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Enhancement of 5G Architecture and Framework Using Green and Emerging Technology

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Abstract: Due to ever increasing demand for mobile broadband communication, the existing 4G broadband technologies like Long Term Evolution-Advanced (LTE-A) and mobile multihop relay WiMAX networks are facing a fundamental challenges in terms of higher data rates efficient end to end performance, user coverage, low latency, energy consumptions and cost per information transfer. Evolving 5th Generation (5G) cellular networks are envisioned to overcome these challenges. However, 5G is still in its infancy stages and a lot of investigations and debates are ongoing on 5G network architecture that must be proficient enough to accommodate above mentioned challenges. Thus, there is a great demand of in-depth reviews on 5G network architecture for the researchers for their better analysis and designs. This review study revealed about the 5G network architecture based on a few general architecture design which are iNet, Wireless Backhaul WiBACK, MyNet and SONAC and cognitive and Cloud Optimized Network Evolution (CONE) network architecture. In order to make 5G perform every function needed by users without any drop in speed or connection, there are several emerging technologies which can improve the general architecture of 5G network and are comprises of massive MIMO, interference management, spectrum sharing, D2D communication system, ultra dense networks, Multi-Radio Access Technologies (Multi-RAT), Full Duplex radio, milimetre wave spectrum and cloud technologies. Besides, this study also give an overlook on the 5G framework discussing on nomadic node, Wireless/Mobile Broadband (WMB), Distributed Mobility Management (DMM) which is further categories into 3 separated solutions namely PMIPv6, SDN and routing-based DMM solution. To advance this high level vision, green technology in 5G network is introduced which encompasses of edge caching, cognitive radio technologies and energy and spectrum harvesting. Other technologies involvement related to 5G network architecture such as Radio Access Technology (RAT) is also discussed in this study.

Key words: 5G architecture, green technology, framework, D2D, massive MIMO, MM-wave, SDN, small cell

INTRODUCTION

As existing broadband technologies like Long Term Evolution-Advanced (LTE-A) and mobile multihop relay WiMAX networks technology are reaching maturity and have been deployed (Qiao *et al*., 2015; Shen, 2015; Li *et al*., 2012; Khan, 2014; Khan *et al*., 2014 a-c, 2010). However, due to dramatically increasing data traffic among mobile devices with the emergence of various high-speed multi-media applications the existing 4G broadband technologies are facing a fundamental challenges in terms of higher data rates, efficient end to end performance user coverage, low latency, energy consumptions and cost per information transfer. Evolving 5th Generation (5G) cellular networks are envisioned to overcome these challenges. The future 5th Generation (5G) cellular networks have drawn great attention from researchers and engineers around the world. 5G cellular networks are envisioned to attain 1,000 times higher mobile data volume per unit area, 10-100 times higher number of connecting devices and user data rate, 10 times longer battery life and five times reduced latency. Although, it is still too early to give an exact definition of 5G, current research trends have shown that the above ambitious goals can potentially be achieved by a multi-tier and heterogeneous network architecture along with the aggregation of several key technologies.

With the rapidly emerging and evolving of the 5G network technologies, the network architecture acts as a crucial role to ensure the effectiveness of the performance of networking in 5G. There are different types of network architecture that are well-known such as the HetNet, Cone, i-Net, MyNet, SONAC and METIS network architecture which are used to implement in the 5G network. The HetNet or heterogeneous network architecture is a combination of a the macro and Small

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Cells Network (SNCs) with ideal or non-ideal backhaul that able to increase the level of the network nodes cooperation while the CONE also known as the cognitive and cloud optimized network evolution architecture is the network architecture which are enabling the networking technologies associated. MyNet network architecture is the architecture are used to describe 3G and 4G. Furthermore, the MyNet network architecture is user friendly which easy for the user to make any network connection. The combination of the MyNet and SONAC network architectures will boost the performance of the 5G network. SONAC is recommended in 5G network as its component able to function in a different time scales and different circumstances which means it is flexible and scalability. METIS network architecture able to reduce the network traffic.

As the demand of faster and improved 5G technology increase, there are a few ways to improve 5G architecture indefinitely. Full Duplex radio, multi radio access technology association, spectrum sharing, interference managing, cloud technology are techniques and methods that can improve 5G architecture. Cloud technology is an internet based technology that is vital as it can support multi RAN protocol, dynamic adaption of signal processing resources, wide variety architecture, transportation network, multi-standard operation and joint processing. Therefore, cloud technology may perhaps be essential as it can be used for multi radio access technology association in 5G which is an improvement from its predecessor. By using spectrum sharing, multiple 5G operators can use and owns the same spectrum simultaneously. Energy efficiency can be reached by spectrum sharing and 5G network capacity can be increased tremendously. Besides that interference managing is ways to manage interference from one or multiple sources and maintain Quality of Service (QoS). Full Duplex radio is one of the methods to ensure interference is at minimum. Full duplex radio is where a transceiver can concurrently transmit and receive signal. In this research study, we can conclude that 5G technology can be implemented with various framework and architecture. Proper approach to improve 5G architecture and future technology trends will be present in this study. Additionally, we will elaborate and categorize in more details in the literature review.

CONCEPTUAL TERMINOLOGIES AND DEFINITIONS

Massive MIMO: Is the advancement of current MIMO technology which has hundreds of antennas which able to which provide the frequency slot that able to serve many tens of user terminals at the same time (Gupta and Jha, 2015).

Define: Massive Multiple Input Multiple Output (MIMO), the enhancement of basic MIMO technology which adding more antennas to support huge areas (including sub-urban).

Device-to-Device (D2D): Communication is defined as enabling the devices to communicate directly without pass through the network infrastructure by exchange the data traffic (Bangerter *et al*., 2014; Niephaus *et al*., 2014). Features that enable devices to communicate among themselves with limitation of small area (based on connectionless oriented).

The back-haul techniques are used to avoid the interferences between the Radio Access Network (RAN) and available utilized spectrum (Bastug *et al*., 2014). Backhaul load is the consumption amount of bandwidth by backhaul links over the wireless bandwidth (Demestichas *et al*., 2015). Separate service that act as intermediate between core networks and services provided (the 'one' who in-charge for network efficiency).

QoS/QoE (Quality of Service/Quality of Experience): To be consistent with certain level of service availability, performance, reliability and usability (CVNI., 2018). Standard level that supposedly provided by the desirable network.

5th Generation (5G) technologies: An improvement from the current IMT-advanced technologies that will be needed for beyond 2020. This is because it is necessary to produce a new wireless technology that provides support 1000 times higher mobile data volume per area (Ahlgren *et al*., 2012). Mobile communications standards beyond the current 4G/IMT-advanced standards which has speeds beyond what the current 4G can offer.

Information Centric Network (ICN): Provide native support for scalable and highly efficient content retrieval while enabling the enhanced capability for mobility and security (Liang and Yu, 2015). An approach to evolve the internet infrastructure to directly support leverages in-network caching, multiparty communication trough replication and interaction models decoupling senders and receivers.

Network Function Virtualization (NFV): Wireless network infrastructure can be decoupled from the services that it provides, so that, differentiated services can share the same infrastructure, maximizing their utilization (Hawilo *et al*., 2014) into more cost-efficiency (Anonymous, 2004). Virtualize entire classes of network node functions into building blocks that may connect or chain together to create communication services.

Heterogeneous Network (HetNet): A network that consists of a group of small cells that supports the aggressive spectrum spatial reuse but HetNet will be architected to integrate with progressively different set of frequency bands inside a scope of network topologies, together with the macrocells in licensed bands and small cells in licensed or unlicensed bands (Anonymous, 2012a-c). A network connecting computers and other devices with different operating system or/and protocols

Long-Term Evolution (LTE): Continue to develop in a backwards-compatible way and will be an important part of the 5 G wireless-access solution for frequency bands below 6 GHz (Anonymous, 2012a-c). Long-Term Evolution (LTE) will be implemented into 5G wireless-access solution with less or without special adaptation or modification for frequency below 6 GHz.

Machine to Machine communication (M2M): The communication between two or more devices such as smartphones, tablets or game console but not restricted to those devices (Zakrzewska *et al*., 2014). These machines can be other devices such as cars, health monitoring devices and other household appliances in the near future. Machine to Machine (M2M) communication allows multiple devices to communicate each other through wired or wireless technology where devices are ranged in vast varieties.

Ubiquity: The requirement in wireless access experience (Baldemair *et al*., 2013). The requirements are the connectivity at any given time anywhere from any devices that can connect to wireless technology. Ubiquity is a special feature of wireless access experience which allows devices to connect to the wireless technology indiscriminating their types, brands, vendors, etc. and these types of connections are location and time independent.

SDN: A new network architecture proposed and standardized by Open Networking Foundation (ONF) and it is developed to increase the network agile and cost effective (Baldemair *et al*., 2013). Software-Defined Networking (SDN), dynamic network architecture was introduced by ONF to improve the network structure, volatility, manageability and cost-effectiveness.

TAXONOMY OF 5G ARCHITECTURE AND TERMINOLOGIES

In this study, this study will discuss the general architecture in 5G network. Several types of architecture will be explained in this study such as HetNet, CONE, i-Net, SONAC, Features of small cell network architecture, WiBACK. This study will also explain on several ways to improve 5G architecture by using low latency service architecture, massive MIMO, D2D, ultra dense network, millimeter wave communication, full Duplex radio, multi radio access technology association, ubiquitous communication, spectrum sharing, cloud technologies, interference management and Massive Machine Communication (MMC). Besides, this stydy will discuss on approach to 5G architecture on analysis of scenario and relation of fixed network evolution. This study is following by 5G framework such as nomadic node framework, wireless/mobile broadband framework and distributed mobility management in SDN based, routing based and PMIPv6 based.

The last part in this section is technology that can be used in 5G network such as green technology, energy and spectrum harvesting, new multiservice interface, RAT and information centric network (Fig. 1).

5G cellular network general architecture: The advancement of wireless based network is vital to fulfil the challenges in the coming decades (Gupta and Jha, 2015). Auxiliary component required evolved technologies to enhance wireless based technology in future (Gupta and Jha, 2015). A general 5G cellular network architecture and technology used will be explain (Flores *et al*., 2013).

Overview: The strategy of planning and design the architecture of 5G network have to make a massive change to meet all demands and challenges (Bangerter *et al*., 2014). Since, 80% of the time, wireless users will remains inside while 20% of the time is outside, therefore current architecture, the data rate, energy efficiency and spectral efficiency will reduced due to the penetration loss (Rusek *et al*., 2013). A solution is to design the technique that used to scheme the architecture of 5G to distinct the setup of outside and inside with the assist of massive MIMO technology (Wang *et al*., 2014). Massive MIMO is to distribute the array of antenna geographically. There are several conditions to build a huge MIMO network (Bangerter *et al*., 2014). The size if the outside base station should be large enough and set up a large antenna array from outside the building (Bangerter *et al*., 2014). Therefore, it will be able to correspond with the outdoor base stations. For indoor, cable is using for large antenna arrays to connect to the wireless access point (Haider *et al*., 2016). Heterogeneity is the features in 5G cellular network, therefore small cell concept is an important part of 5G wireless cellular network which included the small cell concept and mobile relay partially

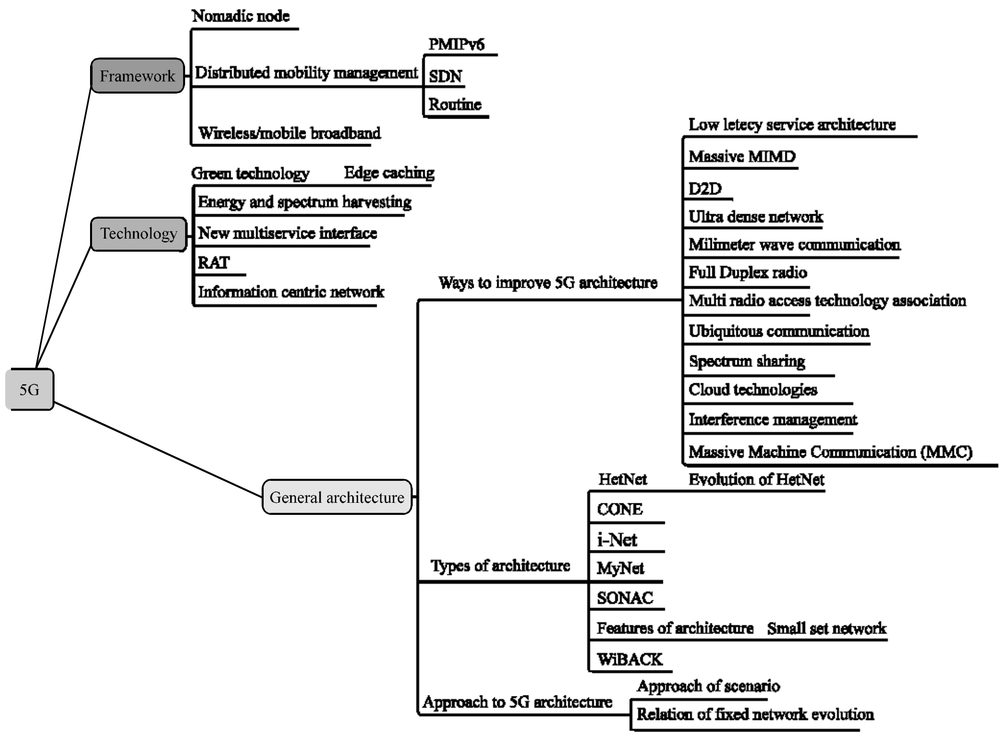

Fig. 1: New multiservice interface

(NGMN., 2013). Radio network and network cloud are the logical layers for network architecture of 5G wireless cellular. Each have their own responsibilities. For the high layer functionality, it is control by network cloud (Bangerter *et al*., 2014). Network cloud have two main functionality which are User Plane Entity (UPE) and Control Plane Entity (CPE). There is necessary for network cloud to connect with radio network (Bangerter *et al*., 2014). In order to form the connection, XaaS is needed to offer the service like resource pooling.

Approach to 5G architecture

Analysis of scenarios: There are 4 scenarios which are proposed in this analysis. The first one is amazingly fast (METIS, 2015) which handles large data rates and also preparation and equipping of high network capacities. The second scenario is ubiquitous things communicating (METIS, 2013) where mobile networks will be challenged with different requirements which involves air interfaces, energy efficiency and provide better coverage. The third scenario is great service in a crowd (METIS, 2015) which aims at preparing and equipping mobile internet services under conditions or areas which are crowded where its main obstacle is to improve its scalability and versatility. The next scenario is best experience follows you (METIS, 2015) which needs close to full coverage and requires high data rates. These needs can be met with mobile backhauling and multi-operator feasibility.

Relation to fixed network evolution: Another way used as an approach to 5G architecture is relation to fixed network evolution where technologies such as Gigabit Passive Optical Networks (GPON), Optical Network Terminals (ONT) and Optical Line Terminators (OLT) will affect processes such as mobile backhauling and fronthauling. High rates of fronthaul are affected by base band processing, RRU on basis of I/Q samples according to Common Public Radio Interface (CPRI) or Open Radio Interface (ORI) protocol specifications (Wu *et al*., 2014).

5G mobile wireless network approaches: There are few techniques or approaches to overcome the challenges on the new implementation of the new mobile wireless networking, 5G.

Used of Visible Light Communication (VLC) in the mobile networking: This is based on the use of the lighting source for the VLC networking. Because of the real architecture of 5G is still unclear but the specification should be more in improvement compare to the currently, existing network communication. The advantages of this approach are it is more secure enable the use of high spatial and efficiency of high energy (Ge *et al*., 2014).

Create new network function virtualization framework: The framework is to modify the structure of the current telecommunication infrastructure into more cost-efficiency (Anonymous, 2004). This approach is done by separate the software application from the underlying hardware and allowing the software to run in a virtualized environment. In conclusion, this approach is just a way to simplify and improve the network function virtualization, so that, it is more acceptable in the current telecommunication industry (Khan *et al*., 2014a-c).

Carrier aggregation/channel bonding between licensed, unlicensed and shared access carrier: New technology nowadays creates more advanced devices that enhanced the hardware and at the same time give support for multiple network interfaces such as cellular and Wi-Fi where they can be used in different protocols and function over larger bandwidths in different spectrum bands. Moreover, these advanced devices also enriched the Carrier Aggregation/Channel Bonding (CA/CB) structures that can be used by an integrated network across the different types of spectrum for increasing capacity.

Information-centric wireless network virtualization: A new technology known as "Information Centric Network (ICN)" has attached great interests from both academia and industry (Liang and Yu, 2015). ICN is an approach to evolve the internet infrastructure away from a host-centric paradigm based on perpetual connectivity and the end-to-end principle to a network architecture in which the focus point is "named information" (content or data) (Liang *et al*., 2015). By using this solution, the connectivity may well be intermittent, end-host and in-network storage can be capitalized upon transparently.

Besides that a significant advantage of ICN is to provide native support for scalable and highly efficient content retrieval while enabling the enhanced capability for mobility and security (Chowdhury and Boutaba, 2010). Therefore, in order to provide better services in 5G mobile wireless network, it is considerable joining both wireless network virtualization and information-centric network these two technologies. By integrating wireless network virtualization with information-centric network technique, these may improve the end-to-end network performance.

Wireless network virtualization enables the sharing of not only the infrastructure but also the content, among different service providers. With virtualization, physical cellular network infrastructure resources and physical radio resources can be abstracted and sliced into virtual cellular network resources holding certain corresponding functionalities and shared by multiple parties through isolating each other. Nevertheless, virtual resources allocation such as nodes, links and resources should be selected and optimized and it is a significant challenge of wireless network virtualization. As content retrieval is given a high priority in Information-centric network, the process in wireless network virtualization will be significantly affected by information-centric network. By integrating wireless network virtualization with the information-centric network technique can significantly improve the end-to-end network performance and maximized the utility function and efficiency of virtual mobile wireless network operation (Chowdhury and Boutaba, 2010). Exclusive surveys on advancements in network virtualization are found by Wang *et al*. (2005, 2013) and Kokku *et al*. (2012).

In traditional network connectivity, dedicated physical resources from specific operators are used for content delivery. As these physical resources cannot be shared by different operators, content delivery increases the complexity of the network as well as the CapEx and OpEx (Chowdhury and Boutaba, 2010). With dedicated physical resources, operators do not have the flexibility to react to these rapid changes. Moreover, wireless network virtualization enables the sharing of not only the infrastructure but the content among different service providers. Fortunately, wireless network virtualization brings a win-win situation for both MVNO and MNOs (Kokku *et al*., 2012). Hence, by introducing network virtualization into information-centric network, new networking technologies that are designed for information-centric network can be deploy and implemented quickly without effecting traditional network. Through, the combination of virtualization and ICN, not only the physical resources but also, the content can be shared. Since, duplicative content transmissions consume physical resources, sharing content among virtual networks can reduce unnecessary duplicative transmissions. Consequently, the CapEx and OpEx of wireless access network, content delivery as well as core network, can be significantly reduced (Chowdhury and Boutaba, 2010).

The advantages that accrue from NFV, SDN and cloud computing are similar agility, cost reduction, dynamism, automation, resource scaling and so on. The general idea of integrating NFV with cloud computing is to make the cloud carrier-grade in terms of performance, reliability, security, communication between function and so on. On the other hand, NFV goals can be achieved using non-SDN mechanism and relying on the techniques currently in use in many data centers. However, approached relying on the separation of the control and data forwarding planes as proposed by SDN can enhance performance, simplify compatibility with existing deployments an facilities operation and maintenance procedures. In the same way, NFV is able to support SDN by providing the infrastructure upon which the SDN software can be run. Therefore, the modern variant of a data center relies on automated management that may be obtained from SDN and NFV. In particular, software instantiated via. APIs running aspects such as network as a service, load balancing, firewall, VPN and so on.

In conclusion, due to the user demands for real-time, on-demand, online, inexpensive, short-lived services, a new technology have been explored to deliver these services in ways that are agile and with CapEx and OpEx saving (Mijumbi *et al*., 2016). We proposed to integrate wireless network virtualization with the information-centric networking technique over 5G mobile wireless network. This will eventually lead to sustainable and evolvable wireless virtualization framework in the future (Szufarska *et al*., 2013). NFV has emerged as a possible approach to make network equipment more open and hence allow TSPs to become more flexible, faster at service innovations and reduce operation and maintenance cost. It is clear that NFV, together with the closely related and complementary fields of SDN and cloud computing may be big of future telecommunication service provision (Wen *et al*., 2013).

Low latency service in 5G: The wireless traffic will be due to traditional web applications and new applications and services, satisfying the diverse and stringent requirements of users (Anonymous, 2013; Cattoni *et al*., 2015). One of the user's requirement is want to have the "always on" feeling everywhere anytime at an affordable cost, plus billions of machines (Machines Type Communication, MTC) will be connected (Cattoni *et al*., 2015). Delay sensitive and mission critical applications is the real challenge of MTC applications for mobile networks that require architecture enhancements in order to be properly supported (Bangerter *et al*., 2014). The flexible mobile network architecture should be provided to host all applications without affecting performance.

In order to provide local services, 3GPP specified architecture enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access. By enabling certain traffic to be offloaded and routed close to the user giving also access to local services Selected IP Traffic Offload (SIPTO) and Local IP Access (LIPA) Services continuity due to user mobility is not supported in EPC/SAE architecture that affects the relocation of Packet Data Network Gateway (PDN-GW) (Taleb and Ksentini, 2013).

The frequency should be minimized through optimal placement of virtualized functions over federated clouds or must prevent the relocation of Serving GW (S-GW) in SAE architecture is proposed. In order to accomplish this, it also proposes algorithm for service area planning. However, PDN-GW relocation that may happen due to mobility when access to local services is offered does not have an architecture solution. Access to the service must be close to the radio and PDN-GW relocation cannot be avoided to obtain the lowest latency and high bandwidth.

The mobile WiMAX network architecture support transparent ethernet transport as an optional extension to the IP services architecture to allow the provisioning of ethernet services over IEEE 802.16e.

General design of 5G architecture

Architecture requirements: In order to design a 5G architecture solution, a set of high level requirements was obtained include support of services requiring latencies, support of consistent quality of experience, ubiquitous data rate and capacity for the end user, support of high reliability network services, introduction of enablers and exposure of network capabilities to third party service providers (Sezer *et al*., 2013).

Main technology components: The 5G architecture must allow the network to support multiple services in order to provide very diverse requirements and volume growth. Technology enablers that can be considered for allowing flexibility in 5G networks are Network Function Virtualization (NFV) and Software Defined Networking (SDN).

By introducing support of Ethernet services, operational complexity can be reduced. This is due to the envisioned proliferation of local services. Most MTC use cases for 5G networks are naturally rather locally confined and Local Area Networks (LANs) are almost always based on Ethernet technology. One of illustrative use case is vehicular control communication. Thus, 5GHz spectrum dedicated to V2X is reserved for the wireless ethernet LAN Standard IEEE 1609(WAVE)/802.11p is expected now (Larsson *et al*., 2014).

Proposed reference 5G architecture: The functions of an access to service interface was specified which can isolate mobile access and networking service domains. Those functions enable flexibility in supporting multiple existing services, allow multi-vendor internetworking and ease the integration of future services. User plane component of the ASI (ASIu) is used to Access the Service Instances through Service Access Point (SAPs) . Service flow is the concatenation of tunnels in the mobile access network and on the ASIu interface between the user and an instance of the SAP. Service Edge (SE) used control plane component of ASI (ASIc) to support reporting of mobility event or latencies related to a specific service user. SE will decide whether a service topology optimization is necessary or not to provide low latency based on the reporting of mobility events and service policies. This will result in GW (Gateway) relocation which requested using an ASIc procedure. In order to provide low latency services, the position of SE node and application servers must be at the edge of the network, close to the radio site when access GW. GW virtual function is split by control and user plane components, the control part of GW (cGW) can be centralized to manage the relocation of the user plane component (uGW). This show the resulting architecture by replacing both cGW and the Mobility Management Entity (MME) with a control Mobility GW (cMGW).

Emerging technologies for 5G wireless network: There are several emerging technologies which can improve the general architecture of 5G network.

Massive MIMO: The massive MIMO have benefits such as robust, energy and spectrum efficient and secure (Nam *et al*., 2014). Massive MIMO increase the radiated energy efficiency by 100 times due to the additional antenna and capacity of order increases more than 10 times due to the multiplexing technique (Bangerter *et al*., 2014). The major changes is reduce the amount of coaxial cables which are more costly (Bangerter *et al*., 2014). Less expensive and low power component placed together for the system able to transmit the small peak signal to average ratio (Bangerter *et al*., 2014). It also reduces the latency, especially on air interface causes by fading. This is due to the increasing amount of antenna and beam forming which able to prevent the fading. Massive MIMO also simplify the multiple access layer (Bangerter *et al*., 2014). Lastly, Massive MIMO able to against man made interference and jamming. This is due to multiple antennas, massive MIMO is able to enhance its robustness which able to repel the signal from jammers (Bangerter *et al*., 2014).

Interference management: Interference management consists of advance receiver and joint scheduling techniques used for utilization of resources (Bangerter *et al*., 2014). Advance receiver is able to detect, discover and decipher the signal or symbol of interference (Bangerter *et al*., 2014). From the decoded output, the signal will be rebuilt and block from the receiving signal therefore, the performance of decipher can be enhanced (Fallgren and Timus, 2013). Joint scheduling is the technique of interference management that used for cellular system and link variation from the network perspectives (Bangerter *et al*., 2014).

Spectrum sharing: Wider bandwidth and more spectrum is the key to enhance the performance of broadband system in future (Tehrani *et al*., 2014). Joint spectrum is act as a balancing role for network components. The techniques that used for spectrum sharing are distributed and centralized. Distributed solution is efficient because it can run in local (Bangerter *et al*., 2014). The usage is to manage the transmission that causes the interference of system. There is pros and cons in centralized solution (Bangerter *et al*., 2014). The cons are the information might not complete while the pros are reliability, certainty and control (Bangerter *et al*., 2014).

Device to device communication system: D2D has two level: macro call level and device level. Macro cell level responsible on the communication between base station and device. Device level responsible on communication between devices. D2D system still provide services to device but at congested area, mesh network can created to allow communication between devices (Taleb and Ksentini, 2013). There exists four types of device level communication. Device relaying with base station controlled link formation is used when the signal strength is weak. This can improve the performance of service and also improve the battery life span. The exchanging data between the source and destination with the assist from base station is known as direct communication between device to device and base station controlled link formation. The third type of device level communication does not have any involvement from base station. The source and destination will handle the synchronizing interactively. The last type of device level communication is the device direct communicate themselves with device controlled link formation. Devices are act as source and destination without involvement of base station, this allow the resource fully utilized (Qiao *et al*., 2015).

Ultra dense networks: User increases, traffic increases. Ultra dense network needed to produce a denser and dynamic heterogeneous network. The three challenges in performance is interference, mobility and backhauling. For example, the technique used to mitigate the interference in LTE is less flexible. Therefore, for the new generation, it should be more flexible to handle the interference issue (Mei *et al*., 2008).

Multi radio access technologies association: 5G is a heterogeneous network. It is able to integrate between many types of radio access technologies. 5G devices should also support radio access for 3G, 4G LTE and different types of Wi-Fi.

Full Duplex radio: Half Duplex radios cannot transmit and receive at the same time on the same channel. Therefore, full Duplex radio is proposed. Difficulties to implement is the spectrum demands of cellular network need to decrease by half to achieve the equal performance. In terms of communication, self-interference need to be removed because it block the receiving signal which can decrease the signal to noise ratio.

A millimetre wave solution for 5G cellular network: Network congestion is challenges in the future. New technologies is required to meet user demands. Current work is to increase the data rates using steerable antennas and millimetre wave spectrum. The utilization of millimetre wave spectrum is lacking because it is not suitable for the cellular communication due to three main reasons path loss effect, blocking, atmospheric and rain absorption.

Cloud technologies for flexible 5G radio access networks: Mobile cloud computing has several features that needed such as availability, scalability and adaptability (Oleshchuk and Fensli, 2011). Flexibility in processing and management is vital, therefore, centralization is the main objective in 5G mobile network. Radio access as a service as a service is act as software and distribute all the functions within cloud platform. This can improve the processing performance and data storage. The spreading of small cell layer is costly and hard to deploy for backhaul. The transport network design is a must to transmit the data to central unit. This is to maximizing the flexibility when adding new functionality to the network (Qiao *et al*., 2015).

Challenges and development direction of 5G network architecture

Machine to machine communication: The first challenge is machine to machine communications which is used by devices to transmit automated data (Zakrzewska *et al*., 2014). This study focused on e-Health applications, needing high bandwidth which 5G can offer and provide, but the challenge is it has high Quality of Services (QoS) requirements. Apart from that radio resource management needs to be done due to diverse traffic types. The trend to this is the regulations of access to BANs (NB., 2014).

Capacity crunch: New broadband services and high mobile data demand require high capacity in future wireless systems as compared to the wireless systems present today. The capacity requirement in wireless systems increases as the demand of users increase. Enhancement of capacity can be done through dense deployment, adding more spectrum bands and increase spectral efficiency. Deploying new spectrum bands that can support high data rates can solve the problems in the capacity and performance issue. In addition, reinvesting on the earlier available spectrum bands such as the 900 and 1800 MHz bands may also increase the number of spectrum available. Increasing the new spectrum bands will not be enough to satisfy the traffic demands in the near future. Therefore, efficiency of the spectral projection should be greatly increased. Fifth Generation Non-Orthogonal Waveforms for Asynchronous Signaling (5GNOW) project can reduce the sophisticated requirements by allowing non-orthogonal waveforms and asynchronous traffic to de deployed.

Enhanced local area access: Small cell solutions and dense network are the means to keep up with the increasing traffic growth. Small cell solutions which is the Heterogeneous Networks (HetNets) shows promising increase in capacity and coverage are enhanced in the process. Phantom cell concept can be used in order to tackle this issue as it separates data and control plane at small cells and transmitting the next one towards the overlaying command site. The IEEE 802.11 Standard which includes its amendments and the mesh networking topology can enhance mobile networks and assist in balancing the traffic through steady offload techniques. IEEE 802.11u is a new amendment to the 802.11 Standard which boasts automatic authentication and handoff of WiFi enabled devices to WiFi networks. This new standard overcomes the constraint of authenticating user credentials and connectivity by automating network access discovery and selection and supporting the non-visible authentication. In mesh networking topology or in this case it is Wireless Mesh Networks (WMNs) it is defined as multiple network connections formed by a static mesh router which provide a distributed system over a full or partial mesh topology. WMNs do not require high financial cost to be deployed low cost nodes and free software can be used. It is also easy to the deployed.

New radio access network architectures: The proposal of new radio access network architectures such as the cloud Radio Access Network (Cloud RAN) and Bunngee approach is done in order to cope with the capacity requirements and in the attempt to reduce CapEx and OpEx to reduce the cost per bit (Foschini *et al*., 1999). Cloud RAN emphasized on cooperative, centralized and green technology concept which is connected over fibre link to a number of antennas (QMGLLC., 2015). Cloud RAN has the advantages in terms of increasing system capacity while maintaining low power consumption due to the smart antenna system (Boccardi *et al*., 2014) and lower cost of operation can be achieved. In Bungee approach, it is aimed to increase the capacity density to 1 $Gbps/km^2$ and greatly reduce CapEx and OpEx. This architecture allows the increase in network capacity at a low cost.

Self-organizing and cognitive networks: Self-organizing and cognitive networks focuses on the features such as self-organization, self-optimization and self-healing in order to make process faster and induce lower cost of operation. The network should be able to organize itself based on the configuration made by themselves. Self-healing concerns the network faults such as coverage errors. The network will then be able to optimize itself in order to cope with the demands by users and learn and utilize based on current and past observations.

Core network virtualization: Core network virtualization is also considered in order to improve network adaptability and scalability. Dynamic and faster network deployment can be expected in the new network structures.

Potential disruptive technologies and their implications for 5G: Henderson-Clark Model (Andrews, 2013) was used to explain the impact of new technologies, firstly the evolutions in the design: minor changes at both the node and architectural levels. According to Afuah (2003), the five potential disruptive technologies can cause both architectural and component design changes are namely as device-centric architectures. Time might be consumed to reconsider the concepts of uplink and downlink as well as control and data channels to enhance information flows (Afuah, 2003). Next, millimeter wave (mmWave): mmWave technologies are standardized for short-range services (IEEE 802.11ad) and deployed for niche applications (Afuah, 2003). Then, massive MIMO: Massive Multiple-input Multiple-output (MIMO) recommends more usage of antennas to multiplex messages for numerous devices on each time-frequency resource and focusing the radiated energy toward the planned instructions while reducing intra and intercell interference (Boccardi *et al*., 2014). Following, smarter devices: 5G systems should drop this design assumption and take advantage of the intelligence at the device side within different layers of the protocol stack (Nam *et al*., 2014). Finally, Machine-to-Machine (M2M) communication of built-in support: a native inclusion of M2M communication in 5G comprises of fulfilling three requirements related with the respective classes of low-data-rate services (Afuah, 2003).

Devices-centric architecture: A cellular device gains service by starting a downlink and an uplink connection by carrying both control and data traffic with the base station (Zander and Mahonen, 2013). The fast growing base station density is caused by the rise of heterogeneous networks (Afuah, 2003). The main modifications in 5G where the deployment of base stations with different transmit powers and coverage areas for example, calls for a decoupling of downlink and uplink in a way that allows information flow, puts forward the concept of a phantom cell (Lozano *et al*., 2013). Besides, the emergent of a fresh concept namely centralized baseband indicates to a decoupling among a node and the hardware allocated to handle the processing associated with this node (Afuah, 2003). The usage of smarter devices could impact the radio access network (Pi and Khan, 2011). Based on these trends, the journal had concluded that the cell-centric architecture should develop into a device-centric one that is a device (human or machine) should be able to converse by substituting multiple information flows over few possible sets of heterogeneous nodes (Boccardi *et al*., 2014).

Millimeter wave communication: Microwave cellular systems that currently in used to divide among operators are around 600 MHz (Rappaport *et al*., 2013). The analogous characteristics found for microwave frequencies are distance-dependent path loss and the possibility of non-line-of-sight communication (Afuah, 2003). Sensitivity to blockages is the transformation between microwave and millimeter wave frequencies (Marzetta, 2010). Therefore, during analysis, millimeter wave cellular research needs to integrate sensitivity to blockages and more complex channel models. Antenna arrays are a key feature in mmWave systems. Huge arrays used to preserve the antenna aperture constant whereby adaptive array processing algorithms are required, so that, it can adapt fast when beams are blocked by people (Fallgren and Timus, 2013).

Massive mimo: Massive MIMO is a kind of multiuser MIMO in which the amount of antennas at the base station is more than the number of devices per signaling resource. From an implementation viewpoint, realization of massive MIMO can be done with modular low-cost low-power hardware and each of its antenna functions semi autonomously however an improvement through researches is required in order to demonstrate the cost effectiveness of this solution (Baracca *et al*., 2014). In conclusion, the adoption of massive MIMO for 5G could be a major surge of the art in system and component design (Afuah, 2003).

Smarter devices: Some of the likelihoods can permit the devices to have a more active role and then for an increase in devise smartness, permit how 5G's design should account. They had focused on three diverse samples of technologies that could be incorporated into smarter devices D2D, local caching and advanced interference rejection.

D2D: Connection through the network involves gross inefficiencies at a variety levels such as the multiple wireless hops are used to achieve what requires, the transmit powers of a part of a watt (in the uplink) and several watts (in the downlink) are utilized to achieve what requires. Therefore, pointless levels of battery drain and interference to all other devices engaging the same signaling resources elsewhere is required. Not only that the path losses to possibly distant base stations are also much durable than direct link. D2D has been proven that it has the potential to handle local communication more efficiently and also be conducted by other radio access technologies such as Bluetooth or WiFi direct (Fallgren and Timus, 2013).

Local caching: According to QMGLLC (2015) caching large amounts of data at the edge of the wireline network right before the wireless hop made little sense in voice-centric systems because it only helps to delay-tolerant traffic. Caching has now made it easy to imagine mobile devices with enormous amounts of memory. Therefore, local caching is an important alternative at both the radio access network edge and mobile devices (Pi and Khan, 2011).

Advanced interference rejection: Moreover, D2D capabilities and massive volumes of memory can also be incorporated into future mobile devices. For example, the devices might have capacity for several antennas with the consequent opportunity for active interference rejection. Thus, a joint design of receiver processing and transmitter and proper control and pilot signals are significant to allow advanced interference rejection (Afuah, 2003).

Native support for M2M communication: There are a few obligations by a typical service, namely a huge number of connected devices, very high link reliability as well as low latency and real-time operation. The existing systems are not designed to concurrently serve the aggregated traffic accumulated from large number of devices. These extreme changes the communication paradigms because of the existing coding methods that depend on long code words are inappropriate to very short data blocks. The control plane is now strong as it represents only a modest fraction of the pay load data but suboptimal. Proposed that optimized design should aim at much tighter coupling between the data and control planes. The frame-based approaches need rethinking at system level in order to, meet the necessities for latency and flexible allocation of resources to a huge number of devices (Afuah, 2003).

Wireless Backhaul (WiBACK) architecture

Overview: Back-haul segment is a part of core network that need the trigger changes to pact with the demanding requirements in terms of allocated bandwidth, latency and supported services (Bastug *et al*., 2013, 2014). Implementing SDN approaches give several challenges associated in WiBACK architecture. Initially, SDN was created for wired network but due to its large potential, many test cases have been discussed for application wireless domain (Niephus *et al*., 2012, 2015). Besides, the pilot installation evaluates all core components those presented in WiBACK architecture (Anonymous, 2014).

WiBACK architecture technique

Architecture of WiBACK with SDN concept: As shown in Fig. 2, Khan *et al*. (2014a-c) show the WiBACK architecture highly depends on wireless links that can be seen as the SDWN by implementing the SDN concept. The architecture consists of configured satellite of overlay network as the intermediate nodes are suited with bidirectional satellite equipment to provide connections among the nodes in the back-haul (ONF., 2013). The heterogeneous technologies in WiBACK architecture such as RAN, small cell networks and core network are depends on massive MIMO technologies to achieve higher capacity and good connections. The SDN controller and the devices on the infrastructure layer used a protocol called OpenFlow to forward the actual data devices (Bernardos *et al*., 2014). The OpenFlow is responsible to request the viewing information and send the packets back to the controller. There are two main characteristics of SDN which are decoupling of control data-plane and programmability. As mentioned by Lindblad (2004), SDN concept can be implemented to become wireless domain (SDWN) which is bring more advantages than the wired domain (Niephus *et al*., 2012, 2015).

Pilot installation: Lee and Lee (2010) mentioned about the pilot installation in network area, the core

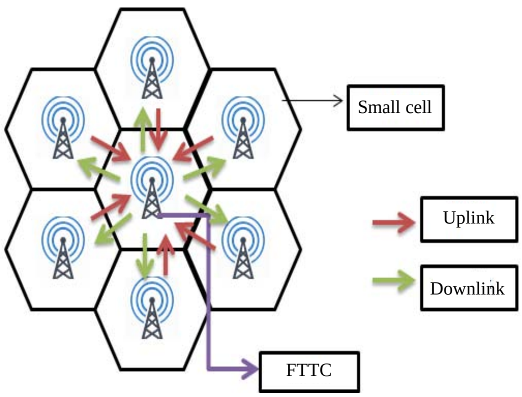

Fig. 2: Overview of WiBACK architecture

components in WiBACK architecture are evaluated on a number of pilot installations. It shows that the core components, e.g., spectrum management and capacity management modules are evaluated based on QoS parameters to achieve efficiency and performance (Bastug *et al*., 2014)

Challenges associated with the WiBACK architecture: The challenges that associated with WiBACK architecture can be categorized into two issues which are physical layer and higher layer issue.

Physical layer: The physical layer challenge is focusing on spectrum management. The spectrum management should work out itself independently assigning the suitable frequencies to produce the spectrum pattern usage patterns and access minimizes the interference without the help of an administrator.

Higher layer: The higher layer issue is focused on the capacity planning and traffic engineering issues. Capacity discrepancy can occur in back-haul network because of complex routing process and increase latency demands. In addition, this issue needs the continuous monitoring process and detecting the problems. We can use the efficient system modelling to remove the capacity constraint by sending the promised capacity (Ziegler *et al*., 2015). Furthermore, the congestion in traffic's QoS and bad QoE perceived by the user need to avoid by centralized the intelligent traffic steering (Bastug *et al*., 2014). The intelligent traffic steering considers the traffic demands and potential capabilities.

Cognitive and Cloud Optimized Network Evolution (CONE) network architecture

Overview: To support the requirements of 5th-generation (5G), the End-to-End (E2E) network architecture will divide the mobile network into the heterogeneous access networks that including ultra-dense Radio Access Network (RAN) and small cells in mm-wave and cm-wave bands with advance antenna solutions (Anonymous, 2012a-c). E2E latency is managed using multi-path and specialized traffic streams management. Cognitive networks using real-time collection of networks and usage data, associated analysis likewise automated proactive action enabling automated, optimized network operation. It also balancing Telco cloud for a customized user experience as well as abstraction of control and user plane Software Defined Networks (SDN) when optimizing functional split and redefining legacy radio and core domains (Anonymous, 2012a-c).

CONE architecture design: The changes of technology developments caused the development of "Cognitive and cloud Optimized Network Evolution" (CONE) architecture such as the transformation of network elements and functions from dedicated and specialized HardWare(HW) unit to SoftWare (SW) entities which running on standard HW through ETSI NFV (ONF., 2014a, b), the concepts of software defined networking which is bring by open networking foundation (Osseiran *et al*., 2014) the research on "5G" (Afuah, 2003) and so on. CONE is a layered architecture and enables the architectural and technological components, interfaces and relationships between layers and the associated standards (Anonymous, 2012a-c). It consist of 8 domains which is Cognitive layer, service enabling layer, shared data layer, virtualization framework and SDN, software appliances, RAN and two vertical-cross layer domains like management/Orchestration and security.

Cognitive layer: Cognitive network collecting data and events from network and transfer to multiple applications through SDL. Finally, it will analysis the relevant patterns with advanced visualization technologies and coordinated by coordinated actuation layer in network.

Service Enabling Layer (SEL): SEL offers distributed of cloud computing capabilities and IT software environment to application developers. It also provides a Software Development Kit (SDK) and sandbox to support application design, provisioning, testing, reporting, analytics and integration into platform.

Shared Data Layer (SDL): SDL provides network abstraction to shared data access for applications from each operator domains which existed in data network intelligence proposals (Lenzerini, 2002). Unified data management consists of architecture and technology, data model and governance. It do the separation of data from applications, data-centric publish model that applied to offline and online data, data authentication and authorization with role-based access control, the implementation of data availability and integrity and performance agreements provided to applications and lastly, all applications connected to SDL to share information through same mechanism and interfaces.

Software appliances environment: All physical resources needed to implement network element that are virtualized and act as service accessible through infrastructure manager (ONF., 2015). In order to fulfill the high telecom network requirements, OpenStack project (LF., 2015a, b) develops an industry standard for a virtualization infra-structure manager for this area.

Virtualization framework and SDN: It comprises execution plane and automation plane. Execution plane consists of computer, networking and storage which accessed by network functions in virtualized manner through virtualization layer or bare-metal manner. Automation plane makes the automated management of execution plane through operations like creation, deletion and scaling functions and allocation of underlying resources. Virtualization enablers like hypervisor need to provide support for real-time functions on General-Purpose Processors (GPP). Virtualized Infrastructure management will go hand-in-hand with virtualization technologies to providing automated instantiation and scaling of virtualized network functions. Transport network virtualization is important to providing logical networking between elastically-scaling instances of different network functions including RAN using SDN controllers and protocols. For example, OpenDaylight Project.

RAN: RAN requires faster transport network to ensure that compute resources can be centralized and reach Radio Frequency (RF) sites with small delay. The compute processing power can be hosted at macro sites and turning them into a small data centers.

Orchestration and management: According to ETSI NFV (2012), NFV Orchestrator is supported by the VNF-manager which hides the specifics of internal employment structure of an application from orchestration task of network. Recently, an open source project like OpenNFV was started to define and develop standard interfaces. Orchestrator also covers a network end-to-end on the pure SW nature of network function.

Security and privacy: It make the architecture always have fixed vigilance, increased automation of data collection, analysis and response, evaluation of threat vectors beyond network boundaries and multi-dimensional consideration.

i-Net 5G mobile network architecture

Overview: i-Net is an evolution of existing networks that includes base stations for macro cells and small cells and CN elements including the Mobility Management Element (MME), the Serving Gateway (S-GW), the Packet data network GateWay (P-GW) and so on. The coordination competence among multi-BS, multi-bands and multi-RATs is also improved. The i-Nodes can commerce information via an inter-connected channel to achieve signal and resource coordination. The 5G cellular architecture should also be a heterogeneous one with macro cells, microcells, small cells and relays, so that, it can accommodate high mobility users such as users in vehicles and high speed trains. i-Net intends to make full use of the multiple frequency bands via. the evolved CA function of LTE-advanced (Chandrasekhar *et al*., 2008) in an attempt to provide high data rates for mobile customers.

Main features of i-Net 5G mobile network

Interconnection: Demanding interactivity between users of mobile internet applications that intends to modify the traditional vertical shaft-like structure and create a direct data channel between users only via. i-Nodes. i-Net is capable of offloading traffic within the RAN c without the involvement of the CN. i-Net can provide powerful local file transfer, local multi-media streaming, local video-conference, local advertisements, a local Content Delivery Network (CDN), etc. Wireless users stay indoors for about 80% of time while only stay ourdoors about 20% of the time.

Integration: i-Net aims to integrate and exploit all available radio resources via. tight coordination among multiple BSs, multiple frequency bands and multiple RATs. i-Net intends to make full use of the multiple frequency bands via. the evolved CA function of LTE-advanced (Anonymous, 2012a-c) in an attempt to provide high data rates for mobile customers. All coordination operations require an interconnected channel to exchange information between i-Nodes which can be conveniently provided by i-Net with the inter-connection feature.

Intelligence: It is foresee that i-Net will amazingly reduce the costs of network construction and maintenance through the brilliant feature while enabling more flexible service line-up and value-added variation. Energy consumption is a significant operations cost driver with the RAN estimated to consume 70-80% of the energy requirements. Network virtualization can provide enabled infrastructure for progressive interconnection and integration appearance.

MyNet and SONAC 5G wireless network architecture

Overview: Basically, MyNet architecture is derived into control and data planes. New network function is developed with the enhancement and extension of existing functions. SONAC is proposed as control plane function in order to support the SCVNs provision. All other network function is classified as management plane function (Bastug *et al*., 2013). Based on the research done on discovering the 5G enabling method, NFV (Han *et al*., 2015; Jain and Paul, 2013; Callegati *et al*., 2014; Soares *et al*., 2015) and SDN (Bulakci *et al*., 2015) are recognized as the key solution.

Although, there are similarity of SDN/NFV architectures and SCVNs enabling between MyNet and NGMN. MyNet illustrate the different when comparing with NGMN based on their new management functions and new logical architecture SONAC (ONF., 2014a, b).

5G network architecture, MyNet is introduced with the hypothesis of the availability of Software Defined Networking (SDN) and Network Function Virtualization (NFV). The architecture illustrates the redefined wireless network control and SCVNs functionality. Service-oriented virtual network auto-creation also known as SONAC is selected by the MyNet to provide the network service (Bastug *et al*., 2014). The main purpose is to provide SCVNs which the resource pool in GWNI is able to use by the SONAC. SONAC is derived by 3 components: Software Defined Topology (SDT), Software Defined Resource Allocation (SDRA) and Software Defined Protocol (SDP. These components provide the SCVN full automation and customized virtual network. SDT is used to define the VN logical topology of SCVN, VN graph of SCVN and data processing of v-s-SFWs. VN graph control the association and data handling among devices between network function elements outside Vs.SGWs and Vs.SGW. VN logical topology determines the mapping of logical links and logical function elements (ONF., 2008). SDRA not only consists of SDN functionality but also manage the resource allocation between wire and wireless network segments. SDRA allocate the resources according to service traffic statistic and device distribution. It also enables the service based and flow based resource allocation. SDP is used to determine the customized protocol. The customized protocol may determine the VN part only. SONAC enable the hierarchical structure implementation to control the complexity and increase the speed of control signaling. The three components can be implemented and execute differently in the hierarchy based on the functionality needed (Bastug *et al*., 2014).

5G FRAMEWORK

Nomadic node: Popovski *et al*. (2014) study stated that one promising 5G framework segment that tries to react to the boosting movement volume without bounds data society is the idea of an itinerant system IEEE in 2015. A nomadic network comprises of haphazardly dispersed non-administrator conveyed hubs (e.g., stopped vehicles with on-board hand-off foundation what's more, best in class backhaul reception apparatuses) offering the likelihood for handing-off in the middle of MTs and Base Stations (BSs). While the area of administrator sent transfer nodes is upgraded by method for system arranging, the area of the NNs in a nomadic network is out of control of a system operator and along these lines is thought to be irregular. Also, their accessibility and position may change in time because of battery state and node development. The NNs work in a self-sorted out design and are when all is said in done initiated and deactivated in view of limit, scope, load adjusting or vitality productivity requests. In this manner, the idea of a roaming system portrays a successful expansion of the cell foundation that takes into consideration a dynamic system arrangement.

The most appealing point of preference of nomadic networks is the procurement of handing-off usefulness for execution improvement without hand-off site-renting. Countless NNs, both exclusive vehicles and organization owned car armadas (e.g., car rental, car sharing and taxi) are accessible for performing system advancement. Contingent upon the accessibility of NNs in the objective administration district, NN operation can give both scope and limit upgrades. Besides, there are bigger spaces for the receiving wire and handset plans for vehicle-mounted NNs contrasted with customary little cell access hubs, permitting potential backhaul join improvements and progressed handing-off implementation (Popovski *et al*., 2014). On the other hand, the traveling system because of its randomness, raises to challenges both in specialized and non-specialized perspectives. The fundamental specialized test is the administration of such an extensive number of element system hubs including radio asset administration (RRM) arrangements to battle obstruction for execution upgrades, security matters and critically the battery life time of the NNs. Furthermore, the business participation between portable system administrators, auto fabricates and other private partners should accomplish a helpful bargain to grow the advantages for all partners in the business.

Wireless/Mobile broadband framework: Over the past 30 years in WMB world, there has been a great progress carried out (Nokia, 1865, 2015). According to for next 20 years at a more rapid measures, there would have a terrific pressure to continue in this path. Currently, there are many attempts to build a new 5G WMB (Marzetta, 2010; TM Forum, 2015). This report focus on the framework of 5G WMB which is the combination of requirements and technology trend.

Requirements of the 5G WMB framework

Application and services: Living in the information technology era, applications and services are inevitably required by most people. Through wireless/mobile technology users have the opportunities to communicate with each other.

List of general goals required (CUNI., 2018):

- To widely expand the effectiveness of all economy sectors
- To manage the critical infrastructures, cities, building and the ecosystem
- To plan a digitally enhanced way of living for users

Requirements for the proper planning of the application:

- Deployment of services or applications that is fast, simple and dependable (ITU., 2002, 2015)
- Ensure that different levels of Quality of Services (QoS)/Quality of Experience (QoE) can be related to the deployed application and services (Hadjiantonis and Stiller, 2012)
- Effectively plan a suitable application in a very challenging and varying contents of operation (Mena, 2013; Gundavelli *et al*., 2008; Chen *et al*., 2012; Giust *et al*., 2014; Bernardos *et al*., 2014)

Valorization of the infrastructure: Currently, the two factors that affect the stability of WMB world are network costs increased and lack of ability to enhance the operator's income. Steps have to be taken in order to counteract these trends. As the network expand to serve for the increasing traffic demand, costs will definitely increase. It has been confirmed that operator revenues will not increase at the same time as consumption and most likely will not even increase the potential cost. In the unstable business situation, a workable and profitable business model is required for actions that lead to a higher economic pressure of the infrastructure. Following steps are required: require more monetary for the application or services establishment (Narten *et al*., 2017; Giust *et al*., 2015; McCann, 2012; Rekhter *et al*., 2005; Chan *et al*., 2014) and extremely improving the cost effectiveness. Precaution management on the Total Cost of Ownership (TCO) could improve the cost effectiveness (Galinina *et al*., 2015; Deb *et al*., 2014). TCO consists modules that relate to the elements or resources developed and correspond with the procurement of the sites like civil works where the elements will be arranged.

Energy efficiency: In global energy consumption, information technologies use 2% of energy consumption. If includes the consumption of computers and centralized repository, the energy consumption reaches 4.5%. The >50% of the energy consumption of telecommunication operator networks is used by the WMB infrastructures. Operations for base stations use more than 80% of this energy and the other 20% energy consumption is used for the users, the core network and the control mechanisms (Khan *et al*., 2014a-c). Under certain circumstances, energy consumption in WMB world can be increased up to 90%. At this stage, the biggest challenge is to include the technologies that can minimize the energy consumption.

Technology trend in 5G WMB framework

New multiservice air interface: Purpose of this technology is to build technologies that can maximize the volume of user-plane data that can be carried through the system resources. It will ensure the necessary flexibility to achieve effective service running in different situations. It can also extent to mission-critical communications and vehicular communications from mobile broadband and massive machine communications. It is a chip sets that could implements into devices and enable the device to support one common air interface for all services. The new multiservice air interface could fully addressed the 5G requirements (Khan *et al*., 2014a-c).

Distributed Mobility Management (DMM) framework: Ahlgren *et al*. (2012) show that mobile traffic growth will rise tenfold from 2014-2019. There are two main problems to solve like how to offer sufficient capacity in the access and how to handle all the traffic in the transport network. There are two potential choices to operate the Evolved Packet Core (EPC) of 4G networks such as the General Packet Radio Service (GPRS), Tunnelling Protocol (GTP) (Chen *et al*., 2012) and Proxy Mobile IPv6 (PMIPv6)

(Bernardos *et al*., 2013). The central anchor can track user activities by redirecting the packets over channels created with the access router where the Mobile Node (MN) is presently connected. On the other hand, the mobility anchor is a single point of failure, postures scalability matters and generally leads to suboptimal paths between MNs and their communication peers. Therefore, concentrate on the comparison of DMM-only solutions, however a centralized vs. distributed research can consider the analysis reported (Bernardos *et al*., 2014).

PMIPv6-Based DMM solution: There are three Distributed Mobility Management (DMM) solution approaches such as PMIPv6, SDN and routing-based. The first DMM solution is Proxy Mobile IPv6 is the Local Mobility Anchor (LMA) creates bidirectional channels with Access Gateways (MAGs) located in the access networks (Narten *et al*., 2007). Proxy Binding Update (PBU) and Proxy Binding Acknowledgement (PBA) use signalling messages between the MAG and LMA. The PMIPv6 protocol coordinates is allowing the LMA identify which MAG an MN is connected to appropriately route its traffic. Based on DMM solution, the DMM gateway is replacing MAG role. A DMM-GW changes from a MAG for instance it is provided with links to the Internet that do not imply paths traversing the LMA. The mobile node attachment usually after getting a router solicitation message from MN which detected by a DMM-GW.

SDN-based DMM solution: Software defined networking (SDN-based) is one of DMM solution. It is a separation of the control and data progressing planes of a networking paradigm. This separation lets faster configuration and provisioning of network connection. By using SDN, network administrators can program the performance of both the traffic and the network in a centralized way without needing independent retrieving and configuring each of the network's hardware device. In SDN, the Network Controller (NC) is in charge of configuration the nodes in the network through an Application Programming Interface (API). The Network Controller (NC) arranges the progressing rules on access routers such as DMM-GWs using the OpenFlow 1.3API. The role of anchors is played by DMM-GWs (Qiao *et al*., 2015). An access point is attached by a Mobile Node (MN). Then, the DMM-GW notifies the NC which allocates a network prefix to the MN. After attachment discovery, "the NC configures the OpenFlow rules in each DMM-GW visited by the MN" (McCann, 2012).

Routing-based DMM solution: Another DMM solution is Routing-based. This solution is to eliminate any anchor from the architecture when terminals move by means of IP routing protocols. Then, allowing all the network nodes re-establish a new routing map. By using this analysis, we take the solution recommended by Rekhter *et al*. (2005) which builds on topmost of the Border Gateway Protocol (BGP) (Galiinina *et al*., 2015) and the Domain Name System (DNS). Regarding an MN attachment to a DMM-GW's access link, the MN's DNS name is studied by the access router after verification. Next, the IP address is retrieved by the DMM-GW and linked with the MN's DNS record. In order to reach the MN's prefix, IP address proclaims itself as a next hop. By doing this in the rest of the network a BGP routing update is generated by the DMM-GW. When the BGP process meets by using a new path within the network, the MN is accessible at the new position (McCann, 2012).

5G multi-rat LTE/WiFi ultra-dense small cell: Paradigm shift enable user to experiment the new experience of network design. Typical methodology use in recent years which is the cellular to WiFi offloading is changing towards the real technology integration.

Overview: 5G is the next step in the evolution of mobile communication. In order to promote this high-level vision of 5G system that offers ubiquitous connectivity for any kind of device and application, effective Radio Access Technology (RAT) selection algorithm is proposed. It is then followed by conducting specific analysis which taking into consideration the system-level dynamics which contribute to the increase in uplink performance of an integrated multi Radio Access Technology (RAT) solution as compared to the outdated legacy methods. Recommendation in enabling architecture which represents the close interaction among the different Radio Access Technology (RAT) can increase possibility to transform envision design into reality.

Innovation approach towards implementation of 5G network

Densification in cellular technologies: Mobile network takes measure in enhancing performance of the 4th Generation (4G) Long-Term Evolution (LTE) communication technology. The convention approaches of 4G network not adequate to sustain increasing capacity of universal cellular coverage due to the lack appropriate network infrastructure. According to Monogioudis, macro cell network unable to expand further due to high installation, maintenance and backhauling cost and also shortage of vacant sites. Besides, adding more bandwidth to legacy wireless connection will suffer ridiculously high costs. Long-Term Evolution (LTE) networks have transform to embrace abundant of small nodes, like femto cells and pico cells (ElSawy and Hossain, 2014) with a WiFi-like range and mass of spread antenna systems (Hwang *et al*., 2013). With this network densification trend, User Equipment (UE) has nearer experience to a massive number of network radio units (Dahlman *et al*., 2014). According to Park *et al*. (2014), ultra-dense heterogeneous networks has high possibility to turn into the only viable solution to 1000×capacity within 10 years time frame.

Integration with WiFi networks: LTE small cells are favored due to its distribution flexibility, lower capital, operational costs and energy usage reduction (Narten *et al*., 2007) and has been an effective solution for local-area connectivity. This leads to the integration between LTE and WiFi Radio Access Technologies (RATs) to effectively recognize offloading and balancing of user data traffic which utilize resources that exist in both systems (Andreev *et al*., 2014). The incorporation of RAN-level may improve LTE/WiFi collaboration (Dhillon *et al*., 2013) are plentiful from providing simple information like network loading (Andrews, 2013) to full-scale centralized radio resources management. Advance multi-RAT integration should allow mobile devices to transmit data on both radio interfaces simultaneously and expected with improved performance (Xu *et al*., 2014). Multi-RAT and multi-tier solutions need network management interfaces (Agyapong *et al*., 2014) to deliver flexible primary network connectivity to the envisioned next-generation 5G system architecture (Li *et al*., 2014). The vision of Heterogeneous Network (HetNet) is embraced from different types of low-power and low-cost small cells that operate under licensed (LTE) and unlicensed (WiFi) frequency bands which are connected to the core network's with various types of backhaul links (Qureshi *et al*., 2007). The detail concept will be discussed in study.

Radio Access Technologies (RAT) (Noramalina): RAT selection is needed in order to efficiently manage the RAT handover procedure, reduce the ping-pong effect due to unnecessary handover events and choose the most appropriate RAT that guarantees high user's throughput and low delay (Qureshi *et al*., 2007) (Fig. 3).

IEEE Standard 802.21: According to Itturralde *et al*. (2012), IEEE standard might not suitable in the selection of effective RAT. This standard might not be able to manage in an efficient way handover processes in a dense environment with multiple RATs and network providers. Besides, IEEE 802.21 does not perform good performance in term of mobility. It also does not provide to the upper layers all the facilities necessary for efficiently managing vertical handover as described by Iturralde *et al*. (2012).

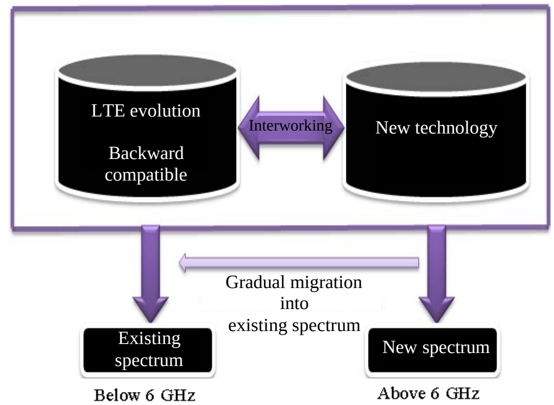

Fig. 3: Radio Access Technologies (RAT)

System model and problem formulation: As mentioned by Hossain *et al*. (2014), there are different type of small LTE BSs such as macrocell, picocell and femtocell. The mapping between the Channel Quality Indicator (CQI) and the received SINR for the LTE technology is needed. Although femtocell architecture proposes an interesting alternative to improve the QoS. By simulation we have shown the impact that interference causes in their performance (Hossain *et al*., 2014).

The Reference Base Station Efficiency (RBSE) metric is defined. This will take RAT selection into the real network condition in term of BS transmitted power, BS load and required user data-rate. Different BS association for uplink and downlink transmission opens a new challenges. At the same time increases degrees of freedom for power control (Tolli *et al*., 2002).

Common Radio Resource Management (CRRM) and Joint Radio Resource Management (JRMM): CRRM based on a concept which is two-tier RRM Model that contains CRRM and RRM entities. Lower tier has RRM entity to manage RRUs within a RAT. The CRRM located at upper tier to control a number of RRM entities and it also can communicate with another CRRM entities. By controlling the RRM entities, CRRM get to know the RRU availability of multiple RATs and allocate a user to the most suitable RAT. The RRM and CRRM shared two functions which are as the information reporting function and RRM decision support function. So, it allows RRM to report any information to the CRRM entity and describe how can the RRM and the CRRM make decision. Benefits of CRMM are described by Serrador and Correia

(2010). JRMM is also one of the combination of different radio source management. One of the function of JRMM is to manage handover in a cooperative 3G heterogeneous network. For JRMM, High Big Rate Network (HBNs) RAT is more suitable RAT. HBNs handle and release more traffic, generating more signaling related with JRRM functionalities.

Proposed RAT selection problem: Phases needed during the process RAT selection process is described briefly by Anonymous (2012). Basically, this process has 3 phases which are measurement collection phase, decision making phase and handover execution phase. If the third phase fail, the UE discards the previous target RAT and selects a new suitable candidate from the list. In phase 2, it collect all the needed measurements through the Access Network Discovery and Selection Function (ANDSF) entity. The main purpose of ANDSF is to assist the UEs to discover the potential 3GPP and non-3GPP access networks as is described more by Anonymous (2012a-c).

Simulation setting and result: The performance of the proposed RAT selection scheme has been evaluated the open-source Network Simulator 3 (NS-3). The proposed RAT selection scheme is compared as by Anonymous (2012a-c). The proposed handover is performed toward the BS characterized by a low traffic load and hence with low levels of inter-and intra-cell interference.

Proactive small cell networks: Small Cell Networks (SCNs) are the network model/structure that represents the concept of using a small amount of power, short-range and a depreciated Small Base Stations (SBSs) underlying the macro cellular network. Previously, a researched and studies has been conducted related to the problems of reducing the data traffic, Inter-Cell Interference Coordination (ICIC) which enables a limitation to the Radio Resources Management (RRM) block and energy efficiency in a condition of using a reactive networking model/structure (Anonymous, 2012). As a result of the researches, it showed that the small cell networks only reduce only a small amount of traffic (Demestiches *et al*., 2015). To accomplish the important of the energy efficiency which ensure the assurance of the Quality-of-Service (QoS) requirements and cost expenditures, the suggested proactive networking model/structure is effective to get the user's context information and the user's data demand (Gesbert *et al*., 2007). By using the proactive networking model/structure, the network nodes are able to record the user's demand profiles which make it easier to anticipate the user future needs (Demestichas *et al*., 2015).

Heterogeneous Network (HetNet): 5G will be focus on the network efficiency based on the design of Heterogeneous Network (HetNet). The HetNets are the low-cost approaches that have the constant connectivity experience and would meet the larger capacity needed by the industry. HetNet consists of a group of small cells. This group of small cells supports the aggressive spectrum spatial reuse but HetNet will be architected to integrate with progressively different set of frequency bands inside a scope of network topologies, togethers with the macrocells in licensed bands and small cells in licensed or unlicensed bands.

The evolution of HetNet architecture: The evolutions of HetNet together with the network densification via. small cells and D2D communications, multi-cells cooperation through anchor-booster architecture and cloud-based architecture and multi RAT virtual radio access networks are discussed. For the 5G HetNets, there are ideal or non-ideal backhaul for the connection of macro and small cells which result in different levels coordination. The anchor-booster architecture is used for coordination between macro and small cells when the ideal backhaul is not available to access. Macro cells is as anchor base station that responsible for control and mobility while small cells is as booster base station that responsible for offload data traffic. Cloud Radio Access Network (C-RAN) is an architecture that creates super base station with distributed antennas. It is support the multiple RAN protocols and its signal processing resources is adapted dynamically based on traffic load insides the scope of geographical coverage.

D2D communication is the exchange of data traffic between devices without assistance of base station. Multiple RATs with overlapping coverage is supported by 5G networks as part of single multi radio HetNet by combining capacity across different RATs. There are some enabling technologies that importance for improving the efficiency of networks. Advanced interference mitigation is to control the resulting of network interference. In multi-cell cooperation technologies, the achievable gains will be limited by both availability of channel state info and latency. In order to approach the rates, several practical strategies currently been proposed (Larsson *et al*., 2014). Massive Multiple-Input Multiple-Output (MIMO) is to increase the capacity for cellular systems and multiplexing gains increased that offers by MU-MIMO. Simultaneous Transmission and Reception (STR) could provide higher spectral efficiency . Point-to point communication such as wireless backhaul could be realized by doubling of spectral efficiency (Atwa *et al*., 2010). The context awareness is to improve existing services efficiency and user-centric and personalized services are provided.

Challenges of 5G ultra-dense networks

Overview: The ongoing increasing population of wireless mobile user resulted the needs to for 5G Ultra-Dense Network (UDN) to provide large distribution of user-throughput (Levanen *et al*., 2014). 5G UDN occupied much higher density than previous generation of networks which lead to more interferences between the cells in the networks (FCC., 2010). By mitigating the inter-cell interference, 5G UDN can be performed better. Some solutions to mitigate the interference of cells in networks are presented in this study.

Architecture of 5G Ultra-Dense Networks (UDN): An appropriate radio frame structure is needed to achieve the target of lower latency as well as 1 msec RTT (Yu *et al*., 2011). In radio frame structure, narrowband and wideband beacons are utilized to collect user positioning information and also the low latency Channel State Information (CSI) at the transmitter (FCC., 2010). The Guard Period (GP) is added to each switch point for switching from DL to UL or vice versa (Lee *et al*., 2014). Knowing user position allows the networks to get track of it in order not to lost the connection and easy to reconnect if users is back from sleep mode (Goebbles, 2010). When there is energy-efficient discontinuous reception (DRX, UL and DL control channel that located at the center of the data frequency-band will do the low power control-channel monitoring (FCC., 2010).

Algorithms to improve performance of 5G UDN: Performance of 5G UDN will be affected by some aspects such as channel aging or inter-cell interference. Channel aging problem could be an important issue to consider when choosing a MIMO approach, MIMO system performance will be degraded under the effects of channel aging. In order to avoid channel aging, the time elapsed since last CSI measurement should be used to prioritize users (FCC., 2010).

A good scheduling framework can minimize the effects of channel aging problem. A Packet Scheduler (PS) that handled of three phases of domain is introduced in the 3 phases are Time Domain (TD), Frequency Domain (FD) and Space Domain (SD). The scheduling process is start running from TD phase to FD phase, then from FD phase to SD phase. In TD phase, a subset of users from all scheduling candidates will be chosen based on Time Since Last Beacon (TSLB) value. After that, in FD phase, first user will be selected based on scheduling priority metric. Then, in SD phase, users will be checked if they are allowed to reuse the resources in past two phases. These three phases will keep looping until there are no more users to be scheduled or maximum users amount is reached due to the network capabilities (Bastug *et al*., 2013).

Interferences between cells in 5G UDN could be serious due to high density of the networks. Mitigation of inter-cell interference will be introduced in order to improve performance of 5G UDN. Utilization of interference coordination that consists of scheduling coordination and beamforming coordination is a way to mitigate the inter-cell interference (Li *et al*., 2014). Scheduling coordination is a kind of semi-static coordination technique while beamforming coordination is a kind of dynamic coordination technique, both of it are significant to increase the network spectral efficiency (Chen *et al*., 2012). Based on the past average user-throughput by Chen *et al*. (2012), scheduling coordination will set a limit scheduling for high throughput users in some sub-frames of every access node. Poor scheduling decisions will be terminated as in beamforming coordination (Jain and So-In, 2008).

Poor design of precoding will results in high inter-cell interference, a proper design of precoding can helps to mitigate the interference (Lee *et al*., 2013). Precoding design can be divided into linear precoding and non-linear precoding (Mukhrjee, 2014). Linear precoding consists of Zero-Forcing (ZF) precoding and Matched-Flter (MF) precoding (Mukhrjee, 2014). MF precoding provides a good compromise between throughput and it is more robustness to channel aging compared to ZF precoding (Mukhtarrjee, 2014). However, ZF precoding that is location-based is performed better on CSI measurement (Levanen *et al*., 2014).

Green technology for 5G network

Overview: This part will discuss the role of edge caching as an energy efficient solution to reduce the power consumption used by the Base Stations (BSs). The circumstances to reduce the Area Power Consumption (APC) but at the same time the conditions for Quality of Service (QoS) is adhere. Poisson Point Processes (PPP) is used to randomly distribute the BSs and User Terminals (UTs) (Demestiches *et al*., 2015). In the pursuit of achieving higher speeds and bandwidth in mobile networks both the industry and academic world are in the race to create a new and better mobile networks and the goal is to upgrade the network to 5G. One of the methods suggested was caching the user’s content locally at the edge of the network. This is done at the base stations in conjunction with the user terminals. Base stations are intermediary between wireless mobile network and mobile phone which are the user terminals. By prefetching and storing the content near to user, the load at the base stations can be reduced significantly (Demestichas *et al*., 2015). When the load at the base stations are reduced, the base station will use less power and thus, power is saved.

Recently, interest has risen greatly with regard to wireless networks with renewable energy sources such as thermal, vibration, solar, acoustic, wind and even ambient radio power which are used to reduce energy costs or potentially harmful effects on the environment caused by CO_2 emissions (FCC., 2010). A recent report published by the Federal Communication Commission (FCC) reveals that most of the licensed spectra are rarely utilized continuously across time and space (Yu *et al*., 2011). In order to address the spectrum scarcity and under-utilization, Cognitive Radio (CR) technology has been proposed to effectively utilize the spectrum (Werner *et al*., 2015). In a CR network, the CR users/devices are allowed to opportunistically operate in the frequency bands originally allocated to the primary users/devices when these bands are not occupied by primary users. Secondary users are capable of sensing unused bands and adjusting transmission parameters accordingly which makes CR an excellent candidate technology for improving the spectral efficiency (Goebbels, 2010).

Edge caching: Several works has been done on caching at base stations and user terminals such as edge caching (Golrezaei *et al*., 2012, 2013), Femto caching (Bastug *et al*., 2013) and proactive caching (Chen *et al*., 2012). Stochastic geometry is being used in this model. Stochastic geometry is the study of random spatial patterns. It involves the usage of Poisson Point Process (PPP) which is the key component for random spatial patterns. This is important to accurately identify what the content popularity distribution is for a certain population in an area. The content popularity is an estimation of media objects (e.g., video and local news) that the user will use in that area of population. Therefore, the media content will be cached and stored near the base stations.

In order to investigate the power usage of a base station, the base stations are arranged in either regular hexagonal or grid topology (Jain and So-In, 2008). Intensive system-level stimulations are done to find the optimal values and ultimately reduce the power usage of the base stations but within quality-of-service constraints (Lee *et al*., 2013). However, to implement it on a large scale networks, it is rather impossible since the calculation for the optimal values for power usage is computationally impossible and not to mention, it is costly.

Therefore, to simplify the calculation, two base stations are used on a two dimensional plane, the computational problem are able to be calculated. The power usage of cache-enabled network using spatial model based on stochastic geometry. Besides that, the spatial distribution of signal-to-interference-plus-noise-ratio, coverage probability and average rate (Mukherjee, 2014; Perabathini *et al*., 2015) will need to be calculated to determine the optimum power usage that adhere to quality of service restrictions. The integration of caching capabilities of base stations does reduce the power usage in wireless mobile networks. The caching mechanism could be a huge impact in 5G networks. Furthermore, more research needs to be done to ensure the caching model could be applied in other network environment. Besides that storing all the popular media content require a precise estimation of content popularity distribution which could not easily be done in real world application and will cost more power needed to calculate it. Therefore, randomized caching policies in a stochastic scenario (Blaszczyszyn and Giovanidis, 2015) could be the key to efficient power usage of caching.

Cognitive Radio (CR) technologies

Energy-efficient communication: The energy harvesting technology is an appealing solution which can harvest energy from environmental energy sources and it easy to apply due to the re-configurability of a CR device. Also, the combination of different energy harvesting technologies can be utilized in the energy harvesting CR assisted 5G wireless networks.

Prioritized spectrum access: By leveraging the software re-configurability of the CR technology users are able to rapidly switch among different wireless modes, satisfy different service requirements and fit in different networks tiers.

Interference management: By employing the environmental sensing ability of energy harvesting CR, users in 5G networks are able to persistently detect the spectrum usage situation and ongoing transmissions of the other users or networks. Hence, the energy harvesting CR assisted 5G devices/networks can potentially reduce or even avoid the interference caused by other devices/networks.

Data rate and latency: Dense urban areas, the 5G wireless networks are envisioned to enable an experienced data rate of 300 and 60 Mbps in downlink and uplink, respectively in 95% of locations and time (Wu *et al*., 2014). Providing efficient spectrum utilization is the reasons for applying spectrum harvesting in 5G networks and energy harvesting CR also provides sufficient energy by harvesting energy from an ambient environment to improve data rate while decreasing the transmission latency.

Network architecture: Enrgy harvesting CR device is equipped with the energy harvester is able to convert ambient energy into electricity. D2D networks are underlaying network with sensing ability. Considering the D2D network with CR technology, Lee *et al.* (2012), Park *et al.* (2013) proposed a method for the D2D network where devices from a secondary network, either harvest energy from transmissions by nearby transmitters from a primary network or transmit information if the primary transmitters are sufficiently far away. To improve both energy efficiency and spectral efficiency of renewable energy-harvesting CR networks, some joint spectrum and energy management mechanisms are needed (Hasan *et al.*, 2013). Devices can dynamically join or leave the network without extra operations. However, the transmission collisions are eminent when huge number of M2M devices trying to communicate the BS all at once (Vinel *et al.*, 2009). The defect of TDMA is the low transmission slot usage if only a small portion of devices have data to transmit (Huang *et al.*, 2011). Picocell networks consists of a BS and energy harvesting CR devices. It manages the spectrum and energy harvesting within its coverage in a centralized manner. Femtocell network is including Access Point (AP) and it harvest energy from renewable source and controls the spectrum and energy usage of all users. Lastly Macrocell network is able to collect the spectrum and energy information from the device, low level networks and energy sources. It is therefore, important to include a complementary technology (Huang *et al.*, 2011) or provide a mixture of traditional power to mitigate or cancel the volatility.

MAC protocol: The cooperative sensing MAC protocol that proposed can improve sensing performance and have three phases contention phase, sensing phase and transmission phase. Throughput performance-two crucial design parameters to balance the trade-off between the sensing overhead and the achievable throughput is the number of the cooperative SUs and the energy in cooperative sensing. Different between this two indicates the aggregate throughput of the CR network.

To summarize the analysis, 5G can be described in terms of architecture, framework, technology and technique to improve the architecture. There are several framework such as Wireless/Mobile Broadband (WMB), nomadic nodes and Distributed Mobility Management (DMM) solution consists of PMIPv6, Software Defined Networking (SDN) and routing based. WMB world is one of the framework that asked to provide all types of media to billions of users or devices and trillions of connected-things in anywhere and anytime. However, stability of the WMB and energy usage are the important issues to be concerned in order to achieve a better WMB world.

Besides that nomadic nodes is another framework which very useful in order to provide access towards services in a certain location as it can provide area coverage and capacity enhancement of the services needed in the defined location. Its mobility creates a good features for any organization on the move or roaming. Although, nomadic nodes have issues concerning its accessibility, frequency, security and lifetime, it is an option in the next generation of connectivity as it provide great value in terms of its mobility, coverage and capacity for any services needed that the nomadic nodes support.

The distributed mobility management approach which consist of three framework like Proxy Mobile IPv6 (PMIPv6), Software Defined Networking (SDN) and routing-based solution. PMIPv6 is allows the overprovisioning usually performed when designing the aggregation links from the access to the network core to be reduced. SDN is behavior of both the traffic and the network in a centralized way, without requiring independent accessing and configuring each of the network's hardware devices. PMIPv6 and SDN can react faster to the changes in the network but they require signaling and specialized entities to perform needed operations. Thus, it is needed to ensure that signaling overhead can be solve and measure due to depend on number of active anchors. Routing-based is related to high handover latency and signaling overhead when using on larger network domains. However, routing based is react slower than in network PMIPv6 and SDN. Hence, it should find a new solution or method to implement the mobile operator with flexibility to handle user's traffic. Based on the SDN used WiBACK method. The purpose of Wireless Back-haul (WiBACK) is providing a holistic cross-layer solution for wireless Back-haul networks. The main enhancement of WiBACK on the infrastructure layer is the definition of message that allow for configuring the physical parameters of the wireless interfaces. The existing of Unified Technology Interface (UTI) enables to configure and monitor the interfaces or ports in Open-flow terminology. Plus, UTI also used by boot strap module as a regular controller. However, in order to react on events in the network, spectrum management module need to be runs continuously. As WiBACK implements Software Defined Network (SDN) concepts and extend them, the flexibility of networks should be considered in the future.

There are combination of several techniques that make up the architecture. Firstly is the MyNet and SONAC architecture. MyNet architecture and SONAC are a good combination in order to improve the performance of 5G. Both have specific functions and characteristics including strengths and weaknesses, so that it can give benefits to 5G users. MyNet completely redefines the current 3G/4G architecture while being able to coexist with existing network equipment and devices. However, some recommendations need to be implement to MyNet and SONAC, since, it still lacking of some characteristics to achieve customer satisfaction while using 5G. We then discuss about the Heterogeneous Network (HetNet) which integrate several macro and smalls cell together to provide network efficiency for 5G network by enriching its capacity and coverage. However, Hetnet experiencing problem related to network interference which could be better improved using recommended Self-Organizing Network (SON). Besides, Cognitive and Cloud Optimized Network Evolution (CONE) that outlines 5G architecture by enabling the architectural and technological components, interfaces and relationship between layers and associated standard is also included in the discussion. This is needed to ensure 5G network requirements fulfilment that embraces throughput, latency and scalability. Moreover, we also discussed on small cells which possess characteristics like cost-saving, flexible, energy-saving and ultra-dense. Lastly is the i-Net. There are huge challenges in virtualizing i-Net especially for the RAN functions. Besides that the bandwidth requirement for coordination between i-Nodes for either intelligent signal cooperation.

There are several techniques have been used in 5G network architecture. Massive MIMO is spectrum, energy efficient, secure, robustness and it improves the radiant energy. Therefore the latency is reduced. However, by removing massive parts such as large coaxial cables, it is difficult in downlink as the process for uplink is not suitable for downlink. Hence, Time Division Duplexing (TDD) is required as it is able to utilize the channel reciprocity. Ultra-dense network is able to provide seamless coverage for 5G network. However, there are possibilities of interferences that will affect the MIMO performance. To improve, the interference mitigation must be flexible for rapid changes in the network. Ubiquitous in 5G is important in QoS as it involves with the real-time connection, although, it consumes high power. Therefore, a standardized of protocols is needed for scalability and coverage. Massive Machine Communication (MMC) is a part of IoT as it enhances the network performance. The weakness of it is there is increased in network traffic. Hence, it is recommended to consider the scalability and adaptability of the network. Software Defined Networking (SDN) and Network Function Virtualization (NFV) are used to implement low latency in 5G network. But it is costly as there are massive deployments needed. In order to provide low latency, the network must be available and reliable for the service. By using millimeter wave solution, it increases the data rates for network access. However, there is propagation issue of the implementation. The solution should provide better access regardless of situations. Device to Device (D2D) communication allows communication exchange without the network architecture of devices. However, it is prone to attacks and threats to the system. Therefore, security utilization is required in D2D communication. Meanwhile, analysis of scenarios and relation to fixed network evolution show that there is mobile broadband availability in congested area and the network can handle many devices with various requirements, respectively. This is due to backhaul and fronthaul as they provide high data rates and lower cost, accordingly. However, it is more conceptual and no actual proof. Hence by using METIS it should provide empirical value to strengthen the proof.

There are 5 types of technology that will improve the 5G communication. First is energy and spectrum harvesting that will improve in communication with the network and the way of device consuming energy. But it will supply uncertainty due to the volatility of device generation. To cancel volatility is with providing a mixture of traditional power. Second is edge caching that helps with speed of 5G communication. But it needs a lot of storage at the base stations to store all cache files. Overcome this by implementing file compression to decrease the size of the file. The third is Radio Access Technology (RAT) that can transmit both radio interfaces that will improve the performance. However, it needs additional infrastructure enablers to carry out network connectivity. Recommendation in RAT is to use under-researched multiple radio access technology to improve capacity and connectivity. Next is new multi service air interface that will make the 5G communication more flexible and efficient to handle the network. But devices need to be designed to support one common air interface for all services and old device cannot support new multiservice air interface. Hence, we need to implement the interface that's compatible with old device, so, all devices can use multiservice air interface. Lastly is an information centric network that will help 5G communication, improve in end-to-end network performance. The weakness of this technology is complicity in network architecture and different from the IP architecture. As the ICN techniques only applied at networking layer, it is should be implement also to be able apply in the application layer. The technology gives a big improvement in 5G wireless communication from interface to data.

As to conclude, there are few others techniques that stated in analysis and discussion. First is the full Duplex. Full Duplex is known for its ability to transmitting the data in both directions on a signal carrier at the same time. Furthermore, it has potential to speed up the wireless communication. That is the reason why the full duplex becomes one of the techniques choices in implement 5G network. Next is the interference management. Interference management consists of two main technique which are advanced receiver and join scheduling. Advanced receiver helps to detect and decode interference signals within certain circumstances like channel, resource allocation, etc. But it also limit the inter and intra cell interference. Hence, to solve the problem of advanced receiver, number of antenna need to increase. Join scheduling manage the interference between cellular systems and link variation. But join scheduling did not autonomously determine the transmission rates and scheme of multiple cells. To solve the problem of joint scheduling, advanced interference management scheme by joint scheduling from the network side is determined in detail in 5G system. Besides, spectrum sharing is one of the techniques. The radio spectrum which refer to the licensed spectrum or some dedicated free spectrum is an importance resources especially in wireless communication and networks. Due to the rapidly increasing traffic demands and broader bandwidth needed to provide gigabit data rates in the future 5G era, the spectrum sharing has play an importance roles in wireless communication and network virtualization. The roles of the spectrum sharing is to promote the full virtualization that multiple operators could share all the available radio spectra. By using the spectrum sharing, all the operators that owned all or part of the licensed spectra could be utilized by multiple operators based on agreements. Thus, the spectrum efficiency and network capacity could be improved. Licensed Shared Access (LSA) is one of the sharedspectrum technologies that recently been deployed. In order to create larger amounts of spectrum that available to the future International Mobile Telecommunication (IMT) systems, LSA, a novel schemes that has the potential in expanding the IMT bands which could support larger channel bandwidth. Next, multi-radio access technology provides communication services over various radio access technologies such as CDMA, 4G, LTE, 3G and several types of Wi-Fi. It has improved the overall utilization of radio resources by reducing network management difficulty. Because of implementing multiple access types into a same structure, Multi RAT is cost-effective comparing to the legacy network types. Multi-Radio Resource Management (MRRM) enables controlling the accesses and monitoring them efficiently. This technology is always ready to accept any form of new features by adapting new requirements which allows multi-RAT to be a strong ubiquitous network. Drawback of multi-RAT is the possibility of added complexities involved in managing multiple sites of their networks. Moreover, the lack of procedures to merge the resources and manage interferences of multiple layers with different frequency and connection types can be impediment to performance of end-user's facilities. The imbalance of data traffic in various networks needs to be minimized to serve the end-user without any interruption. It is important that up-to-date information are needed to select the most appropriate access. Intelligent management should be implemented to reduce the service delays which may occur due to increase in signaling overhead. The last technology discussed is the cloud technology. Cloud technology support multi RAN protocol, dynamically adapting the signal processing resources, wide variety architecture, transportation network, multi-standard operation and easy enabling joint processing. Therefore, cloud technology saves on operational cost by locating all the processing of multiple base stations in one unit. Besides that cloud technology also, provide smooth migration of all ongoing IP service based on mobile network and share all kinds of resources such as communication, computation and storage. But the problem of inter-BS transmission bandwidth and latency requirement. In this case, requirement for reaction latency is usually critical due to collecting information from machines, analyze the information and possibly react to control the machines based on the analyzed results. Applying cloud technology is difficult to properly allocate the intelligence in the protocol stack from physical to management layers and partition between hardware implementations and cloud-based ones. To overcome the problems, bandwidth should increase in order to supports more users and sharing of information. However, proper allocation of intelligence in the protocol stack from physical to management layer should be carefully considered to proceed to successful realization of intelligence in future 5G networks.

CONCLUSION

We had discuss about the problem statement, or issue in this study. Next, identifying the significance and future trends towards future 5G. We also have focused on suitable framework, general architecture, architecture, technology and challenge to be implement in future 5G networks.

We have discuss and analyse five type of framework which will be used in future 5G network in this study. These five framework like Wireless/Mobile Broadband (WMB), Nomadic Nodes and Distributed Mobility Management (DMM) solution consists of PMIPv6, Software Defined Networking (SDN) and routing based which follow different approaches. The first framework is Wireless/Mobile Broadband (WMB). WMB is the combination of requirements and technology trend. The requirements of WMB includes rapid service deployment, the guarantee of the highly different QoS/QoE level and the drastic improvement of the cost efficiency. New multiservice air interface is the technology trend in WMB framework that can maximize the volume of user-plane data that can be carried through the system resource. Nomadic nodes is another framework that provide access towards services in certain location. This can provide area coverage and capacity enhancement of services needed in the defined location. In addition, Distributed Mobility Management (DMM) solution had mention about three main framework such as Proxy Mobile IPv6 (PMIPv6), Software Defined Networking (SDN) and routing-based solution. PMIPv6 is the original protocol had been modified and extended to accommodate a new set of operations. As for SDN is the performance of both the network and traffic in a centralized. Next, SDN did not needed independent retrieving and configuring network hardware device. The last mechanism works the routing protocol to perform the mobility functions needed to send the packets to and from moving users.

Device-to-Device (D2D) communications and ultra-dense networks are general architecture example. Another emerging technologies used in 5G wireless system are D2D communications and ultra-dense networks, architecture of both emerging technologies have been discussed in this study. The proposed architecture of D2D system consists of two level communications and four types of device level communication. Such a system allows local exchange of user plane traffic without using a network infrastructure which can improve performance of 5G wireless networks by enhancing service performance of system, increase device's battery life span and also highly utilize of resources in the system. Concept of ultra-dense networks is also proposed to be used in 5G wireless system. The proposed novel architecture of ultra-dense networks can make an efficient distribution of user-throughput that results to better network experience for users. Some techniques and algorithms used in ultra-dense networks allowed increase of density of the networks and mitigation of interference. Hence, network capabilities can be increased without degrade of the network performance.

Furthermore, the general architecture is approach to 5G network architectures able to natively support very diverse services include delay sensitive applications. The flexibility of 5G network architecture is done by splitting the GW in control and user plane, selecting a GW depending on the service with local, regional or centralized uGW part. By enable the service de-centralization and layer 2 Ethernet switching, the low latency requirement is accomplished. In order to achieve mobility and service continuity, the local uGW is relocated and the "make before break" principle is used. The proposed 5G network architecture attains flexibility by using Network Function Virtualization (NFV) and Software Defined Network (SDN) principles. Finally, among other architectures, the combination of NFV and SDN promising candidate to allow on-demand creation of customized Virtual Networks (VN) using a shared resource pool. VNs are based on SDN architecture which enables effective decoupling of control and data plane in order to optimize routing and mobility management.

An unexpected change of the system requirements is expected in the next years that need a fast reaction to adapt the network architecture and protocols, so as to efficiently support each use case. The 5G solutions will have to enable service aware optimal coverage, size and authenticity with lowest cost and energy expenditure. The transformation towards software driven networks signals the emergence of new ecosystems and new approaches to industry alignment, leveraging best practice and scale from the IT world. A conceptual view has been developed with the high-level cognitive and cloud optimized network evolution together with layers and associated architectural when the details of 5G architecture and technology choices are open and findings from ongoing research and standardization. To ensure a unified and global 5G architecture, technology and standards as well as a successful introduction of commercial 5G networks towards the end of this decade, we will continue to evolve and refine our vision, aligning with future oriented customers and various players of the ecosystem.

In order to overcome the high traffic of volume demands spurred by the proliferation and penetration of wireless services of the future 5G cellular wireless network, a new paradigm of integrated spectrum and energy harvesting has been proposed. Spectral efficiency and energy efficiency are the most essential for the future

5G network. Therefore, to boost up the spectral efficiency, Cognitive Radio (CR) technology is proposed by exploiting the spectrum. Cognitive radio technology are energy-efficient communication which is an appealing solution that can harvest energy from environment energy sources and it is easy to use because of the re-configurability access. Besides that CR technology also provide sufficient energy by yield energy from an ambient environment while reducing the transmission latency to improve data rata. Moreover, Reference Base Station Efficiency (RBSE) is defined to perform better performance in Radio Access Technologies (RAT). Caching mechanism also could be a tremendous impact in 5G networks. The integration of caching able to reduce the power consumption used in wireless mobile network yet still able to maintain the quality of the service. A key to efficient power usage of caching is randomized caching policies in a stochastic scenarios.

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