Emerging Antennas for Modern Communication Systems

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This paper presents three types of antennas, which have been created and tested at the Warsaw University of Technology – antennas with photonic, ferroelectric and semiconductor elements.

Nowadays, a continuous progress in new generation services offered to the users of communication systems led to the need for very rapid development of both backbone and access networks. The strongest growth is visible for wireless systems, which offer mobility, flexibility, ease of installation and modernization of the network. Modern wireless devices: mobile phones, laptops, tablets etc., stimulate the development of services that combine simultaneous transmission of voice, data and multimedia content, resulting in the need to ensure the requirements for the transmission parameters for each of them. These requirements include: high capacity, high data rate, the security of transmitted information, system reliability, scalability and flexibility. To use the advantages of fiber-optic communication, while leaving the benefits of wireless transmission, such as flexibility and the ability to develop and modify the structure of the network, an idea of Wireless over Fiber (WoF) systems has been widely introduced. Our idea was designing and investigation of photonic antenna stations for bidirectional transmission in the last mile. Three different photonic antenna stations in the last mile WoF links have been tested. For construction of antenna stations commercially available optoelectronic devices have been used. The solutions differ from each other by the mean of ensuring separation between transmitting and receiving modes of operation. The separation is realized on the microwave side. All antenna stations have been designed, realized and measured in various kinds of measurements. The results prove that all propositions can be successfully applied to uplink and downlink IEEE 802.11b/g wireless LAN systems, employing WoF technique.

An smart or adaptive antennas are the most suitable for wireless communication, especially for 3G and 4G systems. The key property of the intelligent technology is the ability to respond automatically by changing an appropriate radiation pattern. The best solution will be the possibility for dynamic reconfiguring of the antenna aperture. Many solutions of the reconfigurable antennas have been described in the literature. The key elements of the antenna, which has been presented in this paper, are individually controlled SPIN diodes. This antenna shows the extensive functionalities. First of all, it can be used as the conventional frequency scanning antenna. It is easy to see, that the reconfigurable antenna can direct radiation beam to desire direction. The first additional possibility in comparison with the conventional waveguide slot antenna, is that the reconfigurable antenna can be used for operating at one frequency, but with generating two or more different radiation patterns at different moments. Changing the configuration of the reconfigurable elements between e.g. two configurations, there is a possibility to achieve two different radiation patterns for the same frequency. The second extending possibility of the presented reconfigurable antenna is that the antenna can operate at different frequencies with supporting radiation in the same direction.

Advances in several areas of materials science have led to a variety of new materials with strong potential applications to microwave and millimeter-wave components. The high tunability and low dielectric losses are only the desired properties of material which can be applied in the tunable micro- and mm-wave devices. A number of the device configurations are a promising solution to inexpensive steering. A new low-cost scan antenna concept (without phase shifters) has been presented. The substrate of the presented microstrip antenna has been made using a ceramic–polymer composite with modified ferroelectric powder Ba Sr TiO and an appropriate polymer (grains of the powder were sprayed into polymer with the use of a specific method). The ceramic–polymer composite was designed to change permittivity in response to an applied electric control field for antenna utilization. It allows changing the electrically phase constant of the propagation wave and in result - changes of the main beam direction. Currently, different compositions of the ceramic polymer with modified ferroelectric powder have been investigating.