Design and Simulation of OFDMA Transceiver for High Speed 5G Wireless Network using Hybridization of Particle Swarm Optimization and Genetic Algorithm

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Abstract-the availability of doubly massive MIMO wireless links enables the generation of very narrow beams, resulting in redDL-EEed co-channel interference to other users using the same time-frequency resources. Another key advantage of doubly massive MIMO systems at mm-Waves is the fact that the computational complexity of channel estimation weakly depends on the number of antennas, especially for the case in which analog (beam-steering) beamforming strategies are used. While massive MIMO at frequencies is gradually entering 3GPP standards, mm-Waves and in particular massive mm-Wave MIMO systems are still under heavy investigation, both in academia and industry

Keywords-*5g, MIMO, OFDM*

I. INTRODUCTION

5th generation mobile networks or 5th generation wireless systems, abbreviated 5G, are the proposed next telecommunications standards beyond the current 4G/IMT-Advanced standards. An initial chip design by Qualcomm in October 2016, the Snapdragon X50 5G modem supports operations in the 28 GHz band, also known as millimeter wave (mmW) spectrum. With 800 MHz bandwidth support, it is designed to support peak download speeds of up to five gigabits per second. 5G planning aims at higher capacity than current 4G, allowing a higher density of mobile broadband users, and supporting device-to-device, ultra reliable, and massive machine communications. If 5G appears and reflects these prognoses, then the major difference, from a user point of view, between 4G and 5G must be something other than faster speed (increased peak bit rate). For example, higher number of simultaneously connected devices, higher system spectral efficiency (data volume per area unit), lower battery consumption, lower outage probability (better coverage), high bit rates in larger portions of the coverage area, lower latencies, higher number of supported devices, lower infrastrDL-EEture deployment costs, higher versatility and scalability, or higher reliability of communication. With the 4G telecommunications systems now starting to be deployed, eyes are looking towards the development of 5th generation or 5G technology and services. Although the deployment of any wireless or cellular system takes many years, development of the 5G technology systems is being investigated. The new 5G technologies will need to be chosen developed and perfected to enable timely and reliable deployment. The new 5th generation, 5G technology for cellular systems will probably start to come to fruition around 2020 with deployment following on afterwards [10].

5G mobile systems status

The current status of the 5G technology for cellular systems is very mDL-EEh in the early development stages. Very many companies are looking into the technologies that could be used to become part of the system. In addition to this a number of universities have set up 5G research units focused on developing the technologies for 5G. In addition to this the standards bodies, particularly 3GPP are aware of the development but are not actively planning the 5G systems yet. Many of the technologies to be used for 5G will start to appear in the systems used for 4G and then as the new 5G cellular system starts to formulate in a more concrete manner, they will be incorporated into the new 5G cellular system. The major issue with 5G technology is that there is sDL-

EEh an enormously wide variation in the requirements: superfast downloads to small data requirements for IoT than any one system will not be able to meet these needs. Accordingly a layer approach is likely to be adopted. As one commentator stated: 5G is not just a mobile technology. It is ubiquitous access to high & low data rate services [3].

5G cellular systems overview

As the different generations of cellular telecommunications have evolved, each one has brought its own improvements. The same will be true of 5G technology.

- ***First generation, 1G:*** These phones were analogue and were the first mobile or cellular phones to be used. Although revolutionary in their time they offered very low levels of spectrum efficiency and security.
- ***Second generation, 2G:*** These were based around digital technology and offered mDL-EEh better spectrum efficiency, security and new features sDL-EEh as text messages and low data rate communications.
- ***Third generation, 3G:*** The aim of this technology was to provide high speed data. The original technology was enhanced to allow data up to 14 Mbps and more.
- ***Fourth generation, 4G:*** This was an all-IP based technology capable of providing data rates up to 1 Gbps.

Any new 5th generation, 5G cellular technology needs to provide significant gains over previous systems to provide an adequate business case for mobile operators to invest in any new system. Facilities that might be seen with 5G technology include far better levels of connectivity and coverage. The term World Wide Wireless Web, or WWWW is being coined for this. For 5G technology to be able to achieve this, new methods of connecting will be required as one of the main drawbacks with previous generations is lack of coverage, dropped calls and low performance at cell edges. 5G technology will need to address this.

5G specifications

Although the standards bodies have not yet defined the parameters needed to meet a 5G performance level yet, other organizations have set their own aims, that may eventually influence the final specifications. Typical parameters for a 5G standard may include:

Table 1.1:5G Wireless Performance

SUGGESTED 5G WIRELESS PERFORMANCE	
PARAMETER	SUGGESTED PERFORMANCE
Network capacity	10 000 times capacity of current network
Peak data rate	10 Gbps
Cell edge data rate	100 Mbps
Latency	< 1 ms

These are some of the ideas being put forwards for a 5G standard, but they are not accepted by any official bodies yet [30].

1.2 Current research

There are several key areas that are being investigated by research organizations. These include:

- ***Millimetre-Wave technologies:*** Using frequencies mDL-EEh higher in the frequency spectrum opens up more spectrum and also provides the possibility of having mDL-EEh 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[6, 8][14].

- ***Future PHY / MAC:*** The new physical layer and MAC presents many new interesting possibilities in a number of areas:

Waveforms: One key area of interest is that of the new waveforms that may be seen. OFDM has been used very sDL-EEcessfully 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, Generalized 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, utilizing different waveforms adaptively for the 5G mobile systems as the requirements dictate. This provides considerably more flexibility for 5G mobile communications.

Multiple Access Schemes: Again a variety of new access schemes are being investigated for 5G technology. Techniques including OFDMA, SCMA, NOMA, PDMA, MUSA and IDMA have all been mentioned.

Modulation: Whilst PSK and QAM have provided excellent performance in terms of spectral efficiency, resilience and capacity, the major drawback is that of a high peak to average power ratio. Modulation schemes like APSK could provide advantages in some circumstances.

Duplex methods: There are several candidate forms of duplex that are being considered. Currently systems use either frequency division duplex, FDD or time division duplex, TDD. New possibilities are opening up for 5G including flexible duplex, where the time or frequencies allocated are variable according to the load in either direction or a new scheme called division free duplex or single channel full duplex. This scheme for 5G would enable simultaneous transmission and reception on the same channel. *Read more about **5G full duplex***

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 [13].

Dense networks RedDL-EEing the size of cells provides a mDL-EEh more overall effective use of the available spectrum. Techniques to ensure that small cells in the macro-network and deployed as femtocells can operate satisfactorily are required.

II. RELATED WORK

Amaliet.al. [1] This survey aims to provide a comprehensive review on cellular evolution towards 5Gnetworks and essential requirements of 5G wireless systems in terms of massive capacity, high data rate, spectral efficiency, latency and QoS. This paper also pointed out the new architectural paradigm shift, associated with key technologies sDL-EEh as Ultra-Dense Networks (UDN), Software-Defined Networking (SDN), Network Function Virtualization (NFV), wave communication, Cloud Radio Access Network (C – RAN), HetNets, smart antennas and massive MIMO in order to understand the inherent features of enabling technologies, so as to realize the potential benefits of 5G networks. It also provided a review of the basic principles of multi carrier transmission system, advantages and drawbacks of the popular OFDM system in wireless networks. This paper also presented new candidate waveforms alternative to OFDM for the implementation of the air interface in future 5G communication systems. This survey will serve as a guideline to identify the major research issues and possible future research directions in 5G wireless communications.

Abdelhamied A. Ateyaet.al. [2]. This paper explains the designing of 5G cellular system faces various challenges related to the capacity and traffic. One way to solve these challenges is to employ device-to-device (D2D) communication and mobile edge computing (MEC). Employing these technologies offload the core network and increase the capacity of the system. In this work, we propose a frame work for the 5G cellular system based on D2D communication and multi-level cloud units employed at the edge of the cellular network. The system employs four levels of cloud units with various hardware capabilities. The D2D communication is used as the communication technology in the first level of clouds. Employing D2D together with multi-level edge cloud units achieves varies benefits to the system as the system level simulation provides.

Trang Nguyen et.al. [3] This paper investigates optical camera communication (OCC) technologies, targeting new spectrum, multiple-input-multiple-output diversity, transmission access, and novel architectures with augmented reality user experience for the extended 5G wireless network. It provides the current OCC research status and trend pertaining to these technologies, especially an inside view on the revision of IEEE 802.15.7-2011 known as the IEEE 802.15.7m (TG7m) Optical Wireless Communication Task Group. SDL-EEh standardization activities have a major impact on the development of OCC technologies. In addition, it provides a detailed review of the related literature.

Kun Zhu et.al. [4] In this paper, aim to address this two-level hierarchical resource allocation problem while satisfying the requirements of efficient resource allocation, strict inter-slice isolation, and the ability of intra-slice customization. To this end, design a hierarchical combinatorial aDL-EEtion mechanism, based on which a truthful and sub-efficient resource allocation framework is provided. Specifically, winner determination problems (WDPs) are formulated for the InP and MVNOs, and computationally tractable algorithms are proposed to solve these WDPs. Also, pricing schemes are designed to ensure incentive compatibility. The designed mechanism can achieve social efficiency in each level even if each party involved acts selfishly. Numerical results show the effectiveness of the proposed scheme.

Zhijian Lin et.al. [5] in this paper, proposed two types of D2D device discovery and access procedure for the 5G cellular network, presented the system model based on the Markov process, designed an access control algorithm, and provided the performance analysis. Moreover, condDL-EEted extensive simulations using the Vienna Matlab platform. In this analysis, this obtained the relationship between the access probability and the collision probability for different maximum number of collisions. A reasonable trade-off between the allowable maximum number of collisions and the collision probability was discussed, and the simulation results showed that the average access latency increased as the number of either preambles or users increase.

Mattia Rebato et. al. [6]In this paper, discuss resource sharing, a key dimension in mmWave network design in which spectrum, access and/or network infrastrDL-EEture resources can be shared by multiple operators. It is argued that this sharing paradigm will be essential to fully exploit the tremendous amounts of bandwidth and the large number of antenna degrees of freedom available in these bands, and to provide statistical multiplexing to accommodate the highly variable nature of the traffic. In this paper, investigates and compare various sharing configurations in order to capture the enhanced potential of mmWave communications. The results reflect both the technical and the economic aspects of the various sharing paradigms. It delivers a number of key insights, corroborated by detailed simulations, which include an analysis of the effects of the distinctive propagation characteristics of the mmWave channel, along with a rigorous multi-antenna characterization. Key findings of this study include (i) the strong dependence of the comparative results on channel propagation and antenna characteristics, and therefore the need to accurately model them, and (ii) the desirability of a full spectrum and infrastrDL-EEture sharing configuration, which may result in increased user rate as well as in economic advantages for both service provider.

NishaPanwaret. al. [7] In this paper, the researchers investigate and discuss serious limitations of the fourth generation (4G) cellular networks and corresponding new features of 5G networks. Various challenges in 5G networks are identified, new technologies for 5G networks, and the paper also presents a comparative study of the proposed architectures that can be categorized on the basis of energy-efficiency, network hierarchy, and network types. Interestingly, the implementation issues, *e.g.*, interference, QoS, handoff, security–privacy, channel access, and load balancing, hugely effect the realization of 5G networks. Furthermore, our illustrations highlight the feasibility of these models through an evaluation of existing real-experiments and testbeds.

Ahmed IyandaSulyman et. al. [8] This article presents empirically-based large-scale propagation path loss models for fifth-generation cellular network planning in the millimeter-wave spectrum, based on real-world measurements at 28 GHz and 38 GHz in

New York City and Austin, Texas, respectively. The experts consider industry-standard path loss models used for today's microwave bands, and modify them to fit the propagation data measured in these millimeter-wave bands for cellular planning. Network simulations with the proposed models using a commercial planning tool show that roughly three times more base stations are required to accommodate 5G networks (cell radii up to 200 m) compared to existing 3G and 4G systems (cell radii of 500 m to 1 km) when performing path loss simulations based on arbitrary pointing angles of directional antennas.

Vincenzo Sciancalepore et. al. [9] proposed Opportunistic traffic offloading to tackle overload problems in cellular networks. However, existing proposals only address device-to-device-based offloading techniques with deadline-based data propagation, and neglect content injection procedures. In contrast, the proposed work tackles the offloading issue from another perspective: the base station interference coordination problem during content injection. In particular, the experts focus on dissemination of contents, and aim at the minimization of the total transmission time spent by base stations to inject the contents into the network. We leverage the almost blank sub-frame technique to keep under control the intercell interference in sDL-EEh a process.

Waqas Bin Abbaset. al. [10] In this work, the experts argue that analog beamforming can still be a viable choice when context information about mmWave base stations (BS) is available at the mobile station (MS). We then study how the performance of analog beamforming degrades in case of angular errors in the available context information. Finally, they present an analog beamforming receiver architecture that uses multiple arrays of Phase Shifters and a single RF chain to combat the effect of angular errors, showing that it can achieve the same performance as hybrid beamforming.

Fangmin Xu et. al. [11] proposed a novel software-defined radio access network (SDRAN) architecture and the function modules. In particular, the motivation, challenge, and deployment roadmap of SDRAN framework are discussed. The relationships between alternative solutions (Cloud RAN, network function virtualization) and complementary technologies (cognitive radio, self-organizing network, big data analysis) are analysed in detail. Taking interference management of heterogeneous mobile network as the example use case, scheme design and preliminary system evaluations are given to show the benefit of SDRAN architecture.

Zhijian Lin et. al. [12] in this paper, two strategies of D2D device discovery and access procedure for the 5G cellular networks are proposed with the mathematical model based on two-dimensional discrete time Markov process. In addition, it provides the performance analysis. Furthermore, we condDL-EEt extensive simulations using the Matlab platform. In our analysis, we obtain the relationship between the accessing probability, collision probability and the maximum number of collisions. A reasonable trade-off between the allowable maximum number of collisions and the collision probability is discussed and the simulation results show that the average accessing latency increases as the growing number of preambles or the decreasing number of accessing users.

Gang Liu et. al. [13] This article, first give a brief survey of them. For in-band FDR, a historic perspective, the self-interference cancellation technologies, and the merits are discussed. For wireless virtualization, present the basic idea and a multi-dimensional perspective. Then propose virtual resource management architecture for in-band FDR networks. It is demonstrated that the proposed scheme can substantially improve the performance of virtualized FDR networks, where SPs, MNOs, and users can benefit from these two emerging technologies in 5G cellular networks.

Jian Qiao et.al. [14] in this article, focus on building D2D communications over mmWave 5G cellular networks. Discuss the mmWave propagation characteristics and the corresponding challenges to enable D2D communications. The future 5G cellular network architecture and MAC strDL-EEture are described. A resource sharing scheme to allocate time slots to concurrent D2D links to increase network capacity is proposed. Then conclude the article with a summary and a brief discussion of future work.

Anna Zakrzewska et.al. [15] This paper analyses new technologies that could enable 5G networking, discusses potential standardization and development directions, and presents recent research efforts in the area of future mobile networks.

III. THE PROPOSED METHOD

The criteria that determine the adjustment of individual run-length unit and the entrance into one of the states i.e., exploitation and exploration are the following. i Criterion-1: if the bacterium discovers a new, promising domain, the run-length unit of this bacterium is adapted to another smaller one. Here, "discovers a new promising domain" means this bacterium registers a fitness improvement beyond a certain precision from the last generation to the current. Following Criterion-1, the bacterium's behavior will self-adapt into exploitation state. ii Criterion-2: if the bacterium's current fitness is unchanged for a number Ku user defined of consecutive generations, then augment this bacterium's run-length unit and this bacterium enters exploration state. This situation means that the bacterium searches an unpromising domain or the domain where this bacterium focuses its search has nothing new to offer. This self-adaptive strategy is given in Pseudocode 2, where t is the current generation number, Ci t is the current run-length unit of the ith bacterium, εi t is the required precision in the current generation of the ith bacterium, α and β are user-defined constants, and Initial and initial are the initialized run-length unit and precision goal, respectively. The flowchart of the ABFO1 algorithm can be illustrated by Figure 4b, where S is the colony size, t is the chemotactic generation counter from 1 to max-generation, i is the bacterium's ID counter from 1 to S, Xi is the ith bacterium's position of the bacteria colony, Ns is the maximum number of steps for a single activity of Swim, and flag is the number of generations the ith bacterium has not improved its own fitness.

3.2 Algorithms

Algorithm 2: PSO-GA

*1: **Begin***
2: define the starting participants;
3: define intial computation cost;
4: define best solution, best ←Sol;
5: define number of loop;
6: Set the participants of 5G USERS;
Deploy nodes with 5G USERS network.
Deploy nodes, calculate distance and make clusters.
In every cluster there are multiple nodes and every node has queue n_s and total queue N_C.
7: Initialize queue priority according to number of packets. If packets are same then choose randomly
8: while participant O=E;
Iter ←0;
//optimize
*10: **while** (iter<N)*
11: for i=1:
Find random solution and optimize by following equation

$$P_i = \frac{\sum \left(1/_{fit_i} \right)^{-1}}{fit_i}$$

end for
*12: **for** i=1: O*
$Solution1^*$ ← select the solution who has the highe probability;
$Solution2^{**}$ ←Apply a random Nbs on Sol^*;
if ($Solution1^{**} < Solbest$)
$Solbest = Sol^{ution2^{**}}$;
end if
end for
***13:** S determines the 5G USERS buffer find for effective communication.*
14: Iter ++
*15: **end do***
*16: **exit***

Algorithm 2: PSO-GA

*1: **Begin***
2: Deploy nodes with 5G USERS network.
3: Deploy nodes, calculate distance and make clusters.
4: In every cluster there are multiple nodes and every node has queue n_s and total queue N_C.
5: Initialize queue priority according to number of packets. If packets are same then choose randomly
6: Population ←∅
7: P_{g_best} ←∅
*8: **for** (i=1 toP)*
$X_{velocity}$ ←Velocityrandom()
$X_{position}$ ←Positionrandom($Poluplation_{size}$)
X_{p_best} ←$X_{position}$
***If** ($cost(X_{g\_best}) \leq cost(X_{p\_best})$)*
P_{g_best} ←P_{p_best}
End if
End for
*9: **While** (¬exist())*
for (P)

$X_{velocity}$ ← update ($X_{velocity}$, X_{g_best}, X_{p_best})
if (cost(X_{p_best}) ≤ cost(X_{g_best}))
X_{g_best} ← X_{p_best}
End if
End for
***End While** 10: **Return** (X_{g_best}*

IV. RESULT ANALYSIS

4.1 Result Analysis

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============================ 15kHz ==================================

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|(complex)TF-Spacing| Bandwidth(LF)| Time (KT)

OFDM (with CP) | 1.07 | 1.44 MHz | 642.86 µs |

PSO | 1.00 | 1.44 MHz | 600.00 µs |

GA | 1.09 | 1.44 MHz | 653.57 µs |

PSO-GA | 1.09 | 1.44 MHz | 654.02 µs |

PSO-GA-OFDM | 1.09 | 1.44 MHz | 654.02 µs |

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============================ 120kHz ================================

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|(complex)TF-Spacing| Bandwidth(LF)| Time (KT)

OFDM (with CP) | 1.07 | 1.44 MHz | 642.86 µs |

PSO | 1.00 | 1.44 MHz | 600.00 µs |

GA | 1.27 | 1.44 MHz | 764.29 µs |

PSO-GA | 1.27 | 1.44 MHz | 760.71 µs |

PSO-GA-OFDM | 1.27 | 1.44 MHz | 760.71 µs |

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============================ 480kHz ================================

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|(complex)TF-Spacing| Bandwidth(LF)| Time (KT)

FBMC | 1.00 | 1.44 MHz | 600.00 µs |

Generate receive matrices ... this may take a while...

=============== In-Band SIR ======================

OFDM | PSO | GA | PSO-GA | PSO-GA-OFDM |

15kHz: InfdB | 66.34dB | InfdB | 67.16dB | -11.36 dB |

120kHz: InfdB | 65.67dB | InfdB | 64.26dB | 56.51 dB |

480kHz: | 66.79dB | | | |

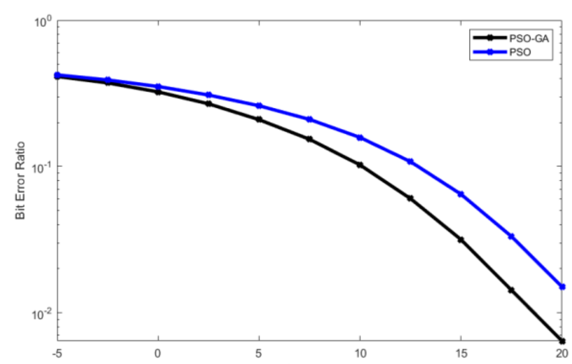

Figure 5.1Comparison of Bit rate

The high data rate having a complex data symbol and the single block having K complex symbol. Since K subcarriers are to be generated, the serial-to-parallel converter is used to converts the high speed data stream into low speed stream of data that is show in Fig. 8 each low speed data stream produced in the rate of RS/K sps. In doing so, the serial-to-parallel converter assigns successive data symbols (at its input) to K separate sub-streams (at its outputs)

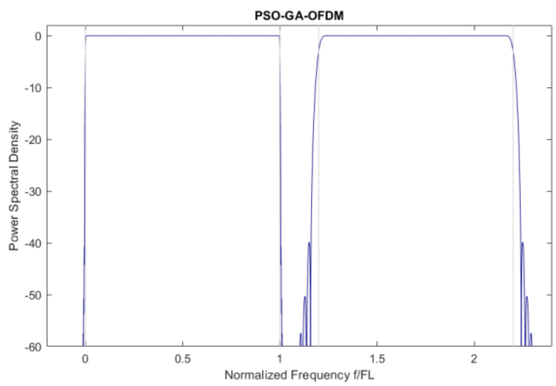

Figure 5.2Power spectral inference in PSO-GA

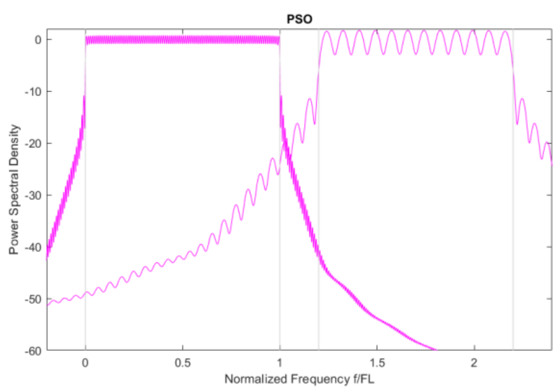

Figure 5.3 Power spectral inference in PSO

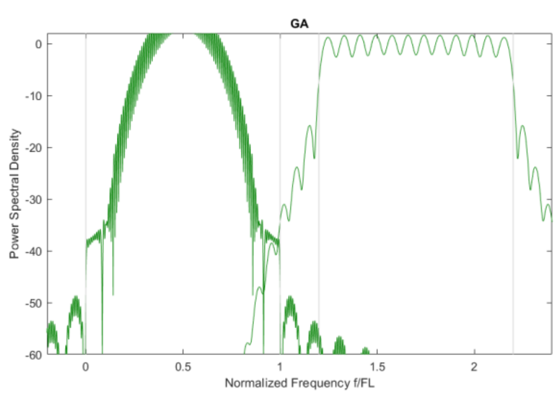

Figure 5.3 Power spectral inference in GA

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================== Basic Settings (guard time and band are ignored) ======================

|(complex)TF-Spacing| Bandwidth(FL)| Time(KT) | BitRate

OFDM (with CP) | 1.07 | 0.36 MHz | 1.00 ms | 2.02 Mbit/s |

FBMC-OQAM | 1.00 | 0.36 MHz | 1.00 ms | 2.16 Mbit/s |

WOLA | 1.07 | 0.36 MHz | 1.00 ms | 2.02 Mbit/s |

FOFDM | 1.07 | 0.36 MHz | 1.00 ms | 2.02 Mbit/s |

UFMC | 1.07 | 0.36 MHz | 1.00 ms | 2.02 Mbit/s |

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================================ Transmitted Power ===

| (Sim.) Trans. Energy | Time | (Sim.) Av. Power | SNR rel. to OFDM |

OFDM (with CP) | 1.00 mJ | 1.00 ms | 1.00 W | 0.00 dB |

FBMC-OQAM | 1.00 mJ | 1.00 ms | 1.00 W | 0.00 dB |

WOLA | 1.00 mJ | 1.00 ms | 1.00 W | 0.04 dB |

FOFDM | 1.00 mJ | 1.00 ms | 1.00 W | 0.09 dB |

UFMC | 1.00 mJ | 1.00 ms | 1.00 W | 0.08 dB |

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IV. CONCLUSION

for 5G and beyond-5G wireless networks. Massive MIMO has been studied in conjunction with two other current research topics for the future wireless networks: the mm-Wave frequencies and the distributed antenna systems. Chapter 1 has given a brief overview on the requirements of the future wireless systems and it has discussed the contribution of the massive MIMO technology to the development of 5G and beyond-5G wireless networks. Chapter 2 has briefly explained some of the mathematical tools used in the current literature in order to study the performance of the massive MIMO systems and it has given a comparison between different techniques currently used to evaluate the spectral efficiency bounds of sDL-EEh a system

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