The Route to the Fifth Generation (Challenges on Antenna Design)

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With the demand for faster data and reliable service in mobile communication, the fifth generation (5G) of the wireless network is aiming to provide such requirements. In a simple way, 5G will enable users to download a high-definition film in a fraction of a second. In addition, such wireless network will help the development of other technologies such as Autonomous Vehicles, Smart Cities, Health Care, Virtual Reality (VR) and Internet of Things (IoT), and even in Food and Agriculture.

5G is still in the planning stages, many companies have started working using their concept, and some have demonstrated prototypes, and at the same time, some groups are collaborating to find out what 5G will be. However, with the anticipated number of mobile users and the data that should be handled with such high speed, today's base station will not be able to handle such demand. Converting these requirements to numbers, the data should be delivered to the users with a delay of less than a millisecond delay, which is 70 ms with the current fourth generation (4G), and the peak download speeds should be down to 20 Gb/s (1 Gb/s with 4G). Although we still don't know what technology will win in the long run, millimeter waves (30-300 GHz) compared to nowadays below 6 GHz, small cells, massive multi-input-multi-output (MIMO), full duplex, and beamforming will be favored.

Although millimeter waves are in use in communication between base stations as radio links, their use in mobile communications between users and the nearby station is not that simple. Millimeter waves suffer from its inability to penetrate objects or building and the environment such as fog and snow, rain are severely affecting millimeter waves, which cause high attenuation. Therefore, new dense new base stations network should be established referred to as small cells. It is predicted that the small cells are small portable base stations with low power operation that will be placed every few hundred meters through cities. The density of the network should prevent signal dropping and will act as a relay network to receive a signal from base station to another till it reaches the user at any location and any time. As the frequency increases, the antenna physical size decreases. Therefore, it will be possible to allocate places easily for the base stations within the city. For low power use, the antenna must be of the high gain type, which means narrow directive beam. Such narrow beam nature reduces interference and allows the reuse of the frequencies on different nearby regions to serve the users.

For high gain antennas, arrays are the proper concept. Therefore, the new network will take advantage of this array to use the massive MIMO technology. Unlike the 4G MIMO system that consists of 12 antennas (eight for the transmitter and four for receivers), the 5G massive MIMO system will support more than 100 ports, which allow the base station to send and receive from much more users simultaneously. Thus, increasing the capacity of wireless networks by a factor over twenty than the 4G MIMO system. Due to the anticipated many antennas that will be used to handle the mobile traffic, it is expected to have high interference level. Therefore, the 5G base station must use beamforming, which identifies the data level to a user and reduce the interference with the nearby users. Many challenges face the 5G technology, but with the availability of the 5G technology in the near future, many other technologies will prosper. This talk will provide an overview of this technology and provide some new concept related to the antenna design as it is a critical part for this technology.