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5G Using Millimeter Wave in Ultra-Reliable Machine-to-Machine Communications

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ABSTRACT: 5G Using Millimeter Wave in Ultra-Reliable Machine-to-Machine Communications 5G networking using Millimeter wave wireless communications system challenges of existing cellular networks, higher data rates, excellent end to-end performance and user-coverage in hot-spots and crowded areas with lower latency, energy consumption and cost per information transfer. To address these challenges, 5G systems will adopt a multi-tier architecture consisting of macro cells, different types of licensed small cells, relays, and device-to-device (D2D)networks to serve users with different quality-of-service and energy-efficient manner. Starting with the visions and requirements of 5G multi-tier networks.

Keywords. fifth generation**,** quality-of-service, Millimeter Wave.

I. INTRODUCTION

Fifth Generation wireless or mobile networks, abbreviated as 5G, are the proposed next telecommunication standards beyond the current 4G and LTE standards. This standard is based on mm-wave communications, which refer to electromagnetic signals with a wavelength of 1-10 mm millimeters in the frequency range of ~30 to 300 GHz. Wireless communications in 5G enable higher capacity than current 4G and LTE communication standards to allow higher density of mobile broadband users per area and support of ultra-reliable device-to-device and machine-to-machine communications. There has been a growing demand in Radio Frequency (RF) applications in the last few decades, in applications such as sensing, detection, identification and communication applications. Examples of these applications include Gb/s local-area and wide area-networks, mm-wave automotive radar, imaging in the mm-wave and THz frequencies, wireless senor networks, Radio Frequency Identification (RFID) and other multiple access communication systems. It is estimated that over 50 billion devices will be connected to the internet by 2020, in contrast to the current number (2017) of 28.4 billion devices. Moving towards 5G is a natural course, as higher data rates and high density of connected devices per unit area is the requirement from next generation of communication standard.

The key system technologies enabled by 5G technology are classified as: (a) Wi-Fi Cellular and Backhaul Communications, (b) Vehicle-to-Everything (V2X) communications for Advanced Driver Assistance Systems (ADAS), (c) Internet of Things (IoT), (d) Massive MIMO, (e) Cognitive Radio. These are illustrated in Figure.

Cellular systems in 5G technology are in its early developmental stages with technology giants working towards introducing modems and similar communication devices in the market.

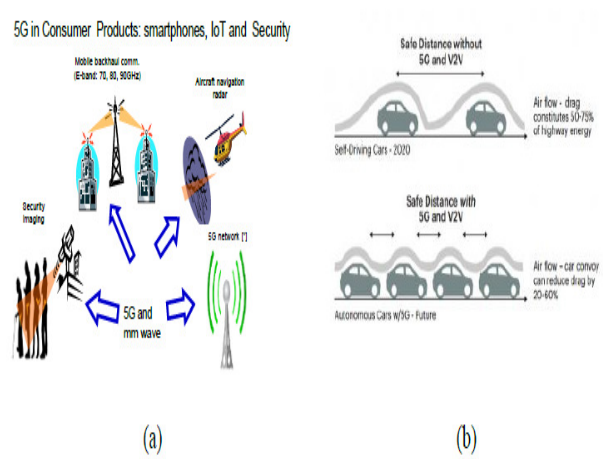

Fig. 1. 5G applications for communications and automotive ADAS applications.

The bands set for testing 5G cellular systems are 28 GHz in the US and 39 GHz in the Europe. The frequency ranges are 24.5 to 29.5 GHz and 37.0 to 43.5 GHz for the 28 and 39 GHz spectrum, respectively. Improved data rates of up to 2.5 Gbps with reduced latency and support of multiple connections are the key features of 5G cellular communications [1].

A relatively new Wi-Fi standard IEEE 802.11ad that operates in the 60 GHz band to achieve as much as 7 Gbps data transfer rate is also under development. This band can be used without a license for short-range communication. It was launched by the Wireless Gigabit Alliance back in 2009 and is poised to be an essential enabling technology with the increase in demand of bandwidth for applications such as gaming and HD video streaming. It is often termed as Wi-Gig due to its immensely fast data rates as compared to the current Wi-Fi standards operating at 2.4 and 5 GHz. Other bands such as 71-76, 81-86 and 92-95 GHz bands are also used for high-bandwidth communication links as these frequencies do not suffer from environmental absorption. In case of the 92-95 GHz band, 100 MHz has been reserved for space-borne radios to limit this reserved range to a transmission rate of a few gigabits per second [7]. The automotive industry is currently undergoing key technological transformations as the trends are strongly shifting towards self-driving cars requiring more and more vehicles to connect to the internet and to each other. In order to deal with real-time complex road situations, automated vehicles must rely on their own sensors but also work with the sensors around them whether they are on other cars or the roads themselves. These trends post a significant challenge to the underlying communication system as the information must reach its destination reliably within extremely short time frame. It is beyond the capability of current wireless technology to accomplish this. However, the next generation mobile communication technology holds promise to fulfill the challenges in latency, reliability, throughput in mobility and connectivity density. On the device and package levels, 5G technology has pushed the design and process engineers to investigate new methods to miniaturize sensors and other devices to operate flawlessly with high efficiency and reliability in a harsh environment such as a vehicle. Internet of Things requires a confluence of technologies and standards such as actuators and sensors, wearable computing, communications and protocols, storage and computing infrastructure, network and varying data and analytics. Automation and integration of everything from entire factories to ubiquitous home appliances such as microwave ovens entail the transportation of bursts of data packets to and from large number of end-devices. At the receiving end the information bits are retrieved accurately, if the channel characteristics are known. The channel may vary instantaneously because of the propagating medium, which leads to the signal degradation. The Channel State information (CSI) provides the known channel properties for a wireless link. It provides the effects of fading and scattering on a signal propagating through the medium. Normally the CSI estimated at the receiver fed back to the transmitter. If it is not estimated accurately at the receiver, leads to system degradation. It can be estimated by using different channel estimation algorithms. This estimation can be done with a set of well known sequence of unique bits for a particular transmitter and the same can be repeated in every transmission burst.

Thus the channel estimator estimates the channel impulse response for each burst separately from the well known transmitted bits and corresponding received samples. This paper describes the fundamentals of MIMO-OFDM system and study of various channel estimation techniques and their performance. In order to satisfy the exponential growing demand of wireless multimedia services, a high speed data access is required. Therefore, various techniques have been proposed in recent years to achieve high system capacities. Among them, we interest to the multiple-input multiple output (MIMO).The MIMO concept has attracted lot of attention in wireless communications due to its potential to increase the system capacity without extra bandwidth [9].Multipath propagation usually causes selective frequency channels. To combat the effect of frequency selective fading, MIMO is associated with orthogonal frequency-division multiplexing OFDM) technique. OFDM is a modulation technique which transforms frequency selective channel into a set of parallel flat fading channels. A cyclic prefix CP is added at the beginning of each OFDM symbol to eliminate ICI and ISI. The inserted cyclic prefix is equal to or longer than to the channel [10].

The 3GPP Long Term Evolution (LTE) is defining the next generation radio access network. LTE Downlink systems adopt Orthogonal Frequency Division Multiple Access (OFDMA) and MIMO to provide up to 100 Mbps (assuming a 2x2 MIMO system with 20MHz bandwidth). The performance of a MIMO-OFDM communication system significantly depends upon the channel estimation. However, in most of these research works, the CP length is assumed to be equal or longer than the maximum propagation delay of the channel. But in some cases and because of some unforeseen channel behavior, the cyclic prefix can be shorter than channel length. In this case, both ICI and ISI will be introduced and this makes the task of channel estimation more difficult. Equalization techniques that could flexibly detect the signals we will focus on the study of the performance of LS and LMMSE channel estimation techniques for LTE Downlink systems under the effect of the channel length.

Wireless services require high-bit-rate transmission over mobile radio channels. To reduce the effect of inter symbol interference (ISI) caused by the dispersive Rayleigh-fading environment [11], the symbol duration must be much larger than the channel delay spread. In orthogonal frequency-division multiplexing (OFDM) the entire channel is divided into many narrow sub channels, which are transmitted in parallel, thereby increasing the symbol duration and reducing the ISI. Therefore, OFDM is an effective technique for combating multipath fading and for high-bit-rate transmission over mobile wireless channels. To eliminate the need for channel estimation and tracking, differential demodulation can be used in OFDM systems, at the expense of a 3–4-dB loss in signal-to-noise ratio (SNR) compared with coherent demodulation. Accurate channel estimation can be used in OFDM systems to improve their performance by allowing for coherent demodulation. Furthermore, for systems with receiver diversity, optimum combining can be obtained by means of channel estimators. A channel estimator for OFDM systems has been proposed based on the singular-value decomposition or frequency-domain filtering. Time-domain filtering has been proposed to further improve the channel estimator performance. However, the besttime- or frequency-domain filtering shapes for channel estimation has not been studied. Investigate minimum mean-square-error (MMSE) channel estimation for OFDM systems. We first derive the MMSE estimator, which makes full use of the correlation of the channel frequency response at different times and frequencies. In particular, for mobile wireless channels, the correlation of the channel frequency response at different times and frequencies can be separated into the multiplication of the time- and frequency-domain correlation functions.

Hence, our MMSE channel estimator can be a frequency-domain filter using the fast Fourier transform (FFT), followed by time domain filters. Since the channel statistics, which depend on the particular environment, are usually unknown, we present a *robust* estimator, that is, an estimator that is not sensitive to the channel statistics. Computer simulation demonstrates that the performance of OFDM systems using coherent demodulation based on our channel estimator can be significantly improved. Frequency-division multiplexing (OFDM) to wireless and mobile communications are currently under study. Although multicarrier transmission has several considerable drawbacks (such as high peak to average ratio and strict requirements on carrier synchronization), its advantages in lessening the severe effects of frequency selective fading without complex equalization are very attractive features. In order to obtain the high spectral efficiencies required by future data wireless systems , it is necessary to employ multilevel modulation with non constant amplitude (e.g., 16QAM[2]). This implies the need for coherent receivers that are capable to track the variations of the fading channel. The channel estimation (tracking) in OFDM systems is generally based on the use of pilot subcarriers in positions of the frequency-time grid. For fast-varying channels (e.g., in mobile systems), non negligible fluctuations of the channel gains are expected between consecutive OFDM symbols (or even within each symbol) so that, in order to ensure an adequate tracking accuracy, it is advisable to place pilot subcarriers in each OFDM symbol. In particular, in this paper, we consider the comb pilot pattern arrangement, which has been shown to satisfy different criteria of optimality such as mean square error on the channel estimate and capacity In this framework, the traditional approach to channel estimation, that may be used as an initial estimate in iterative or decision directed receivers, consists of two steps. First, the least squares (LS) estimates of the channel gains over the pilot subcarriers are obtained by simply back rotating the received signal according to the knowledge control and cell association strategies to demonstrate their limitations for interference management in 5G multi-tier prioritized cellular networks (i.e., where users in different tiers have different priorities depending on the location, application requirements and so on). Design guidelines will then be provided to overcome these limitations.

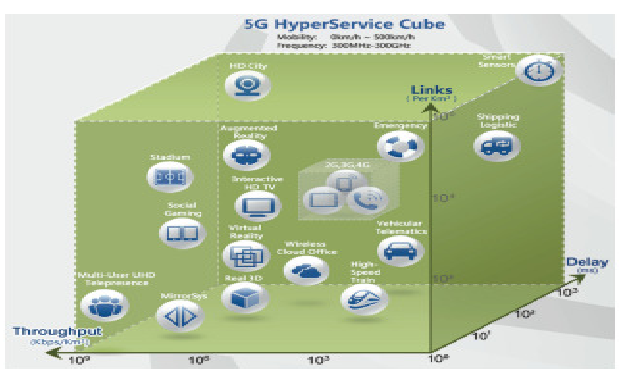

Fig. 2. A technology vision1 5G.

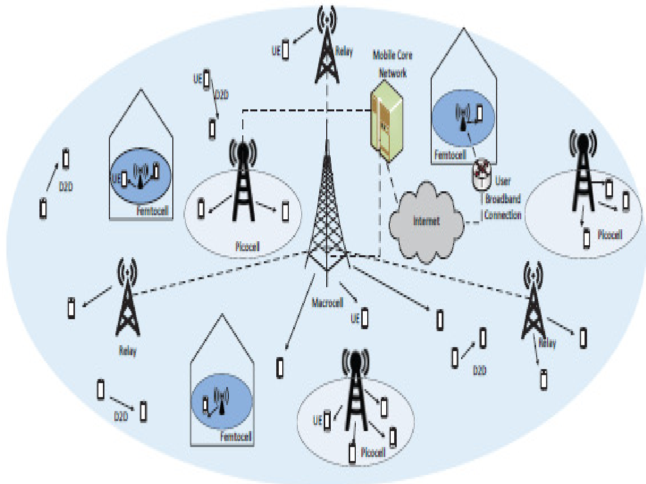

Fig. 3. Multi-tier cellular network architecture.

The effects of impulsive noise for both MCM systems and single-carrier modulation (SCM) system have previously been analyzed in [8] where the BER of orthogonal frequency-division multiplexing (OFDM) QAM based systems has been derived by varying impulse power and probability. Robust detection of DS-CDMA and OFDM based signals under similar channel conditions has been studied and various nonlinear detection techniques have been investigated in [3]. The BER performance of MC-CDMA in the presence of impulsive noise and both noises Gaussian and Non-Gaussian where Middleton's class A model is the one that fits better with most of Non-Gaussian noises [12]. The main parameter of the Gaussian model is the average noise power across the channel. The Gaussian probability density function and a constant power spectral density characterize in this model. on the other hand impulsive noise is completely random and has an unpredictable power and cannot know when it is going to occur. The only way to get statistical information about it is doing measurements in a specific place and characterizing it [3].Gaussian noise is defined as noise with some particular statistical properties. This noise has a probability density function as a normal distribution also known as Gaussian distribution. That means the power of the noise is Gaussian distributed for an specific case of this noise and the noise we are going to work with is Additive White Gaussian noise which besides of the values of the noise in two different times are statistically independent and uncorrelated which makes it appear in broadband [4]. Impulsive noise is non-stationary and is compounded by irregular pulses of short duration and signifier energy spikes with random amplitude in spectral content so this is why impulsive noise is considered the main cause of burst error occurrence in data transmission causing a temporary loss of signal. Therefore this is essential to know the statistical nature of impulse noise in order to be able to evaluate its impact on a communication system. These pulses are made by two main causes ambient electromagnetic interferences (storms) and natural electromagnetic interference or errors on telecommunications systems by man-made. Impulsive noise is a sequence of pulses characterized by three parameters and those are pulse amplitude, time-duration of the pulse and the time between consecutive pulses.

II. DEVICE-TO-DEVICE (D2D) COMMUNICATION

1 D2D communication (already being studied in 3GPP as a 4G add-on) should be natively supported in 5G as another cell-tier. Permits transmitter-receiver pairs coexisting in close proximity to establish direct peer-to-peer connections without the use of BSs (social networking, peer-to-peer content sharing, public safety communications) Enables short-range, low-power links to coexist with cellular links (improves spectral efficiency, decreases power consumptions of UEs, improves total network throughput)4Dense spectrum reuse, irregular interference topology Spectrum overlay or spectrum underlay. Multiple access/interference management and advanced waveform technologies combined with advances in coding and modulation algorithms (for massive IoT connectivity) Miniaturized multi-antenna technologies and significantly advanced baseband and RF architecture (e.g., for massive MIMO computations) Advanced RF domain processing, single-frequency full-duplex radio technologies Device technologies to support a vast range of capabilities Backhaul design for ultra dense networking Virtualized and cloud-based radio access infrastructure.

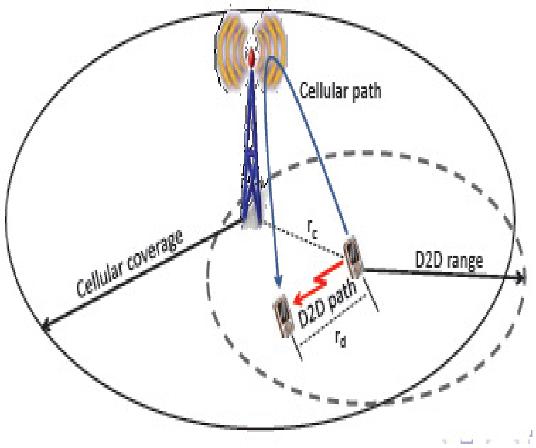

Fig. 4. Device-to-device (D2D) communication.

Open challenges are highlighted and guidelines are provided to schemes in order to overcome these and make them suitable for the emerging 5G systems. The multi carrier code division multiple access (MC-CDMA) systems and analyze the performance by examining the MC-CDMA system model in time domain. We have discovered that conventional Walsh-code based MC-CDMA is less robust as compared in presence of impulsive noise than the direct sequence DS-CDMA and the multi carrier modulation based (MCM) systems. It is cleared that the performance of MC-CDMA depends strongly on the selection of the utilized spreading codes and modified MC-CDMA structure is called as MC-SI-CDMA and it is investigated in impulsive noise that employs sub carrier interleaving (SI) to reduce the cross correlation between the time domain MC-CDMA waveforms and the impulsive noise. From Computer simulation results it is cleared that to support our analysis the proposed MC-SI-CDMA system in impulsive noise can gives a performance improvement of 2.5 dB at a bit error rate (BER) level of 10−3 and it is compared with the DS-CDMA system.

III. SIMULATION RESULT

Machine-to-Machine Communications in evaluated by varying the transmitting and receiving antennas the performance of the system in terms of SER and SNR Eb/N0(db)with 16PSK based 16QAM system transmit and receive antennas gives better performance in SER when compared to the system.

Machine-to-Machine Communications in evaluated by varying the transmitting and receiving antennas the performance of the system in terms of SER and SNR Eb/N0(db) with 16PSK based 256QAM system transmit and receive antennas gives better performance in SER when compared to the system.

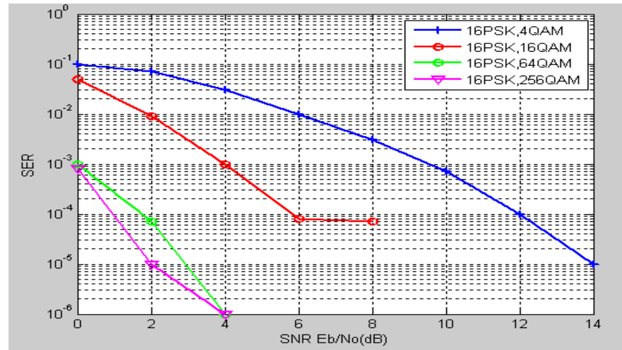

Fig. 5. 5G using Millimeter Wave in Ultra-Reliable.

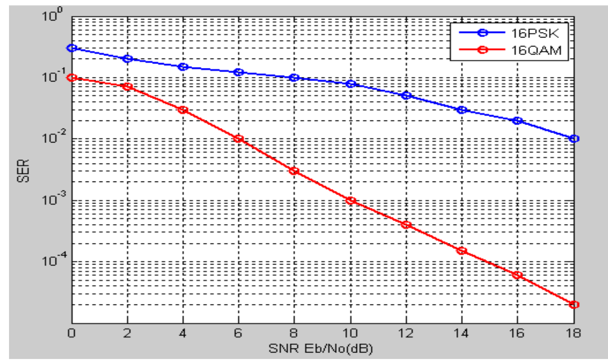

Fig. 6. SER 16 PSK, 4QAM 5G Using Millimeter Wave in Ultra-Reliable.

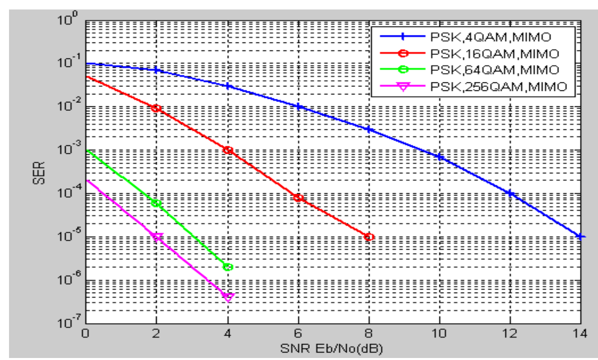

Fig. 6. SER 16 PSK, 4QAM 5G using Millimeter Wave in Ultra-Reliable.

Machine-to-Machine Communications in SER 16 PSK, 4QAM Performance of Volte IP multimedia advance radio technology use of PSK, QAM, MIMO, channel coding system *with* 16 PSK based QAM is evaluated by varying the transmitting and receiving antennas the performance of the system in terms of SER and SNR Eb/N0(db)with 16PSK based proposed 256QAM system transmit and receive antennas gives better performance in SER when compared to the system.

IV. CONCLUSION

5G Using Millimeter Wave in Ultra-Reliable Machine-to-Machine Communications in Proposed a smart small cell concept to playa key role in supporting 5G networks, in which a user-specific hybrid beam forming. In this thesis, we first validated the feasibility of the by implementing real-time system-level simulations to investigate the system-level potential gain of the proposed smart small cell system. We expect our prototype design to provide worthwhile insights into developing the most viable solution for future wireless systems with an in-depth consideration of implementation.-speed, universally accessible wireless service capability Creating a revolution Networking at all locations for tablets, smart phones, computers, and other devices Similar to the revolution caused by Wi-Fi Our focus Goals and requirements, complete system architecture, core network.

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