REVIEW OF SCP TEST SET-UP AND RESULTS – I

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Abstract

The specific test set-up equipment and the obtained experimental results of the proposed by the author SCP technology are given in the report. Special attention is given to the methods and equipment, suitable to perform SCP processing in the simplest way. Two analog schemes for SCP processing, as well as the obtained by them experimental results, are considered. The results supports the validity of the two main properties of the SCP technology – the spatial selectivity between different radio sources, as well as the obtained high antenna gain. The disadvantages of the used methods, leading to deep ripples of the spatial distribution of the system sensitivity, are mentioned too.

1. BASIC SCP CONCEPT

The block scheme of the basic SCP concept is shown in fig. 1. The objectives of this communication principle is to receive one or more radio signals coming from one or several spatially distributed sources (satellites), insuring high gain of the antenna systems, as well as to ensure spatial selectivity high enough to cancel the same frequency channel interference, coming from different space directions [1].

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 [2]. SCP receiver terminal is equipped with random phased antenna array. The phase shifts of the signals, coming from the antenna elements, are random at the antenna output regardless of the information source direction. These phase spread signals correlate with the recovered pilot signal, phase spread in the same manner, in a correlator. Since this pilot comes from the same direction and propagates in the same random environment to the antenna output, it should have the same phase spread as the information one. The result of the correlation process is the recovered information signal at low intermediate frequency or at baseband. 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.

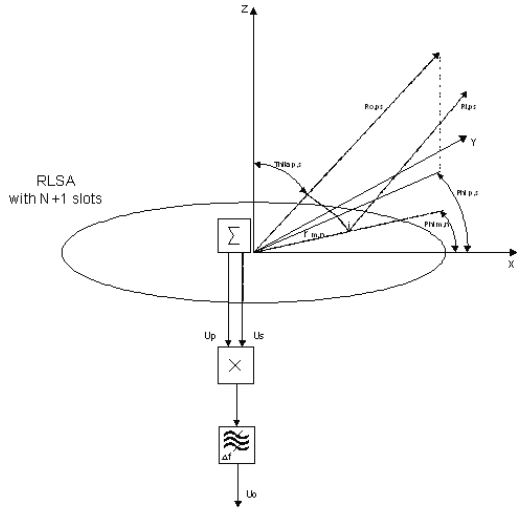

Figure 1. Basic SCP concept block scheme

2. FIRST SCP TEST SET-UP

The objectives of the first tests were to prove in experimental way the SCP approach with available standard equipment, as well as to test in anechoic chamber the shape of the SCP cooperative pattern of a random phased Radial Line Slot Antenna (RLSA) with diameter Φ 30 cm. The experiments were held in the following conditions:

- The tests were held in SkyGate (SG) anechoic chamber facility, the distance between transmit and receive antenna was 3,5 m.
- Two signal generators (simulated pilot and unmodulated information signals) were used (Fig.2).
- Standard detector mount HP 8470 A was used as mixer (correlator) at first IF=1,5 GHz.
- RLSA with diameter Φ=30 cm and with about 300 random distributed slots were used.

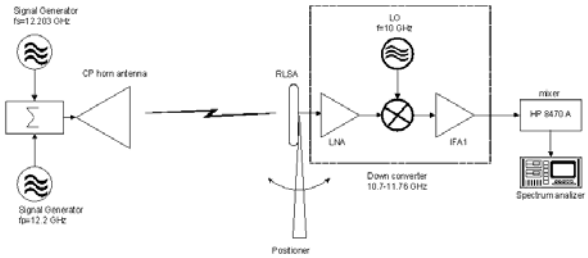

Figure 2. First SCP test set-up

Hundred tests were performed in order to meet the objectives, mentioned above. The variable parameters in the different tests were:

- Frequency
- Slots distributions, inclinations and numbers
- RLSA high and permittivity
- Polarizations and angles of the antenna pattern cuts

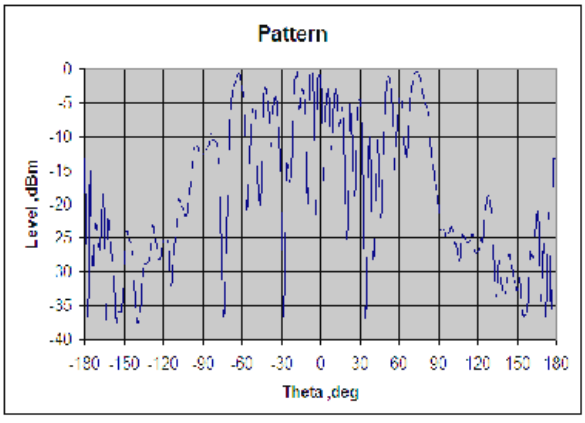

Figure 3. SCP cooperative pattern of RLSA with diameter 30 cm

A typical cooperative pattern of RLSA with Φ 30 cm is shown in fig. 3.

Conclusions, based on the first tests trials, could be summarized as follows:

- The tests proved the main SCP principle – the phase dispreading during the process of correlation, as well as the signal recovery.
- The obtained cooperative patterns are approximately uniform in the tilt angles of +-70 deg., which means that it is possible to use the RLSA in horizontal position as mobile receiving antenna in GSO satellite environment.
- The obtained cooperative patterns suffer from big ripples (up to 20-30 dB). It means that the system will have different sensitivity for different azimuth and elevation angles. As reasons for this ripples at the test time were considered:
  - The phase correlation among the neighbor slots, due to poor design.
  - The low number of slot radiators.

The solution, based on the above conclusions, was that the sensitivity of the equipment, as well as the number of the slot radiators should be increased significant.

3. SECOND SCP TEST SET-UP

The objectives of the second SCP test set-up and trials were to prove in experimental way the SCP approach in receive mode with improved (more sensitive) nonstandard equipment, as well as to test the shape of the SCP cooperative pattern of RLSA - Φ 30 cm and RLSA - Φ 57 cm at different polarizations and simulated satellite Effective Isotropic Radiated Powers (EIRP,s).

The specific conditions here were as follows:

- One RF generator for easy tuning in SG open range conditions was used. Pulse modulation with Fmod=10 KHz was used for 100% amplitude modulation of the RF carrier.
- Modified analog satellite receiver with correlator (analog multiplier) at second IF (480 MHz) was used to improve the sensitivity of the equipment in order to

be closer to the real satellite environment.

- The distance between transmitter and receiver was 3,5 m in anechoic chamber and about 70 m in the open range.

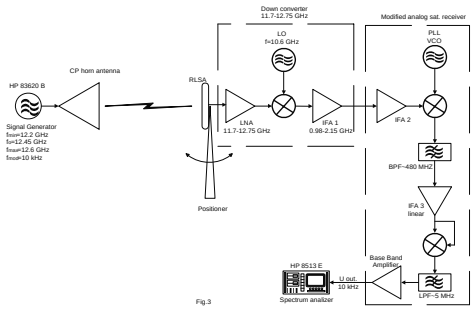

Figure 4. Second SCP test set-up

Hundred tests were performed in order to meet the objectives, mentioned above. The variable parameters in the different tests were:

- Frequency
- Slots distributions, inclinations and numbers
- RLSA high and permittivity
- Polarizations and angles of the antenna pattern cuts
- Satellites EIRP,s

Some of the test results, provided by the second SCP set test-up, are shown in the figures below, as follows:

- Fig. 5. SCP cooperative patterns - test set-up shown in fig.4, RLSA Φ 57 cm, four different cuts of the cooperative SCP pattern.
- Fig. 6. SCP cooperative patterns at differrent simulated EIRP - test set-up shown in fig.4, RLSA Φ 57 cm.
- Fig. 7. SCP cooperative patterns at Right Hand-Left Hand (RH-LH) Circular Polarization - test set-up shown in fig.4, RLSA Φ 57 cm.
- Fig. 8. SCP cooperative patterns - test set-up shown in fig.4, RLSA Φ 30 cm.

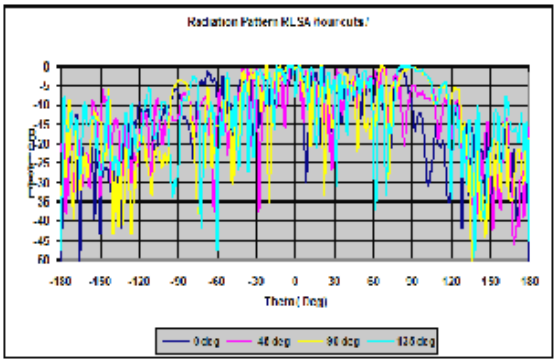

Figure 5. SCP cooperative pattern of RLSA with diameter 57 cm

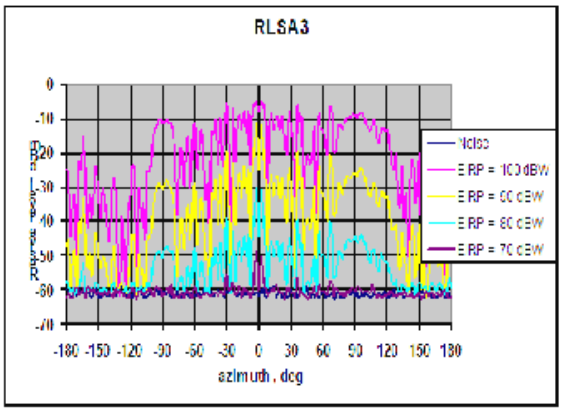

Figure 6. SCP cooperative pattern at different simulated EIRP - RLSA with diameter 57 cm

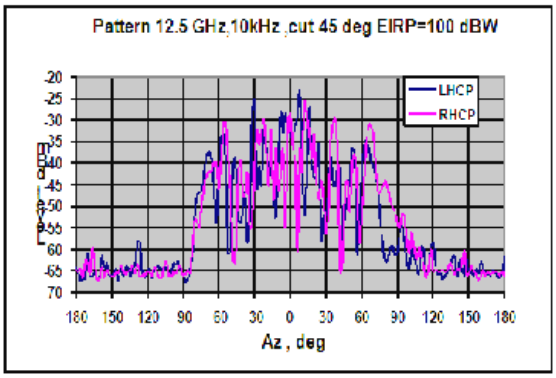

Figure 7. SCP cooperative pattern of RLSA with diameter 57 cm

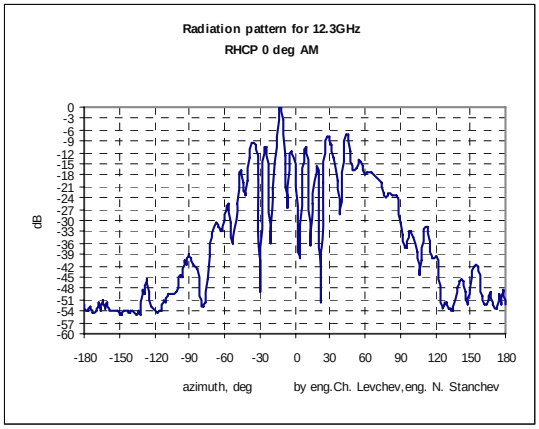

Figure 8. SCP cooperative pattern of RLSA with diameter 30 cm

Conclusions, based on the second tests trials, could be summarized as follows:

- The second generation tests proved again the main SCP principle – the phase dispreading during the process of correlation, as well as the signal recovery.

- The obtained cooperative patterns are approximately uniform in the tilt angles of +-70 deg., which means that it is possible to use the RLSA in horizontal position as mobile receive antenna in GSO satellite environment.

- The test results, shown in fig.6, are very important. They show that the SCP output signals depend on in square low from the EIRP levels (the used receiver is autocorrelation type). This results from the test set-up block-scheme too. In a real SCP-CDMA system the pilot signal will be noise free and his level can be chosen as big as it is necessary for the proper process of correlation. The last means that in such case the SCP output signal will depend linear from EIRP levels. If we reduce the cooperative 100 dBW pattern with 50 dB (EIRP=50 dBW), the computed new pattern will be several dB above the noise floor of the receiver. The last means that the equivalent gain of the RLSA – Φ 57 cm is more than 33 dB.

- The obtained cooperative patterns suffer from big ripples (up to 20-30 dB), which means that the system will have different sensitivity for different azimuth and elevation angles. As reasons for this ripples at the test time were considered:

  – Residual phase correlation among the neighbor slots, due to poor design. For this reason random inclined slots and CP were used in the latest RLSA designs, as well as improved algorithm for random slots distribution.

  – The used signals, as well as the signal processing (correlation) are not exactly the same as that in the proposed SCP system. A precise analysis of the processes in this test system showed that they differ with the proposed in the phase probability density function (in this particular case it is not uniform between 0 and 360 deg.). For this reason SCP test set-up, described in section II, was proposed.

References

[1] V. Demirev, "SCP technology – the new challenge in broadband satellite communications", *ICEST,04 Conference Proceedings,* pp.159-162, Bitola, Macedonia, 2004.

[2] V. Demirev, A. Efremov, "SCP-CDMA GSO,s system proposal", *ICEST,04 Conference Proceedings,* pp.163-166, Bitola, Macedonia, 2004.