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5G WIRELESS TECHNOLOGY

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ABSTRACT
What the 5G will be? Will it be an incremental advance on 4G. The previous four generations of cellular technology have made a major pattern shift that has broken the compatibility with respect to its previous generation. Indeed, 5G will also need to be a paradigm shift that includes high carrier frequencies with massive bandwidths, huge base station and device densities, and large number of antennas. However, it will also be highly integrative: tying any new 5G air interface and spectrum together with LTE and WiFi to provide high-rate coverage and a seamless user experience. But for this, the core network will also have to reach a very high-level of flexibility and intelligence, spectrum regulation improved, and energy and cost efficiencies will become even more critical considerations. This paper discusses all of these topics, identifying challenges to occur in future research and preliminary 5G standardization activities.

INTRODUCTION
The cellular networks are evolving through several generations. The first generation (1G) wireless mobile communication network was analog system which was used for public voice service. The second generation (2G) is based on digital technology and network infrastructure. It can support text messaging. Its success and the growth of demand for online information via the internet prompted the development of third generation systems (3G).

3G systems refer to the developing technology standards for the next generation of mobile communications systems. One of the main goals of the standardization efforts of 3G is to create a universal infrastructure that is able to support existing and future services. Separation of access technology, transport technology, service technology and user application from each other make this demanding requirement possible.

The 4th Generation LTE (4G) wireless mobile internet networks are research items in academy, which will integrate current existing cellular networks and Wi-Fi networks to support wireless mobile internet as the same quality of service as fixed internet, which is an evolution not only to move beyond the limitations of 3G, but also to increase the quality of services, to enhance the bandwidth and to minimize the cost of the resource.
The 5th wireless mobile multimedia internet networks can be completed wireless communication without limitation, which bring us perfect real world wireless – World Wide Wireless Web (WWWW).

The 6th generation (6G) wireless mobile communication networks shall integrate satellites to get global coverage. The global coverage systems have been developed by four courtiers. These in depended systems are difficulty for space roaming.

The task of 7th generation (7G) wireless mobile communication networks are going to unite the four systems to get space roaming. This paper mainly focuses on how a 5G network can provide more approach to a common man to utilize his available possessions in an immense way to make him to feel the real progress.

HOW 5G WILL WORK?
Mobile phone users and service providers are always on the lookout for higher data rates in mobile networks. The next generation of technology which is currently in the development phase is simply the 5th Generation Mobile technology (5G). It is the next major advancement in mobile telecommunication standards which will supersede 4G standards. The 5G technologies include all type of advanced features which makes 5G technology most powerful and in huge demand in near future. Since 5G is still in the development stage, standards have not been laid out for it by any telecommunication standardization body.
Going forward, the need and desire for faster and higher data rates in cellular communication networks, not only the mobile phone users but also cellular companies, is one of the biggest motivations behind today's ongoing 5G research. Most experts predict that the deployment of 5G networks will likely occur around 2020.
With an exponential increase 4G will be easily replaced with 5G with an advanced access technology named Beam Division Multiple Access (BDMA) and Filter Bank multi carrier (FBMC) multiple access. The concept

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behind BDMA technique is explained by considering the case of the base station communicating with the mobile stations.

In this communication, an orthogonal beam is allotted to each mobile station and BDMA technique will divide that beam according to locations of the mobile stations for giving multiple accesses to the mobile stations, which correspondingly increase the capacity of the system.

An idea to shift towards 5G is based on current drifts, it is commonly assumed that 5G cellular networks must address six challenges that are not effectively addressed by 4G i.e. higher capacity, higher data rate, lower End to End latency, massive device connectivity, reduced cost and consistent Quality of Experience provisioning.

To meet the demands of the user and to overcome the challenges that has been put forward in the 5G system A general observation of the researchers has shown that most of the wireless users stay inside for approximately 80 percent of time and outside for approximately 20 percent of the time.
For a mobile user to communicate whether inside or outside, an outside base station available in the middle of a cell helps in communication.

So for inside users to communicate with the outside base station, the signals will have to go through the walls of the indoors, and this will result in very high penetration loss, reduced spectral efficiency, data rate, and energy efficiency of wireless communications. To overcome this challenge, a new idea or designing technique that has come in to existence for scheming the 5G is to distinct outside and inside setups .The idea will be supported with the help of massive MIMO (Multiple Input Multiple Output) technology, in which dispersed array of antenna's are deployed which have tens or hundreds of antenna units. Present MIMO systems are using either two or four antennas.

Firstly, the outside base stations will be fitted with large antenna arrays and among them some are dispersed around the cell and linked to the base station through optical fiber cables, aided with massive MIMO technologies.

The mobile users present outside are usually fitted with a certain number of antenna units but with the help, a large virtual antenna can be constructed, which together with antenna arrays of base station form virtual massive MIMO links.
Secondly, every building will be installed with large antenna arrays from outside, to communicate with outdoor base stations.

The wireless access points inside the building are connected with the large antenna arrays from cables for communicating with indoor users. This will significantly improve the energy efficiency, cell average throughput, data rate, and spectral efficiency of the system .With the introduction of such an architecture, the inside users will only have to connect with inside wireless access points while larger antenna arrays remained installed outside the buildings. For indoor communication, certain technologies like WiFi, ultra wideband, millimeter wave communications are useful which having large data rates.
Since the 5G cellular architecture is heterogeneous, so it must include macrocells, microcells, small cells, and relays.

A mobile small cell concept is an integral part of 5G wireless cellular network. It is being introduced to put up high mobility users, which are inside the automobiles and high speed trains. Mobile small cells are positioned inside the moving automobiles to communicate with the users inside the automobile, while the massive MIMO unit consisting of large antenna arrays is placed outside the automobile to communicate with the outside base station. According to user's opinion, a mobile small cell is realized as a regular base station and its users are all observed as a single unit to the base station which proves the above idea of splitting indoor and outdoor setups. Mobile small cell users have a high data rate with considerably reduced signaling overhead.
The 5G cellular network architecture is explained. It has equal importance in terms of front end and backhaul network respectively. It describes the interconnectivity among the different emerging technologies like Massive MIMO network, The concept of Device to Device (D2D) communication, small cell access points and Internet of things (IOT) has also been incorporated in this proposed 5G cellular network architecture by this 5G cellular network may provide a good platform for future 5G standardization network.
But there are several issues that need to be taken care of in order to realize the 5G wireless network.

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COMPARISON OF 1G,2G,3G,4G & 5G

Generations	Access Technology	Data Rate	Switching	Applications
1G	Advanced Mobile Phone Service(AMPS)	2.4 Kbps	Circuit	Voice
2G	Global Systems for Mobile Communication(GSM), Code Division Multiple Access(CDMA)	10.0 Kbps	Circuit	Voice + Data
2.5G	General Packet Radio Service(GPRS)	**50.0 Kbps**	Circuit/Packet	Voice + Data
3G	Wideband Code Division Multiple Access(WCDMA) / Universal Mobile Telecommunications Systems(UMTS)	384 Kbps	Circuit/Packet	Voice + Data + Video Calling
3.5G	High Speed Download Packet Access(HSDPA)	5-30 Mbps	Packet	Voice + Data + Video Calling
4G	Worldwide Interoperability for Microwave Access (WiMax) , Long Term Evolution (LTE)	**100-200 Mbps**	Packet	Online Gaming + High Definition Television
5G	Beam Division Multiple Access (BDMA) & Filter Bank Multiple Carrier	10-20 Gbps (Expected)	Packet	Ultra High Definition Video + Virtual Reality Applications

EMERGING TECHNOLOGIES

It is expected that mobile and wireless traffic volume will increase a thousand-fold in the next decade which will be driven by the devices connected to the cloud by 2020 and all need to access and share data, anywhere and anytime. With a rapid increase in the number of connected devices, some challenges appear which will be increasing capacity, improving energy efficiency, cost and spectrum for stable scalability

We will cover a wide area of technologies with a lot of challenges arises due to variety of applications and requirements of the user. To provide a common connected platform and requirements for 5G, we will go through the below technology components:

1.**Multiple Input Multiple Output (MIMO),** is an evolving technology that has been upgraded from the present technology. The Massive MIMO system uses arrays of antenna containing few hundred antennas which are at the same time in one time, frequency slot providing service to many tens of user terminals Fig.1 (a). The main objective of Massive MIMO technology is to use all the benefits but on a larger scale. In general, massive MIMO is technology of next generation networks, which is energy efficient, robust, secure, and spectrum efficient.

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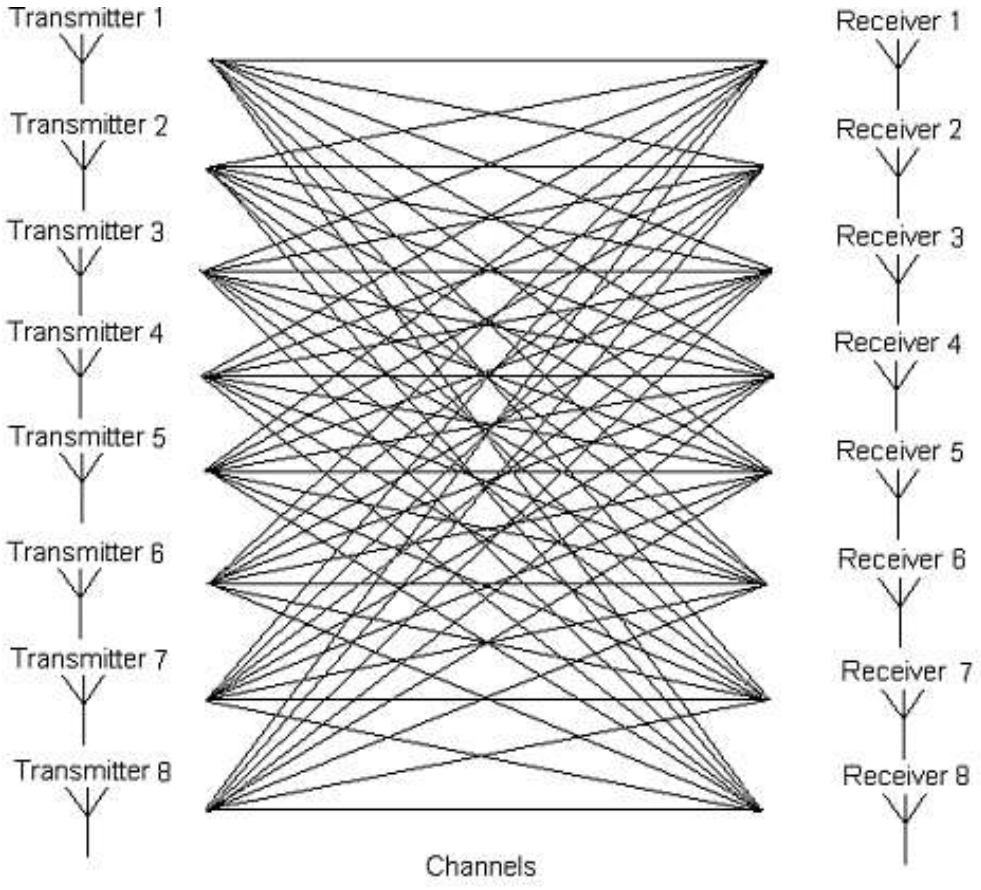

Fig.1 (a) Massive MIMO Technology

Massive MIMO depends on space multiplexing, which further depends on the base station to have channel information, both on the uplink as well as on the downlink. In case of downlink, it is not easy, but in case of uplink, it is easy, as the terminals send pilots. On the basis of pilots, the channel response of each terminal is approximated. In conventional MIMO systems, the base station sends the pilot waveforms to the terminals, the terminal estimate the channel, quantize it and feedback them to the base station. This process is not valid for massive MIMO systems, because of two reasons. Firstly the downlink pilots from the base station must be orthogonal among the antennas, due to which the required time, frequency slots of the downlink pilots increases with the increase in the number of antennas. So Massive MIMO systems would now require a large number of similar slots. Secondly, as the number of base station increases the number of the channel estimates also increases for each terminal which in turn needed 100 times more uplink slots to feedback the channel response to the base station. A general solution to this problem is to work in Time Division Duplexing (TDD) mode and by the reciprocity of the uplink and downlink channels.

Massive MIMO technology depends on phase coherent signals from the antennas at the base station. Below are certain positives of a massive MIMO system:

- **Capability Of Massive Mimo**

The increase in capacity is because of the space multiplexing technique used in Massive MIMO systems. The improvement in the radiated energy efficiency, it is because of the increase in the number of antennas, the energy can now be concentrated in compact regions in the space. It is based on the principle of coherent superposition of phases. After transmitting the shaped signals from the antennas, the base station just has to confirm that all the waves that have been from the antennas possibly will add constructively at the terminal's locations and destructively somewhere else.
The desirability of maximum ratio combining (MRC) is more because of its computational ease i.e. received signals are multiplied by their conjugate responses and due to this reason it is executed in a dispersed mode at

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every antenna element. The main reason behind the efficient use of the MRC with massive MIMO involving large number of base station antennas, the channel responses with the different terminals tend to be almost orthogonal. With the use of MRC receiver, we are able to operating in noise restricted system. MRC in Massive MIMO system will scale down the power to an extent possible deprived of spectral efficiency and multiuser interference, but the hardware deficiencies are likely to be overcome by the thermal noise. But the motto behind the overall Massive MIMO is to provide 10 times higher spectral efficiency as compared to conventional MIMO and it is possible because 10 times more terminals are served concurrently in the same time frequency resource.

- **Massive Mimo Systems Of Low Power And Less Cost**

Massive MIMO has come up with a change mainly in concept, schemes and execution. Massive MIMO systems use hundreds of less costly amplifiers with respect to costly ultra-linear 50 Watt amplifiers because earlier they are having an output power in the milliwatt range, which is much better than the latter which are being used in conventional systems. It is disparate to conventional array schemes, as it will use little antenna's that are being fed from high power amplifiers which are having a notable impact. The most significant improvement that can be made is by the removal of a large number of expensive things and massive items like large coaxial cables.

With the use of a large number of antennas in massive MIMO technology the noise, fading and hardware will be minimized because signals from a large number of antennas are combined with together in the free space. It reduces the limits on precision and linearity of every single amplifier and altogether what matters is their collective action. This will increase the resistance of massive MIMO against fading and failure of any one of the antenna elements.

A massive MIMO system has high degree of freedom. For example, with 100 antennas, 10 terminals are showing presence while the remaining 90 degrees of freedom are still available. These available degrees of freedom can be enslaved by making them used for signal shaping which will be friendly to our hardware. Specifically, each antenna with the use of very cheap and power proficient radio frequency amplifiers can transmit signals having small peak to average ratio and constant envelope at a normal price of increased total radiated power. With the help of constant envelope multiuser precoding, the signals transmitted from each antenna are not being formed in terms of beam. Rather, a wave field is created and sample is checked with respect to location of the terminals and they can see precisely the signals what we make them to see. Massive MIMO has a key property which makes it possible. The massive MIMO channel is having large null spaces in which nearly everything can be occupied without disturbing the terminals. In general, modules can be placed into this null space that makes the transmitted waveforms fulfill the preferred envelope restraints. Nevertheless, the operative channels between the base station and every terminal, can be processed without the involvement of PSK type modulation and can take any signal as input.

The improvement is required in the energy efficiency facilitates for massive MIMO systems to work two steps of lower magnitude than with existing technology on the total output RF power. This is important because the base stations consume a lot of power and that is what we need to concern about. If base stations that consume less power could be driven by renewable resources like solar or wind and therefore it will be helpful to also deploy the base stations to the places where electricity is not available. Along with this, the increased concerns of producing electricity will be considerably less.

- **Massive Mimo Decrease In Latency**

Latency is the prime area of concern in the next generation networks. The main cause why peoples hesitate to use wireless communication is latency. This phenomenon occurs amid the base station and terminal, i.e. when the signal is transmitted from the base station, it travels through different multiple paths because of the scattering phenomenon, reflection and diffraction before it reaches the terminal. When the signal through these multiple paths reaches the terminal it will interfere either constructively or destructively, and in the case when following waves from all these multiple paths interfere destructively, the received signal reduces considerably to a lower strength. If the terminal is caught in a fading dip, then it has to wait for the transmission channel to change until any data can be received. Massive MIMO, due to a large number of antennas and the idea of beam forming can avoid fading dips and now latency can be further decreased.

- **Massive Mimo Makes The Multiple Access Layer Simple**

With the arrival of Massive MIMO, the channel strengthens and now frequency domain scheduling is not enough. OFDM provides, each subcarrier in massive MIMO system with considerably the same gain due to which each and every terminal can be provided with complete bandwidth, which reduces most of the physical layer control terminated.

- **Massive Mimo Increases The Strength Equally Against Man Made**

Jamming of the wireless systems of the civilian is a prime area of concern and poses a serious threat to cyber security. To limited bandwidth, the distribution of information over frequency just is not possible. Massive MIMO offers the methods of improving robustness of wireless communications with the help of multiple

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antennas. It provides with an excess of degree of freedom that can be useful for canceling signals from intended jammers. If massive MIMO systems use joint channel estimation and decoding instead of pilots for channel estimation, then the problem from the intended jammers is considerably reduced.

The advantages of massive MIMO systems can be reviewed from an information. Massive MIMO systems can obtain the promising multiplexing gain of massive point to point MIMO systems, while eliminating problems due to conventional MIMO and unfavorable propagation environments.

2. **Radio-links**, includes the development of new transmission waveforms and new approaches of multiple access control and radio resource management.

3. **Multi-node and multi-antenna transmissions**, includes designing of multi-antenna transmission or reception technologies based on massive antenna configurations and developing advanced inter-node coordination and multi-hop technologies.

4. **Network dimension**, includes considering the demand traffic and mobility management, and approaches for efficient interference management in complex heterogeneous deployments.

5. **Spectrum usage**, includes the considering extended spectrum band of operation, as well as concept for new spectrum regimes that carefully addresses the needs of each usage scenario.

6. **Device-to-Device (D2D) communications** can be explained by visualizing a two level 5G cellular network firstly the macro cell level and second is device level. The macro cell level comprises of the base station to device communications as in an old cellular system. The device level comprises of device to device communications. If a device links to the network with the help of base station, then it will be operating in the macro cell level and if a device links directly to another device or captures its transmission through the support of other devices, then it will be on the device level. In these types, the base stations will attend the devices as usual. But in the congested areas and at the cell edges, and for this type of situation mesh network is created and devices will be permitted to communicate with each other.
In the insight of device level communications, the base station either have full, partial control over the resource allocation between source, destination, and relaying devices, or not have any control. Thus, we can describe the four main types of device-level communications:-

- DEVICE RELAYING WITH BASE STATION CONTROLLED LINK FORMATION.
- DIRECT DEVICE TO DEVICE COMMUNICATION WITH BASE STATION CONTROLLED LINK FORMATION.
- DEVICE RELAYING WITH DEVICE CONTROLLED LINK FORMATION.
- DIRECT DEVICE TO DEVICE COMMUNICATION WITH DEVICE CONTROLLED LINK FORMATION.

7. **Massive Machine Communications (MMC)** will form the basis of the Internet of Things (IOT) with a wide range of application fields including the automotive industry, public safety, emergency services, medical field, etc.

8. **Moving Networks (MN)** will enhance and extend linking together of large number of jointly moving communication devices.

9. **Ultra-dense Networks (UDN)**, to meet the demands of users due to the increased traffic, densification of the infrastructure will be the most important aspect of 5G communications. But for achieving ultra-dense, heterogeneous networks are most important. With the introduction of moving networks and social networks, the heterogeneous networks are becoming more effective. Though dense and dynamic heterogeneous networks will evolve new challenges in terms of interference, mobility and backhauling. To overcome these challenges, there arises the requirement of designing new network layer functions for maximizing the performance from the present design of the existing physical layer.

In present networks like Long Term Evolution (LTE), there are interference mitigation techniques like Inter-Cell Interference Coordination and autonomous component carrier selection. But these techniques are applicable only to dense small cell deployments and have limited mobility. So for 5G networks, the interference techniques

should be more flexible and open to the variations as changes in the traffic and deployment are expected to occur quickly than existing networks.

With the introduction of smart wireless devices, the interaction between these devices and with the environment are believed to increase. To end the challenges that have been raised because of the increasing density of nodes and interchanging connectivity options, there also arises the need independent algorithms by the user himself. So future smart devices are designed in such a way that with the help of context information, they themselves will decide how to manage the connectivity. Contextual information possibly will be given by the approaching service profile, battery position of a device or complete data acquired through either in built sensors, cloud servers or serving base station. For example, to enable the quick initialization of direct Device-to-Device communications and multicast group making, context information about the social networking will be very helpful as it will decrease the signaling overhead in the network. Context information can also provide sustenance for the network to decrease the use of energy in base stations because of the switching of cells by improving the mobility and traffic management procedures.

In short, future smart devices and small cell networks will be capable of providing the best wireless connectivity with minimized interference and less power consumption. Along with this, they should be rapidly adaptable to the changing requirements of devices and accessibility to the network.

10. **Ultra-reliable Networks (URN)** will enable high degrees of availability.In this section, we identify several technologies, which will be crucial in future wireless standards.

CONCLUSION

In this paper, a detail has been done on the performance requirements of 5G wireless cellular communication systems that are defined as capacity, data rate, spectral efficiency, energy efficiency, and Quality of service. A 5G wireless network architecture has been explained in this paper with massive MIMO technology.

Certain short range communication technologies, like WiFi , Small cell and millimeter wave communication technologies, has been explained, which provides a promising future in terms of better quality and increased data rate for inside users and at the same time would also reduce the load from the outside base stations. Some emerging technologies have also been discussed that can be used in 5G wireless systems to fulfill the probable performance desires, like massive MIMO.

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