

Physical Layer Aspects of the Wireless Communication Systems and Their Utilization in 5G.

This lesson identifies the main challenges in the key 5G area at the intersection of waveform design and large-scale multiple antenna systems, also known as Massive MIMO. The property of self-equalization is introduced for Filter Bank Multicarrier based Massive MIMO, which can reduce the number of subcarriers required by the system. It is an entirely new research line towards a better understanding of waveform design with emphasis on FBMC-based Massive MIMO networks. There are several areas that are being investigated:

- **Millimetre-Wave technologies:** Using frequencies much higher in the frequency spectrum opens up more spectrum and also provides the possibility of having much wide channel bandwidth - possibly 1 - 2 GHz. However this poses new challenges for handset development where maximum frequencies of around 2 GHz and bandwidths of 10 - 20 MHz are currently in use. For 5G, frequencies of above 50GHz are being considered and this will present some real challenges in terms of the circuit design, the technology, and also the way the system is used as these frequencies do not travel as far and are absorbed almost completely by obstacles.

- **Future PHY / MAC:** The new physical layer and MAC presents many new interesting possibilities:

Waveforms: One key area of interest is that of the new waveforms that may be seen. OFDM has been used very successfully in 4G LTE as well as a number of other high data rate systems, but it does have some limitations in some circumstances. Formats being proposed include: GFDM, Generalised Frequency Division Multiplexing, as well as FBMC, Filter Bank Multi-Carrier, UFMC, Universal Filtered MultiCarrier. Each has its own advantages and limitations and it is possible that adaptive schemes may be employed, utilising different waveforms adaptively for the 5G mobile systems as the requirements dictate. This provides considerably more flexibility for 5G mobile communications.

- **Massive MIMO:** Although MIMO is being used in many applications from LTE to Wi-Fi, etc, the numbers of antennas is fairly limited. Using microwave frequencies opens up the possibility of using many tens of antennas on a single equipment becomes a real possibility because of the antenna sizes and spacings in terms of a wavelength.