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5G KEY ENABLING TECHNOLOGIES

Within 5G, wireless communication applications are expected to expand into new market segments with many new features. 5G systems should support emerging new use cases, including applications requiring very high data rate, a large number of connected devices, ultra-low latency and high reliability. This paper briefly introduces the key technologies that enable future wireless systems to meet most challenging 5G performance requirements.

It's expected that the major future breakthroughs will include technologies enhancing the radio interface, advanced antenna techniques, mmWaves communications, full-duplex radios, Cognitive Radio and novel deploying technologies such as ultra-dense networks, device-centric architectures, software-defined networks / network function virtualization, based on cloud computing techniques.

1. *Technologies to enhance the radio interface*. The fundamental requirements for 5G will be the high spectral efficiency, resistance to interference, handling high data rate wide bandwidth signals and low latency transmissions. There are also requirements for synchronization, computational complexity and implementation costs, energy efficiency, etc. The OFDM has been an excellent choice for 4G. However there are some novel waveforms that could bring new advantages under certain conditions: Filter Bank Multi-Carrier (FBMC), Universal Filtered MultiCarrier (UFMC), Filtered OFDM, etc.

Orthogonal multiple access schemes such as FDMA/TDMA/CDMA/OFDMA have been used in the past. To address challenges such as higher spectral efficiency, massive connectivity, and lower latency, non-orthogonal multiple access (NOMA) schemes are currently investigated such as power-domain NOMA, multiple access with low-density spreading, sparse code multiple access (SCMA), multiuser shared access (MUSA), pattern division multiple access (PDMA), etc.

Multi-user MIMO, cooperative MIMO, and massive MIMO as well as 3D-beamforming are key techniques for achieving better spectrum efficiency.

2. *Deploying technologies and new network topologies*. The increased integration between the different radio access technologies generally referred to as heterogeneous networks is one more key feature of 5G. Determining which standard to utilize and which base station or user to associate with will be a truly complex combinatorial optimization task in future networks.

As the extremely effective way to increase the network capacity is to make the cells smaller, 5G is likely to be focused around dense deployments of small cells such as picocells and femtocells having WiFi-like range, as well as distributed antenna systems. The cell-centric architecture may be radically changed in 5G as the deployment of the cells with vastly different coverages will lead to decoupling of downlink and uplink in a way that allows the corresponding information to flow through different sets of nodes. The traditional concepts of uplink/downlink and control/data channel will be rethought.

5G will require an infrastructure that is highly flexible, resource efficient and can scale any time to meet the dynamic needs of rapidly emerging new services. The key technology trends are network function virtualization and software defined networking. The Cloud RAN is a cellular network architecture to embody these both paradigms. It separates the Base Band Unit which is responsible for the signal processing functions in the BS, from the RRH transmitting signals over the radio interface.

References

1. 5G requirements - From Technology to Verticals. Panel 1 of the 24th European Conference on Networks and Communications (EuCNC'15), 29 June-2 July 2015, Paris, France.

2. Introducing the 5G Infrastructure PPP – Launching the European 5G Initiative - Part I, II. SPS09, SPS10 of the 24th European Conference on Networks and Communications (EuCNC'15), 29 June-2 July 2015, Paris, France.

3. Recommendation ITU-R M.2083-0: "IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond".