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ERHEL, Yvon[1]; LEMUR, Dominique[2]; OGER, Martial[2]; LE MASSON, Jerome[1]
1. C.R.E.C. French Military Academy of Saint-Cyr (France)
2. IETR University of Rennes 1 (France)

Antenna selection in a SIMO architecture for HF radio links

Abstract:
This work takes place in the global design of a SIMO architecture (single input multiple output) for trans horizon radio links, aiming at a significant increase in the data rate if compared with standard modems. As an alternative to spatial diversity, we proposed a compact and heterogeneous antenna array, set up with collocated antennas of different types and presenting a diversity in their polarization sensitivities [1]. Such a device has the advantage of a reduced aperture for practical implementation. Given the number NC of receive channels, the problem consists in the selection of the most effective antennas in a set of NA possible candidates including monopoles, dipoles, loop antennas with various geometries and orientations. The criterion to be maximized is the SIMO outage capacity, a quantity based on the statistical distribution of the SIMO Shannon capacity estimated for a large number of ionospheric channel realizations, each of them being quantified by its channel impulse response including the receive antenna directional responses. For a given receiving site, a channel realization is associated with a set of 5 parameters: link range, azimuth of the transmitter, carrier frequency, date, hour. The corresponding impulse response is computed thanks to the Locapi software developed by IETR. It combines a ray tracing method based on the Bouguer relation valid in non homogeneous media and a MQP model of the electron density, providing the values of attenuation, group delay and angles of arrival which are the significant data. In addition, the polarization characteristics at the ionosphere exit are estimated by a calculation involving a terrestrial geomagnetic field data base and the Budden conditions. Associated with a NEC2D description of an antenna, these polarization estimations make possible a computation of the antenna directional response which is inserted in the channel impulse response.

A reliable statistics of channel realizations is available by making the 5 above mentioned parameters variable: a typical number of tries is approximately 2000. Each simulation results in the computation of NA impulse responses including the directional gains of the NA possible antennas. All combinations of NC antennas among a set of NA possible sensors are then considered and, for each of them, the outage capacity is calculated, involving the statistics of the SIMO Shannon capacity. The final selection is based on the SIMO/SISO gain, which is the ratio dividing the 2 outage capacities, the SISO capacity being computed for a given receive antenna chosen as a reference.

Results : In a given set of NA=10 antennas, one configuration is identified as the most efficient for arrays of NC=3 sensors. Its outage capacity gain, including array and diversity gains, is equal to 4.01. The corresponding outage capacity reaches up to 4.21 bits/s.Hz what seems promising if compared with standard modems.

[1] A method of direction finding operating on an array of collocated antennas Y.ERHEL, L.BERTEL and F.MARIE 1998 IEEE-A.P. international symposium, Atlanta 21-26 June 1998, vol.1, pp 207-210