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5G Mobile Communications: A mandatory wireless infrastructure for Big data

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***Abstract*—5G appeared as a suitable platform for next generation networks since 2012. Indeed, two main motivations of 5G are Internet of things (IoT) and big data. In IoT man-to-man communications has been extended to machine-to-machine (M2M) communications. In 5G bit rate is an order of 1 Giga bits per second which is suitable for transmission, display and process of big data. Thus, while studying the properties of big data in this paper, we describe the properties and specifications of 5G and the roll of its components e.g. cloud computing (CC), network function virtualization (NFV), Massive /3D MIMO to deploy a reliable and robust platform for handling the big data. Besides, big data has been generated from different types of traffic from different sources. Data aggregation is also a main item in 5G which we cope with it in this paper.**

***Keywords*—Big data, 5G, CC, NFV.**

I. Introduction

Subscribers are always interested in accessing to a higher bit rate and a send / receive error free data with a small delay and more mobility. In line with this, different wireless network operators are always seeking new solutions to serve the users with higher quality of services. Accordingly, 5G researches have introduced and begun it in different countries to provide a real roadmap to standardize and establish the 5G network. On the other hand, trillions bits from different sources such as business websites, customer care centers, social networks, etc. are generated and saved in the distributed storages. These data have different structures. Companies manipulating those, may encounter to many problems such as managing, administrating and transmitting them.

Besides, since progress and motivation in the wireless communications developed human nations economic and architecture, governments are interested in developing the wireless communications and consequently operators are encouraged to extend coverage area and enhance quality of services which all of them will result in big data. 5G network has been introduced with the three following aims in 2020 [1]:

- To provide 1000 times data rates in comparison to 2010,
- To provide connections up to 10 times in comparison to 2010,
- To provide higher quality services in comparison to 2010.

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Big data is a term or phrase to describe enormous size of structured and unstructured data which may be stored in some distinct data centers, so their processing is very difficult by the customary tools and applications. Thus, the big data is aggregated from different sources and storages and needs high data rate transmission lines [2]. Big data may help the companies to operate with more productivity and adapt themselves with business variations and provide their required information to cap the competitors. To handle big data, we need a very high transmission rate.

5G technology provides up to 10Gbps data rate. According to 5G capabilities, we study its requirements and functions pertinent to big data handling in this paper. These functions include network functions virtualization (NFV), cloud computing (CC), machine-to-machine communications (M2M), massive /3D MIMO, IP6 [3]. 5G is predicted to appear between 2020 and 2030. In line with the evolution of the previous generations, deploying 5G has provided novel technologies in the access and core networks. These technologies also provide data aggregations and transmission of different traffic sources. Thus, we consider big data characteristics in section 2. In sections 3 and 4 we study 5G specifications and technologies respectively. In section 5 we review the heterogeneous network and finally we draw the conclusion.

II. Big data specifications

Burgeoning new technologies and applications, we have met very different volumes of traffic resulting from social networks, web servers, sensors, monitoring data traffics, satellite pictures, bank transactions, stock market, scan of documents, path monitoring data from GPSs, vehicle telemetry, etc. The total aggregated traffic volumes may have Petabytes or Exabytes files from billion persons or equipment. In addition, each traffic source may also have a very high traffic volume, different data structure and different data rates by itself. The goal of handling big data by companies is to provide a precise administration, business and developing programs through data mining. Since big data helps the organizations to adapt to occurred variations fasters than the competitors, it may help the organizations to improve their performances, cap their competitors and reduce cost of their services and products [4].

III. Perspective of 5G KPI

5G services stems from new requirements in human nations to facilitate relations in the society. KPIs of 5G

services have been risen in comparison with LTE-A and in addition, these services are based on new technologies such as CC, NFV, M2M, etc. Table I shows the 5G threshold parameters.

TABLE I. 5G KPIS AND APPLICATIONS [5, 6]

Parameters	Desired values in 2018	Application
Bit rate	1-10 Gbps	ICT center
Traffic volume	190 Exabytes	Monitoring, social networks, etc.
Spectral density	Tens of Tbps/km2	Real time traffic
Delay	Less than 1 ms	Sensors and actuators
Battery life	A decade	Sensors and actuators
Connected machines	30000 in each application	Sensors and actuators
Reliability	99.9999%	Security, smart grid

Figure 1 depicts the above parameters and compares them with 4G parameters.

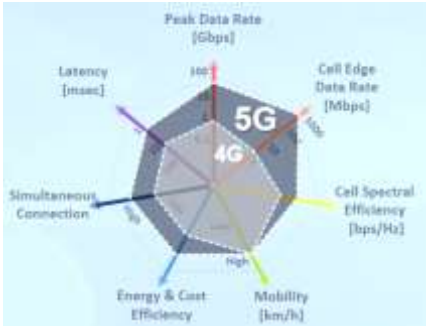

Figure 1. 5G and 4G parameters comparison

As it is shown 5G parameters are very nice, e.g. maximum bit rate in 4G is 1Gbps while it is 10Gbps in 5G and delay is 100ms in 4G while it is 0.1ms in 5G.

Relevant technologies in 5G [3]: According to main 5G projects in the world, we may divide the 5G building blocks into core and radio access parts which are explained each one as follow:

Core section: According to the enhanced characteristics of 5G, e.g. improved KPIs and integration among heterogeneous networks, core network should have high capacity and rate. These properties may be provided by the following technologies:

- Fully IP based network

Customary networks are based on a mix of IP, ATM which complicate the switching between channels and reduces the network's QoS. 5G is an evolved version of release 8 3GPP in which backhaul and backbone are all based on IP network.

- IP6

To make the users mobility feasible whole the network, they should be assigned a global unique identification number. Indeed by IP6 the pool of addresses has been increased by the ratio of 128/32.

- Network Function Virtualization (NFV)

NFV concept was firstly appeared by telecommunication operators to provide new capabilities in the networks by consolidating most of the network equipment and switches in the standard servers and storages in the data centers.

Today, architecture of mobile core network which consists of evolved packet core (EPC) and other relevant components are to be evolved to the virtual machines and other cloud based technologies. This architecture has changed the hardware based networks to software defined networks (SDN) to control the component created by NFV concept. NFV may be applied to both network control and data planes [7].

- Cloud Computing (CC)

Cloud computing is a technology that provides the capabilities to the users to access to a set of resources in the remote servers. These resources consist of networks, servers, storages, applications and services and in addition is reconfigurable and may be seized and released with a little attempt of the users. Besides, this technology renders the application programs and consequently any users needn't install application program in the servers. Contents may also be provided by content servers on the cloud. Therefore, this technology enables the operators to attract the more users and scaling and flexibility in their networks [8].

Access technology [9]: Concerning to increase of the number of users, connected machines and required services in 5G, modification in wireless access technology is mandatory. Some of the relevant technologies in the 5G access network are machine-to-machine communications, massive MIMO, C-RAN, FBMC, FQAM and NOMA. The last three technologies are used in air interface for the data modulation and access methods to increase the spectral efficiency. We explain others in this paper as follows:

- Machine-to-machine technology

M2M communications is a generalization for communication between humans and is used for automatic data exchange among machines. The word "machine" may be said to virtual machines. Figure 2 depicts a M2M network in a home.

Figure 2. An aspect of M2M Communication in a home [9]

As sit is shown in Fig. 2, controlling the housewares such as machine wash, heater, security tools, official tools e.g. printers, cameras are in the M2M communications domain. Other applications of M2M communications are as:

- ✓ Industrial automation
- ✓ Intelligent Transport Systems (ITS)
- ✓ Electronic medicine
- ✓ Intelligent measurement
- ✓ Smart Grid
- ✓ Mobile payment
- ✓ Home networks
- ✓ Intelligent city

Each of the above applications generates traffic with different property and characteristic which may contribute in big data. M2M communications may cause all devices to communicate, extend the coverage area, increase the transmission rate and reduce the delay.

- Massive /3D MIMO technology

Mobile generations next to LTE-A should support a spectral efficiency more than what LTE-A has achieved. Besides, 4G network supports the user at a speed of at most 250km/h while the 5G network supports the users at a speed up to 500km/h [10]. Massive MIMO is a technology to eliminate the drawback of last generations. A 128 antennas array is under the test to be used in 5G network now [11]. Figure 3 depicts a multiuser MIMO system by array antennas in BS. As it is seen a cluster which has a specific color has been formed by a definite numbers of arrays and covers one or more than one user distinctly [12].

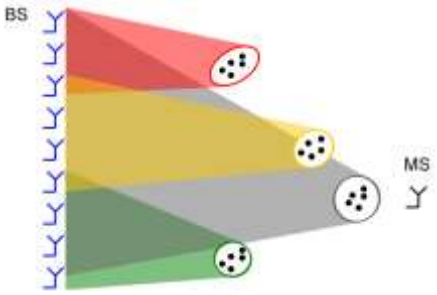

Figure 3. A aspect of a massive MIMO operation in a multiuser scenario [12]

Massive MIMO has been introduced as one of the five important and effective technologies in 5G. Some of the outcomes of massive MIMO are increasing the capacity up to 10 times, energy saving, reducing the delay and interference in the air interface [13].

- Cloud radio access network

Since radio access network consumes the greater part of power in the wireless network and in addition, in order to integrate the different radio access technologies, cloud radio access network (C-RAN) has been introduced in 5G as an important technology. C-RAN like BS includes central processing unit, radio unit and real time cloud computing unit. Central processing unit consists of a data center and some software based digital units (DUs) by the name of DU pool, moreover C-RAN includes a low cost remote radio unit (RRU) (Fig. 4).

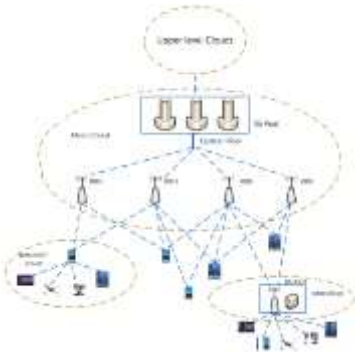

Figure 4. Cloud radio network architecture [14, 15]

C-RAN benefits are as follow:

- Resource sharing,
- Elasticity,
- On-demand and prepaid services based on real-time virtualization,
- Reducing the CAPEX and OPEX costs by integration some DUs in a central office,
- Flexible and easy resource assignment during the non-uniform traffic times,

C-RAN has an effective roll in reducing the inter-cell interference, coordinated multipoint transmit/receive mechanisms and simplifying the mobility between RRUs by central processing of a big cluster of RRUs.

IV. Heterogeneous networks

As it is mentioned above, big data is an aggregation of different traffics which are generated from heterogeneous networks. Heterogeneous network integration has also been included in 5G network. Integration has been accomplished both in the radio and core network. Radio integration has been done to make coexistence among customary and next generation networks and in addition among multilayer cell RANs (Fig 5).

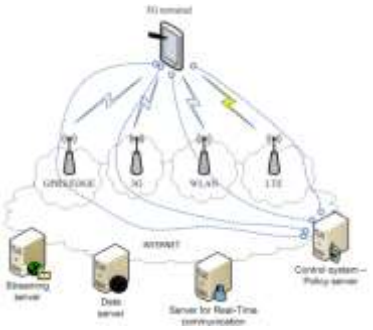

Figure 5. 5G Functional architecture [17]

Interference between cells and mobility management in the heterogeneous networks are important challenges in this context [16, 17].

The integration in the core networks is based on the NFV and SDN. Figure 5 also depicts integration plan among different networks in 5G which is done via control system policy server (CSPS) in the Internet network [18].

v. Conclusion

Totally, we may conclude that 5G networks and big data have correlated in two directions, i.e. 5G is mandatory for big data transmission and inversely, generation of big data also depends on a new efficient mobile system. In addition we saw that we encounter to huge data generated and exchanged in the future which are generated from many machines, sensors, vehicles, etc. in the wireless networks. Big data need some improvement in the wireless networks e.g., data rate of the order of 10Gbps, increasing the mobility, spectral efficiency and the user speed to 500km/h and decrease the delay to one tenth millisecond which has been included in 5G.

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