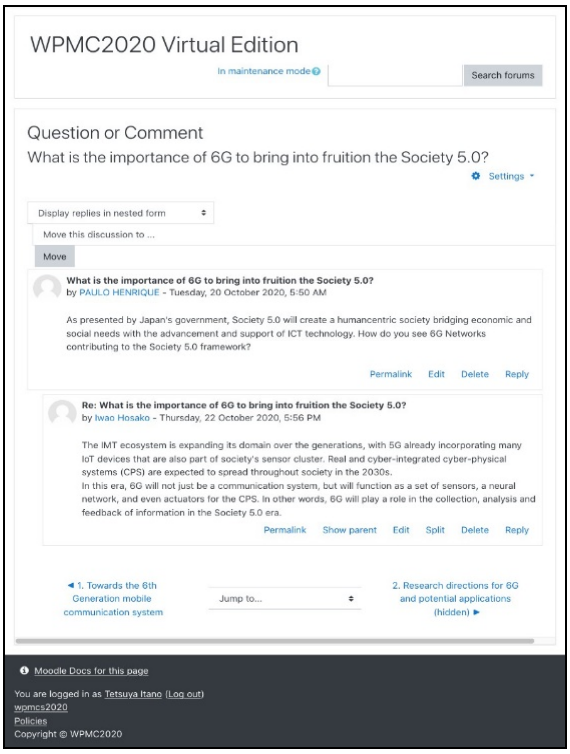


Fig. 1 An example of Q&A page on WPMC Website.

4. Statistics

A total of 114 papers were submitted from 21 countries. After peer-reviewed process, 73 of them were accepted. The number of registered participants reached 105 from 27 countries, having academia 47, student 27, government 14, industry 13, NGO 1, and other 3 in registration category. The result shows that online conference might attract participants from more countries than conventional one.

Conference had 2 keynote speeches, 5 special sessions including 22 papers, and 16 regular sessions including 73 papers.

5. Awards

The technical program committee awarded the following five papers:

- Best Paper Awards: "Performance Options of a High Performance Receiver Filter bank Channelizer," presented by Frederic J. Harris (University of California San Diego, USA) and "Analytical Model of Quantization Noise for In-Band Full-duplex Wireless Communications," presented by Keiichi Mizutani (Kyoto University, Japan).

- Best Student Paper Awards: "Automated Joint Access and Backhaul Planning for 5G Millimeter-Wave Small Cell Networks," presented by Beatriz Marques (Instituto Superior Técnico (IST), Portugal), "Autonomous Decentralized Frequency Resource Allocation using ACK Signal in LoRaWAN," presented by Kosuke Suzuki (National Institute of Technology, Numazu College, Japan), and "Exploring the Use of Early Inter-view Offset Estimation for Low Complexity MV-HEVC," presented by Belbel Amel (University Badji Mokhtar of Annaba, Algeria).

6. Conclusion

In the midst of our first experience of COVID-19, at the beginning the local organized committee was worried that WPMC could not be held as an in-person conference because sufficient papers were not able to be collected. After a long discussion in the committee, the final decision was that we should create a place to present papers even though COVID-19, and as a result, we could hold a web-based conference which could attract an unexpected number of papers, and we felt that our hard work had paid off. The success of WPMC 2020 came from the effort of all relevant people including the committee and the TPC members.

The committee is planning to hold the next WPMC 2021 in Okayama City in December 2021 as an in-person conference [2], but would still consider more suitable form of holding based on this experience depending on COVID-19's situation.

References

[1] https://WPMC2020.wpmc-home.com.
[2] https://WPMC2021.wpmc-home.com.

Publicized March 1, 2021.

Report on Japan–Africa Conference on Electronics, Communications, and Computations 2020 (JAC-ECC2020)

Osamu Muta (Kyushu University)

1. Introduction

The Japan–Africa Conference on Electronics, Communications, and Computation 2020 (JAC-ECC2020) was held as an online virtual conference during December 14–15, 2020. The conference, organized through international collaboration between Kyushu University in Japan and the Egypt–Japan University of Science and Technology (E-JUST) in Egypt [1], was also technically co-sponsored by the Technical Committee of Radio Communication Systems (RCS) and the Technical Committee of Communication Systems (CS) of the IEICE Communications Society [2] (IEICE-CS), and the IEEE Egypt Section [3]. The IEEE Fukuoka Section was a conference supporter.

This international conference addressing the fields of electronics, communications, and computer engineering, JAC-ECC stands out among engineering conferences, offering unique value. The conference features formulation of academic and human networks among international researchers from academia and industry in Japan, the Middle East, and Sub-Saharan Africa.

This report briefly provides historical background and an overview of JAC-ECC2020 while introducing an invited presentation related to information communications technologies (ICT) in Japan, in cooperation with IEICE Communications Society and JAC-ECC committee. Actually, JAC-ECC2020 is the eighth international conference. The past seven conferences were held either in Egypt (six times) or Japan (once). Because of the continuing COVID-19 pandemic, the conference organizing committee decided to hold JAC-ECC 2020 as an online virtual conference.

2. JAC-ECC History and Overview

In 2012, Kyushu University and E-JUST co-organized an international conference called the international Japan–Egypt Conference on Electronics, Communications and Computers (JEC-ECC). Since then, it has been held four times: once in Japan (Fukuoka in 2015) and the rest in Egypt (2012, 2013, and 2016). Most articles presented at JEC-ECC have been published in the IEEE Xplore online library of the Institute of Electrical and Electronics Engineers (IEEE).

As an advanced edition of JEC-ECC, a renewed international conference, JAC-ECC was organized in 2017. Unlike the four conferences mentioned above, JAC-ECC (with “A” for Africa in place of “E” for Egypt) was organized as a platform for extending

Fig. 1 Organizing committee members at JAC-ECC online virtual conference center in E-JUST Campus (in Egypt).

collaboration among international researchers in Japan and Middle-Eastern/African countries. The second and third editions of JAC-ECC (i.e., the Seventh Edition Conference in total) were held respectively in 2018 and 2019 at the E-JUST campus. Unlike earlier years, because of the continuing COVID-19 pandemic, JAC-ECC2020 was held as an online virtual conference, unlike the past seven conferences including JEC-ECC. The Zoom webinar was used as an online virtual conference tool, so that all keynote, invited, and regular session presentations were presented online. Figure 1 depicts some organizing committee members at the virtual conference center at the E-JUST campus.

The organizing committee and technical program committee members of the conference were invited from various countries such as Japan, Egypt, Canada, Saudi Arabia, New Zealand, Germany, and Ireland [1]. The members participated in the conference. For this conference, the Technical Committee of Radio Communication Systems (RCS) and that of Communication Systems (CS) in the IEICE

Communications Society also cooperated as they did in earlier conferences (JAC-ECC and JEC-ECC).

JAC-ECC2020 includes nine main technical tracks:

- Artificial Intelligence
- Big Data Analytics and Cloud Computing
- Communications
- Circuits and Systems
- Signal, Image, and Video Processing
- Microwave and Antennas
- The Internet of Things (IoT)
- Biomedical Engineering and Applications
- Smart Grids

The JAC-ECC technical program committee (TPC) peer-reviewed all submitted articles. Contributing to the peer-review process, the TPC was supported by experts in the fields of electronics, communications, and computers from Australia, Canada, China, Egypt, Japan, India, Kuwait, Malaysia, New Zealand, South Africa, South Korea, Sweden, and the United States. At JAC-ECC2020, the technical program committee received 38 submissions. Among the submissions, 21 papers were accepted, with a 55% acceptance ratio in the final program. The accepted papers were presented in oral online sessions similarly to other international conferences in the same research field.

Fig. 2 Opening Session in JAC-ECC2020.

3. Technical Session

The technical program of JAC-ECC included four regular technical sessions. Additionally, we organized the special session as an international workshop. Furthermore, we had keynote sessions for five invited speakers, all of whom were leading engineering researchers. In the conference, technical regular sessions were held on the first day of the conference. Figure 2 depicts the opening session in JAC-ECC2020 held through the Zoom webinar at beginning of the conference.

In JAC-ECC2020, we organized a workshop entitled "5G Communication for Smart Cities" with presentations by prominent researchers from Japan and Egypt. Each presentation had 40 min for a presentation and 5 min for questions. Impressive topics were presented such as wireless communications, the Internet-of-Things (IoT) technologies and vehicular networks. At this workshop, we were privileged to hear an invited lecture [4] from Japan by Dr. Celimuge Wu (University of Electro Communications) as a member of IEICE and an expert in information technologies as shown in Fig. 3.

Fig. 3 Invited presenter in the workshop (Prof. Wu).

4. Conclusion

JAC-ECC 2020 was the eighth edition of the conference including the past four editions of JEC-ECC organized through international collaboration of Kyushu University and E-JUST in cooperation with the IEICE Communications Society. Details and venues of the next edition of the conference, JAC-ECC, have not been determined yet. For additional information, please visit our conference site [1]. We welcome your submission to the conference. Finally, we express our sincere gratitude to all speakers, participants, and committee members for their contributions to the conference.

References

[1] JAC-ECC2020 website: https://jac-ecc20.ejust.edu.eg/
[2] IEICE Communications Society website: http://www.ieice.org/cs/
[3] IEEE Egypt Section website: http://www.ieee.org.eg/
[4] C. Wu, "Collaborative Intelligence for Internet of Vehicles," Dec. 2020.

Report on the 9th IEEE International Conference on Renewable Energy Research and Applications (ICRERA2020)

Kazuhiro Kajiwara
Nagasaki Institute of Applied Science

1. Introduction

The 9th IEEE International Conference on Renewable Energy Research and Applications (ICRERA2020) was held as a digital conference from Sept. 27th through 30th, 2020. ICRERA is the annual world-class technical forum presenting the latest research topics in the renewable energy technologies and their applications.

2. Overview

The conference program included 7 keynote addresses, 17 technical sessions, 3 industrial talks, and 4 tutorials on state of the art and emerging topics. In this conference, 6 papers were selected for best paper award.

The main sponsors of ICRERA2020 were the International Journal of Renewable Energy (IJRER). The conference was also technically co-sponsored by IEEE Industry Applications Society (IEEE IAS), IEEE Industrial Electronics Society (IEEE IES), the Institute of Electronics, Information and Communication Engineers (IEICE) and the Institute of Electrical Engineers of Japan (IEEJ). It was also supported by University of Strathclyde, UK, Gazi University and Nisantasi University, Turkey, Nagasaki University and Nagasaki Institute of Applied Science, Japan.

3. Opening Ceremony and Keynote Speeches

The conference was commenced by welcome address by General Chair, Prof. Khaled Ahmed, General co-chairs, Prof. Ilhami Colak and Prof. Fujio Kurokawa. After the opening ceremony, two high-profile keynote speeches were presented. The first speaker Mr. Akira Kawaguchi, who is Executive Officer Vice President of Power Electronics Systems Division at Toshiba Mitsubishi-Electric Industrial Systems Corporation (TMEIC), talked about Power Electronics in Everything, Provides Solutions to Global Difficulties. The second speaker Mr. Carl Barler, who is a consulting engineer at GE, talked about GE Renewable Energy. Furthermore, five keynote speakers, Prof. Gungor Bal, Mr. Ricardo Da Silva, Prof. Dr. Andrea Tonello, Mr. Benjamin Marshall and Prof. Necmi Altin gave keynote speeches in the morning of Sept. 29-30.

4. Technical Program

In this conference, 134 papers are submitted from 29 countries. The technical program committee selected papers for presentation by careful peer review process. Finally, 73 papers were presented.

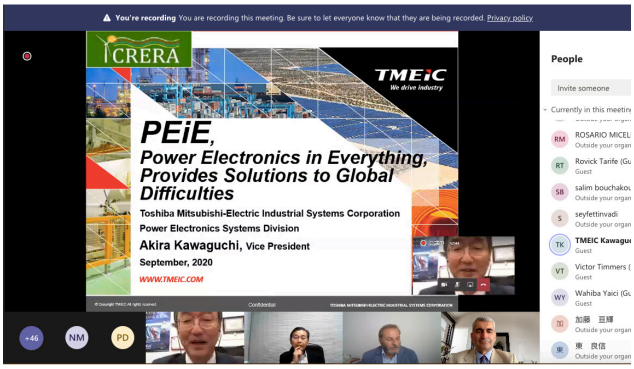


Fig. 1 Keynote speech by Mr. Akira Kawaguchi.

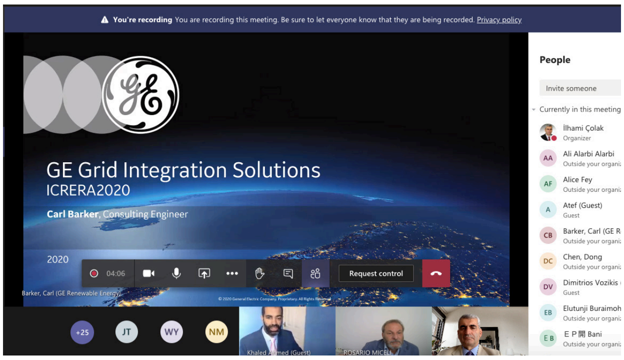


Fig. 2 Keynote speech by Mr. Carl Barler.

All presentations were organized in 17 technical sessions by using Microsoft Teams. Each session was mostly well-attended, and they discussed advances and developments in renewable energy research and applications.

5. Conclusions

ICRERA has been the forum for researchers and engineers in the renewable energy field since 2012. Total 73 papers were presented at ICRERA2020 from 29 countries and regions. Due to spreading COVID-19, ICRERA2020 was a digital conference for the first time. Despite such a difficult situation, the conference successfully provided an excellent platform and facilitated the research collaboration in renewable energy technologies.

The next IEEE ICRERA will be held in Ankara, Turkey on Sept. 26-29, 2021.

Report on the 11th International Conference on ICT Convergence (ICTC 2020)



Jong-Ho Lee[1], Jae-Hyun Kim[2], and Moon-Sik Lee[3]
[1]Soongsil University, Korea, [2]Ajou University, Korea, [3]ETRI, Korea

1. Introduction

The 11th International Conference on Information and Communication Technology Convergence (ICTC 2020) was held in Ramada Plaza Hotel, Jeju Island, Korea from October 21th to 23th, 2020. ICTC is a leading, flagship international conference hosted by the Ministry of Science and ICT (MSIT) of Korean government, organized by the Korean Institute of Communications and Information Sciences (KICS) and technically co-sponsored by IEICE-CS and IEEE Communications Society. ICTC 2020 features an extremely rich program with the main theme of "Data, Network, and AI in the age of 'Untact'." The conference addresses numerous challenges of ICT convergence over various industrial sectors, including wireless and mobile communication systems and infrastructure, future networks, services and applications, smart devices and consumer appliances, cloud computing, green communication, healthcare and bio-informatics, and the Internet of Things (IoT).

2. Conference Program

The conference program includes plenary sessions, invited industrial sessions, technical paper sessions, and special sessions. Considering the ongoing COVID-19 pandemic, the conference was held in a hybrid format. Pre-recorded presentations and online live discussions were made available to overseas participants.

In three plenary sessions (Fig. 1), we had six keynote speeches. The Plenary Session I started with the opening address by Prof. Saewoong Bahk, (President of KICS). Then, Dr. Sunghyun Choi (Head of Advanced Communications Research Center, Samsung Electronics Co., Ltd, Korea) delivered a keynote speech on "Challenges and Prospect of Next-Generation Mobile Communications". Plenary Session II consists of two keynote speeches. Prof. Lajos Hanzo (University of Southampton, UK) delivered a keynote speech on "'Rebooting Communications' – A Quantum-Signal Processing Perspective" and Dr. Yoon Kim (CTO, SK Telecom, Korea) delivered a keynote speech on "Human-Centered AI for a Hyperconnected Post-COVID World." Plenary Session III provides three keynote speeches. Mr. Edward Zhou (VP of Global Public Affairs, Huawei, China) delivered a keynote speech on "ICT for Post COVID-19: From Pandemic Resilience to Economic Recovery" and Prof. Mohamed-Slim Alouini (King Abdullah University of

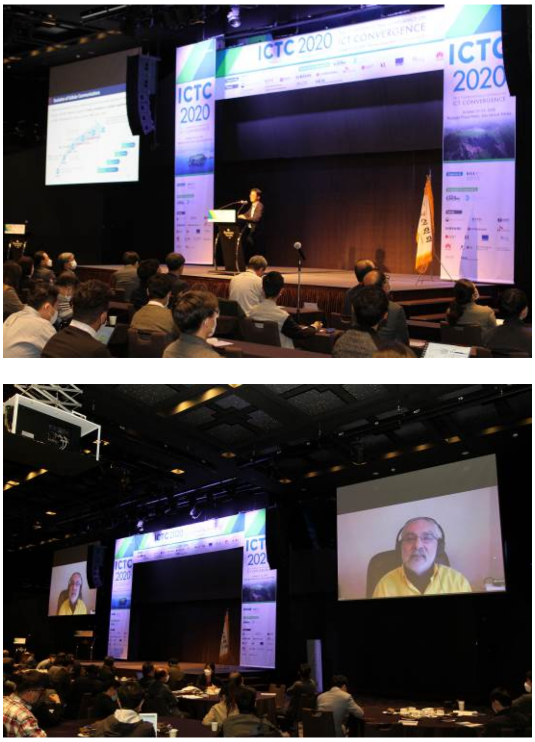


Fig. 1 Plenary Session.

Science and Technology (KAUST), Saudi Arabia) also delivered a keynote speech on "Unleashing the Potential of Tethered Networked Flying Platforms". Then, Dr. Sang-Kyu Park (Executive Vice President, Electronics and Telecommunications Research Institute (ETRI), Korea) delivered a keynote speech on "Technology Strategy of ETRI for x + AI."

Each of two industrial sessions (Fig. 2) consists of three invited talks from industries. The theme of Industrial Session I was connected intelligence, 5G standardization, and the internet of sensors. Dr. Sungjin (James) Kim (Senior Research Fellow (VP), LG Electronics, Korea), Mr. Satoshi Nagata (Manager, 3GPP TSG-RAN Vice Chairman, NTT DOCOMO, INC., Japan), and Mr. Anders Johansson (Head of R&D Ericsson-LG / R&D Site Head of 5G/6G SW Development in Ericsson, Korea/Shanghai) gave excellent talks on the theme. In Industrial Session II, Dr. Jung-Woo Ha (Head of AI Research, NAVER Corp., Korea), Dr. Intaik Park (Vice President, Samsung Electronics, Korea) and Dr. Volker Ziegler (6G

Fig. 2 Industrial Session.

Fig. 3 Technical Session.

Leadership, Nokia Bell Labs & CTO, Germany) gave interesting talks on AI, softwarization & intelligence, and 5G & Beyond.

Regarding technical paper sessions (Fig. 3), 1187 papers were submitted to the conference. After thorough review process, the technical program committee (TPC) accepted 506 papers, which were organized into 23 oral sessions and 6 poster sessions. The overall acceptance ratio was about 42.6%. The topics of technical paper sessions covered artificial intelligence and machine learning, 5G/4G/WLAN, the internet of things, maritime & military communications systems, wireless & mobile communication systems, information & communication theory, network virtualization and future internet technologies, applications for ICT convergence, SDN and network virtualization, smart media & broadcasting and smart devices, energy internet, smart grid infrastructure and applications, big data and smart computing, signal and image processing, and vehicular information & communication technologies. In addition, six workshop sessions were provided and 17 special sessions were organized with various invited talks from academia and industries.

3. Social Events

The conference banquet (Fig. 4) was held at the first night. The banquet began with a welcome address and introduction of OC members by Dr. Seung Chan Bang (Organizing Committee Chair). Prof. Jae-Hyun Kim (TPC Chair) made a TPC report, including paper statistics and Best/Excellent Paper Award selection procedure. Two Best Paper Awards and four Excellent Paper Awards were presented to the authors of six

Fig. 4 Conference Banquet.

Fig. 5 Best/Excellent Paper Award.

selected papers (Fig. 5). All participants enjoyed the banquet course.

4. Conclusion

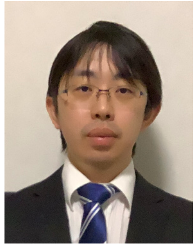
Since 2010, ICTC has been the unique global premier event for researchers, industry professionals, and academics interested in the latest developments in the emerging industrial convergence centered on the ICT technologies. On behalf of OC and TPC, we would like to thank all the participants and sponsors who made ICTC 2020 a big success. It is our great pleasure to announce that the next event, ICTC 2021, will be held in Ramada Plaza Hotel, Jeju Island, Korea, during October 20-22, 2021 [1]. ICTC 2021 invites the submission of original research works in all areas of infrastructure, services, technologies, and application of ICT convergence.

5. Reference

[1] http://ictc.org/

Report on International Teletraffic Congress ITC32

Daichi Kominami
Osaka University



1. Introduction

The International Teletraffic Congress ITC32 was scheduled to be held at Osaka University, Japan. However, due to the evolving COVID-19 situation, it had become difficult for researchers to visit Japan, so the congress was decided to be held online. In this report, I describe the purpose and summary of ITC32.

2. Purpose of the Congress

The International Teletraffic Congress ITC32 is an international conference in the field of network science and practical applications, and has provided a forum for discussion of the latest technologies in a wide range of areas related to traffic modeling, network systems, and measurement since 1955. In 2020, the Congress aims to bring together researchers in network science in Europe, the United States, and Asia to stimulate discussions on the latest technologies, and to provide an opportunity to disseminate knowledge of the latest technologies and research in network science to our society.

3. Organizing Committee

The Committee of ITC32 was strongly leaded by General Chairs and supported by TPC Chairs and International Advisory Council members. The other organization is technical program committee. These main committee members are listed as the followings.

- General Charis:
  Masayuki Murata (Osaka University, Japan),
  Kohei Shiomoto (Tokyo City University, Japan)
- TPC Charis:
  Yuming Jiang (NTNU, Norway)
  Hideyuki Shimonishi (NEC, Japan)
  Kenji Leibnitz (NICT, Japan)
- International Advisory Council Chair:
  Michela Meo (Politecnico di Torino, Italia)
- International Advisory Council Liaison Chair:
  Zhisheng Niu (Tsinghua University, China)

4. Program and Activities

The congress is composed of one tutorial session, four keynote sessions, two special sessions, four technical sessions, and one PhD workshop.

As the latest research topic, there was a tutorial lecture on the use of machine learning in wireless networks given by Prof. Koji Yamamoto and Prof. Takayuki Nishio of Kyoto University. In addition to keynote lectures by prominent researchers from Japan and abroad (Prof. Shoji Kasahara of Nara Institute of Science and Technology; Prof. F. Richard Yu, Carleton University; Prof. Hisashi Kobayashi of Princeton University; and Mr. Masakatsu Fujiwara of NTT), a special session on "Modeling Challenges in the Emerging Internet Applications" and a special session on "6G/AI" were held.

For the technical sessions, 20 papers were accepted out of 53 submitted papers (acceptance rate: 38%), and high-level research presentations on network science were made at the Congress. In the PhD workshop, four doctoral students discuss their research in the style of poster presentations.

5. Summary

Although the conference was held online this year, the number of registered participants was 100 (of which the top registered participants by country were 40% from Japan (1st place), 15% from Germany (2nd place), and 10% from China (3rd place)). Each session always attracted 40 to 60 participants, providing an opportunity to stimulate discussions on the latest technologies and to disseminate knowledge on the latest technologies and research in network science.

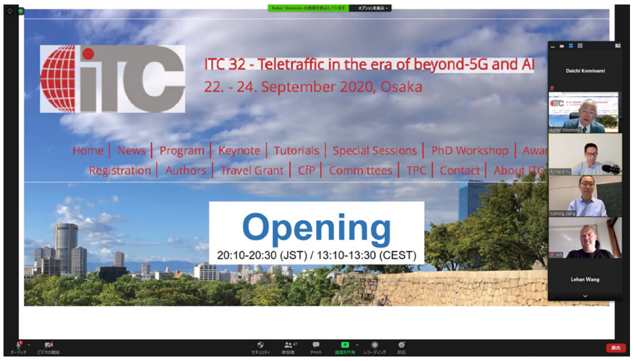


Fig. 1 ITC32 Opening session.

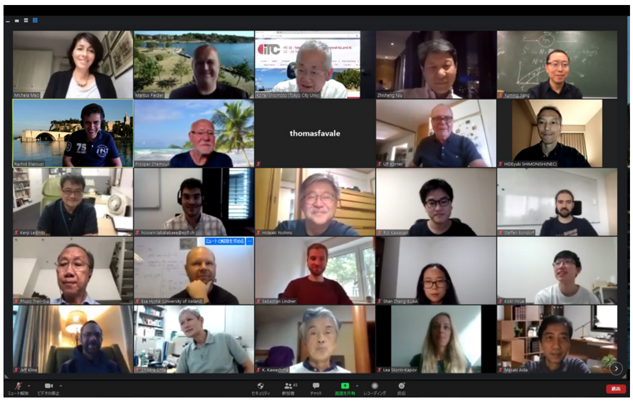


Fig. 2 Group photo in ITC Closing session.

  Publicized March 1, 2021.

From Editor's Desk

●GNL fully online now

As announced in previous issues, GNL is now fully online from this issue. Advance publications will be newly available every month in addition to the regular publications on our web site (https://www.ieice.org/cs_r/eng/gnl/). As per this change, now we accept your submissions anytime!

●IEICE General Conference 2021

The IEICE General Conference 2021 will be held online, from 9th through 12th of March 2021. Complete English sessions are also scheduled in the conference. Please check out the latest conference information on the IEICE web site at:
https://www.ieice-taikai.jp/2021general/en/index.html

●Season's Greetings

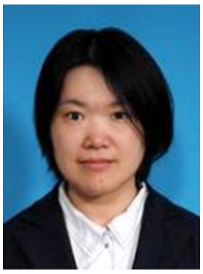
New way of life forced by the COVID-19 is highlighting the importance of communication technologies where our research has been focusing on. Let's get through this together this difficult situation!

We welcome your contribution of article submissions to GNL. For article submission, please refer to the Submission Guideline of IEICE-CS GLOBAL NEWSLETTER:
[ENG] https://www.ieice.org/cs_r/eng/gnl/submission_guideline.html
[JPN] https://www.ieice.org/cs_r/jpn/gnl/submission_guideline.html

IEICE-CS GLOBAL NEWSLETTER Editorial Staff

Editorial Staff of this issue

No special order is observed.



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The Institute of Electronics, Information and Communication Engineers (IEICE) Communications Society

About Communications Society

IEICE Communications Society shall endeavor to facilitate research and investigation activities in the field of communications, and to contribute to research activities through cooperation with other societies, in order to promote the development of science and technology in this field.

◆ Technical Committees

Twenty regular technical committees, seven ad hoc technical committees and one special ad hoc technical committee carry out research activities. The following is a list of the technical committees.

Regular Technical Committees

- Antennas and Propagation (AP)
- Internet Architecture (IA)
- Space, Aeronautical and Navigational Electronics (SANE)
- Satellite Telecommunications (SAT)
- Electromagnetic Compatibility (EMCJ)
- Communication Quality (CQ)
- Information and Communication Management (ICM)
- Information Networks (IN)
- Smart Radio (SR)
- Short Range Wireless Communications (SRW)
- Communication Systems (CS)
- Energy Engineering in Electronics and Communications (EE)
- Network Systems (NS)
- Optical Communication Systems (OCS)
- Optical Fiber Technology (OFT)
- Photonic Network (PN)
- Healthcare and Medical Information Communication Technology (MICT)
- Radio Communication Systems (RCS)
- Wireless Power Transmission (WPT)
- Sensor Network and Mobile Intelligence (SeMI) (Joint committees of ASN/MoNA）

Ad Hoc Technical Committees

- Standardization & Innovation in ICT Technologies (SIIT)
- Extremely Advanced Optical Transmission (EXAT)
- Network Virtualization (NV)
- Photonics-applied Electromagnetic Measurement (PEM)
- Information-Centric Networking (ICN)
- Networked Digital Service Platform (DPF)
- Underwater Wireless Technology（UWT）

Special Ad Hoc Technical Committees

- Multiple Innovative Kenkyu-kai Association for wireless communications（MIKA）

◆ Publications

IEICE Transactions on Communication

The IEICE Transactions on Communications (English and Japanese editions) are published monthly.

The impact factor of IEICE Transactions on Communications (English edition) was 0.580 in 2018.

https://www.ieice.org/cs/jpn/EB/index.html

Document date: 2020.4

IEICE Communications Express (ComEX)

IEICE Communications Express (ComEX) is an online letter journal, where researchers can exchange new topics easily and in a timely manner.

You can download PDF files from the ComEX site.

https://www.ieice.org/publications/comex/

Magazines

- **GLOBAL NEWSLETTER (GNL)**

GLOBAL NEWSLETTER (GNL) exchanges information on global activity between overseas/foreign members and other members in IEICE-CS.

GNL is published every March, June, September, and December.

https://www.ieice.org/cs/pub/global_news.html

- **Communications Society Magazine "B-plus"**

The Communications Society Magazine (Japanese edition only) "B-plus" provides technical reviews, surveys, practical topics, etc. "B-plus" is published quarterly in Japanese. The electronic version has been accessible free of charge since March 2015.

https://www.ieice.org/~cs-edit/magazine/

◆ Membership Services

Technical Report Archives

Technical Report Archives is an archive of all the technical reports of IEICE-CS published more than one month ago. It is part of the IEICE Technical Report Online System.

Email News

We call for papers of transactions and international conferences, as well as technical workshops from CS members by email.

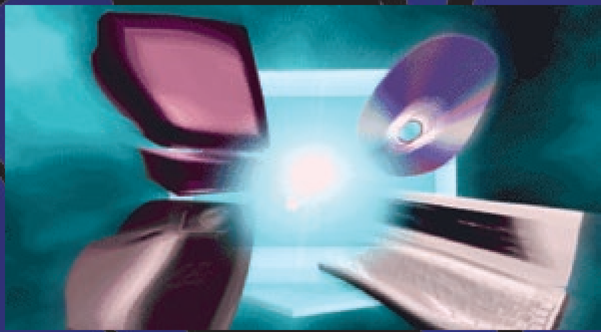
◆ Sister Societies

Communications Society has sister-society agreements with the following six overseas societies.

- IEEE Communications Society (ComSoc)
- Informationstechnische Gesellschaft within The Verband Der Elektrotechnik Elektronik Informationstechnik (VDE/ITG)
- Korean Institute of Electromagnetic Engineering and Science (KIEES)
- The Korean Institute of Communications and Information Sciences (KICS)
- China Institute of Communications (CIC)
- IEEE Electromagnetic Compatibility Society (EMCS)

To Probe Further and Keep Up-to-date with Communication Technologies

IEICE Communications Society



IEICE General Conference 2021

9-12 March 2021

Online Conference

Every spring, the four Societies, together with the Human communications Group, jointly hold a General Conference to provide a forum where members can present their study results and exchange views. Besides the presentation of papers, there are special events and conferment ceremonies of Young Investigators Awards. The Communications Society holds English language sessions as well.

Please check out the latest information on the IEICE web site at:

https://www.ieice-taikai.jp/2021general/en/index.html

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