RESEARCH OF MULTIANTENNA SYSTEMS OF TELECOMMUNICATION NETWORKS

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Abstract

In the given work different types of multiantenna systems are investigated: with several aerials on transferring or on the reception party, and also on both parties simultaneously (MIMO, Multiple Input Multiple Output). Different kinds of processing of signals, as on transferring (STBC, Space-Time Block Coding) and on reciving to the party (BLAST, Bell Laboratories Layered Space-Time) are considered.Influence of multiantenna systems on the basic indicators of wireless neetworks (probability of occurrence of bit errors, speed of transfer data) is investigated.

Keywords: STBC, SDMA,MISO, MIMO.

Increase of demand for services of a cellular telephony and means of wireless access to telecommunication networks leads to necessity continuously to increase capacity of existing systems. As we remember, the capacity of cellular system expressed in density of the traffic, falling to area unit, depends on many factors. Those are:

- width of the frequency range, allocated to system;
- width of the spectral channel demanded for one bearing;
- a used method multistation / plural access;
- a modulation kind;
- methods of reception and processing of an information signal;
- admissible size of the relation a signal/noise;
- type of aerials of base stations, in particular quantities of antenna sectors.

1. DESTINATION OF MULTIANTENNA SYSTEMS

The major factor thanks to which there is a possibility in the near future essentially to increase capacity of systems of a mobile communication, systems of antennas are. For achievement of high speeds of data transmission in modern stationary and mobile communication systems use the multiantenna technics - MEA, Alamouti STC (STBC), SDMA, MISO, MIMO.

The multiantenna system can be considered as a communication system with several spatial channels. All channels work in the same strip of frequencies at a time and are divided only at the expense of spatial diversed radiating and reception antennas. Possibility of the organisation of many spatial channels explains high spectral efficiency of multiantenna systems by working out of high-speed communication systems.

The easiest way of improvement of throughput of a complex network is equipment of a point of access by set of antennas, each of which serves a separate final point.

This method is called SDMA, it has the positive side: only it is necessary for access point to be equipped with plural antennas. In this connection the expenses connected with increase of throughput, it is mentioned only one point of a network - an access point.

Method SDMA is effective and economical way of increase in throughput by increase in quantity of the devices simultaneously informed with a point of access. The method realises a pure prize in the throughput, linearly dependent on quantity of the antennas located on a point of reception. The increase in quantity of antennas twice will lead to a doubling of the general throughput.

The technology of existential coding Alamouti named also space-time block coding STBC is the most simple technics using diversed of transferring antennas. Its application does not assume knowledge of characteristics of a radio channel by transfer and does not demand difficult algorithms of processing of signals at reception. A lack of technology STBC of that. That it provides not so high speed of an information transfer, as other ways of spatial coding.

Capacity of a signal on an exit of system of existential coding is equal to the sum of the capacities arriving in the receiver from all betraying antennas. At identical fading the STBC-system prize in SNR is equal to number of radiating antennas. Advantage of the considered system of existential block coding that it is reached without complication of the reception block.

MISO (Multiple Input Single Output) - scheme Alamouti is used in standard IEEE 802 (WiMAX). Generally initial scheme Alamouti is calculated on presence 2M transmitters and M of receivers, however at corresponding increase in number of intervals of radiation or orthogonal frequencies for reception it can appear enough and one antenna. In particular, coding is made for four transmitters under so-called extended Alamouti scheme.

Technology MIMO (Multiple Input Multiple Output) assumes in the transmitter, and in the receiver use of several antennas. Them often name systems with many inputs and many exits. In the receiver the problem of division and an estimation radiated Nt signals dares. For this purpose it is necessary to solve system from Nr the equations with Nt unknown persons. At Nr = Nt it is possible to take advantage of a matrix, a return matrix of the channel. At Nr> Nt it is possible to apply the generalised inversion which is turning out at the decision of system by a minimum mean-square error – MMSE [1].

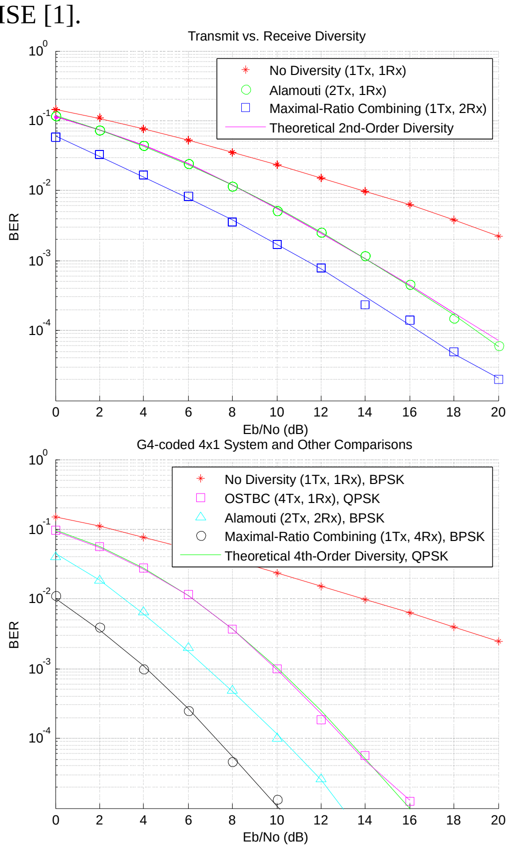

Fig. 1. Dependences of bit error rate on a signal to noise ratio for various multiantenna systems

Carrying out of the analysis of characteristics of antenna systems (fig. 1) is important. The MIMO-communication system provides an information transfer on Nt to spatial channels. All channels work in the same strip of frequencies and are divided only at the expense of spatial diversed radiating and reception antennas. If to draw an analogy with wire systems the considered MIMO-system is similar to a communication system with Nt the feeders connecting the transmitter with the receiver. Traditional (SISO - Single Input Single Output) the communication system with one spatial channel is an analogue of wire system with one feeder [3,5].

2. Use many antenna systems in telecommunication networks

On fig. 2 the structure of system MIMO from Nt antennas of the transmitter and Nr receiver antennas is shown. Data in binary system d are coded by step RC, alternating, turn in Nt parallel data flows, so-called layer, are modulated to a character set of level of M and moves on the antenna. The coding can be spent by alternation of each stream after series-parallel transformation. If the coding is made before series-parallel transformation the coded data can be transferred to the carried antennas of the transmitter. If channel coding occurs after series-parallel coding at decoding reduction of factor of errors is possible, in particular at successive interference cancellation SIC.

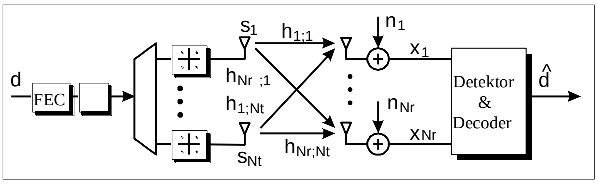

Fig. 2. Model MIMO - systems from Nt antennas of the transmitter and Nr receiver antennas.

Provided that capacity of radiation of each antenna of the transmitter is normalised and data - uncorrelated the autocorrelation matrix represents an individual matrix.

An autocorrelation matrix of noise we will accept also is individual, but a proportional dispersion of noise. The channel matrix contains not correlated, complex factors with distribution of Gauss and an individual dispersion.

As the receiver detector ML use (Maximum - Likelihood Detector), definition of the greatest probability working on a method would be the best. Detector ZF application (Zero - Forcing Detector) or with the minimum mean-square error (MMSE - Detector) is possible. A lack of the listed detectors is their rather low efficiency. Alternative is technology BLAST (Bell Labs layered space-time). The algorithm has updatings D-BLAST and V-BLAST. Algorithm D-BLAST allows to receive, basically, higher speeds of an information transfer, but is more combined in realisation. As losses in speed at transition from D-BLAST to more simple algorithm V-BLAST are insignificant, to the second algorithm the preference is given [2].

On fig. 3 linear detectors LD-ZF and LD-MMSE, and also linear detectors SQRD - PSA and detector ML are presented. Calculation is spent for not coded QPSK-signal, quantity of antennas of transfer Nt=4, reception Nr=4.

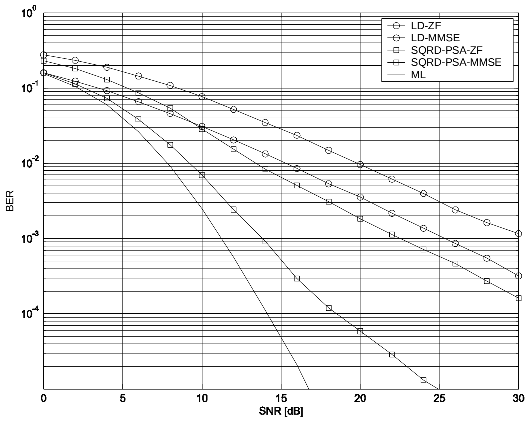

Fig. 3. Characteristics of detectors

At high speeds of transfer the method of coding of the data, named orthogonal frequency division of channels with multiplexing (OFDM) is applied. The stream of transferred data is distributed on set of frequency subchannels and transfer is conducted in parallel on all such subchannels. Thus high speed of transfer is reached at the expense of simultaneous data transmission on all channels whereas speed of transfer in the separate subchannel can be and low. Technology MIMO allows to increase peak throughput of the data link to proportionally number of active antennas. The technology allows to bypass the restrictions inherent in OFDM-modulation, used by devices of standard IEEE 802.1g. The increase in speed of data transmission is reached thanks to different channels of data for transfer of the office information and a useful content. Application of set of antennas allows to increase a cover zone essentially. On fig. 4 block diagramme MIMO-OFDM of the transmitter and the receiver is presented.

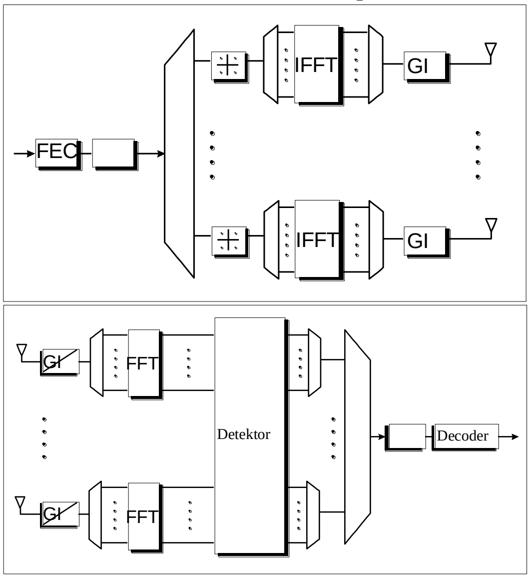

Fig. 4. Block diagramme MIMO-OFDM of the transmitter and the receiver

The way of division of the broadband channel on orthogonal frequency subchannels is called as orthogonal frequency division with multiplexing (OFDM). For its realisation in sending devices return fast transformation Fourier (IFFT), translating preliminary multiplexed on n-channels a signal from time representation in frequency, and in a reception - fast transformation Fourier (FFT), carrying out inverse function is used. Technology OFDM does not exclude multibeam distribution, but creates preconditions for elimination of effect of an intersymbolical interference [4].

3. Conclusion

1. Use of multiantenna systems allows to receive the best values of bit error rate at the same value of a signal to noise ratio. And use of various kinds of modulation and algorithms signal processing occurs to increase in number of antennas not only decrease in bit error rate increase in speed of data transmission.
2. The optimum choice of quantity of transferring and reception antennas, methods of formation of diagrammes of an orientation, type of modulation and detecting systems, algorithm of processing of a signal is of interest for telecommunication networks. Such task probably to solve only introduction of model which will provide a choice:
   - parametres of multiantenna system,
   - kind of modulation and coding of a signal,
   - algorithm of processing of a signal.

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