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DEVELOPMENT OF 5G TECHNOLOGY

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ABSTRACT

This technology is the future of current LTE technology which would be a boost to the future of wireless and computer networks, as the speeds would be way higher than the current LTE networks, which will push the technology to a new level. This technology will make the radio channels to support data access speeds up to 10 Gb/s which will turn the bandwidth radio channels as WiFi. Comparing it with other LTE technology's it has high speed and capacity, support interactive multimedia, voice, internet and its data rate is 1 Gbps which makes it faster than other LTE's . This is much more effective than other technology's due to its advanced billing interfaces. This paper provides detail explanation of 5G technology, its architecture, challenges, advantages and disadvantages, issues and ends with future of 5G technology.

Key Words: LTE, 5G, high speed

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1. INTRODUCTION

The world has seen a lot of changes in the realm of communication. Today we no more use landlines. Everyone possesses a mobile phone that functions nine to seven. Our handsets not only keep us connected with the world at large but also serve the purpose of entertainment gadget. From 1G to 2.5G and from 3G to 5G this world of telecommunications has seen several improvements along with improved performance with every passing day. 5G technology is on its way to change the way by which most of the users access their handsets. Users will go through a level of call volume and data transmission with 5G pushed over a VOIP enables gadget. With increasing awareness of customers with respect to upcoming technologies, affordable packages and good looks; it is very important that mobile producers must give an altogether decent package for keeping up the customer loyalty. The most important and leading motive of leading mobile phone manufacturers is the creation of best and latest technology to compete with innovative market giants. We have seen great cell phones one after another, with unbelievable traits. Apple has remained successful in shivering the electronic world by putting forth its latest iPhone 7 has taken the market by storm.

In such a small electronic piece, huge features are getting embedded. There are very few mobiles left without mp3 player or/and camera. People are focusing on getting everything without spending a penny more. Keeping in mind the user's pocket, economic cell phones are introduced with maximum features. With 5G technology you can hook your mobile phone to your laptop for broadband internet access. The characteristics especially video player, camera, mp3 recorder, messengers, photo treatment and games have made today's mobile phone a handheld computer. The developed world is already utilizing 4G and it is beyond imagination that what will be engulfed in 5G as everything is already embedded such as smallest mobile phones, speed dialing, largest memory, audio and video player,Microsoft office, etc. Pico net and Bluetooth technology has made data sharing a child's play. Initiallyinfrared kept us bound for properly aliening two handset devices for data sharing. We still remember thedisturbance and irritation caused in transferring data but the advent of Bluetooth changed the history. Itenabled us to share data between two gadgets within a range of 50 meters. With the swiftness in datasharing the cell phone manufactures focused on mobile broadband that can open a new window ofcommunicationand navigation in theworld oftelecommunication.

5G technology will change the way cellular plans are offered worldwide. A new revolution is about to begin. The global cell phone is around the corner. The global mobile phone will hit the localities who can call and access from China to Germany's local phone with this new technology. The way in which people are communicating will altogether upgrade. The utilization of this gadget will surely move a step ahead with improved and accessible connectivity around the world. Your office will shrink into your handset with this cell phone that is going to resemble PDA (personal digital assistant) of twenty first century.

2. ARCHITECTURE OF 5G TECHNOLOGY

- **KeyFeaturesof5GArchitecture.**

The main challenges to focus on is the challenges of 1000 times higher traffic volume and 100 times higher user data rate. This explosive traffic growth and the user data rate can be controlled by many technologies but we can focus on the three which can control such a high ratio. They are, the Physical layer(PHY) technologies which include the massive Multiple Input and Multiple Output(MIMO), Filter Bank Multi-Carrier(FBMC), Non-Orthogonal Multiple Access(NOMA), etc. It mainly focuses on the improvement of spectrum efficiency to enhance the network capacity. Furthermore, the exploitation of underutilized spectrum at the millimeter(mm) Wave Frequency can be very useful to improve the network capacity.

Lower Latency: Some services and applications related to healthcare, security, vehicle-to-vehicle and mission-critical control may have strict requirements on latency, in which the most challenging demand is on the order of 1ms . Fortunately, one PHY scheme named Generalized Frequency-Division Multiplexing (GFDM) is designed to overcome the real-time challenge for 5G network.

Huge Number of Connected Devices: Different from human-to-human communication, MTC has a wide range of characteristics and requirements. The huge number of connected MTC devices further broaden the diversity of MTC. On the one hand, the number of served users per eNB can be decreased through network densification, thereby alleviating the pressure of eNB. On the other hand, the network needs deeper programmability and flexible adaption to different applications and guarantees the correspondingQoS.

Decrease of Cost: Since the network functions always come with separate proprietary hardware entities, the deployment of new network services means a high cost for energy, capital investment challenges and rarity of skills necessary to design, integration and operation of complex hardware-based appliances. Moreover, hardware-based appliances rapidly reach end of life, requiring much of the procure-design- integrate-deploy cycle to be repeated with little or no revenue benefit. Worse, hardware lifecycles are becoming shorter as technology and services innovation accelerates, inhibiting the roll out of new revenue earning network services and constraining innovation in an increasingly network-centric connected world.

Improvement of Energy Efficiency: Energy efficiency can be understood from two viewpoints, which are the energy efficiency of network infrastructure and terminal. Higher energy efficiency

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of network and terminal implies lower operational cost and longer battery lifetime, respectively. The above technologies (massive MIMO, UDN, etc.) are able to improve the link quality, which reduce the energy consumption on radio link. Both the network and terminal can save energy consumption simultaneously.

- **BasicArchitectureof5G**

Architecture of 5G is highly advanced, its network elements and various terminals are characteristically upgraded to afford a new situation. Likewise, service providers can implement the advance technology to adopt the value-added services easily. However, upgradeability is based upon cognitive radio technology that includes various significant features such as ability of devices to identify their geographical location as well as weather, temperature, etc.

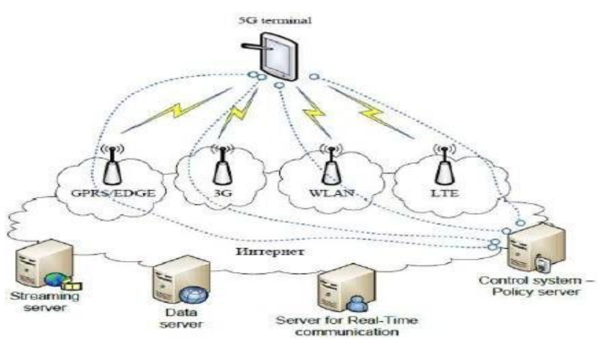

Figure1:5GBasicArchitecture

The following image, the system model of 5G is entirely IP based model designed for the wireless and mobile networks. The system comprising of a main user terminal and then a number of independent and autonomous radio access technologies. Each of the radio technologies is considered as the IP link for the outside internet world. The IP technology is designed exclusively to ensure sufficient control data for appropriate routing of IP packets related to a certain application connections i.e. sessions between client applications and servers somewhere on the Internet. Moreover, to make accessible routing of packets should be fixed in accordance with the given policies of the user.

There are different sections in 5G architecture: core, cellular, wireless and mobile. The most widely used section is network architecture, which is discussed in the below subsection.

3. SOFTWARE PLATFORMS OF 5G

The Open-Air Interface(OAI) platform includes a full software implementation of fourth generation mobile cellular systems which complies with 3GPP LTE standards which is coded in C language under real-time Linux which dedicated for x86. At the physical layer, it provides the following features:

- LTE release 8.6, with a subset of Release 10;
- FDD and TDD configurations in 5, 10 and 20 MHz bandwidth;
- Transmission mode: 1 (SISO), and 2, 4, 5, and 6 (MIMO 2x2);
- CQI/PMI reporting;
- HARQ support (UL and DL);
- Highly optimized baseband processing (including turbo decoder).

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This are the operations made and practically defined when the LTE was new. Currently, MATLAB has performed some operations to

generate the type of signals which would be

- **WLANSIMULATIONSRESULTSFROM MATLAB:**

- WLAN transceiver:

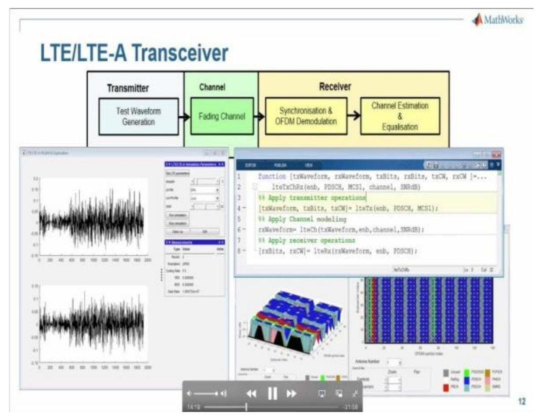
Figure2:BlockDiagram and Code functionalities of WLAN

Transmitter: A transmitter side is an equipment or tool used to generate and transmit electromagnetic waves carrying messages or signals especially those of like radio signals. Here we would be using transmitter as an input function used to generate a test waveform.

Channel: A channel can be defined as the bandwidth used to allocate the frequencies used for radio and television transmission. A fading channel can be referred to a communication channel that experiencesfading. In wireless systems, fading can be due to a multipath propagation and due to shadowing from obstacles affecting the wave propagation, referred to as shadow fading.

Receiver: Similarly, to the transmitter side which is used to transmit the signals, there is a receiver side which is there to receive those signals. We have two operations at the receiver side they are synchronization and OFDM demodulation and channel estimation and equalization.

Synchronization: In wireless communication, the receiver side should determine the time instants for the incoming signal which needs to be sampled (timing synchronization). For bandpass communications, the receiver needs to take the frequency and the phase of its local carrier oscillator with those of the received signal which will be



termed as carrier synchronization.

Orthogonal Frequency-division Multiplexing(OFDM) demodulation: The term is used as a digital multi-carrier modulation method. It can be defined as a large number of closely spaced orthogonal sub- carrier signals are used to carry data on several parallel data streams or channels. OFDM can be demodulated using FFTs (Fast Fourier Transform). But if in case you have a very few number of carriers, you might be able to use a small number of orthogonal quadrature demodulators.

Channel estimation: It can be defined as the User Defined pilot-averaging method performs two-dimensional interpolation to estimate the channel response between the available pilot symbols. An interpolation window is used to specify which data

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is used to perform the interpolation.

Equalization: It is a process of adjusting the balance between the frequency components within an electronic signal. The most common equalization can be seen in the sound recordings and reproduction where there are many applications in signal processing tools and telecommunications.

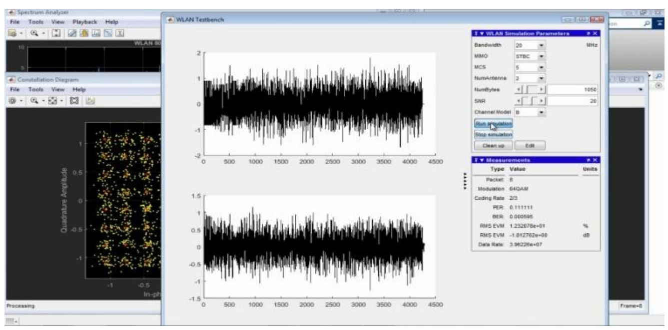
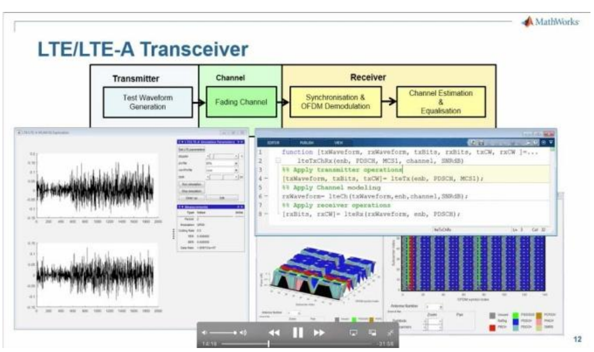


Figure3:SimulationofWLAN

- Once the run simulation has been initiated we can see that for the convenience we have set



the bandwidth to 20 MHz and by default the MIMO has been set to Space time block code (STBC), the multilevel coordinate search (MCS) has been set to 5, Number of antennas has been

set to 2, Number of bytes has been set to 1050, Signal to Noise ratio (SNR) has been set to 20 and channel model has been set to B. In the graph the x axis has been set to Megahertz (MHz) and y axis has been set to decibels (dB). The top shading graph is the output of the signal before channel modeling and the bottom shade presentation is the output after channel modeling. The test bench also performs the measurements which also reports you the modulation and coding rate and it also continuously reports you the packet errors rate (PER) and the Bit Error Rate (BER) and packet by packet it computes the Root Mean Square (RMS) FBMC: Filter Bank Multi Carrier and

- UFMC: Universal Filtered Multi Carrier.

➢ **FBMC:FilterBankMultiCarrier–**

It introduces per- Sub carrier filtering to reduce the side lobes. It has couple of implementation techniques they are frequency spreading (extended IFFT/FFT) and poly-phase network (more efficient, commonly employed)

- **Code for FBMC:**

Error Vector Magnitude (EVM) values in percentage and Decibels (DB) and give the data rates.

LTE/LTEATransceiver:

Figure4:BlockDiagram and Code functionalities of LTE/LTEA

LTE/LTE A Simulation:

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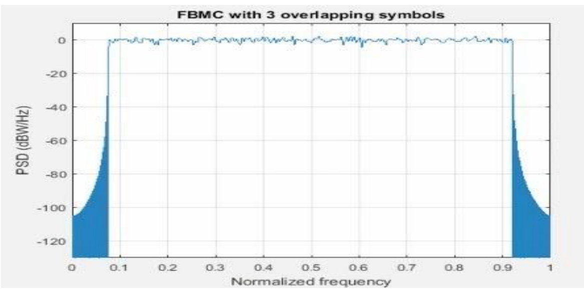
Figure5:LTE/LTEA Simulator

5G

5G Systems requires both spectral efficiency and robust synchronization. Majority of candidates



are multicarrier and Non-orthogonal waveform The members of "filtered" OFDM designs are

- FBMC: Filter Bank Multi Carrier and
- UFMC: Universal Filtered Multi Carrier.

➢ **FBMC:FilterBankMultiCarrier–**

It introduces per- Sub carrier filtering to reduce the side lobes. It has couple of implementation techniques they are frequency spreading (extended IFFT/FFT) and poly-phase network (more efficient, commonly employed)

- **Code for FBMC:**

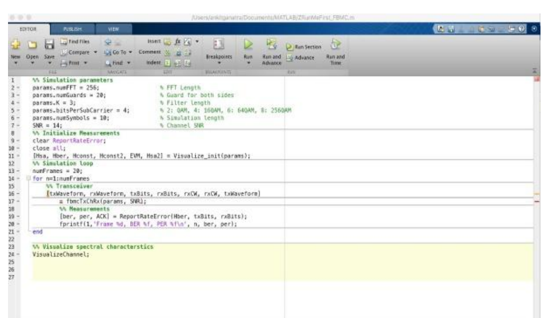
The most important characteristic of FBMC is that at a given FFT length it can perform much better than the corresponding OFDM. OFDM composes a rectangular window, the sub carrier is based on the sinc function, side lobe attenuation has a very gradual drop about 20db. We can use FBMC by managing the filter length of 3 which will be the same as but FBMC will have a very sharp drop until -100db as you can see in figure 28. Without too much use of the guard length we can pack the same frequency adjacent together. This implies the main benefit of FBMC module being proposed.

Waveforms Generated:

Figure7:WaveformGenerationforFBMC

➢ **UFMC:UniversalFilteredMultiCarrier–**

In this process, the filtering is applied per sub-bands (not per sub-carrier as in FBMC), filtering is



parameterized by side-lobe attenuation, reduced filter length (compared to FBMC), good for short bursts, suited for uplink with multiple users,

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orthogonal in the complex plane, use QAM symbols, reapply MIMO schemes, Receiver complexity and like OFDM, uses per sub carrier equalization.

- **Code function for UFMC:**

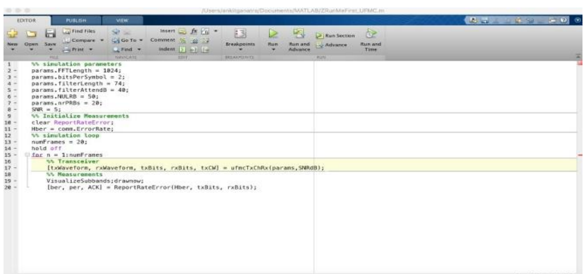


Figure8:CodefunctionforUFMC

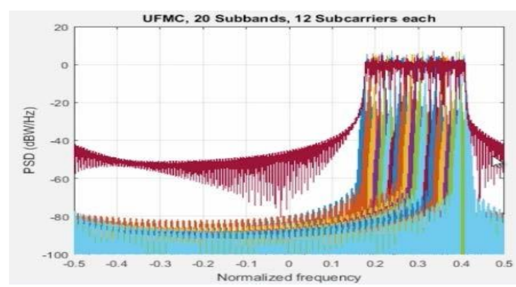
Waveform obtained from UFMC:

Figure9:WaveformgeneratedforUFMC

4. CHALLENGES IN 5G TECHNOLOGY

The aforementioned vision 5G reveals a plethora of challenges that we can outline: 5G strives to provide a universal ICT infrastructure that addresses wider societal challenges through a flexible alignment of stakeholder incentives by virtue of being truly programmable, secure, dependable, privacy preserving, and flexible, while minimizing the costs per bit by efficiently harnessing all communication capabilities and reducing the system power consumption by harvesting any kind of accessible energy from the environment. First, this vision points towards a significantly increased (in comparison to earlier generations) set of stakeholders that 5G needs to accommodate when providing communication solutions. Examples of stakeholders are:

- Individual and communities of people.
- SMEs, corporations, not-for-profit and social organizations.
- Digital asset owners, such as public transport and utilities authorities and organizations.
- Vertical sectors like energy, health, manufacturing, robotics, environment, broadcast, content and creative industries, transport, smart cities.
- Municipalities and public administrations.
- Public safety organizations and defense



bodies.

network, including aspects as subscriber management, core network and transport features. This view on 5G leads to many key performance challenges that 5G technologies will need to address for meeting expected key performance indicators (KPIs):

Throughput: provide 1000x more available throughput in aggregate, as well as 10x more speed to individual end users, in order to enable fully immersive experiences. This may require the integration of new forms of broadcast services.

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- **Latency:** provide service-level latency down to about 1ms (when needed) for tactile Internet, interactive and immersive experiences as well as standard Internet services.
- **Energy efficiency:** Wireless/mobile broadband infrastructures account for more than 50% of the energy consumption of telecommunication operator networks, while the amount of global energy consumption of ICT approaches 4.5% with a rising trend. It is important that future 5G networks meet requirements and challenges in an energy efficient manner
- **Service creation time:** enable the creation of user experiences from the application over the individual service components down to the individually participating network(s) in a matter of seconds or less.
- **Battery lifetime:** provide 10x better battery lifetime for low throughput solutions such as sensors.
- **Coverage:** with many more people expecting to have the same coverage when travelling (on cruise liners, passenger aircraft, high-speed trains and in holiday villas), it is key to provide seamless extension of 5G services anywhere anytime. IoT coverage to wide areas involving sensors and M2M connections are ideal services to make use of satellite wide area coverage.
- In addition to the key performance challenges, we also outline system-level challenges that arise from the changing ecosystem in which 5G is expected to operate:
- **Privacy by design challenge**: provide accountability within the communication substrate and enable truly private communication when needed, aligned with policy constraints in terms of data management and ownership, ensured by the infrastructure operators that realize the overall service.
- **Quality of Service challenge:** in order to allow for optimizing the Quality of Experience5 (QoE) for the end user, 5G should provide differentiated services across various dimensions such as throughput, latency, resilience and costs per bit as much as possible independent of users' location with respect to the antennas deployment geography. This includes increased security, availability, resilience and delivery assurance for mission critical applications such as health-related or emergency applications, but also ultra-low cost solutions for emerging countries with less stringent QoE requirements.
- **Simplicity challenge:** provide to 5G users the best network services seamlessly without complex customer journeys (e.g. for inter

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RAT switching).

- **Density challenge:** increased number of diverse devices connected in proximity, e.g., challenging the current architecture for mobility management.
- **Multi-tenancy challenge:** provide service solutions across different infrastructure ownerships, with the different networks (not necessarily IP-based) co-existing and providing and providing an integrated as well as efficient interaction between the wireless domain and the backhaul.
- **Diversity challenge:** Beyond the diversity of stakeholders, 5G must support the increasing diversity of optimized wireless solutions (to different application domains, e.g., M2M) and the increasing diversity and number of connected devices, and associated diversity of traffic types.
- **Harnessing challenge:** exploit any communication capability, including device-to-device (D2D), for providing the most appropriate communication means at the appropriate time.
- **Harvesting challenge:** devise radically new approaches to provide devices with power, which not only has to come from batteries, but also harvests existing environmental energy.
- **Mobility challenge**: support for unlimited seamless mobility across all networks/technologies
- **Location and context information challenge**: provide positioning and context capabilities in the sub meter range in order to enable the Internet of everything, e.g., through the integration of cellular and satellite positioning systems.
- **Open environment challenge:** enable horizontal business models by opening the right business interfaces within the system in order to enable flexible operator models in a multi-tenancy fashion.
- **Manageability:** Improve manageability of networks in order to reduce the need for manual management and reduce the human involvement. QoE is the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and / or enjoyment of the application or service in the light of the user's personality and current state. Whitepaper for public consultation, August 2014 13
- **Hardening challenge:** deploy a communication system through a combination of bearer techniques such as cellular and satellite that is intrinsically robust to attacks from malicious entities as well as to natural disasters; a resilience without which the smart-grid/smart-city

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paradigm will never be achieved.

- **Resource management challenge:** provide access agnostic control, policy and charging mechanisms and protocols for dynamic establishment, configuration, reconfiguration and release of any type of resource (Bandwidth, Computation, Memory, Storage), for any type of devices (e.g. terminal, car, robot, drone, etc.) and services (e.g. Network, Security, Data, Knowledge, Machine, and Thing as a Service), including in E2E fashion when necessary.
- **Flexibility challenge:** devise truly flexible control mechanisms and protocols for relocating functions, protocol entities and corresponding states in a truly end-to-end manner, leveraging programmable network technologies such as SDN and NFV.
- **Identity challenge:** provide identity management solutions for any type of device (terminal, car, robot, drone, etc.) with access agnostic authentication mechanisms that are available on any type of device, device to device and network to device, independent from specific technologies of communication entities and of their current location.
- **Flexible pricing challenge:** provide methods for flexible pricing mechanisms across and between different parts of the future 5G value chain in order to enable pricing regimes that are common across the industries that will utilize the future 5G infrastructure. Furthermore, new business models could consider the underlying technology (e.g., wireless or mobile, legacy or later one) as well as other aspects like the contribution of a privately owned small cell to the operator's infrastructure through its open access.
- **Evolution challenge:** provide the ability for evolution and adaptation, allowing a transparent migration from current networks and permitting future development.

Finally, the flexible alignment of incentives, as envisioned by our 5G vision, will truly enable fluid information-driven markets through our 5G platform. We will need to study the potentially transformative changes within the many industries that 5G intends to provide solutions for in the light of this new economic market fluidity. For instance, we can already see today that the ‘app economy’ of smartphone- based applications has had an impact on areas such as public transport as well as health. Quantifying this impact, identifying new business models as well as fostering emerging stakeholders in these future markets are the priorities of this economic research in the 5G context.

5. FUTURE AND CONCLUSIONS

The many initiatives and discussions on 5G going

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on around the world by governments, vendors, operators and academia demonstrate the continuing ethos of collaboration and innovation across the industry. In these debates, we must ensure that we continue to co- ordinate with aligned goals to maintain momentum in completing the definition of 5G. The key 5G considerations at this stage are: When 5G arrives will be determined by what 5G turns out to be as discussed earlier, there are currently two differing views of what 5G is. The first view makes its implementation somewhat intangible – 5G will become a commercial reality when sufficient industry voices say so, but this will be difficult to measure by any recognizable metric. The second approach is more concrete in that it has a distinct set of technical objectives, meaning that when a service is launched that meets those objectives it will count as the advent of 5G.

As the requirements identified for 5G are a combination of both visions, in some cases the requirement set is self-contradictory – for example, it would not be possible to have a new RAN with beam forming and meet a requirement for power reduction, because beam forming uses a lot more power than today's RAN. As a result, there must be an established answer to the question of what 5G is before there can be an answer to the question of when it will arrive. The case for a new RAN should be based on its potential to improve mobile networks. The principal challenge in the 5G specification is the sub-1ms latency requirement, which is governed by fundamental laws of physics. If, as discussed above, this challenge proves too much and the requirements for sub-1ms delay are removed from 5G, the need for a new RAN would be questioned. Whether a new air interface is necessary is arguably more of a question of whether one can be invented that significantly improves mobile networks, rather than on a race to the arbitrary deadline of 2020.

5G is an opportunity to develop a more sustainable operator investment model. If previous generations of mobile technology have taught us anything, it is it that, as with each preceding generation, 5G will unlock value in ways we cannot and will not anticipate. Services that were initially expected to have a negligible impact became hugely popular (e.g. SMS), while those expected to be the 'next big thing' have been slow to gain traction (e.g. video calling). Through the development of 5G, we as an industry can expect a paradigm shift in the way that all the stakeholders in the mobile ecosystem play their role. Regulators especially can use this as an opportunity to create healthier environments that stimulate continuing investment in next generation technology. Some of the business cases that have worked well for 3G and 4G technologies may not be the right ones for 5G. By actively conceiving and exploring 5G business cases at an earlier stage, operators will have greater potential to shape the new paradigm. The GSMA will continue to work

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with its members to shape the future of 5G. Whichever form 5G eventually takes, the GSMA, as the association representing the mobile industry, looks forward to contributing to the development of a 5G ecosystem through collaboration and thought leadership.

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