Ultra-High Speed wireless communications: Challenges and approaches

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According to different predications of Engholm's law as well as of Fettweis, we can expect a continuously growing demand for wireless communication speed. Within the German DFG Research Priority Program "Wireless 100Gb/s and beyond" we are focusing on the 100Gb/s challenge. This speed can be achieved by different approaches provided that the product of bandwidth efficiency and available bandwidth results in 100Gb/s.

At lower frequencies the available bandwidth is scarce. So, e.g. at frequencies below 10GHz we can get approximately 3 GHz between 7GHz and 10GHz. The use of these frequencies is regulated such that the emitted spectral power density must not be above -41 dBm/MHz (UWB regulation). Moreover, to achieve 100Gb/s we need to have a bandwidth efficiency of >30 b/s/Hz. This causes a enormous effort in the digital baseband processor using e.g. massive MIMO approaches. At this rather low frequencies the attenuation is quite low and the properties of transmission are well understood

At higher frequencies bandwidth is not an issue. So, e.g., between 240GHz and 280GHz we can get a non-regulated continuous band of 40GHz. To achieve 100 Gb/s we require a bandwidth efficiency of only 2.5 b/s/Hz. The attenuation at these ultra-high frequencies, however, is quite high and the component design challenges are also high. The propagation characteristics of electromagnetic waves at these frequencies are almost like that of light such that we can only realize line of sight communications (LOS). For outdoor scenarios rain, fog and other weather-caused condition have huge impact on the attenuation as well.

The paper will discuss the challenges of designing 100Gb/s wireless systems. Two examples will be presented where both extremes, i.e. bandwidths efficiency >30b/s/Hz and ultra-high frequencies are outlined and discussed in more detail. Some initial results from the 11 projects conducted under the DFG research grant SPP1655 will be explained. Moreover, the paper will discuss also other challenges like the required MAC protocols for this kind of systems.

Finally, a short inside in the planned work under SPP1655 grant and a possible extension onto European level will be discussed.