World Radiocommunication Conference WRC'19 - Impact over security of the modern human society

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Abstract: *ITU's World Radiocommunication Conference 2019 (WRC 19) is playing a key role in shaping the technical and regulatory framework for the provision of Radiocommunication services in all countries, in space, air, at sea and on land. It will help accelerate progress towards meeting the Sustainable Development Goals (SDGs). It is providing a solid foundation to support a variety of emerging technologies that are set to revolutionize the digital economy, including the use of artificial intelligence, big data, the Internet of Things (IoT) and cloud services. The last items are very close related to the security of the modern human society. The importance of the WRC,19 decisions is discussed in the report. Two new radio-communication principles, named Spatial Correlation Processing - Random Phase Spread Coding (SCP-RPSC), are analysed from WRC, 19 decisions point of view. They were proposed by the author a decade before as antenna transmit-receive beam forming methods with many applications in microwave frequency bands.*

***Keywords**: WRC-19; 5-G; IMT; IoT; SMART CITIES; SCP-RPSC*

1. Introduction

ITU's World Radiocommunication Conference 2019 (WRC 19) is playing a key role in shaping the technical and regulatory framework for the provision of Radiocommunication services in all countries, in space, air, at sea and on land [1]. It will help accelerate progress towards meeting the Sustainable Development Goals (SDGs). It is providing a solid foundation to support a variety of emerging technologies that are set to revolutionize the digital economy, including the use of artificial intelligence, big data, the Internet of Things (IoT) and cloud services. The last items are very close related to the security of the modern human society.

Every three to four years the conference revises the Radio Regulations (RR), the only international treaty governing the use of the radio-frequency spectrum and satellite orbit resources. The treaty's provisions regulate the use of telecommunication services and, where necessary, also regulate new applications of Radiocommunication technologies. The aim of the regulation is to facilitate equitable access and rational use of the limited natural resources of the radio-frequency spectrum and the satellite orbits, and to enable the efficient and effective operation of all Radiocommunication services.

Each World Radiocommunication Conference affects the future development of information and communication technologies (ICTs) in many ways, including:

- Introducing and expanding access to the radio spectrum for new Radiocommunication systems and applications;
- Protecting the operation of existing Radiocommunication services and providing the stable and predictable regulatory environment needed for future investments;
- Avoiding the potential for harmful interference between radio services;
- Allowing the provision of high-quality Radiocommunication while protecting vital uses of the radio spectrum, particularly for distress and safety communications;
- Facilitating international roaming and increasing economies of scale, thereby making it possible for network and user devices to be more affordable.

The importance of the WRC,19 decisions over the future security of the modern human society is discussed in the report. Two new radio-communication principles, named Spatial Correlation Processing - Random Phase Spread Coding (SCP-RPSC), are analyzed from WRC,19 decisions point of view. They were proposed by the author a decade before as antenna transmit-receive beam forming methods with many applications in microwave frequency bands.

2. WRC-19 activity and decisions

2.1. Introduction

WRC 19 was held in Sharm El-Sheikh, Egypt, from 28 October to 22 November 2019. A record 3400 participants attended WRC-19, including delegates from most of the 193 ITU Member States as well as more than 260 members of the ITU Radiocommunication Sector (ITU-R) representing international organizations, equipment manufacturers, network operators and industry forums, who attended as observers. Its agenda covered a wide range of Radiocommunication services and activities, dealing with security of the modern human society.

2.2. Deployment of non-geostationary satellite (NGSO) systems in specific radio-frequency bands and services

The agreement reached at WRC-19 establishes regulatory procedures for the deployment of NGSOs, including mega-constellations in low-Earth orbit. The agreement struck in Sharm el-Sheikh reflects the rapid pace of satellite innovation that is driving an increase in the deployment of non-GSO constellations. Indeed, with the availability of launch vehicles capable of supporting multiple satellite launches, mega-constellations consisting of hundreds to thousands of spacecraft are becoming a popular solution for global telecommunications. This includes extensive low-latency broadband coverage, remote sensing, space and upper atmosphere research, meteorology, astronomy, technology demonstration and education, close related to human security.

2.3. International agreements that will help pave the way for better smart-city transportation

The agreements at ITU's WRC-19 aim to improve traffic management, public transportation systems, road safety, train safety and railway traffic control – among other aspects of transportation that aim to leverage information and communication technologies (ICTs) to make the world's cities safer and smarter. Specifically, delegates representing governments from across the world have approved a new Recommendation on Intelligent Transport Systems (ITS) and a new Resolution on railway Radiocommunication systems between train and trackside (RSTT).

2.4. Additional radio-frequency bands for High Altitude Platform Station (HAPS) systems

These easily deployable stations operating in the stratosphere (layer of the Earth's atmosphere starting at 20 kilometers) are high enough to provide service to a large area or to augment the capacity of other broadband service providers. Technological innovations in recent years — and the growing urgency to expand the availability of broadband – led to the development of HAPS systems. The agreements reached at WRC-19 help pave the way to connect more of the world's people to the benefits of today's digital economy, particularly in underserved communities and in rural and remote areas. A new Resolution passed at WRC-19 also mentioned that "current technologies, such as HAPS, can be used to deliver broadband applications for broadband connectivity and disaster-recovery communications with minimal ground network infrastructure". HAPS systems can be used to provide both fixed broadband connectivity for end users and transmission links between the mobile and core networks for backhauling traffic. Both types of HAPS applications would enable wireless broadband deployment in remote areas, including in mountainous, coastal and desert areas.

Delegates at WRC-19 agreed that allocations to the fixed service in the frequency bands 31-31.3 GHz, 38-39.5 GHz will be identified for worldwide use by HAPS. They also confirmed the existing worldwide identifications for HAPS in the bands 47.2 – 47.5 GHz and 47.9 – 48.2 GHz are available for worldwide use by administrations wishing to implement high-altitude platform stations. They agreed to the use of the frequency bands 21.4-22 GHz and 24.25-27.5 GHz by HAPS in the fixed service in Region 2.

2.5. The deployment of Earth stations in motion (ESIM)

Earth stations in motion (ESIM) address a complex challenge: how to provide reliable and high-bandwidth Internet services to moving targets. They provide broadband communications, including Internet connectivity, on platforms in motion.

There are currently three types of ESIM: ESIM on aircraft (aeronautical ESIM), ESIM on ships (maritime ESIM) and ESIM on land vehicles (land ESIM). They connect people on ships, aircraft and land vehicles and ensuring their safety, security and comfort on the move. Advances in satellite manufacturing and earth station technology have made ESIM more readily available and more practical. When ships are at sea or aircraft cross the oceans, they are out of reach of terrestrial networks. ESIM systems can provide continuous and consistent service with very wide, or literally global, geographic coverage as ships and aircraft operate at or over almost any location. In addition, the typical data rates currently provided by terminals operating in networks serving ESIM are around 100 Mbit/s. That is much higher, or faster, than those provided historically by mobile-satellite service (MSS).

To address the increasing need for radio-frequency spectrum for ESIM, while protecting other services, delegates at WRC-19 decided on the regulatory and technical conditions under which the frequency bands 17.7 19.7 GHz (space-to-Earth) and 27.5-29.5 GHz (Earth-to-space) can be used by the three types of ESIM communicating with geostationary (GSO) space stations in the fixed-satellite service (FSS).

2.6. Identification additional radio-frequency bands for International Mobile Telecommunications (IMT), which will facilitate the development of fifth-generation (5G) mobile networks

5G is expected to connect people, things, data, applications, transport systems and cities in smart, networked communication environments [2]. It will transport a huge amount of data much faster, reliably connect an extremely large number of devices and process very high volumes of data with minimal delay.

5G technologies are expected to support applications such as smart homes and buildings, smart cities, 3D video, work and play in the cloud, remote medical services, virtual and augmented reality, and massive machine-to-machine communications for industry automation. 3G and 4G networks currently face challenges in supporting these services. These new functionalities and new services necessitate a new way of deploying advanced mobile services, as well as new approaches in making 5G technologies work together in industrial settings by machine-to-machine communications, Internet of Things (IoT) or with connected vehicles.

While identifying the frequency bands 24.25-27.5 GHz, 37-43.5 GHz, 45.5-47 GHz, 47.2-48.2 and 66-71 GHz for the deployment of 5G networks, WRC-19 also took measures to ensure an appropriate protection of the Earth Exploration Satellite Services, including meteorological and other passive services in adjacent bands.

In total, 17.25 GHz of spectrum has been identified for IMT by the Conference, in comparison with 1.9 GHz of bandwidth available before WRC-19. Out of this number, 14.75 GHz of spectrum has been harmonized worldwide, reaching 85% of global harmonization.

In addition, WRC-19 has also defined a plan of studies to identify frequencies for new components of 5G. As an example, to facilitate mobile connectivity by High Altitude IMT Base Stations (HIBS). HIBS may be used as a part of terrestrial IMT networks to provide mobile connectivity in underserved areas where it is difficult to be covered by ground-based IMT base stations at a reasonable cost.

IMT-2020, the name used in ITU for the standards of 5G, is expected to continue to be developed from 2020 onwards, with 5G trials and commercial activities already underway to assist in evaluating the candidate technologies and frequency bands that may be used for this purpose. The first full-scale commercial deployments for 5G are expected sometime after IMT-2020 specifications are in force.

3. SCP-RPSC approach

3.1. Introduction

SCP-RPSC (Spatial Correlation Processing – Random Phase Spread Coding) is an entirely new approach in the field of microwave beam forming antenna theory. It was developed by the author before more decade [3,4,5,6]. The goal was to solve the problems of the tracking microwave antenna systems for mobile satellite communications.

3.2. SCP technology

The main objectives of the SCP technology [3,4,5,7] are:

- To receive one or more radio signals coming from one or several spatially distributed signal sources (satellites, base stations), insuring high gain of the antenna systems and using fixed or mobile receiving terminals, equipped with SCP signal processing equipment;
- To ensure spatial selectivity high enough to cancel the same frequency channel interference, coming from different space directions, using simple one channel receiver.

The objectives stated above are achieved by a patented by the author method for radio communications, which proposes application of additional pilot signal transmitted in the band of information signals and available in the receiver by Code Division Multiple Access (CDMA). The SCP receiver terminal is equipped with antenna array with random phase aperture excitation. The phase shifts among the signals, coming from the antenna elements, are random at the antenna output, regardless of the information source direction. These random phase spread signals correlate with the recovered pilot signal, phase spread in the same manner, in a signal recovery unit. The result of the correlation process between pilot and information signals is the recovered information signal at base band.

The main features of the SCP approach are:

- Simple, cheap and flat passive antenna, suitable for mass production even in mm-Wave frequency bands;

- One channel convenient microwave receiver with simple signal processing;
- Omni directional for the cooperative signal source, but with high Figure of Merit G/T;
- Selection of the different signal sources and polarizations by PN-codes;
- Multi-beam and soft handover features.

3.3. RPSC technology

The RPSC technology was proposed and patented by the author too [6]. It is based on transmission of broadband microwave signals in the open space by means of multi element random phased antenna arrays. The sum of the different element signals in a given point in the space has Gaussian probability distribution and noise like properties. The sums in the different directions of the space are not correlated each other. In such way the proposed principle solves simultaneous the problems of spreading and beam forming.

The main features of the RPSC technology, when it is used in the up-links of the wireless communication links, additionally include:

- Omni-directivity for the cooperative receiving terminal, but high equivalent (at base-band) Equivalent Isotropic Radiated Power (EIRP);
- Selection of different terminals and polarizations by Pseudo-Noise (PN) codes;
- Soft handover and virtual multi-beam features;
- The coherent demodulation by means of pilots (specific property of SCP technology), cancelling the Doppler shift and the phase jitter, introduced by local oscillators in the wireless communication system;
- RPSC up-link protection against terrorist jamming, coming even from points, close situated to the transmitting stations;
- The knowledge of the receiving terminal positions for the transmitting equipment is not necessary;
- The SCP-RPSC approach is a breakthrough technology, leading to unpredictable increase of the frequency reuse factor in the wireless broadband networks. Close situated subscriber terminals could communicate with base stations, using the same frequency channel without interference. The isolation between the terminals is provided by their specific random phase spread coding, aiming to RPSC-MA (Multiple Access).

All of the listed above new Radiocommunication technologies, subjects of the WRC-19 activity, are planned for centimetre and millimetre microwave frequency bands. SCP-RPSC principles and technologies could be successfully used there in order to improve the parameters of the future communication technologies and networks. May be the most important benefit will be transition from “shaped beam” to “steerable beam” mobile networks without complex and expensive electronically scanned multi-beam antenna arrays.

4. Conclusion

The practical SCP-RPSC technology implementation as antenna beam-forming and pattern diversity approach in the future wireless fixed and mobile Radiocommunication systems, subject of the WRC-19 activity, will drastically change the existing paradigm in the broadband terrestrial, HAPS and satellite communication systems in general. Many of the existing problems, dealing with frequency reuse, orbital positions, narrow antenna beam pointing, pattern diversity, terrorist jamming, etc. will be solved successfully. The results of the 25 years long author research activity will be a very strong Bulgarian contribution for the improvement of the security of the modern human society.

5. References

1. Managing spectrum for evolving technologies, ITU News Magazine, N 5, 2019.
2. Johnson, M., - "5G, Opening a new era of digital economy", Sixth Wuzhen World Internet Conference, 21, October 2019 - Wuzhen, China.
3. Demirev, V., “Spatial Correlation Processing – the New Approach in the Broadband Satellite Tracking Systems”, Journal of Electrical and Control Engineering, Volume 3, Issue 5, pp. 49-54, October, 2013.
4. Demirev, V., “Some Important Parameters of the Spatial Correlation Processing Technology “, Journal of Electrical and Control Engineering, Volume 3, Issue 5, pp. 55-64, October, 2013.
5. Demirev, V., “Recent Trends and Future Developments of Vehicle Mounted Satellite Tracking Communication Systems“,CEMA,13, Sofia, pp. 66-69, October, 2013.
6. Demirev, V., “Random Phase Spread Coding – the New Way to Communicate with Noise Signals at Microwaves“, Journal of Electrical and Control Engineering, Volume 4, Issue 2, pp. 1-9, April, 2014.
7. Demirev, V., “Space diversity – essential factor for the security of 5-th G communications”, International Scientific Conference “ConfSec,18”, Borovets, 2018; Security & Future, N 2, pp.72-75, 2018.