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Future of Mobile Communication 5G: Perspectives, Challenges and Services.

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Abstract: *The evolution towards 5G mobile communication networks will be characterized by increasing number of wireless devices, service complexity and the requirement to access mobile services ubiquitously. This article presents an overview of future mobile communication generation (5G) with its Perspectives, Challenges and Services. Morever we propose novel network architecture for next generation 5G mobile networks with evolution of HETNET Architecture (5G). It serves with its key elements as Small cells, MULTI-RAT, D2D communication and Cloud-RAN to ensure users with Quality of service (QoS) requirement in a spectrum & energy efficient manner.*

Keywords: *5G, Heterogeneous networks, Multi-RAT, D2D communication, Cloud RAN, Quality of Service (QoS).*

I. Introduction

With rapid development of information and communication technologies (ICT), particularly the wireless communication technology it is becoming very necessary to overlook wireless technologies that will meet the requirement of continuous increase in users. In just the past 10 years, we have seen a great evolution of wireless services which we use every day. With the exponential evolution, there has been equally exponential growth in use of the services, taking advantage of the recently available bandwidth around the world. As per market survey data usage around the world exceeding 7 billion by 2013 [1-2]. It should surprise no one that the Smartphone revolution is fuelling this growth, and by 2017, three fourth of all mobile devices in the world will be smart phones [3]. As mobile networks expand to accommodate new types of connected devices and corresponding services – from electricity meters to cars to household appliances to communication that supports industry applications – new and widely varying requirements are placed on them. A one technology fits all solution will therefore likely not be the most efficient option. Rather, today's wide area technologies will continue to evolve, resulting in enhanced system performance and extended capabilities. They will also be complemented with other technologies for particular use cases that are difficult to address with evolved versions of today's technologies. The seamless integration of such complementary technologies with evolved 3G and 4G will bring a new consumer experience and enable the introduction of a host of new services.

With increase in number of users, demanding for high speed data rates and advanced applications, communication industries are approaching towards next generation system i.e. 5th generation wireless system. 5G (5th generation mobile networks or 5th generation wireless systems) denotes the next major phase of mobile telecommunications standards beyond the current 4G/IMT-Advanced standards. 5G is also referred to as beyond 2020 mobile communications technologies. 5G does not describe any particular specification in any official document published by any telecommunication standardization body.

The evolution of LTE will be fundamental to this future, as will the evolution of HSPA and Wi-Fi. Even GSM will play an important role, continuing to be an important RAT in many parts of the world – even beyond 2020. Hence 5G is not about replacing existing technologies but rather about evolving them and complementing them with new RATs for specific scenarios and use cases [4].

5G wireless uses OFDM and millimeter wireless that enables data rate of 20 mbps and frequency band of 2-8 GHz. 5G is going to be a packed based network . The 5G communication system is envisioned as the real wireless network, capable of supporting wireless World Wide Web (wwww) applications in 2010 to 2015 time frame. The 5G technology provides the mobile phone users more features and efficiency than the 1000 lunar module. A user of mobile phone can easily hook their 5G technology gadget with laptops or tablets to acquire broadband internet connectivity. Up till now following features of the 5G technology have come to surface- High resolution is offered by 5G for extreme mobile users, it also offers bidirectional huge bandwidth.- 5G technology's excellent quality service is based on Policy in order to evade errors.- It provides transporter class type gateway that has unequalled steadiness.- The 5G technology's billing interface is highly advanced making it efficient and appealing.- It offers huge quantity of broadcasting data, which is in Giga Bytes, sustaining more than 60,000 connections.- This technology also provides remote diagnostic feature.- Provides up to 25 megabytes per second connectivity. Also it supports the private virtual networks [5].

II. Evolution of 5G Architecture

Today's 3G and 4G networks are designed primarily with a focus on peak rate and spectral efficiency improvements. In the 5G Era, we will see a shift towards network efficiency with 5G systems based on dense Het-Net architectures. Het-Nets are among the most promising low-cost approaches to meet the industry's capacity growth needs and deliver a uniform connectivity experience [**6**]. Fig.1 shows the architecture of propose HET-NET network.

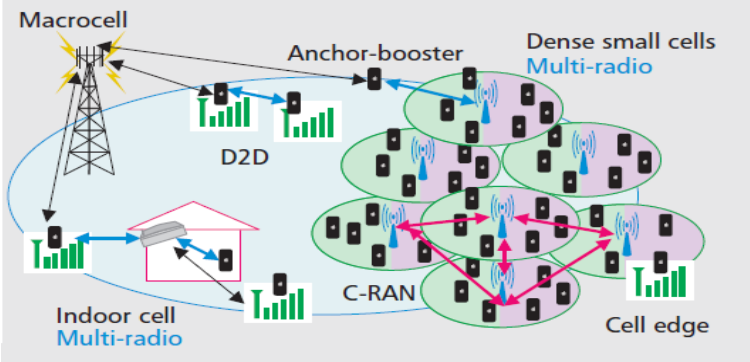

Fig.1. Proposed HET-NET architecture

Het-Net comprises a group of small cells that supports aggressive spectrum spatial reuse. However, HetNets will be architected to incorporate an increasingly diverse set of frequency bands within a range of network topologies, including macrocells in licensed bands (e.g., LTE) and small cells in licensed or unlicensed bands (e.g., WiFi). New higher frequency spectrum (e.g., mm-wave) may also be deployed in small cells to enable ultra-high-data rate services. In addition to small cells, client devices will become an integral part of the 5G Era network. Together, small cells and D2D communication will form a new underlay tier of low-cost infrastructure that complements the coverage and capacity of conventional cellular networks. Cost and flexibility of deployment will also be important factors in 5G networks, requiring a shift toward software-based implementations and virtualization technologies. In particular, 5G systems will be able to create multiple virtual core networks tailored to the specialized requirements of particular applications. For example, the system could feature a virtual core network to support M2M, a separate virtual core network to support over-the-top Internet content, and another virtual core network to support operator- differentiated media services, all of which can be configured by dynamically utilizing the network resources from the same or different networks.

III. Het-Net Key Elements And Perspectives

3.1 Small Cells

With mobile traffic expected to be double annually, one of the effective solution to operate with high dense traffic is to reduce the size of cell. With faster radio access with LTE & LTE-Advanced will go a long way to meet the demands and is not enough to upgrade macro network capacity alone. Therefore the development & deployment of a small cells to provide capacity for indoor, outdoor and for business. In 5G HetNets, macro and small cells may be connected to each other via ideal or non-ideal backhaul, resulting in different levels of coordination across the network for mobility and interference management. Increasing degrees of network cooperation, from loose network node coordination to completely centralized control, will provide increasing levels of network capacity. When access to ideal backhaul is not available, anchor-booster architecture may be used to coordinate between macro and small cells. In this architecture, the macro cell operates as an anchor base station, and is primarily responsible for control and mobility, while the small cell operates as a booster base station and is mainly responsible for offloading data traffic [6]. The separation of data and control plane in anchor booster architecture eases the integration of other RATs, such as WiFi or future mm-wave RATs, as booster cells within the LTE framework.

3.2 Multi-RAT

5G networks are expected to support multiple RATs with overlapping coverage deployed as part of a single multi-radio HetNet, creating rich opportunities for intelligently combining and aggregating capacity across the different RATs. To accomplish this, 5G systems will need to support end-to-end network architectures and protocols that seamlessly combine multiple RATs and technologies (operating over licensed, unlicensed, and higher-frequency bands) together into a single virtual RAN, and do so in a manner transparent to the end users. An integrated virtual radio network will enable joint management and simultaneous use of radio resources across different radio technologies to significantly improve radio capacity, and enhance coverage and wireless link reliability. It will also ensure seamless application sessions across the virtual radio

network by enabling simultaneous transport and dynamic switching of application flows and radio bearers over multiple physical radio networks [6].

3.3 D2D Communication

D2D is a new paradigm to enhance network performance in cellular network. These are classified based on spectrum in which D2D classification occurs as D2D communication enables the exchange of data traffic directly between user equipment without the use of base station or core network other than for assistance in setting up direct connections [6]. In absence of network coverage ,D2D communication supports new usage models based on the proximity of users, including peer-peer content sharing, social network application & public safety communication. It has several advantages such as increased spectral efficiency, reduced communication delay, improved cellular coverage, reduced end to end latency.

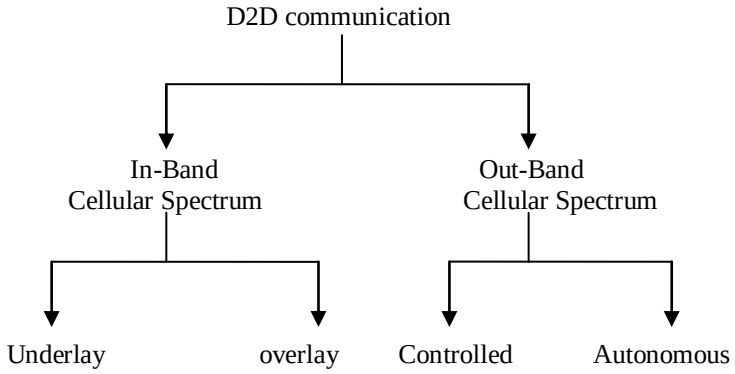

Fig. 2: Classification of D2D communication

3.4 Cloud RAN

Figure shows proposed architecture of cloud RAN.

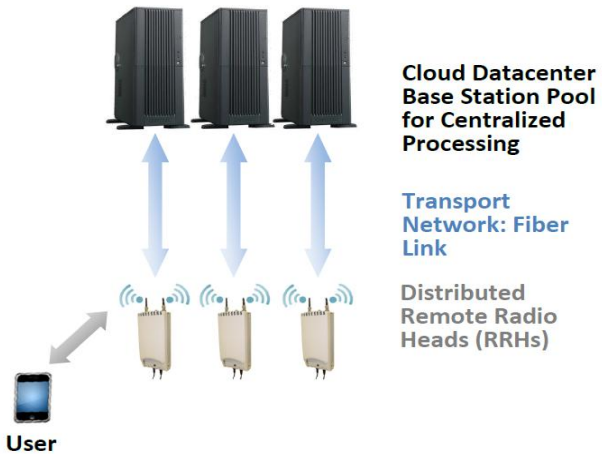

Fig.3: Architecture of C-RAN [7]

In scenarios where small cells can be connected to macrocells with low-latency high-rate ("ideal") backhaul, the baseband signals from several hundred cells can be received and processed at a centralized server platform. This architecture, known as Cloud RAN (C-RAN), creates a super base station with distributed antennas supporting multiple RAN protocols and dynamically adapting its signal processing resources based on the varying traffic load within its geographical coverage [7]. The techniques rely on real-time lowlatency virtualization, which provides a pool of resources that can be dynamically allocated for baseband processing. C-RAN architecture saves on operational cost by locating all the processing of multiple base stations in one unit, and simplifies implementation of LTE-Advanced features such as coordinated multipoint (CoMP) and enhanced intercell interference coordination (eICIC) by centralizing baseband processing. The evolution of C-RAN will include even more advanced techniques such as joint processing and demodulation of multiple users' signals, and joint resource allocation across multiple RATs to further increase 5G capacity. The Cloud RAN architecture is typically favored by operators with access to optical fiber and low-cost wireless fronthaul, or in extremely high-density scenarios such as sports stadiums.

IV. 5G Technology And Configurational Issues

In case of 5th generation wireless systems various technologies can be adopt to insure quality of service(QoS) and more applicability as illustrated below

4.1 Reconfigurable Antenna Technology

The key concept for advanced wireless communication system is Reconfigurable Antennas. It is cost effective solution for providing agility in dynamic channel environments, spectrum efficiency & increased capacity. For example cognitive radio concept used in control & management of electromagnetic spectrum for future communication systems which places challenges on the antenna design & technology [8].

4.2 So-HetNets

Self –organizing Heterogeneous networks deployment & operation of the Het-Net based 5G systems is an extremely complicated task & there is need of focusing on various factors such as planning, installations ,testing, pre-launch optimization, post launch optimization, monitoring performance, failure mitigation & corrections. All these activities are costly, error pron & labor intensive .So-HetNets have been defined in the third generation partnership project(3GPP) [9]. These improves the overall operational efficiency and able to suppress co-channel interferences & improves energy efficiency performance.

4.3 Shared spectrum

An efficient, flexible & dynamic spectrum utilization is essential for future wireless communication.iin recent years, dyanamic spectrum access based on cognitive radio techniques has been investigated in order to achieve more efficient spectrum utilization. An alternative solution proposed to solve the delimma of the primary user is authorized spectrum access (ASA) also known as Licensed Spectrum access (LSA).based on the spectrum LSA allows authorized users to access licensed spectrum. This would allow more effective use of under-utilized spectrum and also solve the problem of quality of service for the primary user [10].

V. 5g: Network Services , Requirements & Challenges

5.1 Services

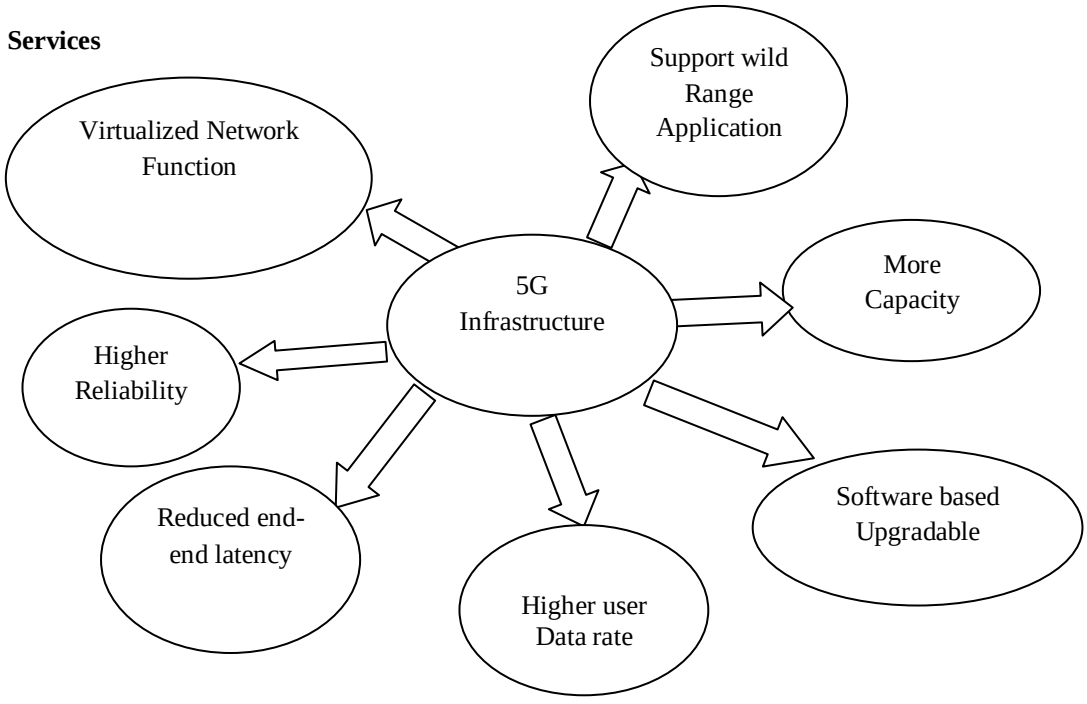

Fig.4:5G services

5.2 Requirements

Following are the requirements of future wireless generations [11]

1. Local IMT small cells.
2. Design for MIMO.
3. Design of flexible spectrum usage.
4. Data rate Latency.
5. Machine type communication.

6. Multiple RATs.
7. Prioritized spectrum access.
8. Network assisted D2D communication.

5.3 Challenges of HETNET

1. Intercell interference.
2. Distributed interference co-ordination
3. Efficient medium access control.
4. Device discovery & link setup.

VI. Conclusion

In this article, we have provided an overview of what will be future mobile communication networks i.e.5G. We have also proposed architecture along with its Perspectives, challenges and services. While there is still a gamble between what & how will be 5G? , but it will surely fulfill the requirements of Quality of service from user perspectives in spectrum and energy efficient manner.

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