International Journal of Computer Sciences and Engineering Open Access
Review Paper Volume-5, Issue-6 E-ISSN: 2347-2693

# Integration of Different Wireless Technology and Methodology for Future Generation of Wireless Communication

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**Available online at: www.ijcseonline.org**

Received: 25/May/2017, Revised: 02/Jun/2017, Accepted: 20/Jun/2017, Published: 30/Jun/2017

***Abstract***— There are many technologies and methodologies present to support existing wireless mobile communication**.** We propose a concept to integrate best methodologies and technologies that suits the future generation in terms of high system, spectral efficiency, and energy efficiency etc**.** Our approach to achieve requirement of next or upcoming generation 1stly we analyze best technology and methodologies **(**like multi input multi output **(**MIMO**)**, orthogonal frequency division multiple access **(**OFDMA**)**, Direct**-**device to device **(**D2D**)** communication, MIMO, Mm wave, Spatial modulation, Radio access technology etc**.)** of each generation and then check the possibility of integration of technologies and methodologies**.** And design architecture with integrated technologies and methodologies with respect to future generation**.** So, we check the possibility and try to integrate various technologies and methodologies of different generation to fulfill the requirement of next generation**.**

***Keywords—*** Cognitive radio, SDR, Spectrum Secrecy, Spectrum Efficiency, MIMO, Mm Wave, D2D

## I. INTRODUCTION

No doubt, in last few decade technologies involved in the communication systems have been developed exponentially along with attractive features and facilities. Wireless communication system is one of the biggest inventions of the century and its developments can be processed in different terms of generation having approximate 10 years for each one. Each generation is to provide link with persons at every corner of globe with set of quality services.

Today we are in 4th Generation; it is categorized based on its characteristic services and features like transmission signals, data transmission rate, bandwidth frequency and nature of the services provided. 1$^{st}$ Generation is introduced in 1980, so each generation had been coming at the end of every decade. 1st generation used analog signals, circuit switching and FDMA with 30 kHz channels holding the 824MHz 894MHz frequency band. 1$^{st}$ generation supports only voice transmission. The data was not reliable, there were interrupted communication and few other problems in 1$^{st}$ Generation [1]. 2$^{nd}$ Generation technology was established in 1990, which used digital signals for transmission and two digital modulation schemes TDMA and CDMA with circuit switched network. 2$^{nd}$ Generation uses the extant radio spectrum to provide the services. It was developed to overcome the previous generation's limitations, and to have data and voice transmission. But this generation also has few limitations like limited coverage, lack of reliability and speed was excising in [6].

Till 2$^{nd}$ generation we are not talking about data services but at the mid of 2$^{nd}$ Generation data service is a big issue in wireless communication. The transformation to 2$^{nd}$ Generation (2G) to 3$^{rd}$ Generation (3G) is about successfully adding more functionality, possibilities and value of the existing network. 3$^{rd}$ generation developed in 2001, it not alone provides the transmission speed from 125kbps-2mbps but also include many services such as global roaming, superior data and voice quality services. 3$^{rd}$ Generation used Code division multiple access (CDMA) multiplexing with Packet switched network (PSN). Limitations of 3$^{rd}$ Generation are requiring higher bandwidth, High cost for the 3$^{rd}$ Generation mobile phone, Size of the phone is large, Difficult to build the infrastructure for 3$^{rd}$ Generation. The amount is high for 3$^{rd}$ Generation Licenses Services [6]. 4$^{th}$ Generation of wireless communication system which was introduced in the year 2010. 4$^{th}$ Generation mobile system is IP-based that provides access through a collection of radio interfaces. The significant features of 4G technology are video conferencing, location based services, secure, high speed, high capacity and low cost per bit with many real-time services. 4th Generation wireless technology is combined together with the existing and the proposed wireless network technology (e.g. OFDM, MC-CDMA, LAS- CDMA) [4] to provide flawless roaming from one technology to another. LTE and Wi-MAX [1] technologies that are used for 4th generation. The battery use in 4th Generation cell or mobile phone is high; Implementation of hardware is difficult and Complicated and not cost effective. Exclusive network is compulsory to implement the following generation network. From 214 million subscribers in 1997 to 1.162 million in 2002 [1], it is predicted that by 2020 there will be 7 Billion subscribers worldwide [6]. There is a huge increment in the mobile subscription, so it is a challenge to researchers and industries to move next generation the main aim of future generation technology is to provide not only better voice communication experience but try to give the user access to a new global communication reality, high data rates, better quality of experience (QoE), high system capacity for voice, multimedia, internet and multi-service capacity and cost effective. The Future generations do not pretend to on the basis of available facts as discussed, we can say that in coming year there will be required an integrated technology that exist in previous generations (e.g. GSM, GPRS, IMT-2000, Wi-Fi, Bluetooth, MC-CDMA, OFDMA, MIMO, RAT, D2D, Mm Wave, Femto cell etc.) [3], [4] Of communication system for upcoming generation. In this paper 1stly we discuss about previous generation technologies and its features, in second section we are able to select best technologies of previous generations and some new technologies, in 3rd section of paper we check possibility to integrate selected technologies, 4th section is conclusion i.e. we propose an integrated architecture for future generation wireless communication.

### *A. Basic Need of upcoming or next Generation*

When we think about next generation then a question arises that what and why need of upcoming generation of wireless communication while previous four generation s present to fulfil user requirements. Answer of this question is each generation provides some new facilities and have some limitations also so to remove limitation of previous generation and add more features to user we need a new generation. We are in 4th generation it provides many facilities and removes drawbacks of 3rd generation but some limitation is also there in 4th generation will be a fully IP-based integrated system. 4G will be theoretically pretend to provide speed of data rate between 500Mbps and 1Gbit/s speeds both indoors and outdoors but typically it doesn't reach the maximum speed shown in table1, global seamless coverage is an issue, high battery consumption, system capacity needs to improve and much money pay to use by user etc. So, for many reason we need to future generation. We expect many facilities that future generation provides like

- High Data rates like 100Mbps should be supported for thousands of users.
- 1 Gbps to be offered, concurrently to workers on the same office floor.
- Several million of concurrent connections to be supported for Mega MIMO deployments.
- Spectral efficiency should be significantly enhanced compared to 4G.
- Coverage should be improved.
- Signalling efficiency enhanced.
- Global Accessibility.
- Provide service on the basis of type of user.
- Increase battery life of terminal devices.
- Mobile network systems will require expanding to support millions of applications and billions of machines.

| | Technologies | Frequency | Theoretical | Practical |
|---|---|---|---|---|
| 2G | GSM | 825-1900MHz | 10Kbps | 9.6Kbps |
| 2.5G | GPRS | 850-1900MHz | 200Kbps | 56-114 Kbps |
| 2.75G | EDGE | 850-1900MHz | 400 Kbps | 120-384Kbps |
| 3G | UMTS | 1.6-2.5GHz | 14Mbps | 384Kbps-2Mbps |
| 3.5G | HSPA | 1.6-2.5GHz | 42Mbps | 600Kbps-10Mbps |
| 4G | Wi-Max | 2-10GHz | 100Mbps | 3-10Mbps |
| 4G | LTE | 2-10GHz | 300Mbps | 30-40Mbps |
| 5G | ------ | ------- | 500Mbps | -------- |

Table 1: Technologies of Generations and their Data Rate

## II. PROPOSED TECHNOLOGIES FOR FUTURE GENERATIONS

### *A. Cognitive Radio*

Efficient and effective utilization of spectrum by secondary usage of underutilized spectrum licensed to primary system is provided by Cognitive radio technology (CR) [2], [6]. A secondary Cognitive radio network is promising to obtain dynamic spectrum environments and achieve its communication goals without stake co channel primary services. Cognitive radio networks classify into two categories, 1st one is, interweave Cognitive radio networks and other one is overlay Cognitive radio networks. 1st one offers a practical solution to achieve coetaneousess of primary and secondary networks. Second one [6]. That takes a more fundamental view on coexistence by shifting the focus from primary transmitters to primary receivers. Secondary transmissions are allowed as long as the actual interference perceived at the primary receivers is controlled to full fill certain protective constraint.

 

Cooperative hybrid CR network, which is more realistic and advanced in three aspects.

- One virtual antenna array to be active at a time (in a cell) assumed in a time-sharing system [6], allowing. Contrary to [6], this paper considers a distributed VAA system that allows multiple VAAs to simultaneously operate to bring significant increases to the system capacity.
- FDMA scheme was assumed for transmissions in the secondary band. This scheme is replaced by CDMA. This change is non-trivial since CDMA provides an inherent advantage to use the wideband feature of the secondary frequency band to improve the system efficiency. [6]
- Amplify-and-forward relaying. This scheme is preferable for delay-constrained services but requires high SINR in the source-to-relay link to avoid harmful noise propagation. While the reason mechanism provided [6] to control noise propagation, a refined VAA signalling scheme with power control is proposed to prevent harmful noise propagation the capacity of the proposed cooperative hybrid Cognitive Radio network will be studied first at the link level and subsequently at the system level

Cooperative hybrid Cognitive radio network can achieve a promising capacity improvement when high Cognitive Radio user densities and a wide secondary bandwidth are available. More importantly, this capacity improvement is insensitive to the primary user density and interference power from the primary network. We conclude that the proposed cooperative hybrid Cognitive Radio network is a promising alternative to conventional pure Cognitive Radio networks to be deployed in urban scenarios.

### *B. Mm Wave*

Traffic in wireless communication increases approx. 1000 times in year 2020 [1] and approx. 10 000 times in year 2030 [2]. By exponential increase on traffic throughput per square area decreases .so we want to develop a new concept for increase throughput in wireless networks i.e. either reduce cell size. But concepts not fulfil our requirements it only improve throughput. But 1000 times increase in network capacity could be achieved through an increase in performance; spectrum availability and massive densification of small cells there are two obvious methods which can be attempted in addition to massive cell densification to meet this needed large increase in capacity.

The first approach is to do everything possible to increase the throughput of LTE systems [3] below 6 GHz using massive MIMO, carrier aggregation, coordinated multipoint, heterogeneous networks, and authorized shared access and any number of interference management/cancellation techniques. However, all of these methods at the very best may only meet the 1000-fold increase, but will not be able to grow much beyond that point given high spectral efficiency already obtained with MIMO (e.g. up to 8 × 8 MIMO in LTE), interference management techniques, and the limited spectrum available.

The second option is to adopt new frequency bands, which have a large amount of spectrum and to use large bandwidths to achieve very high peak and cell edge rates. Particular bands of interest are the Mm-wave (mm Wave) bands of 20–90 GHz and more specifically the 28 and 38 GHz bands (where there is 3–4 GHz available) and the 70 and 80 GHz E-band where there is an incredible 10 GHz of spectrum available, as shown in Fig. 2. The E-band is of particular interest over other mm Wave bands because it is already lightly licensed and is provisioned to allow up to 5 GHz of contiguous bandwidths given the popularity of OFDM in 4G cellular, one would think that OFDM would be a natural choice for mm Wave communications. However, an important feature of OFDM for use below 6 GHz, the multiplexing of users in frequency, is not necessarily a valuable feature for the much wider bandwidths at mm Wave. There are many reasons why this feature may not be important for mm Wave communications. 1st, mm Wave will be deployed in small cells with very small slot sizes (e.g., 100 μsec), meaning very few users will need to transmit within a slot. Second, the high bandwidth and small cell coverage results in small OFDM symbol times (e.g. 66.67 μsec) and small propagation delays, meaning that the active users could just as efficiently be multiplexed in time, rather than frequency. Lastly, mm Wave systems will need large antenna arrays at least at one end of the link to overcome path loss.

Mm wave bands, in particular the 28, 38, 71–76 and 81–86 GHz bands for a 5G eLA. Extensive channel measurements show very comparable path loss behaviour for both the access and backhaul scenarios for 28 and 73 GHz bands in New York City. This indicates that mm Wave propagation in many different bands will be quite comparable and viable for eLA deployment with directional, high gain antennas used at the mobile device and access points. The mm Wave systems achieve similar coverage at different bands since for the same form factor larger antenna arrays can be used at high bands to compensate for the path loss difference between high and low mm Wave bands. The eLA system described in this paper exploits large bandwidths in the mm Wave regime to achieve peak data rates in excess of 10 Gbps and edge data rates of more than 100 Mbps. We proposed null cyclic prefix single carrier modulation for mm Wave systems and presented simulation results showing the system level performance of the proposed eLA system can achieve cell edge rates in excess of 100 Mbps with proper densification of the access points.

### *C. Generalized Spatial Modulation*

To improve the performance a new transmission scheme was Spatial modulation is introduced. It improves spectral efficiency, energy efficiency with low complexity. When no of antenna increase then data rate also increases.

GSM is a hybrid version of spatial multiplexing and spatial modulation it removes drawbacks of spatial multiplexing and spatial modulation. In Spatial multiplexing, all antennas are active during communication so spatial multiplexing is less energy efficient. In spatial modulation, all antenna is not active during communication only participating antennas are active.

### *D. Enhance version of MIMO or Mega MIMO for improving spectrum efficiency*

Mega MIMO is also known as Large-Scale Antenna Systems or Very Large MIMO. In Mega MIMO extra antennas help by focusing energy into every smaller region of space to bring huge improvements in throughput and radiated energy efficiency. Mega MIMO includes the extensive use of inexpensive low-power components, reduced latency. Mega MIMO is a technique that improves system or channel capacity. Some challenges are also present with Mega MIMO like complexity, cost efficiency, implementation etc. but Mega MIMO is more beneficial in comparison than traditional MIMO. Use of Mega MIMO is best suited for future generation [3], [7].

### *E. Femto Cell*

Indoor wireless communication. Femto cell act as a cellular access with self-organize and self-managing at low prices generating efficient capacity and coverage shows in table 2 [8], [9]. Femto cell system provides connectivity between internet router and mobile phone locally available shown in figure 1. Femto cell system contains internet router to move data from femto cell via internet, core network gateway, internet link and femto cell itself. Network gateway provides link internet into network [10]. Main application of Femto cell is indoor like residential enterprise, residential and also in high mobility Metro Train. Latest standards LTE and Wi-Max use Femto cell. It provides site shield from macro cell and multipath propagation reach maximum gains by MIMO antenna technology. Femtocell in LTE provides higher modulation rate with improved spectral efficiency to serve large number of end users [9], [10].

Table 2: Power Range and Radius of Different Cell size

| Cell Type | Cell Radius | Power Range |
|---|---|---|
| Femto cell | 10-50m | 10-200mW |
| Pico cell | 100-300m | 250mW-2W |
| Micro cell | 250m-1Km | 2-20W |
| Macro cell | >1Km | 20-`60W |

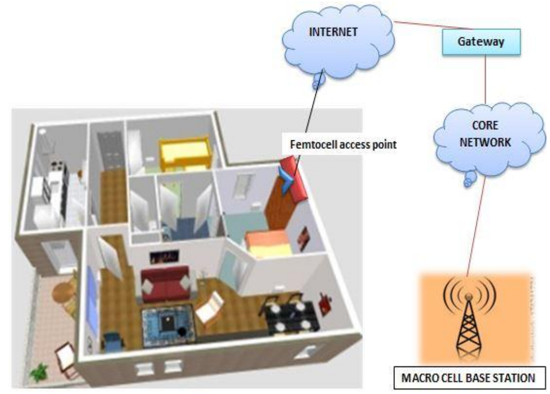


Figure 1: Indoor Solution Femto cell Access Point

## III. INTEGRATION OF SELECTED TECHNIQUES

### *A. Mega MIMO with Mm-Waves*

MIMO makes popularity in wireless communication but it fails to give facility that MIMO claims we can say that MIMO has not fulfil the requirements of wireless communication in real world. Mm wave with Mega MIMO provides 3D Beam forming that is beneficial for wireless communication in future generation we will use small cell for indoor communication with increase in frequencies i.e. Mm wave then more antenna needed to collect same energy of signal as before. Then it also helps. Array gain and multiplexing gain is provided by Mega MIMO as an option on cellular band. Mm waves enable the use of very small Antenna arrays, which are quite suitable for Mega MIMO deployments

### *B. MIMO in Cooperative Cognitive radio*

In cognitive radio network, Primary user enrols the secondary user to adopt primary traffic primary user share some part of channel access time to secondary user for cooperation in data exchange. It minimizes the performance of both. Common problem is interference, false alarm, low probability of detection in the cognitive radio network. MIMO that suppresses problems via pre-coding and improves performance of network [12], [13]. MIMO is an antenna technology that provides multipath propagation i.e. transmitted signal reaches at receiver end after travelling many paths. MIMO have three stages Pre-coding, Spatial Multiplexing, Diversity coding, Pre-coding is a Multistream beam forming. Cognitive system generally used for feat unused frequencies of primary Spectrum. Transmit beam forming & Pre-coding technique is effective for reduce interference of Primary network. Sensing projection based Pre-coding is most practical pre-coding scheme [14], [16]. It is not useful for reduce interference between primary transmitters to Cognitive receiver. So, two more improved and effective sensing projection based Pre-coding scheme 1st one is full projection and second is partial projection based Pre-coding via sensing these schemes reduce interference of primary Cognitive Radio. Removal of interference in Full projection via sensing and this technique improve flexibility & throughput. Partial Projection improve throughput of cognitive Radio transmission a subspace that partially span the estimated null space of the Cognitive Radio primary interference channel so Cognitive Radio throughput further increases [12], [15], [16].

### *C. Mega MIMO with Spatial Multiplexing and Modulation*

The reliability of a MIMO wireless system can be improved using various data transmission schemes like Spatial Multiplexing (SM). Using this spatial multiplexing scheme, the channel Capacity can be improved depending on the number of antennas employed at the transmitter and receiver. In Mega MIMO there are huge no of antennas and all antenna are active during communication in Spatial Multiplexing so there are many disadvantages of this technique like inter channel interference, inter antenna synchronization etc.

Implementation of Mega MIMO with Spatial Modulation is less complex as compared to spatial multiplexing and it is Cost efficient and Energy efficient. In Spatial modulation all antennas are not active during communication. By this property, it removes the drawbacks of Spatial Multiplexing e.g. inter channel interference, inter antenna synchronization. It also Supports Multiple RF chains to increase in multiplexing gain in Spatial Modulation with number of antenna increases but it does not improve the system capacity. To improve system capacity a new version of Spatial Modulation is introduced i.e. multiple active Spatial Modulation (MA-SM) also known as Generalized Spatial Modulation (GSM). It is a hybrid of Spatial Multiplexing and Spatial Modulation. A comparison by Halil Saygili (2013), between Spatial Multiplexing (BLAST), Spatial Modulation and Multiple Active Spatial Modulation (MA-SM). Multiple Active Spatial Modulation gives high system capacity between Spatial Multiplexing, Spatial Modulation and Multiple Active Spatial Modulation (MA-SM) [13], [19]. If number of antennas is less then Spatial Multiplexing and Spatial Modulation give identical result but if number of antennas increases then Spatial Multiplexing give better result. Hybrid Version of Spatial Modulation (MA-SM) with MIMO gives logarithmic increase in system capacity but when MA-SM use with Mega MIMO it gives exponentially increase system capacity but complexity is an issue with this concept [11].

## IV. CONCLUSION

As we discuss in the introduction section that 4th generation have LTE and Wi-Max technologies to improve coverage area, spectrum efficiency, system capacity, energy efficiency and high data rate. As we seen that system capacity, spectrum efficiency, energy efficiency, data rate, seamless coverage, cost factor issue present in all generation and current generation also, it improves generation by generation but further need more improvement in these. Then we conclude that all previous generation may fails to provide best solution for indoor and outdoor use like high system capacity, Seamless coverage, Data Rate, High Spectral Efficiency etc. So to achieve these facilities we design a conceptual integrated model for future generation of wireless communication based on antenna technology Mega MIMO to provide multipath propagation and allows many user at a time improve data rate by help of Mega MIMO it is easy to exploit MM wave, use of small cells like Femto cell to improve through put and system capacity as for both indoor and outdoor user with high mobility, Mm wave spectrum as an option to utilize and remove the problem of spectrum secrecy, Cognitive radio to improve spectral efficiency. And all the technology connected through internet and internet connectivity provided by core network operator by macro cell base station.

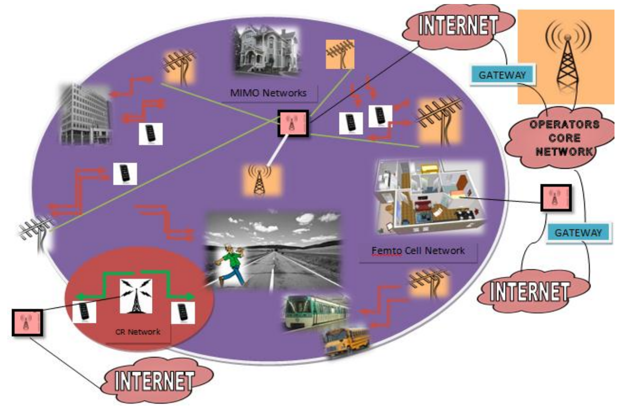


Figure 2: Proposed Architecture of Upcoming Generation Wireless Communication

## V. FUTURE WORK

As expected by Proposed architecture for upcoming Generation of wireless communication on the basis of previous technologies and methodologies to provide seamless coverage and improved spectrum efficiency both indoor and outdoor user of wireless communication system. We check the feasibility and implementation in future research because proposed architecture is hypothetical architecture.

In present communication system access satellite indirectly, some user of wireless communication access satellite directly because it is very costly so in future we will try to develop new concept for access satellite by each user in wireless communication for global coverage of network.

## ACKNOWLEDGMENT

We are thankful to the Faculty members of Computer Science and Engineering, Shri Ramswaroop University and colligues of HITM, Lucknow, India for their motivation and continuous support. Our special vote of thanks to Dr. Neeraj Kumar Tiwari for their valuable suggestions and contributions.

 

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