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5G Mobile Communication, Challenges: A Survey

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Abstract: The hest for technological advancement in mobile communication is due to augmentation of wireless user. The deployment of 5G mobile communication is less than 4G mobile communication due to challenges in security like cyberwarfare, espionage, critical infrastructure threats. Nevertheless, critic of neurological discomforts, tissue damage in living organisms occur in the existence of EMF radiation. Also, physical scarcity for spectral efficiency arises due to ubiquitous data traffic. Inspite of these disputes data rate, low latency, device to device communication is also a challenge. In this paper we provide a survey on radiation effects, security threats, traffic management.

Keywords: EMF exposure, Massive MIMO, mm wave, Beamforming, Resilience and security.

1. Introduction

The prodigious triumph of mobile communication system is mimic by an expeditious of technology innovation. The upcoming generation of mobile networks need to meet an expectation of multiple requirements. The current era is based on digitalized environment henceforth life depends on high speed connectivity. Increased number of user creates data traffic. As wireless medium nature is a broadcast requirement the vulnerability arises in the form of various malicious threats. Attacks are common in the wireless medium in spite of more authentications. Next threat is electromagnetic radiation. Exposure to increased radiation causes health effects [1,2], brain cell damage. Metabolic disturbance, Sleep disorders. Nevertheless, frequency bands in the existing generation was upto 3.6GHzThe upcoming generation needs increased frequency spectrum which is a challenging task. This is enabled by millimetre (mm wave) which is given as electromagnetic waves with complex frequency band range of 30-300GHz.There is requirement in multiband for the signal efficiency creating a complexity in transmission. Appending to this Multiple input and Multiple Output (MIMO) is a challenging task as it requires device capacity and

complex algorithm. Next comes beamforming techniques which is mainly required for the localization of user location precisely and transmit the signal to particular direction using sophisticated antenna array system. Desideratum of latency is essential for calculation in time interval between the simulation and response. Wherein network Latency for a network is determined by time taken for a packet of data from one point to destination terminal. This requirement should

be fulfilled within stipulated time for increased number of users. Less than 1ms is essential which is challenging task. Device to Device communication [3] is emerging technology for mobile connectivity enhancement. In this technology one device acts as a hub and other device acts as a base station.

2. Requirements gf 5G Systems

Mobile internet aims at user experience by people-oriented communication. Beyond 2020 Ultra-high definition [UHD] will be a drift. For successive launch of 5G system the major requirements are

Peak Data Rate:

It is given by received data rate assumed to be error free condition assigned to single mobile station.5G should have connectivity for data rate of 1Gbps to 10Gbps ubiquitous. The peak data rate for downlink are expected as 20Gbps and for uplink 10Gbps.[4]

Fig1. Data Transmission

The above figure states the data transmission from sender and receiver. The base station and the small cells should have the capacity to send higher data rate

Peak Spectral Efficiency:

Higher bandwidths support higher frequency wherein lower spectral efficiency results in minimum bandwidth.30bps/Hz is the spectral efficiency for downlink similarly 15bps/Hz for uplink.

Bandwidth:

These are supported by single or multiple RF carriers. The bandwidth should be greater than existing mobile generations.

Control plane Latency:

Refers to time usage from battery efficient state to start of continuous data transfer. The latency should be 10ms.[4]

User plane Latency:

Latency for Upper link is 4ms and DL is 4ms.

Mobility:

Radio node transfer with maximum speed. It is expected to be 500km/hr

Mobility Interruption time:

When user terminal cannot exchange plane packets during transition in any base station at this moment shortest duration support given by mobility interruption time. The fixed target should be zero.

Reliability:

It is evaluated by transmission of more packets within stipulated period of time. The target is given by 1-10-5 within 1ms.

Coverage:

164dB is fixed as target for coverage. Maximum coupling loss for a data rate of 160bps relied on uplink and downlink between base station and device.

The diagram represents the coverage of signal. Without any loss in the signal strength the data are expected to transmit efficiently by user.

User Equipment (UE) battery life:

Without recharging the equipment usage are determined by battery life. Also, life span of battery target is fixed up to 10 years.

Fig 2. Network Coverage

Multiple Radio Access Technologies:

Along with wireless fidelity,4G(LTE-A), the 5G networks are built on.5G characteristic should not affect the existing efficiency.

Energy and Cost Efficiency:

Compared to current technology, the energy efficient should be more with reasonable cost for equipment. Approximately value should be 100 times more than IMT advanced.

Spectrum Efficiency:

Data throughput in a cell should be more for spectrum resource.It is expected to be 3 times more than IMT advancement.

Area Traffic Efficiency:

It is calculated as the total traffic throughput in a specific geographic area. The traffic is expected as 10Mbit/m2.

3. Challenges In 5g Mobile Communication

A. Security and Privacy challenges:

However, many practices are made to secure the signal and data, threat becomes always an issue [5-10]. As a major, privacy threat is divided into Identity privacy and Data privacy. Identity privacy is a kind attack that has target attack on sender and receiver. Data privacy concentrates attack only on transmitted data.

- Privacy preservation for 5G based radio access network.
- Authentication for 5Gsmall cell based smart grids.
- Data set for intrusion detection Passive eavesdropper, whichdoesn't transmit any signal by itself.
- Active eavesdropper, it is a type of attack in which attacker jointly transmit signal for the user disruption. By these attacks, Jamming occurs. It can be mitigated through minimum mean square error (MMSE) and Zero forcing (ZF) method. Jamming attack occurs due to additive noise. It can also be reduced by pilot spoofing.

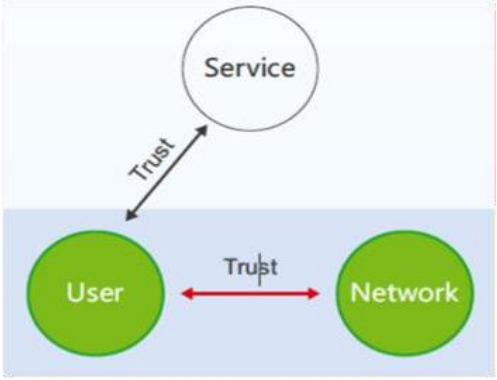

Fig 3. Basic Security threat model

From the above defined security threat model, it is identified that when there is security threat between user and network, at that instance users switch to other services. Security issue emerges when massive number of nodes transmits data simultaneously by the

sender and receiver. In mobile communication the diversity of nodes created a security challenge. The counter measures for security enhancement are given by.

- Cryptography method which ensures public key, Symmetric key.
- Human factors which ensures passwords, biometric and smart card. Intrusion detection method which ensures signature based, Anamaly based and hybrid based.

B. EMF Exposure

The Electromagnetic field radiations emitted from mobile phones and cell tower affect the brain of living organisms [11-17]. This creates neurological changes leads to morphological changes and disrupts brain and other internal organs. The electromagnetic spectrum is classified into ionizing radiation which wavelength below 10-7m and frequencies above 3x1015Hz.Non-ionizing radiation which have wavelength between 10-3m & 105m and frequencies 3x1011Hz to 3x103Hz.The major health issue due radiation are:

- Carcinology which cause brain tumors, glioma, breast, cancer, acoustic neuromas, leukemia, parotid gland tumors.
- Mutagen city causes genetic mutation.
- Tetragonality causes fetal deformity.
- Neurodegenerative diseases cause Alzheimer's disease, Amyotrophic lateral sclerosis.

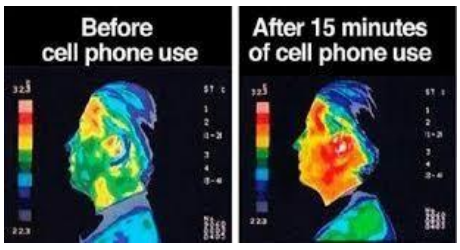

Fig 4. Effect of EMF radiation in human head

This diagram clearly projects the effects of radiation in human brain. This radiation penetration creates problems like neuro behavioral provides threat to autism, reproductive problems, excessive reactive oxygen species, inflammation, apoptosis, blood brain headache, irritability, fatigue, Blood brain barrier, sleep disturbance, depression, dizziness, burning and flushed skin, headache, Concentration difficulties, Adverse health issues on neural, circulatory, immune, endocrine and skeletal systems. At an average influence of 1GHz radiation penetrates human tissue to few centimeters.5G is expected to operate at least minimum wavelength of 6GHz.Hencefroth the critic of EMF radiation exposure to organism is the biggest challenge. There exist some techniques to reduce radiation like keeping the user equipment at a specific distance which is not followed regularly. By following two methods radiation can be minimized to some extent. Proper shielding can avoid absorption of radiation. By maintaining earth, the radiation can be neutralized. A study says walking in bare foot on earth for 15 minutes can neutralize radiation in human body.

C. mm Wave Propagation Challenge:

Millimeter wave propagation has the frequency bandwidth from 30-300GHz[18,19]. The figure shown below explains the bandwidth structure of millimeter wave form. This band structure is essential for upcoming transmission generation. This is required for upcoming mobile generation. The major challenges are given by

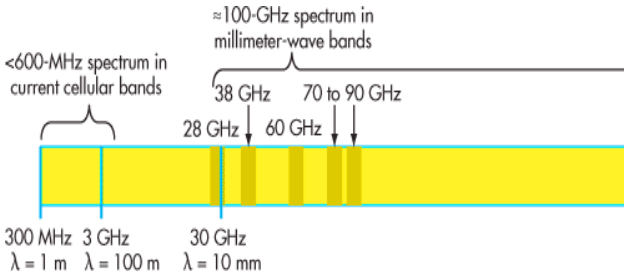

Fig 5. Millimeter band structure

Path LOSS:

This limits propagation of signal. There are three main types of path loss namely Free space path loss model, Rural Macro cell path loss model, Urban microcell path loss model.

Rain Attenuation:

During heavy rain mm-wave faces attenuation due to transmission as raindrops are close to size of mm wave. When there is heavy fall of 25mm/hr. the rain attenuation is measured as 28GHz, faces a challenge in signal attenuation.

Atmospheric ABSORPTION:

Atmosphere is covered with oxygen and water. The attenuation is related to atmospheric absorption for 0.012dB over 200m at 28GHz and 0.016dB, over 200m at 38GHz.wherein 70 to 100GHz and 125GHz have also minimum loss.

Table 1. Licensed frequency for mobile system

Frequency (GHz)	Band type	Application
28,38 and 73	Licensed	Mobile cellular system

The above table explains mobile cellular system licensed with the frequencies upto 73GHz

Human Blockage:

Fading of channels are caused by pedestrians in urban environment which have an impact on mm wave. This is mainly caused due to base station height variation. Around 20dB signal strength is reduced by human body.

D. Massive MIMO

Massive Multiple Input and Multiple Output is denoted by multiple antennas with transmitter and receiver [20],[21]. The diagram explains the variation between 4G and 5G. The future networks always require additional components for better transmission of data rates. This system came into existence as it has ability to enhance spectral efficiency and to improve security. It is also called as large-scale antenna system, hyper MIMO, full dimension [MIMO].

Fig 6. Massive MIMO comparison between 4G and 5G network.

It is essential for parameter measurement related to non-stationary properties. Nevertheless, it is difficult for estimation as it exhibits fluctuation in each scenario. The major challenge is to increase number of antennas which requires many radio frequencies.

E. Beamforming Challenges:

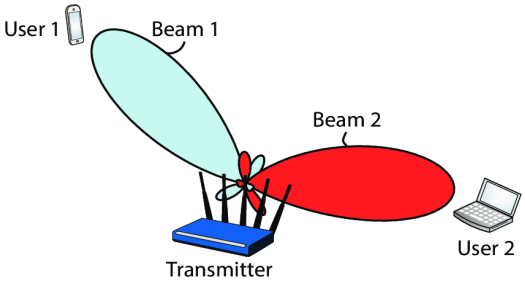

Fig 7. Beamforming technique

Beamforming technique is deployed for improving base station antenna gain to focus antenna output in a desired direction. [22, 23] The above diagram describes the changes made in 5G from 4G. Also, in cellular application it is used to reduce interference. Some unresolved

issues [24-26]in this stream are Pilot Contamination, Millimeter wave hybrid beamforming, Channel correlation of beamforming array antennas for millimeter waves, Scarcity of beams. The challenge in beamforming is silicon technology required for complex processing as 5G puts on ultra-low latency.

4. Conclusion

In this paper we made a survey on 5G mobile communication challenges. Security and privacy challenge can be conquered through security techniques-physical layer security, light weight encryption, network slice security, user privacy protection, Block chain technology. EMF radiation exposure creates adverse effect in health issues. Reduction of radiation is essential. But reduction in radiation may lead to loss of signal efficiency. Hence it is a challenging task to reduce the radiation without any critic on signal and data which are transmitted and received radiation can be mitigated by proper shielding and grounding process. MIMO, beamforming are challenging due to increased requirement in antenna which again increases the radiation. Fabrication techniques can be established to minimize the base station.

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