Performance Analysis of 5G for Low Latency Transmission Based on Universal Filtered Multi-Carrier Technique and Interleave Division Multiple Access

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***Abstract*—**5G mobile communication system has drawn more and more attention. The 5G system needs to provide three different types of services, including enhanced Mobile BroadBand (eMBB), massive machine-type communication (mMTC), and ultra-reliable and low-latency communication (URLLC). Universal Filtered Multi-Carrier (UFMC), Filter Bank Multicarrier (FBMC), and Filtered Orthogonal Frequency Division Multiplexing (f-OFDM) are suggested as a well-known candidate waveform for the coming 5G system. Themachine-to-machine (M2M) communications are one of the essential applications in 5G, and it involves exchanging of concise messages with a very short latency. However, in UFMC systems, the subcarriers are grouped into subbands but f-OFDM only one subband covers the entire band. Furthermore, in FBMC, a subband includes only one subcarrier, and the number of subbands is the same as the number of subcarriers. This paper mainly discusses the performance of UFMC with different parameters for the UFMC system. Also, paper shows that UFMC is the best choice outperforming OFDM in any case and FBMC in case of very short packets while performing similarly for long sequences with channel estimation techniques for Interleave Division Multiple Access (IDMA) systems.

***Keywords*—**UFMC, IDMA, 5G, subband.

I. Introduction

ABOUT each decade, a new generation of digital wireless communication systems is introduced [1]. As a first digital wireless network, the second generation was presented in Global System for Mobile (GSM) in 1990. The third generation arrived around 2000, Universal Mobile Telecommunications System (UMTS). The fourth generation, Long Term Evolution (LTE), offered broadband data services worldwide, which is an essential step towards the ubiquitous Internet [2]. It is anticipated that the Internet of Things (IoT) and MTC will play a vital role in the future of communication traffic [3]. Therefore, the new generation of the digital wireless system should provide low latency, high data rate, and ultra-reliable communication for these applications [4]. As predicted by The Mobile and Wireless Communication Enabler for the Twenty-twenty, Information Society (METIS) [5], 5G is a multi-rate system, covering the user's communication and machine type communication. Compared to the 4G network, the Quality of Experience (QoE) of 5G system is sufficiently improved, including 1000 times capacity, 10-100 times typical user's data rate, support 10-100 times connections, ten times battery life, and one fifth End-to-end (E2E) delay compared to the 4G network [6], [7].

Due to the 5G targets, the new Radio (NR) has been standardized to allow tight interworking with LTE, which supports the interconnection within their Base Stations. These Base Stations can then be used in combination to serve the population of User Equipment (UE) [8]. 5G network architectures based upon tight collaboration between LTE and NR are known as Non-Standalone (NSA) [9]. However, Standalone (SA) NR Base Stations provide connectivity to a 5G Core Network. The combination of NR Base Station and 5G Core Network is known as a 5G System (SGS) [10].

The Radio Communications Sector of the International Telecommunications Union (ITU-R) [11] has specified a set of requirements for IMT2020 technologies within the report ITU-R-M.2410-0 [12]. These requirements will be used when evaluating candidate technologies, e.g., the 5G solution specified by 3rd Generation Partnership Project (3GPP) [13]. NR radio-access technology in 3GPP, the overall system architectures of both the Radio Access Network (RAN) and the Core Network (CN) were revisited, including the split of functionality between the two networks [14].

Several researches compare the performance of OFDM and UFMC in different aspects [15]-[17]. 4G modulation methods suffer from the problem of high Peak to Average Power Ratio (PAPR). Sideband leakage is another problem in OFDM. Our current 4G systems rely on the OFDM waveform, which is not capable of supporting the diverse applications 5G will offer. The traffic generated by 5G is expected to have very different characteristics and requirements when compared to current wireless technology [15]. Moreover, the combination of IDMA technique with OFDM and UFMC is widely discussed in many researches. OFDM-IDMA systems are analyzed and designed in [18]. Also [19] evaluates the OFDM-IDMA approach to wireless communication systems. On the other hand, the combination of UFMC with IDMA is considered as a next wireless communication system [20], [21].

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reducing out-of-band radiation, which increases the robustness against ICI, e.g., caused by timing offsets. Compared to FBMC, the UFMC method serves outperformance in short-burst/low latency transmission scenarios and can provide complex orthogonality evading many traps. We can illustrate that IDMA outperforms FDMA at a low rate, and UFMC can effectively combat against misalignments and indicate that the proposed UFMC-scheme can be a promising candidate for future 5G wireless systems. Future work will deal with optimizing the UFMC filters.

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