BROADBAND SATELLITE SCP-RPSC COMMUNICATIONS – THE NEW CHANCE FOR THE TELEMEDICINE

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Abstract

A new technology, named SCP-RPSC, was developed recently for broadband interactive satellite fixed and mobile terminals. It uses entirely new approach, based on random phase antenna arrays and correlation processing in the receiver. The goal of this report is to discuss the possibilities and the advantages of the implementation of SCP-RPSC technology in satellite communications, particularly as telemedicine subscriber terminal front end equipment.

Keywords: *Spatial Correlation Processing Random Phase Spread Coding Telemedicine*

1. Introduction

The most important use of satellite technology in the health and medical sectors in the near term will be in broadcasting information to the broad public on such matters as how to combat the spread of infections, nutrition, ways to cope with epidemics, finding access to medications or vaccinations, and so on [1]. Today these applications have already saved millions of lives in Asia, Africa, South and Central America, and other parts of the world. The second wave of satellite-based telehealth applications will come as a result of satellite and Internet-based training for medical practitioners and researchers in remote locations. These medical personnel can use these systems to learn the latest treatments, order needed vaccines, train their nurses and medical aides, and otherwise support their operations even in the most isolated locations. Satellite networks now allow remote clinics—whether in a jungle or an off-shore oil rig—to train their nurses, request diagnoses based on high quality video scans, and otherwise assist their operations. Eventually satellite networks will be able to provide a variety of medical services to patients in remote locations as a matter of routine.

One of the biggest technical problems of Satellite Communication Ground Systems (SCGS) for telemedicine is the antenna system. The need to change the polarisation, to select one of several Geo Stationary Orbit Satellites (GEO,s) positions, as well as the requirements for mobile reception, low price and mass market production leads to unsolved by traditional antennas problems. The required antenna gain is above 36 dBi, corresponding to half power beam width of about 4 degrees. Even in fixed telemedicine applications the pointing of the antenna beam to the selected satellite is not easy. Often the base of the antenna support equipment is not stable and due to different factors as strong winds, human activities ets. the satellite reception is a problem. Phased arrays have been used for many years to achieve electronic beam control in applications ranging from communications to radar. An adaptive array is a variation on this which involves the use of the output signals of the array elements in a feedback arrangement to control the phase shifters.

This has found application in communications systems where more sophisticated beam control is required to achieve direction finding and the formation of multiple nulls to avoid jamming signals. Both such arrays depend on a central control system and suffer of many disadvantages when high gain antenna arrays with thousand radiators are employed.

The solving of the SCGS antennas problems needs entirely new approach, which is subject of several years research activity of the author [2], [3], [4]. The name of the new technical solution is Spatial Correlation Processing – Random Phase Spread Coding (SCP-RPSC).

2. SCP approach – objectives and principles of operation

The main objectives of the SCP technology [2], [3] are:

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

The objectives stated above are achieved by a patented method for radio communications, which proposes application of additional pilot signal transmitted in the band of information signals and available in the receiver by one of the known methods for access (for example CDMA-Fig.1). SCP receiver terminal is equipped with antenna array with equal in amplitude and random in 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 the Signal recovery unit. Since the pilot comes from the same direction and propagates in the same random environment to the antenna output, it has the same phase spread signature as the information one. The result of the correlation process between the pilot and information signals is the recovered information signal at base band. The signals coming from other satellites will propagate in different random environment. Their phase spread will be different from those of the chosen pilot and will not correlate with it during the signal processing. This lack of correlation in fact ensures the spatial and polarization selectivity of the SCP system.

One of the main parts of the SCP system is the random phase antenna. In principle all kind of antenna arrays could be used, but for Ku band particular suitable for this purpose is the Radial Line Slot Antenna (RLSA). Until now it is used as phased array for fixed satellite reception.

The main features of the SCP approach in the particular telemedicine applications are:

- Simple, cheap and flat passive radial line antenna, suitable for mass production in Ku and Ka frequency bands and for mounting on cars and unstable bases.
- One channel convenient microwave receiver with simple signal processing.
- Omnidirectional for the cooperative satellite, but with high figure of merit G/T.
- Selection of different satellites and polarizations by PN-codes.
- Applications in existing S-DVB systems with minor modifications of the ground transmitters, compatible with the existing satellite transponders.

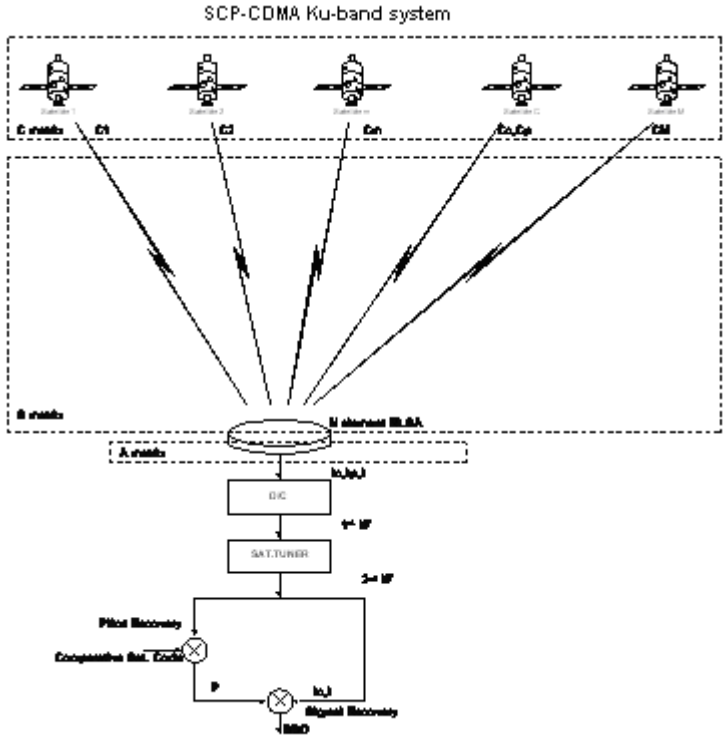

Fig. 1. Block scheme of a SCP-CDMA system

The practical implementation of the SCP approach leads to the problem of pilots transmission through the same propagation environment as that of the cooperative information signals. The CDMA approach matches in the best way to the pilots transmission requirements. The frequency spectrum of a SCP-CDMA system is shown in the Fig. 2 below:

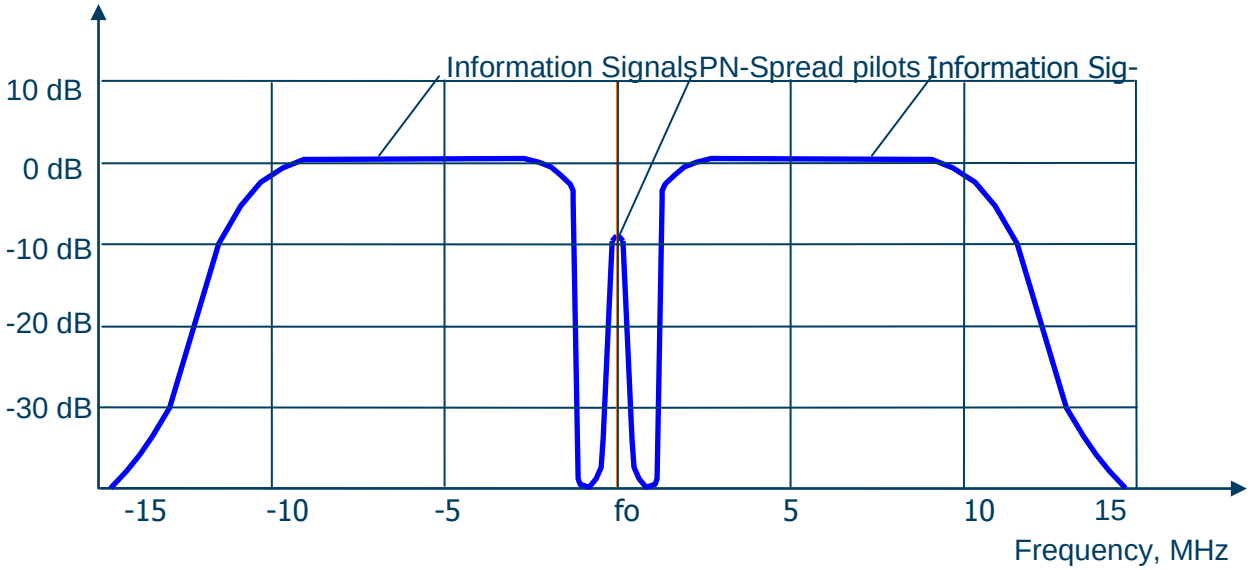

Fig. 2. Frequency spectrum of a SCP-CDMA system

3. SCP-RPSC approach

3.1. Introduction

The idea to use the SCP principle in transmit mode (Ref. 4) was born during the SCP project research. The transmitting antennas, as well as the receiving random phase antenna arrays in SCP technology are pure passive, without any active or nonreciprocal elements. The specific SCP processing is situated in the receiver. According to the basic electromagnetic antenna lows the replacement of the passive transmitting antenna with passive random phase antenna array in the transmitter, and vice versa in the receiver should not change the system working principles and system parameters. The transmitted by the random phase antenna array signals have specific phase spread. It can be considered as random spatial coding. That is why the term SCP-RPSC (Random Phase Spread Coding) will be used instead SCP, transmit in the text below. The signals and the propagation matrix components in the SCP-RPSC case will be denoted with "t".

3.2. The main SCP-RPSC features

The main features of the SCP technology in receive mode are listed in the text above. The proposed SCP-RPSC system will have the following additional features:

- Providing full duplex interactive system with one simple and cheap transmit-receive antenna.
- The transmitted random poly-phase spread signals will not cause significant harmful interference to the conventional satellites, using the same frequency channels. The interference will be similar to that, caused by the sidelobes of a phased antenna array with random inter elements spacing.
- The transmitted random poly-phase spread signals are uniformly radiated in the space above the antenna. Several satellites, equipped with the same SCP receivers and providing space diversity, receive them. The knowledge of the receiving satellites positions for the transmitting equipment is not necessary (as it is for a conventional satellite earth station).
- The SCP-RPSC approach could be a breakthrough technology, leading to unpredictable increase of the frequency reuse factor in satellite and terrestrial wideband networks. Close situated subscriber terminals could communicate with terrestrial or satellite base stations, using the same frequency channel without interference. The isolation between the terminals will be provided by their specific random phase spread coding, due to their specific random design.

3.3. Background of the SCP-RPSC technology

A block scheme of a SCP-RPSC satellite system is shown in fig. 3, where:

(1) is a transmitter of SCP signals (modulated information signals and CDMA-spread pilot signals).

(2) is a Random Phase Antenna Array (RPAA).

(3) is a conventional microwave receiving antenna.

(4) is a conventional one channel receiver with IF output.

(5) is a SCP Pilot recovery unit.

(6) is a SCP Signal recovery unit (correlator).

(7) is a baseband signal processing equipment.

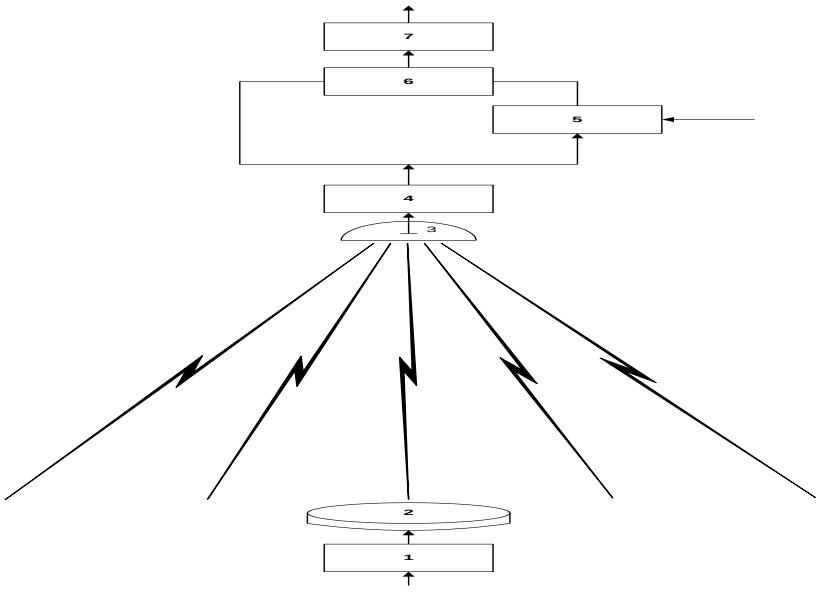

Fig. 3. Block scheme of a SCP-RPSC system

4. Conclusions

The practical SCP-RPSC principles implementations in transmit and receive mode will drastically change the existing paradigm in the satellite communication business in general. Many of the existing problems of the proposed LEO, MEO and GSO satellite systems, dealing with frequency and orbital resource sharing, beam pointing, beam shadowing, etc., will be solved successfully. The SCP-RPSC technology will be particularly useful for the future telemedicine applications in all kinds of their aspects.

5. References

[1]. J. Pelton, R. Oslund, P. Marshall, *Communication Satellites – Global Change Agents*, Laurence Elbaum Associates, London, 2004.

[2] V. Demirev, "SCP technology – the new challenge in broadband satellite communications", *ICEST,04 Proceedings of Papers*, Bitola, Macedonia, vol.1, pp. 159-162, June 16-19, 2004

[3] V. Demirev, A. Efremov, "SCP-CDMA GSO,s system proposal", *ICEST,04 Proceedings of Papers*, Bitola, Macedonia, vol.1, pp. 163-166, June, 16-19, 2004

[4] V. Demirev, "Review of SCP-RPSC technology", *ICEST,05 Proceedings of Papers*, Nis, Serbia and Montenegro, vol. 2, pp.630-633, June 29-July 1, 2005.