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Architecture and Technology Components for 5G Mobile and Wireless Communication

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***Abstract*— This paper present a future mobile and wireless communication system that will provide highly versatile consumption, cost and spectrum usage. The main purpose of 5G system concept to fulfil the requirements of information society, the 5G network is revolutionary technology that can change consumers internet use habits as it create a wireless environment. It is faster with better quality and more secure. The goal of this generation is to produce specifications for a new radio access technology to provide higher data rates, low latency and generates spectral efficiency.**

Keywords*— Massive MIMO, C-RAN (centralized radio access network), Software defined radio (SDR), LTE.

I. INTRODUCTION

This paper gives us an idea about 5G. During the last few decades mobile communication have significantly contributed to economic and social developments of both development and developing countries. Today mobile communications from an indispensible part of the daily lives of millions of people in the world, a situation which is expected to continue and become even more undeniable in the future. New mobile generations are typically assigned new frequency bands and widest spectral bandwidth per frequency channel. From user point of view, previous mobile generations have implied substantial increase in peak bit rate (layer net bit rate for short distance) upto 1Gbit/s offered by 4G.

The 5G network vision is to provide user a super-efficient mobile network. Super fast mobile networks are converged with fiber-wireless network. A super efficient mobile network provide better performance network with low cost of investment and it addresses the mobile network operators. It would not just be data speed performance that optimized low latency needed by application such as the internet of things (IoT). A supper fast mobile network will comprising the next generation of small cells densely crusted together to give a continuous coverage over at least urban area and delivering peak data rate of up to 1Gbit/s. A converged wireless fiber network is used for the first time for wireless fiber network is used to access millimeter (mm) wave bands that support data accessing speeds upto 10 Gbit/s.

A. 5G Requirements

- High system capacity: Supports diverse environment and services. The future network will have an increased density through development. This is a challenging requirement for future network to achieve 1000 fold system capacity per km^2 compared to LTE. This will manage the traffic volumes of order of magnitude larger than today's network.

- Higher data rate: This provides the higher data rate than today's LTE technology. These rapidly emerging trends towards cloud services. This will provide high data rate services along with more uniform quality of users experience compared to LTE higher peak data rates will also become important for new scenarios such as mobile back hauling for moving nodes.

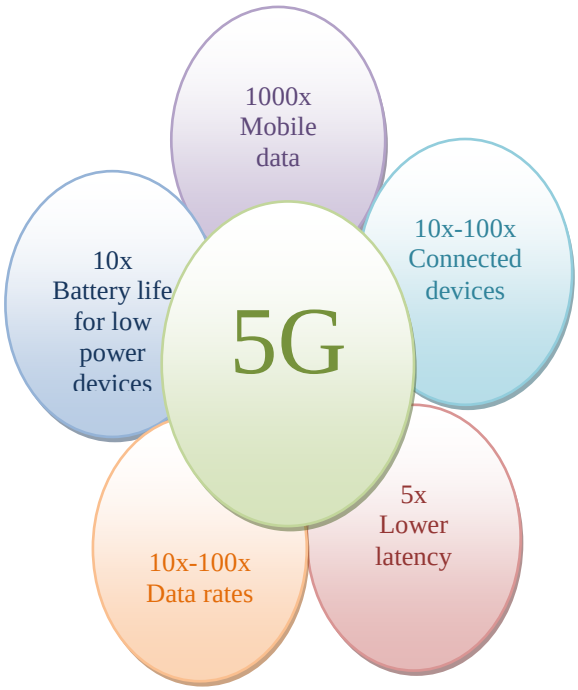

Fig. 1. 5G Requirements

- Suppers connectivity: This massive number of devices connected to the network in order to support all-time connected cloud services. This target to achieve 100 fold increases in the number of connected users compared to LTE.
- RAN Latency: 5G will provide end latency of forms, which is at least an order of magnitude, less than the experience in LTA systems. This service requires guaranteed maximum latencies. This will enables future cloud services with almost zero latency.

- Energy Saving and Cost Reduction: 5G will provide increased capacity per unit networks cost and be energy efficient. This is most important to future network that provide small cell for communication.

B. 5G Feature

A new revolution of 5G technology is about to begin because 5G technology going to give tough completion present wired and wireless network and the normal computer and laptops whose market place value will be effected.

- Provide bi-directional large bandwidth and offers higher resolution for user cell phones.
- Larger broadcasting of data that supports the connections upto 65,000 in Gigabit.
- Sub-carrier supervision tool supports fast action of the system.
- 5G technology provide upto a 5Mbps connectivity speed and remote diagnostics.
- Support virtual private network and traffic statistics to make more accurate system.
- Enhanced high data bit rate and provide connectivity to the word.

II. NEW TECHNOLOGY

A. Radio link network

This network link defines cognitive radio (CR) network. This is an innovative software defined radio technique to improve the utilization of the congested RF spectrum. In CR network, secondary system can share spectrum bands with the licensed primary system on an interference free basis. In interference only when licensed users do not use them. The most challenging part in this network to design a new air interference to support low power consumption, low data rate to multimedia services. The spectral efficiency in the physical layer, reduce power consumption and enhanced air-interference, Capability and robustness of the wireless network. A waveform with Ultra-low out of band emission used that allowed to develop flexible spectrum. The interference free CR networks figure out how to detect the spectrum. CR network have been proposed for adaptation in cellular networks to explore additional bands and expand the channel capacity.

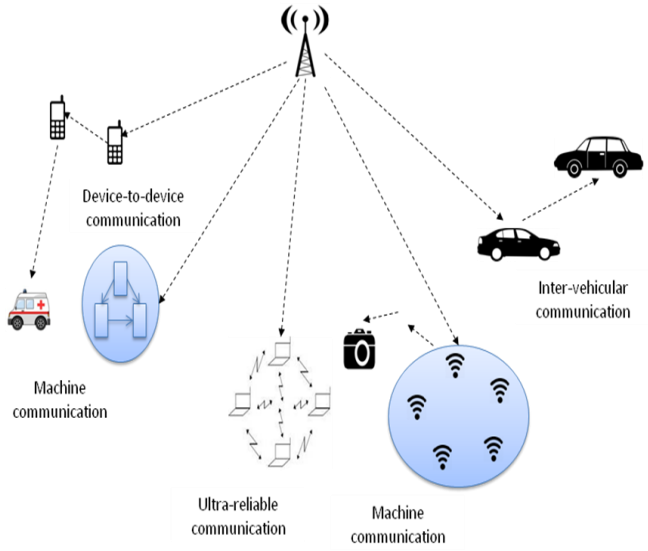

Fig. 2. Senior of radio networking

B. Multi-Node and Multi-Antenna transmission

This technology will boost the system performance and capacity for the future wireless communication system. Massive multi-antenna configuration is addressed based on beam forming. Space Division Multiple (SDM) access, Spatial Multiplexing and Spatial Modulation (SM) is a novel MIMO technique that provides low complexity MIMO systems. This technology is intended to expand the wireless connectivity from human to machine devices and can be the most important chance for future mobile and wireless communication this communication will provide connectivity for tens of bill of network enabled dives. Main purpose for this device, it should provide low cost will loss energy consumption devices to avoid battery charging and coverage should be provide everywhere. This new technology will create enables that allow an efficient high number of nodes located in an hetero or homogeneous network wireless backhaul is self configurable network topology to provide low latency in the network.

C. Millimeter cellular network

The global band width shortage wireless carriers motivated millimeter (mm) wave frequency spectrum for future cellular communication networks. The massive MIMO base station and small-cell access point are two promising approaches for future cellular. Small cells offload traffic from base stations by overlaying a layer of small cell access points. This will decrease the distance between transmitter and user data rate and energy efficiently. The back bone network of 5G will move from copper and fiber to mm-wave wireless connections allowing rapid deployment and mesh like connectivity with cooperation between base stations. The mm-wave frequencies could be used to augment the currently 700M hz to 2.6G hz radio spectrum. Spectrum would allow larger bandwidth allocation, which translate directly to higher data transfer rates. Small scale fading, a key factor for the design of urban cellular when directional antennas are used. Spectrum provide significant expand the channel bandwidth beyond the present channels used by 4G customers.

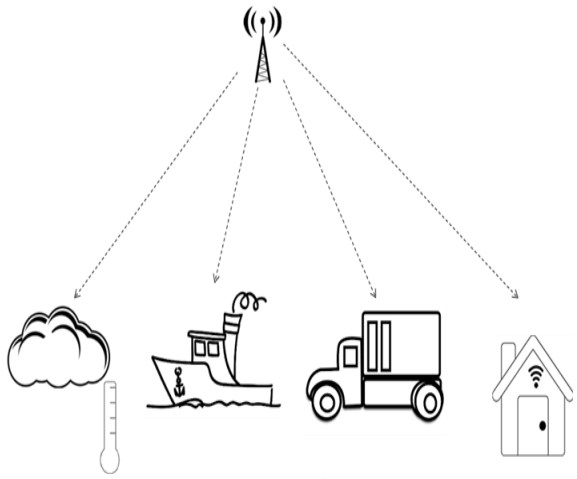

Fig. 3. Scenario for Connectivity

D. Multiple RAT and Multiple-layer Network

Multiple RAT and multilayer heterogeneous network are expected in the next generation mobile MIMO systems consist of multiple antennas at both the transmitter and receiver. By adding multiple antennas a greater degree of freedom can be achieved to transmit more information data. Hence we can see significant improvements in terms of reliability, spectral efficiency and energy efficiency. In massive MIMO systems, the transmitter and receiver are equipped with large number of antennas elements massive MIMO significant and energy efficient. In massive MIMO system the effect of noise, fast fading and intra cell interference can be mitigated using linear prediction coding method. By proper utilizing MIMO in massive MIMO system the medium access control layer can be design to avoid scheduling process. The base station can send separate signals to individual users using the same time-frequency resources this network mainly focus on network co-existence, collaboration and interference management. Mobile operation need to predict and utilize the information by the users. This information can help to optimize the selection of the RAT and network layers novel mobility management concept to decrease signaling new management interface, automatic integral and manage new network nodes.

III. 5G NETWORK ARCHITECTURE

The 5G architecture main concentrated on three aspects namely flexibility, scalability and service oriented management. These three aspects are interrelated to each other to drive the 5G technology to fulfil the various requirements in the network flexibility. Core aspect to enable the configuration network for the efficient realization of services. The architecture will be flexible enough to handle the requirements of the use case service. Scalability will assist by flexibility to fulfil the requirements of the services.

The new generation of RAN networks needs to be efficiently handled multiple layers and a variety of air interfaces in the access and the backhaul domains. They have to control the dynamic traffic, user behavior, and active nodes involved. This need to be able to differentiate a larger variety of QoS characteristics. This network control will be transparent for the user. SDN, Network Function Virtualization (NFV) and Self-Organizing Network (SON) technologies. It will play an important role in the implementation and control the network nodes to improve scalability and reliability.

The 5G network architecture as sketched in Figure 4 must accommodate a number of technical enablers and communication while taking into account existing and emerging evolutionary and revolutionary architectural trends. The network topology will comprise various flavors of Cloud-RAN (C-RAN), traditional access nodes as well as new virtual access nodes where the fixed-cell concept disappears in favor of device-centric communications. Traditional access node are existing communication network that emerges from both hardware and software components topology. Virtual access node is the new motion anticipated for 5G mobile and wireless communication network, where the functionality at an access node will run by various virtual machines based on services.

Moreover, 5G network architecture will a scenario and use-case specific, e.g. it may be different in areas with low user density compared to deployments in ultra-dense areas, such as Mega-Cities. In this sense, this will be used to provide specific and realistic design approaches for architecture development. Implementation of radio network and services function in RAN environment will simply map SDN and NFV features (known from core function virtualization in data centers) to the radio network. This increases flexibility with respect to functions in the C-RAN processing units like local mobility management, local breakouts as well as content delivery networks with channel capabilities due to centralized processing and minimum delay among baseband processing units (BBUS). C-RAN environment simplify clustering of cells for joint various network and interference co-ordination (In clouding coordinated multi point transmission reception (COMP)). Depending on the network infrastructure availability of the mobile network operators (MNO) and delay limitations set on back/fronthaul links, eg., by COMP scheme C-RAN's can be developed in a distributed or more centralized way. Which differentiate especially in the number of contain BBUs. The BBU number of a local C-RAN can be also high in case of ultra dense network eg., for a stadium environment.

The operators with both fixed and mobile network infrastructure cost reduction is a grater improvement in the 5G technology. Reuse of network infrastructure on transport and access layer (Fixed mobile convergence (FMO)) against SDN/NFV is seen as enables to allow multi-operator network infrastructure and resource sharing. The architecture will provide the necessary flexibility to realize efficient integration and cooperation of functional block according to individual service. The function can be flexibly modified, tailor and created by the function co-coordinator according to the dataflow and can be moved to the relevant network demand.

The architecture is based on WSDN approach to enables on demand creation of customized virtual networks using shared resources and effective service adaptive decoupling of control and data plane in order to provide routing and mobility management. When compared to present 4G certain

functionalities of the user equipments may be partially controlled by the operator. The flexibility may be limited by capabilities of the network such as sensors, which may not be updated with all new functionalities. This vision for 5G mobile network environment can create synergy among fixed and mobile networks.

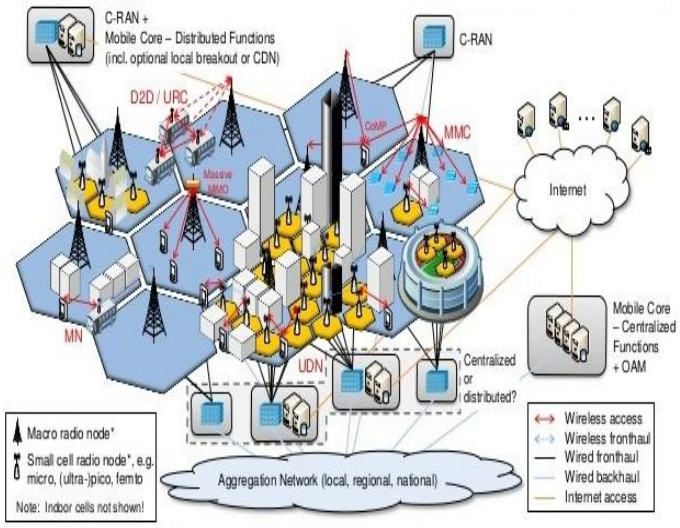

Fig. 4. 5G Architecture

IV. TECHNOLOGY COMPONENTS OF 5G

A. *Phantom cell*

Network densification using small cells with low power nodes is promising solution with mobile traffic explosion, especially in high traffic area (hot spot area). These cell develops advanced centralized RAN (C-RAN) architecture for commercial use. Advanced C-RAN adopts the centralized network architecture with many branches of remote radio equipment (RRE) and utilizes LTE advanced carrier aggregation (CA) functionality between macro and small cell carrier. CA functionality help to maintain the connectivity and mobility under the macro cell coverage while small cells called 'Add-on' cells achieve higher throughput performance and larger capacity. The advanced C-RAN architecture handles all processing for CA and handover within a centralized baseband unit (BBU) at eNodeB, which drastically reduces the amount of signaling to the core network. The "Phantom cell" concept is based on a multi layer network architecture, which spills the control (C) plane and user data (U) plane between macro cell and small cell using different frequency bands as shown in figure 5.

The major benefits of the phantom cell architecture are similar to those of advanced C-RAN architecture for LTE-Advanced, which include enhanced capacity by small cell, easy deployment of higher frequency bands. The concept of phantom cell architecture includes advanced functionalities such as inter node aggregation, relaxed backhauling and signaling requirements and enhanced small cell discovery. 5G concept user Phatom cell architecture as the baseline which to integrate future multilayer networks using lower and high frequency bands.

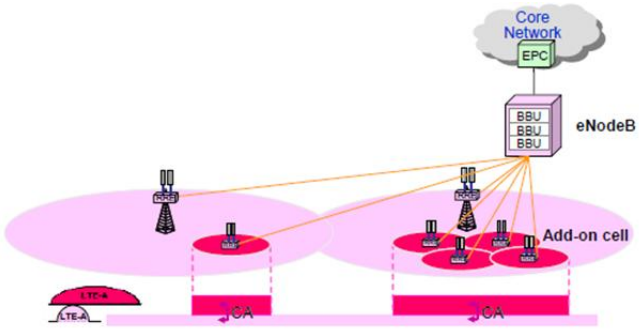

Fig. 5. Phatom cell concept

B. *Flexible Duplex*

A frequency separate network deployment, where different frequency bands are individually assigned to different cell layer may use different duplex schemes. i,e frequency division duplex (FDD) and time division duplex (TDD) for low and higher frequency bands. Therefore it is desirable to support the Phatom cells solution irrespective of whichever duplex scheme is used in either the lower or higher frequency bands. The support of flexible duplex via the joint operation of FDD and TDD and/or opportunistic carrier selection for bands including unlicensed spectrum bands will be a key technology.

C. *Numerology and Waveform Design*

The new RAT should provide significant gains for 5G. It offer higher data rate and support wider bandwidth at higher frequency bands. From numerology point of view, the new RAT should be designed to ensure phase noise, which is larger in higher frequency bands. A new RAT based on scale LTE numerology can also provide shorter transmission time interval (TII) below 1ms to achieve reduced latency. It would provide advantage based on commonality with LTE numerology such as efficient support of tight interworking between enhanced LTE RAT and new RAT and less complex implementation for enhanced LTE RAT/new RAT dual mode terminals.

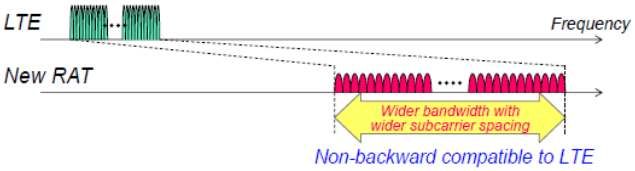

Fig. 6. LTE and New LTE concept

D. *Non- Orthogonal Multiple Access (NOMA)*

NOMA is an inter cell multiuser multiplexing scheme that utilizes an additional new domain. For downlink NOMA, non -orthogonally is intentionally introduced via power domain user multiplexing either in time or frequency or code domain. User de-multiplexing is obtained through the allocation of large power difference between paired users at the transmitter side and the application of successive interference cancellation at the receiver side. The power sharing reduce the power allocation to each single user, both the user with high and low channel gains benefit from being scheduled

more often and assigned more bandwidth. NOMA performs user multiplexing without relying on the knowledge of the transmitter of the instantaneous channel state information (CSI) of each user. NOMA can be introduced as LTE/LTE advanced enhancements in low frequency bands.

E. Communicating in the near field using massive array

Deployed in a hot spot equipped with MIMO system to simultaneously connect the multiple users in the near filed. Massive arrays with large aperture are deployed to serve as the multiple access point in new infrastructure, such as airport halls, shopping malls, stadium etc.

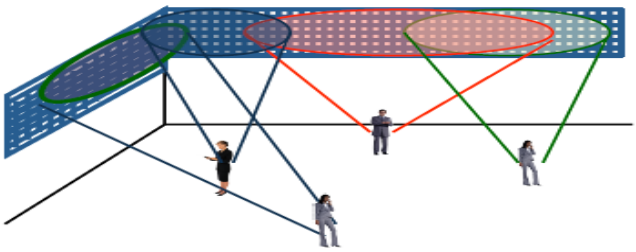

Fig. 7. Communicating in the near field of a large aperture massive array

F. Low rate and simple coordination techniques for pilots

Pilot-to-data power ratio (PTDPR) is balanced in the uplink in the multicell system. Pilot resources coordinates in multicell, resources within the cell is orthogonal but suffers from inter-cell interference. This model interfaces is the pilot power on the quality of channel estimation. Thus impact of inter-cell interference on the data channels and tradeoff between data power and pilot is proposed to be used for simultaneous transmission of pilot data signal

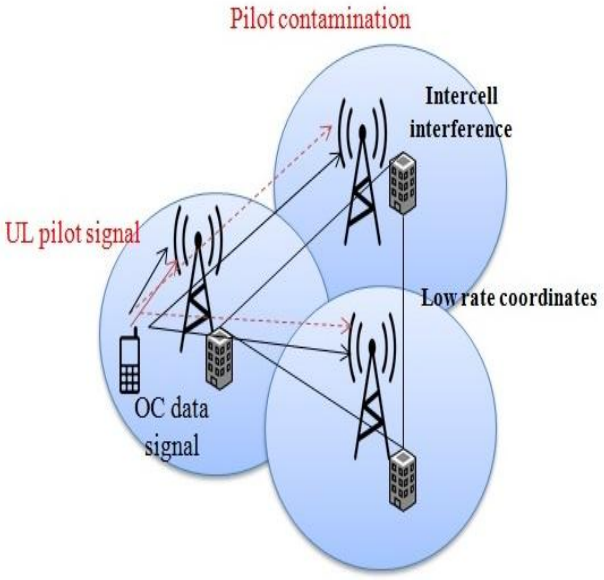

Fig. 8. Multicell pilot

G. Modelling with spherical waves, Linear precoding

Spherical wave is considered in the channel model for spectral efficiency instead of planer wave. Aperture size of the antenna is considered when antennas are placed in uniform spacing. The error will be reduced at the far field.

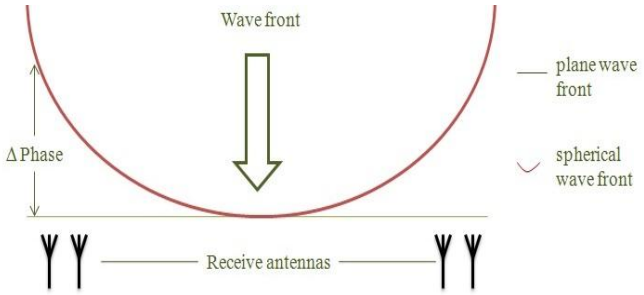

Fig. 9. Spherical wave modeling

H. Robust and energy efficient wireless backhaul for very fast moving relays

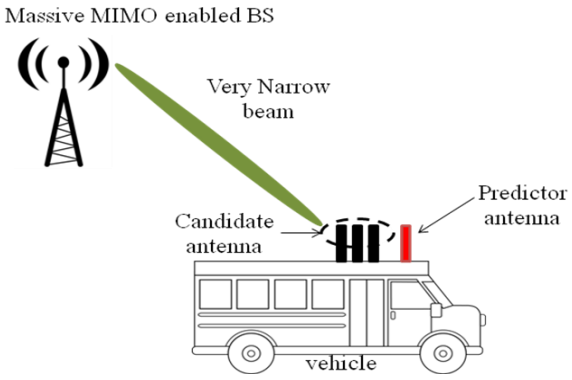

Fig. 10. Massive MIMO using narrow beam

Massive MIMO are used to sever the high speed vehicle communication and vehicle is equipped with one predictor antenna and set of candidate antenna. Separate Receive and Training Antennas (SRTA) with antenna Switch Off Scheme (SOS) is used with MISO downlink beam forming in TDD to achieve high energy efficient wireless backhaul for fast moving vehicle. Antennas are placed on the roof the vehicle predictor antenna at the front and several candidate antennas aligned behind predictor antenna.

V. CONCLUSION

In this paper we have presented the concept of 5G architecture, technological components which are the main contribution of the paper. A new revolution of 5G technology is about to begin because 5G technology going to give tough completion to normal computer and laptops whose market place value will be effected . Thus there is a lot of improvements from 1G, 2G, 3G and 4G to 5G in the mobile and wireless communication. The new coming 5G technology is available in the market affordable rate, high peak, future and much reliable than its preceding technology.

5G communication system is dwell in many application of real time communication system with high speed network capacity. Fast/seamless handover across multiple networks. Wireless access technology, MIMO and multimedia support. The high end 5G architecture have flexibility to construct the networking process in an effective manner to integrate the corporate , private and public network. This paper gives review on requirements, components and features of 5G.

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