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Brief Overview of 5G

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ABSTRACT
5G is one of the most powerful technology of the previous generations of wireless telephone technology. Fifth generation is designed to not be an incremental advance on 4G technology. 5G has its unique paradigm shift that would include very high carrier frequencies with very high bandwidths, and unique base station and device densities with unmatched, adorable numbers of antennas. In addition, 5G has the ability of attachment and coupling any new air interface and spectrum together along with LTE and WiFi to provide universal high-rate coverage and a seamless user experience. To reach these levels of integrations, flexibility and network intelligence will be massively enhanced and resolved.

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I. INTRODUCTION

It is very important to review the previous network generations from the oldest network before getting into the latest new network revolution. This will help us to figure out the weakness and strength of each generation since it's deployment and applied, reaching the latest generation. 1G is the first generation of wireless telephone technology, which provides a speed up to 2.4 Kbps. This network provides limited voice calls to only one country, it is a network is based on using analog signal. There are many weaknesses in this network such as, poor quality of voice, poor battery life, large phone size, limited capacity, and very weak hand-off reliability. 2G is based on the global system of mobile communication (GSM). 2G network uses digital signals and reach data-rate up to 64 Kbps. This network provides more different services than the first generation such as text massages, picture messages, and multimedia messages (MMS). Comparing the voice calls quality to 1G, it has better quality. 2.5G is a technology between 2G and 3G and called second and half generation. It combines 2G technology with the general packet radio service (GPRS). This network provides phone calls, sending and receiving e-mail messages, web browsing, and has speed up to 144 Kbps. Also, the voice call quality enhanced. Third generation (3G) network was presented in year 2000 with data-rate from 144 Kbps to 2 Mbps. This network has capabilities to send large numbers of e-mails, faster web browsing, video conferencing, and mobile TV. Fourth generation (4G) came up with higher data rate and higher quality video streaming. The speed in this network is up to 100 Mbps to 1 Gbps. The switching technology that of this network has become totally packet switching which leads to very high data transmission capabilities. Due to the combination of both WiFi and WiMax together, 4G has much better quality of service (QoS) with lower costs per bit. However, fourth generation has higher battery usage and higher network equipment's cost.

Due to the tremendous increases of the wireless network usages and the huge growth in demand for the data transmission, with the huge variation in the volume of data traffic along the years for the internet protocol (IP) network, a new generation network with no limitations is needed to meet all these demands.

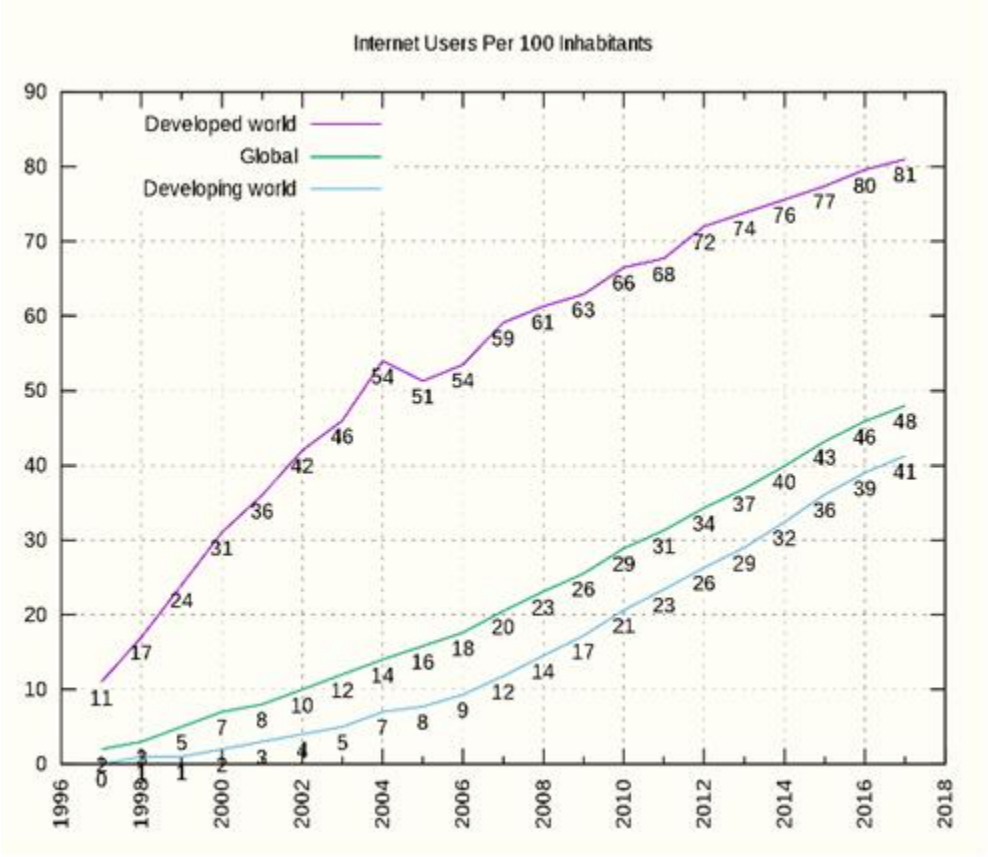

Figure 1. Demand for transmission over IP in different years.

What is it?

Fifth generation (5G) is the solution to meet and provide a unique network that can broadcast very large amount of data transmission in gigabits per second. Indeed, the expectations in this new generation to provide better communication network and support several simultaneous connections for deploying massive numbers of sensors. Rather than its ability to enhance the spectral efficiency and lower network latency that reaches about 1 ms, lower battery consumption, lower outage probability, and higher number of supported devices. Considering 5G for the future network necessitates the need to improve technologies related to transportation at cell sites corresponding to needed change in the network, devices, and applications. Another fact about 5G is that it will interconnect the entire world without limits by employing intelligent technology. It will be based on a new concept of multiple data path scheme for providing a real worldwide wireless wed (WWWW). To design such a wireless world, the integration of networks is required. The final design is expected to be a multi-bandwidth data path, which is designed through collecting the current and feature networks and introducing the new network architecture of 5G in reality.To achieve these goals, 5G network must have the following characteristics:

(1) fifth generation (5G) should be highly flexible and highly intelligent. (2) It should have a significant spectrum management scheme.(3) It is expected to improve efficiency while decreasing the cost.(4) It should be able to provide an Internet of Things (IoT).(5) It should introduce flexible bandwidth allocation based on the demands of users.(6) It should be able to integrate with previous and current cellular and WiFi standards, which provides a high data rate of communication and decrease delays.

5G network is expected to be deployed at year 2020 with network densification and millimeter wave (mmWAV) cellular systems, and deploying multiple-input, multiple-output (MIMO).

Why 5G?

5G network is required to handle multiple technologies including both Wi-Fi and LTE, provide multiple frequency bands, and support greater numbers of subscribers compared with previous networks. There has been amazing increase in the use of smartphones, tablets, video streaming and online games during the previous years, so that any thinking of creating and starting a new network with

better performance is of great value. In addition to the growth in amount of data, number of devices and the data rate that is related to channel capacity will increase dramatically. This also including the usage of applications that used by new subscribers with different ages and demands. From this point of view, a new network is raised to determines the degree to which network can support the mobile data traffic explosion. The total number of data served by a network in bits (aggregate data rate), the worst data rate that is expected by a user within the range of a network (edge rate (%), and the highest expected data rate (peak rate) are parameters cannot be compromised. 5G goal is to increase the aggregate data rate and the edge rate, respectively, by factor of 1000 and 100 compared with 4G network. Latency is another issue with which the network can be evaluated. 5G should be designed to reach 1 ms, which is much lower than it is in 4G (15 ms). The data rate will increase to reach 100X in 5G, therefore the cost per bit should be decrease by 100X. so in this case a cheaper mmWAV spectrum should be provided for 5G.

Another fact about 5G is that it will interconnect the entire world without limits by employing intelligent technology. It will be based on a new concept of a multipath data path scheme for providing a real worldwide wireless web (wwww). It is expected to be a multi-bandwidth data path, which is designed through collecting the current and future networks and introducing the new network architecture of 5G. Therefore, in such a real wireless world, code-division multiple access (CDMA), orthogonal frequency-division multiple access (OFDM), multicarrier code-division multiple access (MCCDMA), ultrawide band (UWB), and internet protocol version 6 (IPv6) will support the new network. As a result of such an extensive network architecture, by using 5G it will be possible to have remarkable data capabilities and connect unlimited call volumes and infinite data broadcast. Another anticipation of 5G is its ability to distribute internet access to nodes across the world at a smooth speed. Using 5G, the provided solution for a wireless network will be high and there will be bidirectional large bandwidth shaping. A great characteristic of 5G technology will be its ability in remote diagnostics. Users will experience a network that gets better and fast solutions via remote management.

Engineering Requirements for 5G

To more understanding the engineering challenges facing 5G, and plan to meet them, it is necessary to first identify the requirements for the 5G system. The following items are requirements in each key dimension but should be stressed that not all these need to be satisfied simultaneously. Different applications will place different requirements on the performance, and peak requirements that will need to be satisfied in certain configurations are mentioned below. For instance, very-high applications such as streaming high-definition video and may have relaxed latency and reliability requirements compared to driverless cars or public safety applications, where latency and reliability are paramount but lower data rates can be tolerated.

1) Data Rate: the need to support the mobile data traffic explosion is unquestionably the main driver behind 5G. data rate can be measured in several different ways, and there will be a 5G goal target for each such metric.

2) Latency: the current 4G roundtrip latencies are on the order of 15 ms, are based on the 1 ms subframe time with necessary overheads for resource allocation and access. Although this latency is sufficient for most current services, anticipated 5G applications include two-way gaming, novel cloud-based technologies such as those that may be touch screen activated, and virtual and enhanced reality. As a result, 5G will need to be able to support a roundtrip latency of about 1 ms, an order of magnitude faster than 4G. in addition to shrinking down the subframe structure, such severe constrains may have important implications on design choices at several layers of the protocol stack and the core network.

3) Energy and Cost: as the movement toward 5G is going, costs and energy consumption will, ideally, decrease, but at least they should not increase on a per-link basis. Since the per-link data rates being offered will be increasing by about 100x, this means that the Joules per bit and cost per bit will need to fall by at least 100x. at this point of view, mmWave spectrum should be 10-100x cheaper per Hz than 3G and 4G spectrum below 3GHz. Similarly, small sells should be 10-100x cheaper and more power different than macrocells. A major cost consideration for 5G, even more so than in 4G due to the new BS densities and increased bandwidth, is the backhaul from the network edges into the core.

4) Device Types and Quantities:5G network will need to be able to efficiently support a much larger and more diverse set of devices. With the expected rise machine-to-machine communication, a single microcell may need to support 10,000 or more low-rate devices, along with its traditional high-rate mobile users. This will require wholesale changes to the control plane and network management relative to 4G network. Whose overhead channels and state machines are

not designed for such a diverse and large subscriber base.

Key Technology for 5G Networks

In 5G networks, it is desired to provide a multi-gigabit per second-based data rate for communication by using massive MIMO, mmWAVs, and new waveforms.There is a great demand for a radical increase in the capacity and bandwidth of different cellular and wireless networks. The data rates in a future generation 5G network must increase up to several gigabits per second. This high data rate can be processed by using mmWAV spectrum steerable antennas. This smaller millimeter wavelength can be integrated with directional antenna for higher throughput because massive MIMO as a spatial processing technique can provide polarization and beam-forming adaptation. Fiqure-2 shows the available mmWAV bands for a mobile access network. Carrier aggregation will be applied to offer considerably higher data rates, which create a larger virtual bandwidth by combining a separate spectrum band.

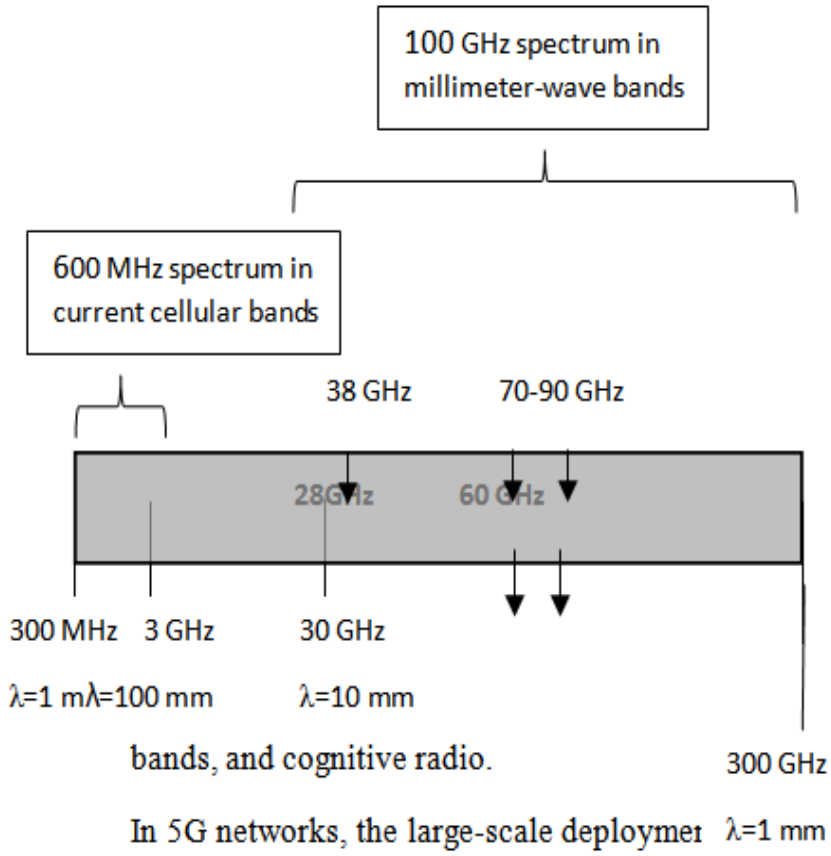

Figure 2. Millimeter waveform bands for mobile access networks

One of the strategies to improve the bandwidth is using the carrier aggregation of licensed and unlicensed bands. 5G networks will be also highly dense networks, using advanced small cells, advanced internode coordination, and self-organization networks. Another advantage in 5G networks is utilizing a higher spectrum by considering carrier aggregation, operation and unlicensed bands, operation on mmWAV bands, and cognitive radio.

In 5G networks, the large-scale deployment of machine-type communication (MTC) devices will be achieved based on gathering devices with similar mobility patterns. Therefore, 5G supports many exciting wireless operation modes such as device-to-device (D2D), very low power consumption operation mode, multi-radio access technology (RAT) integration and management, advanced multiple-access schemes, and optimized operation in lower bands.The 5G network will benefit from all networking possibilities and therefore its architecture should be highly flexible.

II. CONCLUSION

5G with the above-mentioned features is going to revolutionize the market for a wireless system. The concept of a super core will be enhanced by 5G in which all the network operates will be connected through one single core and have one single infrastructure no matter what their access technologies are. The 5G network will be combination of several improved technologies to meet the requirements for establishing a more efficient network with higher capacity and better QoS, and with green technology. To design a network with such great quality and ability, a network that is denser with small cells is key. Spectrum sharing is still a challenge for the wireless industry in 5G networks.

5G is going to address all the issues related to progressing from today's wired communication to a wireless one. Safety and security are among other important issues of the available network generation. It is expected that 5G will establish an extensive and reliable network with the ability to provide security. It is anticipated that the 5G network will be established by 2020 since the growth in data traffic necessitates having such a strong network. The 5G network is where any future wireless application can be implemented.

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