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A Proposal of Optimal Strategy for Emptying the Buffer at the MIMO Transmitter based Spatial Multiplexing Techniques

Svetlana Furtula[1], Ranko Vojinović[2]

Student, Faculty of Information Technology, Podgorica, Montenegro [1]

Assistant professor, Faculty of Information Technology, Podgorica, Montenegro [2]

Abstract: In this paper, weanalyse the buffer behaviour in MIMO transmitter, depending on the traffic incoming intensity and service discipline of the outgoing process, respectively, depending on the buffer filling and emptying processes. Using a mathematical study and a simulation model we propose an optimal strategy for employing the buffer at the MIMO transmitter based spatial multiplexing techniques.

Keywords: MIMO, spatial multiplexing, buffers, M/M/1/c.

I. INTRODUCTION

The main characteristic which allows that 802.11n systems has better performances than the previous 802.11a/b/g systems, is MIMO (Multiple-Input Multiple-Output) technology [1]. The main idea of MIMO is to improve quality (BER)and/or data rate (bits/sec)by using multiple antennas at the transmitter and receiver.MIMO technology has attracted attention in wireless communications, because it offers significant increases in data throughput and link range without requiring additional bandwidth or transmit power [2].

There are various categories of MIMO techniques. A commonly used techniqueis spatial multiplexing [3].Spatial multiplexing is used to transmit simultaneously independent and separately encoded data signals, so called streams, from each of the multiple transmit antennas, over the same radio frequency channel. Therefore, the space dimension is reused, or multiplexed, more than one time. The main goal of the technique is to achieve high data rates.

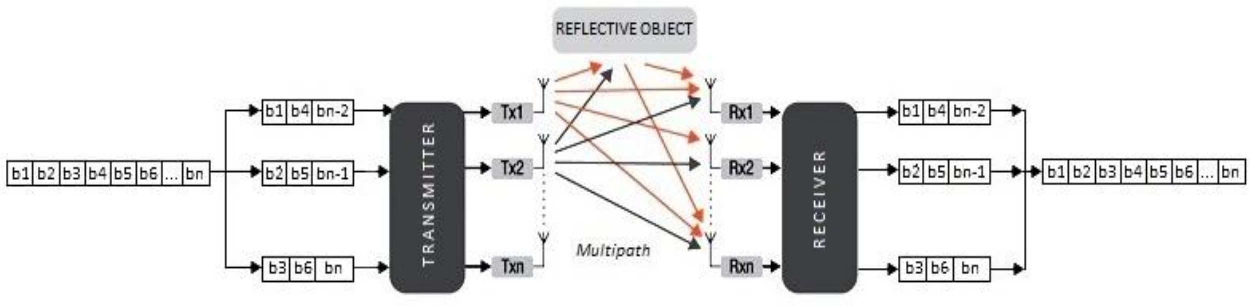

Fig. 1. Spatial multiplexing

We assume that inputdata packets are buffered at the transmissionside of MIMO system,before the packets will be sent to a circuit that performs modulation and mapping of the packets to certain antennas, as shown in Fig.1.

One of the problems is to determinebuffer capacity in a function of traffic intensity, in order to prevent buffer overflow, respectively, packet loss. In this case, it is necessary to determine an optimal strategy for emptying the buffer.

The rest of thispaper is organized as follows. In Section II, M/M/1/C model is analized. In Section III, a model service discipline that gives the optimal strategy for emptying the buffer is proposed. Also, results of the analizes and its comparison is described in the Section III. in MIMO systems

II. M/M/1/C MODEL

Data packets (b_1, b_2, $b_{3, \dots,}$ b_n)arriveat the transmission part of MIMO system, and before spatial multiplexing they are stored in bufferwith limited capacity C.

We assume that the data packets arrive random from different sources, and the arrival process can be described as a Poisson process, with parameter λ while the service discipline in the buffer is exponential as well, with parameter μ. Obviously, the system was presented as M/M/1/C modelwhich means in the buffer can be stored C packets[4]. The case when the buffer is empty is included too.If the buffer is full, all packets that arrive will be lost. In this case, appropriate parameters are:

$$\lambda_n = \begin{cases} \lambda \text{ for} n = 0,1,\dots,c-1 \\ 0 \text{ for} n = c, c+1 \end{cases} \quad (1)$$

We will define ρ = λ/μ as the traffic intensity of the system which is a ratio of the arrival and service rates.

For ρ϶ (0,□) \ {1}, we have:

$$S_0 = (1 + \rho + \rho^2 + \dots + \rho^{c+1})^{-1} = (1-\rho) / (1-\rho^{c+2}) \quad (2)$$

and for ρ = 1, we have:

$$S_0 = \frac{1}{c+2} (3)$$

where S_0 is the probability that the buffer is empty.

Probability of state of the buffer in a moment when a packet is in a multiplexing queue are:

$$S_n = \rho^n S_0 n = 1, 2, \dots, c \quad (4)$$

Respectively,

$$S_n = \begin{cases} \frac{\rho^n(1-\rho)}{1-\rho^{c+1}} & for\ \rho \neq 1 \\ \frac{1}{c+2} & for\ \rho = 1 \end{cases} \quad (5)$$

With L we denote the packet error probability, so, effective throughput, T, or probability that the incoming packet will be multiplexed is:

$$T = \lambda (1-L) \quad (6)$$

The probability of opposite event will be:

$$\overline{T} = 1 - \lambda (1 - L) \quad (7)$$

The packet will not be multiplexed when in the observed interval does not have incoming packets. So,the expression of the expected number of packets that are lost because of overdraft capacity of the buffer will be:

$$L = \rho^{c-1} \frac{1-\rho}{1-\rho^{c+2}} \quad (8)$$

III. RESULTS ANALYSIS

Firstly, let us review the basic foundations of the model which has been presented in details in [5].

Input flow packets which arrive from different sources are random, so, the statistics of incoming packets in a buffer of limited capacity, are treated asPoisson process. Service discipline of a transmitter is such that buffers empty with constant flow.

The probability of arrival of k packets in a certain time interval is:

$$P_A(k) = \frac{\lambda^k e^{-\lambda}}{k!} (9)$$

where λ is expected number of packets in the interval.
Probability of state of the buffer is given by the expresion:

$$S_n = \sum_{k=0}^{n} S_k\, P_A(n-k) for 1 \leq n \leq C-1 \quad (10)$$

The packet error probability is:

$$L = 1 + \frac{S_0\, e^{-\lambda} - 1}{\lambda} (11)$$

Secondly, we compare the results obtained in [5] with results obtained usingthe M/M/1/C model.

We note that the M/M/1/C model is indicated by the full lines and the other model is indicated by the dashed lines.

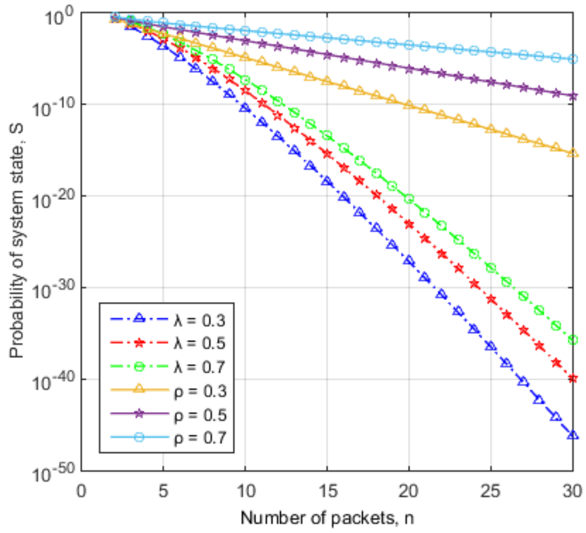

Fig.2. The probability of system state depending on number of Packets

Fig. 2. shows the probability of the system state S depending on numbers of packets n for the chosen values of λ(λ = 0.3, λ = 0.5 and λ = 0.7)and ρ (ρ = 0.3, ρ = 0.5 and ρ = 0.7). It can be seen that the probability of the system state decreases with increasing of the number of packets in the both model but there are differences between them. When the number of packet is very small, the probabilities are almost approximate, but with the increasing the number of packets, the probability of system state of the M/M/1/C model is much higher than the probability of system state of theother model.

Fig. 3. shows the packet error probability depending on the capacity of the buffer due to the buffer capacity distortionfor the chosen values of λ (λ = 0.3, λ = 0.5 and λ = 0.7) and ρ (ρ = 0.3, ρ = 0.5 and ρ = 0.7). It can be observed that the packet error probability decrees with increasing of the buffer capacity. With the larger buffer capacity, the packet error probability of the M/M/1/C model is much higher than the packet error probability of the other model.

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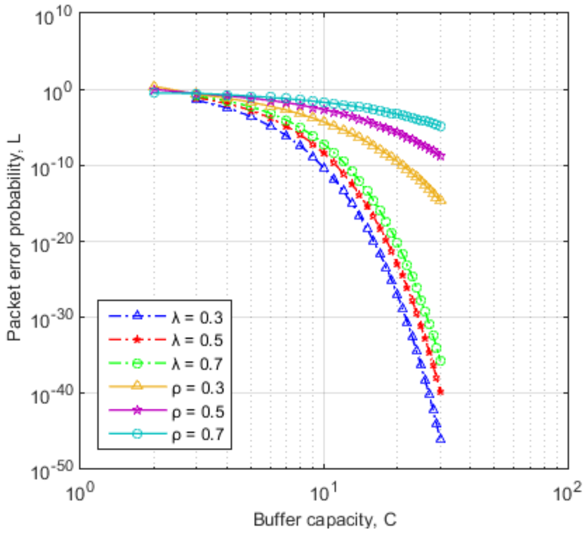

Fig.3. The packet error probability depending on the capacity of the buffer due to the buffer capacity distortion

IV.CONCLUSION

This paper presents the results obtained by analysingbuffer behaviourin MIMO transmitter depending on the buffer filling and emptying processes. Using a simulation model, realized in MATLAB, and the theoretical analysis confirm that the strategy for emptying the buffer with constant output flow is an optimal strategy for emptying the buffer that may well approximate the spatial multiplexing of packets that are buffered and forward them to transmit antennas

REFERENCES

[1] RachanaKhanduri and S.S. Rattan, "Performance Comparison Analysis between IEEE 802.11a/b/g/n Standards",International Journal of Computer Applications (0975 – 8887) Volume78– No.1, September 2013s.
[2] Andreas F. Molisch and Moe Z. WinSadk, "MIMO Systems with Antenna Selection", IEEE Microwave magazine, March 2004.
[3] Hardeep Singh and Lavish Kansa, "Performance Analysis of MIMO Spatial Multiplexing using different Antenna Configurations and Modulation Techniques in AWGN Channel", Volume 14, Issue 5 Version 1.0, Year 2014.
[4] Richard M. Feldman, Ciriaco Valdez-Flores, "Applied Probability and Stochastic, Processes", Springer, 2010.
[5] RankoVojinović and Svetlana Furtula, "Buffer behaviour in Massive MIMO systems", International Journal of Advanced Research in Computer and Communication Engineering, Vol. 5, Issue 5, May 2016.

BIOGRAPHY

Svetlana Furtula received B.Sc. and Spec.Sc. degrees in Information Technologies from University of Mediterranean, Montenegro, in 2013 and 2014, respectively. She was an exchange master student in Telecommunications at University of L'Aquila, Italy, in 2015. From 2016 to 2017, she worked in a Department of Telecommunications in Montenegro Police Directorate. Currently, she does her master thesis and her main research interests are in telecommunication networks.

Ranko Vojinović received the B.Sc. degree in Electrical Engineering from University of Montenegroin 1982, and the M.Sc. and Ph.D. degrees from University ofBelgrade in 1992 and 2003, respectively. Since 1982 he has worked in a Department of Telecommunications in Montenegro Police Directorate. From 1996 to 2006, he was with the Maritime faculty at the University of Montenegro.In 2007 he joined the Faculty of Information Technologies of the University "Mediterranean" (Montenegro), where he is currently an Assistant Professor, teaching several courses in computer networks. His main research interests are in telecommunications and modelling and analysis of network protocols.