RF-NEMS Integrated Frequency Reconfigurable Antenna for Waveform Diversity Schemes

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True benefits of newly emerging adaptive wireless communication systems can only be exploited through a smart design that is able to effectively respond to the constantly changing wireless channel. Waveform Diversity exploits different transmitted waveforms from a single system to improve performance [1]. This technology allows one or more sensors onboard a platform to automatically change operating parameters such as frequency, gain pattern, polarization to meet the requirements for varying channel conditions. To this end, different diversity dimensions such as spatial, temporal, polarization, frequency and modulation can be used. Most of the adaptive technologies as investigated in the current literature, however, implicitly assume communication devices with fixed RF front-ends and focus on system optimization at a "software" or algorithmic level. In other words, the intelligence resides in the signal processing used in conjunction with an array of dumb antennas. On the other hand, a multifunction reconfigurable antenna (MRA) enables a single antenna to perform multiple functions by dynamically changing its geometry thereby introducing ***important additional degrees of freedom*** in adaptive system parameters as is evident from recent R&D results [2, 3]. In order to dynamically change the properties of an MRA, the current distribution over the volume of the antenna needs to be changed, where each distribution corresponds to a different mode of operation. To this end, one can change the geometry of the antenna by switching on and off various geometrical metallic segments (pixels, strips, etc) that make up the MRA. Nanoelectromechanical system (NEMS), microelectromechanical system (MEMS) or semiconductor electronic type switches (p-i-n diode, FET, etc) can be employed to achieve the required switching. In our work, we prefer using NEMS switches due to monolithic integration capability with antenna segments along with their very low loss characteristics. NEMS switches that we are currently developing are 200-1000 times smaller than their MEMS counterparts. They require only 5-10 Volts actuation voltage and switch much faster (a few tens of nanosecond). This switching speed allows not only fast reconfigurability to respond to short term channel statistics but is also capable of supporting most dynamic adaptation schemes such as opportunistic beamforming schemes.

In this paper, we will present the modeling, design and nanofabrication of a NEMS integrated quad-band MRA, which, at a given time, can be reconfigured to operate at any one of the four frequency bands (0.7, 0.8, 2.4 and 4.9 GHz). The radiation characteristics (gain, polarization, shape of the pattern) remain the same for these four reconfigurable modes of operation. The main building blocks of the MRA are a new type of DC-contact double-arm cantilever type NEMS switches. The design, nanofabrication and measured RF performance of these switches will also be presented.

References:

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