hardware vendors, scientific/academic community and

Development of 5G Mobile Network Technology: Its Benefits, Security and Limitations

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Abstract: ***Fifth Generation (5G) network technology is the forthcoming step of mobile communication that will provide rich ubiquitous communication infrastructure with wide range of high-quality services by 2020-2025 in several countries. In modern information society, people use real-time interactive e-government services, advanced e-health diagnostics surrounded by Internet of Things services or participates in mass cultural events through high-quality digital media. To cope with ever-increasing demand for higher data rate and increase in the number of users, wireless networks have recently witnessed a tremendous growth in the data traffic. It is envisioned that 5G communication will offer significantly greater data bandwidth and almost infinite capability of networking resulting in unfaltering user experiences for virtual/augmented reality, massive content streaming, user-centric computing, crowded area services, smart personal networks, Internet of Things (IoT), smart buildings and smart cities, etc. Advanced studies on 5G mobile technology are mostly related to the development of World Wide Wireless Web (WWWW) allowing the execution of a highly flexible network such as Dynamic Adhoc Wireless Network (DAWN). This 5G technology will make use of IPv6, Flat-IP and VOIP (Voice over IP) network technologies, which will provide improved data rates, increased spectrum efficiency and will support ubiquitous computing. Moreover, 5G aims at utilizing many promising network technologies and it will also support a huge number of connected devices integrating above mentioned advanced technologies. On the other hand, these innovating techniques will certainly bring tremendous challenges for security, privacy and trust. Therefore, secure network architectures, mechanisms and protocols are required to address the problem of security-by-design as well as also security-by-operations rules. Due to high radiation of electromagnetic fields in cumulative 5G networks, health problems may also arise. Bandwidth access and sharing could be other concerned issues, since the current bandwidth is not enough for the expected massive use of the mobile infrastructure. Thus, new technical insights/ideas presenting the challenges faced by 5G deployment as well as their potential solutions are expected from all the stakeholders including operators, administration. It is expected that 5G technology will help in creating a universally connected world with uninterrupted access to information, communication and entertainment.***

Keywords: LTE, 5G, Architecture, Mobile technology, WWWW, Security

1. INTRODUCTION

Telecommunication providers and technology companies around the world have been working together to develop new technology solutions to meet the growing demands for mobile data from consumers and industrial users. The development of wireless technology started in early 1970’s and the development of mobile wireless technology was projected from 1G to 5G technology in the next four decades. Fifth-generation (5G) mobile technologies represent the next iteration of mobile communication technologies that were designed to improve 3G and 4G mobile networks. 5G technologies were developed to accommodate the increasing demands for mobile data (i.e., more people using more data on more devices) [1]. 5G technologies are expected to serve current consumer demands and future applications (e.g., Internet of Things, autonomous vehicles). 5G Technology is highly intelligent technology, which adds up a large number of specifications to the 4G technology and makes it completely wireless without any limitation. 5G provides very high bandwidth with many other advanced features such as spectral efficiency, energy efficiency, etc., making it perfectly wireless for real world and so makes powerful and beneficial for the users. 5G networks are expected to provide faster speeds, greater capacity and the potential to support new features and services [2].

The fifth generation wireless mobile technologies offer tremendous data capabilities and unrestricted calls, and in addition an infinite data broadcast with latest mobile operating system. The idea of WWWW (World Wide Wireless Web) was started with 4G technology and is completed with the 5G mobile technology. This technology helps in creating a universally connected world with uninterrupted access to information, communication and entertainment. This will definitely change our lifestyles in a significant manner. 5G technology is envisioned to extend traditional services from enhanced mobile broadband to vertical markets such as connected cars, industry automation, smart metering and health care [3]. 5G technologies are expected to yield significant consumer benefits (e.g., assisting the disabled, enabling telemedicine), industrial benefits (e.g., automated processes, increased operational efficiencies, data analytics), and economic benefits (e.g., new revenues, new jobs). However, there are still many technical challenges that must be overcome in order to make this vision a reality. Although the exact pathways to 5G systems, devices and architectures is still under development [4], massive growth in applications and data consumption by mobile consumers will be a strong driver to push the industry towards 5G technology. The current technical achievements along with future challenges and possible developments in this exciting area are briefly discussed in this paper.

2. EVOLUTION OF MOBILE NETWORK TECHNOLOGY

The wireless communication was developed by an Italian inventor, G. Marconi by communicating a letter upto distance of 3 km (from starting point to its destination point) with the help of electromagnetic waves. After this initiation, wireless communication became a very important part of present styles of living. With the passing of time, a number of modifications were made as per the requirement, which led to different generations of wireless technologies. Today we have different wireless and mobile technologies, which are mass deployed such as 3G mobile networks (UMTS, cdma2000), LTE (Long Term Evolution), WiFi (IEEE 802.11 wireless networks), WiMAX (IEEE 802.16 wireless and mobile networks), as well as accompanying networks, such as sensor networks or personal area networks (e.g., Bluetooth, ZigBee). Mobile terminals include variety of interfaces, including the GSM ones, which are based on old-fashioned circuit switching.

The first mobile phones appeared in the 1980s. Since then, the use of mobile phones has increased exponentially. The number of smartphone users in the United States has grown from nearly 63 million in 2010 to an estimated 238 million in 2018. Worldwide, there are an estimated 4.5 billion mobile phone users, 2.5 billion of which are smartphone users. Now-a-days, large numbers of people are using extensive data on more mobile devices; as a result, demand for mobile data is rapidly increasing. Telecommunication companies continually invest in their networks to provide faster, more reliable service, expand the capacity of networks to meet growing demands for data and support new technology uses. Approximately within every 10 years, a new technology solution emerges from industry research that offers vastly improved speeds, supports new features and functions, and creates new markets and new revenue for service providers (SPs). These technologies offer such significant improvements to networks and devices that they change the way people use mobile communications, and thus represent the next generation of mobile technology [5].

In mobile communications, there have been five generations of technology (Fig. 1). 1st Generation mobile network was developed in 1980s and completed by early 1990s. First-generation (1G) technologies brought consumers the first mobile phone. It used analogue radio signals with frequency 150 MHz and voice call modulation was done with the help of Frequency Division Multiple Access (FDMA). Its speed was up to 2.4 kbps and it allowed users to make voice calls within a country. It offered limited coverage and capacity (Table 1). Subsequently, 2G (Second Generation) mobile technology was launched in 1991. It was based on digital system, which supported voice and texting. Its speed was up to 64 kbps. Main services provided were digital voices and SMS facility with more clarity, using the bandwidth of 30 KHz to 200 KHz. Networks were expanded and phones were made more affordable leading to increasing adoption. It gave semi global facility. Vital eminent technologies used were GSM and Code Division Multiple Access (CDMA).

3G (Third Generation) mobile network was developed between late 1990s and early 2000s. Its transmission speed was between 125 kbps to 2 Mbps. Data were sent through packet switching technology and circuit switching was used for interpretation of voice calls. It provided superior voice quality and also provided the facility of video conferencing, e-mailing, online banking-billing, global roaming, mobile TV etc. Smartphones were introduced and people began using mobile phones as computers for business and entertainment, greatly increasing demand for data. The 4G (Fourth Generation) technology was developed in 2010. 4G technologies offered increased speeds upto 100 Mbps and true mobile broadband that could support music and video streaming, mobile applications and online gaming [6]. It provided improved communication network based on IP. It provided high performance in low cost. Long Term Evolution (LTE) was considered as main technology for 4G. Multimedia Messaging Service (MMS), digital video broadcasting, High Definition (HD) TV and video chat are the services provided by 4G in addition to features of 3G [7]. The 4G integrates three standards (WCDMA, CDMA and TD-SCDMA) of 3G into MC-CDMA [8]. Providers offered unlimited data plans and mobile devices that could be used as hotspots to connect other devices to the network, further increasing demand for mobile data.

Recently, 5G (Fifth Generation) is next coming phase of wireless networks. It provides 10 times more capacity than other existing systems. It expected speed will be up to 1 Gbps. It is completely wireless communication with almost no limits supporting Wireless World Wide Web (WWWW). It is more reliable and faster with lower cost. It will provide high capacity, large phone memory, faster data transmission and will support interactive multimedia, etc. Fifth-generation (5G) networks utilize 5G standards, which will use new promising network technologies, such as Software Defined Networking (SDN), Massive multiple-input Multiple output (MIMO), Network Functions Virtualization (NFV), Information Centric Network (ICN), Network Slicing, Cloud-based Networks etc. 5G deployment methods will provide faster speeds, greater capacity and enhanced services. Moreover, 5G will also support a huge number of connected devices integrating above mentioned advanced technologies [9]. Thus, 5G networks are expected to meet the increasing demand for data from consumers and to support new services. 5G was also designed to meet growing demands for data from industrial users and to support the growing use of mobile communication technologies across multiple industries (e.g., crop management systems, public safety applications, new medical technologies).

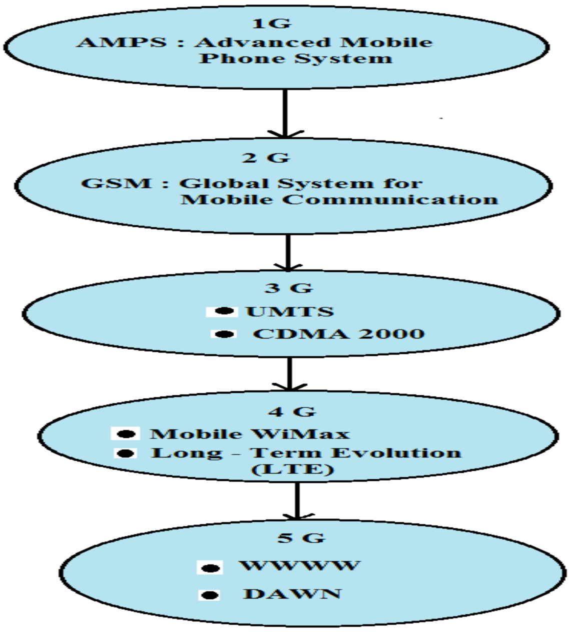

Fig. 1. Evolution phases of mobile network technology and advancement in telecommunications

Each generation was built to achieve certain levels of performance (e.g., certain levels of speed, higher capacity, added features). In earlier generations, companies and countries adopted different technical standards to achieve performance requirements. In 3G and 4G technologies, companies and countries began building networks to the same standards. This enabled equipment to be used in many countries, enabled manufacturers to achieve economies of scale and enabled carriers to speed deployment. For example, for 4G, companies and countries adopted Long-Term Evolution (LTE) standards, which redefined the network architecture to offer greater speeds and capacity.

Besides all the other benefits of 4G technology, the most important concept of 5G technology is consumer-oriented instead of service centric and operator oriented. In this technology, priority is given to consumers as compared to other existing mobile technologies. Some features such as cheaper traffic fees, user oriented, security, high speed, artificial intelligence (AI), storage, etc, became the reason for the development of 5G technologies. 5G technology will provide very high bandwidth. Other advanced features which led to the development of 5G technology and migration from 4G technology includes Multi Mode User Terminal, choice of selection of the best network among the various available wireless communication systems, charging and billing, data encryption, attack on application level and device to device communication.

Table 1. Development of different generations of mobile communication technologies

Features	1G	2G	3G	4G	5G
Deployed	1980s	1990s	2000s	2010 -	2018 -
Devices Functions	• First mobile phone • Basic voice services • Limited coverage • Expensive	• Voice and some text • Digital standards offered higher quality voice • More coverage • More affordable	• Voice, data and access to the internet (email, audio and video) • First mobile broadband • iPhone was introduced • People begin using their phones as computers	• Voice, data, high-speed access to the internet on smartphones, tablets, laptops • True mobile broadband; unlimited plans; devices used as hotspots • Streaming, new applications, online gaming	• Voice, data, high-speed access to the internet on smartphones, tablets, laptops • True mobile broadband; unlimited plans; devices used as hotspots • Streaming, new applications, online gaming
Speed	2.4 kbps (0.002 Mbps)	64 kbps (0.064 Mbps)	2 - 10 Mbps	10 - 100 Mbps	1000 - 1400 Mbps
Download time (2 hrs movie)	N/A	N/A	10 - 26 hours	6 minutes	3 - 4 seconds

Some defects and unavailability of some properties or functionalities in the existing system becomes the need for the development of the next generation. The functionalities lacking in 4G technologies were basically about the integration of different technologies and networks. 4G technologies combined various existing and future wireless technologies to ensure freedom of movement from one technology to another. 4G can supports 100 Mbps data rate in full-mobility wide area coverage and 1Gbps data rate in low mobility local area coverage. 4G integrates all access technologies, services and applications unlimitedly to run through wireless over wire line using IP address. But 5G technology will bring us perfect real world wireless or WWWW (World Wide Wireless Web). Talking about the working of 4G, although LTE provide benefits certain people with wide range of effective wireless communication technology. LTE is basically for use in commercial areas, so cannot be used for creating an environment to be used by common people for downloading purpose, video call, etc. So, this became the main reason behind the development of 5G technology.

Table 2. Advanced features of 5G mobile technology over 4G technology

S. No.	Specifications	4G (IV Generation)	5G (V Generation)
1	Bandwidth	Up to 100 Mbps	Greater than 1 Gbps
2	Frequency band	2 GHz to 8 GHz	3 GHz to 300 GHz
3	Technologies	Unified IP, seamless integration of broadband LAN/WAN/PAN and WLAN	4G, advanced technologies based on OFDM modulation and IPV6
4	Services	Global roaming, Dynamic Information Access, HD streaming, Wearable Devices	Wearable Devices, Dynamic information access, HD streaming, Devices with AI capabilities
5	Standards	IP based on LAN/WAN/PAN	IP based on LAN/WAN/PAN and WWWW
6	Multiple Access	CDMA	CDMA, BDMA, FBMC
7	Core Network	All IP Networks	5G Network Interfacing, Flatter IP Network
8	Antenna Type	Sub Wavelength Antenna	Array Antenna
9	Radiation Pattern Switching	Omni-directional Packet Switching	Fan-beam Directional Packet Switching
10	Diversity and MIMO	Present	Present
11	Deployment Year	2000-2010	By 2020

3. NETWORK ARCHITECTURE OF 5G MOBILE TECHNOLOGY

The model of 5G technology is entirely IP based model for both mobile and wireless communication [10], The various components involved in the architecture (Fig. 2) make it very fast, secure and famous among the customers in all over the world. The various components included in the architecture are as follows:

- **GPRS:** General Packet Radio System (GPRS) is basically a step developed for internet access during third generation. It is the first step towards the end to end wireless communication. It provides data rates from 56 Kbps to 114 Kbps. It also promises to provide continuous connection of internet to mobile and computer users. It consumes comparatively less battery during internet access.
- **EDGE:** Enhanced Data GSM Environment (EDGE) provides an evolutionary path from 3G technology to GSM and TDMA. It provides maximum data transmission rate up to 473 Kbps. It is developed to increase the bandwidth of GPRS technology.
- **3G:** Third Generation (3G) technologies were developed to access wireless communication. It provides high quality, cost effective, wireless multimedia application, greater security features, video calls/conferences and enhanced wireless application as compared to previously available services.
- **WLAN:** Wireless Local Area Network (WLAN) provides the facility of wireless connection and communication among the devices. It uses high frequency radio waves, micro waves, etc. for its functionality. Use of WLAN increases mobility, productivity, scalability as it provides high speed wireless connection.
- **LTE** (LTE stands for Long Term Evolution): LTE works by using all IP network architecture. It supports data as well as voice communication. LTE supports MIMO (Multiple Input Multiple Output), because of which higher data rate is achieved. As a result LTE is a standard for high speed data transmission for mobile networks, providing a high speed up to 100 mbps. As it uses improved architecture, handoff from one region to other is smooth. This results in smooth data flow without any interruption.

The Long Term Evolution (LTE) is designed by incorporating high security measures, by using strong cryptography and mutual authentication mechanisms between all network elements in LTE core [11]. However, in a virtualization deployment, attackers can target mobile user equipment (UE) and LTE core with malware and spam, through eavesdropping, internet protocol (IP)-spoofing, denial-of-service (DoS) attacks and numerous other cyberattacks [12]. Service providers (SPs) are aiming to use 5G deployment for expected increase business profitability but still have to fix number of security issues [13]. Hence, to protect profit of SPs from being spent on the process of recovery and remediation due to frequent security breaches, SPs should curtail all sorts of security risks in both LTEs and IP, and this is achievable through active investment in preventive security measures.

Tudzarov and Janevski [4] showed the system model that proposed design of network architecture for 5G mobile systems, which is all-IP based model for wireless and mobile networks inter-operability. The system consists of a user terminal (which has a crucial role in the new architecture) and a number of independent, autonomous radio access technologies. Within each of the terminals, each of the radio access technologies is seen as the IP link to the outside Internet world. However, there should be different radio interface for each Radio Access Technology (RAT) in the mobile terminal. For example, if we want to have access to four different RATs, we need to have four different access-specific interfaces in the mobile terminal and to have all of them active at the same time, with aim to have this architecture to be functional.

The first two OSI levels (data-link level and physical level) defined the radio access technologies through which access is provided to the Internet with more or less QoS support mechanisms, which is further dependent upon the access technology (e.g., 3G and WiMAX have explicit QoS support, while WLAN has not). Then, over the OSI-1 and OSI-2 layers is the network layer and this layer is IP (Internet Protocol) in today's communication world, either IPv4 or IPv6, regardless of the radio access technology [14]. The purpose of IP is to ensure enough control data (in IP header) for proper routing of IP packets belonging to a certain application connections - sessions between client applications and servers somewhere on the Internet. Routing of packets should be carried out in accordance with established policies of the user. Application connections are realized between clients and servers in the Internet via sockets. Internet sockets are endpoints for data communication flows. Each socket of the web is a unified and unique combination of local IP address and appropriate local transport communications port, target IP address and target appropriate communication port, and type of transport protocol.

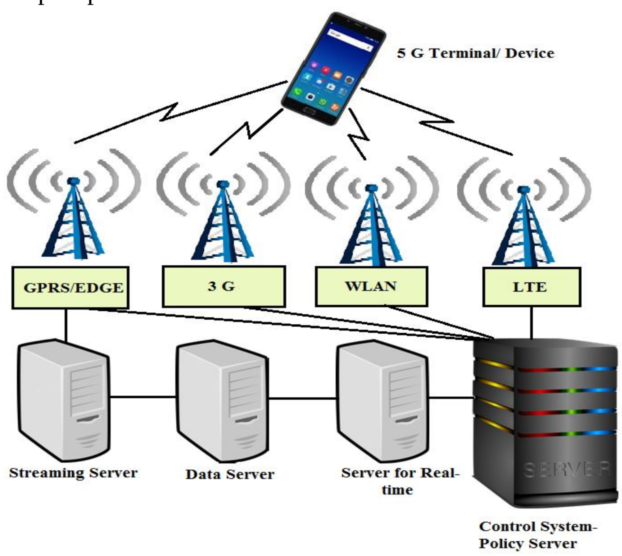

Fig. 2. Functional architectural view of 5G mobile networks

Internet socket is uniquely determined by the application of the client and the server. This means that in case of inter-operability between heterogeneous networks and for the vertical handover between the respective radio technologies, the local IP address and destination IP address should be fixed and unchanged. Fixing of these two parameters should ensure handover transparency to the Internet connection end-to-end, when there is a mobile user at least on one end of such connection. In order to preserve the proper layout of the packets and to reduce or prevent packets losses, routing to the target destination and vice versa should be unique and by using the same path. Each IP interface in the terminal is characterized by its IP address and netmask and parameters associated with the routing of IP packets across the network. In regular inter-system handover the change of access technology (i.e., vertical handover) would mean changing the local IP address. This approach is based on today's Internet communication [15].

To enable the functions of the applied transparency and control or direct routing of packets through the most appropriate radio access technology, a control system in the functional architecture of the networks was introduced in the proposed architecture, which works in complete coordination with the user terminal and provides a network abstraction functions and routing of packets based on defined policies. In fact, the tunnels would be established between the user terminal and control system named here as Policy Router, which performs routing based on given policies. In this way, the client side will create an appropriate number of tunnels connected to the number of radio access technologies and the client will only set a local IP address, which will be formed with sockets opened for Internet communication between the mobile client applications and the Internet-based servers. The way IP packets are routed through tunnels or choosing the right tunnel, would be served by policies whose rules will be exchanged via the virtual network layer protocol. The process of establishing a tunnel to the Policy Router, for routing based on the policies, are carried out immediately after the establishment of IP connectivity across the radio access technology, and it is initiated from the mobile terminal Virtual Network-level Protocol. Establishing tunnel connections as well as maintaining them represents basic functionality of the virtual network level.

4. NETWORK LAYERS OF 5G MOBILE TECHNOLOGY

The main focus of 5G technology is user mobility as the mobile terminals have access to different wireless technologies simultaneously [16]. It can combine some features of other networks also and so finally selects the strongest wireless network (Table 3). The concept behind the working of the 5G technology is explained as follows:

- **Physical/Data link layer:** The first two layers of the OSI model for the 5G technology are based on Open Wireless Architecture.
- **Network layer:** The Network Layer is an Internet Protocol (IP). IPV4 (Internet Protocol Version 4) is spread worldwide with some limitations like limited address space, which are resolved in IPV6 (version 6) but were traded with bigger packet header. Then Mobile IP came into existence and 5G technology will use mobile IP. As a result mobile can be attached to several wireless networks simultaneously. 5G mobile network shall maintain virtual multi wireless networks. For this purpose, there lies a separation in network layer to form two sub layers for 5G mobile phones viz. Lower Network Layer and Upper Network Layer.
- **Open Transport Protocol (OTP) layer:** TCP modifications are proposed for both wireless and mobile networks. The TCP retransmit the lost or damaged TCP segments over wireless links. In 5G, it plays a very important role as it encounters with high installed speed and higher download**.** These mobiles can reasonably download updated version which is targeted to specific wireless technologies from the base station.

Application Layer: An intelligent behaviour facility of selecting best wireless connection out of different networks is provided in 5G. Terminals have access to quality testing and information storage in this layer. A large number of algorithms are used for giving the intelligent behavior to the 5G technology.

Table 3. Network layers of OSI and 5G technology

OSI Network model	Model of 5G Technology
Application Layer	Application (Services)
Presentation Layer	
Session Layer	Open Transport Protocol (OTP)
Transport Layer	
Network Layer	Upper Network Layer
	Lower Network Layer
Data link Layer (MAC)	Open Wireless Architecture
Physical Layer	

The Service Middleware provides the content-seamless and terminal-seamless service. Location Management keeps track of the whereabouts of any mobile device and its movement characteristics. Thus, media conversion can take place when necessary according to the user's current situation and preferences. For example, the video resolution may be automatically reduced when user changes from a large-screen terminal (stationary location) to a smaller screen (on the move). Another example is the conversion from real-time video to audio when the user has to drive a vehicle.

5. ADVANCED FEATURES OF 5G MOBILE TECHNOLOGY AND ITS UTILITY

Fifth generation wireless technology is providing a large number of utility for consumers at highest priority (Fig. 3). The fifth generation wireless technology provides a number of features which makes it perfect wireless for real world [17]. Some of these features include higher bandwidth. It provides high quality services based on policy to avoid error and an advanced billing interface which is more effective and attractive. It provides high resolution and bi-directional large bandwidth shaping.

5G technology provides a unified global standard, which facilitates service portability and global mobility. In addition, this technology works on lower power consumption. It provides better network coverage. 5G technology provides huge broadcasting data with very high connectivity speed of 25 Mbps, which was never before. This technology is expected to provide downloading speed up to 1 Gbps in LAN. The traffic statistics of 5G technology makes it more accurate. Through remote management offered by 5G technology, a user can get a better and faster solution. 5G technology also provides tools of subscriber supervision for fast action. The advanced features of 5G technology will provide enhanced facilities and the life will become more easier with better utility of 5G technology.

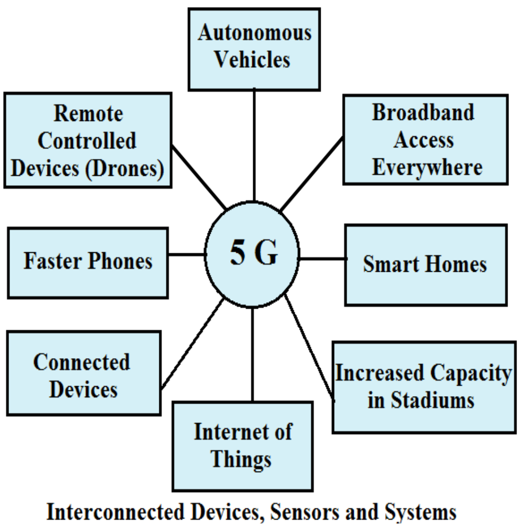

Fig. 3. Utility for consumers of 5G technology

6. SECURITY ISSUES AND PREVENTIVE MEASURES

The security management complexity is considered as key challenge as it is facing the steady rising attackers' interests [18]. Following are some of the most common security issues and their preventative measures in LTE architecture that consists of network segments: UE, evolved node B (eNB) access and evolved packet core (EPC) [19].

6.1. User Equipments (UEs)

UEs are the end communications users that can be exposed to various security issues such as:

- Physical attacks: UEs are small, portable and prone physical theft device itself. These devices can be tampered making possible to access and attack the operator's networks.
- Risk due to the loss of data: New UE are capable of downloading and storing more data than before, thus making them highly vulnerable to the attacks from infiltrators that are related to the data loss on the devices.
- Application layer vulnerabilities: The present network architecture is all IP-based, as a result of which all UEs and LTE network elements work with IP packets. This opens up to new issues related to the vulnerabilities in IP-based systems that traditionally related to Internet such as malware, viruses, spam.

Following preventative measures could improve the security: (i) Subscriber education: It is important to educate the subscribers about the potential damages that could be caused by unsecured resources. It is advised to keep the resources in personal reach and location feature can be turned off for improved privacy. (ii) Anti-virus applications: Attackers are always looking for new ways to attack by making new viruses, malware, spyware or focusing on some vulnerability. It is essential the UEs should install and update anti-virus applications regularly [20]. (iii) Strong Authentication: Strong authentication mechanisms must be in place before accessing the contents of the UE from outside users. This will prevent attackers from having immediate access to the data on the UEs.

6.2. Evolved node B (eNB) access

In the LTE network architecture, the eNB is the communication node between the UE and EPC network. It is also the intersection point wherein SPs are sharing their available RBs. eNB can be exposed to various security issues such as:

- Physical attacks: with the emergence of smaller eNBs, which are located in public domains, they are now more vulnerable to physical tampering through which the SP network can be accessed and compromised.
- Rogue eNBs: Rogue eNBs can be installed by the attackers to emulate the operator's node and through them the attackers can intercept the traffic emanating from the UE. The attackers can therefore listen to the traffic and redirect the traffic to the malicious parties [21].
- Privacy: Attackers can identify the location of the UE through spurious paging instructions and comparing the temporary mobile subscriber identity with the permanent international mobile subscriber identity (IMSI). In addition, the attackers can also respond to the intercepted authentication process, thus enabling them to determine the exact location of the physical device.

Following preventative measures will minimize the security risks: (i) Physical security: SPs have to devise mechanisms for physical safety and security of the eNBs placed in public locations, which can be accessed and tampered to expose the SP's network. (ii) Authentication, authorization and encryption: 3GPP specifies access security, which includes authentication, authorization, and traffic safeguard between the UE and EPC networks. Strong level of encryption between the eNB access and UE will identify both rogue eNBs and man in the middle attack. (iii) Security architecture: SPs have to ensure that the service quality is not affected with the inclusion of the security architecture that consumes BW resources for the process of authentication and encryption.

6.3. Evolved Packet Core (EPC)

The EPC is the core of the LTE wireless network that will manage security related processes such as authentication, accounting and authorization. In addition, it will perform network management functions such as IP address allocation, mobility management, QoS and control signaling. EPC is vulnerable to the following security issues:

- Unauthorized access: Unless it is specifically designed by the SP and security protocols are enabled (i.e., IP security (IPSec) traffic between the evolved universal terrestrial radio access network (EUTRAN) and EPC is not secured that can allow attacker to gain access to unprotected traffic for performing malicious activities [22].
- Over-billing attacks (IP address hijacking or spoofing): An attacker can take control of the IP address of a legal UE while it is being returned to the IP pool and can explore the UE's data. Alternately, an over-billing attack can exist when an IP address is maliciously reassigned to another UE [23].

Following preventative measures could improve the security of EPC: (i) Security architecture: IPSec was recommended by the 3GPP to address IP based vulnerabilities. Moreover, the Next Generation Mobile Network Alliance recommends that the service providers implement VPNs in order to secure transmission in their EPC of LTE networks. This helps by isolating the signaling to the paths defined by the VLAN. As a result, unauthorized access, eavesdropping, and spoofing attacks are limited [21]. (ii) Encryption IKE/IPSec: For prevention of IP based attacks and over-billing attacks, SP can include IKE/IPSec mechanisms in their accounting, authorization and authentication processes and also in the process of securing the integrity and confidentiality [22]. (iii) Load balancing: SPs must adopt load balancing measures to protect their networks, particularly the EPC from the signal surges. The load balancing mechanism will also help in implementing traffic volume policies, shaping and traffic prioritization. This could lead to reduced DoS attacks. Moreover, a hop-by-hop analysis within the EPC elements will ensure higher levels of security [24].

6.4. Denial of Service (DOS)

DoS attack is the attempt to make the networks' resources unavailable to its intended UEs. It refers to the continuous efforts of attackers to prevent a proper allocation service from functioning efficiently, temporarily, or permanently. Considering SPs employing virtualization, attackers would be able to widely attack UEs, since SPs' RBs would be clearly shared within the same eNB. The most common method of attack is saturating the eNB with communications requests, which makes it unable to allocate RBs, or make it respond slowly to its intended UEs so that they will no longer be able to communicate adequately. DoS attacks can silently downgrade LTE UEs by limiting their access to LTE service or limiting them from all networks' services.

7. LIMITATIONS

Although the advanced features of 5G technology will provide enhanced facilities, but these innovating techniques will certainly bring tremendous challenges for security, privacy and trust [25]. To address the problem of security-by-design as well as also security-by-operations, secure network architectures, mechanisms and protocols are required [26]. In addition, due to the conflict of interests between operators and citizens, economic issues may appear. Moreover, health problems may arise by high radiation of electromagnetic fields in cumulative 5G networks. Other issues are concerned with bandwidth access and sharing. Since, the current bandwidth is not enough for the expected massive use of the mobile infrastructure. Moreover, implementation barriers may appear where end-to-end communications with multiple radio and wired standards are concerned [27]. Thus, new technical insights presenting the challenges faced by 5G deployment as well as their potential solutions are expected from all the stakeholders including operators, hardware vendors, scientific/academic community and administration.

8. CONCLUSION

The design of the 5G technology is an open platform on different layers, from physical to application layer. The present work of 5G technology is focused upon providing specified services with WWWW functionalities in lowest cost, keeping the users in the top of the priority. The development of the mobile and wireless networks is going towards higher data rates and all-IP principle. On the other side, mobile terminals are obtaining each year more processing power, more memory on board, and longer battery life for the same applications (services). It is expected that the initial Internet philosophy of keeping the network simple as possible and giving more functionalities to the end nodes, will become reality in the future generation of mobile networks. Moreover, 5G technology will provide uninterrupted access to information, communication and entertainment in creating a universally connected world.

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