Antennas for 5G: Trends, Challenges, and Potential Solutions

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As the demand for more data continues to escalate, research activity for wireless networking technologies is at an all-time high. In the past decade, the data-rates for wireless networks have doubled every 18 months. Following that, we have recently entered the so-called Zettabyte Era, where it is estimated that more than 1 Zettabyte of data (10^{21} bytes) is transferred over networks of all types per year, and a large portion travels over wireless infrastructure. Previously, a significant catalyst in this growth was the proliferation of streamed media services. Now, there is a potentially greater interest: creating a cyber-physical world. In this new layer of life, often referred to as the Internet of Things (IoT), an ecosystem of devices, sensors, and automated systems would allow organizations to optimize for task efficiency, provide remote operations, and offer continuous monitoring capabilities. As with any ambitious goal, grand challenges emerge with the vision for 5G systems that are sure to keep antenna engineers busy.

With current projections on future wireless data speeds, there comes a growing impetus to search for significantly new paradigms regarding cellular access. RF system concepts such as mmWave communications, cognitive radio, and massive MIMO are all on the table for consideration. The promise of wide, open spectrum bandwidths at the mmWave and sub-mmWave frequencies (>28 GHz) has attracted significant attention to overcome many important limitations that come with smaller wavelengths. These include propagation modelling capabilities, efficient, fabrication-friendly and predictable antenna design, and cost-effective electronics. Along the same line of thinking, cognitive radio seeks to exploit open spectrum bands by integrating a cognitive engine within the radio. The vision has been to implement this at the more traditional UHF bands, but this feature may also prove interesting at the higher frequencies as well. In another direction, massive MIMO offers the possibility to dramatically improve the data rate, number of users, and link reliability by using a large number of antennas at the base station. Scaling to the massive scales remains an important challenge, where the base station hardware paradigm shifts from a small number of expensive, high-performance RF chains+antennas to hundreds of low-cost RF chains+antennas.

Whether mmWaves, cognitive radio, massive MIMO, or potential combinations become the next face of 5G is a point of speculation at this stage, but the exciting result is that RF and microwave research has been emphasized as a major focal point for progress in electrical engineering. Our goal for this paper is to provide a brief overview of these three technologies to be discussed in the special session. We also highlight interesting examples of disruptive IoT ideas that potentially integrate within the framework of 5G systems. Current challenges within the context of 5G cellular systems are also discussed to cultivate a conversation among engineers interested in these areas.