4. SINGLE ELEMENT BEAM STEERABLE ANTENNAS

Wireless communication is in increasing demand, becoming increasingly widespread and sophisticated systems are being developed to facilitate increasing demand. For example in 2002, a large contiguous part of radio spectrum between 3.1GHz and 10.6 GHz was made available licence free for low power high bit rate in USA. The EU followed with similar specifications late in 2003 and Ultra Wide Band (UWB) radio systems that can make use of this have been developed accordingly. In these and other wireless communication applications it is often required to direct a beam in a particular direction relative to an antenna.

Changing the direction of the main lobe of radiation pattern is known as beam steering which may be accomplished in conventional systems by switching antenna elements or by changing relative phases of RF signals driving the elements.

For example a phased array antenna is composed of plurality of radiating elements each with phase shifters. Beams are formed by shifting the phase of the signal emitted from each radiating element, to provide constructive/destructive interference so as to steer the beams in the desired direction. [28] However, since the advent of array theory and development of the early beam-steerable phased arrays in the 1960s, phase shifters have been widely recognised as the most complex, sensitive and expensive parts of the phased array systems. [29] Indeed, beam steerable antennas using a phased array concept have been successfully demonstrated for wireless communications. However, this type of antenna is only practical for base stations where stringent requirements for phase shifters, space for multiple antenna elements, signal loss and cost can be borne. The same technology cannot be implemented in handsets or small wireless transceivers due to space limitations. Therefore for mobile terminals current challenge is to develop single element beam steerable antennas. These antennas are compact, has conductor backing with low SAR (Surface Absorption Rate) and maintain high quality links for communication when the user is on the move. These single element beam steerable antennas have switches on their arm to steer the beam or beams are steered with selection of feeding points.
Single element beam steerable spiral antenna suitable for compact communication device comprises a spiral transmission element supported on a dielectric layer. Switching elements in the form of, for example, microelectromechanical (MEM) switches or PIN diodes are provided on the transmission element for selectively short or open circuiting the element. The excitation of the switches either open or short the antenna arm, so as to vary the current flow on the outer circumference of the antenna, thereby allowing the orientation of the radiation pattern to be altered as required and providing beam steerability. [29] [30] [31]

The above-mentioned spiral antenna eliminates the need to employ phase shifters and enables a single antenna element to be used for beam steering. However, due to the deployment of switches on the spiral antenna arm, when a switch is excited, there is a change in the configuration (and therefore the current distribution) of the antenna arm which results in a change in the antenna polarisation, thereby causing polarisation randomness. In other words, the antenna beam can have a dominant polarisation ($E_1/E_2$ or circular polarisation) under one switching configuration which may then change drastically under another switching configuration. This means that, if the communication is linear polarised, nil signal will be received in the event of a polarisation mismatch or, in the case of a circularly polarised link, a weak signal will be received (up to 3dB received signal loss) in the event of polarisation mismatch. In addition, other antenna parameters (e.g. gain, VSWR, etc) may vary with each switching configuration. [32] [33] [34] [35] Therefore benefit of beam steerability becomes absolutely futile if the communication is polarisation dependent.