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Review Article

Review On Channel Estimation In 5g Massive Mimo Using Tdm and Ai

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ABSTRACT
In the wireless communication sector, there is higher shortage in bandwidth has motivated to the exploration of a wireless access technology named as Massive Multiple-Input Multiple- output (MIMO). Massive MIMO is an advanced technology for future generation networks in grouping the antennas at transmitter and receiver to furnish higher spectral and efficiency of energy using relatively simple processing. By deploying 5G-TDM-Artificial Intelligence- networks will overcome the above mentioned issues for accomplish various applications of the intelligent system. This paper furnishes the comprehensive study on evolution of cellular networks and key enabling technology for 5G. The time-division multiplexing (TDM) helps in estimating the channel and improves the performance of error rate. Also this research proposes the new methodology of integrating the hybrid deep learning algorithms in channel estimation with massive MIMO models. This paper also presents thebenefits and importance of Massive MIMO and 5G networks. Additionally, a comparative analysis is presented between distant algorithms of artificial intelligence for MIMO.

Keywords: Channel Estimation, Energy, Massive MIMO, 5G,TDM.

Section 1
Introduction

The wireless Local Area Network (LAN) are positioned at everyplace and covers around 100 meter distance where the cellular system are deployed with higher demands in traffic. The traffic has been increased by increasing the broad band services for mobiles and also by the contribution of new technologies like Internet of Things (IOT) and Machine-to-Machine (M2M). The mobile phone users are used to various distinct services such as video calling, WhatsApp, twitter and online gaming by the mobile data for changing the life with third- generation (3G) networks, fourth-generation (4G) networks and fifth-generation (5G) networks that are capable to perform with low latency and higher data rate. The traffic in smartphone has increases around 10 times and managing the data traffic will be a demurrers in wireless technology [1,2].

The achievement of the throughput for an area is dependent on the increase in bandwidth spectrum or densifying the cells which is the primary demurrer in the development of wireless networks as it leads to higher latency. The spectral efficiency that can improve the through is untouched and not changed in the development and growth of the network. the potent wireless access technology can furnish higher throughput and achieves the demands without increasing or densifying the spectrum or cell. The 5G and TDM can deliver the needs for accessing the technology. The massive MIMO can deliver the demands of 5G and improves the efficiency in spectrum and throughput. The radios, antennas and spectrum are brought together for enabling the capacity and speed for the 5G [1,7].

This technology helps the intelligent system of sensing to rely and inextricably linked on the 5G networks. The higher amount of smart sensors with multi-access schemes helps in collecting the data that may lead to lower data rate, higher latency and minimizes the reliability. Hence the massive MIMO with multiplexing gain and capabilities of beamforming for sensing, collecting and transmitting with low latency and also these concurrent sensors furnishes the reliable and higher connectivity and data rates. This technology gathers the information from intelligent sensor that are transmitted to the locations where the central monitoring are available for smart applications like autonomous vehicle, smart antennas, smart building, smart grids, smart highways and remote healthcare and environment monitoring. The figure 1 represents the Massive MIMO in 5G networks [1,8].

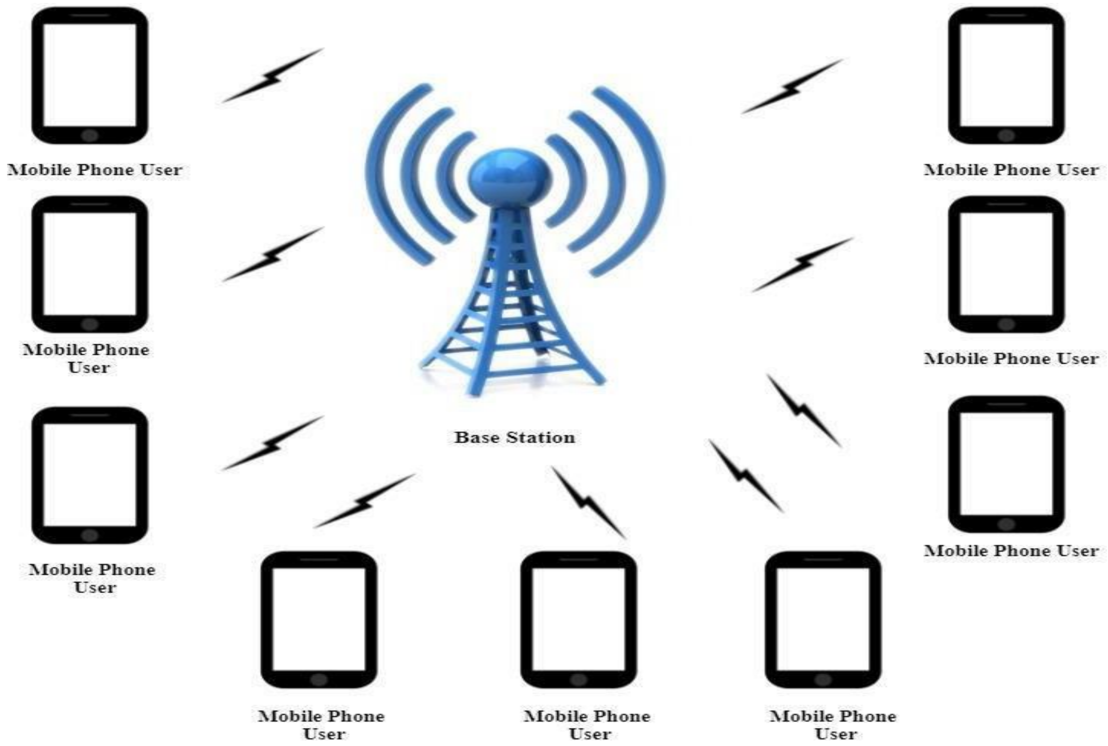

Fig.1: Massive MIMO

The performance of the bit error rate can be improved and the transmission rate can be increased by Time Division Multiplexing (TDM) [4]. The artificial techniques helps the massive MIMO for beamforming, estimating the channel, detecting the signals, balancing the load and optimizing the spectrum. The algorithms such as Convolutional Neural Network (CNN), Deep Neural Network (DNN), MMSE algorithm, Recurrent Neural Network (RNN), Long Short-Term Memory (LSTM), Non-Linear_ Autoregressive_ Network with eXogenous (NARX) helps in predicting and classifying the channel in massive MIMO system.

The paper is organized as: Section 2 propounds the evolution of cellular networks from 1G to 6G networks. Section 3 discusses the TDM for massive MIMO system. Section 4 discusses the advantage of massive MIMO and section 5 furnishes the importance of massive MIMO. The section 6 presents Pilot contamination reduction techniques with proposed method.The section 7 presents the artificial techniques for the massive MIMO systems. The section 8 concludes the paper by summarizing the techniques and challenges in massive MIMO for 5G networks.

Section 2
Evolution of Cellular Networks

The mobile communication has shown higher growth from past decades. The cellular networks have evolved from 1G to 5G networks and are composed of base station, core networks and equipment of user (mobile phones). This section furnishes the detailed description of cellular networks.

2.1 1G

The first generation networks introduced in 1980s and uses the analog signal for furnishing the service such as only voice. The Frequency Division Multiple Access (FDMA) and can offer the data rate around 2.4 kbps. As there is higher interference the quality of voice is poor. These systems also comprises of Advanced _ Mobile _Phone _Systems (AMPS), Nordic _ Communication _ Systems (NMTS) and Total_ Access _Communication_ System (TACS) [9].

2.2 2G

The second generation networks are digital version of first generation cellular networks. The services furnished by this cellular network are voice, Short Message Service (SMS), and emils. These systems furnishes the data rate from 14.4 kbps to 64 kbps and uses Code_Division_Multiple_Access (CDMA) and Time_Division_Multiple _Access (TDMA) techniques. This system comprises of Global System for Mobile communication (GSM) and IS-95 CDMA. These network have bounded capability of hardware and mobility [9].

2.3 3G

The third generation network offers services on mobile phones such as browsing on web, voice, SMS and Multimedia Message Support (MMS) based on CDMA and GSM. These systems comprises of Universal Mobile Telecommunication Systems (UMTS) and WCDMA where the usage of smart phones have grown increasingly. The data rate furnished by this network is 384 kbps but the demurrer is the need of larger bandwidth and the infrastructure is complex [1].

2.4 4G

The data rate furnished by the fourth generation network are 100 Mbps and also handles the higher data traffic with higher Quality of Service (QoS). This network comprises of applications such as online gaming, mobile TV and video conferencing. This system comprises of Long Term Evolution (LTE), LTE-Advanced (LTE-A) and Worldwide Interoperability for Microwave Access (WiMAX). This systems are feasible but the requirement of frequency bands that are expensive and requiring 4G enabled cellular phones for operation in the network are considered to be the demurrer [1].

2.5 5G

The fifth generation cellular networks aims to be 100 times faster than the previous generation networks. This cellular network furnishes the data rate of about 10 Gbps, higher reliability and lower latency where the HD movies can be downloaded within few seconds. The Internet of Things (IoT) devices and vehicles can be maintained by this generation technology. However it increases the throughput without densifying or increasing the cells or bandwidth to achieve the appropriate demands. The figure 2 represents the advantages of using 5G networks in the massive MIMO system [1,9].

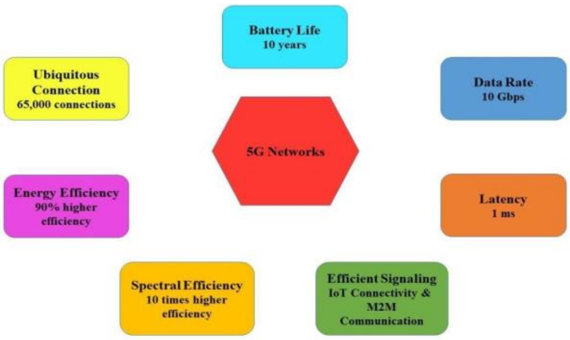

Fig.2: Merits of 5G networks

2.6 6G

The sixth generation cellular networks have no limitation but yet it is in the development stage that aims in furnishing the higher speed in transmission in terabit range. The smart antenna, mobile phones with larger memory and higher optical networks are needed for this technology. This cellular networks would enable the artificial intelligence which will be cell free and to increase in data rate higher frequency bands will be required. The autonomous systems, robotics, blockchain technology, space travel, tactile internet, industrial internet and wireless brain computer services are general applications that can be connected with this generation cellular networks. The figure 3 represents the advantages of using 6G networks in the massive MIMO systems [1].

Section 3
TDM for Massive MIMO systems

The TDM helps in mitigating the peal-to-average power ratio (PAPR) issue along with amending the performance of BER using frequency-domain equalization (FDE). This TDM increases the transmission rate of data for the provided bandwidth. The reduction in sub carriers helps in minimizing this PAPR problem. Haris GACANIN et.al proposed an idea of combining the orthogonal_frequency division multiplexing (OFDM) and TDM for minimizing the PAPR issue and to improve the transmission rate of data in the channels. The average power are ensembles to normalize the peak power and the probability of PAPR value decreases as it could not take large values as the subcarriers are reduced when the slot get increases. The distinct techniques of FDE considers the criteria such as Zero Forcing (ZF), minimum mean square error (MMSE) and maximizing ratio combining (MRC). Followed by FDE, the Gaussian approximation derives the conditional BER expression and the BER can be evaluated using numerical computation method called Monte-Carlo. The author also proves the better resultant in the performance of BER by combining the OFDM and TDM [4].

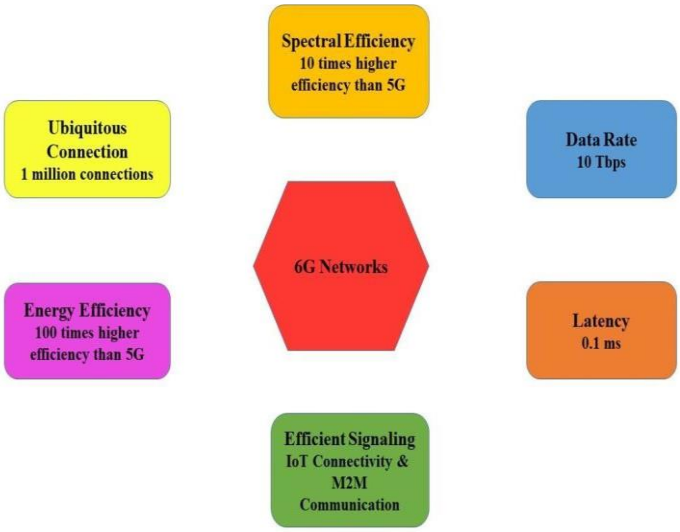

Fig.3: Advantages of 6G network

Haris Gacanin et.al presented the combination of OFDM and TDM for pilot-assisted channel estimation (CE). This can be done by employing the minimum mean square error frequency- domain equalization (MMSE-FDE) on frequency selective and nonlinear fading channels. The signal-to-noise ratio (SNR) gets increased by employing the time-domain filtering and frequency-domain interpolation. The performance of BER is improved by combining the OFDM and TDM rather than the TDM [3].

Section 4
Advantages of Massive MIMO for 5G cellular networks

The Massive MIMO allows the antenna array to focus on the narrow beams towards user for furnishing higher spectral frequency. The current MIMO in 5G furnishes ten times higher spectral efficiency than 4G networks. The requirement of energy in Massive MIMO is reduced as the radiated power is less needed for the antenna array to focus in a small particular section. The capacity and data rate of systems are increased by Massive MIMO due to spatial multiplexing and array gain. The tracking of user is more accurate and reliable in massive MIMO as the narrow signal beams are used towards the user [1].

The consumption of power is significantly minimized by Massive MIMO as ultra lower power linear amplifiers are built to eliminate the electronic equipment in the system. Since the higher amount of antenna are at the receiver side, the massive MIMO is resilient for fading [1]. The latency of the massive MIMO are minimized upon air interface [10]. Due to larger antenna, these system are robust on one or limited failures and are against interfaces and jamming [11]. The reliability of link are maximized when massive MIMO furnishes diversity gain by having higher amount of antennas [12]. As the narrow beams and the orthogonal mobile station channels are threat the massive MIMO system furnishes the higher physical security [13]. The ordinary signal detectors are made by the higher amount of base station antenna and also precoders optimal for the system [1].

Section 5
Importance of Massive MIMO for 5G cellular networks

As massive MIMO comprises of enormous support for 5G cellular standardization, it has become an important research topic in the community based on wireless communication. The present Massive MIMO are unable to withstand with an influx in data traffic. The M2M communication, augmented reality, IoT and virtual reality are unable to furnish the needed spectral efficiency. However the Massive MIMO have proved to be important with the experimentation and it have furnished better spectral efficiency. The validation for the operation of massive MIMO are carried out to prove the efficiency and also furnishes the robustness in operation with lower complexity in radio frequency and basebands [1]. The demurrer that are faced during the deployment of Massive MIMO system are represented in Figure4.

Fig.4: Demurrers in deploying Massive MIMO

Testing of hardware implementation is done to demonstrate that these systems can be fabricated with lower complexity and in radio frequency and hardware at lower cost for digital and analog baseband and RF chains. Additionally many precoding, scheduling, equalization and detection algorithms are designed for reducing the power and cost. The SoftBank Group Corp.,Vodafone, Huawei, Nokia, Samsung are the companies who have implemented the Massive MIMO systems. On the theory basis, these systems have huge amount which may be infinite in number of antennas at the base station. But in practical it comprises of 64 to 128 antennas. The Nokia, leaders Ericsson and Samsung Electronics are companies who have deployed 128 antennas for transmitting and receiving the signals in massive MIMO systems. However the current smart mobile phones comprises of 2 to 4 antennas [1].

Section 6

6.1. Pilot Contamination

The obtaining the channel state information (CSI) is crucial in massive multiple-input multiple-output (MIMO) wireless networks. A main challenge in channel estimation is that due to the limited coherence time, pilot sequences assigned to multiple users across multiple cells cannot all be orthogonal. The nonorthogonality between the pilots, e.g., when the same set of pilots is reused across cells, causes the channel estimation for one user to be affected by the pilots of other users. This effect is referred to in the literature as pilot contamination [16],[17].

The higher spectral efficiency is attained by serving several terminals in the same time-frequency resource through spatial multiplexing, and the increase in energy efficiency is mostly due to the array gain provided by the large set of antennas [18]. The expected massive MIMO improvements assume that accurate channel estimations are available at both the receiver and transmitter for detection and precoding, respectively. Additionally, the reuse of frequencies and pilot reference sequences in cellular communication systems causes interferences in channel estimation, degrading its performance. Since both the time-frequency resources allocated for pilot transmission and the channel coherence time are limited, the number of possible orthogonal pilot sequences is also limited, Moreover the pilot sequences have to be reused in neighbor cells of cellular systems.

Therefore, channel estimates obtained in a given cell get contaminated by the pilots transmitted by the users in other cells [19]. This coherent interference is as pilot contamination, i.e., the channel estimate at the base station in one cell becomes contaminated by the pilots of the users from other cells [20]. The contamination not only reduces the quality of the channel estimates, i.e., increases the MSE, but also makes the channel estimates statistically dependent, even though the true channels are statistically independent. Moreover, pilot contamination does not disappear with the addition of more antenna[21],[22]

6.2 Related Works

Various techniques have been applied to eliminate pilot contamination. A previous study demonstrated the impact of shifting pilots amid adjacent cells through simultaneous transmission of signals [23]. As a result, channel approximation and precoding operations improved. Another study investigated the decrease in pilot contamination based on the orthogonality of pilot sequences between neighboring cells, where the optimum pilot sequence for all UEs was determined [24]. By contrast, the author in [25] studied a multi-cell massive MIMO for downlink with or without pilot-aided coherent detection with maximum ratio-combining or zero-forcing (ZF) precoding under the effect of pilot contamination. Another study applied linear precoding to reduce the transmission of power distribution across multiple cells by employing an improved subset of the BS [26]. The authors of this study determined the closed form of spectral effciency through linear precoding and the use of a suitable channel distribution. Furthermore, in [27], the author used ZF beamforming with a time-shifted pilot scheme by increasing the number of antennas to infinity in both the uplink and the downlink to achieve a high sum rate. In [28], linear precoding was applied to evaluate the effect of uplink training by transmitting similar pilot sequences [28]. The authors studied the resulting pilot contamination by establishing novel multi-cell minimum mean square error (MMSE) systems created using the precoding technique.

6.3 Problem Statement

Even though the literature survey discusses about the various methods of channel estimation with MASSIVE MIMO and effects of the pilot contaminations during massive MIMO, still need for intelligent algorithm is required for the prevention of pilot contamination.

6.4 Proposed Methodology

To overcome the above drawback, this research proposes the new methodology of integrating the hybrid deep learning algorithms in channel estimation with massive MIMO models.The hybrid deep learning algorithm combines the powerful features of convolutional neural networks with single feedforward training networks . As the first phase, hybrid learning algorithms plays a role in extracting features of the spatial information from the contaminated signals and maintains the pure SNR, BER mechanism.

Section 7
Artificial Intelligence (AI) Techniques for Massive MIMO systems:

The machine and deep learning algorithms are subset of AI that helps in solving the prediction and classification issues. The network security, natural language processing, automated systems such as autonomous cars that are widely used areas of AI techniques. In designing the networks such as 5G and 6G the crucial role is played by the machine and deep learning technology. The game theory and stochastic geometry are sophisticated and also acquires huge computation power hence they may not suit to the massive MIMO system as it needs complex optimizations. However the dynamic nature of machine and deep learning techniques helps in estimating the channel, beamforming, detection of signals, balancing the load and optimizing the spectrum. For estimating the channels, the data of channels are assumed as big data hence the machine and deep learning mechanisms helps in predicting the channels of massive MIMO [1]. The normalized Mean Squared Error (NMSE) is exploited to access the quality of output. The figure 5 describes the resultants for the various distinct artificial intelligence techniques for the NMSE [5, 14].

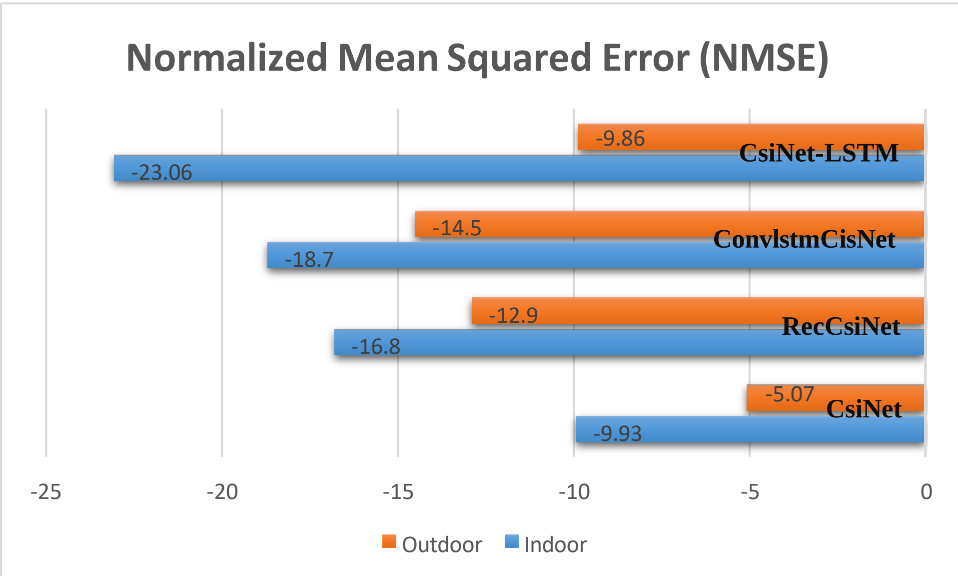

Fig.5: NMSE with Artificial Techniques

The machine and deep learning algorithms such as CNN, LSTM, DNN, RNN, NARX demonstrates the feasibility and estimates the channel in very complex channel model [1,15]. The DNN helps in modifying the modules in the base station and the RNN furnishes the solution for the time series learning problems. The NMSE exploits the quality of the output for the CsiNet, RecCsiNet, ConvlstmCisNet and CsiNet-LSTM. The several artificial techniques exploited in detecting the uplink signals of massive MIMO system. However the detection of signals are computationally inefficient and complex due to larger amount of antennas. Hence many machine and deep learning algorithms are proposed to furnish the better robustness in performance [1]. The figure 6. Describes the NMSE with quantization for various distinct artificial intelligence mechanisms [6].

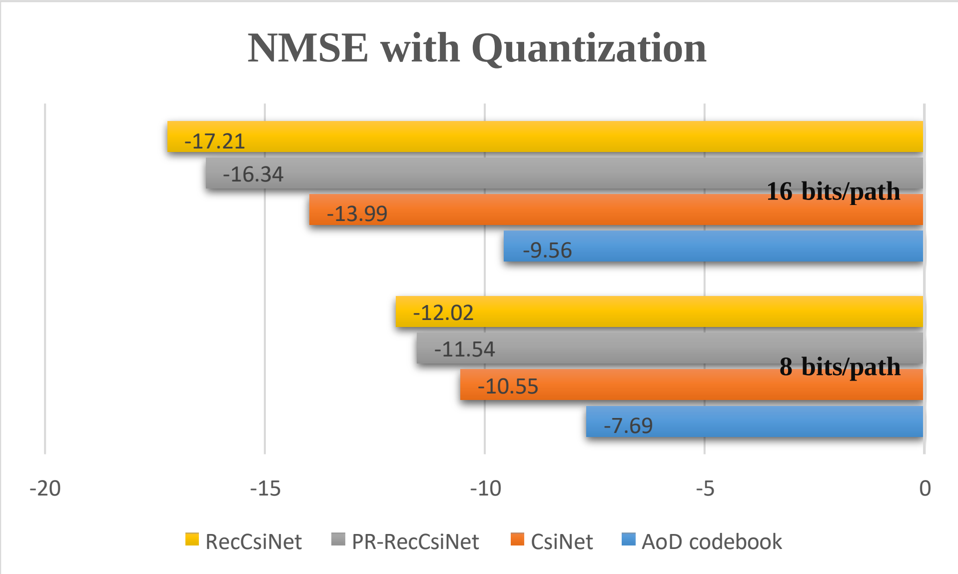

Fig.6: NMSE with Quantization

Section 8
Conclusion

The massive MIMO systems gathers all the antennas at receiver and transmitter side and exploits the relatively simple processing for furnishing the higher spectral and energy efficiency.an efficient spectrum is required for the worldwide but yet only bounded amount of research are conducted on this massive MIMO technology. This paper provides the overview of Massive MIMO system and TDM for massive MIMO of 5G networks. The distinct artificial techniques are discussed for massive MIMO technology that may help in minimizing the issues such as estimating the channels, detecting the signals and scheduling the user. This paper motivates the researchers to find the newer paths as they work on 5G and Massive MIMO technology.

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