

Spatial Methods for Increasing the Bandwidth of a Mobile Information Network

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Abstract—In the presented work, a comparative analysis of the bandwidth of information networks of mobile communications is carried out, with a change in the frequency resource of the network and the spatial selectivity of the antenna systems of base stations. It was shown that the use of adaptive antenna systems at the base station allows to achieve a significantly larger increase in network bandwidth compared to an increase in the frequency resource. It is also possible to implement parallel data reception with simultaneous suppression of interfering signals and to coordinate the maximum coverage area of the base station both in the downlink and in the uplink. This allowed us to propose methods to increase the bandwidth of the information network, based on spatial and random methods, in which complex signals are used to coordinate the energy budgets of the downlink and uplink.

Keywords—bandwidth; information network; mobile communication network; Space Division Multiple Access; adaptive antenna system; Multiple Input Multiple Output; antenna pattern

REFERENCES

- [1] V. Grigoriev, O. Lagutenko and Y. Raspayev, *Seti i sistemy radiodostupa [Radio Access Networks and Systems]*. Moscow: EKOTRENDZ, 2005. (In Russian).
- [2] H. Alazemi, A. Margolis, J. Choi, R. Vijaykumar and S. Roy, "Stochastic modelling and analysis of 802.11 DCF with heterogeneous non-saturated nodes", *Computer Communications*, vol. 30, no. 18, pp. 3652-3661, 2007. doi: 10.1016/j.comcom.2007.07.007.
- [3] I. Abboud, "Design and Implementation Adaptive Antenna System in WiMAX (IEEE 802.16d)", *Engineering and Technology Journal*, vol. 33, no. 1, pp. 165-174, 2015.
- [4] M. Lotter and P. van Rooyen, "Space division multiple access for cellular CDMA", 1988 IEEE 5th International Symposium on Spread Spectrum Techniques and Applications - Proceedings. Spread Technology to Africa (Cat. No.98TH8333). doi: 10.1109/isssta.1998.722521.
- [5] G. Tsoulos, J. McGeehan and M. Beach, "Space division multiple access (SDMA) field trials. Part 1: Tracking and BER performance", *IEE Proceedings - Radar, Sonar and Navigation*, vol. 145, no. 1, p. 73, 1998. doi: 10.1049/ip-rsn:19981782.
- [6] F. Shad, T. D. Todd, V. Kezys and J. Litva, "Indoor SDMA capacity using a smart antenna base station," *Proceedings of ICUPC 97 - 6th International Conference on Universal Personal Communications*, San Diego, CA, USA, 1997, pp. 868-872 vol.2. doi: 10.1109/ICUPC.1997.627287
- [7] B. Suard, G. Xu, H. Liu and T. Kailath, "Uplink channel capacity of space-division-multiple-access schemes", *IEEE Transactions on Information Theory*, vol. 44, no. 4, pp. 1468-1476, 1998. doi: 10.1109/18.681322.
- [8] P. Gupta and P. Kumar, "The capacity of wireless networks", *IEEE Transactions on Information Theory*, vol. 46, no. 2, pp. 388-404, 2000. doi: 10.1109/18.825799.
- [9] H. Yin and H. Liu, "Performance of space-division multiple-access (SDMA) with scheduling", *IEEE Transactions on Wireless Communications*, vol. 1, no. 4, pp. 611-618, 2002. doi: 10.1109/twc.2002.804188.
- [10] M. Franceschetti, M. Migliore and P. Minero, "The Capacity of Wireless Networks: Information-Theoretic and Physical Limits", *IEEE Transactions on Information Theory*, vol. 55, no. 8, pp. 3413-3424, 2009. doi: 10.1109/tit.2009.2023705.
- [11] Z. Luo, W. Shum and G. Zhao, "User capacity analysis of space division multiple access channel", *Conference Record of the Asilomar Conference on Signals, Systems and Computers*, vol. 1, pp. 223-227, 2003.
- [12] N. Kikuma, K. Nishimori and T. Hiraguri, "Effect of User Antenna Selection on Block Beamforming Algorithms for Suppressing Inter-User Interference in Multiuser MIMO System", *IEICE Transactions on Communications*, vol. 101, no. 7, pp. 1523-1535, 2018. doi: 10.1587/transcom.2017cq0001.
- [13] A. Dia and M. Saito, "A study on channel capacity of MIMO systems with a receiver with antenna pattern modulation", *2017 International Symposium on Antennas and Propagation (ISAP)*, 2017. doi: 10.1109/isapn.2017.8228953.
- [14] M. Saito, "Periodically Variable Antenna Pattern for Maximizing Path Diversity Gain in MIMO Receivers," *2018 5th IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON)*, Gorakhpur, 2018, pp. 1-6. doi: 10.1109/UPCON.2018.8597063.
- [15] K. Henderson, *Adaptive Antenna System for Both 4G LTE and 5G Cellular Systems*. Alabama: ProQuest Dissertations And Theses; Thesis (M.S.E.E.) - University of South Alabama; Masters Abstracts International, 2017.
- [16] S. Dastoor and N. Patel, "Adaptive Antenna System: Design and Applications for the Next Generation Mobile Devices", *International*

Journal of Engineering and Innovative Technology (JEIT), vol. 1, no. 2, pp. 134-139, 2012.

- [17] D. Voskresenskiĭ and A. Kanashchenkov, *Aktivnye fazirovannyye anteny reshетки [Active phased array antennas]*. Moskva: Radiotekhnika, 2004, p. 488. (In Russian).
- [18] K. Fujimoto, *Mobile antenna systems handbook*, 3rd ed. Boston: Artech House, 2008, p. 769.
- [19] A. Babaskin, V. Kalinichev and R. Mtech, "Koltsevaya antennaya reshетка dlya tochek dostupa s polnym pokrytiem po azimutu" [Ring antenna array for access points with full azimuth coverage], *Zhurnal radioelektroniki*, no. 6, pp. 5-16, 2014. (In Russian).
- [20] I. Obod, L. Nikitina, S. Nikitin and I. Svyd, Kharkiv National University of Radio Electronics, "Sposib peredachi informatsiyi [Method for information transmission]", UA 70955 U, 2012. (In Ukrainian).
- [21] I. Obod, I. Svyd, O. Maltsev, G. Maistrenko, O. Zubkov and G. Zanolodko, "Bandwidth Assessment of Cooperative Surveillance Systems," *2019 3rd International Conference on Advanced Information and Communications Technologies (AICT)*, Lviv, Ukraine, 2019, pp. 1-6. doi: 10.1109/AIACT.2019.8847742.
- [22] I. Obod, I. Svyd, O. Maltsev, O. Vorgul, G. Maistrenko and G. Zanolodko, "Optimization of Data Transfer in Cooperative Surveillance Systems," *2018 International Scientific-Practical Conference Problems of Infocommunications. Science and Technology (PIC S&T)*, Kharkiv, Ukraine, 2018, pp. 539-542. doi: 10.1109/INFOCOMMST.2018.8632134.
- [23] I. Svyd, I. Obod, O. Maltsev, I. Shtykh, G. Zanolodko and G. Maistrenko, "Model and Method for Request Signals Processing of Secondary Surveillance Radar," *2019 IEEE 15th International Conference on the Experience of Designing and Application of CAD Systems (CADSM)*, Polyana, Ukraine, 2019, pp. 1-4. doi: 10.1109/CADSM.2019.8779347.
- [24] I. Svyd, I. Obod, O. Maltsev, T. Ôkachova and G. Zanolodko, "Optimal Request Signals Detection in Cooperative Surveillance Systems," *2019 IEEE 2nd Ukraine Conference on Electrical and Computer Engineering (UKRCON)*, Lviv, Ukraine, 2019, pp. 1-5. doi: 10.1109/UKRCON.2019.8879840.
- [25] I. Svyd, I. Obod, O. Maltsev, O. Vorgul, G. Zanolodko and A. Goriushkina, "Noise Immunity of Data Transfer Channels in Cooperative Observation Systems: Comparative Analysis," *2018 International Scientific-Practical Conference Problems of Infocommunications. Science and Technology (PIC S&T)*, Kharkiv, Ukraine, 2018, pp. 509-512. doi: 10.1109/INFOCOMMST.2018.8632019.
- [26] D. B. Pavlova, G. E. Zanolodko, I. I. Obod, I. V. Svyd, O. S. Maltsev and L. F. Saikivska, "Comparative Analysis of Data Consolidation in Surveillance Networks," *2019 10th International Conference on Dependable Systems, Services and Technologies (DESSERT)*, Leeds, United Kingdom, 2019, pp. 140-143. doi: 10.1109/DESSERT.2019.8770008.
- [27] I. Svyd, I. Obod, O. Maltsev, I. Shtykh, G. Maistrenko and G. Zanolodko, "Comparative Quality Analysis of the Air Objects Detection by the Secondary Surveillance Radar," *2019 IEEE 39th International Conference on Electronics and Nanotechnology (ELNANO)*, Kyiv, Ukraine, 2019, pp. 724-727. doi: 10.1109/ELNANO.2019.8783539.
- [28] D. B. Pavlova, G. E. Zanolodko, I. I. Obod, I. V. Svyd, O. S. Maltsev and L. F. Saikivska, "Optimizing Data Processing in Information Networks of Airspace Surveillance Systems," *2019 10th International Conference on Dependable Systems, Services and Technologies (DESSERT)*, Leeds, United Kingdom, 2019, pp. 136-139. doi: 10.1109/DESSERT.2019.8770022.