IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 11, Issue 3, Ver. I (May-Jun .2016), PP 80-85
www.iosrjournals.org

5G –The Next Generation Mobile Radio Communication

Sharad Jain[1], Sunil Chavda[2]
[1](Electronics & Communication Engineering, IES,IPSA/ RGPV, India)
[2](Electronics & Communication Engineering, IES,IPSA/ RGPV, India)

Abstract: *The designing aim of 4G was to improve capacity, user data-rates, spectrum usage and latency with respect to 3G. 5G is just more than an evolution of mobile broadband communication. It will be a Important key enabler of the future digital world. The vision of 5G mobile is driven from the predictions of up to 1000 times data requirement by 2020 and the fact that the traffic could be two thirds video embedded. 5 G in one sentence may be called as "Always Sufficient Rate" to give users the ability of Infinite Capacity". This paper gives an overview of the 5G mobile radio communication. The paper addresses the key drivers and disruptive capabilities for 5G as well as the design principles, key technological components, spectrum considerations etc.*

Keywords: *4G, 5G, internet of things(IOT), Network Functions Virtualization (NFV), software defined, networking (SDN)Ultra Dense Networks (UDN)*

I. Introduction

5G is not only an evolution of mobile broadband networks. It also have new unique network and service capabilities. 5G will make user to experience continuity in challenging conditions such as high mobility (in trains), very dense or scattered areas, and journeys covered by heterogeneous technologies. Apart from that, 5G will be a key enabler for the Internet of Things (IoT) by providing a platform to connect a massive number of sensors, performing devices and actuators with required energy and transmission constraints. Furthermore, mission critical services which require high reliability, global coverage with low latency, will become natively supported by the 5G infrastructure.

Networking, computing and storage resources will be will integrated into one programmable and unified infrastructure with 5G. It will allow for an optimized and more dynamic usage of all distributed resources, and the convergence of fixed, mobile and broadcast services.5G will also support multi tenancy models, enabling operators and other players to collaborate in new ways.

5G will provide improved performance in terms of more capacity, lower latency, more mobility, and more accuracy of terminal location, increased reliability and availability. It will be to connect more devices simultaneously and to improve the terminal battery capacity life.

5G infrastructures will be also much more spectral efficient. The increased spectral efficiency will make 5G systems to consume a very less energy where 4G mobile networks consumes today for delivering the same amount of transmitted data. 5G will reduce service creation time and will provide the facility of integration of various players delivering parts of a service. Lastly, 5G systems will also be hardware efficient. The ultra-efficient 5G hardware will be very flexible, energy aware, and interworking in very heterogeneous environments. The cost of 5G infrastructure will be reduced dramatically due to increased efficiency.

II. Prime Technological Components

5G wireless is expected to support a heterogeneous set of integrated air interfaces: for current access schemes as well as brand new technologies. 5G networks will have cellular and satellite solutions. Smooth handover between heterogeneous wireless access technologies will be a main feature of 5G, as well as use of simultaneous radio access technologies in order to increase reliability and availability. The installation of ultra-dense networks with number of different small cells will require new interference minimization techniques, backhauling and installation techniques.

5G wireless will be driven by software. To meet the performance targets especially at the edge of the network functions are expected to run on unified operating system in a number of points of presence, As a result, to achieve the required performance, scalability and agility it will heavily rely on emerging technologies such as Network Functions Virtualization (NFV), Software Defined Networking (SDN), Fog Computing (FC) and Mobile Edge Computing (MEC).

5G will optimize and ease network management operations. The development of cognitive features as well as the advanced automation of operation by proper algorithms will ease to optimize complex business objectives, like end-to-end energy consumption.

III. A Sustainable And Scalable Technology

5G systems have to resolve the basic challenge of handling the expected growth in the number of terminal devices, the continuous growth of traffic (at a 55-60% CAGR), and heterogeneous network without causing an increase of power consumption and management complexity of networks. In addition, users and the society will be much more sensitive to the sustainability of telecom services. Therefore, 5G will have to be designed to be a technology having sustainability and scalability.

Firstly, 5G will bring extreme energy efficiency improvement and develop energy harvesting everywhere. Using this energy chase terminal devices, network elements, and the network as a whole including data centers will be covered. For example, it will enable a approximately 9-10 years lifetime of a battery powered sensor.

5G will attach advanced automation towards autonomics and cognitive management features to improve the efficiency of operators. Furthermore, to support continuous access in developing countries (the next 2 Billions of people) or in areas of low-density, options of ultra-low cost network will be developed. These lower cost technologies at all levels of networks (access, backhaul, IT, energy), as well as some new deployments such as high altitude platforms (balloon, drones etc), will be inquired by relaxing target objectives on availability, peak rate, and latency.

IV. A Great Eco System

An ecosystem will be created by 5G for technical and business innovation so more and more partners will be involved in this business models delivering a part of the value. The extension of the cloud computing model to the telecom industry will release innovation and new players will be allowed to access the ecosystem.

With 5G, network services will depend massively on software. It will strengthen the software industry, including small and medium enterprise developers and solutions providers that can better compete in an increasingly hardware market. Some large IT providers have already entered in this market a short while ago, trusting on their expertise in cloud computing and virtualization in order to provide the same value proposition towards the telecom sector. It will cause a innovative impact to network manufacturers which will change of their image themselves, with a rollout of software solutions from their own developed labs, or strategic partnerships with IT providers.

In 5G, the resources will be adjusted dynamically to demands. Also infrastructure resources, connectivity and all network functions will come under the class of service. It will be like foster partnership business models. Operators will tap into the opportunity to increase the value of third party services. Partnerships will be fixed on multiple layers starting from sharing the infrastructure, to exposing network capabilities as a end-to-end service, and integrating partners' services into the 5G system. This will be done through a rich and software oriented capability set.

In addition, there are some specific network platforms for each vertical sector that has dedicated features and performance requirements like high reliability for health or automobile verticals or high density of terminals for smart cities. Instead of current proprietary technologies the use of COTS (Commercial of the Shelf), will change the market with these industries which have much greater influence on the development of network services and their SMEs will be able to innovate and launch new applications expecting the new capabilities of 5G.

V. Capabilities

The 5G disruptive capabilities will provide all over access to a wide range of applications and services. These will be provided with increased elasticity, continuity, and much higher resource efficiency with a significant decrease in consumption of energy. At the same there is provision of time security and privacy. In addition, 5G should provide large extent improvements in capacity and increased user data rates. In particular, to support services such as 3D telepresence on mobile devices peak data rates in the order of 10-12 Gb/s will be required. In addition, to cover a stadium with 30.000 devices relaying the event in social networks at 50 Mb/s, a capacity of 10 Tb/s/km² will be required. Moreover, to ensure ultra-responsive mobile cloud-services and to support interactive applications, end-to-end latencies of the order of 5 ms are needed. Future 5G infrastructure is expected to cope with 35-50 Mb/s for a single video transmission (before channel coding) and perform most of the sound-field and light-field processing in the network, in order to adapt the data stream with (close to) "zero latency".

It is expected that a wide variety of Massive Machine-Type Communication (M-MTC), ,Internet of Things (IoT), and Ultra-reliable Machine-Type communication (U-MTC) will be ubiquitous by 2020 besides human-centric applications outlined above it. There may be need of restructuring key architecture components of mobile systems to support the diverse requirements coming from IoT verticals.

The highly demanding turbulent capabilities of 5G require an enormous research effort for industry and academia, because it requires a very large improvement over the current technology and infrastructure also.

A system architecture based on software, support for terrestrial and/or satellite communication ,easier authentication, support required for shared infrastructure, multi -tenancy and multi -RAT (with smooth handover), privacy, robust security, and lawful interception capacity are the main features in non-quantitative capabilities of the technology. All of the above performance parameter will not be required by every terminal at all the places and at all time. All connected device will normally have average latency, bandwidth and traffic intensity characteristics. Also, each connected area will have its specific characteristics: The same coverage from the network will not be provided for a business district, a stadium, a residential area, or on board of a bus, train, boat, airplane etc. This is reason that the infrastructure has to be followed to the features of the service demand expected at each area.

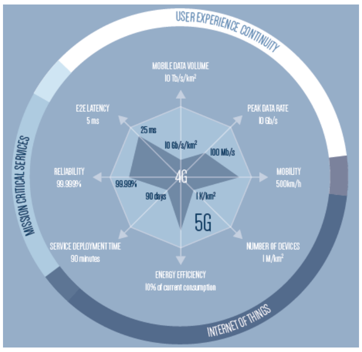

Fig 1- RADAR diagram of 5G disruptive capabilities

VI. Principle Of Design

The design of 5G will provide high workability and will be driven by a service approach. The network shall have flexibility and fast adjustability to a broad range of usage requirements. The network shall deliver converged services and at the same time will also preserve security and privacy across an all round architecture with unified control of any type of ICT resources.

Since 5G will allow new business models in a programmable way, To get support for a variety of network and service application developers, Application Programming Interfaces (APIs) should be available at different levels i.e. resources, connectivity and service enablers. Small cells will be replaced by Ultra Dense Networks (UDN) in order to meet the anticipated high throughput targets. Device -to- device, person-to-device and Person-to-person communications will be covered by 5G and this will push the future infrastructure towards all-surrounding smart connectivity: smart cars, smart grids, smart cities, smart factories and so forth. It will also stimulate new Radio Area Network pattern such as Device to Device (D2D) and Moving Networks (MN).

In order to meet the expected business and performance requirements, especially in terms of latency and reliability, and to support new business models and structures, beyond what is currently foreseeable the architecture of 5G will change in theatrical manner compared to previous generations. In order to realize such a entire view on what the 5G infrastructure is to be, the all different 5G subsystems and interfaces, as well as their integration into the overall 5G substrate require to be influenced by modern operating system architectures.

Recent mobile networks are an overlay on top of transport network infrastructures, therefore the basic principles of calculations of architectures and soft ware recommends the design of 5G as a group of native service and/or network applications, and integrating all fundamental procedures of the non access stratum (NAS) and access stratum (AS) protocols, like mobility, security connection, and, especially, routing management.

It shows convergence between fixed and mobile networking services with the corresponding evolution of core and transport networks. This will make the latency to be reduced dramatically due to simplification of protocols and most favourable locations of network/services applications and corresponding states; free from the limitation of a single dimensional communication chain; enabling new business models through open interfaces (APIs for resources, connectivity and services enablers); and support birthright services and communication systems running applications which are fully compatible to them and their future improvement. Also reliability will be improved by the chance of establishing simultaneously multiple connections. Figure 2 shows the vision of 5G networks and services.

While there will be an apparent increase in diversity of services and the complexity of the infrastructure, therefore it is expected that 5G will radically cut total cost of ownership (TCO) of the infrastructure, on the one side, and the service creation and time of deployment , on the other side.

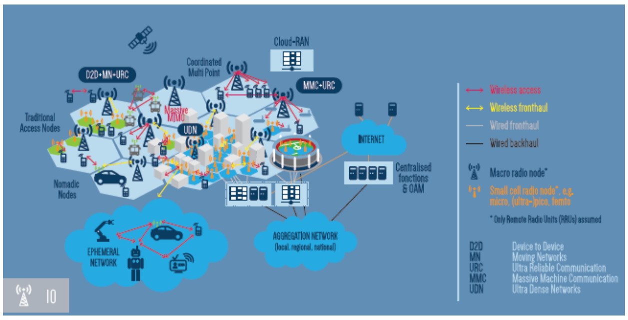

Fig 2- 5G networks and service vision

VII. Key Technologies

To satisfies future demands for both human-centric and machine-centric services simultaneously, requires the technologies which is capable of using contiguous and wide spectrum bandwidth; schemes for flexible resource allocation and sharing; changeable air interfaces; agile access techniques; advanced multi-antenna beam-forming and beam-tracking and multiple input and multiple output (MIMO) techniques; new radio resource management algorithms, to name just a few.

A heterogeneous set of integrated air interfaces will also be supported by 5G wireless. It is expected that 5G network will be deployed in the "low" band, i.e. frequencies below 6GHz on macro and small cells, coexisting with legacy (2-3G) and 4G technologies; and frequencies above 6GHz i.e. in the "high" band, means on small cells, together with Wi-Fi and previous releases of 3GPP technologies. Using 5G network architecture we will be able to integrate of small cells and ultra-dense networks (UDN). It will require new operational models to access the networks like crowd networking ,which will call for new standard interfaces.

The novel 5G architecture will also integrate both front haul and backhaul into a common transport network. The technologies, having span from fiber optics with software-defined optical transmission to novel CPRI-over-packet technologies, also consider wireless links such as mm Wave. On top of these technologies a general processing plane is expected to takeaway bulk operations in shared media, and provide excellent services in terms of re-configurability, energy efficiency and multi-tenant operations.

Furthermore, to achieve the required capacity, latency, reliability, and coverage ,energy consumption improvements, the 5G architecture is expected to i) will use converged optical-wireless-satellite infrastructure to access the network, backhauling and front hauling with the possibility of digital transmission and modulation of signals over the physical media; ii) flexible intra-system spectrum usage; iii) make optimal utilization of the specific strengths of the different infrastructures e.g. leverage multicast for satellite or flexible spectrum for optical.

VIII. 5g-A Software Driven Technology

Using virtualization of network functions and software-based networking, it is possible some new design principles that will allow flexibility and tighter integration with infrastructure layers. Still performance and scalability need further investigation. NFV takes the maximum advantages from recent advances in server virtualization and enterprise IT virtualization while SDN introduces logical centralization of control functions and depends on advances in server scale out and cloud technologies. However, SDN and NFV both are not a networking technology, as the network is assumed to be there, before NFV or SDN can be even used. So, 5G will provide a united control for networks of multi-tenant and services through deployment of functional architectures across many operators' frameworks. 5G will make possible the fundamental shift in model from the most popular services by management of organizational facilities ownership to a unified control framework using virtualization and programming of networks and services.

IX. Energy Efficiency And Security

Energy efficiency is also an important factor in circuit design, such as power amplifiers and analog front-ends in microwave and millimeter frequency ranges, DSP-based optical transceivers for access and backhaul networks, and ultra-low power wireless sensors gathering surrounding energy, such as solar energy, thermal energy, vibration energy and electromagnetic energy. Also, wireless power transfer technologies and optimization of sleep mode switching present some exciting substitute to battery-less sensor operation for M2M and D2D communications.

For such a great revolution in the network infrastructure parallel evolution of the connected objects (machines, terminals, drones, robots, etc.) in terms of wireless connectivity, computational power, memory capacity, battery lifetime and, cost are very required.

In 5G, due to the expected multiplication of both types of stakeholders and numbers of tenants ,security issues are radically amplified. To resolve this complexity within the system, it will become necessary to work under different circumstances and to always consider security domain. New access control models will be required, as we know their existence in the domain of online social networks and, generally, online services. Beyond privacy, honesty and availability, cyber-physical system security, and some other new security concepts in this area, need to address reliability of information, integrity of remote platforms, contextual correctness, proof of ownership and similar topics. Probabilistic security mechanisms will be required to deploy for the existence of and support for highly limited devices such as sensors in parallel to the high-security solutions mentioned before. At the same time tailored security at the service and device level should be visualized: To provide differentiated security services on request, 5G might consider dynamic control and data plane support for different security system instantiations. Security guarantees are needed for the dynamic composition of the 5G infrastructure within the system: beyond the mutual validation and creation of secured channel, we will need to hunt through into topics of infrastructure or system integrity and operational security affirmation. Since prevention and protection model tend to limit degrees of freedom, Therefore the solution here is to go beyond the currently prevailing operational these security models. As per recent NFV and SDN initiatives suggestions, If the system dynamics is key to achieve the agility of stakeholders then the survivability must be increased understood as the major operational security model.

X. Spectrum Analysis

It is believed that 5G access networks for some services will require very wide adjacent carrier bandwidths from several hundred MHz up to several GHz, to be provided at a very high overall system capacity. To support the requirements for wide adjacent bandwidths, carrier frequencies above 6 GHz need to be considered. If we consider any new bands for such services then it will require careful assessment and remembrance of other services using, or planning to use, these bands. Maintaining a stable and foreseeable regulatory and spectrum management environment is censorious for the investments for long time. To conserve them, research on this spectrum has to take into account for long-time investments. The entire mobile licensed spectrum assignment methods will remain dominant even if new techniques may be predicted to improve utilization of spectrum under some circumstances.

Video applications and the continuous-increasing use of smart phones, tablets and machine communication, mobile data traffic is expected to grow beyond expectation according to several reports. These indicate about 45 to 65 % annual growth over the five year period 2013 to 2018, a trend may also be well continue beyond 2020.

Wide contiguous bandwidth can be obtained with higher carrier frequencies that can provide for very high overall system capacity. Now the effective user range will be relatively short, therefore there is a possibility of very efficient frequency reuse over a given geography. With higher carrier frequency the propagation conditions become more in demand than at the traditionally used lower frequencies for wireless services. Since the path loss and diffraction loss both become more severe, therefore atmospheric effects must be accounted for, and the use of directional antennas becomes necessary. The result will be relatively short links which to some degree basically depends on line-of-sight paths. In fact, this can be considered as benefit rather than a drawback, in order to provide high capacity ,cell sizes are becoming smaller in dense urban settings (e.g. of the order of hundreds of meters). Furthermore, advances in technology like 3D beam-forming and massive MIMO techniques will achieve their full potential when taking advantage of the short wave-lengths, which come with high frequency bands.

XI. Methods Of Spectrum Management

To keep the terrestrial and satellite operators and service providers into networks in a long term, services, and spectrum, and maintaining a stable and predictable regulatory and spectrum management environment is critical. The methods of assignment of mobile licensed spectrum will remain important for ensuring stability for long-term investments into networks and the underlying spectrum. For improving spectrum utilization, new techniques and technologies may be expected to support long-term co-existence between applications and the services. New technologies using of higher frequency bands and advanced regulatory tools could provide some new spectrum coexistence opportunities for 5G systems.

XII. Conclusion

This paper has presented the overview of 5G mobile radio communication. The examined potential area include: greater capacity, much lower latency, more mobility, more accuracy of terminal location, increased reliability and availability. We have also highlighted a number of challenges in the implementation of 5G networks. This paper addresses the as the design principles, key technological components, spectrum considerations for 5G as well as key drivers and disruptive capabilities.

References

[1]. Thompson J. et al, '5G Wireless Communications Systems—properties and challenges', IEEE Communications Magazine Feb 2014.
[2]. Cost IC 1004 White paper, Scientific challenges towards 5G Mobile Communications-—ncardona@iteam.upv.es
[3]. 'Scenarios, requirements and KPI's for 5G mobile and wireless systems' ICT-317669-METIS/D1.1.April2013.
[4]. Horizon2020-Advanced 5G Networks Infrastructure for future Internet PPP—www.Net!works.eu
[5]. EC H2020 5G Infrastructure PPP—Prestructuring model RTD & INNO strands—www.5g-ppp.eu