

A Review: Evolution of 5G, Security and Multiple Access schemes in Mobile Communication

Uzairue Stanley¹, Nwukor Frances², Alashiri Olaitan³, Amiaze Peter⁴

^{1,3,4}Electrical and Information Engineering, Covenant University, Nigeria

²Electrical and Electronics Engineering, Petroleum Training Institute Warri, Delta State, Nigeria

Abstract - 5G wireless communication is a next generation technology that is set to beat 4G LTE and provide maximum internet speed (Gbps) and high base station capacity. The need for 5G is due to the multiplying increase of smart phones and instantaneous data, introduction of fresh evolving multimedia applications. Security has also been and will be a vital issue in mobile communication systems, especially in key production processes and mobile users' authentication.

In this paper, I intend to make a review of the evolution of wireless communication towards 5G networks alongside key production solutions and authentications and also discuss the different types of multiple access schemes and comparisons used in mobile communication.

Key Words: 5G, LTE, Signal Strength, OFDMA, WCDMA, MIMO

1. INTRODUCTION

Over the last years, the world has witnessed a lot of development in the aspect of wireless communication technology towards second, third and fourth generation networks. Security and multiple access schemes have also been developed over these years so as to reduce interference and to ensure fidelity of information when transmitting signals over these networks. Speedy development in physical layer technologies like OFDMA, WCDMA, MIMO etc. have significantly contributed in the direction of this gradual development [2].

There has been a rise in the demand for radio systems with high data rates in recent years. Also, the introduction of smart phones and an increase of mobile broadband for personal computers have had a major impact on our desire for continuous access to the internet. It was obvious that 3G was not sufficient even at its peak speed. The 3rd Generation Partnership Program (3GPP) primes the description of the next radio access technology that should take the telecommunication industry into the 2020s, this is known as LTE (Long Term Evolution) [2]. LTE is required to be more flexible in the way it utilizes the bandwidth and is expected to give high latencies and data rates at the cell edges. So therefore, the transmission techniques of uplink (Mobile station to base station) and downlink (base station to mobile station) need to be equipped with new solutions better than 3G networks to support the requirements stated above [2].

The high data rate of LTE is the reason why it demands a higher bandwidth and a more advanced modulation technique, which is why OFDM was considered. Although, it is quite good but it has some major limitations like PARR which can upsurge the complication and the transmitter power P_t in uplink. A resolution to this issue was to use SC-FDMA which is quite similar to OFDM but contains an additional DFT precoding. SC-FDMA means Single Carrier Frequency Division Multiple Access, It is a potential scheme for uplink communication that uses high data rates. It is an altered form of OFDM with some similarity in the complexity.

The LTE network offers quite a number of advantages when compared to past network architectures e.g. minimization of protocol processing and a proliferation in the security of communications. Security has become a major issue in communication systems especially LTE systems so as to prevent malicious attacks & threats without altering its reliability, integrity, speed etc. For this reason, the 3GPP has defined a technical specification of SAE security architecture by stating 5 security feature groups [1].

2. EVOLUTION OF 5G NETWORKS

2.1. Challenges faced by existing mobile networks:

A recent wireless network statistics shows that "global mobile growth experienced about 70% growth in 2014, only 26% smartphones (of the total global mobile devices) are responsible for 88% of total mobile data traffic" [2]. The use of smartphones is growing at an exponential rate in mobile video traffic and it was also said that an average mobile subscriber is expected to download about 1TB (terabyte) worth of data by 2020. Sustaining this massive and rapid increase in the use of data and network connectivity would be difficult on the present 4G LTE systems. For example; while standard LTE networks were intended to support up to 600RCC-connected subscribers per cell, IoT needs about tens of thousands of connected devices in one cell. The main reason of 5G wireless network is exploring unused, high frequency mm-wave band which ranges from 3 ~ 300GHz, but most of these present wireless communications make use of a spectrum of about 300MHz to 3GHz [2].

2.2. The Vision and motivation of 5G:

Wireless Communication foresees magnitudes of growth in wireless data rates, coverage and connectivity as well as a

huge drop in the consumption of energy, Below are some of the requirements for the next generation 5G systems:

- 1 ~ 10Gps data rates in real networks
- 1ms round trip latency
- Large number of end users
- High bandwidth in every area
- A perceived availability of almost 100%
- A huge drop in the consumption of energy
- A 99.99% coverage connectivity at any time everywhere

With the above mentioned requirements, wireless academia and research institutions & organizations have started joining hands in different parts of 5G wireless network.

2.3 The Evolution of Radio Network: 5G cellular technology is required to work with a large number of subscribers /users and diverse services so therefore there is a need to integrate 5G base stations with the present cellular networks (2G, 3G & 4G). The concept of narrow beams permits adequate band overlap and also increases the quality of the link between the subscribers and the base station. So, therefore, radio networking in next generation 5G communications is projected to be different from the present-day networks

CONCEPT OF 5G TECHNOLOGIES

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 (OWA)
Physical Layer	

Challenges faced in migration from 4G networks include:

- Multi-mode user terminals
- Security
- Choice among various wireless systems
- Quality of Service support and Network Infrastructure etc. [3]

Some of the features of the next generation 5G network are:

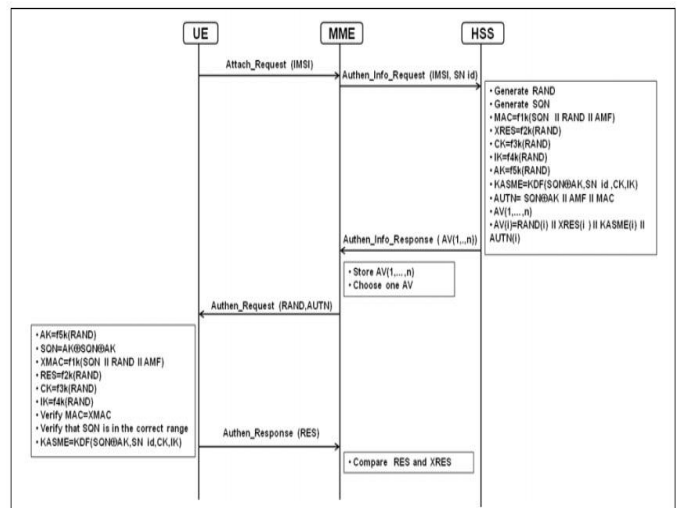
- It will support Virtual Private Network (VPN)
- It will offer Bi-directional large spectrum modeling
- It will offer better remote management to help users with faster solutions to their problems

- It will provide up to 25Mbps connectivity speed and a huge broadcasting of data in Gigabit while supporting almost 65,000 connections [3]

3. SECURITY IN MOBILE COMMUNICATION

The emergence of new threats and attacks has made us to seek for new solutions or altering the existing ones so as to make them better because the importance of protection of authentication of data and information cannot be overemphasized. Two solutions have been proposed which are: EPS-AKA protocol and J-PAKE mechanism [1]

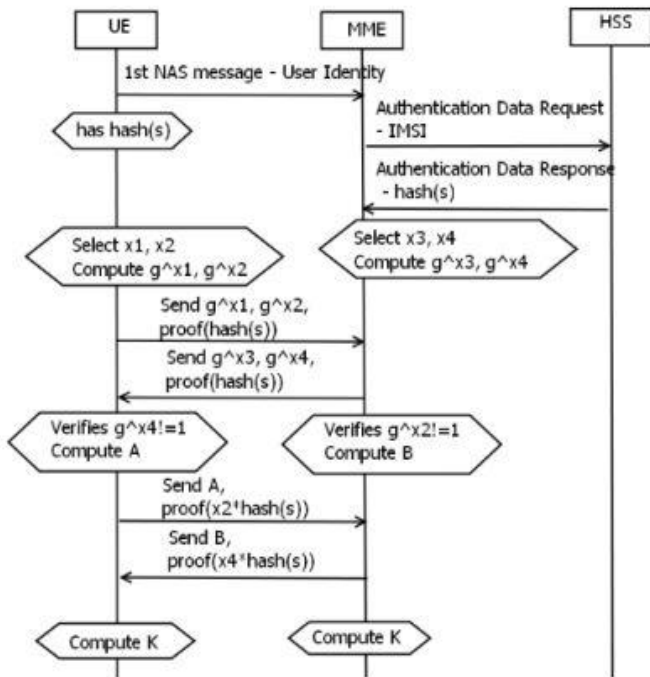
3.1. EPS-AKA: The security architecture has been defined by the 3GPP group alongside authentication and the procedure for key arrangement, this is quite similar to a procedure used in 3rd generation network but this one has been altered a bit. The procedure is illustrated with the diagram below [1]



3.2. J-PAKE Protocol: It could also be referred to as “password Authenticated Key Exchange” is among the balanced PAKE protocols which employ a symmetric key to provide a secluded and valid communication between two users. Cristna-Elena Vintilă et al was the one who proposed using J-PAKE on the LTE networks. J-PAKE protocols fulfill the following security properties:

- Off-line dictionary attacks resistance
- On-line dictionary attacks resistance
- Forward secrecy
- Known-key Security [1]

The procedure for J-PAKE protocol is explained with the diagram below



Source: [1]

[4] A Survey of Uplink Multiple Access Techniques in LTE Mobile Communication System by Kussum Bhagat and Dr. Jyoteesh Malhotra

4. MULTIPLEXING SCHEMES IN MOBILE COMMUNICATION

SC-FDMA is the latest multiple access scheme to be employed in LTE uplink transmission scheme. Compared with the common OFDMA, which is employed in the LTE downlink transmission and WiMAX. Due to its articulate ‘single-carrier’ property and in-built frequency diversity, SC-FDMA is preferred over OFDMA [4]

5. CONCLUSION

Speedy infiltration of wireless network usage has grown at an exponential rate, which brings about the need for 5G technology. The 5th Generation technology is designed as an open platform on diverse layers, from the application down to the physical layer. A new revolution of 5G is about to commence because 5G is going to give tough accomplishment to electronic devices that make use of its technology. The incoming 5th Generation technology will release a new age in mobile communication.

6. REFERENCES

- [1] Security analysis of LTE/SAE networks over E-UTRAN by Mourad Abdeljebbar and Rachid ELKOUCH
- [2] Next Generation 5G Wireless Network: A comprehensive Survey by Mamta Agiwal, Abhishek Roy and Navrati Saxena.
- [3] 5G Technology of Mobile Communication: A survey by Asvin Gohil, Hardik Modi and Shobhit K Patel